



# SOURDINE II

## Executive summary

Project acronym: SOURDINE II  
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Sourdine II Consortium:

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EUROCONTROL	<i>European Organisation for the safety of Air Navigation</i>	INT
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## Executive summary

With the continuing growth of air traffic as well as the ever increasing level of urbanisation around most airports in Western Europe, the impact of aircraft noise and emissions on the quality of life for the surrounding communities has become a serious issue to be dealt with. Many European airports already face the conflicting problems of increasing their airport capacity to meet the amount of traffic, and the increasing pressure from the general public to reduce environmental impact, particularly noise and emissions, of the increased traffic volume. Many efforts are already being undertaken to reduce the source noise itself by the introduction of more silent aircraft and engines. On the other hand, a further solution to noise reduction around an airport is the definition of **new approach and departures procedures**. By modifying or optimising the operations and traffic flow of aircraft around the airport, it should be possible to achieve noise reduction.

The conclusions of the initial Sourdine project have already clearly indicated that the introduction of new noise friendly operating procedures can only be successful provided the current airport capacity and safety levels are not negatively affected. Current noise abatement measures are often accompanied by a reduction in capacity, mainly due to a lack of enabling technology in this field.

Therefore, the objectives of Sourdine II have been set at the development of new procedures and supporting technology:

- Development of new advanced and innovative environmental friendly approach and departure procedures. The results from the Sourdine I project will be used as an initial input.
- Provide an accepted implementation plan by all involved stakeholders to be able to migrate from the current situation to advanced environmentally friendly approach and departure procedures. This avoids the need to develop specific local solutions to a European problem.
- Development of enabling technology to achieve the successful introduction of the selected departure and approach procedures, such as ATC controller tools, automated aircraft-ATC interaction and cockpit monitoring tools
- Achievements will consist of quantified results for each procedure in terms of safety, capacity and environmental benefits, as well as associated costs or benefits. Objective evaluation of these issues will be performed by comparing controller and pilot workloads during baseline scenarios, i.e. current day, with future procedures. Metrics to be used will be in line with standardised European metrics and stakeholders' metrics.

The Sourdine II consortium included Airbus France (Toulouse), EUROCONTROL Experimental Centre (Brétigny), AENA (Madrid), INECO (Madrid), Isdefe (Madrid), SICTA (Naples) and NLR (Amsterdam). The consortium was supported by an expert panel, which provided feedback on intermediate results during the various expert panel sessions.

The project started with the generation of an overview of current practices and future technology related to the environmental friendly approach and departure procedures. Based on those results and after feedback from the expert panel a first set of potential procedures was developed. Those procedures were assessed using single event simulations (SES) with Airbus aircraft performance and noise calculation tools. Aircraft included in the study are the short/medium-range twinjet A320-200 and the long-range, four-engines A340-300. The performance studies involved computation of operational trajectories based on the procedure descriptions. These studies enable a first selection of the initial procedures based on aircraft performance limitations and provide trajectories that reflect performance characteristics and limitations of the aircraft. The trajectories are used as input for single event noise prediction carried out with Airbus Noise Level Calculation Program (NLCP).

This assessment led to the selection process where 5 approach and 3 departure procedures were selected to be further assessed in detail during the project.

Approach procedure I (reference approach procedure): Baseline FMS approach procedure: This procedure features a standard vertical flight path, with a level segment at 3000ft which is flown completely decelerating, with idle thrust.

Approach procedure II: Basic CDA with 2° initial FPA: this procedure follows a fixed 2-degree path angle from 7000ft up to ILS intercept at 3000ft. The aircraft decelerates at idle thrust in clean configuration during this part of the flight, deploying the cleanest possible landing configuration on landing.

Approach procedure III: Basic CDA with 2° initial FPA and increased final glide slope: the difference between procedure II and procedure III is the steeper flight path angle on the ILS (3° proc II vs. 4° proc III).

Approach procedure IV: CDA with constant speed, variable FPA segment at landing configuration: the procedure is largely flown, from 7000ft to ILS intercept, with idle thrust and in landing configuration.

Approach procedure V: CDA with constant speed, variable FPA segment at landing configuration: the procedure is similar to procedure n° IV, with the difference that the variable FP is the result of an idle thrust descent from 7000ft to ILS intercept on an intermediate landing configuration.

Departure procedure 1 (reference departure procedure): this is the baseline departure procedure (NAP ICAO-A)

Departure procedure 2: Sourdine optimised close-in: this is the optimised close-in departure procedure, for which the noise relief is located relatively close to the runway. The procedure features a deep cutback in thrust, followed by a gradual increase in thrust starting at 3000ft. Upon reaching max climb thrust, acceleration and flap retraction takes place.

Departure procedure 3: Sourdine optimised distant: this is the optimised distant departure procedure, for which the noise relief is further away from the runway. The procedure features a deep cutback in thrust applied upon reaching Vz<sub>f</sub> (zero flap speed), followed by a gradual thrust increase starting at 5000 ft

In the following phase the above-mentioned procedures were assessed on different aspects, including safety, capacity, noise, emissions, user acceptance and cost benefit.

The **safety assessments** for the various procedures have been executed with different levels of detail. Because complete detailed safety analysis would be a very elaborate and demanding effort, part only of the four approach and two departure procedures were identified to fall within the scope of detailed evaluation. Therefore, a further selection of these procedures was made. To accomplish such a selection, an initial high-level safety evaluation of all six procedures was first done. It is noted that these procedure definitions do not include an embedding of the procedure in an operation.

Based on the initial high-level safety evaluation and on inputs not related to safety the Sourdine II management made a selection of three procedures for safety assessment. For each of these three procedures an operation was defined on a specific airport, including also specific human roles and technical systems. For each of these three operations, a safety assessment was performed, based on the TOPAZ safety assessment methodology.

The **capacity assessment** has been focused exclusively on the arrival noise abatement procedures designed by Sourdine II Project. Two platforms have been used to validate the new set of procedures from the capacity point of view: TAAM (Total Airport and Airspace Modeller) from Preston Aviation Solution and SIMMOD (Airport and Airspace Simulation Model) from ATAC Corporation. They have been used as the fast time simulation tools for the different phases of the Sourdine II project. Amsterdam-Schiphol, Paris-Charles de Gaulle and Madrid-Barajas airports validation activities used TAAM for simulation purposes. Naples Capodichino airport selected SIMMOD as the FTS platform to validate the new procedures.

There is a decrease in the peak hour arrival airport capacity when NAAPs designed within Sourdine II are implemented. This decrease in capacity is caused by the extended separation required to compensate the speed differences between aircraft. The more speed differences between aircraft types, the more separation was needed in order to maintain minimum safe separation between successive aircraft (e.g. wake turbulence). This increase of separation affects arrival delay negatively and therefore arrival capacity decreases.

The lack of speed control between the beginning of the CDA and the runway leads to larger spacing between successive arrivals. An increased arrival separation at 30NM from the runway threshold is required to achieve the necessary wake turbulence separation at the runway.

Another factor which plays a role in the delay is the route structure close to the airport: the effect of speed differences mentioned above will play a more severe role when the number of RNAV-routes available is smaller. In that case, more aircraft will have to fly a longer trajectory on the same RNAV route.

When an airport is operated in a way that the demand is exceeding the available peak hour arrival capacity during some periods of the day, the introduction of the new procedures will lead to additional delay. However, when the arrivals are distributed more regularly over the day, delays will decrease, or even not occur. When traffic is scheduled in this way and hourly arrival demand does not exceed the available airport capacity, for the traffic foreseen for the year 2015 in the four airports considered in this analysis, there exists no sustained capacity problem.

The airport **noise assessment** analysis was performed using a research version of the US FAA's Integrated Noise Model (INM), specially developed by the FAA to cover the needs of the Sourdine II project, with special data supplied by both Airbus and Boeing (with funding from NASA). These data covered a limited set of representative aircraft types determined based on the fleet mixes of the four airports. Per airport the actual fleet was replaced by a substitute fleet composed of these aircraft.

During this project it became clear that (see section 7.4) it would not be possible to perform any comparative analyses of fuel-burn and CO<sub>2</sub> production. Analysis of pollutants produced below 3000ft that contribute to a deterioration of local air quality was, however, carried out. This analysis showed that nearly all of the procedures produced more unburnt hydrocarbons (HC) and Carbon Monoxide (CO), Sourdine II arrival procedure III being the notable exception for mid-sized aircraft and procedure IV for heavy aircraft. Arrival procedure III also produced much less Nitrogen Oxide (NO<sub>x</sub>). The other arrival procedures were beneficial in terms of NO<sub>x</sub> for mid-sized aircraft. Sourdine II departure procedures did not affect NO<sub>x</sub> production.

Within the **user acceptance assessment** two simulation experiments – a flight simulation and an ATC simulation - were carried out in order to evaluate the SII procedures. The flight simulation covered the evaluation of SII procedures with respect to its impact on the crew's tasks and performance as well as on a number of specified flight parameters. The ATC simulation covered the evaluation of the SII procedures with respect to the impact on the controllers' tasks as well as on safety, efficiency and capacity in handling air traffic.

From the various assessment results as well the activities to have a balance analysis and the first step towards an implementation plan the following conclusions can be drawn.

The noise assessment results show that all Sourdine II procedures provide significant noise reduction as compared with current day practice.

With single event simulations, it has been demonstrated that the SOURDINE II reference approach procedure shows benefits more than 5dBA in a very large range of the procedure.

From all approach procedures Sourdine II arrival procedure III, featuring an increased final glide path angle, provides the largest noise benefit compared to the reference procedure.

1. The optimized departure procedures featuring optimized thrust management provide noise reduction in the targeted zones compared to current PANS-OPS procedures, either close-in or at distant positions.
2. The distribution of the fleet mix will influence the shape of the noise contours considerably (i.e. unbalanced use of runways).
3. Noise assessment conclusions are the same (i.e. slight differences depending on fleet-mix flow) for all scenarios.
4. Major noise benefits are mainly determined by higher altitudes for approaches while for departures on the thrust settings.

The two departure procedures studied have different aims, one to reduce noise close to the airport and one further away. The results of the noise analysis show that the "close-in" procedure is beneficial only within the 3.5NM immediately after the end of the runway, whereas the "distant" procedure provides benefit from 2.5NM after the runway end.

In general it can be stated that both procedure II and II-A (variation of procedure II including speed constraints) are acceptable for pilots and controllers. Procedure II-A basically leads to more time between the various configuration changes and therefore makes it more controllable for the pilot. This has the risk however of leading to a negative noise impact as compared with a more noise-ideal procedure II. It was suggested by some of the controllers to extend the current implementation of the ATC monitoring aid with an alert when the separation minima are violated and the controller needs to intervene. To get to an implementation of these noise abatement procedures it is important that the pilots will strictly follow the prescribed procedures.

Controllers also need to get hands-on experience concerning the "new" speed profiles and aircraft performance. Due to the fixed RNAV routes inside the TMA there are fewer possibilities to make changes to the arrival sequence and therefore an arrival manager and an accurate hand-over from ACC to APP (30-60 seconds accuracy) is required. The current implementation of the RNAV shortcuts provided sufficient flexibility for the controllers. The combination of parallel runways with CDA procedures is an identified problem. Possible solutions on this subject that need further exploration are for example the use of curved approaches based on approach procedure with vertical guidance (APV procedure) or to have a short level segment for one of the runways.

It is recommended to perform flight trials to get detailed feedback on aircraft performance as well as pilot and controller acceptability from hands-on experience. Results from these flight trials can support additional assessments like performed in this project to reach the ultimate goal: continuous descent approaches during peak-hour operations at major European airports while maintaining or even improving capacity and safety.

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