



ACTIVITY REPORT FRENCH CIVIL AVIATION TECHNICAL CENTRE



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2021 A YEAR OF INNOVATION AND MAJOR PROJECTS



The year 2021 was, like 2020, strongly marked by the health crisis. Beyond the containment episodes, this crisis will have accelerated the transformation of the way we work together. After the shock of the first containment in 2020, we have learned to work remotely, to make better use of the collaborative tools we have at our disposal, which, thanks to the efficient work of the IT support, have continued to be perfected. Moreover, for the first time in our history, the STAC "journée technique" was held remotely. Despite some slight technical difficulties, with an increase in participation of almost 83%, we can say that this new edition was a success. The remote format allowed more foreign partners to follow the event. We will learn from this for the organisation of our next Edition, which may adopt a mixed format.

The rules for teleworking at STAC have thus evolved and transformed our professional relations. Almost all STAC staff now telework, often for two or even three days a week. As STAC is a service spread over three sites, we were already used to working together from afar. While we still need to consolidate together the means to maintain and strengthen the collective we form, our successes in 2021 show that we work as well in telework as we do in the office.

This activity report gives the reader a complete picture of these successes, in all our fields of intervention. There is not enough space here to mention them all, but it is worth noting that the year 2021 saw important advances for STAC in the fields of innovation, sustainable development and scientific cooperation.

Thus, the STAC is coordinating for the DGAC the Transport Innovation Agency (AIT), created in 2021 and jointly supported by the DGITM (Directorate-General for Infrastructure, Transport and Energy and Mobilities) and the DGAC. This is a strong recognition of STAC as a driver of innovation in air transport, not only by the DGAC, but also by the Ministry. This allows us to open up even more to the entire transport ecosystem, in the service of sustainable aviation that meets society's expectations.

This openness is reflected in our partnerships on subjects such as green airports and hydrogen. On these two topics, STAC, working in a consortium with Ineris and the Gustave Eiffel University, was selected as part of the 'H2 Hub Airport' call for expressions of interest launched by Airbus, the ADP Group, Air France KLM and the Île-de-France region. This issue is also central in the European OLGA project, led by ADP and bringing together nearly 41 partners including STAC. The project, launched in October 2021, aims to take a holistic approach to airports from an environmental point of view. STAC's experts are therefore involved in most of the department's areas of expertise, such as aeronautical pavements, air quality, biodiversity, visual nuisance for pilots, etc.

The STAC is also involved in safety and security with the study of issues such as the containment of lithium batteries, the evaluation of security equipment on airport platforms, assistance to State services with a security mission at airports, biometrics and AI for security. New air mobility is also an integral part of STAC's themes. For example, we can mention the acoustic measurements of electric aircraft and VTOLs carried out at the request of the DTA. This is just a sample of our topics. In all our activities, we are committed to providing high-level expertise, with the aim of serving sustainable aviation, while remaining an international reference. All this work illustrates the department's strategic project: "STAC 2035, preparing the tomorrow's sky".



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JANUARY

Publication of the results of the Green Airport AAP: the OLGA (hOListic Green Airport) project, led by ADP, is one of the three winners. Bringing together 57 partners and third parties, including STAC, the project aims to develop sustainable and innovative solutions on 4 test sites: Paris CDG, Milan Malpensa, Zagreb and Cluj.

MARCH

STAC wins the FEREC Foundation's call for projects alongside the Gustave Eiffel University. The EASY - DD(AI)2 project involves the study of a method for measuring damage to aeronautical pavements using low-cost cameras and the development of associated image analysis methods using artificial intelligence.

APRIL

Creation of the Transport Innovation Agency, prefigured by the Mission for Innovation, Digital and Territories (MINT) for the DGITM and by the STAC for the DGAC.

MAY

Selection of the Use-In H2 consortium (Ineris, STAC, Université Gustave Eiffel) as part of the AMI aimed at creating an airport hydrogen industry. Under the aegis of Airbus, the ADP Group, Air France - KLM and the Ile-de-France region, the AMI aims to identify solutions that will enable the Airbus hydrogen-powered aircraft to be installed by 2035. The Use-In H2 consortium is one of the 11 winners selected from 124 proposals.

JUNE

STAC Technical Day. For the first time, Due to the Covid pandemic, the event was held remotely on the two mornings of 10 and 11 June. 330 participants responded to STAC's invitation, an 83% increase in participation compared to the face-to-face editions.

OCTOBER

Launch of the OLGA project for a period of 5 years (60 months).

NOVEMBER

Inauguration of the Transport Innovation Agency in Toulouse, at the Directorate of Technology and Innovation (DTI) in the presence of Jean-Baptiste DJEBBARI, Minister Delegate for Transport, and simultaneously in La Défense, at the innovation laboratory of the Sequoia Tower.

The Minister inaugurated the first two local AIT offices, which will host the AIT's work (animation of collaborative workshops, hosting of innovative projects) and are intended to multiply over the coming months in order to create a territorial network throughout metropolitan France and overseas.

CREATION

OF THE

06



STAC IS ENTRUSTED WITH THE COORDINATION OF THE AIT FOR DGAC

The transport sector is facing major challenges: ecological transition, digital revolution, the need to strengthen territorial cohesion, resilience in the face of crises, social cohesion.

Announced in April 2021, the Transport Innovation Agency (AIT) is a catalyst for innovation in the transport sector. Its purpose is to federate the mobility ecosystem and its initiatives, to bring together economic players and representatives of the Ministry of Ecological Transition, and to foster a culture of open innovation.

The AIT is an organisation supported by the Ministry of Transport, co-led by the two general directorates of the Ministry, the Directorate General of Civil Aviation (DGAC) and the Directorate General of Infrastructure, Transport and Mobility (DGITM). It was inaugurated on 22 November 2021 by Jean-Baptiste DJEBARRI, Minister for Transport, and the two Directors General, Damien CAZÉ, DGAC, and Marc PAPINUTTI, DGITM. Through a memorandum of understanding signed between the two Directorates General, its management is entrusted to two coordinators: Claire BARITAUD, Deputy Director of Multimodality, Innovation, Digital and Territories (MINT) for the DGITM and Frédéric MÉDIONI, Director of the STAC for the DGAC.

At the DGAC, the AIT actions are carried out by a network of agents distributed among the four DGAC directorates, a network led and coordinated by the STAC.

In charge of detecting and supporting the most promising innovative projects, and as part of a process of stimulating and facilitating innovative ideas that will shape tomorrow's mobility, the AIT has launched the Propulse programme. The aim of the programme is to accelerate the most promising and high-impact innovations of all types: service, usage, technical, social, organisational and industrial, with the support of the departments of the General Directorates of Civil Aviation and of Infrastructure, Transport and Mobility.

In order to encourage the diversity and plurality of projects, four calls for projects constituting the Propulse programme have been

• The "Sustainable Transport" call for projects aims to support projects outside the administration that take part in the emergence of sustainable mobility services in order to benefit from state support to accelerate their development.

launched in 2021:

• The "Data Communities" call for projects aims to bring together data providers and solution providers within the mobility ecosystem.

• The call for projects "Space planning for multiple use" focuses, for this first edition, on the theme of U-space, which aims to experiment on a large scale with air traffic management services for very low altitude drones.

• The call for projects "Intrapreneurship" helps public officials and their departments to improve public service in the transport sector. The calls for projects

The "Sustainable Transport" and "Data Communities" projects received nearly 60 applications. 30 finalists had the opportunity to present their projects to juries composed of qualified and recognised experts from the transport sector, and chaired by MPs Jean-Marc ZULESI and Damien PICHEREAU.

The innovations proposed by the 15 winners cover a large number of modes of transport, both air and land, for passengers but also for goods, and are carried by players of all sizes.

The winning projects are accompanied by the AIT and benefit from the support of high-level experts. Carrying the AIT label, they are put in touch with the Agency's ecosystem and benefit from enhanced visibility through the Agency's and the Ministry's communications. The Propulse programme provides solutions for each innovative project leader in the field of mobility: removal of regulatory barriers, contractual and legal support, contact with experts to benefit from their expertise, identification of experimentation sites to test prototypes or first series, assistance in seeking public and private funding, contact with a scientific and technical network.

The "Intrapreneurship" call for projects also led to the selection of 5 winning projects. The selected intrapreneurs benefit from direct financing of their project up to €100k and from individualised and personalised coaching according to their project.

In addition, within the framework of the missions carried out by the AIT, the STAC works with all the other DGAC directorates to build and disseminate a common innovation culture within the two directorates of the ministry. To this end, several joint seminars with DGITM staff have been organised for managers and innovation stakeholders. A meeting in the form of a webinar is also offered to agents: the Digital Innovation Kiosks.

In order to carry out the various missions entrusted to it, the AIT has surrounded itself with several structuring partners. Collaborations with the Defence Innovation Agency (AID), the French Association of Competitiveness Clusters (AFPC), the French Institutes of Technology (FIT) and the Fabrique des Mobilités (FabMob) were announced at the AIT's inauguration.

In 2022, the AIT will continue its development with high ambitions: the year will be marked by the support of the selected Propulse winning projects, by the setting up of a strategic orientation council, contributing to the elaboration of the AIT's strategic roadmap, and of a funders' club in order to work on the orientation of funding towards innovations in the transport and mobility sector.



QUALITY MANAGEMENT

QUALITY MANAGEMENT AT THE CENTER OF THE STAC STRATEGIC PLAN



The STAC main goal throughout its Strategic Plan is to remain the DGAC's expert service by continuously improving the value and relevance of its outputs.

The STAC is currently in a cycle of opportunity, placed at the heart of innovation and standards that must define tomorrow air transport. The ongoing health and economic crisis is forcing our sector to find solutions that will enable it to revitalize itself and address climate change challenges.

But in a changing world, those that do not evolve are rapidly overtaken.

The quality management system serves to ensure that we can provide products and services that are not only compatible with current regulations, but also meet the changing needs of our customers, however varied they may be.

The ISO 9001 standard can be a guiding light to bring out the talent of each STAC employee. It is structured in its latest version to lead us to question the best way to manage our risks and opportunities. It leads us to rethink the transversality of our activities in the different areas of the STAC. To develop sustainable expertise, we have placed transversality at the very heart of the STAC 2035 strategic plan, in order to share best practices and, in a context of successive crises, to anticipate constraints.

One of the strengths of a successful quality management system is risk management. Risk should be understood as the uncertainty inherent in any human activity. Thus, defining risk consists of considering the uncertainty of each process put in place to produce products and services that will satisfy the beneficiaries of the process. The treatment of each of these risks is specific to the activity concerned and may include seizing an opportunity, for example in an emerging market. Again, this is not without risk to the organisation.

Quality management, a voluntary approach by a company, is essential for measuring the achievement of objectives based on defined procedures, including those in the plan STAC 2035. At the same time, it represents an opportunity for our entity to rethink our collective work and to put in place robust methods to meet our ambition as a complex civil aviation expertise service.

In this process of continuous improvement of customer satisfaction, together with the recognition of the work of STAC staff, quality management can be an essential link in the collective success of STAC 2035.

OUR JOB: TO LISTEN TO YOU!

A pillar of quality management is the continuous assessment of client satisfaction. To meet this requirement of the ISO 9001 standard, STAC has set up a standardised customer feedback system based on the LimeSurvey solution. The actors of STAC's processes can now find a catalogue of questionnaires forms on the intranet that they can use as is or adapt as needed. These forms are seamlessly transformed into online questionnaires that are sent to clients as a weblink. A guide for analysing the survey is also available on the intranet.

A METRONOME FOR METROLOGY

One of the levers for progress in quality is to promote the use of best practices. The metrology community of STAC laboratories has therefore launched a working group whose objective is to harmonise the current metrology function. Sharing and unity are the key words of the group. The first stage aims to decompartmentalise the laboratories through regular communication on their practices and tools. The second step consists of reaching a consensus on the best practices and the most suitable tools for tests and measurements in the various STAC accredited activities.

INTERNAL AUDIT ACADEMY

Controlling our products and services is an ambition that is reflected in all our activities and at all stages of these activities. Certification or annual accreditation is a recognition by an external body that verifies this control by sampling. But to really guarantee control, it is necessary to check more frequently and more exhaustively all the production, or the management processes involved.

The actors of this verification are the internal auditors. To replenish our pool of Sherlock Holmes to the tune of a dozen agents, STAC called on AFNOR Compétences. After an initial three-day theoretical module based on ISO 9001, the conduct of the audit and an initial role-playing exercise, our apprentice auditors were put into real conditions to carry out a one-day audit of a STAC process under AFNOR supervision. After this accreditation, several auditors have already carried out new internal audits of our processes in total autonomy, each time identifying areas for progress, sensitive points, and non-conformities to be corrected in order to ensure the continuous improvement of our activities.



STOP

SAFETY

STAC SIGNS A PARTNERSHIP WITH MICHELIN AND UAF

In the spring of 2021, a multi-year partnership was set up between STAC, the Michelin Group and UAF & FA. The objective is to pool potential research topics related to the improvement, use and impact of tyres on aeronautical pavements, with a view to continuously improving the safety of ground movements.

Aircraft tyres are subject to extreme stresses (speed, load, resistance to FOD, etc.) and are the essential interface for controlling aircraft trajectories.



A set of topics has been defined by the partners for a progressive study. The first topic concerns the Rubber deposits on of runways, the mechanism of which, as well as the impact on drainage and runway adherence, must be better understood. At the same time, it concerns the removal of rubber, both in terms of the frequency of intervention and the techniques currently used in France, which are considered aggressive. For Michelin, the challenge lies in improving tyres and their endurance.

The partners have defined a work programme (qualitative and descriptive study, statistics, in-situ monitoring, laboratory tests and experimentation) to better understand the various aspects of this phenomenon and its consequences. On the airport side, the main partner in this project is Roissy-Charles de Gaulle airport, which is highly exposed to this phenomenon due to its traffic.

Other topics will be launched at the end of 2022, following this first joint study.

AIRFRANCE

OLGA PROJECT, WORK ON SUSTAINABLE PAVEMENTS

The OLGA (hOListic Green Airport) project, led by the ADP Group, was selected by the European Commission as part of the H2020 call for projects under the Green Deal, focusing on environmental innovation.

STAC is part of the OLGA consortium along with 40 other partners. Within this framework, STAC is particularly involved in Work Package 4.2.1 dealing with green and intelligent pavements. Innovations are being studied by the SA department teams, in conjunction with ADP, on the topics of pavement design, materials, asset management and intelligent pavements. Notable work is in progress on the recycling of pavement materials and innovative design methods, which should open the door to 1:1 scale experiments at CDG airport.



CONTAINMENT OF LITHIUM BATTERIES

Initiated in 2020, the joint study by STAC and the Direction Générale de l'Armement Techniques Aéronautiques (DGA TA) on the behaviour of the containment devices of portable electronic devices (PED) powered by a lithium battery was completed in 2021.

The tests revealed differences in the performance of some of the equipment tested in terms of smoke and/or fire resistance. The lack of an international standard or certification for these products partly explains these results.

The results of this study were presented to the CASD as well as to the ICAO via the Safety and Cabin Group (SCGSWG).

PAPI WEDGING BY DRONES

The verification of the setting of the 4 lighted units of the visual approach slope indicator (PAPI) is a periodic and regulatory action. It aims to check the setting angle of each PAPI unit in order to give the pilot reliable visual information on the glide path.

The main methods of verification are the use of an aircraft flying sinusoidally on either side of the glide path or an operator detecting the colour transition with a gondola. Both of these methods are expensive and can generate significant runway occupancy time.

The emergence of innovative systems, reducing these constraints for the airport operator, led STAC to organise a comparative measurement campaign between the different methods and systems available: aircraft, gondola, alidade, drone and ground photometry and colorimetry equipment.

The analysis of the results in terms of accuracy and precision of measurement led to three favourable technical opinions (two unmanned aircraft systems and one ground equipment). These opinions are available on the STAC website under the heading "Publications".



AUTOMATED DAMAGE SURVEYS WITH LOW-COST CAMERAS



At the end of 2020, in partnership with the Gustave Eiffel University, STAC launched a research programme on the automated survey of damage to aeronautical pavements, using low-cost vehicle-mounted cameras.

The aim is to develop an alternative method to manual damage surveys, which are on the one hand subjective and on the other hand time-consuming and involve significant operational constraints.

The project includes, in addition to the automated survey method, the development of advanced image analysis methods using artificial intelligence. A feasibility study was carried out at the end of 2021 at Lognes airport, which made it possible to validate the measurement device and then to train and test the image analysis recognition algorithms. The results obtained are very encouraging.

A more ambitious experimental campaign is planned for early 2022 at CDG airport.

INTERNATIONAL WORKING GROUPS RELATED TO AIRPORT DEVELOPMENT AND OPERATIONS

In February 2022, the fourth plenary meeting of the ICAO Aerodrome Design and Operations Panel took place. On this occasion, ADOP members approved proposed amendments that could impact airport design and operations.

The revision of the width of runway bands without code digit 3 instruments was accepted, reducing it from 150 m to 110 m and smoothing the increase in band widths with the code digit.

Code digit	1	2	3	4	
Currently	60 m	80 m	150 m	150 m	
Proposed	60 m	80 m	110 m	150 m	

The previous modification is based on the consideration of wingspan as well as on the analysis of a base of aircraft lateral exits on these runways that STAC had contributed to build up, in comparison with runways without different code numbers.

The review of obstacle limitation surfaces (OLS) initiated in 2015 was concluded in December 2021, with the proposal for a complete revision of Chapter 4 of Annex 14 describing OLS and the introduction of an associated chapter in the PANS-Aerodromes at a Symposium organised by ICAO and ACI. The feedback from the community represented by several hundred participants at the symposium was positive. This feedback led to a proposal for revision, to which STAC contributed its expertise. This proposal was adopted by the ADOP members.

Subject to approval by the Air Navigation Commission, the schedule provides for:

- a letter to the States in early 2023, seeking their views on the proposal;
- the entry into force of the new edition of Annex 14 and the PANS-Aerodromes in 2024;
- compliance in 2028.

Finally, the ADOP approved the introduction of new regulations on ground handling, to which STAC has actively contributed. In response to comments made by various authorities at the end of 2021, the final proposal involves the gradual implementation of provisions governing ramp activities and ground handling supervision.

In July 2024, a first phase will bring into effect the amendment of Annex 14 including simple provisions on apron layout and management as well as impact assessment and ground handling monitoring.

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ACTIVITY REPORT 2021

FROM ACN/PCN TO ACR/PCR

A NEW METHOD FOR COMMUNICATING THE BEARING CAPACITY OF PAVEMENTS

The ACN/PCN method, published in 1981, is a system for communicating the bearing capacity of aeronautical pavements. It is used by infrastructure managers to assess the admissibility of aircraft on their pavements, and is therefore part of an asset management approach. However, this system has shown its limitations. Indeed, it is based on so-called semi-empirical methods, which make it difficult to take into account complex geometry landing gear and new generation materials. In addition, the procedure for assessing the accommodation of aircraft outside the reference traffic (so-called overweight aircraft) is not standardised at international level. Finally, design methods have evolved considerably over the last few decades, and now tend to be rationalised on the basis of linear elastic modelling of pavements.

For all these reasons, ICAO launched in 2012, via the APEG (Airfield Pavement Expert Group), in which STAC participates, a vast revision of the ACN/PCN method with a view to evolving it towards a new system known as ACR/PCR. A sub-group of the APEG was set up for this purpose, the ACN/PCN Task Force, comprising STAC, the FAA, Airbus and Boeing. The work of this sub-group has led to the development of a generic method for calculating ACRs (with the provision of a reference calculation software) and PCRs, to be adapted by each ICAO Member State at national level. The ACR/PCR method retains the same philosophy as its predecessor, based on a comparison between an indicator of aircraft aggressiveness, the ACR, and an indicator of pavement bearing capacity, the PCR. The major changes are that ACRs and PCRs are now calculated using a linear elastic model, and the categories of supporting subgrade are harmonised for both flexible and rigid pavements.

Regarding the calculation of PCRs, each State may, if it wishes, use national specificities. STAC has made this choice concerning the calculation of PCRs for rigid pavements. In fact, those pavements are likely to fail either by brittle failure (due to excessive stress when a given aircraft passes over them) or by concrete fatigue (due to repeated passage of aircrafts). However, the generic method currently only considers the fatigue criterion. The STAC has therefore conducted an extensive comparative study in order to validate a second criterion that takes into account the possible brittle failure of rigid pavements. The PCR of rigid pavements, in accordance with French specificities, will then be the most penalising value among the PCR obtained according to the fatigue criterion and the one calculated using the brittle failure criterion. This specificity makes it possible to be more consistent with the calculation of rigid ACRs (which takes account of brittle failure and not fatigue), while retaining the philosophy desired by ICAO for the calculation of PCRs (opening up the possibility of making limitations on both aircraft's weight and the number of passes authorised). It also allows compliance with the rational design method for rigid pavements, currently under development at STAC.

The PCR calculation method will be implemented in a dedicated module under the Alizé-Aeronautics software. This module will be free of charges and accessible to all. It will allow the calculation of PCRs for flexible and rigid pavements, taking into account French specificities, to carry out admissibility studies for overload operations, and to generate an associated calculation note. The module for the calculation of PCRs on flexible pavements is scheduled to be released in the summer of 2022, while the integration of rigid PCR calculations will be carried out by the end of 2022.

The ACR/PCR is effective since July 2020, initiating a transition period during which both systems (ACN/PCN and ACR/PCR) coexist. In November 2024, only ACR/PCR will be allowed. In order to prepare for the transition to ACR/PCR, STAC has already undertaken training activities on this new method via ENAC. The sessions proposed by STAC are co-animated with the APEG chairman, and focus on the fundamentals of the method, on the French specificities, but also on the correct use of the tools made available by STAC. The positive feedback and the strong interest for this training have allowed its renewal for the year 2022. STAC will also participate in training activities at the international level via APEG, with training sessions planned in the regional offices of the ACI.

Finally, the STAC will organise, with the support of the DSAC, a symposium to launch the ACR/PCR method. This will be an opportunity to present the documentary and software tools made available by the STAC, but also to allow the actors to exchange on the theme of asset management. This symposium will be held in the second half of 2022, depending on the evolution of the health regulations in force.

LIGHTING OF WIND TURBINES

STAC is participating in the IEC work on marking and lighting of wind turbines through the PT61400-29 working group. This draft standard aims to complete the ICAO requirements, in particular for wind turbines located within a wind farm, considering separately onshore and offshore wind farms. Qualitative provisions are also introduced, in relation to the issue of compatibility of LED lights with Night Vision Goggles (NVGs). In addition, various methods of reducing light pollution caused by wind turbine lighting are described, including systems for adapting (reducing) the lighting intensity of the lighting in the event of optimal meteorological visibility conditions or systems for activating the lighting only when an aircraft is detected in the vicinity of the wind farm.

At the level of the French State, the problem of light pollution caused by the beaconing of wind turbines is also developed by a working group co-lead by the DTA and the DIRCAM. Experiments have thus made it possible to authorise medium-intensity lights, known as "modified beam" lights, with a beam aperture that has been measured on site, for the night-time beaconing of the main wind turbines of a wind farm, instead of medium-intensity type B lights. Other experiments are also underway on aircraft detection systems for conditional activation of wind turbine lighting.

STANDARDISATION OF SYSTEMS FOR IDENTIFYING METEOROLOGICAL CONTAMINANTS ON RUNWAYS



The European working group WG-109 for the standardisation of runway weather information systems, aiming to ensure that aerodrome operators have robust devices to facilitate the implementation of the Global Reporting Format, completed its work in 2021 with the publication of a Eurocae standard in December. The working group, started in 2018 and led from the outset by STAC, included operators, industry and authorities from different countries. Its work has enabled a consensus to emerge, which has been transcribed into a normative text.

STUDY OF LANGUAGE SKILLS ON THE MANOEUVRING AREA

The new requirement ADR.OPS.B.029 of Regulation (EU) No 139/2014 states that all personnel holding a driving licence on the manoeuvring area of European certified aerodromes (e.g. ARFF officers, officers carrying out runway inspections or maintenance officers) shall demonstrate a satisfactory level of English, i.e. at least ICAO operational level (level 4).

The CASD called on the STAC to help it assess the impact of compliance with this requirement on airport safety. The possibility of derogation is provided for but must be accompanied by an assessment that demonstrates that the level of safety is equivalent.

Within the framework of this new study, STAC will include the expertise and opinion of all stakeholders affected by the regulatory change. Thus, the Local Runway Safety Teams and Safety Management Systems of the airport operators, the air navigation services and the regional delegations of the DSAC will be fully involved throughout the study.

This project echoes the study conducted by STAC in 2017 on the obligation of pilots to use the English language only for radio communications.

THE L2E WITH NEW TOOLS FOR ITS INTERLA-BORATORY COMPARISON CAMPAIGNS

The Laboratoire Essais et Expertise (L2E) regularly organises inter-laboratory comparison campaigns (CIL). In order to optimise this approval process for functional continuous friction measurement equipment in accordance with technical appendix no. 1 of the decree of 10 July 2006 relating to the technical characteristics of certain land aerodromes used by fixed-wing aircraft, the L2E has just deployed an application to automate this approval process.

It is an internet platform called OMEGA (Outil Modulaire pour l'Exploitation et la Gestion des Mesures d'Adhérence) which covers the whole process from the registration of the participants, to the processing and exploitation of the measurement data, up to the edition of the reports. This highly ergonomic tool has successfully reduced the time spent on CIL by the various parties involved (clients and STAC staff) and, above all, it reduces the risk of errors inherent in human handling of the data from the measurements.

With the aim of continuous process improvement, it is planned to extend the scope of this tool to the intrinsic measurement of runway friction in situ.

The deployment of OMEGA was carried out at the same time as the commissioning of two new, more powerful towing vehicles during a CIL. The additional power of the vehicles gives them a greater water-carrying capacity. This means that they replace the ageing vehicles that were previously used. The new vehicles now have a shorter acceleration distance from the runway.

This new performance allows more runway lengths to be covered and saves time when measuring on longer runways with only one full tank of water.

In the same spirit of seeking efficiency and performance, the L2E has diversified its means of measurement, in particular by developing a section devoted to the bearing capacity of aeronautical pavements. Thus, it has acquired two dynaplaques that meet the various standards in force, including NF P94-117-2 (October 2004). This equipment measures the modulus of the sub-base layer before laying the asphalt and detects compaction problems. One is portable (less than 30 kg) and allows access to difficult terrain or terrain not suitable for vehicles. The other is transportable with a pick-up equipped with a lifting crane and can perform 70kN impacts on the ground with a 150kg drop weight. In addition, the laboratory is equipped with a heavy weight deflectometer to measure the deformation of rigid pavements, particularly at the plate joint.

All this new equipment enables L2E to offer high-level services to all its customers and principals. In addition, STAC's research and development teams now have access to the data obtained through the various measurements carried out on behalf of external entities or on the department's study platforms.



ELECTRICAL STABILITY MEASUREMENTS ON LED LIGHTS

The maintenance of lighting has been eased by the advent of LEDs, as incandescent (now halogen) lamps need to be replaced every 1,500 hours.

But the existing electrical circuits have a structure optimised for these lamps:

• the "series" circuit simplifies connections, makes the lighting intensity of the beacon uniform and allows it to be adapted to visual conditions by means of a current regulator.

However, the electroluminescence of LEDs is very different from incandescence. Each LED light therefore includes a "counter-regulator" to imitate the light intensity of a halogen lamp. But, while it imitates this "light intensity profile", it cannot also imitate its "electrical impedance profile*".

This results in impedance fluctuations that upset the current regulator. These disturbances are most noticeable during transient conditions: switching on or changing light intensity.

The energy and lighting subdivision is developing tests to qualify and quantify as far as possible the potentially disruptive nature of LED lights.

* The relationship, more complex than a resistance, between voltage and current in an electrical circuit element. From Latin "impedare", to prevent: this report indicates how this element prevents the flow of current.

GLOBAL REPORTING FORMAT: ÉPILOGUE

Delayed due to the Covid-19 epidemic, the Global Reporting Format has come into force in Europe and Canada on 12 August 2021 and from 4 November 2021 in the rest of the world.

The STAC has been heavily involved in this issue for several years, both for the French and international regulatory contribution and for the early implementation at two airports in mainland France to allow initial feedback which would benefit to everyone. In 2021, the STAC completed its range of actions by producing materials for operators, both by producing a guide and by assisting ENAC in the development of its online training. It also participated in the DGAC steering committee and acted as the French interface with ICAO.

SSLIA OPERATIONAL OBJECTIVE: 2 MINUTES

Mandated by the DSAC, the Sub LIA of the STAC is in charge of evaluating within the ARFF units, the impact of reducing the intervention time from 3 to 2 minutes on each runway point in service. This is an operational objective for these units operating on certified aerodromes.

This change is imposed by the EU Regulation 139/2014. The Sub LIA proceeded to an inventory of the situation of the ARFF stations, the routes to the runways, the vehicles in service and the times achieved by the ARFF. Ways of improvement were proposed and quantified where necessary in order to evaluate the overall cost of this change.



TOOLS TO ASSIST IN RISK ANALYSIS OR REPRESENTATION OF APPLICABLE AIRPORT SECURITY REGULATIONS

TOOL FOR ANALYSING THE RISK OF VISUAL DISTURBANCE DUE TO THE REFLECTION OF THE SUN ON PHOTOVOLTAIC INSTALLATIONS

The tool has evolved in 2021 with the optimisation of the algorithm and the addition of new functionalities to improve its usefulness in the evaluation of projects against the criteria of the relevant Technical Information Note (TIN). The tool now allows:

- taking into account the visual field of the pilots;
- the inclusion of FATOs;
- 365-day discomfort analysis;
- the generation of an automatic report on the risk of glare.

Today the tool is being tested with volunteer users to verify and stabilise it.

It should be noted that the tool still has some limitations. For example, it cannot deal with all project situations where solutions may need to be found, while ensuring consistency with the TIN currently under revision. This revision covers the following aspects:

- the reflected rays are deduced from a mirror-like reflection;
- variable orientation panels are not considered;
- Aircraft trajectories are limited to the approach and taxiing on the runway.

TOOL FOR REPRESENTING AERONAUTICAL CLEARANCE SURFACES

The tool developed in 2019 to help verify hypotheses in the upstream phase of the development of PSAs, APPSA 3D, has evolved to assist the DSAC in the surveillance of airport platforms and helipads.

This allows all the clearance areas of the aerodromes to be represented quickly and to determine the extent to which they are penetrated by the surrounding obstacles. This representation of the areas also provides a clear view of the clearances, making it easier for operators, project developers and government departments to visualise their impact.

In order to make it easier to use and to enable agents to take full advantage of APPSA 3D, the tool is accompanied by a series of instructional videos and fact sheets.

Today, APPSA 3D continues to develop by integrating the complex surfaces linked to the recoil phase of helicopters in order to calculate the breakthroughs by obstacles.

CONSULTING MISSIONS IN AIRPORT DEVELOPMENT

Inspection of the Cayenne Félix ÉBOUÉ airport runway (French Guiana) by the STAC delegation in September 2021 (in the photo: Lucy TRAVAILLEUR, Didier DERRIAS).

During 2021, STAC continued and expanded its collaboration with the Directorate of Air Transport (DTA) on airport development.

As regards the concessions for Lorient Bretagne Sud and Tahiti Faa'a airports, STAC was responsible for steering the technical bids for the selection of the future operators.

The selection phase for the concessionaires of the calls for tender, which will be closed in the summer of 2021, has largely mobilised the Safety-Structure and Ecodesign (SSE); Environment; Airport Safety and Capacity (SCA); Security; and Equipment divisions of STAC in a multi-criteria analysis of the development projects and the asset management policy of the two platforms.

At the same time, the "Expertise and project management of aeronautical infrastructures" division was commissioned to assist the DTA with an assessment of the technical issues relating to Cayenne Félix ÉBOUÉ airport, whose concession contract expires at the end of 2022.

This expertise resulted in a simultaneous visit to the airport by the DTA, the DSAC-Antilles Guyane and the STAC to meet its users, its operator and the DGAC services on site. Work has since begun on summarising and consolidating the technical issues, in collaboration with the other STAC expertise divisions, in order to prepare the future airport concession contract with the DTA.

CONSTRUCTION OF A NEW EXPERIMENTAL TEST FACILITY

STUDY OF RECLAIMED ASPHALT MATERIALS ON THE BONNEUIL-SUR-MARNE SITE

STAC's Airfield Pavement Structures and Friction department, and in particular its SSE (safety, structures and sustanaible design) division, have for several years fully integrated the challenges of the ecological transition and sustainable development into their roadmap. In 2021, the division continued its efforts to take better account of sustainable development issues by launching a test facility project using flexible structures made of reclaimed asphalt materials. This new project aims at increasing the rates of reclaimed asphalt pavement (RAP) currently recommended in STAC documents (standards application guide - GAN, published in 2009 and for which an actualization is in progress). Indeed, a higher rate of RAP in mix designs would reduce both environmental and economic costs.

The test facility designed by STAC is divided down into 6 sub-facilities, allowing the influence of the use of RAP rate to be assessed for the base and wearing courses. The structures finally selected used substitution rates of 0% (reference), 30% and 50% RAP in the base course and 0% and 30% in the wearing course. These thicknesses and materials were incorporated for all sub-pavements, independently of the RAP rates. Calculations of the exact lifetimes of each sub-pavement will be based on the actual characterisation of the materials. Civil works started in November 2021.

Aircraft traffic will be simulated on each of the sub-facility using loading/unloading cycles applied by a hydraulic servo jack. For this purpose, the bearing capacity trailer (a former pavement testing tool developed at STAC) will be used. In order to guarantee thermal conditions that are representative of reality, the fatigue study will be carried out over six months, between June and December 2022. The behaviour of the sub-facilities will be monitored by means of periodic monitoring campaigns including deflection measurements (HWD tests), rutting and cracking. The comparison between the observed and calculated (according to the design method) damages will allow to evaluate the performance of materials containing asphalt aggregates. The results will contribute to the European project hOListic Green Airport (OLGA).

Laboratories of the RILEM Performance-based Asphalt Recycling (PAR) Technical Committee (TC) have expressed interest in the test facility as a potential reference site for the work of this TC. As a result, material samples were taken during manufacturing and will be shipped to the US and Italy for study by the Federal Aviation Administration and the Universities of New Hampshire and Parma. The research laboratory of Eiffage Infrastructures will also be involved. This materials exchange will allow to cross characterisations and to compare standards to advanced laboratory tests.



GT EMERGENCY PLAN

An EASA audit in 2018 attributed a deviation for the non-performance of emergency plan exercises by some certified airfields. DSAC organised an Emergency Plan WG, in which the SUB-LIA of STAC participated jointly with the Ministry of the Interior, UAF & FA and some SSLIA managers.

This WG aimed to improve the programming and execution of emergency plan exercises provided for by the EU REG 139/2014 for certified airfields and to correct this gap. It identified the regulatory constraints specific to EASA-certified airfields and to the scheduling of ORSEC exercises by the prefectures, as well as the common points of these.

It led to the publication of a guide for operators to help them plan and carry out their exercises and greatly improved the link with the DGSCGC of the Ministry of the Interior and the Ministry of the Interior itself. The latter issued an instruction to the prefectures explaining the context and the possibility of integrating airfield emergency plan exercises into the planning of their ORSEC exercises because of their many common points.

EVOLUTION OF THE STAC CONTRIBUTION TO AERODROME SURVEILLANCE TOWARDS EXPERTISE

Within the framework of the 2035 strategic plan, the STAC optimises its support to the DSAC-IR in their aerodrome surveillance activities in the fields of energy and lighting.

A working group made up of experts from the Energy and Beaconing Subdivision (EBA) and surveillance inspectors met to draw up the protocol for the new areas of collaboration between the DSACs and the STAC.

First of all, the training provided by STAC experts is being reorganised in order to adapt it to the new qualifications of airport surveillance inspectors, while guaranteeing them greater autonomy with regard to EB (energy/lighting) elements.

In parallel, the STAC is developing new tools to facilitate the monitoring of surveillance actions

"This includes a compliance monitoring document to be completed by the operator and a checklist for the surveillance inspectors to use when conducting audits.

The STAC agents will continue to participate in the surveillance actions of the aerodromes in the EB fields in the form of technical expertise requested by the DSAC-IR on the occasion of audits, changes or other specific needs.



SECURITY



CHARACTERISATION OF CHEMICAL PRECURSORS

WORK ON DISPERSION

In order to better assess the risk represented by the release of toxic gases in the aircraft cabin, STAC is seeking to study this phenomenon. For this purpose, it has surrounded itself with renowned experts in the field, such as INERIS. Collaboration with INERIS has resulted in the development of a mathematical simulation model.

This work will continue in the coming years, with the wider inclusion of other STAC external partners, including those from CEAC. All of them are working towards the common goal of a more secure civil aviation.

Ultimately, the aim is to inform the Air Transport Directorate (DTA), which is responsible for the regulatory aspects of security, in its decision-making. The STAC plays the role of technical advisor by building the case for policy decisions. In this case, it seeks to assess the danger of gas dispersion in the cabin in order to calibrate the restrictions on the carriage of various products as accurately as possible. The challenge is therefore to limit the restrictions for passengers, while guaranteeing them the best possible level of safety.

DETECTION OF CHEMICAL PRECURSORS

Once the carry-on restriction has been decided, it is necessary to ensure that it is respected. Here again, STAC is an essential link. In this respect, its action concerns the detection capabilities, i.e. the various technologies deployed in airports to ensure security checks.

In terms of chemical threats, STAC has already started to work on the characterisation of precursors. To go further, it now wishes to evaluate the capabilities for detection of these precursors.

The aim is to ensure that the threats identified are correctly detected by the various security equipment, which are also certified by STAC. In this task, the STAC can rely on its national explosives laboratory (LNE in Biscarosse), which has developed real expertise in the various detection technologies. It also benefits from the links forged with the industrial world, through cross-fertilisation that encourages research and innovation. The new International Methods and Actions subdivision (MAI) feeds these exchanges, for example, in the form of calls for expressions of interest from industry.

BIOMETRICS FOR SECURITY

For several years, biometric technologies have been booming, and facial recognition is no exception. In this area in particular, the "MONA" biometric passenger pathway experiment, the first of its kind in France, carried out at Lyon Saint-Exupéry airport's terminal 2 as part of the Vision Sûreté innovation programme ,continued in 2021.

The results obtained have encouraged the operator to deploy a second boarding gate with facial recognition in spring 2021 and to increase the number of airlines taking part in this experiment. From its launch until November 2021, more than 2,700 passengers on more than 390 flights operated by Transavia, TAP Air Portugal and Air Corsica have benefited from the "MONA" system.

If, at the end of the trial, Lyon airport wishes to perpetuate this new technology, STAC will support the operator by carrying out for the first time a performance evaluation for a facial recognition system. In view of the popularity of the MONA system among airlines, passengers and system operators, the number of deployments of this technology in the airport environment is likely to increase in the years to come.

At the same time, STAC's security division continued its work on biometrics, through the study of a contactless fingerprint biometric system. Nice airport wanted to renew its biometric access control. The health crisis led them to choose contactless technology.

As part of the performance evaluation of the biometric system, the security division then drew up an initial evaluation protocol for the system and launched a call for volunteers from all STAC staff to come and test the device. With more than fifty participants, these tests made it possible to obtain an initial evaluation of the system selected by Nice.

The expertise acquired during this study also made it possible to update the reference framework on which these performance evaluations are based. In particular, new technical specifications have been developed, taking into account Information Systems Security (ISS) aspects.

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IARTIFICIAL INTELLIGENCE FOR THE DETECTION OF PROHIBITED ITEMS



In 2021, the implementation of solutions based on artificial intelligence technologies for the detection of prohibited items (knives, firearms, etc.) has made remarkable progress in the area of cabin baggage.

In recent years, the industry has developed and perfected these software solutions, today commonly referred to as "APIDS" for Automated Prohibited Items Detection System. With this new technology, some ECAC Member States aim to operate cabin EDS (abbreviated EDSCB) in the medium/long term in "show alarm only" mode, where only alarmed baggage would be presented to an imaging operator for analysis. A provision that is widely applied in the hold field but a revolution in the cabin field!

Initiatives to evaluate and test these "APIDS" solutions have multiplied internationally and have led to the emergence of a draft standard and common methodology for European APIDS tests.

The STAC has been a member of a sub-working group (workstream) on APIDS, under the ECAC EDS Study Group, since its creation in July 2021. The discussions within this workstream, in which STAC took part, led to the approval of a draft APIDS standard at ECAC level.

Given the issues at stake, STAC took the initiative to establish a programme for the evaluation and testing of APIDS solutions in order to advise the DTA on the deployment of these solutions in the operational environment.

The first stage of this programme consisted in conducting a laboratory evaluation of APIDS solutions implemented on EDSCBs. Thus, during the last quarter of 2021, 80 prohibited items were tested on EDSCBs of different technologies and manufacturers for a total of over 3,700 acquisitions. This evaluation benefited from the collaboration of the RAID (elite tactical unit of the French National Police) for the provision and handling of the less conventional threats.

The initial results provided a more in-depth knowledge of these solutions in terms of detection and false alarm performance. These results were presented at a CEAC meeting organised by STAC at the end of 2021 at its Bonneuil-sur-Marne site.

Human factor studies, evaluations of third party APIDS solutions, etc.: year 2022 promises to be rich in APIDS initiatives and work that STAC will have the opportunity to take to the national and European levels.

PRINCIPLE OF PKI IN THE AERONAUTICAL WORLD

ICAO AND ACCESS CONTROL

The security of communication between two computer systems is ensured by encrypting messages using a pair of two keys: one public, the other private, specific to each system. Certificates are instruments issued by certification authorities to ensure the correct correspondence between a public/private key pair and its owner. These certificates are issued by a public key management infrastructure.

With the digitalisation of the aviation world, digital identities are becoming crucial. Eurocontrol has therefore developed a key management infrastructure project under the name EACP (European Aviation Common PKI). The STAC is participating at ICAO level in the Trust Framework Study Group which aims to connect the future European system and the American system.

Another key management infrastructure is also used to secure security-enabling systems. STAC provides the keys to these systems and in particular to the access control system at airports.

CYNO EXPERIMENT

The Pyrotechnic Certification and Evaluation (CEP) laboratory in Biscarrosse conducts certification activities for various types of security equipment, including Explosive Detection Dogs (EDD). These EDDs belong to private companies and operate in various fields of air transport.

A total of 567 EDD team certification tests were carried out at the STAC site in Biscarrosse in 2021, all fields combined.

In particular:

- 180 tests in the freight sector,
- 101 for airport vehicles and supplies,
- 96 in hold luggage,
- 52 in the field of odorology,
- 51 for premises and aircraft.

The overall success rate this year was 79.2%.

While waiting for the opening of the CYNODEX test centre, STAC also continued the EDD evaluations for SNCF and RATP in 2021. 86 additional teams could be evaluated, exclusively in the area of forgotten luggage.

In parallel to the certification activities, the STAC's cynotechnical expertise is regularly called upon to conduct experiments on various subjects. Following the exchanges of the 2nd "cynotechical" working group held at the end of 2020 by video conference by the STAC, and following the observation by private companies of a significant increase in the number of filmed hold baggage taken on board aircraft, the STAC conducted tests in 2021 with volunteer EDD teams. The aim was to determine the best methodology for securing this baggage and to propose a technical guide for these companies and operators. Other tests were also carried out on barrels and coffins.



CERTIFICATION AND CONTINUOUS MONITORING OF SECURITY EQUIPMENT

The Bonneuil security laboratory ensures the effective integration of new technologies in the field of security by certifying the equipment deployed at the screening checkpoints of our French airports, as well as in States that recognise STAC's expertise in certification.

In 2021, 15 new models, developed by manufacturers from all over the world, will join the STAC certified equipment pool. This new equipment will enable security agents to benefit from high definition X-ray inspection machines and automatic explosives detection systems (EDS) that are increasingly efficient in order to guarantee the security of our flights and terminals.

Outside the STAC laboratories, these advanced technologies require continuous attention and monitoring to ensure the integrity of the French security system.

In order to do this, the teams visited 9 major platforms in the French air network and the sites of 41 cargo companies over the period 2021 to verify the continued performance of a total of 933 security equipment items deployed.

DEPLOYMENT OF IFBS SYSTEMS WITH STANDARD 3 EDS

With the expiry of the regulatory authorisation to operate Standard 2 Explosive Detection Systems (EDS) for hold baggage and parcel screening (IFBSC) between 2022 and 2024 depending on the airport category, it is becoming imperative for operators to obtain validation of their new screening architectures incorporating Standard 3 EDS with increased detection performance.

Weighing several tonnes, the deployment and integration of this new equipment represents a major challenge in increasingly limited space while maintaining a high level of service to users.

With regard to compliance with the security doctrine, the STAC Security Division is involved in providing the best possible support for these considerations by issuing technical specifications, compliance assessments and carrying out on-site initial performance evaluations of security systems. In 2021, the IFBS installations in Nice, Toulouse and Fort-de-France received the STAC compliance assessments for their new architectures, while the EDS3 installations already operated in Marseille, Bordeaux and Lyon were evaluated. In addition to ensuring the implementation of ever more efficient security installations, these missions are also a prerequisite for the financing of projects by the DGCA via its airport tax mechanism.





BIODIVERSITY AND SUSTAINABLE DEVELOPMENT



INNOVATIVE ACOUSTIC MEASUREMENTS



VTOL AND ELECTRIC AIRCRAFT

In 2021, the acoustic measurement laboratory was commissioned by the Directorate of Air Transport (DTA) to measure the noise of an electric aircraft and to participate in an acoustic measurement project concerning a VTOL, a vertical take-off and landing aircraft.

There has been talk of electric aircraft for some years. Several manufacturers have studied and produced prototypes, some even in small series, but only one aircraft has been certified to date. The Velis Electro SW128 two-seater aircraft from the Slovenian manufacturer Pipistrel, has been certified as the first commercial electric aircraft. The flying school "Fly Provence" based in Aix en Provence, is one of the first purchasers.

In order to promote this new type of propulsion with the Aix les Milles platform manager (EDEIS) in partnership with the DSAC-Sud-Est, asked the STAC, as part of the implementation of the environmental charter, to carry out acoustic measurements.

The acoustic measurement laboratory, taking into account certain constraints (no traffic during these measurements in order to limit the ambient noise), was able to carry out this mission thanks to the provision of a "Velis Electro SW128" aircraft by the "Fly Provence" flying school on 20 and 21 October 2021.

The world of aviation is constantly evolving, with the advent of new, greener fuels, electric aircraft and, in the future field of urban air mobility, new vertical take-off and landing (VTOL) electric aircraft. In order to realise these "new dreams" of flying in urban environments in autonomous machines, several challenges need to be addressed. One of the challenges is to offer VTOL demonstration flights during the Paris 2024 Olympic Games.

With this in mind, the experimental phase of new urban mobility was launched at the Pontoise-Cormeilles-en-Vexin airfield on Thursday 25 November 2021.

Jean-Baptiste DJEBARRI, Minister of Transport, in the presence of elected officials from the Île de France region and industrialists, inaugurated the test area dedicated to urban mobility.

The DGAC and other French companies such as ADP, RATP and institutes such as ONERA will participate in meeting this challenge, starting with acoustic measurements to characterise this new type of aircraft.

These first measurements will be organised at the end of March 2022 with the participation of the German company VOLOCOPTER and its VTOL, the Volocity.

CLASSIFICATION OF LIGHT AIRCRAFT ACCORDING TO THEIR "CALIPSO" NOISE PERFORMANCE INDEX

AUBENAS, 6TH MEASUREMENT AERODROME

Five aerodromes are dedicated to CALIPSO measurements: Montargis, Montceau-les-Mines, Moissac, Mauléon and Vesoul. This distribution covers a large part of the territory except the south-east.

The STAC conducted a study to find a suitable airfield to meet the demands of aircraft based in the South East. The Aubenas Ardèche Méridionale aerodrome has been the focus of attention and will be the 6th CALIPSO measurement aerodrome. A memorandum of understanding was signed between the director of the Syndicat de Développement, d'Equipement et d'Aménagement de l'Ardèche and the STAC.

A first CALIPSO measurement campaign is planned for 2022 on this new site.



GREEN ROLLING

Green taxiing allows for the reduction of polluting emissions and greenhouse gases emitted by aircraft during taxiing. It can be implemented by various means: A-CDM (Airport Collaborative Decision Making), taxiing with N-1 or N-2 engines or assistance systems such as the Taxibot, WheelTug or EGTS (Electric Green Taxiing System).

In 2021, STAC contacted Taxibot India in India and WheelTug in the United States for more information on these systems.

The Taxibot system, certified on the B737 and A320 by EASA, is a hybrid device that tows the aircraft with the main engines switched off. It is controlled from the cockpit. At Indira Ghandi Airport, the Taxibot has been in use since 2019, with more than 2,000 operations resulting in a reduction in CO2 emissions of approximately 1,300 tonnes.

The WheelTug system, currently being certified on the B737, consists of a small engine attached to the landing gear, powered by the APU. The aircraft towed with this system emits 6 kg of CO2 per minute when taxiing, compared with 41 kg of CO2 per minute with conventional taxiing.



CONTRIBUTION TO THE COST-BENEFIT ANALYSIS OF THE PBN-TO-ILS PROJECT AT PARIS-CDG

TRAJECTORY SIMULATIONS AND ASSESSMENT OF OPERATIONAL AND ENVIRONMENTAL IMPACTS

As part of its project to modify the trajectories and intermediate approach procedures at Paris-CDG, the air navigation services have requested STAC's assistance in assessing the impacts of the new procedures envisaged on fuel consumption, CO2 emissions, the populations overflown and aircraft throughput and flight times. As the PBN-to-ILS procedures aim in particular to optimise vertical profiles and traffic management on approach, the impacts on these indicators are crucial for the overall costbenefit analysis of the project. This work was the opportunity for collaboration between the Airport Safety and Capacity (ASC) and Environment (ENV) divisions, the former having conducted time-lapse simulations of typical traffic samples allowing the latter to establish the corresponding noise maps. In addition to the cost-benefit analysis, the simulations and calculations of fuel consumption and emissions carried out by the STAC enabled the air navigation services to refine the variants envisaged for the new procedures during the course of the project and to select the most interesting ones.

INTERNATIONAL WORKING GROUPS MONITORED BY THE ENVIRONMENT DIVISION



ENV staff participate in several CAEP and ECAC working groups, notably in the fields of emissions, noise and climate change. In a difficult health context, the majority of meetings were maintained by video conference and allowed the work of cycle 12 to continue with some adaptations. Cycle 12 ends in February 2022, leaving room for a new three-year cycle.

WG3 (Emissions Technical Issues), WG2 (Airports and Operations) and MDG (Modeling Data Base) will present the results of their work at the CAEP/12 meeting scheduled from 7 to 18 February 2022.

A work programme for the next CAEP cycle will also be proposed. This includes in particular the further development of the supersonic engine standard with a specific LTO cycle, the update of ICAO Doc 9911 on noise modelling, the development of joint noise/CO2 and NOx/particulate standards. This last point will require close coordination between the different CAEP working groups.

EUROPEAN REGULATION FOR PUBLIC INFORMATION

POWERING THE EIONET PORTAL

European Directive 2002-49 of 25 June 2002 requires states to draw up strategic noise maps (CSB) and environmental noise prevention plans (PPBE) around major airports (more than 50,000 movements per year).

The maps describe the current and long-term (day and night) situation. The directive has a fiveyear implementation period: new noise maps should therefore be produced every 5 years and published and made available on the dedicated European platform, EIONET: https://www.eionet.europa.eu/

ENV has prepared the data for the CSBs for deadline 3 (curves and associated population and building counts), for uploading to EIONET.

ACQUISITION OF THE MODEL-BASED SAFETY ASSESSMENT SOFTWARE CECILIA

In order to continue its development in the field of operational safety of complex systems and with a view to innovation, the Air Navigation Division has recently acquired a model-based analysis software. This tool, called Cecilia, has already been used for the certification of heavy aircraft. It is intended to find its place in ATM/ANS applications as well, in full compliance with the EASA guidelines on ATM/ANS IR. The division hopes to conduct its first studies and models as early as 2022.





AIRPORTS ON TIME H2

Distribution or production stations, ground handling vehicles or equipment, and, of course, aeroplanes... In 2021, the number of projects aimed at exploiting or producing hydrogen at airports, in its gaseous or liquid form, is increasing.

In addition to Airbus and its ZEROe aircraft project, STAC is now assisting airport operators and equipment manufacturers to assess and prepare for changes in the reception and operation of hydrogen-powered land and air vehicles, in the design and layout of airport facilities, in airport firefighting in the event of an accident, and in regulatory compliance and environmental impact.

STAC is a member of the OLGA project led by the ADP group and launched in 2021 as part of the European Green Airport call for projects. This project is financed by the Horizon 2020 programme, and notably allows the development of a typical "H2" airport ground plan.

STAC has also joined forces with INERIS and the Gustave Eiffel University to form Use-In H2. This consortium, selected in May 2021 as part of the "H2 Hub Airport" call for expressions of interest, aims to evaluate the safety of equipment and ground operations involving hydrogen.

OVERALL INDICATOR MEASURED WEIGHTED 2020

The IGMP, defined by the decree of 28 January 2003, is representative of the annual noise energy emitted by air traffic at Paris-CDG airport. It is calculated from the maximum noise levels measured along the runway axis at a distance of 5 km from the thresholds and weighted according to the time of day. The ceiling value, set at 100, is calculated from the years 1999, 2000 and 2001.

The IGMP 2020 value is 32.9. This is the lowest value ever achieved due to the COVID-19 health crisis which caused a drop in air traffic. The impact of the crisis on the indicator is however slightly mitigated by the fact that night traffic, mainly due to cargo activity, was less affected than day and evening traffic.



QUATSCHI, WINNER OF THE FIRST CALL FOR PROJECTS FROM THE TRANSPORT INNOVATION AGENCY

The partnership developed between CEREMA, the University of Lorraine and STAC over many years has made it possible to propose a first version of a concentration sensor that measures the quantity of de-icing product remaining on the runway, following winter maintenance operations carried out on an airport platform.

Since 2018, the consortium has approached Sayens with the aim of being able to move from a laboratory version to an improved and patented device. In 2021, STAC successfully submitted an application to the Agence de l'Innovation pour les Transports (AIT), as part of the Propulse call for projects, on the "Intrapreneurship" component. The Quatshi* project thus selected will benefit from personalised support, notably through the organisation of events (conferences, seminars, exchange workshops, etc.). A financial package of €100K may also be made available for the development of the project.

The objective of the Quatschi project is to control the chemistry used during winter operations. This is a goal shared by Sayens and the AIT through their various supports. Future developments will make it possible to promote more virtuous winter management of platforms without compromising the safety objectives inherent in this type of activity.

*Quatshi: QUAntification of Green Surface Treatments



ANALYSIS OF TECHNICAL INCIDENTS ATM/YEAR



Safety often relies on identifying weak signals before they lead to a damaging accident.

In this respect, the Air Navigation Division analyses dozens of ATM/ANS system malfunctions reported by the various air navigation service providers each month, thanks to access to various reporting databases.

In the long term, this work, carried out in synergy with the CASD, will make it possible to better target the audits and examinations of the supervisory authority, with in particular a possible adaptation of the Risk Bases Oversight.

MONITORAGE

3 EXPERT REPORTS IN PROGRESS

The decree of 20 July 2004 requires major French airports to have a noise measurement and aircraft trajectory monitoring system. These systems must comply with the requirements defined by ACNUSA and be assessed by an organisation approved by this authority.

The skills and technical resources of the STAC's acoustic measurement laboratory, as well as its experience in the verification of these systems, allow it to be approved by ACNUSA for these compliance checks. These consist of a verification in the form of a documentary review, tests and comparative acoustic and meteorological measurements.

In 2021, the laboratory carried out the assessment of Nantes-Atlantique airport. Those of Beauvais-Tillé, Basel-Mulhouse and Bordeaux will be carried out in 2022.

AERONAUTICAL INFORMATION FOR BIODIVERSITY AND SAFETY



National Action Plans (NAPs) are strategic operational tools that aim to ensure the conservation or restoration to a favourable conservation status of threatened or special interest species of wild fauna and flora.

Within the framework of the validation of these NAPs, the Air Transport Directorate (DTA) regularly mobilises the STAC's expertise in the field of air safety and biodiversity. Among the species concerned by the NAPs, certain large raptors, such as the Bearded Vulture, the Egyptian Vulture and the Black Vulture, represent a particular challenge given the significant risk they can generate in terms of air safety.

However, beyond the sole issue of air safety, human activity, and in particular aviation activity, can represent a disturbance, likely to conflict with the conservation objectives set out in the NAPs. In this context, the public authorities have listed specific sites, called Major Sensitivity Areas (MSAs), which represent a crucial challenge for the protection of these species. They correspond in particular to breeding sites, certain dormitories or reintroduction sites.

The provision of this information to the general aviation pilots specifically concerned is currently too decentralised to be truly effective, and does not go through the usual channels for disseminating aeronautical information. This is why, in 2021, the STAC launched a project in partnership with the Regional Directorates for the Environment, Planning and Housing (DREAL) in charge of leading the NAPs relating to large raptors and the Aeronautical Information Service (SIA) to improve the dissemination of this information and thus enable pilots to take it better into account when preparing their flights, with the dual objective of protecting biodiversity and safety.

MOWING, BETWEEN SAFETY AND PRESERVATION OF BIODIVERSITY

In 2021, the Animal Risk Prevention subdivision launched a study on mowing practices on airfields with the aim of designing a technical guide for airfield operators, air bases and their animal risk and green space managers. This technical guide will address the subject from both an aviation safety and a biodiversity perspective. It will contain general information on the mowing of airfield grasslands, and will also share good practice and experience gained by airfield managers.

In order to obtain a picture of the practices implemented by operators today, the subdivision sent out a questionnaire to a large number of operators in France and overseas. The large number of responses received and the enthusiastic feedback from a series of interviews that are still ongoing show a keen interest in this work and a growing commitment by the airport community to more environmentally friendly management practices.

POWER SUPPLY AND LIGHTING MAINTENANCE GUIDE FOR AERODROMES

This guide, written by the STAC Equipment Division, aims to describe best practices and preventive maintenance procedures that should be implemented on aerodromes for all power supply and lighting installations.

In addition to the availability and reliability of adequate equipment, compliance with the indications contained in this document should ensure a sufficient level of safety for the aircraft operating on the platform while protecting the staff in charge of maintenance against electrical hazards. The chapter on "protection of workers" was drawn up in close consultation with a national expert from AFNOR

Intended for maintenance teams working on behalf of airport operators and civil aviation supervisory authority staff, it describes, among other things:

- Training of staff working on energy and lighting equipment at aerodromes;
- Procedures and periodicity of maintenance operations;
- Mandatory regulatory tests of electrical installations;

• The levels of operating performance to be achieved by means of qualitative (maintenance of the initial characteristics of the equipment) and quantitative (percentage of lights in service) objectives.

This guide is available on the STAC website since January 2022.



GUIDE FOR WRITING GOOD SAFETY REQUIREMENTS

The Air Navigation Division has published a longawaited guide to writing safety requirements. Highlighting good practice and best practice, it will be particularly useful for air navigation service providers who need to produce a safety case for each change to their functional system.



TECHNICAL BRIEFING NOTE AND NOISE MODELLING GUIDE

In the field of noise, the 4th edition of the Guide on the elaboration of noise maps around civil and military aerodromes has been published.

As in its previous versions, the purpose of this 4th edition is to describe a common methodology in order to harmonise practices at the French level, independently of the service in charge of the cartographic production. The international reference documents for noise calculation methods around aerodromes remain ICAO document 9911, ECAC document 29 and Annex 2 of the European directive DIR EU 2015/996.

This guide is intended not only for modellers in charge of producing noise maps around aerodromes but also for the various actors involved in the production and adoption of these noise maps (State services, local authorities, ACNUSA, members of the CCE, aerodrome residents).

A technical information note on modelling and regulatory noise maps in France accompanies this guide. It summarises the principle of modelling and describes the content of regulatory noise maps.







DISSEMINATION OF AERONAUTICAL KNOWLEDGE FOR THE MINISTRY OF THE ARMED FORCES

Within the framework of the agreements between STAC and the Ministry of the Armed Forces, the Airfield Pavement and Friction department will continue to provide training to various entities of this ministry in 2021.

These training courses cover various fields of expertise specific to airfield pavements, encompassing the different stages in the life of an aeronautical pavement, from the design of new pavements to the reinforcement of pre-existing pavements with the use of softwares such as DCA ("Dimensionnement des Chaussées Aéronautiques") or "Alizé-Airfield".

Asset management tools, are also at the heart of the training, in particular with the training course dedicated to Service Index method. The aim of this training is to make Ministry of the Armed Forces staff operational on these various subjects. This knowledge allows them to apply these elements of pavement evaluation on practical situations specific to military airforce bases.

The health context led to an adaptation of practices. Despite the situation, the training courses continued to be given in 2021, by videoconference for the pavement design courses and in person for those that required it.

TRAINING FOR DSAC AUDITORS AND AERODROME OPERATORS

The STAC, in collaboration with the ENAC and the DSAC, participates in the organisation of training activities for the DSAC surveillance inspectors, in the field of aerodrome energy and lighting. These training activities take place partly in the classroom but also on an aerodrome.

These are the "OPS infra" and "Energy and lighting Audit Techniques" courses.

The first one, "OPS Infra", is held at ENAC and the operator of Pau airport welcomes us on its site. The staff of the Energy and Lighting subdivision co-lead the onsite hands-on exercises. The Pyrenees ATS unit is also involved in this training.

The "OPS infra" training should disappear in its current form and will be adapted and integrated into a more global training to meet the criteria of the new supervisory licences that are currently being set up.

The "Energy and lighting Audit Techniques" training takes place entirely at the Quimper airport with the logistical support of DSAC Ouest. The Energy and Lighting staff of the Brest Quimper Bretagne operator accompany us for the runway inspections, the measurements and the live tests on the facilities. A classroom is available on site for the theoretical part and the presentation of the Energy Audit tools. The Quimper ATS unit is also involved.

The STAC also participates in the ENAC's training activities for aerodrome operators' staff in the field of energy and lighting. The training takes place at ENAC and at Pau airport.

Finally, the STAC participates in the training of agents of the Ministry of the Armed Forces at the ESID (Établissement du Service d'Infrastructure de la Défense – Defense Infrastructures Service) in Bordeaux.

ASSESSMENT OF THE TRAINING PROVIDED BY THE ENVIRONMENT DIVISION

In 2021, the Environment Division provided several training courses on behalf of ENAC:

2 sessions in the field of air quality were delivered to DGAC agents as part of their continuous training.

In the area of noise, training on the IMPACT modelling software and two training courses on noise modelling were given to new agents at the DGAC and to student engineers from the air force.

Finally, nine training courses were given in the field of biodiversity and animal risk prevention to air traffic controllers, surveillance inspectors, DGAC agents, military personnel and aerodrome operators.



HUMAN AND FINANCIAL RESOURCES

THE TRANSFORMATION OF THE SUPPORT FUNCTIONS AT DGAC AND THE IMPACT ON THE ORGANISATION AT STAC

In 2021, a reflection on the support functions has been carried out within the DGCA.

The aim of this reform is to pool the activities and resources of support functions such as human resources, finance, purchasing, IT management and logistics.

This reflection has led to a reform of the DGCA's organisation on 1 January 2022, with the creation of 8 interregional secretariats (SIR), four national purchasing centres and a national training centre.

The Secrétariat Interrégional du Grand Paris (SIR GP) serves all the entities of the DGCA, located at the headquarters of the Directorate, as well as the SNIA and the STAC. It is hierarchically attached to the DGAC's general secretariat, which ensures the management and coordination of these activities.

The purchasing units take charge of the needs of the departments as soon as there is a need for contractual formalisation and accompany them, in relation with the ITS, throughout the procedures.

Some thirty STAC agents who had previously performed support missions within the Administration, Information Systems and Dissemination Department (ASID) and within the STAC support centre were transferred, with their agreement, to the SIR GP and one agent to the SIR Sud Est. However, some agents remained physically at the Bonneuil-sur-Marne site.

The transfer of these agents and their tasks resulted in a reorganisation of the service and more specifically a reorganisation of the ASID department from six to two divisions.

Although the service now relies on the SIR GP for the validation of its purchase requests and the entry of legal commitments as well as the certification of the service done on the annexed budget, it retains full responsibility for its programming and its budgetary monitoring on all budgets.

The budget manager, who reports to the head of the ASID department, manages the use of resources in line with the performance objectives of the various budgets (annex budget and general budget).

THE ASID DEPARTMENT, WITHIN STAC, IS ORGANISED INTO TWO DIVISIONS

The administration and knowledge capitalisation division is now in charge of awarding the service's contracts on the general budget, legal monitoring, and the financial and accounting management of the general budget. In terms of human resources, it manages the professional training of technical personnel, the management of business trips on behalf of the Ministry of the Armed Forces and carries out project management assistance missions for the Air Transport Directorate. As regards the dissemination of knowledge, it continues the ASID mission of disseminating, capitalising on and making available the STAC's technical knowledge, and managing the DGAC's photographic, documentary and iconographic holdings on behalf of the STAC and other DGAC departments.

The Project Assistance and Information Management Division supports STAC's technical departments in their scientific and technical IT developments and in the evolution of the service's existing applications. It manages STAC's internet and intranet sites as well as its computer graphics, and finally contributes to the implementation of STAC's internal and external communication actions, in coordination with the head of the Partnership Programmes and the Communication mission.

This new configuration implies a new organisation, with new processes, as part of the tasks of the STAC are now delegated to the ITS and to the different poles mentioned above.

All of STAC's technical and administrative staff are therefore affected.

WORKFORCE AT 31 DECEMBER 2021 (before the reform of the support functions)	
Technical staff	
IPEF	3
IEEAC	25
ITPE	27
IESSA	4
TSEEAC	29
TSDD	14
Contract agents and RIN	8
Defence Technician	0
TOTAL TECHNICAL STAFF	110
Administrative staff	
Ancillary	4
Ancillary Contract agents and RIN	4
Ancillary Contract agents and RIN Assistants	4 1 10
Ancillary Contract agents and RIN Assistants Assistants	4 1 10 21
Ancillary Contract agents and RIN Assistants Assistants TOTAL ADMINISTRATIVE STAFF	4 1 10 21 36
Ancillary Contract agents and RIN Assistants Assistants TOTAL ADMINISTRATIVE STAFF Laboure's	4 1 10 21 36
Ancillary Contract agents and RIN Assistants Assistants TOTAL ADMINISTRATIVE STAFF Laboure's AC workers	4 1 10 21 36 23
Ancillary Contract agents and RIN Assistants Assistants TOTAL ADMINISTRATIVE STAFF Laboure's AC workers Defence Worker	4 1 10 21 36 23 2 2
Ancillary Contract agents and RIN Assistants Assistants TOTAL ADMINISTRATIVE STAFF Laboure's AC workers Defence Worker TOTAL WORKER STAFF	4 1 10 21 36 23 2 2 25

DTA - BOP 614-1	k€
Environmental and safety studies	200
Aeronautical pavement heritage	554
Airport access control management system and various security systems	82
Laboratory for the detection of liquid and homemade explosives	824
Training	130
IT - Telecommunications	339
Documentation Dissemination of knowledge	54
Logistics	761
Staff travel costs	178
Ancillary staff costs	24
TOTAL	3146
DSAC - BOP 614-2	
Safety and environmental studies	46
Aeronautical pavements	120
Beaconing and ARFF test centres	250
Operation of security test centres	434
Quality - Metrology	39
TOTAL	889
SDP - BOP 613	
Pensions for accidents at work	52
TOTAL	52
Maintenance of the BAN/Auscultation/PEB stop strands	568
Logistics	250
Staff travel costs	21
TOTAL	839
DTA - Budget civil P203 - Nantes Atlantique	566
Certification and monitoring fee	489
ADP (product allocation)	111
TOTAL	600



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QUALITY MANAGER	S. LY
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T. CABANNES

ANIMAL RISK PREVENTION SUBDIVISION

R. DEROO-MASSON

AIR QUALITY SUBDIVISION

S. KERBRAT

SAFETY, PERFORMANCE AND

PLANNING DIVISION

A. BARKAT DEPUTY : A.LOPEZ

ΑCTIVITY CAPACITY

A. GAMA

AERODROME SAFETY ACTIVITY

A. LOPEZ

SAFETY ACTIVITY ATM-ANS

L. EYGLUNENT Aeronautical easement plans

A. ZEMBOULINGAME

Safety division- track adhesion **H. BILOT**

Program manager

C. GOOSSAERT

TESTING AND EXPERTISE LABORATORY M. ABEDRABOU

DEPUTY: S. MATHOURAPARSAD

MEASURING EQUIPMENT AND INNOVATION OFFICER

G. LEHUREAU

- BUSINESS UNITS
- INTER COMPARISONS
- AUSCULTATION
- PORTANCE/IS



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Α

AC: Civil Aviation **ACI:** Airports Council International A-CDM: Airport Collaborative Decision Making ACR/PCN: Aircraft Classification Number/Pavement **Classification Number** ACR/PCR: Aircraft Classification Rating/Pavement **Classification Rating** ACNUSA: Autorité de Contrôle des Nuisances Aéroportuaires **ADP:** Aéroports de Paris **ADOP:** Aerodrome Design and Operation Panel **AE:** Asphalt aggregates **AFNOR:** Association française de normalisation AFPC: Association française des pôles de compétitivité **AID:** Agence de l'innovation de la défense TIA: Transport Innovation Agency Call for expressions of interest **APEG:** Airfield Pavement Expert Group **APIDS:** Automated Prohibited Items Detection System **APPSA 3:** Preliminary Design for 3D Aeronautical Service Plan **APU:** Auxiliary Power Unit **ASID:** Administration, Information Systems and Dissemination Department **ATM/ANS:** Air traffic management/Air navigation services

В

NAS: Naval Air Station BOP: Main Operating Budget

С

CALIPSO: Classification of light aircraft according to their noise performance index CDE: Explosive Detection Dogs CDG: Charles de Gaulle (airport) CEP: Pyrotechnic Certification and Evaluation CIL: Inter-Laboratory Comparisons Covid-19: COronaVIrus Disease appeared in 2019 CSB: Strategic noise map CYNODEX: National Certification Centre for Explosive Dog Detection

D

DCA: Airfield pavement design **DCSID:** Direction centrale du service d'infrastructure de la Défense DGAC: Direction générale de l'Aviation civile (French Civil Aviation Authority) DGA_TA: Direction générale de l'Armement Techniques Aéronautiques (French Armament Authority) DGCSGC: Directorate General for Civil Security and Crisis Management DGITM: Direction générale des infrastructures, des territoires et des mobilités DIRCAM: Direction de la circulation aérienne militaire **DREAL:** Direction régionale de l'environnement, de l'aménagement et du logement DSAC: Direction de la sécurité de l'Aviation civile DSAC-IR: Directions interrégionales de la sécurité de l'Aviation civile DTA: Directorate of Air Transport **DTI:** Technical Innovation Directorate

E

EACP: European Aviation Common PKI EASA: European Union Aviation Safety Agency EB: Energy-Based Lighting EDS: Explosives Detection System EDSCB: European Environment Information and Observation Network EGTS: Electric Green Taxiing System EIONET: European Environment Information and Observation Network ENAC: National School of Civil Aviation ESID: Etablissement du service d'infrastructure de la Défense ESSOP: Environment, System Security and Operation, Planning

F

FAA: Federal Aviation Administration
FabMob: Fabrique des Mobilités
FATO: Final Approach and Take-off Area
FEREC: Business Foundation Collective Research for Construction and Infrastructure
FIT: French Institutes of Technology
FOD: Foreigne Object Debris

G

GAN: Guide to the application of standards **GRF:** Global reporting format

Η

H2: Hydrogen HWD: Heavy Weight Deflectometer

I

IEC: International Electrotechnical Commission IEEAC: Ingénieur des études et de l'exploitation de l'Aviation civile IEESA: Electronic Engineer for Aviation Safety Systems IFBSC: Screening of hold luggage and parcels IGMP: Weighted Global Measured Index IMPACT: An Integrated Aircraft Noise and Emission Modeling Platform INERIS: Institut national de l'environnement industriel et des risques IPEF: Ingénieur des ponts des eaux et des forêts ISO: International Organization for Standardization ITPE: Ingénieur des travaux publics de l'État

J

JVN: Night Vision Binoculars

L

L2E: Testing and Expertise Laboratory LED: Light-emitting diode LNE: National Explosives Laboratory

Μ

MAY: International methods and actions MINT: Mission, Innovation, Digital and Territories MONA: Monitoring Aids MSA: Major Sensitivity Area

Ν

TIN: Technical Information Note

0

ICAO: International Civil Aviation Organization OLGA: hOListic Green Airport OLS: Obstacle Limitation Surfaces OMEGA: Modular tool for the exploitation and management of adhesion measurements ONERA: Office national d'études et de recherches spatiales (National Office for Space Studies and Research) ORSEC: Organisation of the civil security response

Ρ

PANS: Procedures for air navigation services PAPI: Precision Approach Path Indicator PAR: Performance-based Asphalt Recycling PBN-to-ILS: Performance Based Navigation to Instrument Landing System PED: Portable Electronic Devices PKI : Animal Collision Information Programme PGS: Public Key Infrastructure NAPs: National Action Plans PPBE: Plan de prévention du bruit dans l'environnement PSA: Aeronautical Easement Plan

R

RATP: Régie autonome des transports parisiens RILEM: International Union of Laboratories and Experts in Construction Materials, Systems and Structures NIR: National Internal Regulations

S

SA: Airfield Pavement and Friction Department SCGSWG: Safety and Cabin Group Study Working Group SDP: Sub-Directorate for Personnel AIS: Aeronautical Information Service SIR GP: Secrétariat Interrégional du Grand Paris SNCF: Société nationale des chemins de fer français SNIA: Services de la navigation aérienne ARFF: Aircraft Rescue and Fire Fighting Service SSE: Safety-Structure and Ecodesign SSI: Security of Information Systems STAC: Service technique de l'Aviation civile Sub LIA : Aircraft Fire Fighting Subdivision

Т

TAP Air Portugal: Transportes Aéreos Portugueses TC: Technical Committee TSEEAC: Technicien supérieur des études et de l'exploitation de l'Aviation civile TSDD: Senior Sustainable Development Technician

U

UAF & FA: Union des aéroports français et francophones associés

V

VTOL: Vertical take-off and landingp

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