SESAR Solution PJ04-W2-29.3: Validation Report (VALR) for V2

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PJ.04-W2 TAM

TOTAL AIRPORT MANAGEMENT

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Abstract

This Validation Report describes the V2 validation activities and results for solution PJ04-W2-29.3 – 'Environmental Performance Management', and covers the following exercise:

- PJ.04-W2-EXE2931 – A passive Shadow mode trial at Paris Orly (ORY) airport validating the integration of environmental performance into the overall airport operations management process.

Solution PJ.04–W2–29.3 'Environmental Performance Management' aims to integrate environmental considerations into the overall airport operations management process, thereby bringing the question of environmental performance into the decision-making process. The solution develops a range of tools designed to provide real-time information environmental performance information through the use of dedicated dashboards. This toolset and information displays provided the main focus of the validation exercise where the emphasis was placed on the information pertinence and utility from a Human Performance perspective.

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1. Executive summary

This Validation Report (VALR) describes the V2 validation activities and results for Solution PJ04-W2-29.3 – 'Environmental Performance Management'. The document has been authored and reviewed by the PJ04-W2-29.3 partners, namely EUROCONTROL and ADP(SEAC2020).

The validation exercise described in this report was performed in passive shadow mode and executed in the airport of Paris Orly (IATA Code ORY) between the dates of 31/05/22 and 02/06/22.

Solution PJ.04–W2–29.3 builds on work performed in SESAR1, specifically in relation to SESAR Solution PJ.04-02 "Enhanced Collaborative Airport Performance Management" developed from the SESAR Solution 21 (Airport Operations Plan and AOP-NOP Seamless Integration).

Based on these previous solutions, solution PJ.04–W2–29.3 seeks to introduce an element of environmental impact assessment in the overall airport operations performance management, thereby influencing operational decisions in the pre-tactical and tactical phases, introducing a pro-active management approach rather than a reactive one.

The inclusion of Environmental Performance Management is through two high-level parameters, namely noise and emissions. Specific indicators relating to these high-level parameters are assessed as part of an overall performance framework (i.e. goals, targets, rules, thresholds, trade-off criteria and priorities) in both the planning and execution operations phases.

This solution has been developed in the Group 1 (large and hub) airports scope, those more bounded by current and upcoming regulations. Nevertheless, other airports are free to introduce the Solution if it is considered appropriate.

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The V2 validation exercise reported herein was supported by the development of a set of environmental performance monitoring and environmental impact assessment tools and the feedback relating to the utility and pertinence of these tools forms the principal content of this report. Based on the validation results, stakeholders' feedback and human performance analysis, any necessary updates to the interim SPR-INTEROP/OSED (Reference [9]) and interim Technical Specification (TS) (Reference [10]) documentation will be introduced prior to the delivery of the V2 Data Pack.

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2. Introduction

2.1. Purpose of the document

This document is the Validation Report (VALR) for PJ04-W2-29.3 “Environmental Performance Management” of the Wave 2 Total Airport Management project (PJ.04). The validation of this Solution has been achieved through a single shadow mode exercise performed in the airport of Paris Orly (IATA code ‘ORY’) starting in the month of May 2022.

2.2. Intended readership

The intended audience of this document are those who are interested in how the partners involved in SESAR Solution PJ.04-W2-29.3 have defined the operational concept and developed the associated validation exercise.

In addition, the SESAR Transversal Areas, notably Human Performance and Environmental Performance, should find useful reference material within this document.

2.3. Background

Previous work performed in the SESAR programme on the new operating methods described within this document was done under the auspices of SESAR OFA05.01.01. SESAR 2020 Wave 1.

The Airport Operations Management concept described by OFA05.01.01 in SESAR 1 focusses specifically on large and hub airports. Work in this OFA culminated in Solution 21 (Airport Operations Plan and AOP-NOP Seamless Integration) which will be deployed in line with obligations under the Common Project Implementing Rule (EU) 116/2021 repealing Commission Implementing Regulation (EU) No 716/2014

The scope of Solution 21 only extends to airport planning, steering and monitoring services. The remainder of the concept addressing management and post-operations analysis services as well as a wider consideration of the specific needs of smaller and regional airports is continued by PJ.04 as ‘Total Airport Management’ in SESAR 2020.

Specifically relating to Environmental Performance Management, EUROCONTROL, since 2000, has developed a series of models to support its Member States and, by extension, the entire aviation community, designed to estimate the magnitude of the environmental impacts that current or future air traffic movements might have. These models have continually evolved, in line with the improvements in the level of knowledge relating to environmental modelling in the aviation sector as well as parallel advances in the available computing technologies.

The current environmental tool suite of EUROCONTROL is composed of three main models: Advanced emission model (AEM), Open-ALAQS and IMPACT.

All three of these models successfully passed ICAO’s stress tests in 2008-2009 and have since become part of the approved suite of assessment models used by ICAO’s Committee on Aviation Environmental Protection. These models are designed to assess future regulatory policy options such as introducing tighter aircraft noise and emissions standards.

AEM, Open-ALAQS and IMPACT are also the recommended models for conducting environmental impact assessments in SESAR.

The principal tool used for the noise assessment within the validation exercise described in this report is based on IMPACT. Nevertheless, IMPACT has not been developed for use in real-time, being more a tool designed for large studies and requiring a significant ‘data preparation’ phase. For the

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specific needs of Solution PJ04-W2-29.3 a new tool was developed (entitled INTACT) which offers all of the computational power and accuracy of IMPACT but also offers the necessary flexibility for use in a real-time operations assessment. Indeed, the development phase of INTACT was the most significant technical activity in the preparation of the exercise.

As a complement to INTACT, a number of additional tools were developed by both EUROCONTROL and ADP (and its partners). These tools are further described in this report along with the feedback relating to their utility in the specific exercise environment developed as part of the Human Performance Assessment activity.

2.4. Structure of the document

Section 3 of this VALR describes the context of the validation and highlights the principal elements of the validation exercise, the success criteria and any deviations from the Validation Plan.

Section 4 presents the overall results of the validation exercise and the detailed findings against each of the validation objectives.

Finally, Section 5 provides the conclusions of the validation exercise and overall Solution maturity and provides recommendations for the next phase of the Solution development.

The principal terms and different acronyms used throughout this Validation Report are contained in the following two tables:

- Term	Definition	Source of the definition
Airport Operations Plan (AOP)	The AOP (Airport Operations Plan) is the single, common and collaboratively agreed rolling plan used by all involved stakeholders whose purpose is to provide common situational awareness. It requires individual stakeholders to make changes within their own sphere of operations. The AOP interacts with a number of services, systems and external stakeholders (e.g. Network).	ATM Lexicon
Airport Operations Centre (APOC)	A platform / operational structure, which pro-actively manages the performance of present and short-term airport operations, giving relevant airport stakeholders a common operational overview of the airport, and allowing them to communicate, coordinate and collaboratively decide on their progress.	ATM Lexicon
Total Airport Management (TAM)	The Total airport management (TAM) project (PJ04) is a SESAR 2020 research project that focuses on a range of different airport complexity levels, developing scalable and cost-effective solutions, optimising both the local benefits and the benefits for the European network. Societal concerns will be addressed by ensuring that environmental mitigation measures and impact are included in the airport performance trade-off.	SOL PJ.04 TAM

Table 1 : Glossary of Terms

2.5. Acronyms and Terminology

Acronym	Definition
AEM	Advanced Emission Model
AO	Airport Operator
AOP	Airport Operations Plan
APOC	Airport Operations Centre
ATC	Air Traffic Control
ATCO	Air Traffic Controller
ATM	Air Traffic Management
AU	Airspace User
ENV	Environment(al)
HP	Human Performance
HPAP	Human Performance Assessment Plan
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
IMPACT	Integrated aircraft noise and emissions modelling platform
INTACT	IMPACT model adapted for use in real-time
INTEROP	Interoperability
KPA	Key Performance Area
KPI	Key Performance Indicator
MET	Meteorological
NM	Network Manager
NMOC	Network Manager Operations Centre
NOP	Network Operations Plan
OFA	Operational Focus Area
OI	Operational Improvement
Open-ALAQS	Airport local quality modelling tool
ORY	IATA code for Paris Orly airport
OSED	Operational Service and Environment Definition
RWY	Runway
SA	Situational Awareness
SESAR	Single European Sky ATM Research Programme
SJU	SESAR Joint Undertaking
SPR	Safety and Performance Requirements
TAM	Total Airport Management

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TEL	Taxiing Emissions Lab
TS	Technical Specification
TWR	Tower
VALP	Validation Plan
VALR	Validation Report
VPE	Environmental Protection Volume
WP	Work Package

Table 2: Acronyms and terminology

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3. Context of the Validation

3.1. SESAR Solution 29.3 Environmental Performance Management - A summary

As per the SESAR Multi-Annual Work Programme, the SESAR Solutions addressed by PJ04 Wave 2 are covered by two work packages (WP):

- (WP2) PJ04-W2-28: Network Connected Airports,
- (WP3) PJ04-W2-29: Digital Smart Airports.

Within WP3, Solution PJ.04-W2-29.3, strives to close out the V2 maturity process through validation of a set of tools focusing on introducing the notion of environmental performance monitoring and management into the overall airport operations management process.

The purpose of the solution is to show that airports can benefit from taking into account environmental performance indicators in their operations, and not only at the strategic and pre-tactical horizons but also during the tactical phase. Benefits could include a better adherence to Environmental (ENV) constraints relating to noise levels, emissions and improved ENV footprint of operations.

The possibility to drive operations at the pre-tactical (the day before) and tactical (on the day) level, relies on the availability of tools that can help to:

- Anticipate the level of noise/ emissions[1] that the foreseen traffic can create and any ENV impact that it may cause based on forecast conditions (assuming predicted trajectories, forecasted taxi times, …), in concerned volumes/areas and taxiing.
- Monitor the level of noise/emissions the actual traffic is expected to create in (the same) concerned volumes/areas and taxi paths, based on the predicted aircraft trajectories, MET conditions, aircraft types, stand positions, runways.
- Determine if there is a risk/likelihood that any authorised level will be exceeded in the concerned volumes/areas.
- Propose actions/scenarios (what-if capability) that could help mitigate the risk/likelihood and assisting in the decision-making process.

In today's operations, data relating to noise and emissions are primarily exploited in the post-operational analysis phase in order to influence and guide strategic decisions. However, real time ENV analysis is generally not exploited when taking operational decisions.

For this reason, this solution proposes the introduction of an environmental framework that covers both pre-tactical (day D-1) and tactical phases and is expected to enhance the APOC collaborative decision-making process. This is done through the elaboration of an Environmental performance dashboard capability.

From the perspective of the ATM Master Plan, the following table describes the Solution PJ04-W2-29.3 in terms of its associated Operational Improvement (OI) Step and Enablers.

[1] In the framework of the exercise, noise was considered in the air while emissions were addressed on the ground during taxiing phase.

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SESAR Solution ID	SESAR Solution Description	Master or Contributing (M or C)	OI Steps ref. (from EATMA)	Enablers ref. (from EATMA)
PJ.04–W2–29.3	Environmental Performance Management	M	**AO-0822** "Enhancement of Environmental Performance Management"	Enablers (see table below)

Table 3: SESAR PJ04-W2-29.3 Solution under Validation

OI description		Applicable OI step
AO-0822 - Enhancement of environmental performance management		AO-0822
EN code	EN description	
AIRPORT-07a	Decision support tools for airport ENV performance management	AIRPORT-07a
HUM-037	New responsibilities for the APOC Supervisor relating to ENV Performance management	HUM-037
HUM-038	New role for Airport Performance Committee Coordinator	HUM-038
SVC-054	Airport CDM Environment Management	SVC-054

Table 4: Enablers linked to Solution PJ04-W2-29.3

The Operational Requirements for the exercise are fully described in the relevant SPR-INTEROP/OSED document (Reference [9]) and the validation objectives mapping to operational requirements can be found in the exercise Validation Plan (Reference [11]).

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From the perspective of the improvements that the Solution PJ04-W2-29.3 is trying to bring, the following table compares a number of areas of functionality within the Solution scenario compared to the available functionality in place today (in ORY):

Comparison of the Reference and Proposed Solution scenarios		
Item	**Reference Scenario**	**Solution scenario**
Environmental performance framework for operations at the airport level	Objectives and thresholds for noise and aircraft ground emissions in the APOC are not available. A night curfew is in operation at ORY between 23:30LT and 06:00LT in order to limit the exposure of the surrounding population to aircraft noise. In addition, an objective of reducing the average taxi CO2 emissions by 10% by 2025 is driven by environmental considerations. Environmental protection volumes – (VPE) are defined for Orly airport by the French Government in order to limit noise exposure for specific population zones.	The ENV performance framework is defined for monitoring ENV indicators in the APOC. Indicators for noise and taxiing emissions with corresponding thresholds are defined in collaboration with the ENV experts using available historical data and target objectives published by the Competent authority. Specific zones of interest out of airport are defined and thresholds for monitoring KPIs (for noise, at each noise station, value per hour). Existing ENV restrictions are applicable as defined in the reference scenario (curfew and VPEs).
ENV Real-time noise and taxiing emissions indicators	There are no noise related indicators in the ORY APOC (including CDM). It is only possible to display aircraft trajectories with a 30 min delay. The noise measured in the fixed stations installed in the runway axes is not available in real time. No link between operational indicators (such as taxi time or waiting time) and ENV indicators is established. Periodic noise and emissions reports with list of specific ENV indicators at different frequencies are published by Airport ENV Unit. Specific reports are shared with local communities but not on daily basis (dedicated platform for information sharing and collecting complaints). Not available in the APOC and not used in operations planning.	The noise indicators are integrated into a Dashboard in the APOC to improve the knowledge of the impact of operations on the population in the vicinity of the airfield. The values of KPIs on the board are calculated (modelled) using the appropriate tool and updated every 15 minutes. Compliance rate at each specified location is then displayed. The GND taxiing emissions indicators are displayed on the dashboard. A link between operational indicators (such as average taxi-time per flight and additional taxi time per flight) and ENV indicators is established (fuel burn and emissions in total, per flight, per passenger). Additional, user defined KPIs could be displayed as well. Daily noise and taxiing emissions reports with list of specific ENV indicators and associated air traffic are be produced for APOC use only.

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Dashboard including noise and taxiing emission KPIs	Not available in the APOC	A hybrid environmental dashboard is available in the APOC containing information on noise and taxiing emissions in planning, execution and post-ops phase. On the noise dashboard, it is possible to display reference noise contours (50dB to 75dB) as well as contours calculated for predicted and real traffic, zones of interest for monitoring noise and other relevant information. The noise level at selected noise stations and compliance rate on the given location (where noise measuring stations are located) are displayed. The taxiing emissions related indicators are also displayed on the hybrid ENV dashboard. Ground (taxiing) emissions dashboard helps in visualising emissions and KPIs such as fuel burn per flight, calculated average and total emissions per flight, per passenger, per hour. Different views are available: - Predictions day before operations (D-1): estimated taxiing emissions. - Day D: taxiing emissions and fuel burn - Day after (post-ops): daily ENV information.
Noise Warning / Alerts	Not available in the APOC.	Warning/Alerts are generated as necessary and displayed through the appropriate dashboard when a pre-defined threshold is exceeded at a specific location and using colour-coding to indicate severity.

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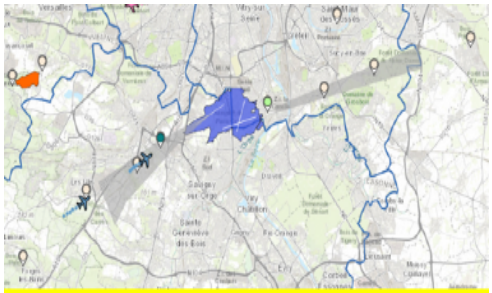
Real-time noise monitoring of ENV performance	Noise level monitoring is not available in real time. The noise level can be followed in the noise measurement stations (updated every 8 minutes) in replay and only after an elapsed 24 hour period.  Air quality stations measure air quality but without the possibility to assess the specific impact of air traffic. The data are not available in the APOC.	A map within the limit of noise contours for a level of 50db is including the nearest fixed stations. APOC supervisor can use the dashboard to monitor in real time the noise contours and emissions for air traffic Noise values are updated every 15 minutes with emissions available in real-time. Specific noise measurement stations can be designated and the calculated noise level are available at each location.
Visualisation of predictive noise contours for scheduled traffic in the time window of 24 h.	There is no tool for visualisation of predictive noise contours.	The modelled predictive noise contours for scheduled traffic on the day of operations is available on a background airport map the day before.

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What-if scenario for noise impact modelling and emissions during the taxi phase	Not available in the APOC. In addition, no environmental impact assessment tool is available in the APOC.	A test scenario is available to evaluate the gains in terms of noise and taxiing emissions when adjusting the schedule for runway inspection purposes. Impacted flights and noise related indicators are used to help in the decision-making process related to the selection of schedule for conducting RWY inspections. Noise dashboard displays calculated noise contours for the scheduled flights and for preselected timeslots for runway inspection. Considering this impact helps in equilibrating noise exposure round airport. Taxiing emissions impact assessment ("what-if") tool permits to calculate emission metrics in advance, to explore the most environmentally friendly time slots for RWY inspection (morning and afternoon). This impact can be made available a few hours in advance in the execution phase and in the planning phase the day before when flight information is available. The estimated taxi time for impacted flights with the runway's inspection process is supported by machine learning (algorithm learns from historical data). Potential benefits in taxiing emissions using N-1 engine taxi-in can be estimated using a simulation tool.
Visualisation of real time taxiing emissions	Not available in the APOC through A-CDM.	A daily report will be possible to edit analysis of date as well to identify potential improvement and use information in the continuous improvement of operations and impact on environment.
Compliance of flights trajectories with VPE restrictions	Not available in the APOC.	List of flights out of VPE is available in APOC through 3D trajectory visualisation.

Table 5 : Reference and Solution scenario functionality comparison

3.2. Summary of the Validation Plan

3.2.1. Validation Plan Purpose

For the progression to V2, a single validation exercise has been performed in the airport of ORY. As the solution contains only one single OI step (AO-0822), the execution of one single exercise is considered to provide the necessary coverage.

The Human Performance Assessment Plan (HPAP) is described in Part IV of the overall VALP documentation (Reference [11]). The results of the HPAP gathered through questionnaires and interviews with the participants are also reported in this VALR.

The initial maturity level of Solution PJ04-W2-29.3 at the commencement of Wave 2 was deemed to be V1 (complete). The target maturity at the end of Wave 2 is V2 completed and with a successful V2 maturity Gate to be performed in the first Quarter of 2023.

The high-level goal for the exercise can be stated as:

"To validate that a set of environmental performance monitoring and management tools relating to noise and taxiing emissions can provide a sufficient increase in situational awareness to allow environmental considerations to be taken into account as part of the overall airport operations management."

Paris Orly airport welcomed 15,7 million passengers in 2021 (31,9 million in 2019). As a major airport relatively close to surrounding communities, its environmental performance is closely scrutinised and all actions which could potentially impact in a positive way its noise and emissions footprints are to be considered favourably.

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Figure 1 : Aerial view of Paris Orly Airport

3.2.2. Summary of Validation Objectives and success criteria

The detailed validation objectives and their link with the individual Operational Requirements have been fully described in the exercise Validation Plan (Reference [11]). However, for ease of reference, the high-level validation objectives and success criteria are repeated below.

Identifier	OBJ-04.29.3-V2-VALP-SOL29.3.010
Objective	To validate that environmental restrictions and considerations can to be taken into account in all stages of operational planning and execution in order pro-actively tackle environment restrictions for the operation and growth of Airports leading to benefits in the environment KPA.
Title	Environmental Performance and Restrictions Accommodated in the Airport Performance Framework
Category	*<performance>, <operational feasibility>, <acceptability>*
Key environment conditions	*Large Airport*
V Phase	V2

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Identifier	Success Criterion
CRT-04.29.3-V2-VALP-SOL29.3.010-1	Environmental restrictions and performance are continually and appropriately monitored and accommodated in airport capacity operations throughout the planning and execution timeframes, surface movement planning and routing.
CRT-04.29.3-V2-VALP-SOL29.3.010-2	Breaches of locally defined environmental regulations and threshold values are reduced or maintained at previous levels.

Identifier	OBJ-04.29.3-V2-VALP-SOL29.3.020
Objective	To analyse the different concept options in terms of business processes, operational procedures, phraseology, roles of actors and their task and human and technology interaction.
Title	V2 Development and validation
Category	<operational feasibility>, <acceptability>
Key environment conditions	Nominal conditions, Traffic sample 2022, Hub Airport with complex layout
V Phase	V2

Identifier	Success Criterion
CRT-04.29.3-V2-VALP-SOL29.3.020-1	The preferred option is fully developed and validated

Identifier	OBJ-04.29.3-V2-VALP-SOL29.3.030
Objective	To assess the impacts on the environment if the concept were deployed, in all potential contexts of application
Title	Assessment of the impacts on the environment if the concept were deployed
Category	<environment>
Key environment conditions	Nominal conditions, Traffic sample 2022, Hub Airport with complex layout
V Phase	V2

Identifier	Success Criterion
CRT-04.29.3-V2-VALP-SOL29.3.030-1	Qualitative and quantitative evidence have been collected, using KPIs from the programme catalogue (SESAR Performance Framework), about impact on environmental sustainability in the most critical (sub) operating environments relevant for the SESAR Solution
To complete	

Identifier	OBJ- 04.29.3-V2-VALP-SOL29.3.040
Objective	To identify and analyse the potential impacts on the human performance if the concept were deployed
Title	Identification and analysis of the impacts on the human performance
Category	<environment>
Key environment conditions	Nominal conditions, Traffic sample 2022, Hub Airport with complex layout
V Phase	V2

Identifier	Success Criterion
CRT-04.29.3-V2-VALP-SOL29.3.040-1	Benefits and issues in terms of human performance and operability related to the proposed SESAR solution have been assessed coherently to V2 maturity
CRT-04.29.3-V2-VALP-SOL29.3.040-2	Potential interactions, from the HP point of view, with related SESAR Solutions have been considered
CRT-04.29.3-V2-VALP-SOL29.3.040-3	Outcomes of V2 validation activities provide evidence that the level of human performance needed to achieve the desired system performance for the proposed solution is consistent with human capabilities
CRT-04.29.3-V2-VALP-SOL29.3.040-4	The proposed solution has been tested with end-users and under sufficiently realistic conditions, including relevant abnormal and degraded conditions
CRT-04.29.3-V2-VALP-SOL29.3.040-5	The major HP issues that could become an impediment to concept implementation (e.g. changes in automation levels, training needs of human actors, changes in staff requirements, need for relocation of the workforce) have been identified and analysed, providing potential mitigations to overcome blocking issues
CRT-04.29.3-V2-VALP-SOL29.3.040-6	Any impact that may require changes to regulation in the area of HP/ATM has been identified (for example: changes in roles & responsibilities, competence requirements, or the task allocation between human & machine)

Identifier	OBJ- 04.29.3-V2-VALP-SOL29.3.050
Objective	To validate that the solution is technically feasible.
Title	ENV decision support tool
Category	<environment>
Key environment conditions	Nominal conditions, Traffic sample 2022, Hub Airport with complex layout
V Phase	V2

Identifier	Success Criterion

CRT-04.29.3-V2-VALP-SOL29.3.050-1	Confirm there exists at least one feasible technical enabler consistent with the selected operational concept.
CRT-04.29.3-V2-VALP-SOL29.3.050-2	Confirm there exists at least one architecture feasible and stable that could support the selected operational concept.

The following table summarises the specific Human Performance (HP) objectives:

PJ04-W2-29.3 HP Validation Objectives			
Objective ID	**HP Objective**	**Success Criteria ID**	**CRT proposal**
OBJ-29.3-V2-HP1	To assess the impact of the changes in roles and responsibilities of human actors related to changes brought by solution 29.3 on human performance (HP Argument 1).	CRT-29.3-V2-VALP-HP1-001	Enhanced responsibilities and operating methods are clear and consistent for the end users.
		CRT-29.3-V2-VALP-HP1-002	The potential changes to human error and preliminary mitigations have been identified.
		CRT-29.3-V2-VALP-HP1-003	The level of workload (induced by cognitive and/ or physical task demands) is acceptable.
		CRT-29.3-V2-VALP-HP1-004	The level of situational awareness is acceptable.
		CRT-29.3-V2-VALP-HP1-005	Human actors can achieve their tasks in timely and accurate way.
OBJ-29.3-V2-HP2	To assess the impact of the changes to the technical system related to changes brought by solution 29.3 on human performance (HP argument 2).	CRT-29.3-V2-VALP-HP2-001	The solution supports appropriate task allocation between human and the machine.
		CRT-29.3-V2-VALP-HP2-002	The information provided by the system supports human performance.
		CRT-29.3-V2-VALP-HP2-003	The HMI supports specific users' needs and associated tasks.
		CRT-29.3-V2-VALP-HP2-004	The HMI design is acceptable for the users.
		CRT-29.3-V2-VALP-HP2-005	HMI supports achieving tasks in timely and accurate manner.
		CRT-29.3-V2-VALP-HP2-006	The level of trust in system information supports the usage of automated functions.
OBJ-29.3-V2-HP3	To assess the changes to the team communication related to changes brought by solution 29.3 on human performance (HP argument 3).	CRT-29.3-V2-VALP-HP3-001	Communication between team members supports human performance.
		CRT-29.3-V2-VALP-HP3-002	The level of shared situation awareness is acceptable.

PJ04-W2-29.3 HP Validation Objectives			
Objective ID	**HP Objective**	**Success Criteria ID**	**CRT proposal**
OBJ-29.3-V2-HP4	To assess the changes to HP related transition factors related to changes brought by solution 29.3 and its impact on human performance (HP argument 4).	CRT-29.3-V2-VALP-HP4-001	User feedback does not indicate a negative impact to overall job satisfaction.
		CRT-29.3-V2-VALP-HP4-002	Any required changes to training content per actor group are identified (preliminary identification only).

Table 6 : Specific HP objectives for exercise 2931

3.2.3. Validation Assumptions

The exercise was executed in passive shadow mode. The validation platform and associated toolset was being fed in real-time by locally available data at ORY airport notably radar data (surveillance data) and flight data. In parallel, the platform was providing environmental performance information to the participating stakeholders.

There was, however, no impact on live operations stemming from the exercise taking place. Specifically, ORY APOC staff, pilots or TWR Controllers in the live environment were not deviating in any way from normal operational procedures in place at the airport.

The Reference scenario reflects the current state of operations in ORY with environmental performance monitoring and management as described above in Table 5.

In the Solution Scenario, environmental performance information was being provided to the participating stakeholders through the various tools available to them.

Success is obtained when the stakeholders provide positive feedback relating to the information available and are able to see and agree on the potential benefits of such information being made available in the future.

3.2.4. Validation Exercises List

Identifier	PJ.04–W2–29.3 – EXE 2931
Title	Environmental performance management in the framework of collaborative airport performance management in an APOC

Identifier	PJ.04–W2–29.3 – EXE 2931
Description	Exercise in passive shadow mode at ORLY Airport in the APOC. For both pre-tactical and tactical phases, the purpose is to assess noise and aircraft taxiing emissions in different scenarios and to display information on the new dashboard using new ENV KPIs and alerts when defined thresholds are exceeded. Following use cases were tested: 1. Plan: prediction of noise and taxiing emissions day before operations and detection of potential alerts. Simulation of ENV impact (noise and taxiing emissions) for runway inspections planning; 2. Monitor: real time noise and taxiing emissions monitoring in nominal operation and during Single RWY operations as a result of planned intervention on the RWY (e.g., RWY inspection). Use of warning/alerts when given thresholds/ targets are overrun; 3. Manage (simulation tool): Specifically for taxiing operations an assessment of the impact of using N-1 engine or the use of 'greener' taxi routes; 4. Learn: post-ops analysis of the conformance to environmental protection zones (VPE compliance), of noise and taxiing emissions.
Expected Achievements	The exercise is intended to demonstrate the feasibility of the ENV dashboard used in an APOC environment (with a focus on the noise and taxiing emissions) as a means of considering environmental impact while managing operational performance at the airport level.
V Phase	V2
Use Cases	Described in SPR-INTEROP/OSED (Reference [9])
Validation Technique	Passive Shadow mode
KPA / TA Addressed	Fuel efficiency, Human Performance
Start Date	31/05/2022
End Date	02/06/2022
Validation Coordinator	EUROCONTROL and ADP (SEAC2020)
Validation Platform	EUROCONTROL INTACT, and TRAJECTORY PREDICTOR, and ENV dashboard, RWY inspection schedular tool and VPE watcher Taxiing Emissions Tool Green taxiing route Adviser (Fuel-saving Trajectories)
Validation Location	Paris Orly (ORY) Airport
Status	Complete
Dependencies	None

Table 7 : Exercise 2931 Key Parameters

3.3. Deviations

3.3.1. Deviations with respect to the S3JU Project Handbook

No events or decisions taken, either in the preparation of, or during, this validation exercise led to any deviations in respect to any SESAR Reference material.

3.3.2. Deviations with respect to the Validation Plan

None.

4. SESAR Solution 29.3 Validation Results

4.1. Summary of SESAR Solution 29.3 Validation Results

As stated previously, the Solution 29.3 has been validated using a single validation exercise with a focus on a single Operational Improvement Step from the ATM Master Plan (AO-0822). As a result, for the purposes of this report, the individual exercise results and the Solution level results are considered *one and the same*.

The following table gives an overview of the exercise results for each validation objective and the subsequent sections explore these results in more detail.

VAL EXE-2931 Validation Objectiv	VAL EXE-2931 Validation	VAL EXE-2931 Success Criterion	VAL EXE-2931 Success Criterion	Sub-operation environment	VAL EXE-2931 Validation Results	VAL EXE-2931 Validation
OBJ-04.29.3-V2-VALP-SOL29.3.010	Environmental Performance and Restrictions Accommodated in the Airport Performance framework	CRT-04.29.3-V2-VALP-SOL29.3.010-1	Environmental restrictions and performance are continually and appropriately monitored	Very Large Airports	The results show potential gain in the environmental performance (reduction of taxing emissions, fuel burn) when the runway inspection timeslots are planned considering ENV footprint in addition to the number of impacted flights and	Partially OK
		CRT-04.29.3-V2-VALP-SOL29.3.010-2	Breaches of locally defined environmental regulations and threshold	Very Large Airports	. The local threshold values defined for noise level at specific stations and target value per flight for taxiing emissions are based on statistics and by environmental experts	OK
OBJ-04.29.3-V2-VALP-SOL29.3.020	V2 Development and validation	CRT-04.29.3-V2-VALP-SOL29.3.020-1	The preferred option is fully developed and	Very Large Airports	Monitoring of taxing emissions in real-time using KPIs ENV was developed and positive feedback from end-users was collected	Partially OK

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OBJ-04.29.3-V2-VALP-SOL29.3.030	Assessment of the impacts on the environment if the concept were deployed	CRT-04.29.3-V2-VALP-SOL29.3.030-1	Qualitative and quantitative evidence have been collected, using KPIs from the programme catalogue	Very Large Airports	Potential benefits for environment and issues were identified and quantified based on two validation exercise scenarios: optimisation of timeslots for runway inspection (for more details see Appendix B and potential gain with	OK
		CRT-04.29.3-V2-VALP-SOL29.3.030-2	Solution 29.3 has potential to increase fuel efficiency on the ground by proposing fuel saving taxi-routes (CO2, less distance	Very Large Airports	ENV Impact assessment tool (simulation what-if) can trigger modification of the initially planned operation, which would increase fuel efficiency at the airport.	OK
OBJ-04.29.3-V2-VALP-SOL29.3.040	To identify and analyse the potential impacts on the human performance if the concept were deployed.	CRT-04.29.3-V2-VALP-SOL29.3.040-1	Benefits and issues in terms of human performance and operability related to the	Very Large Airports	Benefits and issues were identified and are analysed in the OBJ-29.3-V2-HP1, OBJ-29.3-V2-HP2, OBJ-29.3-V2-HP3, OBJ-29.3-V2-HP4.	OK
		CRT-04.29.3-V2-VALP-SOL29.3.040-2	Potential interactions, from the HP point of view, with related SESAR	Very Large Airports	No interactions from HP point of view have been identified.	OK

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	CRT-04.29.3-V2-VALP-SOL29.3.040-3	Outcomes of V2 validation activities provide evidence that the level of human performance needed to achieve the desired	Very Large Airports	The evidence shows no negative impact on human performance with the introduction of solution 29.3 concept. Moreover, the benefit is expected in terms of situational awareness and job satisfaction of the APOC participants.	OK
	CRT-04.29.3-V2-VALP-SOL29.3.040-4	The proposed solution has been tested with end-users and under sufficiently realistic conditions, including relevant abnormal	Very Large Airports	The solution has been tested with end-users (APOC participants from the airport with additional feedback from air traffic controller and a pilot). The validation was executed by the means of a passive shadow mode technique in the ORY APOC facilities. Therefore, the	Partially OK
	CRT-04.29.3-V2-VALP-SOL29.3.040-5	The major HP issues that could become an impediment to concept implementation (e.g. changes in automation levels, training needs of human actors, changes in staff requirements, need for	Very Large Airports	The major HP benefits and issues were identified and are analysed in the OBJ-29.3-V2-HP1, OBJ-29.3-V2-HP2, OBJ-29.3-V2-HP3, OBJ-29.3-V2-HP4.	OK

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		CRT-04.29.3-V2-VALP-SOL29.3.040-6	Any impact that may require changes to regulation in the area of HP/ATM has been identified (for example: changes in roles & responsibili	Very Large Airports	No impact requiring changes in regulation in relation to Human Performance is foreseen.	OK
OBJ-04.29.3-V2-VALP-SOL29.3.050	V2 Technical feasibility	CRT-04.29.3-V2-VALP-SOL29.3.050-1	Confirm there exists at least one feasible technical enabler consistent	Very Large Airports	The LIVE monitoring of taxiing emissions too is a relevant enabler for the ENV performance monitoring. The runway inspection tool is a relevant	OK
		CRT-04.29.3-V2-VALP-SOL29.3.050-2	Confirm there exists at least one architecture feasible and stable that could support	Very Large Airports	Decision support tools including ENV information are successfully connected to the airport operational and airport surveillance data.	OK

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OBJ-29.3-V2-HP1	To assess the impact of the changes in roles and responsibilities of human actors related to changes brought by solution 29.3 on human performance (HP Argument 1).	CRT-29.3-V2-VALP-HP1-001	Enhanced responsibilities and operating methods are clear and consistent for the end users.	Very Large Airports	The APOC participants clearly understand the new responsibilities that would arise as a result of ENV indicators provision. The participants agreed on the importance of inclusion of such indicators in the future, however highlighted that at a first stage the tools would serve increasing their understanding of those impacts, but would not drive the decision-making, hence the operating methods would not change. As for the introduction of a	OK
		CRT-29.3-V2-VALP-HP1-002	The potential changes to human error and preliminary mitigations	Very Large Airports	No change to human error probability with the introduction of the ENV tools was identified. The reason for that is that in the first stage of ENV	OK
		CRT-29.3-V2-VALP-HP1-003	The level of workload (induced by cognitive and/or physical task demands) is acceptable.	Very Large Airports	Given the passive shadow mode validation technique, the workload could only be assessed in isolation, i.e. without integration of ENV considerations with other tasks of the APOC participants. Nevertheless, the workload related to the use of ENV tools was found to be acceptable. During the debriefing discussions, the participants claimed that their workload would not be negatively	Partially OK

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		CRT-29.3-V2-VALP-HP1-004	The level of situational awareness is acceptable.	Very Large Airports	Given the passive shadow mode validation technique, the SA could only be assessed in isolation, i.e. without integration of ENV considerations with other tasks of the APOC participants. Nevertheless, the SA related to the use of ENV tools was found to be acceptable. The APOC participants' situational awareness was assessed in relation to the information provided by the ENV tools as well as discussions were held on how the SA would be impacted if the ENV is introduced into the	Partially OK
		CRT-29.3-V2-VALP-HP1-005	Human actors can achieve their tasks in timely and accurate way.	Very Large Airports	Due to the nature of the passive shadow mode validation technique, the timeliness of tasks achievement could only be assessed in isolation, i.e. without integration of ENV impacts into the APOC participants' decision-making process. The human actors expressed that the timeliness and accuracy of tasks achievement would strictly depend on the accuracy and the	Partially OK

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OBJ-29.3-V2-HP2	To assess the impact of the changes to the technical system related to changes brought by solution 29.3 on human performance (HP argument 2).	CRT-29.3-V2-VALP-HP2-002	The information provided by the system supports human performance.	Very Large Airports	The APOC participants agreed that the information provided by the ENV tools meets their information requirements in terms of the impact of airport operations on the environment. Given the maturity of the tools, some changes were proposed by the users,	Partially OK
		CRT-29.3-V2-VALP-HP2-001	The solution supports appropriate task allocation	Very Large Airports	The participants of the validation agreed that the distribution of tasks between the user and the system was reasonable.	Partially OK
		CRT-29.3-V2-VALP-HP2-003	The HMI supports specific users' needs and associated tasks.	Very Large Airports	The users positively reacted to the ENV tools presented to them. The users agreed that the information presented on the HMI is of their interest. However, some	Partially OK
		CRT-29.3-V2-VALP-HP2-004	The HMI design is acceptable for the users.	Very Large Airports	Overall, the APOC participants were satisfied with the HMI design at a current stage of development. Nevertheless, before implementation, some adjustments need to be made to ensure adequate usability of the tools. For instance, the tools should allow	Partially OK

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		CRT-29.3-V2-VALP-HP2-005	HMI supports achieving tasks in timely and accurate manner.	Very Large Airports	The accuracy of some of the tools should be improved, i.e. the loading of the data should take less time than in the validation in order to ensure full usability of the tools. Additionally, at times, users were not able to easily find the information they were looking for due to large amount of information presented on multiple	Partially OK
		CRT-29.3-V2-VALP-HP2-006	The level of trust in system information supports the usage of automated functions.	Very Large Airports	Overall, the APOC participants expressed that they would trust the outputs of the ENV tools. In order to reinforce the trust in the ENV outputs, the users expressed interest in understanding the scientifical models behind the calculations, i.e. what is included and what is excluded from the calculation, in order	OK
OBJ-29.3-V2-HP3	To assess the changes to the team communication related to changes brought by solution	CRT-29.3-V2-VALP-HP3-001	Communication between team members supports human performance.	Very Large Airports	No significant changes in the communication between APOC participants were identified. The ENV tools do not introduce additional means of communication. Therefore, no negative impact on human performance in terms of communication was identified. Moreover,	OK

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	29.3 on human performance (HP argument 3).	CRT-29.3-V2-VALP-HP3-002	The level of shared situation awareness is acceptable.	Very Large Airports	The APOC participants agreed that if the tools were provided to the APOC, their shared situational awareness would increase. Moreover, if the ENV indicators were provided to other key stakeholders like airlines, ground	Partially OK
OBJ-29.3-V2-HP4	To assess the changes to HP related transition factors related to changes brought by solution 29.3 and its impact on human performance (HP argument 4).	CRT-29.3-V2-VALP-HP4-001	User feedback does not indicate a negative impact to overall job satisfaction.	Very Large Airports	The APOC participants expressed that their job satisfaction would increase due to introduction of ENV tools to their working environment. The users expressed that as the awareness of the environmental	OK
		CRT-29.3-V2-VALP-HP4-002	Any required changes to training content per actor group are identified (preliminary identification only).	Very Large Airports	The APOC participants expressed that in order to fully understand the functions of the ENV dashboards, an extensive training on functionalities should be provided before implementation. Additionally, the users expressed the interest in learning about the technical side of the	OK

Table 8: Summary of Solution 29.3 Validation (Human Performance Assessment) Results

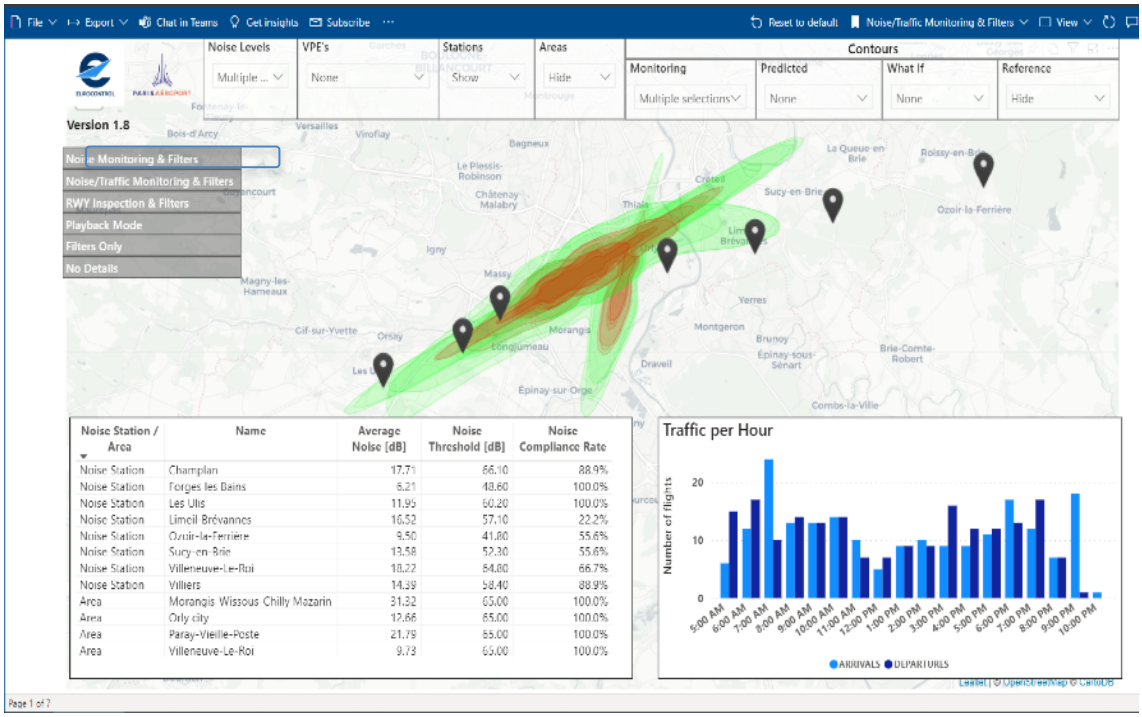
4.2. Detailed analysis of SESAR Solution Validation Results per Validation objective

The more detailed results of the validation exercise are presented as a function of each of the available tools. Therefore, before proceeding with the results of the HP feedback, a short description of each tool is provided with available environmental information for operational monitoring and decision making.

Noise Dashboard

The noise dashboard provides a large amount of information relating to both predicted and (modelled) real-time noise contours and superimposed onto a map covering the airport and its surrounding areas. The content of the dashboard is provided primarily by the INTACT tool.

Figure 2 illustrates the interface an end-user could use to have overview on the noise generated by the traffic. This includes the information on the compliance rate at specific locations, where location of noise monitoring stations and specific area are displayed with associated noise thresholds.



Noise Station / Area	Name	Average Noise [dB]	Noise Threshold [dB]	Noise Compliance Rate
Noise Station	Champlan	17.71	66.10	88.9%
Noise Station	Forges les Bains	6.21	48.60	100.0%
Noise Station	Les Ulis	11.95	60.20	100.0%
Noise Station	Limeil Brévannes	16.52	57.10	22.2%
Noise Station	Ozoir-la-Ferrière	9.50	41.80	55.6%
Noise Station	Sucy-en-Brie	13.58	52.30	55.6%
Noise Station	Villeneuve-Le-Roi	18.22	64.80	66.7%
Noise Station	Villiers	14.39	58.40	88.9%
Area	Morangis Wissous Chilly Mazarin	31.32	65.00	100.0%
Area	Orly city	12.66	65.00	100.0%
Area	Paray-Vieille-Poste	21.79	65.00	100.0%
Area	Villeneuve-Le-Roi	9.73	65.00	100.0%

Figure 2 : Noise dashboard visual representation - noise monitoring & filters

Detailed information on noise level at specific location is accessible via the given map. The environmental impact of operations is calculated, and an alert is displayed in case of noise threshold overrun. Figure 3 illustrates information integrated in the support tools (at this stage in the validation platform) and displayed to the operational staff who can then take it into account in the planning and execution phases.

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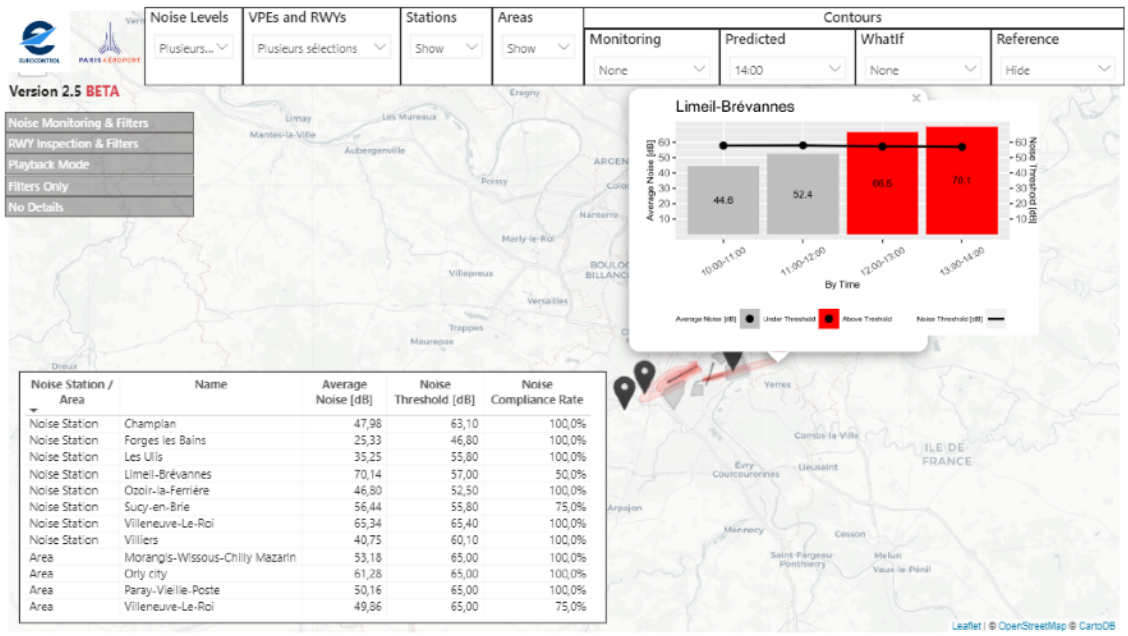

Figure 3 : Noise dashboard visual representation – alert display

Both the predicted noise contours and real-time noise contours are available for the runway inspection scenario involving the transition to single runway operations. Predicted noise contours calculated at D-1 can be displayed taking into account the predicted traffic as well as MET information to determine the likely runway configuration.

Each timeslot is characterised by defined parameters (LAeq contour area, number of impacted flights and number of impacted Heavy aircraft) providing end-user with the evaluation of the scenario.

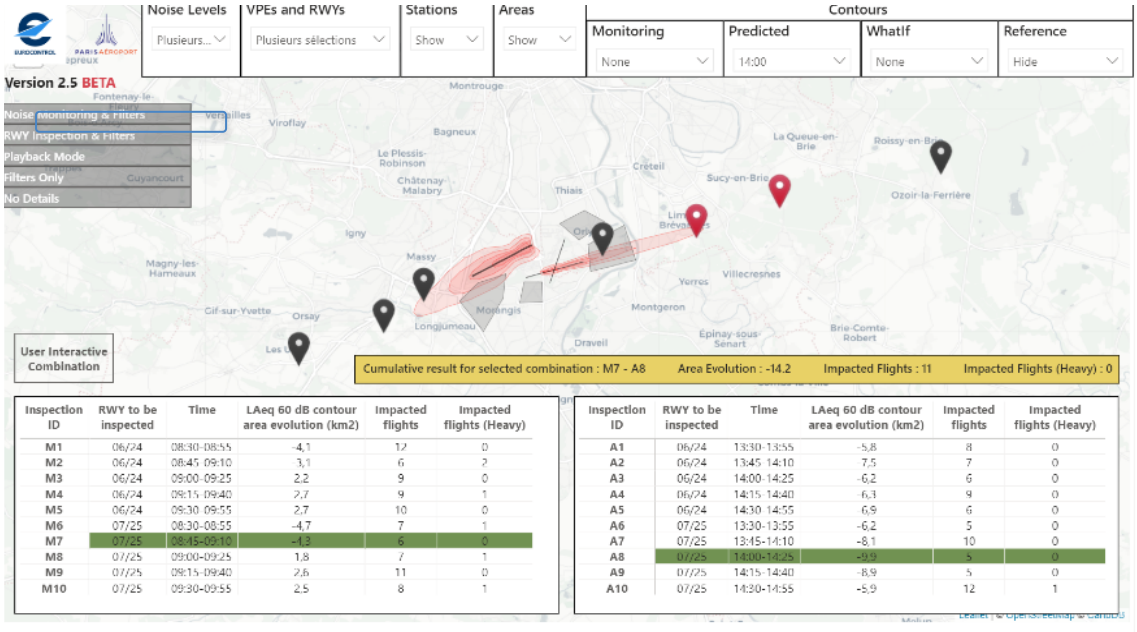

Figure 4 : Noise dashboard visual representation – RWY inspection & filters


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Figure 4 illustrates the combination of two runway inspections in the morning and in the afternoon with less impact according to the specified evaluation rule (i.e. area evolution for noise contour). Using this information, the planning of runway inspection would include environmental impact in the decision making.

Taxiing Emissions Tool

The Taxiing emissions tool provides a range of information concerning a real-time representation of taxiing emissions from aircraft.

Figure 5 : Taxiing emissions dashboard - global view

For single (N-1) engine operations, the dashboard also shows the impact on emissions. Depending on the N-1 engine taxi-in rate, fuel savings and potential emission benefits can be evaluated. Figure 6 illustrates potential gains in CO2 emissions (reduction in 1 670kg CO2, 5,9% of economies) when 30% traffic would taxi-in with N-1 engines during the given period of the day.

Results of expected gains for the traffic on 1st June is given in the Figure 6.

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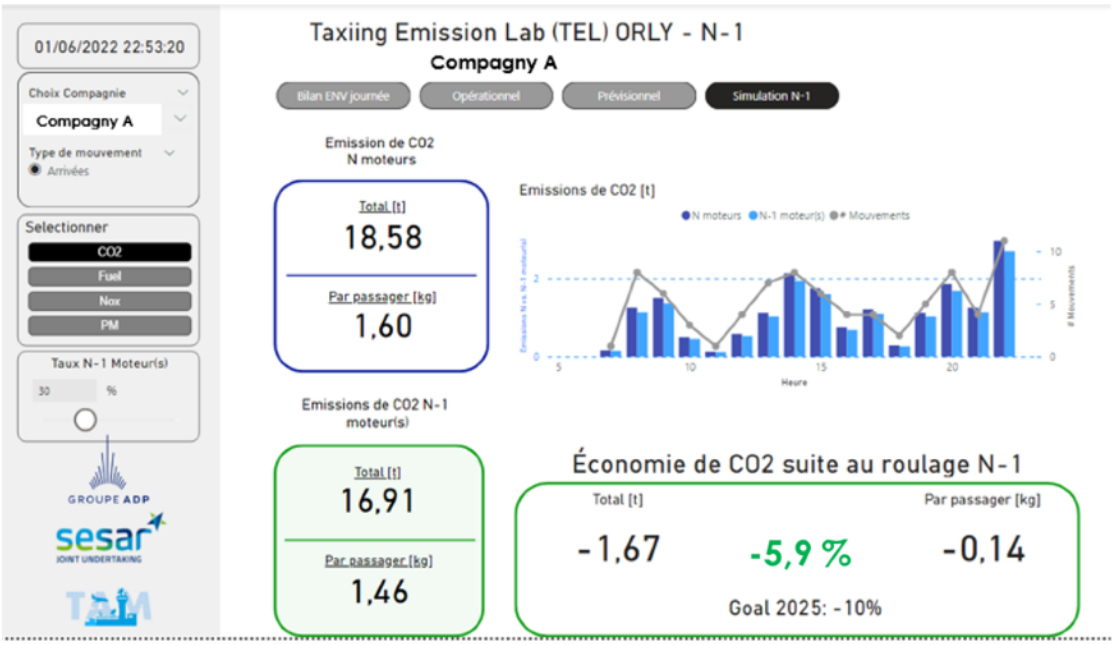

Figure 6 : Taxiing emissions dashboard – simulation N-1 view

Environmental Protection Volume (VPE) monitoring

A number of environmental protection volumes (VPE) are defined for arriving and departing aircraft in the vicinity of ORY airport in order to protect surrounding areas from excessive noise pollution.

The monitoring of the adherence to these zones is available in this particular tool, as presented on Figure 7 and Figure 8.

In case one flight is detected to be out of the VPE, it is displayed along with an observation about the reason why, as presented in the Figure 7.

Figure 7 : Environmental Protection Volume Watcher Dashboard

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Flight information and 3D visualisation to analyse flight trajectory are illustrated on the Figure 8.

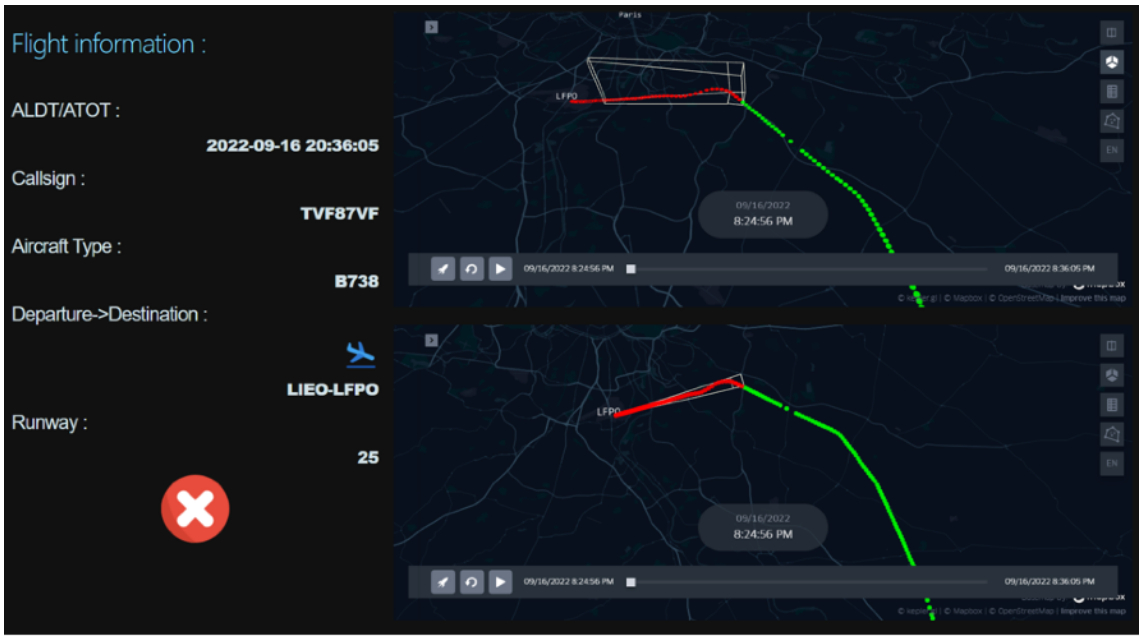

Figure 8 : VPE monitoring tool – flight information

Runway Inspection tool

This tool provides an indication of the impact of a runway inspection at a specific time in terms of the flights impacted, additional distance to be flown and impact on fuel burn and emissions. It is also able to identify the 'best' timeslot between a number of possibilities.

Figure 9 illustrates the interface to support planning of runway inspection on the day of operations. It also provides the possibility to plan runway inspections the day before of operations.

Two strategies are applied by the air traffic controllers (ATC) to organise the traffic for dealing with runway inspections: single runway use and upstream regulation to create time buffer for runway inspections. These ATC operational methods are included in the tool to reflect the realistic environment.

Quantification of environmental impact provides information to the end user about each runway inspection scenario.

For illustration purpose, as presented on Figure 9, two scenarios for runway inspection are compared. Considering that the first runway inspection is conducted in the morning, the potential gain can be evaluated and used for the planning of the runway inspections timeslots in the afternoon. Two slots were compared, one starting at 16h and second at 16h30.

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Figure 9 : Runway Inspection scheduler

According to the impact assessment model, conducting a runway inspection at 16h is more emissions friendly comparing to one at 16h30. Potential gain is evaluated as follows: 258.6kg fuel savings, 817.2kg less of CO2, 7.7kg less of NOx can be observed in this case. On a yearly basis, for illustration purpose, the potential gains in selecting more emissions friendly runway inspection time slot represents 94 tonnes fuel saving for taxiing, 298 tons less of CO2 and 2.8 tons less of NOx.

Study case providing detailed information on the model and potential gains is given in the Appendix B.

Fuel-Saving Trajectory tool

A what-if capability is available in the Fuel-Saving Trajectory tool (Trajectory recommendation tool) to compare different potential taxi routes to / from the gate and the runway threshold. The tool helps to identify more 'greener' routes in terms of emissions.

This tool provides an indication of the potential gain of a trajectory choice to reach the parking stand or runway in terms of fuel burn, emissions, taxi time and distance. The recommended taxi speed is given for each segment of the selected trajectory permitting to optimise fuel-burn and emissions.

Figure 10 illustrates rating of possible taxiing trajectories from the runway to the parking stand for a given flight in terms of fuel burn, CO2 and NOx emissions, duration, and distance. The potential gain in selecting specific trajectory can be observed in the planning phase of the surface routing. It can be observed potential fuel saving of 9 kg between the path #1 and the path #5.

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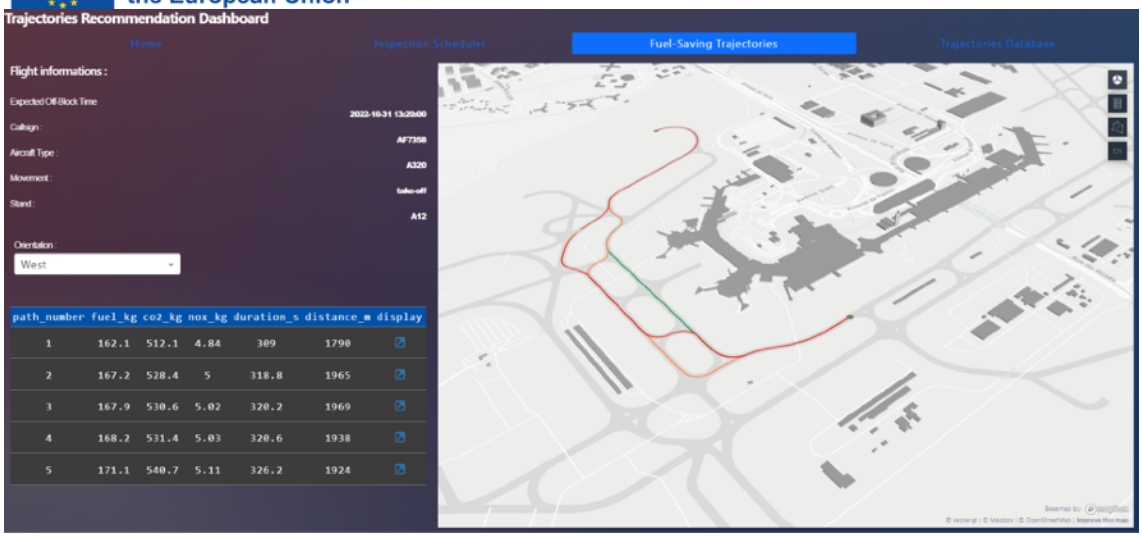

Figure 10 : Trajectories recommendation for AF7358 in West configuration

The additional information on recommended speeds per segment of the selected taxi route is also available permitting to reach potential savings. Figure 11 illustrates the decision support tool for the emissions friendly route planning.

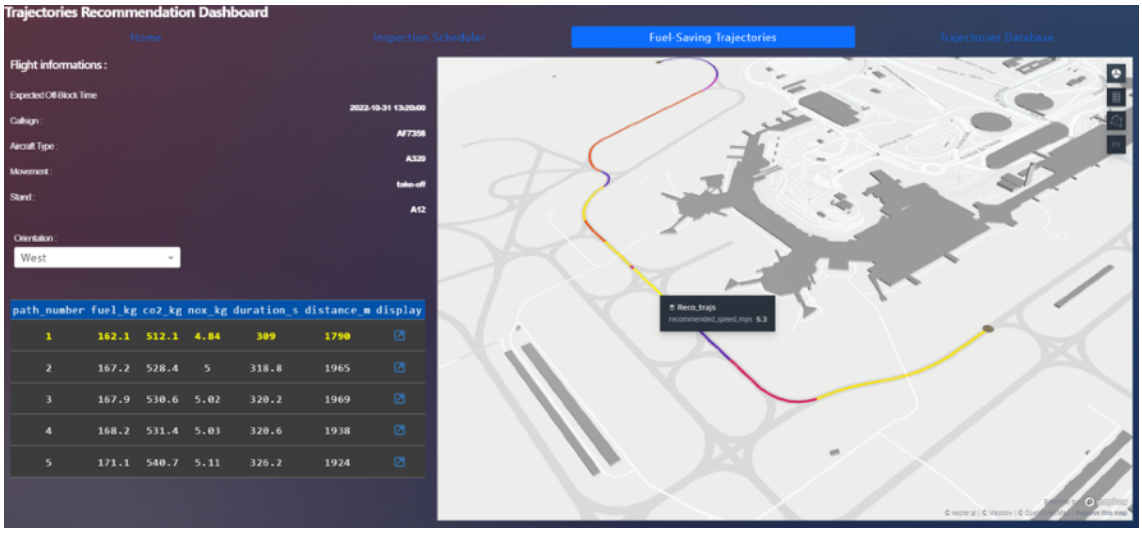

Figure 11 : Recommended taxi speeds for the path #1

Study case providing detailed information on the model and potential gains is given in the Appendix C.

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4.2.1. OBJ-04.29.3-V2-VALP-SOL29.3.010 Results on ENV performance in the airport operations

CRT-04.29.3-V2-VALP-SOL29.3.010-1: *Environmental restrictions and performance are continually and appropriately monitored and accommodated in airport operations.*

Detailed results are in Appendix B and Appendix E. As the exercise was in passive shadow mode, the accommodation in the airport operations has not been fully validated. Hence:

The results are **Partially OK**.

CRT-04.29.3-V2-VALP-SOL29.3.010-2*: Breaches of locally defined environmental regulations and threshold values are reduced or maintained at previous levels.*

The local threshold values defined for noise level at specific stations and target value per flight for taxiing emissions are based on statistics and by environmental experts in the domain. No significant and inexplicable overrun was detected during the exercise. Hence:

The results are **OK**.

4.2.2. OBJ-04.29.3-V2-VALP-SOL29.3.020 Results on development and validation

CRT-04.29.3-V2-VALP-SOL29.3.020-1*: The preferred option is fully developed and validated*

The scope of the exercise covers all envisaged options for solution PJ04 W2 29.3, although not extensively developed at this maturity stage. No blocking issues were identified.

This objective aims in assessing technical and procedural enabler responding to operational need to monitor environmental performance and include it in the airport operations performance management process.

Each prototype has different maturity. The prototype for monitoring taxiing emissions in real time (Taxiing emission Lab) is fully developed and validated. Results for Human Factors' objectives support positive feedback and validation. Scenarios related to the noise and the management of ENV performance need further refinement, since whilst the runway inspection related to a management action, further validation is needed with an active shadow mode and evaluating the potential tradeoffs (to bring towards maturity V3), showing (taking into account ORY examples) how environmental impacts could be included in the decision making. Hence:

The results are **Partially OK**.

4.2.3. OBJ-04.29.3-V2-VALP-SOL29.3.030 Results on performance

CRT-04.29.3-V2-VALP-SOL29.3.030-1*: Qualitative and quantitative evidence have been collected, using KPIs from the programme catalogue (SESAR Performance Framework).*

Human performance results are further presented for each human factor validation objective in the document.

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Quantitative results on potential performance impact (on fuel efficiency, time efficiency) are presented in Appendix B, Appendix C, Appendix D and Appendix E. Considering passive shadow mode of the exercise, impact on punctuality and predictability were not assessed. Hence:

The result is **OK.**

CRT-04.29.3-V2-VALP-SOL29.3.030-2*: The solution permits to increase fuel efficiency on the ground.*

Exercise at Orly APOC was used to assess this criterion and concluded that increases in fuel efficiency could be obtained. The fuel-savings trajectory tool proposed several routes on the ground quantifying emissions, fuel burn, distance and duration, through the identification of fuel saving trajectories in the planning phase. Appendix C contains additional quantification of potential fuel efficiency at the airport.

Fuel efficiency could be improved through the identification of emission friendly timeslots for runway inspection using the Runway Inspection planning tool. Hence:

The result is **OK.**

4.2.4. OBJ-04.29.3-V2-VALP-SOL29.3.040 Results on Human Performance

CRT-04.29.3-V2-VALP-SOL29.3.040-1*: Benefits and issues in terms of human performance and operability*

Detailed results are presented in §4.2.6, §4.2.7, §4.2.8 and §4.2.9.

The results are **OK.**

CRT-04.29.3-V2-VALP-SOL29.3.040-2*: Potential interactions, from the HP point of view, with related SESAR Solutions and* ***CRT-04.29.3-V2-VALP-SOL29.3.040-6:*** *Changes to regulation in the area of HP/ ATM*

No interaction or need for change have been identified.

The results are **OK.**

CRT-04.29.3-V2-VALP-SOL29.3.040-3*: Solution is consistent with human capabilities*

Detailed results are given in §4.2.6, §4.2.7 and §4.2.9.

The results are **OK.**

CRT-04.29.3-V2-VALP-SOL29.3.040-4*: Test of the solution in realistic conditions*

No abnormal and degraded modes were assessed during this validation, it is therefore recommended that this issue is further investigated in the next maturity phase. Hence:

The results are Partially **OK.**

Illustration of the realistic environment is given in the Appendix A.

CRT-04.29.3-V2-VALP-SOL29.3.040-5: *Major HP issues that could become an impediment to concept implementation*

Detailed results are given in §4.2.6, §4.2.7, §4.2.8 and §4.2.9.

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The results are **OK.**

4.2.5. OBJ- 04.29.3-V2-VALP-SOL29.3.050 Results on technical feasibility

CRT-04.29.3-V2-VALP-SOL29.3.050-1*: Confirm there exists at least one feasible technical enabler consistent with the selected operational concept*

Six technical enablers, with different functionalities, were used in the validation exercise and demonstrated technical feasibility. Hence:

The result is **OK.**

CRT-04.29.3-V2-VALP-SOL29.3.050-2*: Confirm there exists at least one architecture feasible and stable that could support the selected operational concept.*

Specific results for this objective are included in the results for human performance validation objectives. Hence:

The result is **OK.**

4.2.6. OBJ-29.3-V2-HP1 Results relating to Roles / Responsibilities and Human Performance

This validation objective feeds from the lower-level Human Performance-related objectives and aims at assessing at higher solution level whether the potential impacts on the human actors were identified and analysed in the scope of PJ.04-W2-29.3.

The human actors participating in the exercise were the APOC representatives from ORY airport environment. Based on the identified potential impacts in the Human Performance Assessment Plan (described in Reference [11]), two groups of the APOC participants were highlighted in addition to common 'Airport Operator' group: APOC Coordinator and Airside Operations Manager. The evaluation was done in threefold ways: end-of-exercise questionnaire twice per day (see Reference [11]) post-trial questionnaire, and daily debriefing sessions with the participants. Additionally, the participants were provided with a pre-trial questionnaire to evaluate their understanding of the concept and the tools provided for the shadow mode trial.

Additionally, there was one airline representative (pilot) who participated in the discussions and final debrief on the last day of the validation, as well one Air Traffic Control representative (controller). However, in order to maintain the consistency in the measurements for each day, only verbal feedback was collected from the pilot, without collecting his feedback through post-exercise questionnaire. This is also based on the fact that none of the tools were planned to be provided to the pilot. As for the air traffic controller, only post-validation questionnaire was provided due to his limited participation in the exercise.

The assessment in this Section is focussed on the impact of the potential changes in roles and responsibilities of impacted human actors on the key areas of human performance, i.e. workload, situational awareness, human error potential, and timeliness of actions.

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4.2.6.1. Responsibilities and Operating Methods

***CRT-29.3-V2-VALP-HP1-001**: Enhanced responsibilities and operating methods are clear and consistent for the end users*

When asked about the need for a dedicated ENV manager role in the APOC, the participants agreed that rather than having a separate working position to specifically analyse ENV aspects, all APOC representatives should be trained on how to include these aspects in relation to their tasks. Some users stated that, if in the future the airport would share the same system with airlines, ground handlers, and air traffic controllers, there could be a potential need for an ENV manager in relation to all airport actors. Nevertheless, the participants felt that the ENV aspects should be centralised on the APOC level in order to facilitate their work. Hence:

The result is **OK.**

4.2.6.2. Situational Awareness

***CRT-29.3-V2-VALP-HP1-004**: The level of situational awareness is acceptable*

In order to assess situational awareness, the China Lakes Situational Awareness scale was used. The scale encompasses a hierarchical decision tree that guides the participants through a ten-point rating scale (1 - lowest 'my situation awareness with regard to the task was far too low, not possible to perform the task' to 10 - highest 'my situation awareness with respect to the task was excellent, I performed my task extremely well').

The participants' perception on the ENV indicators provision to the APOC was unanimously positive. All of the APOC representatives participating expressed that this information could positively impact their situational awareness.

The APOC participants agreed that at this stage, the ENV indicators would be used more to increase situational awareness with regards to the impact the airside operations have on the environment rather than to make operational decisions based on this information. Nevertheless, users agreed that because the environmental KPIs are currently not considered, the first stage of introduction would be to make the Airport Stakeholders aware of these impacts. Yet, users expect that in next stages the environment could drive the decisions making process, especially in the pre-tactical phase of operations.

	China Lakes Situational Awareness		
	Good - Excellent	Not complete - Reduced	Low – Far too low
Count	25	3	1

Table 9: China Lakes Situational Awareness ratings

25 out of 29 responses related to situational awareness of the participants were 8 or higher. This score corresponded to good SA with respect to the task and ability to perform tasks well all of the time. One participant rated their SA as Low. However, this was reported on the first day of the validation and may be associated with the lack of familiarity as the score improved over the following days. The participants were satisfied with the information provided and agreed that their roles and responsibilities related to these new aspects were fully understandable. The main reason for enhanced SA mentioned by the majority of participants was associated with their training and familiarisation with the concept, as well as the tools that were provided ahead of the validation exercise. Hence:

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The result is **Partially OK.**

4.2.6.3. Workload

***CRT-29.3-V2-VALP-HP1-003**: The level of workload (induced by cognitive and/or physical task demands) is acceptable*

In order to assess workload, the Bedford Workload rating scale was used. The scale encompasses a hierarchical decision tree that guides the participants through a ten-point rating scale where each point is accompanied by a descriptor of the associated level of workload (1 - lowest 'Workload insignificant' to 10 - highest 'Task abandoned. I was unable to supply sufficient effort').

On average, the participants agreed that the effort required to perform their tasks was acceptable. During this passive shadow mode trial it was not possible to assess the users' workload in relation to all their tasks during live operations. However, the users highlighted that even though there was a lot of information on the tools, the comprehensive training beforehand could mitigate any potential increase in workload that could arise with the introduction of additional information to their current working positions.

	Bedford Workload rating scale		
	Insignificant - Low	Moderate	High – Too high
Count	16	12	1

Table 10: Bedford Workload ratings

The workload was assessed after each block session of the shadow mode, which resulted in 5 ratings per participant during the three days of the validation. 16 out of 29 participants rated their workload as 3 or lower, which corresponds to low workload and enough spare capacity for all desirable additional tasks. 12 of the participants rated their workload between 4 and 6, which corresponds to reduced spare capacity, but no impact on the primary task. Only one participant rated their workload as 10 out of 10 in one instance. The workload was increased due to additional tasks done in parallel and was not related to the ENV tools. However, it must be noted that due to the nature of a passive shadow-mode exercise, the workload could only be assessed through standardised questionnaire means in relation to the use of the new tools, without incorporating that with the usual tasks of the APOC participants and without including ENV aspects into their decision-making process. Nevertheless, the participants expressed their concern on being presented with too much information. Essentially due to the need to monitor a number of different tools and dashboards. The users agreed that, if implemented in real operations, these should be limited to one or two dashboards presenting correspondingly noise and emissions KPIs. Otherwise, due to large amount of data presented, it may negatively impact their ability to achieve their tasks in a timely manner, as they would spend an increased amount of time and cognitive resource (working memory) while searching for relevant information. Hence:

The result is **Partially OK.**

4.2.6.4. Potential for Human Error

***CRT-29.3-V2-VALP-HP1-002**: The potential changes to human error and preliminary mitigations have been identified*

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In relation to the potential for human error, the participants agreed that as the ENV impacts are considered at the current stage to provide awareness rather than to drive operational decision making based on these indicators. Therefore, no increase of potential for such errors to occur is foreseen. All actors, including the pilot and the air traffic controller, agreed that the primary driver of making decisions is safety of operations and environmental impacts would not be considered in safety critical scenarios/ circumstances.

In relation to new responsibilities of the APOC representatives, the participants expressed the view that environmental impact needs to progressively become a new priority for all airport stakeholders and stressed that, after familiarisation period with this new information, it would be fully acceptable to take on this new responsibility. Hence:

The result is **OK.**

The **validation objective HP1 is Partially validated**.

4.2.7. OBJ-29.3-V2-HP2 Results relating to impact of changes in the system and Human Performance

4.2.7.1. Task allocation between human and the machine

CRT-29.3-V2-VALP-HP2-001*: The solution supports appropriate task allocation between human and the machine.*

The participants of the validation agreed that the distribution of tasks between the user and the system was reasonable. The system was responsible for calculating various indicators for noise and emissions, automatically comparing to the thresholds giving indication whether they are to be exceeded or not, as well as providing the what-if scenarios. The tools were acting in an informative manner and should serve the decision-making process as well as performance-related analysis in the planning and post-ops phases, but are not foreseen to have automated functions in a manner that would take over some of the users' tasks. Hence:

The result is **Partially OK.**

CRT-29.3-V2-VALP-HP2-005*: HMI supports achieving tasks in timely and accurate manner.*

Given that the validation took place as a passive shadow mode exercise, the timeliness of achieving tasks could not be fully assessed in relation to normal operating environment of the APOC participants. However, the participants feedback was collected with regards to how they would foresee their tasks impacted if the tools were implemented in live operations. The participants agreed that the number of the tools provided at once should be lowered to possibly two dashboards, corresponding to noise and emissions ENV indicators. Hence:

The results are **Partially OK**.

CRT-29.3-V2-VALP-HP2-002 *: The information provided by the system supports human performance*

The participants expressed that when they could not easily find information they were looking for on the dashboard, their performance was sometimes impacted, due to large number of different views and functions and their SA would improve if the dashboards were seamlessly integrated into one (or two). Additionally, a general recommendation for the tools' design was to have more meaningful visualisation cues that support easy understanding of the impact 'at a glance'.

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On a condition that the ENV tools would be presented in a more concise way, i.e. fewer number of separate tools, the APOC participants agreed that those tools would support them in their tasks. Especially, the users saw the value in having these tools for post-ops analysis, where they could really analyse the impact the airport operations have on environmental indicators and in the future, this could drive their decision-making processes, without negative effect on human performance. Hence:

The results are **Partially OK**.

4.2.7.2. Acceptability and Usability

***CRT-29.3-V2-VALP-HP2-003**: The HMI supports specific users' needs and associated tasks.*

***CRT-29.3-V2-VALP-HP2-004**: The HMI design is acceptable for the users.*

The mean usability scores derived from the standardised System Usability Scale are ranging between 50 and 60 out of 100 for all prototypes of the ENV tools except for the Taxiing Emissions Lab, which received mean rating close to 70 (Figure 13). According to the methodology (Figure 12), these ranks fall between 'OK' and 'Good' acceptability ranges. 'Poor' usability is considered below 40, therefore it can be assumed that all of the tools have the potential to be used by the airport stakeholders when further developed.

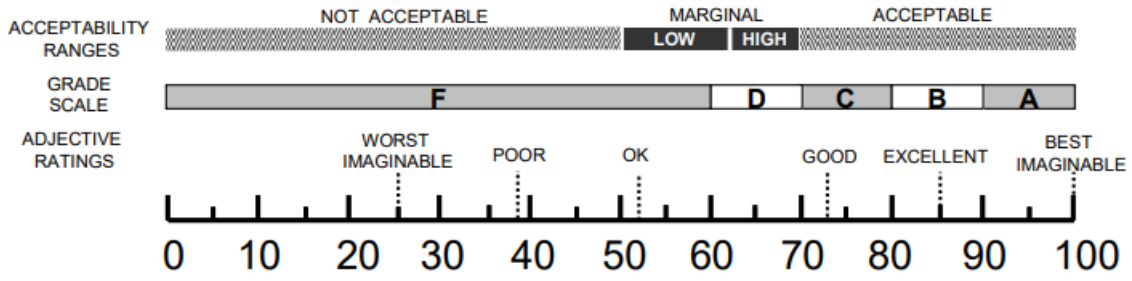

Figure 12: A comparison of SUS ratings and adjective ratings (Bangor et al. 2009)

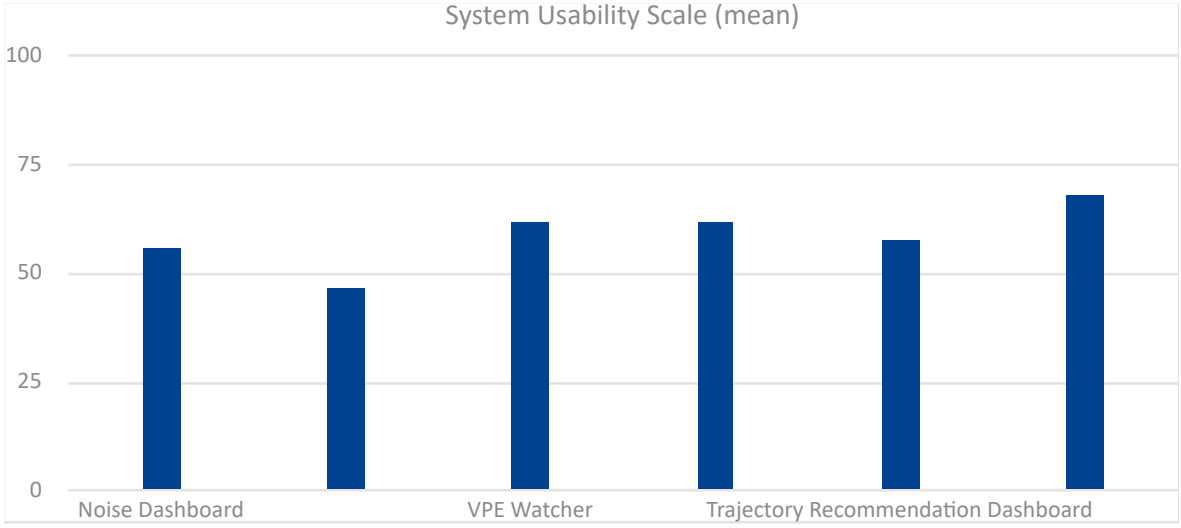

Figure 13: System Usability Scale results (mean)

It must be noted that this is an early stage of the tools' development and given the maturity level of this solution 29.3, lower than excellent usability scores were expected. The various tools are also at

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different levels of maturity. Nevertheless, the main aim of the usability assessment was to identify which of the functionalities were effective and which were deemed as not necessary or cumbersome. The comments of the users highlighted that globally, the tools are well structured to address APOC participants' needs. The following improvements / changes were proposed by the users to drive the future development of the ENV tools.

Noise Dashboard

- The accuracy of the system was not satisfactory, i.e. it took a long time to load the data and it was deemed by the participants that, at this stage, it would be difficult to use this tool in live operations. Additionally, some of the participants complained on the number of bugs that appeared during the validation, which made the tool difficult to use.

- The positioning of the filters on the dashboard made them difficult to understand and utilise fully, therefore the adjustment to the ops users is needed.

- For the noise contours, rather than using 1 hour average, the actual noise measured should be used.

- At a current stage, the alerts were not fully understandable by the users, therefore the visualisations could be improved.

Nevertheless, positive feedback was provided by the participants regarding this tool as well. The users agreed that the tool is good for visualisation of the noise contours, however the above-mentioned adjustments need to be made in order for the tool to be more useful for the APOC participants. From the air traffic controller perspective, the noise contours were deemed as not much aid in relation to ATC tasks. However, below FL060, the noise is a more important factor for the controllers than the gas emissions, therefore the information on noise would still be useful.

VPE Watcher

The tool was deemed as a 'good start' but not mature enough to consider its usability. Limited feedback was provided by the air traffic controller. The ATCO expressed that the tool may not be needed for their working position as they already have a tool to visualise the detection of the VPE. Nevertheless, for the airports where such VPE visualisations are not provided the tool may prove useful.

Runway Inspection Tool

The principal comment on this tool was that it addresses well the needs of the intended users. However, few of the respondents found the tool unnecessary complex and felt that it showed some inconsistency. As the users do not know the runway configuration for the next day, it was difficult to understand how they could make use of all the information provided by the tool. Therefore, operability of the tool requires some adjustments to make the tool more intuitive and simpler to use. For instance, some of the users suggested that the tool could automatically show the best times for the inspection.

This was considered to be more of a tactical tool rather than a pre-tactical tool. Users expressed that, in order to make the best decision, a combination of noise and emissions would be beneficial. Most concerns arose in relation to credibility of the information provided for D+1 forecast. This was caused by the fact that even weather issues that appear on the day of operations would result in different traffic flows. In addition, the time horizons used could be reduced from 1 hour to 0.5 hour in order to identify optimised runway inspection times.

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Trajectory Recommendation Dashboard (Fuel-Savings)

The main issue identified was that the tool should be supporting a “macro” analysis, rather than flight by flight, in order to support post-ops operations. Additionally, the score was impacted by the fact that the APOC representatives found it is designed primarily to be used by ATC, as they do not make decisions on the trajectory of the aircraft. The feedback from the air traffic controller was that the tool gives a good overview of the CO2 emissions estimation, however, at a current stage, the decisions are not made based on ENV impacts, therefore its usability is limited to providing more awareness, which is likely why the SUS score is lower.

Taxiing Emissions Tool

This tool was deemed as the most mature tool out of the six ENV tools presented to the users. The tool consisted of four separate views that the user could switch between. The responses towards the usability of four different views (functions) were consistently positive. The lowest score attributed to the ‘What-if Scenario – taxi in N-1 Engine’ view. However, the result may not be conclusive because for this view only 50% of the SUS questionnaire sheets were returned. This view permits the user to simulate a what-if scenario for N-1 engine(s) taxi in and to determine potential emissions and fuel savings. The participants commented that, in order to fully understand the numbers presented by the tool, training should include a clear explanation of the calculation methodology as well as to formulate the limits and constraints related to N-1 engine taxiing. Additionally, users shared that, for the potential savings (percentage value) as a result of N-1 engine taxi in, it would be interesting for them to see different ratios based on the aircraft type, in order to refine the results provided by the what-if functionality.

Another view with slightly lower rating was the ‘Planning View (D+1)’. This view allows the user to estimate the emissions and fuel burn for the next day (D+1), in relation to the predicted taxi times. The participants expressed that in the beginning they would require technical support, however detailed training on the tool prior to implementation would be a sufficient solution. The vast majority of the participants highlighted the need for training, in order to obtain good understanding of which elements should be primarily monitored as well as how to conduct the analysis. Some of the participants also expressed the concern that it would be difficult to predict taxi times when the parking positions are not yet known. Moreover, several additions to the tool were proposed by the users, namely:

- Addition of a functionality to include user input on the meteorological prediction;
- Improve accuracy of the taxi times data;
- Possibility to compare the predicted outputs with real data;
- Reference thresholds to be displayed on the forecast page to indicate whether the displayed day is above / below / the average, minimum, and maximum. For instance, the average reference thresholds per hour could be displayed.

The users highlighted the need for appropriate training as well as a user guide to all of the views for the Taxiing Emissions Lab in order to be able to use the tool without technical support. For the operational home page (live monitoring), the users commented on the large amount of information, which resulted in the need to look through the data several times in order to consider all given information. Additionally, the users expressed that it would be interesting to have a separate page where all the data is explained in scientific way, e.g. what is included / excluded from the calculations,

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allowing the user to precisely know the characteristics of the data, as well as a display of the forecast for the remaining hours of the day on the histogram, to further increase situational awareness.

The last view of the TEL tool is a post-operations report allowing the user to identify the emissions and fuel burn of the previous 7 days. The vast majority of the participants agreed that the tool can be very useful for post-ops analysis in the APOC. Moreover, they claimed it is an essential view in order to have an understanding of the trend over the past days and to have a reference. An addition of an evolution graph was proposed, e.g. to visualise the impact of a single runway use or increase in traffic. Hence:

The results are **Partially OK**.

4.2.7.3. Trust in the System Information

CRT-29.3-V2-VALP-HP2-006*: The level of trust in system information supports the usage of automated functions.*

Overall, the participants agreed that they would trust the information provided by the ENV tools. However, the users expressed that they are interested in more specific explanation on the formulas used to calculate certain impacts. For example, in the Taxiing Emissions Lab tool the users were interested how the 'top 5' airlines in terms of emissions are calculated, what data is taken into account and what data is excluded. The users also expressed that, in order to be fully confident in the outputs provided, the accuracy of some tools could be improved (Noise Dashboard and Ground Emissions Calculator) so that the users are reassured that the most updated information is presented. Hence:

The results are **OK**.

The **validation objective HP2 is Partially validated**.

4.2.8. OBJ-29.3-V2-HP3 Results relating to Communication

CRT-29.3-V2-VALP-HP3-001*: Communication between team members supports human performance.*

CRT-29.3-V2-VALP-HP3-002*: The level of shared situation awareness is acceptable.*

The vast majority of the participants expressed the need to share the ENV impacts with other stakeholders apart from airport, such as airlines and ground handlers, in order to incorporate ENV mitigations within decision making all of stakeholders. The discussions with the pilot and air traffic controller confirmed that availability of such tools could be a positive addition to the communication between stakeholders.

When it comes to communication between APOC participants, the users could not see any impact on human performance, as the use of the ENV tools would not require any specific communication phraseology nor would significantly increase the amount of required coordination. However, the users agreed that inclusion of the ENV aspects to their daily briefing with all airport stakeholders would be beneficial, but a strategy for companies between commercial and environmental concerns needs to be developed. Hence:

The results are **Partially OK**.

The **validation objective HP3 is Partially validated**.

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4.2.9. OBJ-29.3-V2-HP4 Results relating to transition factors – job satisfaction and training

***CRT-29.3-V2-VALP-HP4-001**: User feedback does not indicate a negative impact to overall job satisfaction*

23 out of 29 participants agreed that their job satisfaction would increase compared to current (2022) situation, with remaining participants claiming no change. From the air traffic control perspective, no change was foreseen, however it must be noted that the participation of the air traffic controllers was limited in this validation (one controller). None of the participants expressed potential decrease in their job satisfaction with the inclusion of the ENV tools.

During the debriefing sessions, the participants discussed the inevitability of the ENV aspects inclusion in the future airport operations and the coordination between airport stakeholders. Therefore, the participants expressed that because ENV aspects are important both to them and their company, having the ability to mitigate some of the environmental impacts would result in increasing job satisfaction. Hence:

The results are **OK**.

***CRT-29.3-V2-VALP-HP4-002**: Any required changes to training content per actor group are identified (preliminary identification only)*

All participants agreed that training on the usability of the tools is required in order to use the tools without assistance of a technical expert. Additionally, the users would like understand the theoretical aspects of the environmental impacts, i.e. on the science behind the ENV calculations and the importance of different indicators in relation to the environment / operations. Hence:

The results are **OK**.

The **validation objective HP4 is validated**.

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4.3. Confidence in Validation Results

4.3.1. Limitations of Validation Results

There are no specific limitations in the validation results. Despite the compressed timeframe for development, all of the tools functioned as desired from a technical perspective. Obviously, at this V2 level of maturity there is room for improvement in the way information is presented and the possible harmonisation of some of the tools. These elements have been described fully above.

The validation was conducted by the means of a passive shadow mode technique which offers a considerable degree of realism (use of live radar tracks etc). Nevertheless, this limits the ability to assess the human performance (e.g. workload, situational awareness, etc.) of the impacted actors, because the ENV tools were not used simultaneously with other tasks of the users. Nevertheless, the current assessment through questionnaires was supported by verbal discussions in the form of debriefings and relevant observations were made.

Only one operator team was available for the three days exercise. In order to increase the significance and quality of the validation results, the exercises were performed employing different scenarios on each day and with a specific focus on different tools in each session.

4.3.1.1. Quality of Validation Results

The participation of operational staff from ORY airport whose normal function is within the APOC gives a high degree of confidence in the quality of the feedback obtained and the pertinence of the exercise results as the Solution moves to the next phase of maturity.

4.3.1.2. Significance of Validation Results

The Significance of the validation exercise results is categorised as high and certainly well in line with reasonable expectations that one may have for a V2 exercise. The feedback from the participants (APOC staff) reflected the good performance of the system during the exercise and the potential for the inclusion of evolutions of the assessed tools in live operations in the future.

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5. Conclusions and recommendations

5.1. Conclusions

Conclusions on Human Performance

In conclusion, the ENV impacts information brings awareness of the airport operations impact on noise and emissions. The APOC representatives agreed that this would be a positive addition to their current operations and did not see negative effects this new task would bring in comparison to their current roles, responsibilities and tasks. On the contrary, the participants see the long-term benefit that this information would bring in terms of collaboration between stakeholders, improving their shared situational awareness and ultimately to support their decision-making process in order to make the airport operations greener. Nevertheless, for the next maturity phase of the solution, key human performance indicators, such as workload and situational awareness, must be assessed in relation to ENV tools integration with the APOC representatives' normal tasks.

The introduction of the ENV aspects such as noise and emissions are not foreseen to negatively impact any of the key human performance areas. The ENV tools are expected to improve situational awareness of the airport stakeholders, as currently none of these impacts are included in standard operations for the APOC participants. However, in order to ensure no increase in workload, the tools should be further integrated into one (or two) dashboards. The users agreed that, with the current amount of information provided, it was difficult to find relevant data at times.

Additionally, further development of the ENV tools is needed to ensure higher levels of usability and acceptability by the users. Nevertheless, at the current maturity, the feedback on the tools was positive, including overall acceptable trust in the system's outputs and interest to use these tools in post-ops analysis.

The participants expressed that the ENV aspects consideration is inevitable and having such tools is the first step in this type of coordination between all airport stakeholders, as the first step is to gain awareness how the operations impact the environment. The next step would be to apply that knowledge and incorporate into their decision-making processes which, based on the feedback, would be too early both at this stage of tools development and because currently those indicators are not considered in tactical decisions in live operations.

5.1.1. Conclusions on SESAR Solution maturity

The validation of this Solution has been performed using a single validation exercise in the airport of ORY.

The feedback from the participants provide **highly satisfactory conclusions for V2 maturity** and it is recommended that these results be used as an important input to the V2 Maturity Gate in early 2023.

5.1.2. Conclusions on concept clarification

The results coming from the Human Performance Assessment indicate that the **Solution 29.3 is operationally feasible** notwithstanding the need for further development of the different tool prototypes. Participants were confident that the introduction of ENV performance parameters into

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the overall airport operations decision-making process (the essential element of this Solution) is feasible in the future.

5.1.3. Conclusions on technical feasibility

The **Solution 29.3 is considered to be technically feasible** and the validation exercise in ORY has fully supported this assertion. Nevertheless, the importance of the quality of the information being provided by the individual tools has been highlighted.

5.1.4. Conclusions on performance assessments

Fully covered in Chapter 4, from a Human Performance perspective.
Potential gains in terms of noise and taxiing emissions are illustrated in the appendices. The validation exercise in active shadow mode or live trial will enable further performance assessment.

5.2. Recommendations

5.2.1. Recommendations for next phase

- It is recommended to assess how the ENV tools impact HP of the APOC participants, with the improvements proposed by the users in this validation (integration into singular dashboard per ENV KPI; specific technical improvements concerning data visualisation and additional desired outputs).
- It is recommended to assess how the ENV tools impact HP of the users when integrated with their primary tasks in the APOC.
- It is recommended to assess how the inclusion of the ENV aspects in the airport stakeholders decision-making processes impact their HP.
- It is recommended that degraded and abnormal modes should be validated in the next maturity phase.
- It is recommended that further assessment with regards to the changes in the operating methods of the impacted human actors should be conducted in the next maturity phase.
- It is recommended that the training of the users includes the theoretical aspects of the ENV indicators and impacts calculations, to ensure full trust in the tools' outputs as well as further increase in users' situational awareness.
- It is recommended that further validation exercises be performed but covering specifically the implementation of operational actions based on the outputs of the various tools i.e. closer to a live trial than a shadow mode trial. This will require the active participation of a wider range of stakeholders, notably the airspace users and ANSP.

5.2.2. Recommendations for updating ATM Master Plan Level 2

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All necessary changes to the ATM Master Plan have been already defined – relating to the Enablers linked to the Operational Improvement Step for this Solution. No further changes are considered necessary.

5.2.3. Recommendations on regulation and standardisation initiatives

Not applicable at this stage of maturity / development.

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6. References

6.1. Applicable Documents

Concept Development

1. SESAR Concept of Operations – Edition 01.00.00 December 2019

Performance Management

2. Performance Framework (2019) – Edition 01.00.01 December 2019

Validation

3. Validation Strategy – Edition 00.01.00 December 2019
4. SESAR 2020 Requirements and Validation Guidelines – Edition 00.02.02 May 2021

System Engineering

5. SESAR 2020 Requirements and V&V Guidelines

Human Performance

6. SESAR Human Performance Assessment Process V1 to V3 – including VLD – Edition 00.03.01 January 2020

Environment Assessment

7. SESAR, Environment Reference Material, alias, “Environmental impact assessment as part of the global SESAR validation”, Project 16.06.03, Deliverable D26, 2014.
8. ICAO CAEP – “Guidance on Environmental Assessment of Proposed Air Traffic Management Operational Changes” document, Doc 10031.

6.2. Reference Documents

9. D3.3.001-PJ04-W2-29.3 Interim SPR-INTEROP/OSED for V2 Part 1 – Edition 00.02.00 dated 25/02/2022
10. D3.3.020-PJ04-W2-29.3 Interim TS -IRS for V2 – Edition 00.02.00 dated 10/06/22
11. D3.3.010-PJ04-W2-29.3 Validation Plan for V2 – Edition 00.01.00 dated 12/04/22

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A. Validation Exercise 2931 Additional information

The validation of Solution PJ04-W2-29.3 has been performed with the single validation exercise (2931) described exhaustively in the main body of this report.

In this appendix, elements on the system architecture and preparation of the validation exercise and execution are provided.

A.1. Architecture

Three different platforms to support new operational concept have been used in the APOC :

- Noise monitoring and decision-making support tool
- Taxi Emissions monitoring tool
- Taxiing emissions "what-if" simulation tools and VPE watcher.

All platforms have been connected to the airport operational airport data base et surveillance data.

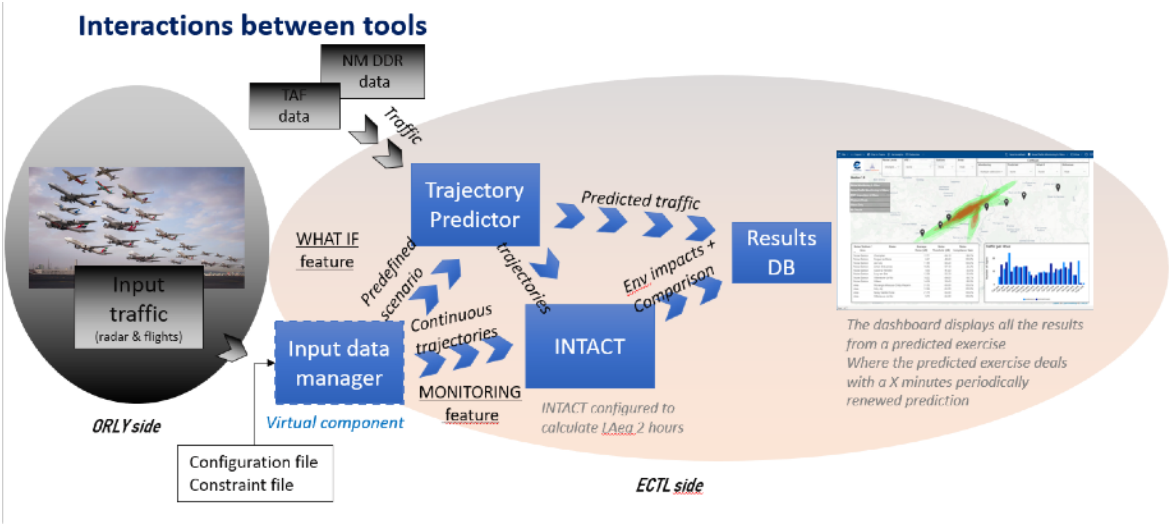

Figure 14 Architecture for Noise Dashboard in the EXE2931

The validation platform consists of noise dashboard where the ENV information is displayed coming from the INTACT tool. Detailed description of the INTACT architecture is given on the Figure 15.

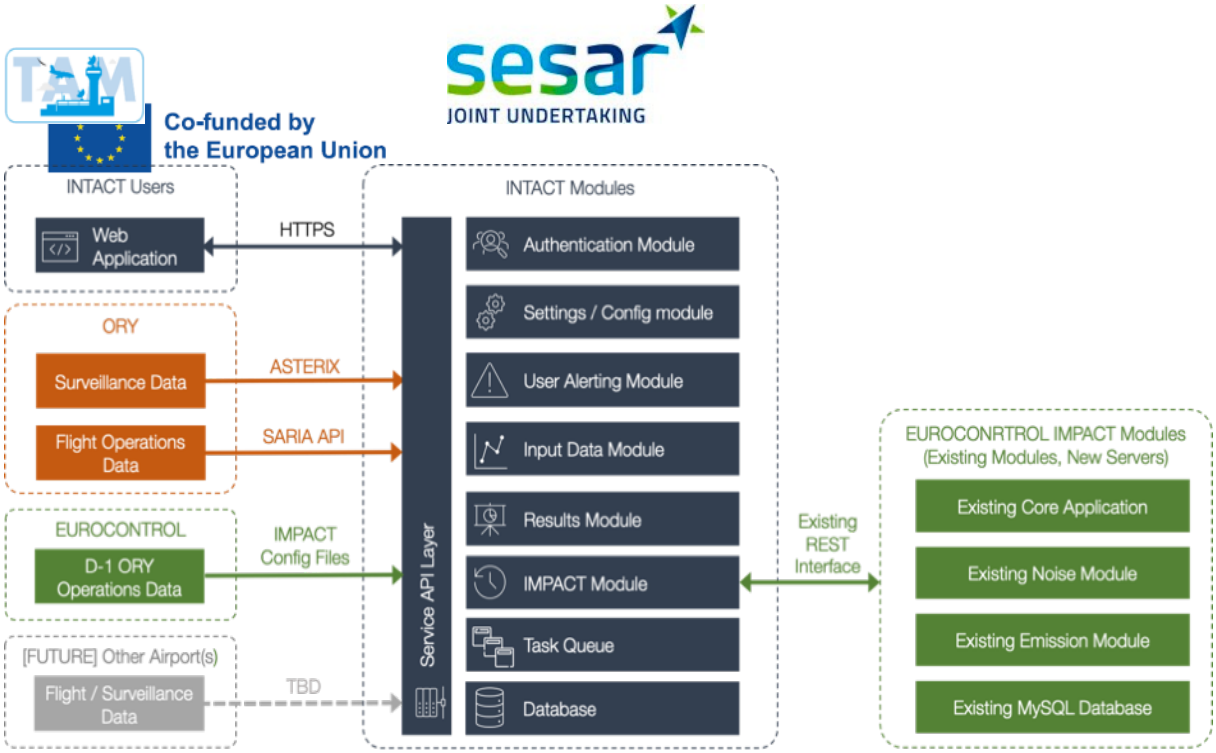

Figure 15 INTACT interface architecture

The architecture of the Taxiing emissions Lab tool, fed with different input data is presented on the Figure 16.

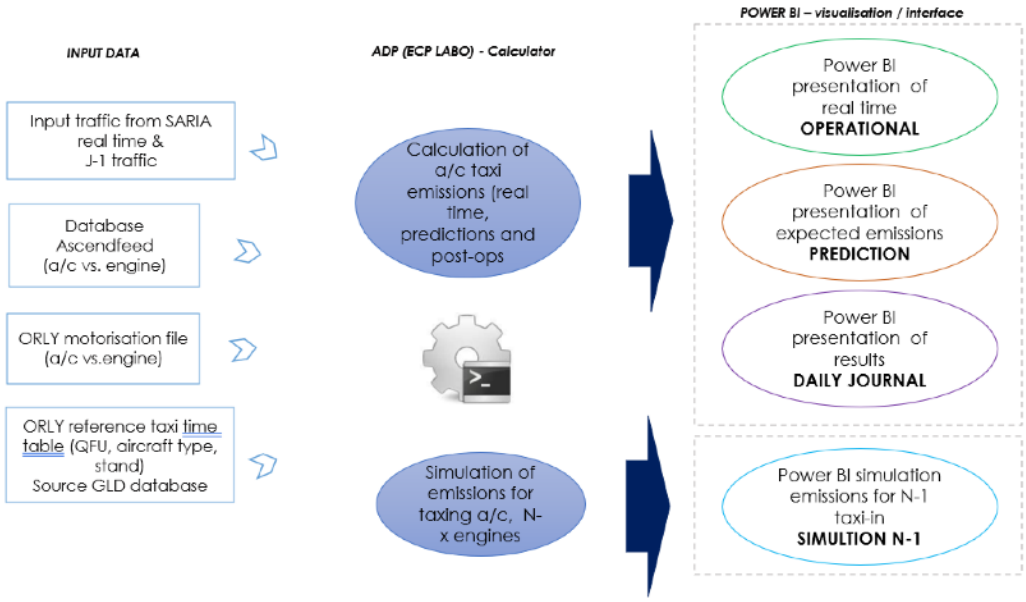

Figure 16 Architecture of taxing emission lab tool

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The architecture of tools supporting VPE monitoring and simulations to optimise emissions footprint is presented on the Figure 17.

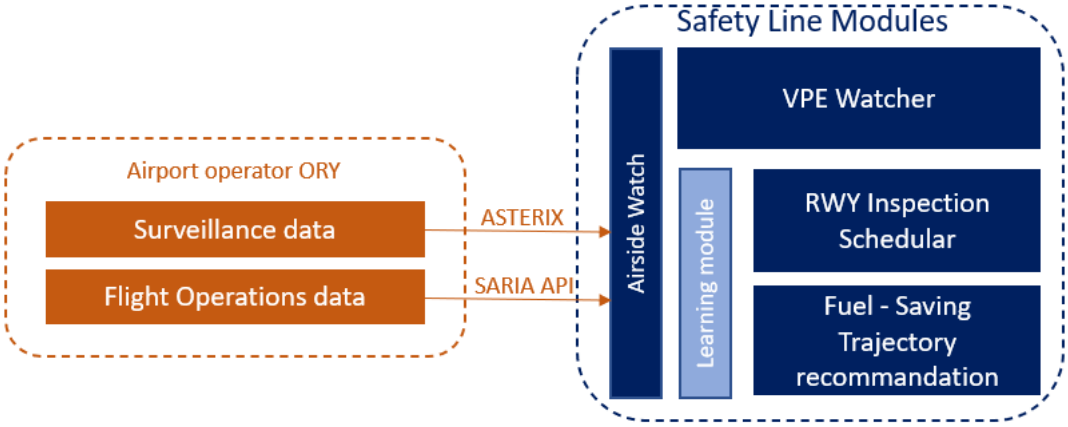

Figure 17 Architecture of system for VPE trajectory monitoring and ENV management tools

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A.2. Validation exercise preparation

Verification of the integrity and correct functionality of the validation platform was performed both 'remotely' and on-site in ORY. The remote testing consisted of evaluating the interface (web application) accessibility. Prior to the dry run which took place on the 20th of April 2022, on - site testing consisted in verifying possibility to access web application from the APOC and CDM cell room, situated close to APOC operational room). Setting of different screens on the walls have been completed two weeks before the validation exercise.

Validation exercise took place in the CDM cell room in the APOC at Orly airport. The CDM cell is used when collaborative decision-making process is needed to manage operational issues. Dedicated positions for APOC supervisor and other APOC participants are available. The room is equipped with two video-walls for displaying operational information.

Figure 18 Dedicated positions in the CDM room

Prior to the start of the exercise, participants were provided with detailed documentation in the form of PowerPoint slides describing the context, scenarios and objectives. The on-site training, on the 24 of May 2022, consisted of a 'top-down' approach covering the SESAR Programme and particularly the operational concept associated to the exercise. In addition, the functionality of the validation platform was clearly explained in the form of presentations and tutorials and with ample time for hands-on experience. Staff from Groupe ADP, EUROCONTROL and Safety Line were available to offer assistance and to answer questions from the participants.

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A.3. Exercise execution EXE2931

During three days validation exercise, plan, monitor, manage and learn use cases are tested. On the Figure 19, APOC supervisor analyses expected emissions using Taxiing emissions lab (TEL) tool.

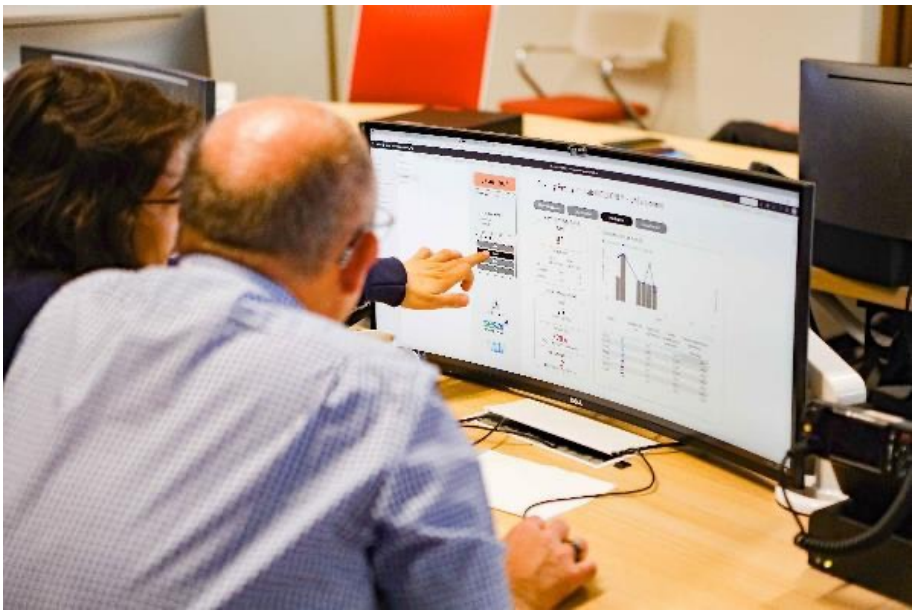

Figure 19 APOC supervision analysing predicted taxiing emissions with support du TEL tool

In addition to the ENV performance management tool, other tools used in everyday activity have been displayed on the video-wall as illustrates Figure 20.

Figure 20 APOC participant working environment including operational information on the wall

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B. Case Study – Gaseous emissions RWY inspection

Gaseous Emissions on Runway Inspection

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C. Case study - Taxiing modes and speeds at ORY airport

Taxiing modes and speeds at Orly airport.

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D. Case Study – Simulation N-1 engine taxi-in Emissions

CO2 and fuel savings of company A using N-1 engines for taxiing-in on the 1/06/2022 until 22:53 LT.

Potential fuel and CO2 saving in the scenario where 30% flights of company A at Orly will be taxiing in using N-1 engines is estimated in 5,9% as illustrated on following figures.

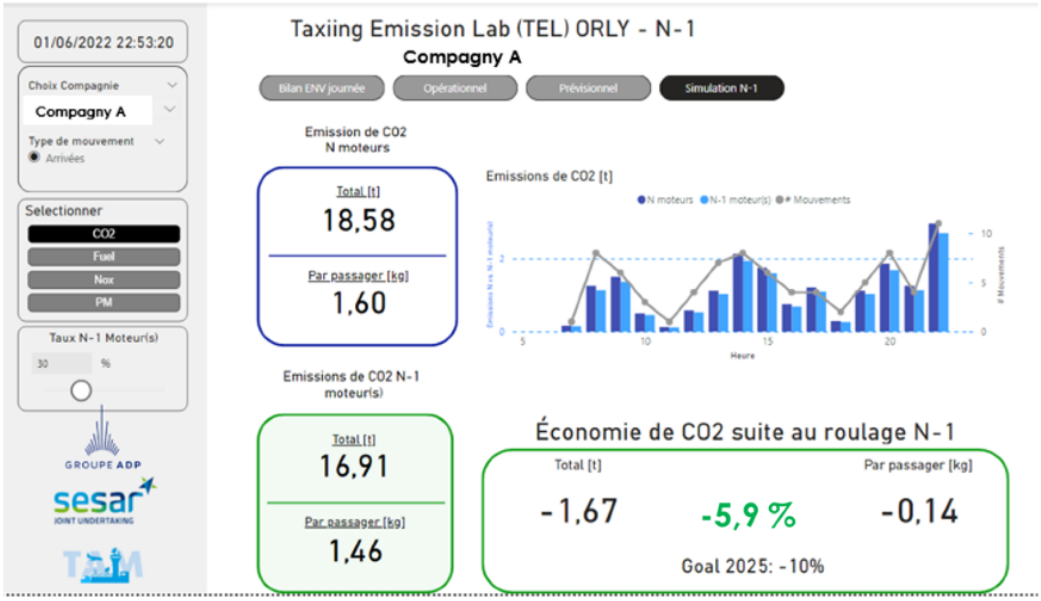

Figure 21 Simulation of CO2 gains for taxiing-in with N-1 engines (1st of June 2022)

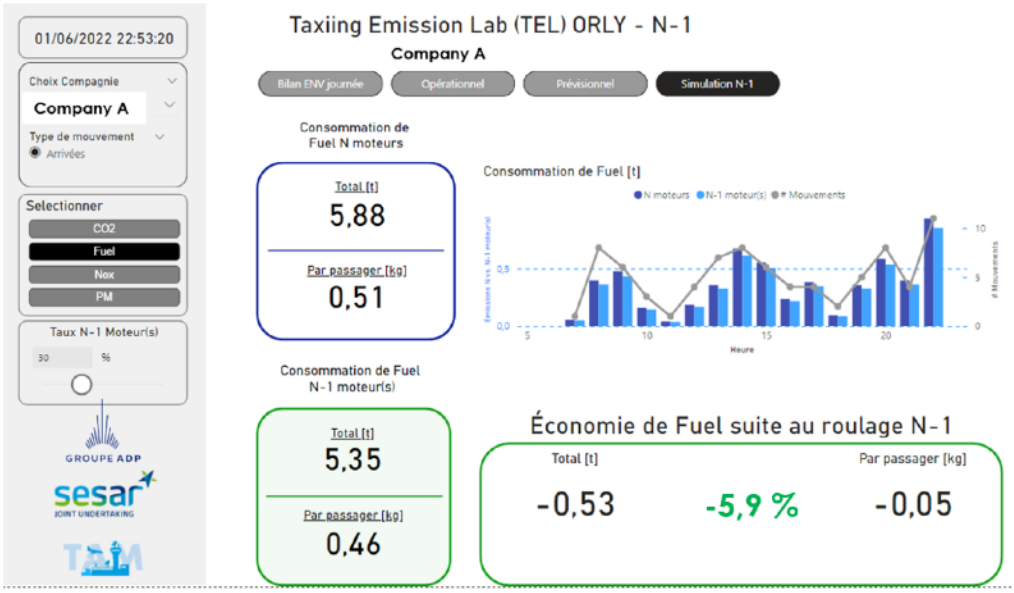

Figure 22 Simulation of fuel savings for taxiing-in with N-1 engines (1st of June 2022)

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E. Real time taxiing emission monitoring during the validation exercise

During three-days exercise, monitored CO2 KPIs is presented on the following figures.

On the first and second day, the target CO2 value per flight was reached. No warning colour is displayed on the dashboard.

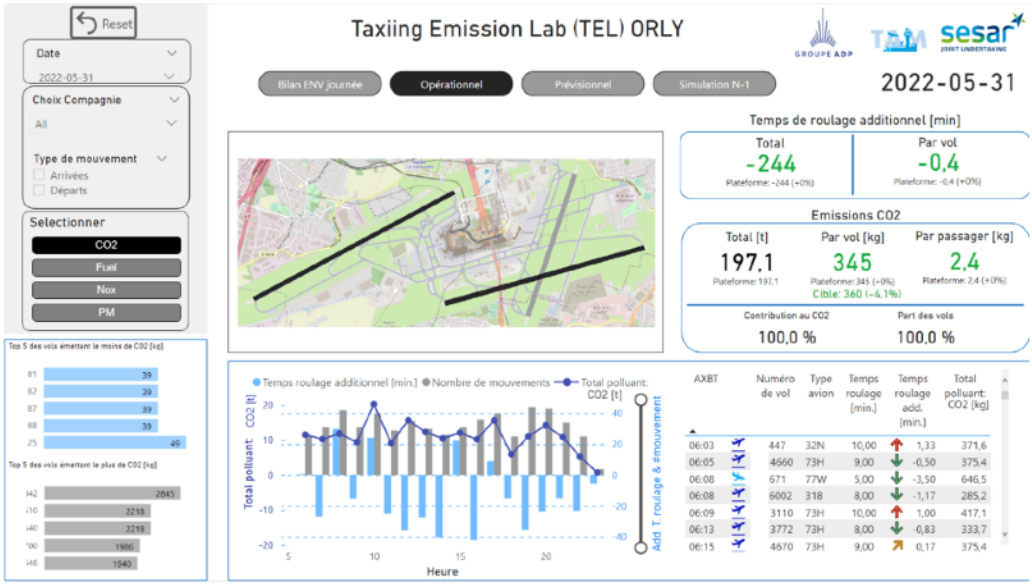

Figure 23 Live CO2 taxiing emissions monitoring on the 31st of May 2022

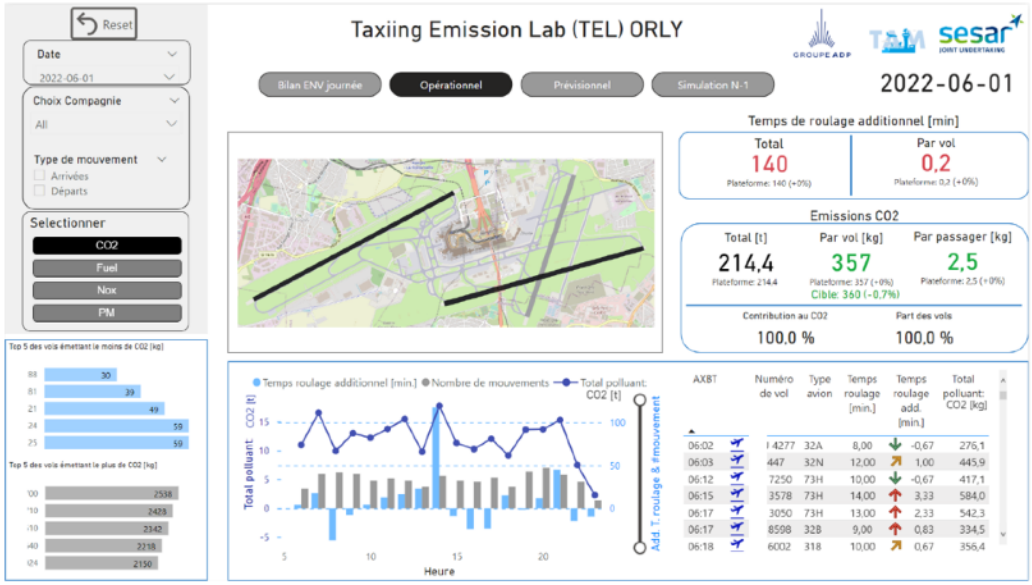

Figure 24 Live CO2 taxiing emissions monitoring on the 1st of June 2022

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On the third day, the overrun of 5,9% of the target CO2 per light has been observed.

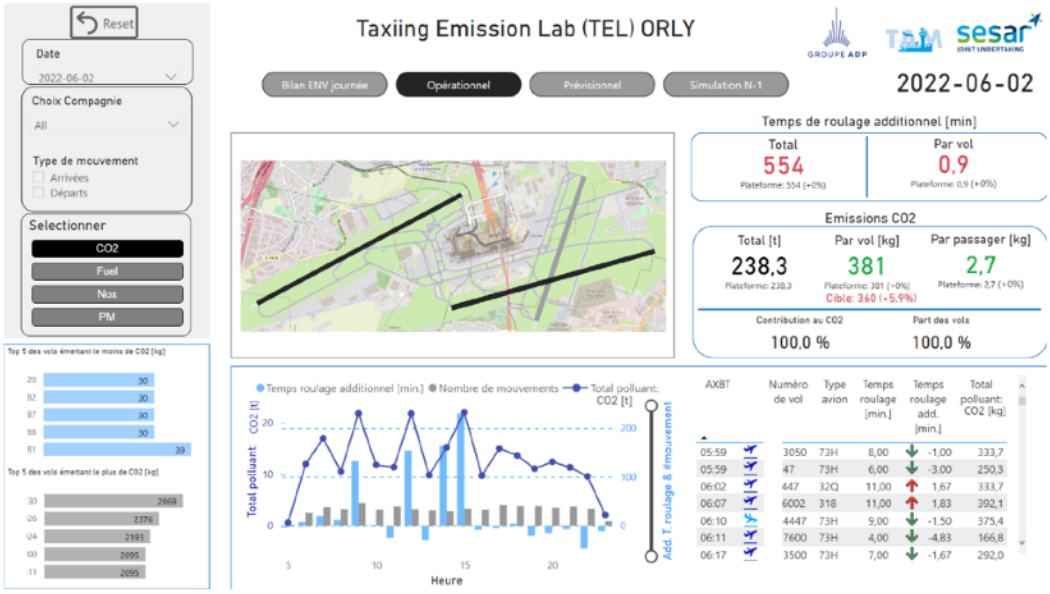

Figure 25 Live CO2 taxiing emissions monitoring on the 2nd of June 2022

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