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System for AirPort noise Exposure Studies (STAPES)

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STAPES

(SysTem for AirPort noise Exposure Studies)

Final Report

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Abstract

This report presents the first release of a regional – multi-airports – aircraft noise model named STAPES. This model can produce detailed noise impact analysis of current or future air traffic scenarios including noise mitigation policies. STAPES includes an information database covering 27 European airports providing approximately 90% coverage of the European population exposed to significant aircraft noise levels.

Keywords

Regional (multi-airports) aircraft noise model	Noise mitigation policy options	ICAO/CAEP
ECAC Doc.29 3rd Edition	Noise contours	Exposed population

Author(s)

Laurent Cavadini

Contact Person(s)	Telephone	Unit
Laurent Cavadini	+33 1 69887293	DSS/REG/ENV
Andrew Watt	+32 2 7295049	DSS/REG/ENV

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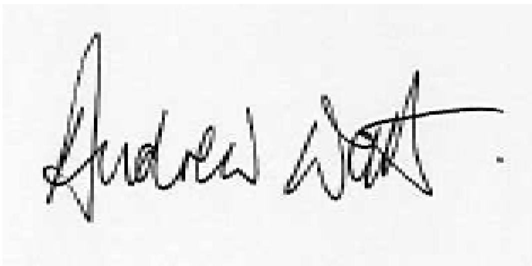
Environment Unit Manager	Andrew Watt (DSS/REG/ENV) 	04/04/2011
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The UK CAA has provided significant support during the STAPES model development cycle, through its technical advice and provision of detailed reference data from ANCON 2, which have enabled the successful verification and validation of STAPES. The UK CAA has also facilitated the rapid inclusion of STAPES in the ICAO-CAEP/8 policy assessment process, notably by sharing with EUROCONTROL initial airport datasets within the European region developed by the UK CAA.

Acknowledgment should finally be given to all the Airports and ANSPs which have contributed to the success of this project by having kindly accepted to provide valuable local airport information necessary to build a high quality STAPES airport database.

DEFINITIONS & ACRONYMS

AIPs	Aeronautical Information Publications
AIRMOD	ECAC/ANCAT task group on aircraft noise modelling
ANCAT	ECAC group of experts on the Abatement of Nuisances Caused by Air Transport
ANCON2	UK CAA Aircraft Noise Contour model
CAEP	ICAO Committee on Aviation Environmental Protection
dB(A)	A-weighted decibel
DNL	Day-night level. It is a descriptor of noise level based on energy equivalent noise level (L_{eq}) over a whole day with a penalty of 10 dB(A) for night time noise.
EAD	EUROCONTROL Aeronautical database
EASA	European Aviation Safety Agency
EATM	Pan-European Air Traffic Management
EC	European Commission
ECAC	European Civil Aviation Conference
EEA	European Environment Agency
END	Environmental Noise Directive 2002/49
EU	European Union
EUROCONTROL	The European Organisation for the Safety of Air Navigation
FAA	US Federal Aviation Administration
GIS	Geographic Information System
GUI	Graphical User Interface
ICAO	International Civil Aviation Organization
INM	FAA's Integrated Noise Model
IPRs	Intellectual Property Rights
JRC	Joint Research Centre (of the European Community)
L_{DAY}, L_{EVE}, L_{NIGHT}	Respectively day-time, evening-time and night-time L_{eq}
L_{DEN}	Day-evening-night level. It is a descriptor of noise level based on energy equivalent noise level (L_{eq}) over a whole day with a penalty of 10 dB(A) for night time noise and an additional penalty of 5 dB(A) for evening noise.
L_{eq}	Equivalent (continuous) sound level (dBA)
MAGENTA	Model for Assessing Global Exposure Noise of Transport Airplanes
MITG	ECAC/ANCAT Modelling and Interdependencies Task Group
MODTF	CAEP Modelling and Database Task Force
NPD	Noise–Power–Distance

PRISME	Pan-European Repository of Information Supporting the Management of EATM
RIAs	Regulatory Impact Assessments
SESAR	Single European Sky ATM Research
STAPES	SysTem for AirPort noise Exposure Studies
UK CAA	United Kingdom Civil Aviation Authority
V&V	Verification and Validation

EXECUTIVE SUMMARY

The European Commission issued a contract to EUROCONTROL in December 2007, following a request for support, to develop a European regional noise model, with technical support from the European Aviation Safety Agency (EASA) and the United Kingdom's Civil Aviation Authority (UK CAA). The objective of the project, known as STAPES (SysTem for Airport noise Exposure Studies), was to develop a multi-airport noise model capable of providing valuable input into both European and international policy-making assessments, in particular ICAO's Committee on Aviation Environmental Protection (CAEP).

A validated and CAEP-endorsed noise model

In line with the planned schedule, a first version of the STAPES model was developed and delivered in October 2008 and is compliant with the best practice modelling guidance provided by both ECAC Doc. 29 3rd Edition[1] and ICAO Document 9911[2].

A thorough validation and verification (V&V) process was carefully applied to the model throughout its development cycle, in the form of extensive comparisons against the UK ANCON model, which is compliant with the international guidance mentioned above and is already one of the official models supporting CAEP policy assessments.

At the November 2008 meeting of ICAO-CAEP's Modelling and database Task Force (MODTF), STAPES was recommended for use within ICAO CAEP policy assessments. This recommendation was subsequently endorsed by the CAEP Steering Group at its meeting in June 2009, and provides the model with global credibility.

An accurate and representative European airport database

Based on a variety of information sources, including strategic noise maps of major airports submitted by EU Member States in line with the Environmental Noise Directive 2002/49/EC, a list of 27 airports for inclusion in STAPES was identified in order to represent approximately 90% of the European population exposed to significant noise levels within the ECAC region.

While a significant amount of the required input data already existed within the EUROCONTROL PRISME data warehouse (e.g. operations with detailed airframe-engine information), a critical part of the STAPES project was the collection of up-to-date local information from European airports (e.g. runway usage) so as to ensure future modelling assessments are robust enough to support informed policymaking.

In order to initiate a spirit of cooperation with European airports, an initial EC-EASA-EUROCONTROL letter was sent out to all relevant airport focal points in August 2008. Good coordination with the majority of the airports was established leading to the putting in place of an efficient data flow process for immediate needs and future updates.

[1] European Civil Aviation Conference (ECAC): *Report on Standard Method of Computing Noise Contours around Civil Airports. Volume 2: Technical Guide*. ECAC.CEAC Doc 29, 3rd Edition (2005).

[2] International Civil Aviation Organization (ICAO): *Recommended Method for Computing Noise Contours Around Airports*. ICAO Doc 9911, 1st Edition (2008)

European population database

As part of the CAEP/8 work, the STAPES project has also identified the EEA-JRC population database as an appropriate single source of data for use on EU airports dealing with issues such as noise exposure. This was complemented with census data for two non-EU airports (Geneva and Zurich), to ensure that population data was available for all airports assessed using the STAPES model.

Valuable contribution to the CAEP/8 work programme

STAPES, in cooperation with ANCON, has successfully contributed to the assessments of CAEP/8 policies on the European region, with significantly more accurate results for Europe than at any previous occasion. This was due to the correct identification of relevant European airports with noise problems and more accurate input data to ensure accurate modeling results. An overview of this work can be found in ANCAT-77 IP-4 within Appendix D of this report

Future work

During this project, STAPES has used future forecast data (fleet and operations) provided by CAEP. This was produced by the US Fleet and Operations Module (FOM), which in turn is based on the forecasts established by the CAEP Forecast and Economics Support Group (FESG). The EUROCONTROL Statistics and Forecasting Service (STATFOR) is a potential data source (operations on city pair basis in seat class, business and cargo categories) on which to develop a detailed European future fleet forecast model that would produce relevant inputs for STAPES. Developing such a forecasting model would give Europe an independent capability to perform analyses on future aviation noise policy options, and would re-enforce the value of the European contribution to the discussions on CAEP policy options, as well as assessments on new operational concepts.

EUROCONTROL, EASA and the European Commission are currently exploring how best to organise their respective resources to support Member States in the context of CAEP. The SESAR Work programme also contains a work package on environmental modelling. It is likely that the future development of STAPES will become clearer during 2010 as these two initiatives move ahead.

Finally, the STAPES airport database could also be further expanded, in particular to include all the major airports designated within the Environmental Noise Directive 2002/49 (END), in order to support any review of European legislation.

1. INTRODUCTION

1.1. Background

When considering policy/rulemaking options, or operational concepts, which are aimed at mitigating the environmental impact of air traffic, either at a European level (EC, EASA, ECAC/ANCAT, EUROCONTROL) or a global one (ICAO/CAEP), a cost-effectiveness or cost-benefit analysis is required. As far as noise is concerned, the expected benefit of options needs to be quantified in terms of reduction of noise contour areas, and – even more relevant for policy makers – reduction of the number of people exposed to varying levels of noise.

Whereas current European Member State noise models have usually been designed and developed to perform noise impact assessments locally (e.g. individual airports), the type of analysis mentioned above requires the availability of a European regional aircraft noise model capable of performing noise impact assessments on a European/global basis (e.g. multiple airports). Such a regional model should be able to perform noise impact analyses of both current and future air traffic (capturing evolutions both in terms of growth and fleet mix), with and without the implementation of envisaged mitigation policy/rulemaking options or operational concepts.

In particular, the adoption of the Environmental Noise Directive (2002/49/EC) and the Establishment Of Rules And Procedures With Regard To The Introduction Of Noise-Related Operating Restrictions Directive (2002/30/EC) highlight the need for a regional noise modelling capability which the European Commission may use to review such European legislation on a regular basis with the goal of improving their effectiveness. Such a tool is also a requirement for EASA in order to perform robust Regulatory Impact Assessments (RIAs) which support Opinions submitted to the EC, and for EUROCONTROL to analyse future operational concepts within the SESAR programme.

In addition, such a European regional noise modelling capability should also be capable of supporting the policy-making analyses conducted under the auspices of the ICAO-CAEP Work Programme, by providing relevant and timely input to the assessments of the envisaged CAEP policy options. In particular, the model should take the lead on assessments for the European region, and complement the results produced by the world-wide scale MAGENTA noise model (US FAA ownership), whose coverage of European airports is limited, particularly due to the absence of high quality data.

European aerospace research is partly based on individual projects sponsored by the European Commission where part-funding is supplied in exchange for exploitation rights. Whilst cost-effective, this process has not promoted the development and ongoing support of integrated tools to support policy decisions in the field of aircraft noise. Consequently, under the Framework agreement N^o TREN/05/ST/F2/36-2 between the European Commission and EUROCONTROL, DG-TREN issued a contract to EUROCONTROL in December 2007 (request for support N^o TREN/05/ST/F2/36-2/2007-3/S07.77778) to develop a prototype of this European regional noise model. As EUROCONTROL has equal interest in developing and further using this model, the contract was signed on the basis of joint EC-EUROCONTROL funding and ownership of Intellectual Property Rights (IPR's).

1.2. Initial objectives and evolutions during the project

The development of this multi-airport noise model, known as STAPES[3] (SysTem for AirPort noise Exposure Studies), started in early 2008, with a key contractual objective to deliver a first version - a prototype - by the end of 2008. The main characteristics and requirements which were set out in the EUROCONTROL Technical Proposal are listed below:

- STAPES shall implement the noise modelling methodology described in the ECAC Doc.29 3rd Edition guidance [Doc.29]. This represents current, internationally agreed, best practice which underpinned the recent publication of ICAO Document 9911 [Doc.9911].

- STAPES shall use the international Aircraft Noise and Performance database [ANP], which accompanies [Doc.29] and [Doc.9911].

- The model will include a number of key European airports which, combined, should represent 90% of the European population exposed to significant aircraft noise levels (e.g. > 55 L_{DEN}).

- The model shall enable the calculation of noise contours for exposure-based metrics including L_{DEN}, L_{DAY}, L_{EVE}, L_{NIGHT}, DNL (for CAEP assessments) and estimate the number of people within these contours.

- The noise model developed shall have to go through a specific Verification and Validation (V&V) process established by CAEP-MODTF, in order to be 'eligible' to support current and future CAEP policy assessments.

- Due to the potentially large number of airports to be covered by the model, the STAPES modelling system should be designed, developed and implemented in a suitable manner such that computation times are minimised.

The option to build STAPES around the existing batch version of the FAA's Integrated Noise Model (INM) noise calculation engine, which is used by MAGENTA and already validated for use in ICAO/CAEP, was initially envisaged. However, it was concluded that there were associated risks for the STAPES project in following this approach, especially with respect to future support / reliance on a US model and the very limited timeframe to develop and deliver a prototype of the STAPES modelling system. Therefore it was decided to develop a bespoke European model/software capability owned and managed by the EC and EUROCONTROL.

While the project was initially planned to be completed by the end of 2008, this proved particularly ambitious due to the time and resources required to contact and coordinate with airports on the provision of detailed and up-to-date local airport information. The work was further complicated by the fact that the STAPES project, during its development phase, also had to support the CAEP/8 work programme in parallel. The initial contract was therefore extended by 10 months in order to ensure key European airports were covered by STAPES with a high degree of accuracy.

This 10-month extension period, which was still compatible with the CAEP/8 schedule, was also

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[3] The human ear has a beautifully designed built-in noise protection mechanism. Three tiny bones - the anvil, the hammer, and the stapes (the smallest bone in the body) - connect the eardrum and the cochlea. These little bones transmit sound vibrations from the eardrum to the cochlea, which detects the frequencies and intensities of impending sound and transmits them to the hearing centres of the brain. If the brain detects noise of an intensity that could damage the cochlea, the stapedius muscle contracts and partially pulls the stapes away from its connection to the cochlea which somewhat diminishes the sound energy transmitted to the cochlea. This mechanism is nature's way of providing some protection against hearing damage caused by excessive noise.

used as an opportunity to develop additional modelling/software features, not planned in the initial EUROCONTROL Technical Proposal. These have been implemented into STAPES 1.2, which represents the current release of the software.

1.3. Working arrangements

EUROCONTROL led this project, both at management and technical levels, notably to coordinate, perform and validate the work with the subcontracted companies mentioned in the last paragraph. EUROCONTROL also acted as the STAPES focal point in support of CAEP/8 policy assessments.

EASA provided assistance in identifying and approaching focal points to obtain local airport information, and managed the introduction and further endorsement of STAPES in the ICAO/CAEP and ECAC/ANCAT context.

The UK CAA provided support during the STAPES model development cycle, through its technical advice and provision of detailed reference data from ANCON 2 to verify and validate the STAPES model.

EASA and the UK CAA also provided invaluable advice to EUROCONTROL throughout the duration of the project.

Following a competitive tendering process, the software development work was sub-contracted to PROTECTIC, and airport data collection and processing activities to ENVISA. These contracts were managed by EUROCONTROL.

2. STAPES MODEL & SOFTWARE

2.1. Overview

The global architecture of the STAPES modelling system is provided in Figure 2-1. The main model's characteristics and software functionalities are listed below:

- STAPES is fully compliant with the airport noise contour modelling methodology described in [Doc.29] and [Doc.9911], and retrieves the required aircraft noise and performance data from [ANP]. In addition, STAPES input data definition and formats follow the specifications defined in the ECAC and ICAO documents, facilitating the incorporation of relevant input data for CAEP policy assessments.

- Aircraft flight trajectories (i.e. series of flight path segments, as needed by the single-event segment noise calculation module) are constructed by "merging" ground tracks and vertical flight profiles. The flight profile/performance data are obtained, along with aircraft noise data (NPDs), from [ANP].

- The model can perform calculations for any exposure-based noise metrics, including Leq, L_{DEN} , L_{DAY}, L_{EVE}, L_{NIGHT} and DNL. Noise levels are calculated and stored on user-defined geographic grids.

- Due to the number of airports to be processed in each scenario run, the model/software has been designed, developed and implemented to work in a multi-processing environment, in order to ensure the computation times are an acceptable.

- From the calculated grids of noise levels, the model generates noise contours which are further exported to the ArcView® GIS. Population counting is performed using the population database supplied by the European Environment Agency (EEA) and EC Joint Research Centre (DG JRC), complemented, where necessary, with local census data.

It should be noted that the STAPES software, in the current 1.2 version, does not include any Graphical User Interface[4] (GUI). The priority has been placed on developing, validating and delivering a robust modelling capability within a very limited timeframe, in order to respect the schedule and milestones of CAEP/8. In particular, noise calculation run options are defined and modified in text-format configuration files; launching noise calculations is done via command lines.

The following sub-sections describe in more details the different components of the developed modelling system.

[4] Except for the standalone tool which automates the contour area and population count post-processing – see 2.5.2

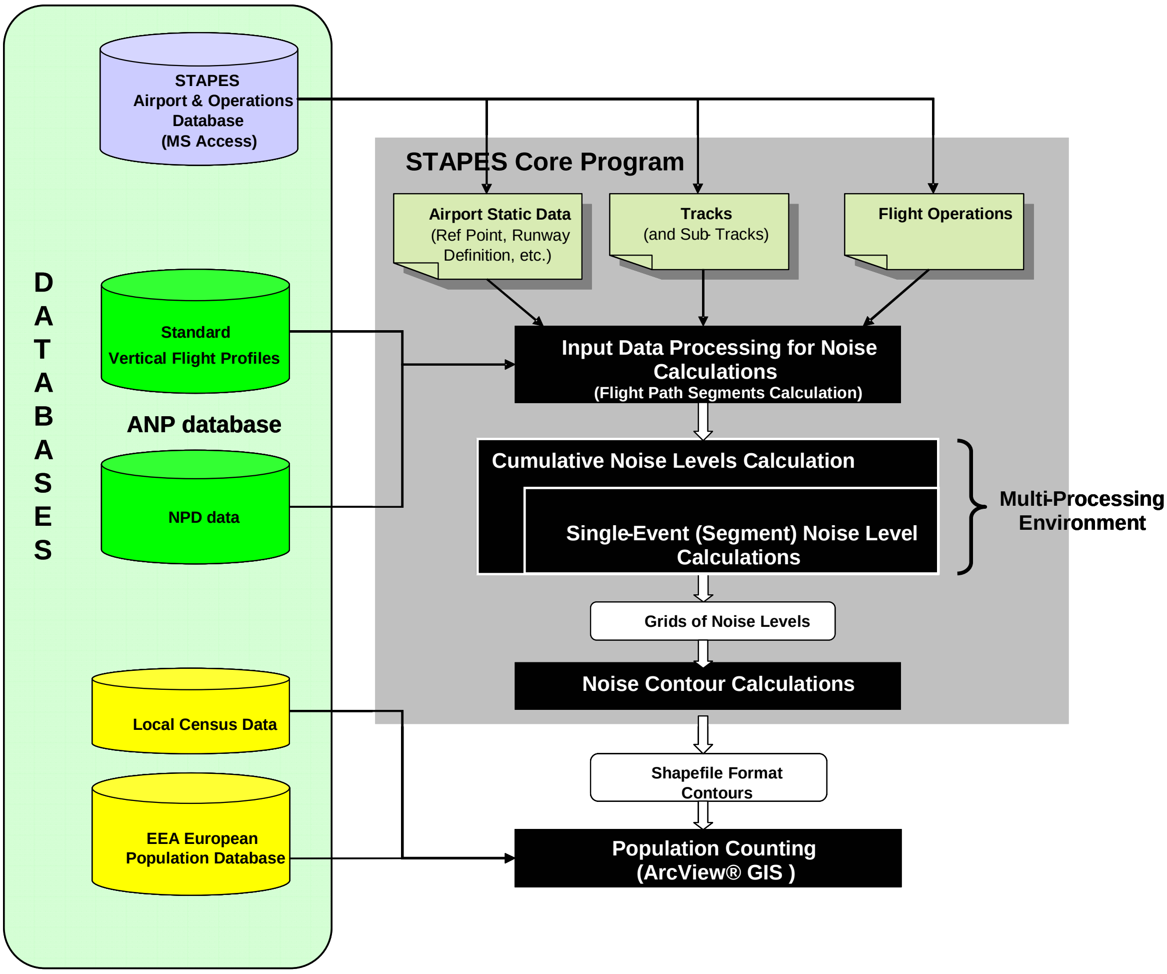

Figure 2-1: STAPES modelling system overview

2.2. Input Data

The input data used by the STAPES model to calculate noise exposure at a given airport for a given scenario are defined in the four text files listed below:

- *Airport*
- *Runways*
- *Tracks*
- *Operations*

These files are generated for each airport individually from the STAPES airport MS Access database, presented in 2.3.3.

The *Airport* and *Runways* files include “static” information about the airport (airport geographic reference point, elevation, runway-ends coordinates, etc.) and information defining the average atmosphere (temperature, pressure, humidity and headwind).

The *Tracks* file provides the description of the ground tracks (e.g. the projection of the 3-D flight trajectories on the ground). The file includes both nominal and dispersed tracks ("sub-tracks"). Each track is represented by a series of coordinates, ordered as followed by the aircraft.

The *Operations* file provides the list of operations over 24 hours, grouped by aircraft type, operation type (arrival, departure), runway/track used, flight procedure/profile and stage length. The number of operations is distinguished between day, evening and night periods, in order to enable the application of noise metric-specific weighting factors accordingly.

More details on the contents of each of these input data files can be found in 2.3.3, which describes the different tables of the STAPES airport MS Access database.

2.3. Databases

2.3.1. ANP database

The ICAO ANP database is the official source of aircraft noise and performance data enabling the practical implementation of the modelling methodology described in [Doc.29] and [Doc.9911].

ANP data is provided for detailed aircraft (airframe-engine) types, covering many of the larger, modern models and variants in the world's airline fleets and therefore governing the noise at most major airports.

The ANP entries are generated and supplied by aircraft manufacturers, in accordance with standard data specifications and formats, which are designed to achieve best practicable levels of data quality and consistency. These entries usually include noise data which has been acquired during noise certification tests carried out under stringent internationally standardised procedures which are regulated by Certification Agencies (e.g. EASA, FAA).

The noise part of the ANP database is mainly composed of Noise-Power-Distance (NPD) data, which is a key element of the noise calculation process. The performance part of the ANP database provides all the information to calculate aircraft vertical profiles (altitude, speed and thrust as a function of travelled ground distance). These profiles are combined ("merged") with input ground tracks to build 3-D flight trajectories, which are further used in the noise calculations.

2.3.2. Population Database

The European Environment Agency (EEA) and the EC Joint Research Centre (JRC) have developed and are maintaining a European population database [EEA] covering the 27 EU Member States. This single, harmonized European source of population data is based on EUROSTAT census data from 2001, which has been adjusted according to satellite spatial analysis information.

This database is available in the form of a GIS raster, composed of 100x100 metre cells, with population density information in each. Section 2.5.2 describes how STAPES uses this raster to determine the number of inhabitants inside the contours.

Although potentially not as accurate as more detailed local population databases, which are often expensive and/or difficult to obtain, the EEA population database has been demonstrated to be the most suitable single, consistent source of information for STAPES in terms of accuracy and granularity.[5]

The EEA-JRC population database has been complemented with local census data around Geneva and Zurich airports (2000 census data), kindly provided by the Swiss Federal Office for Civil Aviation (FOCA). The format and resolution of the Swiss population data are similar to the EEA data (100 by 100m cells, with number of inhabitants in each).

[5] Several analyses have been performed within CAEP-MODTF on individual airports, which have compared - for the same noise contours - population count results using the EEA and other global population databases (GRUMP, GPW, Landscan, JRADS) against reference local census data.

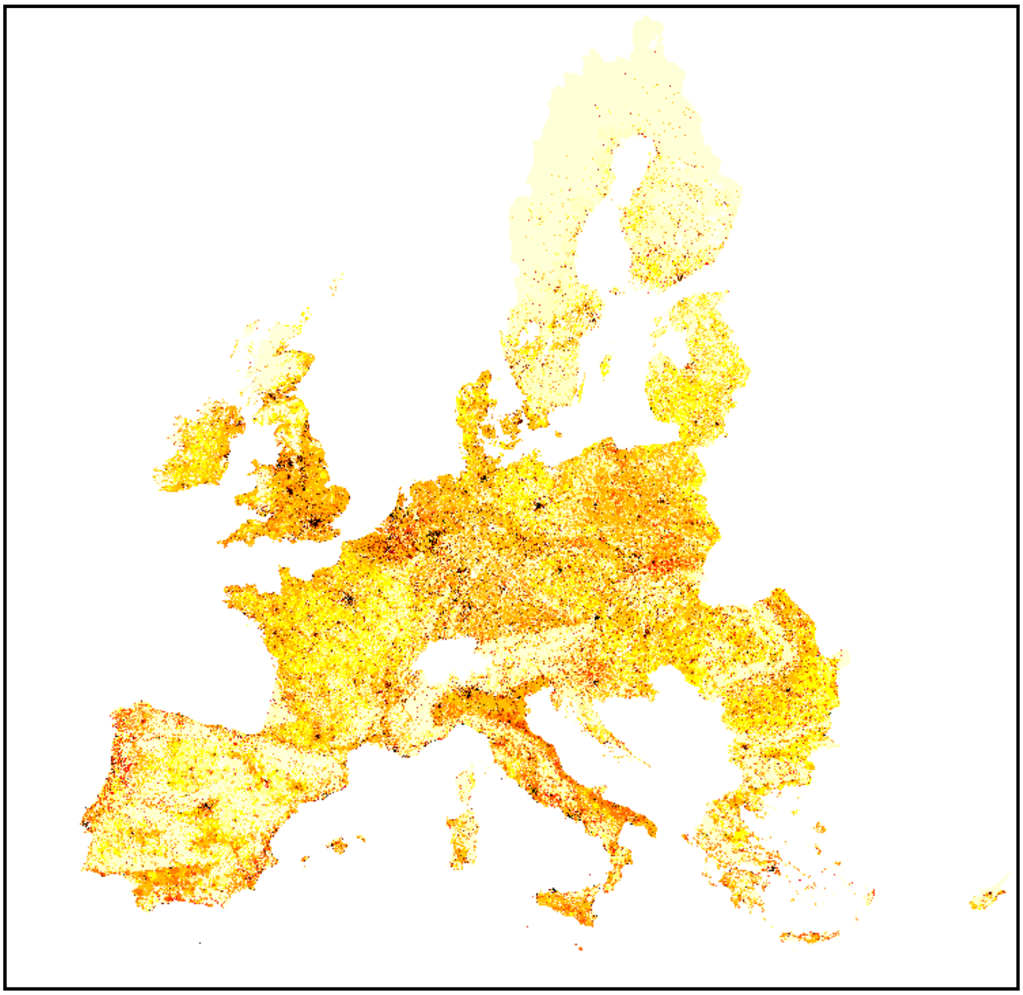

Figure 2-2: The EEA-JRC population database

2.3.3. STAPES Airport database

The STAPES airport database stores all the airport data needed by the STAPES model to perform noise calculations at the 27 airports currently covered by the model.

Built in MS Access, the database is currently populated with data for the 2006 baseline case (see Section 4), but will further be expanded to store data associated with future scenarios. It consists of a set of tables providing all the data fields required to run noise calculations with STAPES, as well as a few others which improve the data readability and traceability (e.g. horizontal coordinates in both Lat/Lon and X/Y formats, additional information about airports, etc.). Figure 2-3 below describes the table contents and relationships.

Specific SQL queries (VBA macro) have been developed to automatically generate and export the database's content into text files directly readable by the noise model (see 2.2).

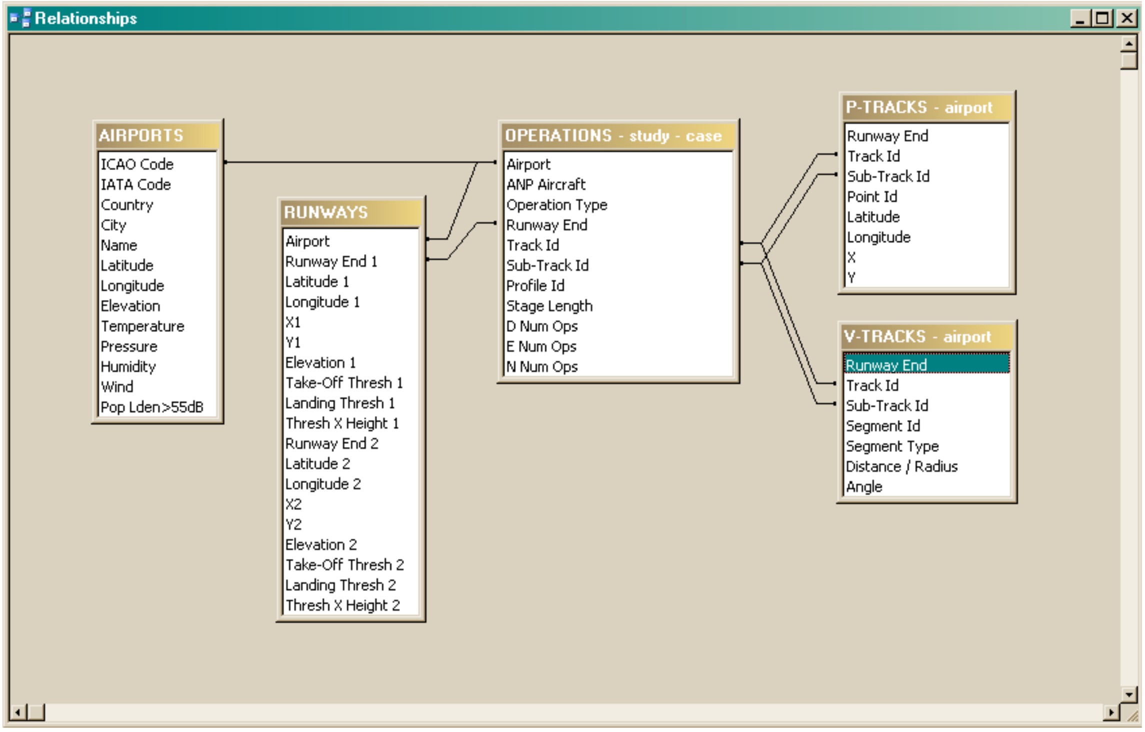

Figure 2-3: STAPES airport database - table relationships

2.4. The different calculation modules

2.4.1. Flight path segment (FPS) calculation module

The *FPS calculation module* combines data from the four input data files described in 2.2, the ANP database and other configuration files, to build a single flight path segment (FPS) dataset, which includes all the necessary information to further perform the noise calculations.

A major task performed by this module is the segmentation process, which "merges" a ground track and a vertical (fixed-point) profile from the ANP database (or other sources) to build the 3-D flight path of each single operation in the form of series of (straight) segments, with, on each, relevant flight parameters for noise calculations (mostly aircraft speed and engine thrust).

2.4.2. Segment-to-point noise calculation module

The *Segment-to-point noise calculation* module is the central component of the overall noise exposure calculation method applied by STAPES. This module is used billions of times by the core program to calculate the noise contribution of a given (finite) segment of a particular flight path at a given observer location on the ground, as illustrated in Figure 2-4 below.

The module implements the methodology and equations provided in Section 4 of [Doc.29].

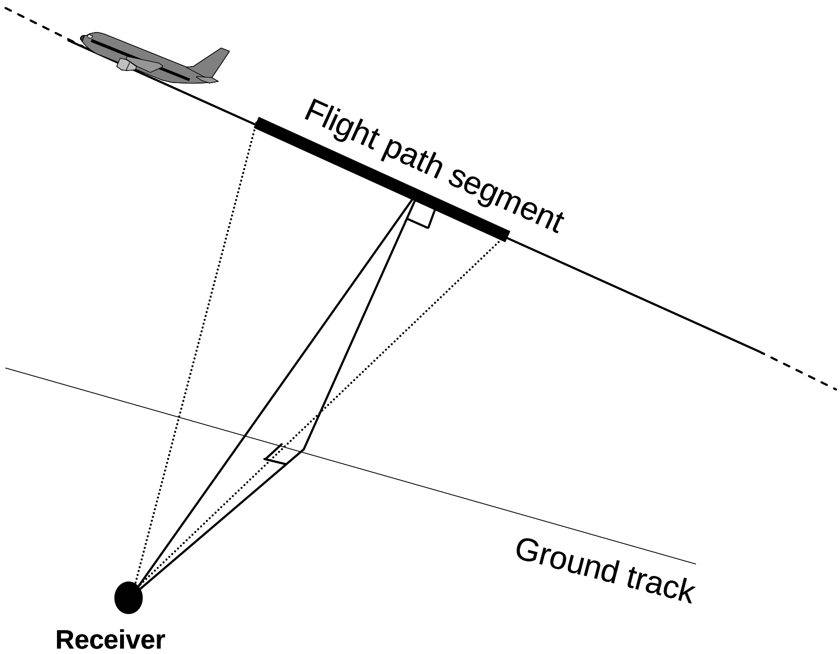

Figure 2-4: Flight path segment-to-receiver geometry

2.4.3. Cumulative noise level calculation module

The *cumulative noise level calculation* module produces grids of noise exposure levels, for a user-specified noise metric, by performing on each point of the grid, the weighted[6] summation of the noise energy fraction of each segment of each flight operation, as illustrated in Figure 2-5.

The grid of calculated noise levels is further used by the STAPES *noise contour calculation* module to produce the noise contours.

[6] e.g. accounting for the weighting factors applied to the operations, depending on the period of the day (day-time, evening-time or night-time)

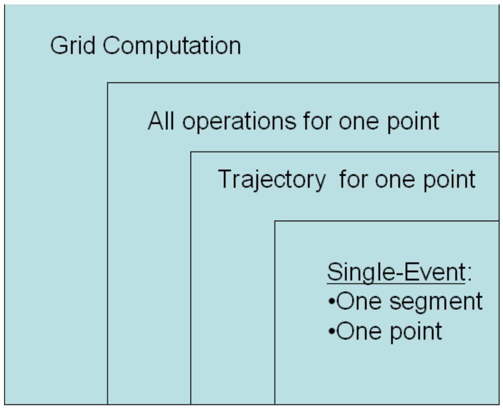

Figure 2-5: Cumulative noise level calculation process

2.5. Post-processing

2.5.1. Noise contour calculation module

From the grid of calculated noise levels produced in the previous step, the *noise contour calculation* module of STAPES interpolates noise contours for user-specified noise level thresholds and stores them as a geo-referenced (polygon-type) shapefile. This shapefile can be further exported to the ArcView® GIS to be displayed and to perform contour area and population count calculations (as explained in 2.5.2)

2.5.2. Contour areas and population count

The noise contour areas and population counting inside these are performed by the *Zonal Statistics* tool which is available in the *Spatial Analyst* toolbox of the ArcView® GIS.

This tool identifies the cells of the population raster from the EEA database, and local census data for Geneva and Zurich, which are located inside the noise contours defined as polygon-type shapefiles. The tool then performs the sum of the inhabitants associated to each of the identified cells to determine the number of people inside the contours. The contour areas, expressed in km^2, are simply the sum of the identified cells inside the contours, multiplied by 0.01 (as each cell is a 100m x 100m square).

Due to the number of contours to process in a given noise analysis study (27 airports multiplied by the number of scenarios to be considered), using the *Zonal Statistics* tool from within the ArcView interface would be a fastidious exercise as there is a need to import the contours into ArcView and then launch the tool for each contour individually. A specific module has therefore been developed in Python language, which enables, via the GUI presented in Figure 2-6 below, to launch the *Zonal Statistics* tool in a batch mode without the need to launch ArcView. The calculated area and population figures for all the selected airports and scenarios are stored in a single output spreadsheet.

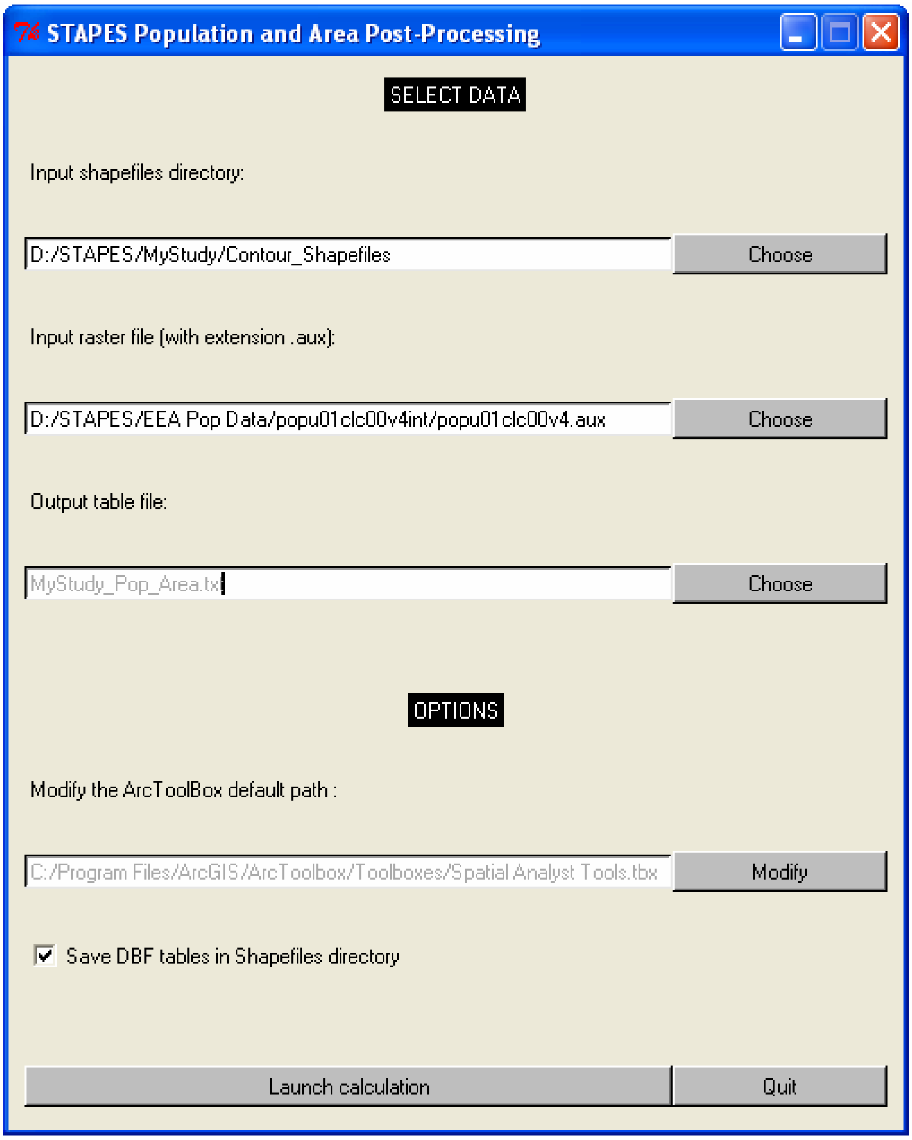

Figure 2-6: Automated contour area and population count processing

2.6. Computation time performances

Due to the number of airports to be calculated by the model (currently 27 – see Section 4) in each study/scenario, STAPES has been designed and developed to work in a multi-processing environment, in order to keep runtimes of each scenario down to a manageable level.

The principle is to distribute the noise calculations to several machines/processors. But instead of assigning the processing of each airport to a particular machine/processor (as done in the US MAGENTA model for instance), the option which has been chosen for STAPES is to process one airport at a time, and distribute the calculation points of the grid to the different available machines/processors. In such a way, the available computation power is permanently exploited, leading to much better computation time performances.

STAPES 1.2 is currently running on a dedicated server enabling up to 63 operations in parallel. The model also makes use of optimized modelling techniques (application of low noise level cutoffs, discard of flight segments which have no influence on cumulative noise exposure levels). Consequently, a typical airport run as undertaken in CAEP/8 assessments (e.g. 20,000 single operations, calculated on a 100x100 m spacing grid) is performed in approx. 90 seconds.

2.7. Additional modelling capabilities and software features

As explained in the Introduction, the extension of the original contract, which was required to complete the airport data collection and processing work, has been taken as an opportunity to extend the modelling capabilities of the initial version of STAPES (1.0) and develop additional software features, which have been implemented into the 1.2 version.

These additional features include noise adjustments for non-reference atmospheric conditions, effect of bank angle in the noise calculations, and an *aircraft performance calculation* module.

The aircraft performance calculation module has been developed in order to calculate aircraft vertical flight profiles (as needed for the noise calculations), based on aircraft aerodynamic and engine performance characteristics, operational weight, atmospheric conditions and operating procedures. From a multi-airport analysis standpoint, the added value of this module is not so much its ability to account for the effect of local airport-specific atmospheric conditions, but the resulting possibility to adjust flight profiles to reflect local operating conditions, and, even more important, the possibility for STAPES to assess the noise impact of new noise abatement procedures across a wide range of airports.

Following the development and integration of these additional modelling capabilities, STAPES 1.2 represents a full implementation of the ECAC Doc. 29 methodology covering all the modelling aspects described in this guidance. Although the model has been designed to perform global noise impact assessments on a multi-airport basis, its modelling capabilities provide the same level of refinement and accuracy as when considering an individual airport.

3. MODEL VERIFICATION AND VALIDATION – CAEP ENDORSEMENT

3.1. Overview

A thorough validation and verification (V&V) process was carefully applied to the model throughout its development cycle, in the form of extensive comparisons against the UK ANCON model, which is compliant with [Doc.29] and had already completed the CAEP MODTF evaluation process and demonstrated good agreement with US FAA MAGENTA model.

The following sections provide more details on the different V&V tasks which have been carried out in line with the requirements/criteria set up by CAEP/MODTF.

Having successfully undertaken this V&V process, STAPES was recommended by MODTF at their meeting in November 2008 for use within ICAO CAEP policy assessments, and this was subsequently endorsed by the CAEP Steering Group at their meeting in June 2009.

3.2. Segment-by-segment numerical comparisons with ANCON 2

The core process of the airport noise contour modelling methodology described in [Doc.29] is the calculation of the noise contribution of each segment of each single-event flight path. To ensure that the STAPES module in charge of this task has correctly implemented the equations/algorithms described in the guidance, extensive numerical comparisons with ANCON 2, on a segment-by-segment basis, have been undertaken, notably to ease the tracking and correction of any modelling deficiencies in the module.

Results of these segment-by-segment numerical comparisons can be found in the attached CAEP-SG/20093-IP/07 Information paper (Appendix C of this report). The comparison tables show that STAPES and ANCON deliver equivalent results for the three test cases.

3.3. Single-event noise footprint comparisons

The single-event noise calculation module and the flight-path calculation module of STAPES have been combined to calculate SEL footprints for three specific single-event operations comprising a B747-400 standard departure, a B747-400 standard arrival, and a MD83 standard departure.

These provide a good coverage of the different situations encountered when modelling noise contours around airports, in terms of types of operations and engine-installation configurations (e.g. wing-mounted and fuselage-mounted engines). No comparison was made for turbo-prop aircraft as this represents a simpler modelling situation, i.e. with no engine installation correction.

As presented in the CAEP-SG/20093-IP/07 Information Paper attached in Appendix C, the noise footprints produced by STAPES closely match those from ANCON.

3.4. Airport-scale comparisons

Having completed the development and implementation phases, STAPES performed a CAEP-specific airport-scale capability demonstration, the so-called NOx Sample Problem, which had already been performed by ANCON 2 on three UK airports. This exercise constituted the final step of the V&V process, and demonstrated the ability of STAPES to accommodate and process data for CAEP policy assessments.

The 11 traffic scenarios of the NOx Sample Problem were processed into STAPES for the three airports. Tables D-1 and D-2 of the attached CAEP-SG/20093-IP/07 Information Paper (Appendix C of this report) present DNL 55 contour area and population count comparisons between both models, for all the scenarios. The observed maximum difference between both models is about 6% in contour area and 8% in population count, this falling to 2.9% and 5.9% respectively when considering global results for the three airports.

This corresponds to average noise level differences of less than 0.5 dB within the noise contours, and is within the typical uncertainty associated with airport noise contour models. Additionally, it should be noted that the observed differences in the NOx Sample Problem results were due, for a large part, to various differences in input data assumptions which have subsequently been identified and fixed before performing the CAEP/8 policy assessments. The observed differences between STAPES and ANCON for the CAEP/8 assessments did not exceed 1.5% in contour areas and 3.3% in population count for individual airports.

4. AIRPORT DATA COLLECTION AND PROCESSING

4.1. Objectives

A critical part of the STAPES project was the collection of up-to-date information from key European airports in order to ensure future modelling assessments are robust enough to support informed policymaking. In order to achieve this quality objective, STAPES had to meet three main requirements:

- Provide the capability to deliver representative results, by covering a sufficient number of airports to capture the largest proportion of population as possible exposed to aircraft noise,

- Represent each airport with a good level of details and accuracy, in order to produce noise assessments results with the same quality level as when considering "traditional" single-airport noise assessments,

- Use common methods and assumptions to develop the input data associated to each of the airports, which, combined with the use of a single/common noise model, can achieve the delivery of consistent results throughout the airports.

4.2. A database of 27 key European airports

Based on a variety of information sources, including strategic noise maps of major airports submitted by EU Member States in line with the Environmental Noise Directive 2002/49, a list of 27 airports for inclusion in STAPES was identified during 2008, in order to represent approx. 90% of the European population exposed to significant noise levels (more than 55 L_{DEN}). This list is provided in Table 4.1 below.

While a significant amount of the required input data already existed within the EUROCONTROL PRISME data warehouse, the project team identified some key data gaps, and so that it was considered particularly crucial to obtain local airport information to complement the information derived from PRISME.

In order to initiate a spirit of cooperation with European airports, an initial EC-EASA-EUROCONTROL letter was sent out to all relevant airport focal points on August 18th 2008, requesting their support on the STAPES project by providing airport local data (see Appendix B).

A very good coordination with the majority of the airports has been established and an efficient data flow process, both for immediate needs and future updates, has been established.

The different types of input data required by the STAPES model (ground tracks, runway usage, SID usage, aircraft types, stage lengths, etc.) have been derived by combining PRISME, AIP and local information. The local information has been a key source of data to determine statistics on runway/SID usage, as this information is generally not available in PRISME. This has enabled the construction of a high quality STAPES airport database for the 27 airports.

Country	Code	Airport
Belgium	BRU	Brussels
France	CDG	Paris Charles de Gaulle
	ORY	Paris Orly
	TLS	Toulouse
Germany	TXL	Berlin Tegel
	CGN	Cologne / Bonn
	DUS	Dusseldorf
	FRA	Frankfurt
	HAM	Hamburg
	HAJ	Hannover
	STR	Stuttgart
Italy	BGY	Bergamo
	LIN	Milan Linate
	MXP	Milan Malpensa
	NAP	Naples
	CIA	Rome Ciampino
	FCO	Rome Fiumicino
Netherlands	AMS	Amsterdam
Portugal	LIS	Lisbon
Spain	MAD	Madrid
	VLN	Valencia
Switzerland	GVA	Geneva
	ZRH	Zurich
UK	BHX	Birmingham
	GLA	Glasgow
	LHR	London Heathrow
	MAN	Manchester

Table 4.1: List of European airports covered by STAPES

5. CAPABILITY DEMONSTRATION: SUPPORT TO CAEP/8

STAPES, in cooperation with ANCON, has actively contributed to the different rounds of noise assessments for the European region in both the CAEP/8 NOx Stringency and Environmental Goals assessment.

The STAPES airport database developed for 27 key European airports has brought significant added value to the CAEP policy assessment process, enabling a more accurate analysis of the European ECAC region than at any previous occasion.

The STAPES analysis identified that the US MAGENTA model was missing key European airports, whereas a significant amount of data for the other European airports within MAGENTA was also out of date (for instance, new runways and flight track changes not being taken into account within the model, incorrect traffic distribution over runway/routes). It also led to the complete removal of two European airports from the CAEP/8 Environmental Goals assessment. Firstly, incorrect runway usage and flight track data in MAGENTA has previously resulted in a significant overestimation of people exposed at a European airport. Correct data illustrated a reduction from approx. 230,000 to 14,000 people exposed to noise levels >55DNL. A second European airport in MAGENTA had closed in 2001 and been replaced by a new airport with less than 5,000 people >55DNL.

The below CAEP/8 Environmental Goals noise results on population exposed to >55DNL, with moderate technology and operational improvements, provide some insight into the differences due to the additional input from STAPES and ANCON on airports in the European region.

	With STAPES/ANCON		**Without STAPES/ANCON**		**Delta**
	Total Population	Ratio	Total Population	Ratio	Total Population
2006	2.625.080	1	2.014.901	1	+610.179
2016	3.196.275	1.22	2.534.390	1.26	+661.885
2026	3.432.300	1.31	2.826.835	1.40	+604.465
2036	3.811.323	1.45	3.159.053	1.57	+652.270

6. CONCLUSIONS - NEXT STEPS

6.1. Project achievements

The STAPES project has developed a new European regional noise model capable of supporting – on a multi-airports basis – policy-making and operational concept assessments, both at European and ICAO-CAEP levels.

The modelling methodology which has been implemented fully complies with current - internationally agreed - best practice as described in ECAC Doc.29 and ICAO Doc 9911.

The model has been fully validated, having successfully undertaken the Verification and Validation (V&V) process set-up by CAEP to evaluate the eligibility of environmental models to support CAEP policy assessments. As a result of these “stress tests”, the STAPES model was endorsed by the CAEP/8 Steering Group of June 2009 as an official aircraft noise model to support noise impact assessments within CAEP/8 and CAEP/9 programmes. Given the complexity of the task that has been undertaken, to have achieved such a result in such a short period of time is a particularly notable achievement.

STAPES incorporates detailed and up-to-date information for 27 European airports, which cover around 90% of the European population exposed to significant aircraft noise levels. The generated datasets of each airport have been produced in a consistent/homogeneous way, following as far as possible a common data processing methodology.

The STAPES noise model, combined with this integrated airport database, is capable of performing global noise impact assessments over the European region, (e.g. on a multi-airports basis) which are:

- Representative (through large coverage of European population exposed to aircraft noise),
- Harmonised (through the use of common modelling method and homogeneous data), and
- Consistent (by using the same levels of detail and accuracy as when considering airports individually).

As practical applications, STAPES has successfully contributed to the noise impact assessments of CAEP/8 policy assessments. CAEP’s Modelling and Database Task Force recognised that STAPES has a better coverage of European airports and higher quality data than the world-wide scale MAGENTA noise model (US FAA ownership). Consequently, MODTF agreed to the use of STAPES as the lead model for the CAEP/8 Goals assessments for the European region.

6.2. Future work

So far, STAPES has successfully undertaken different CAEP/8 policy/goals assessments, but on the basis of fleet and operations data provided by CAEP-MODTF. These were produced by the United States' FAA's Fleet and Operations Module (FOM), based on the forecasts established by the CAEP Forecast and Economics Sub-Group (FESG).

The EUROCONTROL Statistics and Forecasting Service (STATFOR) is a potential data source (operations on a city-pair basis in seat class, business and cargo categories) on which to develop a detailed European fleet forecast model that would produce relevant inputs for STAPES. Developing such a forecasting model, not only for noise but also greenhouse gas and local air quality assessments, would provide Europe with the capability to perform cost-benefit analyses of future policy and operational options in a totally independent way, and would still re-enforce the value of the European input into the CAEP policy assessments. In addition, such a capability would provide for the release of combined traffic and environmental forecasts through STATFOR, a capability which is expected to become increasingly important in the coming years.

EUROCONTROL, EASA and the European Commission have already initiated exploratory discussions to identify how this capability could be developed, especially through some sort of partnership that takes into account EASA's work to bring the AERO model, previously developed by NLR, up to date. These discussions have already identified the interests of both EUROCONTROL and EASA in having access to air traffic, economic and environmental forecasting capabilities. Although these discussions have focussed primarily on fuel burn and emissions issues, the success of the STAPES development provides the potential to extend such forecasting capabilities to include noise.

The needs of the SESAR work programme also need to be taken into account since it includes a work package to develop the requirements for the next generation of environmental models. It is too early to say, however, at this stage, if there could or would be any link between model development for operational and policy-making purposes, although that may be desirable. In any case, it is anticipated that any future development of STAPES will be driven by the needs of both policy-making and operational stakeholders, and that this will become clearer during 2010.

In terms of compatibility with other systems (in order to enable interdependency/trade-off analyses), STAPES has been designed and developed in a transparent and “traditional” way: the databases and input data formats enable easy data importing from external sources. However, some further development would be required in order to automate some data exchange processes, and ensure consistency of data throughout the different analyses (noise, local air quality, etc.).

The STAPES airport database could also be expanded with additional airports from the EUROCONTROL Member States (outside the EU), which have shown, through the CAEP/8 assessments, to have significant noise impact on surrounding populations. In addition, the STAPES airport database could be expanded to include all the major END airports in order to support periodic reviews of European noise legislation.

REFERENCES

[Doc.29] European Civil Aviation Conference (ECAC): *Report on Standard Method of Computing Noise Contours around Civil Airports. Volume 2: Technical Guide*. ECAC.CEAC Doc 29, 3rd Edition (2005).

[Doc.9911] International Civil Aviation Organization (ICAO): *Recommended Method for Computing Noise Contours Around Airports*. ICAO Doc 9911, 1st Edition (2008)

[ANP] ANP database: http://www.aircraftnoisemodel.org

[EEA] EEA-JRC population database link: http://dataservice.eea.europa.eu/dataservice/

Appendix A - Compliance with Annex I of the Contract

Contract Requirement	Pass/Fail	Notes
3. Purpose of this request for support		
1. Identify, if necessary, relevant stakeholders who should participate in the development of the model	P	Direct involvement/support of EASA and UK CAA. Progress report papers informing the different working groups (CAEP MODTF and ECAC ANCAT)
2. Arrange an appropriate forum for discussion and to reach agreement on key design aspects of the model, including:	P	Discussions between EUROCONTROL, EASA and CAA occurred via two preparatory meetings, at relevant CAEP and ANCAT meetings and also via teleconferences / e-mails).
i) the priority European analytical requirements for this type of noise model	P	Mostly provided by EASA in consultation with EC focal points, and also by some ANCAT MITG members.
ii) information on non-European model set-ups and methodologies which provide information on best-practices and weaknesses in existing capabilities in this area	P	Obtained through CAEP-MODTF and SAE A-21, in particular on the US MAGENTA model
iii) the most appropriate airport noise contour modeling methodology for use as a basis in this model	P	Identified as ECAC Doc. 29 and ICAO Doc. 9911 at the beginning of the project to ensure global model credibility (see 4.2 in *Annex II – Offer from EUROCONTROL*)
iv) the input data requirements such as aircraft database, noise engine, movements, fleet, forecasts and output data deliveries/format	P	Linked to the noise modelling methodology (Doc.29), so known from the beginning. For the forecasts, it was specified (4.3.4 in *Annex II – Offer from EUROCONTROL)* that developing a forecast model based on STATFOR data was not part of this project
v) data processing requirements to support this capability	P	Initially identified in Section 4.3 of *Annex II – Offer from EUROCONTROL,* these requirements have been refined during the project

vi) collation, storage and management of relevant input/output data from the model	P	Established during the design and development of the modelling system. Data storage in manageable MS Access database format.
vii) common interfaces/databases/data exchange protocols with relevant models in other domains in order to assess environmental trade-offs	P	STAPES uses "traditional" input data and formats, easy to interface/integrate in a wider modelling platform
viii) the most appropriate existing , or emerging, noise model that may be used to build on and develop this capability	P	The batch version of INM was initially considered as the noise engine of STAPES. This option was not followed and a new European version was developed in order to ensure independence from US models and associated risks.
ix) existing sources of population data surrounding European airports and identification of most appropriate source for this model	P	The EEA-JRC population database has been evaluated (within the CAEP-MODTF group) as the most suitable source of population data in the European region. For the STAPES needs, it has been complemented with local census data for two non-EU airports
x) future impact and monetization requirements beyond population noise exposure	P	STAPES contributed to the CAEP/8 Goals Assessment in order to ensure an accurate analysis of future airport noise contours and population impacted within Europe out to 2036.
3. Identify gaps between "current" and "required" EUROCONTROL noise modelling capabilities	P	Done from the beginning, as EUROCONTROL had no regional noise modelling capability
4. Develop the model to fill gaps and meet the recognised European needs	P	Development of a bespoke model, based on international best practice modelling guidance (ECAC Doc.29 3rd Edition and ICAO Doc. 9911)
5. Perform validation tests and sample analysis to demonstrate the capability of the model for use within European and international working groups	P	Extensive validation and verification work has been undertaken in the context of CAEP. Model capability demonstrated through noise impact assessments of CAEP/8 policies

6. Consider the management structure of the model to ensure long term continuity and maintain best practices in this modelling area	P	Expertise available at EUROCONTROL to ensure future maintenance and development of STAPES. Active participation of EUROCONTROL in ECAC and ICAO working groups in charge of maintaining/updating modelling guidance.
5. Reports and documents to be submitted		
EUROCONTROL shall document and report to EC/EASA on the design phase of the model following completion of work item 3	P	Done through the provision to EASA of the TRS for software development, describing the different components of the modeling system.
Comprehensive final documentation shall be supplied on completion of the project	P	Completed via the provision of this final report.

Appendix B - EC-EASA-EUROCONTROL Letter to Airports

Head of Ufficio Regolamenti e Procedure Protezione Ambientale
Direzione Politiche di Sicurezza ed Ambientali
Viale del Castro Pretorio
118 - 00185 Roma
Italy

18th August 2008

Dear Sir / Madam,

The European Commission and the European Aviation Safety Agency (EASA) have contracted EUROCONTROL to develop a model, known as STAPES, which will be able to perform multi-airport noise contour calculations to support European and International policy assessments.

A key part of this project is the collation of relevant data to ensure that policy-makers are well informed of the possible impact of envisaged environment measures in Europe. We therefore formally request support in the provision of the necessary data for Milan Linate, Milan Malpensa, Naples, Rome Ciampino and Rome Fiumicino airports.

Our policy is to protect stakeholder data, to hold it securely and not to release results for individual airports. The data will also support work within ICAO's Committee on Aviation Environmental Protection (CAEP) in order to represent European interests within this international forum. This data will only be made accessible to modellers, for use solely within CAEP work, once formal data protection agreements are in place.

This co-ordinated approach will reduce future requests for support from different European organisations. In order to further improve future cooperation in this area, EUROCONTROL is also able to offer an exchange of relevant operational data which they currently hold for your airports.

We would like to stress the importance of your data in accurately representing your airports and hope that you will be able to respond positively to this formal request. We will shortly contact you directly to clarify the data requirements and discuss the practical details of this collaboration. In the meantime, if you have any further questions for clarification, then please contact the project focal points which are Stephen Arrowsmith (stephen.arrowsmith@easa.europa.eu) and Laurent Cavadini (laurent.cavadini @eurocontrol.int).

Thank you in advance for your support on this project.

Yours sincerely,

Roberto Salvarani

Head of Unit F.3 – Air Safety
Directorate-General for Transport and Energy,
EUROPEAN COMMISSION

Eric Sivel

Deputy Director
Rulemaking
EASA

Paul Wilson

Head of Airport Operations and Environment Division
EUROCONTROL

Appendix C - ICAO-CAEP Working and Information Papers

ICAO COMMITTEE ON AVIATION ENVIRONMENTAL PROTECTION (CAEP)

CAEP/8 Modelling and Database Task Force (MODTF)

Fourth Meeting

Sunnyvale, California, USA, 20 to 22 February 2008

SysTem for Airport noise Exposure Studies (STAPES[1])

(Prepared by EASA, Eurocontrol and UK CAA)

SUMMARY

This paper reports on the development of a new European multi-airport noise exposure model known as STAPES (SysTem for Airport noise Exposure Studies).

1. INTRODUCTION

1.1 As reported in MODTF-1 WP22, an initial comparison of the 2002 EC Sondeo study and MAGENTA airports suggested that the 15 “Shell 1” European airports currently in MAGENTA only represent approx. 51%-62% of the European population exposed to significant levels of noise, depending on the noise contour level. This is a significant underestimation of the 90% level assumed in the analysis performed during CAEP5.

[1] The human ear has a beautifully designed built-in noise protection mechanism. Three tiny bones - the anvil, the hammer, and the **stapes** (the smallest bone in the body) - connect the eardrum and the cochlea. These little bones transmit sound vibrations from the eardrum to the cochlea, which detects the frequencies and intensities of impending sound and transmits them to the hearing centers of the brain. If the brain detects noise of an intensity that could damage the cochlea, the stapedius muscle contracts and partially pulls the **stapes** away from its connection to the cochlea which somewhat diminishes the sound energy transmitted to the cochlea. This mechanism is nature’s way of providing some protection against hearing damage caused by excessive noise.

1.2 The adoption of the Environmental Noise Directive (2002/49) and the Establishment of rules and procedures with regard to the introduction of noise-related operating restrictions Directive (2002/30), have created a requirement for a modelling capability which the European Commission can use to review these pieces of European legislation on a regular basis with an aim of improving their effectiveness. This tool will also support the requirement on EASA to perform Regulatory Impact Assessments, and on Eurocontrol to analyse future operational proposals within SESAR.

1.3 The European Commission has now issued a contract to Eurocontrol to develop a European regional noise model, with technical support from EASA and UK CAA. The objective of this project is to develop the STAPES model in order to address the above issues, and to provide valuable input into both European and international policy-making assessments, including CAEP/8.

2. COVERAGE OF EUROPEAN AIRPORTS

2.1 Based on the 2002 Sondeo analysis for the European Commission, Eurocontrol 2006 ATM data, and Member State information supplied under the Environmental Noise Directive, a provisional list of 38 European airports have been identified to represent the assumed 90% European population exposed to significant noise levels in CAEP global assessments (Attachment A).

2.2 As part of the development of the STAPES model, up-to-date input data will be collected on these European airports. After all existing ACI airports in MAGENTA have consented to the release of their data to CAEP modellers for exclusive use in CAEP assessments, this additional European airport data will be made available for inclusion in the ICAO Airports Database under the same conditions.

3. STAPES MODEL

3.1 This section provides a brief overview of the anticipated key elements of the model when used to assess CAEP policy options. Equivalent elements will be developed for specific European assessments.

Noise Engine – new noise engine to be developed which is fully compliant with current best practise (ECAC Doc. 29 3rd Edition).

Aircraft grouping and substitution – use of the MODTF approved aircraft grouping and substitution table.

Air traffic operations – use of ICAO Common Operations Database (COD).

Current fleet – use of Campbell-Hill database.

Future fleet – use of FOM output.

Output – airport noise contour areas and population numbers will be provided in the form of >55, >60 and >65 DNL.

3.2 As part of the CAEP model evaluation process, a comparative summary table and a key methodology comparison table will be provided to MODTF. In terms of validation and verification of the noise engine, extensive comparisons will be undertaken against the UK ANCON model, which has completed the MODTF evaluation process and demonstrated good agreement with MAGENTA. Specifically, the verification process will mimic that performed between ANCON and the INM and will report on:

i) Whole airport comparisons;

ii) Single event noise footprint and/or noise level (at specific ground locations) comparisons; and

iii) Segment-by-segment data input/output comparisons.

3.3 STAPES will also be used to undertake the NOx stringency sample problem to the same extent as that done for ANCON (3 London airports).

4. POPULATION DATA

4.1 Population data is a key aspect to accurate European airport noise exposure assessments, Following a review of the available population databases, it is anticipated that the STAPES model will use the EEA single source of European population data, based on satellite spatial analysis work, along with any relevant local census data.

5. TIMESCALES

5.1 Airport input data is expected to be an on-going task during 2008 in preparation for inclusion in CAEP/8 policy assessments.

5.2 Model development has already begun and initial evaluation input will be provided to MODTF at the June 4-6 meeting. This will include the single event noise level comparisons, which represents the most critical part of the V&V process as the single event noise calculation forms the 'heart' of the system. A significant part of STAPES evaluation work will be completed by the September 22-26 SG2008 meeting in order to inform participants of its status. The final V&V information will then be provided to MODTF at the November 4-6 meeting, if not before.

6. ACTIONS BY MODTF

6.1 MODTF are recommended to:

i) note the development of a new European multi-airport model known as STAPES;

ii) note the provisional list of European airports in Attachment A which are to be included in CAEP/8 global assessments, and for which relevant input data is currently being collated;

iii) confirm the STAPES model evaluation input required by MODTF in order to approve its use within CAEP assessments; and

iv) note the anticipated use of the EEA population database within STAPES.

ATTACHMENT A – European Airports for CAEP Global Noise Exposure Assessments

Country	Code	Airport
UK	LHR	London Heathrow
Germany	TXL	Berlin Tegel
France	ORY	Paris Orly
Portugal	LIS	Lisbon
Germany	HAM	Hamburg
France	CDG	Paris Charles de Gaulle
UK	MAN	Manchester
Germany	FRA	Frankfurt
Belgium	BRU	Brussels
Spain	MAD	Madrid
Germany	HAJ	Hannover
UK	GLA	Glasgow
Germany	CGN	Cologne / Bonn
Italy	NAP	Naples
UK	BHX	Birmingham
Germany	DUS	Dusseldorf
Italy	FCO	Rome Fiumicino
Netherlands	AMS	Amsterdam
Ireland	DUB	Dublin
Italy	MXP	Milan Malpensa
Spain	PMI	Mallorca Palma
Luxembourg	LUX	Luxembourg
Spain	BCN	Barcelona
Germany	STR	Stuttgart
Denmark	CPH	Copenhagen
UK	EMA	London City
Switzerland	ZRH	Zurich
Czech Rep	PRG	Prague

Switzerland	GVA	Geneva
Poland	WAW	Warsaw
Hungary	BUD	Budapest
Italy	LIN	Milan Linate
Spain	VLN	Valencia
Italy	CIA	Rome Ciampino
Germany	NUE	Nuernberg
Germany	SXF	Berlin Schoenefeld
UK	BHD	Belfast International
Spain	BIO	Bilbao

ICAO COMMITTEE ON AVIATION ENVIRONMENTAL PROTECTION (CAEP)

CAEP/8 Modelling and Database Task Force (MODTF)

5th Meeting

Lisbon, Portugal, 3 to 5 June 2008

Update on SysTem for Airport noise Exposure Studies (STAPES[1])

(Prepared by EASA, Eurocontrol and UK CAA)

SUMMARY

This paper provides an update on the development of the European multi-airport noise exposure model known as STAPES (SysTem for Airport noise Exposure Studies).

1. INTRODUCTION

1.1 As reported in MODTF-4 WP06, the European Commission has issued a contract to EUROCONTROL to develop a European regional noise model, with technical support from EASA and UK CAA. The objective of the project, known as STAPES (SysTem for Airport noise Exposure Studies), is to develop a multi-airports noise model capable of providing valuable input into both European and international policy-making assessments, including CAEP/8.

[1] The human ear has a beautifully designed built-in noise protection mechanism. Three tiny bones - the anvil, the hammer, and the **stapes** (the smallest bone in the body) - connect the eardrum and the cochlea. These little bones transmit sound vibrations from the eardrum to the cochlea, which detects the frequencies and intensities of impending sound and transmits them to the hearing centres of the brain. If the brain detects noise of an intensity that could damage the cochlea, the stapedius muscle contracts and partially pulls the **stapes** away from its connection to the cochlea which somewhat diminishes the sound energy transmitted to the cochlea. This mechanism is nature's way of providing some protection against hearing damage caused by excessive noise.

2. COVERAGE OF EUROPEAN AIRPORTS

2.1 Based on the 2002 Sondeo analysis for the European Commission, Eurocontrol 2006 ATM data, and Member State information supplied under the Environmental Noise Directive, an updated provisional list of 27 European airports have been identified to represent the assumed 90% European population exposed to significant noise levels in CAEP global assessments (Attachment A).

2.2 As part of the development of the STAPES model, up-to-date input data will be collected on these European airports. After all existing ACI airports in MAGENTA have consented to the release of their data to CAEP modellers for exclusive use in CAEP assessments, this additional European airport data will be made available for inclusion in the ICAO Airports Database under the same conditions.

2.3 The airport input data development task will use, where possible, local datasets which have already been processed for airport noise contouring purposes[1], and can therefore be incorporated in STAPES at a minimum processing cost. For airports which do not have the required airport data readily available, or have only partial information, these shall be derived from, or complemented with, the EUROCONTROL PRISME data warehouse for operations and/or Aeronautical Information Publications for ground tracks (i.e. create ‘manufactured’ airport decks). This will be based on the guidance/recommendations provided in ECAC Doc.29 3rd Edition, such as that for the definition of ground dispersion.

3. STAPES MODEL

3.1 STAPES is being developed to be fully compliant with the current best practise of ECAC Doc. 29R 3rd Edition, and will be able to accommodate relevant input for CAEP assessments. The EUROCONTROL project manager is already engaged in the telecons for MODTF modellers.

3.2 In line with the CAEP model evaluation process, a comparative summary table and a key methodology comparison table will be provided to MODTF.

[1] Especially the input datasets which have been used by EU Member States to produce airport noise contours for the Environmental Noise Directive 2002/49/EC

3.3 Development of the noise engine software has begun and, in terms of validation and verification (V&V), extensive comparisons will be undertaken against the UK ANCON model, which has completed the MODTF evaluation process and demonstrated good agreement with MAGENTA. The table below provides a breakdown of the STAPES development programme, including a short description of the associated module-specific validation and verification. In particular, the proposed step-by-step V&V of STAPES includes the performance of the NOx sample problem which will be carried out when the software has been developed and implemented.

WP	**Description**	**Associated V&V Process via comparisons with ANCON2**	**Delivery Date**
WP1	Single-Event Noise Calculation Module development (SEL only)	Noise levels of segments at specific locations (for jet aircraft with wing and tail-mounted engines plus a turboprop)	July 2008
WP2	Flight Path Segments Construction Module development (for point-tracks combined with fixed-point profiles)	Segment-by-segment comparisons	August 2008
WP3	Noise Contour Calculation Module development	- Initial contour/footprint comparisons (using a test grid of noise levels) - Single-event noise footprint comparisons, complementing the V&V results of WP1	August 2008
WP4	Cumulative Noise Levels Calculation Module development (on fixed-grid for DNL and Lden)	Grid and/or contour comparisons (using a test set of operations)	September 2008
WP5	STAPES Core Program development and implementation in the multi-processing environment	Noise contour comparisons for three London airports, through the performance of the NOx sample problem	October 2008

4. POPULATION DATA

4.1 The STAPES modelling system for application in CAEP will utilise the MODTF agreed population databases: US Census data, JRC-EEA for EU and the Global Rural-Urban Mapping Project (GRUMP) data for regions outside of the US and EEA data coverage. The population counting process will be automated to facilitate the rapid processing of noise contours anticipated as a result of the large number of CAEP/8 policy scenarios.

5. TIMESCALES

5.1 Airport input data is expected to be an on-going task during 2008 in preparation for inclusion in CAEP/8 policy assessments.

5.2 Model development has begun and final V&V information is still anticipated to be provided to MODTF at the November 4-6 meeting.

6. ACTIONS BY MODTF

6.1 MODTF are recommended to:

i) note the updated provisional list of European airports in Attachment A which are to be included in CAEP/8 global assessments, and for which relevant input data is to be collated; and

ii) note the STAPES model V&V schedule in order to help manage the future workload of the MODTF focal points for noise model evaluations.

ATTACHMENT A – European Airports for CAEP Global Noise Exposure Assessments

Country	Code	Airport
Belgium	BRU	Brussels
France	CDG	Paris Charles de Gaulle
France	ORY	Paris Orly
France	TLS	Toulouse
Germany	TXL	Berlin Tegel
Germany	CGN	Cologne / Bonn
Germany	DUS	Dusseldorf
Germany	FRA	Frankfurt
Germany	HAM	Hamburg
Germany	HAJ	Hannover
Germany	STR	Stuttgart
Italy	LIN	Milan Linate
Italy	MXP	Milan Malpensa
Italy	NAP	Naples
Italy	CIA	Rome Ciampino
Italy	FCO	Rome Fiumicino
Luxembourg	LUX	Luxembourg
Netherlands	AMS	Amsterdam
Portugal	LIS	Lisbon
Spain	MAD	Madrid
Spain	VLN	Valencia
Switzerland	GVA	Geneva
Switzerland	ZRH	Zurich
UK	BHX	Birmingham
UK	GLA	Glasgow
UK	LHR	London Heathrow
UK	MAN	Manchester

ICAO COMMITTEE ON AVIATION ENVIRONMENTAL PROTECTION (CAEP)

CAEP/8 Modelling and Database Task Force (MODTF)

6th Meeting

Miami, USA, 4 to 6 November 2008

STAPES (SysTem for Airport noise Exposure Studies) Model Release Overview

(Prepared by EASA, EUROCONTROL and UK CAA)

SUMMARY

This paper presents the first release of the European multi-airports noise exposure model known as STAPES (SysTem for Airport noise Exposure Studies), which was delivered in October 2008.

The model, fully compliant with the modelling methodology described in ECAC Doc.29 3rd Edition, has successfully completed a validation and verification (V&V) process which has consisted of extensive comparisons with the UK ANCON model.

The model has also successfully undertaken the same CAEP NOx Sample Problem previously performed by ANCON (e.g. on three London airports).

Action for MODTF are in Paragraph 6.

1. INTRODUCTION

1.1 The European Commission has issued a contract to EUROCONTROL to develop a European regional noise model, with technical support from EASA and UK CAA. The objective of the project, known as STAPES (SysTem for Airport noise Exposure Studies), is to develop a multi-airport noise model capable of providing valuable input into both European and international policy-making assessments, including CAEP/8.

1.2 In line with the planned schedule presented in MODTF-5_WP05, a first version of the STAPES model was developed and delivered in October 2008. A validation and verification (V&V) process has been carefully applied to the model throughout its development cycle, in the form of extensive comparisons against the UK ANCON model, which has already completed the MODTF evaluation process and demonstrated good agreement with MAGENTA. Once the software had been developed and implemented, the performance of the CAEP NOx sample problem was also completed as part of the step-by-step V&V work.

1.3 This paper gives an overview of the noise model's characteristics and capabilities to support CAEP assessments, along with results of the V&V process mentioned above.

2. STAPES MODEL OVERVIEW

2.1 The diagram below provides an overview of the STAPES modelling system which has been developed.

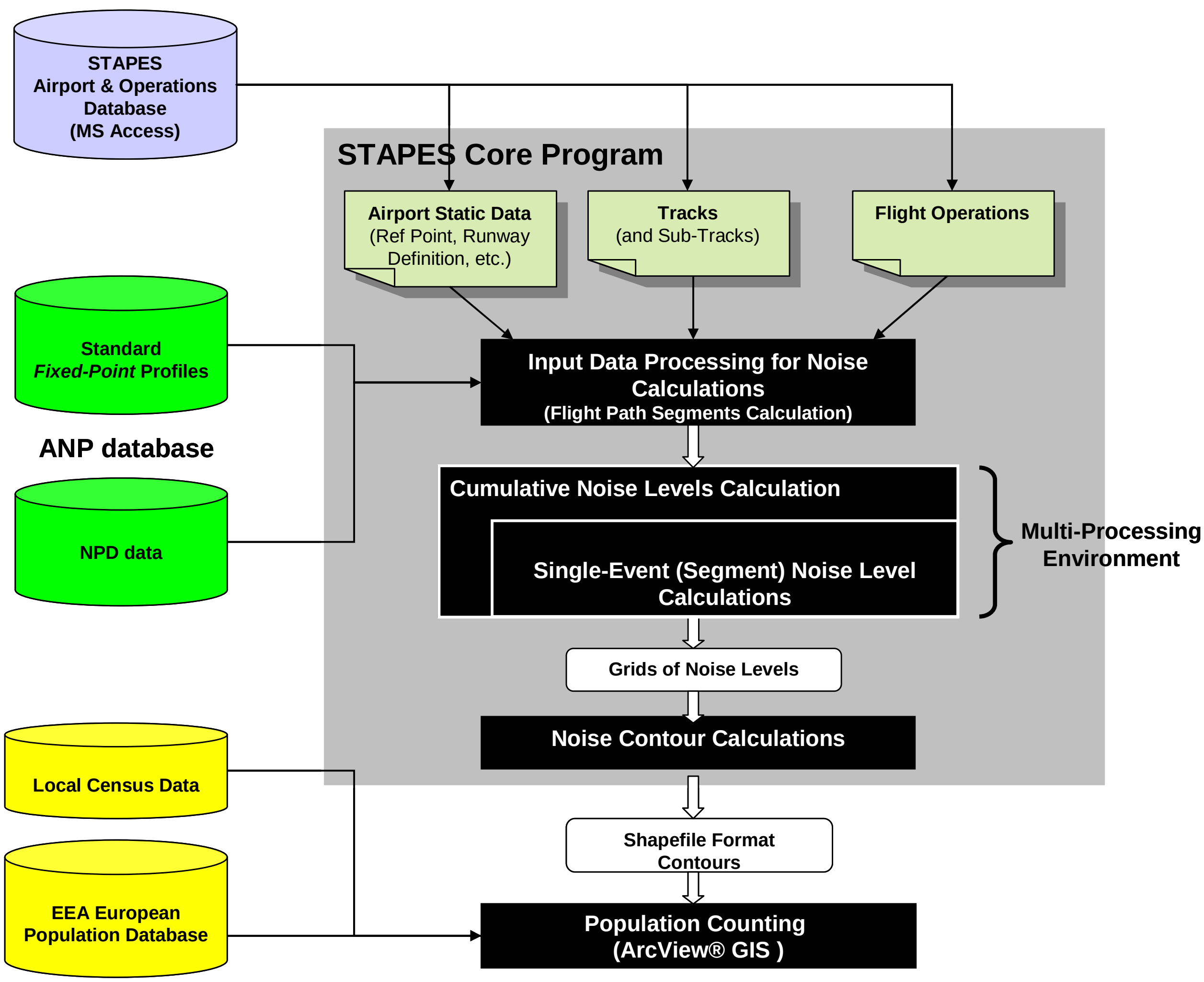

Figure 1: STAPES Modelling System Overview

2.2 STAPES fully implements the airport noise contour modelling methodology described in ECAC Doc.29 3rd Edition guidance, which represents current, internationally agreed, best practice.

2.3 In addition, STAPES input data definition and formats follows the specifications defined in the ECAC guidance, facilitating the incorporation of relevant input data for CAEP assessments.

2.4 Flight trajectories are constructed by “merging” ground tracks and (standard) vertical flight profiles. The current version of STAPES uses pre-calculated standard *fixed-point* profiles to represent the flight procedures. These are obtained, along with associated noise levels, via NPD tables within the ANP Database.

2.5 The model can perform calculations for exposure-based noise metrics including Leq, L_{DEN} , L_{DAY}, L_{EVE}, L_{NIGHT} and DNL. These are computed on fixed-spacing grids.

2.6 Due to the number of airports to be processed in each scenario, the model has been designed, developed and implemented to work in a multi-processing environment, in order to keep the computation times at an acceptable level.

2.7 From the calculated grids of noise levels, the model generates noise contours which are further exported in a shapefile format to ArcView GIS. Population counting is performed using the population database supplied by the European Environment Agency and Joint Research Committee (EEA-JRC) and complemented, where necessary, with local census data..

2.8 Attachments A and B provide the necessary information on STAPES to update both the MODTF comparative summary table of model readiness and the key methodology comparison table.

3. SINGLE-EVENT VALIDATION AND VERIFICATION (V&V) RESULTS

3.1 The core process of the airport noise contour modelling methodology described in ECAC Doc.29 3rd Edition is the calculation of the noise contribution of each segment of each single-event flight path. To ensure that the module in charge of this task has correctly implemented the equations/algorithms described in the guidance, extensive numerical comparisons with ANCON have been undertaken, notably to ease the tracking and correction of any modelling errors in the module.

3.2 The work has consisted of segment-by-segment comparisons, at specific ground locations, of segment-to-receiver geometric parameters, interpolated SELs (from NPDs), and the different corrective terms applied to each segment (e.g. duration correction, lateral attenuation, noise fraction).

3.3 This V&V exercise has been performed for three specific single-event operations comprising a B747-400 standard departure, a B747-400 standard arrival, and a MD83 standard departure. These provide good coverage of the different situations encountered when modelling noise contours around airports, such as types of operations and engine-installation configurations (e.g. wing-mounted and fuselage-mounted engines). No comparisons were made for turbo-prop aircraft as this represents a simpler modelling situation, with no engine installation correction term, which is covered by the other comparisons.

3.4 Another key element of the modelling process is the calculation of the flight path segments by merging and sub-dividing where necessary ground tracks and vertical flight profiles. Again, the module responsible for calculating the flight path segments of each operation has been verified and validated against ANCON through detailed segment-by-segment comparisons of segment geometry, speed and thrust values.

3.5 The single-event noise calculation module and the flight-path calculation module of STAPES have then been combined to calculate SEL footprints for the three single-events mentioned above. The following Figures present STAPES-ANCON footprint comparisons for SELs ranging from 80 to 100 dB(A), by 5 dB increments. They show that the footprints produced by STAPES closely match those from ANCON.

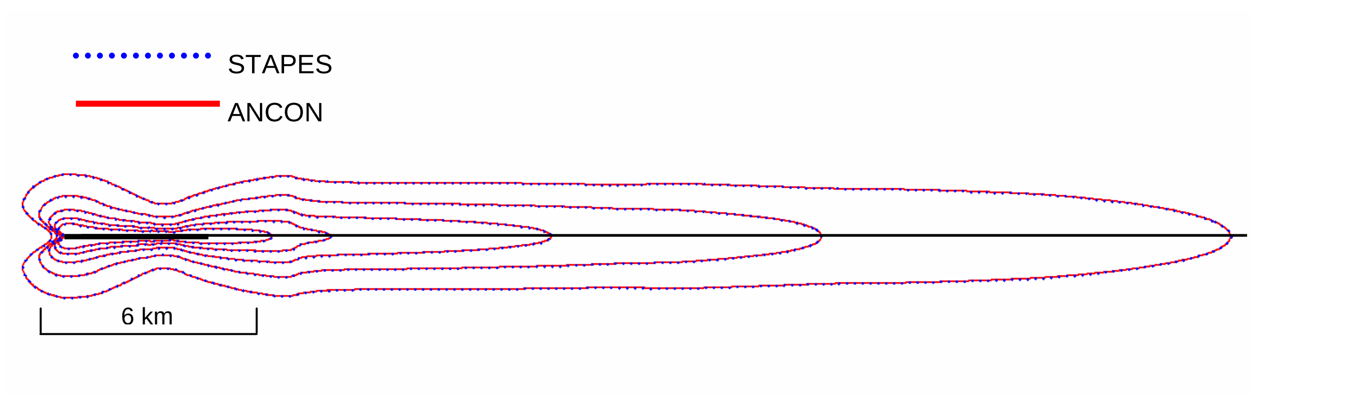

Figure 2: SEL Footprints - B747-400 Departure with Standard Profile, Stage Length 9

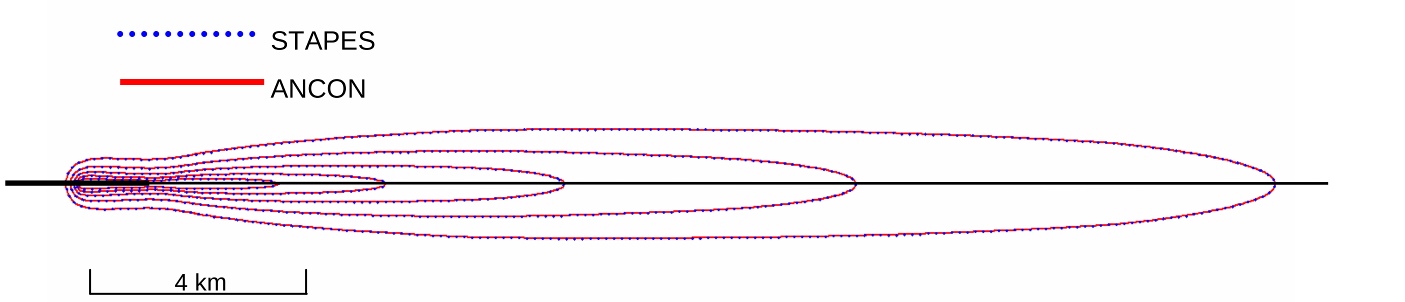

Figure 3: SEL Footprints - B747-400 Standard Arrival

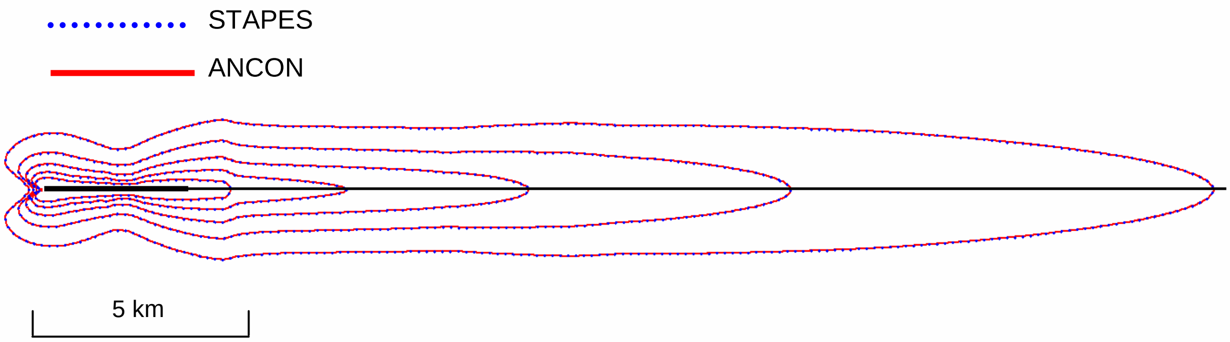

Figure 4: SEL Footprints – MD83 Departure with Standard Profile, Stage Length 5

4. AIRPORT-SCALE VALIDATION AND VERIFICATION (V&V): NOx SAMPLE PROBLEM RESULTS

4.1 Having completed the development and implementation phases, STAPES has undertaken the CAEP NOx Sample Problem as performed by ANCON, e.g. on three London airports: Heathrow, Gatwick and Stansted. This exercise constitutes the final step of the V&V process, and demonstrates the ability of STAPES to accommodate and process data for CAEP policy assessments.

4.2 The 11 traffic scenarios of the NOx Sample Problem were processed into STAPES for the three airports. DNL noise contours were produced for levels 55, 60 and 65 dB(A) and population counts performed for each contour.

4.3 The table in Attachment C presents comparisons of STAPES and ANCON population counts within the DNL 55 contour for all scenarios[1]. The observed maximum difference between both models is about 8% (6% in contour area), which corresponds to average noise level differences of less than 0.5 dB within the noise contours. This remains within the typical uncertainty associated with airport noise contour models. Differences become even smaller when looking at total population counts for the three airports.

4.4 The trends in population counts across the different stringency scenarios were also compared for both models. For each future year (2025, 2035), and stringency scenario, the ratio of the population count relative to that of the "no stringency" scenario was calculated. Results are presented in Attachment D. The table shows that both STAPES and ANCON yield similar trends between the stringency scenarios of a same year, especially when looking at all three airports together. Both models therefore lead to similar conclusions when ranking candidate stringency options by their overall noise impact.

[1] Both STAPES and ANCON population counts were produced using the EEA-JRC population database, the MODTF endorsed population dataset for the European region.

5. TIMESCALES

5.1 As per ANCON, STAPES expects to participate in Round 1 of the CAEP8 MODTF modelling assessments in terms of a limited sample of 10 European airports, which is believed to represent around 75% of European noise exposure. The Round 2 assessment will include the additional ACI data and up-to-date data collated from the identified 26 key European airports, which are estimated to represent 90% of European noise exposure.

6. ACTIONS BY MODTF

6.1 MODTF, and particularly MODTF focal points for noise model evaluations, are recommended to:

i) note the release of the first version of STAPES;

ii) consider the V&V results and Attachments presented in this paper in line with the MODTF model evaluation process; and

iii) approve the STAPES noise model for use within CAEP to support assessments of policy options.

ATTACHMENT A: Detailed Table of Model Readiness

⊘	Does not appear to meet requirement; thus, tool change would be needed
^	Appears to need adaptation to meet the requirement
?	Insufficient information to make a judgment
✓	Appears to meet requirement with minor or no change to the tool
N/A	Not relevant to this type of tool

Can apply / address			STAPES
CAEP Goals Assessment		Goals – CAEP/7	N/A
		Goals – CAEP/8 &beyond	The INM aircraft database would need to be carefully adjusted to account for technology development and this is essentially an expert driven process. It could be used for the European region.
Possible CAEP Modeling Requirement	Policy Scenarios Affecting Fleet	Current aircraft configurations (i.e., TRL 9)	It can model the current aircraft configurations included in its aircraft database.
		Fleet changes with new aircraft/engine combinations and/or new technology	Capability will depend on what data is provided for modelling future technology.
	Policy Scenarios Affecting Operations (Procedures, Number of Flights, etc.)	User input-driven trajectory changes from archived data (e.g., ETMS, ETFMS, etc.)	Limited to the terminal area.
		User input-driven trajectory changes from simulations	Concerns regarding ability to provide simulations for proposed CNS/ATM developments
		Fine-level trajectory changes (e.g., multi-configuration noise data, noise data for various flap settings, performance data)	DATA LIMITATIONS CURRENTLY PREVENT THIS ANALYSIS
Common Tool Issues	Core Modules	FESG forecast	Yes.
	User Input-Driven Global Databases	Airports	Yes.
		Movements	Yes.
		Fleet (e.g., Campbell-Hill Aircraft/ Engine ID Fleet data)	Yes.
	Output	Output by ICAO Region	Only the European ICAO region
	Validation	Has undergone V&V	Yes.
Subject-Specific Requirements	Local Air Quality	BFFM2, BFFM2 Curvefit or DLR method (with ICAO Engine Emissions Databank)	N/A
		Aircraft performance per compliance with ECAC/DOC 29 (with ANP database)	N/A
		Emissions sources	N/A
		Aircraft	N/A
		Other airport	N/A
		Non airport	N/A
		Dispersion capabilities	N/A
		NOx chemistry	N/A
		PM non-volatiles	N/A
		PM volatiles	N/A
	GHG	BFFM2 or DLR method (with ICAO Engine Emissions Databank)	N/A
		Mass emissions gate-to-gate	N/A
		Gridded output (for impacts)	N/A
		Impacts	N/A
	Noise	ECAC/DOC 29 3rd Ed. Compliant (with ANP database)	Yes.
		World-wide coverage	Currently limited to the European region.
		Population exposure to noise	Yes.

ATTACHMENT B: Key Methodology Components

Requirement	STAPES
	Input Databases
Basic Flight Coverage	All commercial flights at modelled airports
Flight Types	All flights.
Airports	Potentially all airports in the MODTF airport database.
Aircraft/ Engine Types	Detailed airframe and engine information is obtained, for CAEP related work, from the Campbell-Hill aircraft registration database, which covers 14038 commercial aviation aircraft worldwide. Additional airframe and engine information obtained from the BACK world fleet database can also use a global fleet database.
Aircraft Performance	Aircraft performance data is obtained from the ANP database. The performance data is used in conjunction with radar trajectories to reflect local airline operating procedures (see methodology).
Airport Taxi and Delay	
Aircraft Movements: Flight Plans and Schedules, Representing both activity and fleet mix	Flights origin, destination, and generic aircraft type information is derived from ETMS/ETFMS flight plans and OAG flight schedules.
Aircraft Movements: Flight Profiles and Trajectories	Flight profiles are expressed in terms of ANP stage length. For Shell 1 airports, departure and arrival flight trajectories are determined by the specific airport's flight track definitions and utilizations. For Shell 2 airports assumptions apply.
Meteorology	ANP standard day conditions.
Population	For European region, uses the European Environmental Agency (EEA) population database. For CAEP applications requiring worldwide coverage, can incorporate US National Census data for US, and GRUMP elsewhere.
	Methodology
Aircraft/engine matching	Exact airframe type and engine using tail number. If the first method cannot be used a distribution of airframes and engines is derived based on the specific airline fleet.
Aircraft Performance in the terminal area	As defined in the ANP database trajectories.
Unscheduled and Cancelled Flights	N/A due to incorporation of ETMS/ETFMS data.
Takeoff Weight and Trajectory Assumptions	Derived from stage length using ANP/INM relationships
Forecasting	Utilizes the MODTF Flight Operations Module (FOM) to define forecast aircraft movements, which incorporates FESG growth rates and any given policy measures.
	Output Databases for Noise
Noise	The current version of the model can produce grids of SEL, Leq, DNL and L_{DEN}
World Grids	Gridded output produced in the vicinity of each airport.
ICAO Regions	Yes, subject to integration of MODTF airports data.
Countries	Yes for European countries covered by STAPES. Outside of Europe subject to integration of MODTF airport data for other countries.

ATTACHMENT C: NOx Sample Problem - STAPES / ANCON2 Population Count Comparisons Above DNL 55 dB

Population above DNL 55 dB																
Analysis Year	Region	ANCON2					STAPES					% Difference (STAPES - ANCON2)				
		Baseline					Baseline					Baseline				
2005 (Datum)	LGW	14790					16016					+8.3%				
	LHR	283169					271880					-4.0%				
	STN	6458					6835					+5.8%				
	Total	304418					294731					-3.2%				
		Stringency Implementation Year					Stringency Implementation Year					Stringency Implementation Year				
			2012		2016			2012		2016			2012		2016	
		Baseline	6.50%	18%	6.50%	18%	Baseline	6.50%	18%	6.50%	18%	Baseline	6.50%	18%	6.50%	18%
2025	LGW	42618	43569	44719	43331	44078	42849	43838	45182	43881	44700	+0.5%	+0.6%	+1.0%	+1.3%	+1.4%
	LHR	645962	656099	669647	652134	659454	601224	614711	627274	611065	618357	-6.9%	-6.3%	-6.3%	-6.3%	-6.2%
	STN	39932	41188	41933	40869	42406	41412	41904	45027	42844	43140	+3.7%	+1.7%	+7.4%	+4.8%	+1.7%
	Total	728512	740856	756299	736334	745939	685485	700453	717483	697789	706197	-5.9%	-5.5%	-5.1%	-5.2%	-5.3%
		Stringency Implementation Year					Stringency Implementation Year					Stringency Implementation Year				
			2012		2016			2012		2016			2012		2016	
		Baseline	6.50%	18%	6.50%	18%	Baseline	6.50%	18%	6.50%	18%	Baseline	6.50%	18%	6.50%	18%
2035	LGW	56599	59041	60828	58453	60560	57712	59612	61934	59223	62286	+2.0%	+1.0%	+1.8%	+1.3%	+2.8%
	LHR	811324	831807	855702	824820	844789	767918	777940	808219	784237	799267	-5.4%	-6.5%	-5.5%	-4.9%	-5.4%
	STN	58020	59248	61353	59587	60750	58995	59906	62398	59878	61877	+1.7%	+1.1%	+1.7%	+0.5%	+1.9%
	Total	925944	950096	977883	942861	966100	884625	897459	932550	903338	923429	-4.5%	-5.5%	-4.6%	-4.2%	-4.4%

ATTACHMENT D: NOx Sample Problem - STAPES & ANCON2 Population Ratio Relative to the 'No Stringency' Scenario

		Above DNL 55 dB				Above DNL 60 dB				Above DNL 65 dB			
		2025		2035		2025		2035		2025		2035	
Airport	Stringency	ANCON2	STAPES	ANCON2	STAPES	ANCON2	STAPES	ANCON2	STAPES	ANCON2	STAPES	ANCON2	STAPES
LGW	2012 18%	1.05	1.05	1.07	1.07	1.05	1.05	1.05	1.05	1.06	1.07	1.08	1.07
	2012 6.5%	1.02	1.02	1.04	1.03	1.03	1.01	1.02	1.02	1.04	1.03	1.04	1.03
	2016 18%	1.03	1.04	1.07	1.08	1.05	1.03	1.06	1.06	1.06	1.05	1.10	1.05
	2016 6.5%	1.02	1.02	1.03	1.03	1.02	1.01	1.02	1.00	1.02	1.05	1.03	1.02
LHR	2012 18%	1.04	1.04	1.05	1.05	1.03	1.04	1.05	1.05	1.03	1.04	1.04	1.04
	2012 6.5%	1.02	1.02	1.03	1.01	1.01	1.02	1.02	1.02	1.02	1.03	1.02	1.01
	2016 18%	1.02	1.03	1.04	1.04	1.03	1.02	1.04	1.04	1.01	1.04	1.03	1.04
	2016 6.5%	1.01	1.02	1.02	1.02	1.01	1.01	1.02	1.01	1.01	1.02	1.01	1.02
STN	2012 18%	1.05	1.09	1.06	1.06	1.05	1.10	1.08	1.08	1.03	1.07	1.09	1.08
	2012 6.5%	1.03	1.01	1.02	1.02	1.06	1.00	1.02	1.01	1.02	1.01	1.02	1.02
	2016 18%	1.06	1.04	1.05	1.05	1.10	1.01	1.04	1.07	1.05	1.02	1.06	1.06
	2016 6.5%	1.02	1.03	1.03	1.01	1.06	1.04	1.05	1.01	1.02	1.03	1.07	1.00
All	2012 18%	1.04	1.05	1.06	1.05	1.03	1.05	1.05	1.05	1.03	1.05	1.05	1.05
	2012 6.5%	1.02	1.02	1.03	1.01	1.02	1.02	1.02	1.02	1.02	1.03	1.02	1.01
	2016 18%	1.02	1.03	1.04	1.04	1.03	1.02	1.04	1.05	1.01	1.04	1.04	1.04
	2016 6.5%	1.01	1.02	1.02	1.02	1.01	1.02	1.02	1.01	1.01	1.02	1.01	1.02

Note: Some differences simply occur due to rounding to the nearest 0.01.

CAEP-SG/20093-IP/7
11/6/09

COMMITTEE ON AVIATION ENVIRONMENTAL PROTECTION (CAEP)

STEERING GROUP MEETING

Salvador, Brazil, 22 to 26 June 2009

Agenda Item 4: Modelling and Databases Task Force (MODTF)

SYSTEM FOR AIRPORT NOISE EXPOSURE STUDIES (STAPES[1])

(Presented by the Rapporteurs MODTF)

SUMMARY

This paper provides a summary of the development of the European multi-airport noise contour model known as STAPES (SysTem for Airport noise Exposure Studies).

The model is fully compliant with ECAC Doc.29 3rd Edition, and has successfully completed the model evaluation process in line with the MODTF criteria, notably through extensive comparisons with the UK ANCON 2 model. On the basis of results of this evaluation work, STAPES was recommended by MODTF for use within CAEP policy assessments. The model has since successfully contributed to the CAEP/8 NOx Stringency and Environmental Goals assessments.

The STAPES project also includes the collection and integration into the model of up-to-date information from key European airports. This will be completed during Summer 2009 and so final STAPES results for the Environmental Goals assessment will be presented at the MODTF-9 meeting on 13-15 October and the subsequent CAEP/8 meeting in February 2010.

Due to the larger number of European airports that will be covered, and the use of more detailed airport data, the noise results for the European region in the Environmental Goals policy assessments are expected to change between the SG2009 and CAEP/8 meetings.

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[1] The human ear has a beautifully designed built-in noise protection mechanism. Three tiny bones - the anvil, the hammer, and the **stapes** (the smallest bone in the body) - connect the eardrum and the cochlea. These little bones transmit sound vibrations from the eardrum to the cochlea, which detects the frequencies and intensities of impending sound and transmits them to the hearing centers of the brain. If the brain detects noise of an intensity that could damage the cochlea, the stapedius muscle contracts and partially pulls the **stapes** away from its connection to the cochlea which somewhat diminishes the sound energy transmitted to the cochlea. This mechanism is nature's way of providing some protection against hearing damage caused by excessive noise.

1. INTRODUCTION

1.1 The European Commission (EC) has issued a contract to EUROCONTROL (ECTRL) in January 2008 to jointly develop a European regional noise model, with technical support from the European Aviation Safety Agency (EASA) and UK CAA.

1.2 The objective of the project, known as STAPES (SysTem for Airport noise Exposure Studies), is to develop a multi-airport noise model capable of providing accurate input into both European and international policy-making assessments, including CAEP/8. It is also expected to support the requirement of EASA to perform regulatory impact assessments, and on ECTRL to analyse future operational proposals within SESAR.

1.3 Based on past EC studies, ECTRL ATM data, and information supplied by EU Member States under the Environmental Noise Directive 2002/49, an updated list of 27 European airports have been identified to represent the assumed 90% European population exposed to significant noise levels in CAEP global assessments (see Appendix F). Hence, the STAPES project comprises not just software development work, but also the collection and integration into the model of up-to-date information from these key European airports in order to ensure future modelling assessments are robust enough to support informed policymaking.

1.4 A first version of the STAPES model was released in October 2008, and subsequently approved by MODTF having completed the agreed model evaluation process as described in detail in CAEP-SG/20082-WP_09. This paper provides a summary of the development and MODTF evaluation of STAPES within the context of CAEP.

2. MAIN MODEL CHARACTERISTICS

2.1 An overview of the STAPES modelling system which has been developed is provided in Figure 1.

2.2 STAPES is fully compliant with the airport noise contour modelling methodology described in ECAC Doc.29 3rd Edition. This represents current, internationally agreed, best practice which underpinned the recent publication of ICAO Document 9911. In addition, STAPES input data definition and formats follows the specifications defined in the ECAC guidance, facilitating the incorporation of relevant input data for CAEP assessments.

2.3 Flight trajectories (i.e. series of flight path segments, as needed by the single-event segment noise calculation module) are constructed by "merging" ground tracks and (standard) vertical flight profiles. The current version of STAPES uses pre-calculated standard *fixed-point* profiles (under ISA conditions for the CAEP needs) to represent the flight procedures. These are obtained, along with aircraft noise data (NPDs), from the ANP Database.

2.4 The model can perform calculations for exposure-based noise metrics, including Leq, L_{DEN}, L_{DAY}, L_{EVE}, L_{NIGHT} and DNL. These are computed on fixed-spacing grids.

2.5 Due to the number of airports to be processed in each scenario, the model has been designed, developed and implemented to work in a multi-processing environment in order to keep the computation times down to an acceptable level.

2.6 From the calculated grids of noise levels, the model generates noise contours which are further exported to the ArcView GIS. Population counting is performed using the population database supplied by the European Environment Agency (EEA) and EC Joint Research Centre (DG JRC), and is complemented, where necessary, with local census data.

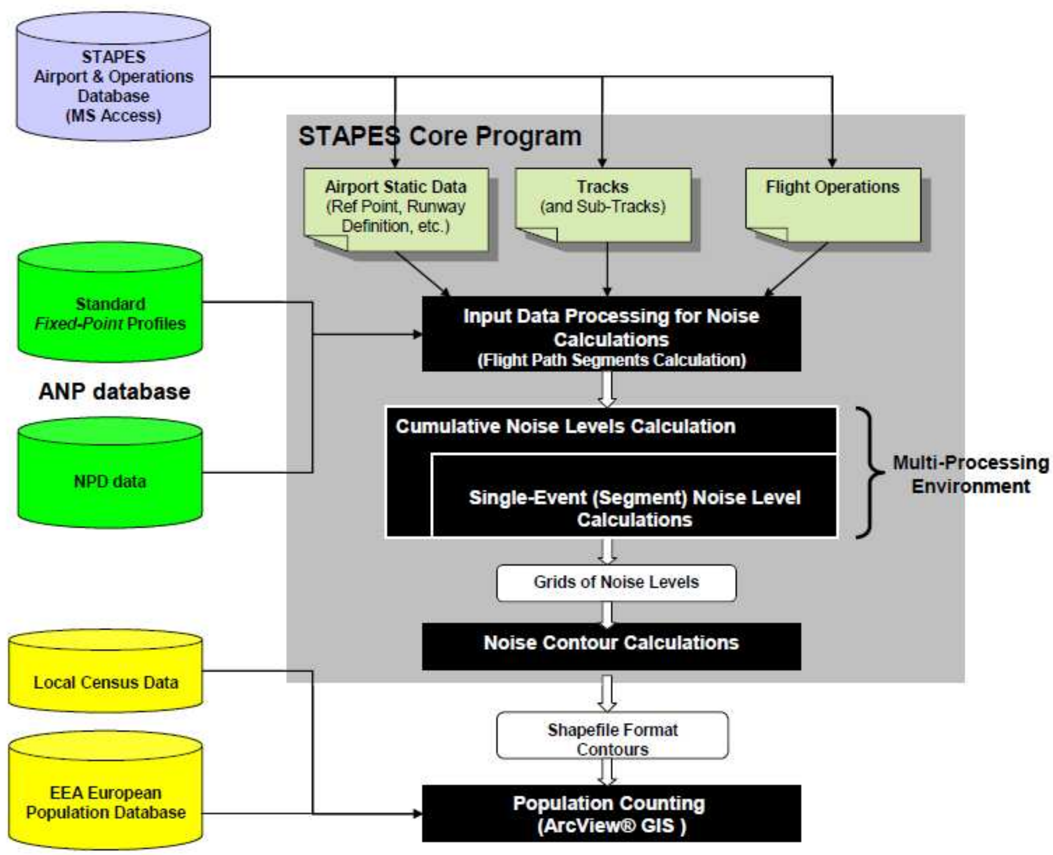

Figure 1: STAPES Modelling System Overview

3. MODEL EVALUATION

3.1 As part of the STAPES model development cycle, the MODTF evaluation process has been applied in the form of extensive comparisons (e.g. segment-by-segment comparisons, single-event operations, airport assessments) against the UK ANCON model. ANCON has already completed the MODTF evaluation process and demonstrated good agreement with AEDT-MAGENTA. Once the STAPES model had been fully developed and implemented, the performance of the CAEP NOx Sample Problem previously undertaken by MODTF (see CAEP-SG/20082-WP_09) was also completed as part of this step-by-step evaluation.

3.2 During the MODTF meeting in Miami on 4-6 November 2008, ECTRL presented a summary of the STAPES model development and evaluation process. Following a question and answer session, and the provision of some minor additional data, STAPES was recommended by MODTF for use within CAEP policy assessments.

3.3 Appendices A and B of this paper provide the necessary information on STAPES to update both the MODTF comparative summary table of model readiness and the key methodology comparison table.

3.4 Appendix C provides single-event noise footprint comparisons between STAPES and ANCON. Appendix D provides airport-scale comparison tables in terms of DNL contour areas and population counts for the NOx Sample Problem results covering three UK airports. Finally, Appendix E provides detailed results of segment-by-segment noise comparisons between both models.

4. EUROPEAN AIRPORT DATA COLLECTION

4.1 A critical part of the STAPES project is the collection of up-to-date information from the key European airports in order to ensure that future modelling assessments are robust enough to support informed policymaking.

4.2 In order to initiate a spirit of cooperation with European airports, a joint EC-EASA-ECTRL letter was sent out to all relevant airport focal points during Summer 2008 in order to develop a network of cooperation. In parallel, ECTRL have reviewed their internal data warehouse (PRISME) to identify key data gaps, and are in discussions with the airport focal points in order to establish an efficient data flow process for immediate needs and future updates.

5. SUPPORT TO CAEP/8 POLICY ASSESSMENTS – TIMESCALES

5.1 STAPES has successfully undertaken the CAEP/8 NOx Stringency and Environmental Goals assessments on a sample of 10 European airports, using the same "manufactured" decks as ANCON 2.

5.2 The collection of the more comprehensive European airport data, and integration of this data into the STAPES model, will be completed during Summer 2009. As a result, this information has not fed into MODTF results for the SG2009 meeting. The final STAPES results for the Environmental Goals assessment will be presented at the MODTF-9 meeting on 13-15 October and the subsequent CAEP/8 meeting in February 2010.

5.3 Due to the larger number of European airports that will be covered, and the use of more detailed airport data, the noise results for the European region in the Environmental Goals policy assessments are expected to change between the SG2009 and CAEP/8 meetings.

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APPENDIX A

DETAIL ASSESSMENT AGAINST CAEP NOISE REQUIREMENTS - STAPES

⦸	Does not appear to meet requirement; thus, tool change would be needed
^	Appears to need adaptation to meet the requirement
?	Insufficient information to make a judgment
✓	Appears to meet requirement with minor or no change to the tool
N/A	Not relevant to this type of tool

Can apply / address			STAPES
CAEP Goals Assessment		Goals – CAEP/7	The model could be potentially used for a global assessment, but lacks the worldwide coverage. In its current state it could be used for V&V analysis
		Goals – CAEP/8 &beyond	The ANP aircraft database would need to be carefully adjusted to account for technology development and this is essentially an expert driven process. It could be used for the European region.
Possible CAEP Modeling Requirement	Policy Scenarios Affecting Fleet	Current aircraft configurations (i.e., TRL 9)	It can model the current aircraft configurations included in its aircraft database.
		Fleet changes with new aircraft/engine combinations and/or new technology	Capability will depend on what data is provided for modelling future technology.
	Policy Scenarios Affecting Operations (Procedures, Number of Flights, etc.)	User input-driven trajectory changes from archived data (e.g., ETMS, ETFMS, etc.)	Limited to the terminal area.
		User input-driven trajectory changes from simulations	Concerns regarding ability to provide simulations for proposed CNS/ATM developments
		Fine-level trajectory changes (e.g., multi-configuration noise data, noise data for various flap settings, performance data)	DATA LIMITATIONS CURRENTLY PREVENT THIS ANALYSIS
Common Tool Issues	Core Modules	FESG forecast	Yes.
	User Input-Driven Global Databases	Airports	Yes.
		Movements	Yes.
		Fleet (e.g., Campbell-Hill Aircraft/ Engine ID Fleet data)	Yes.
	Output	Output by ICAO Region	Only the European ICAO region
	Validation	Has undergone V&V	Yes.
Subject-Specific Requirements	Local Air Quality	BFFM2, BFFM2 Curvefit or DLR method (with ICAO Engine Emissions Databank)	N/A
		Aircraft performance per compliance with ECAC/DOC 29 (with ANP database)	N/A
		Emissions sources	N/A
		Aircraft	N/A
		Other airport	N/A
		Non airport	N/A
		Dispersion capabilities	N/A
		NOx chemistry	N/A
		PM non-volatiles	N/A
		PM volatiles	N/A
	GHG	BFFM2 or DLR method (with ICAO Engine Emissions Databank)	N/A

		Mass emissions gate-to-gate	N/A
		Gridded output (for impacts)	N/A
		Impacts	N/A
	Noise	ECAC/DOC 29 3rd Ed. Compliant (with ANP database)	Yes.
		World-wide coverage	Currently limited to the European region.
		Population exposure to noise	Yes.

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APPENDIX B

KEY METHODOLOGY COMPONENTS - STAPES

Requirement	STAPES
	Input Databases
Basic Flight Coverage	All commercial flights at modelled airports
Flight Types	All flights.
Airports	Potentially all airports in the MODTF airport database.
Aircraft/ Engine Types	Detailed airframe and engine information is obtained, for CAEP related work, from the Campbell-Hill aircraft registration database, which covers 14038 commercial aviation aircraft worldwide. Additional airframe and engine information obtained from the BACK world fleet database can also use a global fleet database.
Aircraft Performance	Aircraft performance data is obtained from the ANP database. The performance data is used in conjunction with radar trajectories to reflect local airline operating procedures (see methodology).
Airport Taxi and Delay	
Aircraft Movements: Flight Plans and Schedules, Representing both activity and fleet mix	Flights origin, destination, and generic aircraft type information is derived from ETMS/ETFMS flight plans and OAG flight schedules.
Aircraft Movements: Flight Profiles and Trajectories	Flight profiles are expressed in terms of ANP stage length. For Shell 1 airports, departure and arrival flight trajectories are determined by the specific airport's flight track definitions and utilizations. For Shell 2 airports assumptions apply.
Meteorology	ANP standard day conditions.
Population	For European region, uses the European Environmental Agency (EEA) population database. For CAEP applications requiring worldwide coverage, can incorporate US National Census data for US, and GRUMP elsewhere.
	Methodology
Aircraft/engine matching	Exact airframe type and engine using tail number. If the first method cannot be used a distribution of airframes and engines is derived based on the specific airline fleet.
Aircraft Performance in the terminal area	As defined in the ANP database trajectories.
Unscheduled and Cancelled Flights	N/A due to incorporation of ETMS/ETFMS data.
Takeoff Weight and Trajectory Assumptions	Derived from stage length using ANP/INM relationships
Forecasting	Utilizes the MODTF Flight Operations Module (FOM) to define forecast aircraft movements, which incorporates FESG growth rates and any given policy measures.
	Output Databases for Noise
Noise	The current version of the model can produce grids of SEL, Leq, DNL and L_{DEN}
World Grids	Gridded output produced in the vicinity of each airport.
ICAO Regions	Yes, subject to integration of MODTF airports data.

Requirement	STAPES
Countries	Yes for European countries covered by STAPES. Outside of Europe subject to integration of MODTF airport data for other countries.

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APPENDIX C

STAPES – ANCON 2 SINGLE-EVENT SEL FOOTPRINT COMPARISONS

The single-event noise calculation module and the flight-path calculation module of STAPES have been combined to calculate SEL footprints for three specific single-event operations comprising a B747-400 standard departure, a B747-400 standard arrival, and a MD83 standard departure (profiles obtained from the ANP database).

These provide a good coverage of the different situations encountered when modelling noise contours around airports, in terms of types of operations and engine-installation configurations (e.g. wing-mounted and fuselage-mounted engines). No comparison was made for turbo-prop aircraft as this represents a simpler modelling situation, i.e. with no engine installation correction. .

The following figures present STAPES-ANCON footprint comparisons for SELs ranging from 80 to 100 dB(A), by 5 dB increments. They show that the footprints produced by STAPES closely match those from ANCON.

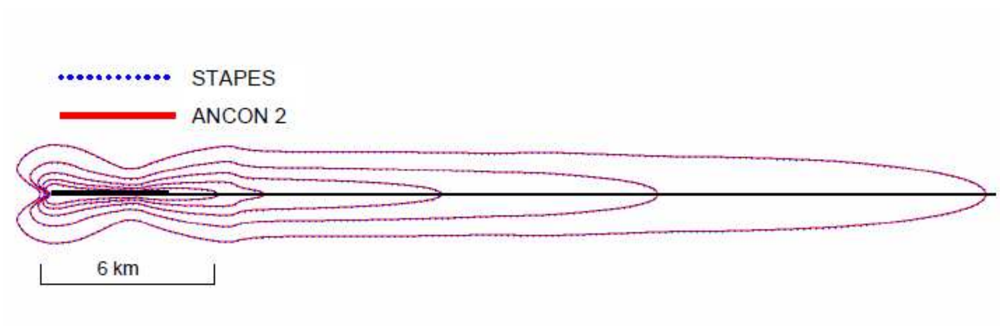

Figure C-1: B747-400 Departure with ANP Standard profile - stage length 9

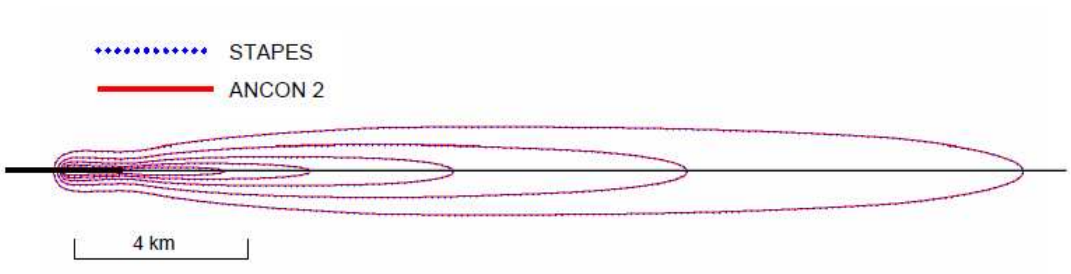

Figure C-2: B747-400 Arrival with ANP Standard profile

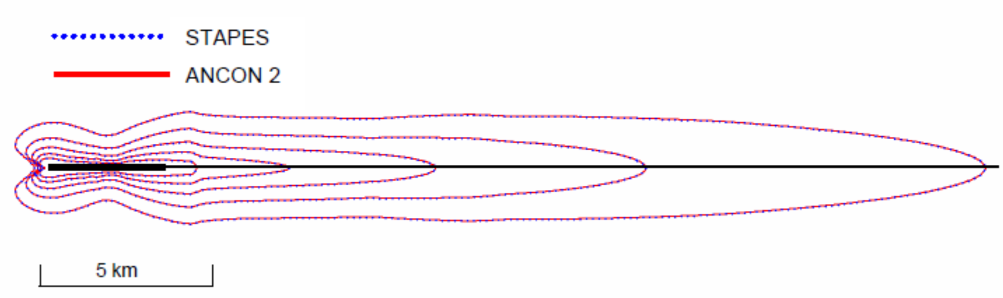

Figure C-3: MD83 Departure with ANP Standard profile - stage length 5

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APPENDIX D

STAPES – ANCON 2 AIRPORT-SCALE COMPARISONS

Having completed the development and implementation phases, STAPES has undertaken the CAEP NOx Sample Problem as performed by ANCON 2, e.g. on three UK airports. This exercise constitutes the final step of the V&V process, and demonstrates the ability of STAPES to accommodate and process data for CAEP policy assessments.

The 11 traffic scenarios of the NOx Sample Problem were processed into STAPES for the three airports. DNL noise contours were produced for levels 55, 60 and 65 dB(A) and population counts performed for each contour.

Tables D-1 and D-2 present DNL 55 contour area and population count comparisons between both models, for all the scenarios. The observed maximum difference between both models is about 6% in contour area and 8% in population count, this falling respectively to 2.9% and 5.9% when considering global results for the three airports.

This corresponds to average noise level differences of less than 0.5 dB within the noise contours. This remains within the typical uncertainty associated with airport noise contour models. Additionally, it has to be noticed that the observed differences in the NOx Sample Problem results were due, for a large part, to various differences in input data assumptions, which have been identified and fixed afterwards, before performing the NOx Stringency and Environmental Goals assessments. The observed differences between STAPES and ANCON for these "official" CAEP assessments do not exceed 1.5% in contour areas and 3.3% in population count (for individual airports).

DNL 55 dB Contour Area (km²)																
		ANCON 2					STAPES					% Difference (STAPES - ANCON2)				
Analysis Year	Airport	Baseline					Baseline					Baseline				
2005 (Datum)	A	65.5					67.6					+3.2%				
	B	120.7					121.2					+0.4%				
	C	55.2					56.9					+3.0%				
	Total	241.4					245.6					**+1.8%**				
2025			Stringency Impl. Year					Stringency Impl. Year					Stringency Impl. Year			
		Baseline	2012		2016		Baseline	2012		2016		Baseline	2012		2016	
			6.50%	18%	6.50%	18%		6.50%	18%	6.50%	18%		6.50%	18%	6.50%	18%
	A	164.2	167.3	171.4	166.6	169.7	155.9	158.8	162.9	158.1	161.3	-5.0%	-5.1%	-5.0%	-5.1%	-5.0%
	B	233.1	236.5	241.2	235.8	239.3	227.0	230.1	235.1	229.4	233.2	-2.6%	-2.7%	-2.5%	-2.7%	-2.5%
	C	191.7	196.0	202.0	195.0	200.0	190.2	194.7	201.2	193.8	198.8	-0.8%	-0.7%	-0.4%	-0.6%	-0.6%
	Total	589.0	599.8	614.6	597.4	609.0	573.2	583.6	599.2	581.3	593.3	**-2.7%**	**-2.7%**	**-2.5%**	**-2.7%**	**-2.6%**
2035			Stringency Impl. Year					Stringency Impl. Year					Stringency Impl. Year			
		Baseline	2012		2016		Baseline	2012		2016		Baseline	2012		2016	
			6.50%	18%	6.50%	18%		6.50%	18%	6.50%	18%		6.50%	18%	6.50%	18%
	A	213.9	219.4	227.0	218.7	225.4	201.3	206.2	213.5	205.6	212.0	-5.9%	-6.0%	-5.9%	-6.0%	-5.9%
	B	286.4	292.8	301.9	292.1	300.0	278.7	284.2	293.2	283.6	291.6	-2.7%	-2.9%	-2.9%	-2.9%	-2.8%
	C	273.4	279.8	291.2	279.9	289.1	271.3	279.3	291.4	278.5	289.0	-0.8%	-0.2%	+0.1%	-0.5%	0.0%
	Total	773.7	792.0	820.1	790.7	814.5	751.4	769.7	798.1	767.7	792.6	**-2.9%**	**-2.8%**	**-2.7%**	**-2.9%**	**-2.7%**

Table D-1: NOx Sample Problem – DNL 55 dB contour area

Population above DNL 55 dB																
Analysis Year	Airport	ANCON 2					STAPES					% Difference (STAPES - ANCON2)				
		Baseline					Baseline					Baseline				
2005 (Datum)	A	14790					16016					+8.3%				
	B	283169					271880					-4.0%				
	C	6458					6835					+5.8%				
	Total	304418					294731					-3.2%				
2025		Stringency Impl. Year					Stringency Impl. Year					Stringency Impl. Year				
		Baseline	2012		2016		Baseline	2012		2016		Baseline	2012		2016	
			6.50%	18%	6.50%	18%		6.50%	18%	6.50%	18%		6.50%	18%	6.50%	18%
	A	42618	43569	44719	43331	44078	42849	43838	45182	43881	44700	+0.5%	+0.6%	+1.0%	+1.3%	+1.4%
	B	645962	656099	669647	652134	659454	601224	614711	627274	611065	618357	-6.9%	-6.3%	-6.3%	-6.3%	-6.2%
	C	39932	41188	41933	40869	42406	41412	41904	45027	42844	43140	+3.7%	+1.7%	+7.4%	+4.8%	+1.7%
	Total	728512	740856	756299	736334	745939	685485	700453	717483	697789	706197	-5.9%	-5.5%	-5.1%	-5.2%	-5.3%
2035		Stringency Impl. Year					Stringency Impl. Year					Stringency Impl. Year				
		Baseline	2012		2016		Baseline	2012		2016		Baseline	2012		2016	
			6.50%	18%	6.50%	18%		6.50%	18%	6.50%	18%		6.50%	18%	6.50%	18%
	A	56599	59041	60828	58453	60560	57712	59612	61934	59223	62286	+2.0%	+1.0%	+1.8%	+1.3%	+2.8%
	B	811324	831807	855702	824820	844789	767918	777940	808219	784237	799267	-5.4%	-6.5%	-5.5%	-4.9%	-5.4%
	C	58020	59248	61353	59587	60750	58995	59906	62398	59878	61877	+1.7%	+1.1%	+1.7%	+0.5%	+1.9%
	Total	925944	950096	977883	942861	966100	884625	897459	932550	903338	923429	-4.5%	-5.5%	-4.6%	-4.2%	-4.4%

Table D-2: NOx Sample Problem - Population above DNL 55 dB

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APPENDIX E

STAPES – ANCON 2 SEGMENT-BY-SEGMENT NOISE COMPARISONS

The core process of the airport noise contour modelling methodology described in ECAC Doc.29 3rd Edition is the calculation of the noise contribution of each segment of each single-event flight path. To ensure that the STAPES module in charge of this task has correctly implemented the equations/algorithms described in the guidance, extensive numerical comparisons with ANCON 2 have been undertaken, notably to ease the tracking and correction of any modelling errors in the STAPES module.

The work has consisted of comparing, on a segment-by-segment basis, calculated SEL at specific ground locations, along with intermediate calculations, including segment-to-receiver geometric parameters, noise levels (SEL and LAmax[2]) interpolated/extrapolated from NPDs, and the different corrective terms applied to the baseline SEL (duration correction, engine installation, lateral attenuation, noise fraction).

This V&V exercise has been performed for the three single-event operations presented in Appendix C (*STAPES – ANCON 2 Single-event SEL footprint comparisons*).

The following comparison tables, which provide a summary of the major noise calculation steps[3], show that STAPES and ANCON deliver equivalent results for the three test cases.

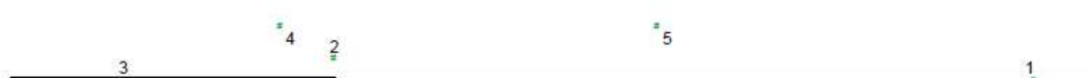
B747-400 Standard Arrival

Location Points

Five location points are defined for which detailed calculation output is provided. The points are located at the following coordinates:

Point Id	X (m)	Y (m)
1	6500	0
2	0	200
3	-2000	0
4	-500	500
5	3000	500

The locations are illustrated below in relation to the runway touchdown location.



[2] LAmax is used in the calculation of the noise fraction term 'Delta_F'
[3] The noise fraction term 'Delta_F' provided in the comparison tables includes the Start-of-Roll directivity correction for ground segments of departure operations

B747-400 Standard Arrival		ANCON 2						STAPES					
Point ID	Segment #	SEL extracted from NPD (dB)	Speed adjustment (dB)	Engine Installation (dB)	Lateral Attenuation (dB)	Delta_F (dB)	Finite Segment SEL (dB)	SEL extracted from NPD (dB)	Speed adjustment (dB)	Engine Installation (dB)	Lateral Attenuation (dB)	Delta_F (dB)	Finite Segment SEL (dB)
1	1	90.44	-2.32	0.00	0.00	-61.26	26.86	90.45	-2.32	0.00	0.00	-61.26	26.87
	2	90.47	-2.02	0.00	0.00	-62.12	26.33	90.47	-2.02	0.00	0.00	-62.12	26.33
	3	90.49	-1.71	0.00	0.00	-59.57	29.22	90.49	-1.71	0.00	0.00	-59.57	29.22
	4	90.51	-1.36	0.00	0.00	-56.76	32.39	90.51	-1.36	0.00	0.00	-56.76	32.39
	5	90.53	-0.99	0.00	0.00	-53.63	35.92	90.53	-0.99	0.00	0.00	-53.62	35.92
	6	90.56	-0.58	0.00	0.00	-50.07	39.90	90.56	-0.58	0.00	0.00	-50.07	39.90
	7	90.88	-0.13	0.00	0.00	-25.86	64.90	90.88	-0.13	0.00	0.00	-25.86	64.90
	8	91.19	0.02	0.00	0.00	-0.28	90.94	91.19	0.02	0.00	0.00	-0.28	90.94
	9	91.28	0.07	0.00	0.00	-12.36	78.99	91.28	0.07	0.00	0.00	-12.36	78.99
	10	91.26	0.09	0.00	0.00	-30.18	61.17	91.26	0.09	0.00	0.00	-30.18	61.17
	11	91.25	0.11	0.00	0.00	-36.59	54.76	91.25	0.10	0.00	0.00	-36.59	54.76
	12	91.24	0.11	0.00	0.00	-40.48	50.88	91.24	0.12	0.00	0.00	-40.48	50.88
	13	91.23	0.12	0.00	0.00	-43.23	48.12	91.23	0.12	0.00	0.00	-43.23	48.12
	14	91.23	0.13	0.00	0.00	-45.28	46.07	91.23	0.13	0.00	0.00	-45.28	46.07
	15	91.67	0.13	0.00	0.00	-47.66	44.15	91.67	0.13	0.00	0.00	-47.66	44.15
	16	121.70	0.24	0.00	0.00	-90.00	31.94	121.70	0.24	0.00	0.00	-90.00	31.94
	17	120.65	0.65	0.00	0.00	-90.00	31.30	120.65	0.65	0.00	0.00	-90.00	31.30
	18	120.65	1.32	0.00	0.00	-90.00	31.96	120.65	1.32	0.00	0.00	-90.00	31.97
	19	120.65	2.10	0.00	0.00	-90.00	32.75	120.65	2.11	0.00	0.00	-90.00	32.75
	20	120.65	3.07	0.00	0.00	-90.00	33.71	120.65	3.07	0.00	0.00	-90.00	33.72
	21	120.65	4.31	0.00	0.00	-90.00	34.95	120.65	4.31	0.00	0.00	-90.00	34.96
	22	120.65	6.05	0.00	0.00	-90.00	36.70	120.65	6.05	0.00	0.00	-90.00	36.70
						Total SEL	91.23					Total SEL	91.22
2	1	94.28	-2.32	0.02	0.00	-71.15	20.83	94.28	-2.32	0.02	0.00	-71.15	20.83
	2	94.31	-2.02	0.03	0.00	-72.75	19.56	94.31	-2.02	0.03	0.00	-72.75	19.57
	3	94.34	-1.71	0.04	0.00	-70.75	21.92	94.34	-1.71	0.04	0.00	-70.75	21.92
	4	94.37	-1.36	0.05	0.00	-68.66	24.40	94.37	-1.36	0.05	0.00	-68.66	24.40
	5	94.41	-0.99	0.06	0.00	-66.44	27.03	94.41	-0.99	0.06	0.00	-66.44	27.03
	6	94.44	-0.58	0.08	0.00	-64.11	29.83	94.44	-0.58	0.08	0.00	-64.10	29.83
	7	94.92	-0.13	0.25	0.00	-49.94	45.09	94.92	-0.13	0.25	0.00	-49.94	45.09
	8	95.43	0.07	0.37	0.00	-45.22	50.65	95.43	0.07	0.37	0.00	-45.22	50.65
	9	95.40	0.09	0.37	-0.06	-39.30	56.50	95.40	0.09	0.37	-0.06	-39.30	56.50
	10	95.39	0.11	0.17	-0.20	-34.84	60.62	95.39	0.10	0.17	-0.20	-34.84	60.62
	11	95.38	0.11	-0.14	-0.39	-30.22	64.74	95.38	0.12	-0.14	-0.39	-30.22	64.74
	12	95.37	0.12	-0.47	-0.72	-25.05	69.25	95.37	0.12	-0.47	-0.72	-25.05	69.25
	13	95.36	0.13	-0.81	-1.39	-18.86	74.43	95.36	0.13	-0.81	-1.39	-18.86	74.44
	14	95.36	0.13	-1.20	-2.69	-11.02	80.59	95.36	0.13	-1.20	-2.69	-11.02	80.58
	15	95.36	0.13	-1.50	-4.81	-3.94	85.24	95.36	0.13	-1.50	-4.81	-3.94	85.24
	16	95.36	0.24	-1.50	-4.81	-5.76	83.53	95.36	0.24	-1.50	-4.81	-5.76	83.53
	17	94.54	0.65	-1.50	-4.81	-7.34	81.55	94.54	0.65	-1.50	-4.81	-7.34	81.55
	18	94.54	1.32	-1.50	-4.81	-17.20	72.35	94.54	1.32	-1.50	-4.81	-17.20	72.36
	19	94.54	2.10	-1.50	-4.81	-23.71	66.63	94.54	2.11	-1.50	-4.81	-23.71	66.64
	20	94.54	3.07	-1.50	-4.81	-28.32	62.99	94.54	3.07	-1.50	-4.81	-28.32	62.99
	21	94.54	4.31	-1.50	-4.81	-31.96	60.59	94.54	4.31	-1.50	-4.81	-31.96	60.59
	22	94.54	6.05	-1.50	-4.81	-35.24	59.05	94.54	6.05	-1.50	-4.81	-35.24	59.05
						Total SEL	89.46					Total SEL	89.46

3	1	98.76	-2.32	0.00	0.00	-80.02	16.42	98.76	-2.32	0.00	0.00	-80.02	16.42
	2	98.81	-2.02	0.00	0.00	-81.79	15.00	98.80	-2.02	0.00	0.00	-81.78	15.00
	3	98.85	-1.71	0.00	0.00	-79.90	17.25	98.85	-1.71	0.00	0.00	-79.90	17.25
	4	98.90	-1.36	0.00	0.00	-77.93	19.60	98.90	-1.36	0.00	0.00	-77.93	19.60
	5	98.94	-0.99	0.00	0.00	-75.88	22.06	98.94	-0.99	0.00	0.00	-75.88	22.07
	6	98.99	-0.58	0.00	0.00	-73.75	24.65	98.99	-0.58	0.00	0.00	-73.76	24.65
	7	99.64	-0.13	0.00	0.00	-60.30	39.21	99.64	-0.13	0.00	0.00	-60.30	39.21
	8	100.20	0.07	0.00	0.00	-57.33	42.94	100.20	0.07	0.00	0.00	-57.33	42.94
	9	100.17	0.09	0.00	0.00	-53.35	46.92	100.17	0.09	0.00	0.00	-53.35	46.92
	10	100.16	0.11	0.00	0.00	-51.24	49.03	100.16	0.10	0.00	0.00	-51.24	49.02
	11	100.15	0.11	0.00	0.00	-49.34	50.92	100.14	0.12	0.00	0.00	-49.34	50.92
	12	100.14	0.12	0.00	0.00	-47.52	52.74	100.14	0.12	0.00	0.00	-47.52	52.75
	13	100.13	0.13	0.00	0.00	-45.69	54.57	100.13	0.13	0.00	0.00	-45.69	54.57
	14	100.13	0.13	0.00	0.00	-43.73	56.53	100.13	0.13	0.00	0.00	-43.73	56.53
	15	100.60	0.13	0.00	0.00	-42.68	58.06	100.60	0.13	0.00	0.00	-42.68	58.06
	16	76.02	0.24	-1.50	-10.81	-18.54	45.41	76.02	0.24	-1.50	-10.81	-18.54	45.41
	17	78.31	0.65	-1.50	-10.80	-14.32	52.34	78.31	0.65	-1.50	-10.80	-14.32	52.34
	18	80.71	1.32	-1.50	-10.79	-13.79	55.95	80.71	1.32	-1.50	-10.79	-13.79	55.96
	19	83.07	2.10	-1.50	-10.62	-13.27	59.78	83.08	2.11	-1.50	-10.62	-13.27	59.79
	20	85.58	3.07	-1.50	-9.70	-12.85	64.60	85.58	3.07	-1.50	-9.70	-12.85	64.60
	21	87.90	4.31	-1.50	-8.54	-12.70	69.47	87.90	4.31	-1.50	-8.54	-12.70	69.47
	22	89.90	6.05	-1.50	-7.43	-13.10	73.92	89.90	6.05	-1.50	-7.43	-13.10	73.93
						Total SEL	**76.00**					**Total SEL**	**76.00**
4	1	87.43	-2.32	0.12	0.00	-60.13	25.10	87.43	-2.32	0.12	0.00	-60.13	25.10
	2	87.46	-2.02	0.15	0.00	-61.83	23.74	87.46	-2.02	0.15	0.00	-61.83	23.74
	3	87.48	-1.71	0.18	0.00	-59.93	26.02	87.48	-1.71	0.18	0.00	-59.93	26.02
	4	87.50	-1.36	0.22	0.00	-57.93	28.43	87.50	-1.36	0.22	0.00	-57.93	28.43
	5	87.52	-0.99	0.27	0.00	-55.83	30.97	87.52	-0.99	0.27	0.00	-55.83	30.97
	6	87.54	-0.58	0.32	0.00	-53.61	33.67	87.55	-0.58	0.32	0.00	-53.61	33.67
	7	87.87	-0.13	0.35	-0.15	-40.59	47.35	87.87	-0.13	0.35	-0.15	-40.59	47.35
	8	88.22	0.07	0.09	-0.43	-36.69	51.25	88.22	0.07	0.09	-0.43	-36.69	51.25
	9	88.20	0.09	-0.29	-0.90	-31.46	55.64	88.20	0.09	-0.29	-0.90	-31.46	55.65
	10	88.19	0.11	-0.58	-1.57	-27.93	58.21	88.19	0.10	-0.58	-1.57	-27.93	58.21
	11	88.18	0.11	-0.82	-2.49	-24.56	60.42	88.18	0.12	-0.82	-2.49	-24.56	60.42
	12	88.18	0.12	-1.04	-3.67	-21.16	62.43	88.18	0.12	-1.04	-3.67	-21.16	62.43
	13	88.17	0.13	-1.24	-5.12	-17.65	64.29	88.17	0.13	-1.24	-5.12	-17.65	64.29
	14	88.17	0.13	-1.43	-6.85	-13.94	66.09	88.17	0.13	-1.43	-6.85	-13.93	66.09
	15	88.17	0.13	-1.50	-8.69	-10.54	67.57	88.17	0.13	-1.50	-8.69	-10.54	67.57
	16	86.17	0.24	-1.50	-9.44	-10.99	64.47	86.17	0.24	-1.50	-9.44	-10.99	64.47
	17	87.63	0.65	-1.50	-8.69	-5.14	72.95	87.63	0.65	-1.50	-8.69	-5.14	72.95
	18	87.63	1.32	-1.50	-8.69	-6.06	72.70	87.63	1.32	-1.50	-8.69	-6.06	72.70
	19	87.63	2.10	-1.50	-8.69	-9.62	69.92	87.63	2.11	-1.50	-8.69	-9.62	69.93
	20	87.63	3.07	-1.50	-8.69	-13.59	66.91	87.63	3.07	-1.50	-8.69	-13.59	66.92
	21	87.63	4.31	-1.50	-8.69	-17.19	64.55	87.63	4.31	-1.50	-8.69	-17.19	64.56
	22	87.63	6.05	-1.50	-8.69	-20.55	62.94	87.63	6.05	-1.50	-8.69	-20.55	62.94
						Total SEL	**78.88**					**Total SEL**	**78.88**
5	1	87.08	-2.32	0.12	0.00	-58.05	26.83	87.08	-2.32	0.12	0.00	-58.05	26.83
	2	87.10	-2.02	0.15	0.00	-59.38	25.84	87.10	-2.02	0.15	0.00	-59.38	25.84
	3	87.12	-1.71	0.18	0.00	-57.21	28.38	87.12	-1.71	0.18	0.00	-57.21	28.39
	4	87.14	-1.36	0.22	0.00	-54.88	31.12	87.14	-1.36	0.22	0.00	-54.88	31.13
	5	87.17	-0.99	0.27	0.00	-52.36	34.08	87.17	-0.99	0.27	0.00	-52.36	34.09

6	87.19	-0.58	0.32	0.00	-49.62	37.30	87.19	-0.58	0.32	0.00	-49.62	37.30
7	87.52	-0.13	0.35	-0.15	-33.62	53.96	87.52	-0.13	0.35	-0.15	-33.62	53.96
8	87.86	0.07	0.09	-0.43	-24.92	62.67	87.86	0.07	0.09	-0.43	-24.92	62.67
9	87.84	0.09	-0.29	-0.90	-10.49	76.25	87.84	0.09	-0.29	-0.90	-10.49	76.25
10	87.83	0.10	-0.46	-1.26	-1.50	84.71	87.83	0.10	-0.46	-1.26	-1.50	84.71
11	87.83	0.11	-0.58	-1.57	-7.83	77.95	87.83	0.10	-0.58	-1.57	-7.83	77.95
12	87.82	0.11	-0.82	-2.49	-16.74	67.89	87.82	0.12	-0.82	-2.49	-16.74	67.89
13	87.82	0.12	-1.04	-3.67	-22.32	60.91	87.82	0.12	-1.04	-3.67	-22.32	60.91
14	87.81	0.13	-1.24	-5.12	-26.12	55.46	87.81	0.13	-1.24	-5.12	-26.12	55.46
15	87.84	0.13	-1.43	-6.85	-29.16	50.54	87.85	0.13	-1.43	-6.85	-29.16	50.54
16	88.18	0.24	-1.50	-8.69	-34.04	44.19	88.18	0.24	-1.50	-8.69	-34.04	44.19
17	87.63	0.65	-1.50	-8.69	-32.25	45.84	87.63	0.65	-1.50	-8.69	-32.25	45.84
18	87.63	1.32	-1.50	-8.69	-34.60	44.16	87.63	1.32	-1.50	-8.69	-34.60	44.16
19	87.63	2.10	-1.50	-8.69	-36.70	42.84	87.63	2.11	-1.50	-8.69	-36.70	42.85
20	87.63	3.07	-1.50	-8.69	-38.67	41.84	87.63	3.07	-1.50	-8.69	-38.67	41.84
21	87.63	4.31	-1.50	-8.69	-40.65	41.09	87.63	4.31	-1.50	-8.69	-40.65	41.10
22	87.63	6.05	-1.50	-8.69	-42.91	40.58	87.63	6.05	-1.50	-8.69	-42.91	40.58
					Total SEL	**86.13**					**Total SEL**	**86.13**

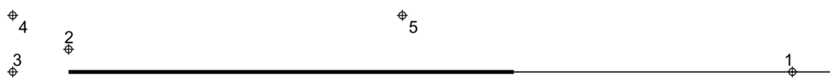
B747-400 Standard Departure (Stage Length 9)

Location Points

Five location points are defined for which detailed calculation output is provided. The points are located at the following coordinates:

Point Id	X (m)	Y(m)
1	6500	0
2	0	200
3	-500	0
4	-500	500
5	3000	500

The locations are illustrated below in relation to the runway and start of roll location.



B747-400 Standard Departure		ANCON 2						STAPES					
Point ID	Segment #	SEL extracted from NPD (dB)	Speed adjustment (dB)	Engine Installation (dB)	Lateral Attenuation (dB)	Delta_F (dB)	Finite Segment SEL (dB)	SEL extracted from NPD (dB)	Speed adjustment (dB)	Engine Installation (dB)	Lateral Attenuation (dB)	Delta_F (dB)	Finite Segment SEL (dB)
1	1	132.76	8.10	0.00	0.00	-90.00	50.86	132.76	8.10	0.00	0.00	-90.00	50.85
	2	132.12	5.69	0.00	0.00	-90.00	47.81	132.12	5.69	0.00	0.00	-90.00	47.80
	3	131.48	4.15	0.00	0.00	-90.00	45.62	131.48	4.15	0.00	0.00	-90.00	45.62
	4	130.84	3.01	0.00	0.00	-90.00	43.85	130.84	3.01	0.00	0.00	-90.00	43.85
	5	130.20	2.11	0.00	0.00	-90.00	42.31	130.20	2.11	0.00	0.00	-90.00	42.31
	6	129.56	1.37	0.00	0.00	-90.00	40.92	129.56	1.37	0.00	0.00	-90.00	40.92
	7	128.92	0.73	0.00	0.00	-90.00	39.65	128.92	0.73	0.00	0.00	-90.00	39.65
	8	128.28	0.18	0.00	0.00	-90.00	38.45	128.28	0.18	0.00	0.00	-90.00	38.46
	9	127.70	-0.31	0.00	0.00	-90.00	37.39	127.70	-0.31	0.00	0.00	-90.00	37.39
	10	127.30	-0.76	0.00	0.00	-90.00	36.54	127.30	-0.76	0.00	0.00	-90.00	36.54
	11	100.11	-0.95	0.00	0.00	-47.47	51.69	100.11	-0.95	0.00	0.00	-47.47	51.69
	12	99.76	-0.95	0.00	0.00	-44.87	53.94	99.76	-0.95	0.00	0.00	-44.87	53.94
	13	99.78	-0.96	0.00	0.00	-42.64	56.19	99.78	-0.96	0.00	0.00	-42.64	56.19
	14	99.81	-0.96	0.00	0.00	-39.61	59.23	99.81	-0.96	0.00	0.00	-39.61	59.24
	15	99.84	-0.97	0.00	0.00	-35.23	63.63	99.84	-0.97	0.00	0.00	-35.23	63.64
	16	99.89	-0.98	0.00	0.00	-27.61	71.29	99.89	-0.98	0.00	0.00	-27.61	71.29
	17	99.98	-1.01	0.00	0.00	-2.47	96.50	99.98	-1.01	0.00	0.00	-2.47	96.50
	18	99.96	-1.02	0.00	0.00	-3.95	94.99	99.96	-1.02	0.00	0.00	-3.95	94.99
	19	97.24	-1.07	0.00	0.00	-11.19	84.98	97.24	-1.07	0.00	0.00	-11.19	84.98
	20	97.10	-1.35	0.00	0.00	-34.42	61.33	97.10	-1.35	0.00	0.00	-34.42	61.33
	21	96.92	-1.61	0.00	0.00	-43.30	52.02	96.92	-1.61	0.00	0.00	-43.30	52.02
	22	96.76	-1.93	0.00	0.00	-49.80	45.03	96.76	-1.93	0.00	0.00	-49.80	45.03
	23	102.50	-2.22	0.00	0.00	-66.83	33.45	102.50	-2.22	0.00	0.00	-66.83	33.45
	24	95.84	-2.27	0.00	0.00	-56.76	36.81	95.84	-2.27	0.00	0.00	-56.76	36.82
	25	96.31	-2.48	0.00	0.00	-60.61	33.21	96.31	-2.48	0.00	0.00	-60.61	33.22
	26	98.32	-2.66	0.00	0.00	-62.65	33.00	98.32	-2.66	0.00	0.00	-62.65	33.00
	27	103.96	-2.82	0.00	0.00	-80.30	20.84	103.96	-2.82	0.00	0.00	-80.30	20.84
	28	105.69	-2.95	0.00	0.00	-87.80	14.94	105.69	-2.95	0.00	0.00	-87.80	14.94
						Total SEL	**99.01**					**Total SEL**	**99.01**
2	1	108.75	8.10	-1.50	-4.81	-6.38	104.17	108.75	8.10	-1.50	-4.81	-6.38	104.16
	2	107.71	5.69	-1.50	-5.04	-3.69	103.18	107.71	5.69	-1.50	-5.04	-3.69	103.18
	3	105.31	4.15	-1.50	-6.18	-2.75	99.03	105.31	4.15	-1.50	-6.18	-2.75	99.03
	4	101.81	3.01	-1.50	-8.00	-8.00	87.32	101.81	3.01	-1.50	-8.00	-8.00	87.32
	5	98.29	2.11	-1.50	-9.67	-15.90	73.33	98.29	2.11	-1.50	-9.67	-15.90	73.33
	6	94.96	1.37	-1.50	-10.77	-17.08	66.98	94.96	1.37	-1.50	-10.77	-17.08	66.98
	7	91.89	0.73	-1.50	-10.79	-15.46	64.88	91.89	0.73	-1.50	-10.79	-15.46	64.88
	8	88.90	0.18	-1.50	-10.81	-14.14	62.63	88.90	0.18	-1.50	-10.81	-14.14	62.63
	9	86.04	-0.31	-1.50	-10.82	-13.22	60.19	86.05	-0.31	-1.50	-10.82	-13.22	60.19
	10	83.31	-0.76	-1.50	-10.83	-12.62	57.61	83.31	-0.76	-1.50	-10.83	-12.62	57.61
	11	99.12	-0.95	-1.50	-4.81	-45.38	46.49	99.12	-0.95	-1.50	-4.81	-45.38	46.49
	12	98.85	-0.95	-1.20	-2.69	-45.17	48.85	98.85	-0.95	-1.20	-2.69	-45.17	48.85
	13	98.87	-0.95	-0.81	-1.38	-45.64	50.09	98.87	-0.95	-0.81	-1.38	-45.64	50.09
	14	98.89	-0.96	-0.47	-0.72	-46.01	50.73	98.89	-0.96	-0.47	-0.72	-46.01	50.73
	15	98.91	-0.96	-0.14	-0.39	-46.39	51.04	98.91	-0.96	-0.14	-0.39	-46.39	51.04
	16	98.95	-0.97	0.17	-0.20	-46.78	51.17	98.95	-0.97	0.17	-0.20	-46.78	51.17
	17	99.00	-0.98	0.37	-0.06	-47.24	51.08	99.00	-0.98	0.37	-0.06	-47.24	51.09
	18	102.32	-1.02	0.37	0.00	-61.56	40.12	102.32	-1.02	0.37	0.00	-61.55	40.12
	19	99.69	-1.07	0.36	0.00	-54.96	44.03	99.69	-1.07	0.36	0.00	-54.95	44.03
	20	99.57	-1.35	0.30	0.00	-58.72	39.80	99.57	-1.35	0.30	0.00	-58.72	39.80

	21	99.38	-1.61	0.24	0.00	-61.45	36.57	99.38	-1.61	0.24	0.00	-61.45	36.57
	22	99.23	-1.93	0.19	0.00	-64.47	33.01	99.23	-1.93	0.19	0.00	-64.47	33.01
	23	90.66	-2.22	0.15	0.00	-54.77	33.80	90.66	-2.22	0.15	0.00	-54.77	33.80
	24	99.00	-2.27	0.10	0.00	-69.56	27.28	99.00	-2.27	0.10	0.00	-69.55	27.29
	25	99.30	-2.48	0.09	0.00	-72.28	24.62	99.30	-2.48	0.09	0.00	-72.28	24.62
	26	89.64	-2.66	0.07	0.00	-53.66	33.40	89.64	-2.66	0.07	0.00	-53.66	33.40
	27	92.03	-2.82	0.03	0.00	-62.28	26.95	92.03	-2.82	0.03	0.00	-62.28	26.95
	28	95.45	-2.95	0.01	0.00	-70.81	21.70	95.45	-2.95	0.01	0.00	-70.81	21.70
						Total SEL	**107.44**					**Total SEL**	**107.44**
3	1	102.73	8.10	-1.50	-8.69	-24.99	75.65	102.73	8.10	-1.50	-8.69	-25.00	75.63
	2	101.12	5.69	-1.50	-9.24	-23.26	72.82	101.12	5.69	-1.50	-9.24	-23.27	72.81
	3	99.05	4.15	-1.50	-9.97	-22.66	69.08	99.05	4.15	-1.50	-9.97	-22.66	69.07
	4	96.72	3.01	-1.50	-10.66	-20.58	66.98	96.72	3.01	-1.50	-10.66	-20.59	66.98
	5	94.29	2.11	-1.50	-10.78	-17.96	66.15	94.29	2.11	-1.50	-10.78	-17.96	66.15
	6	91.74	1.37	-1.50	-10.80	-16.05	64.76	91.74	1.37	-1.50	-10.80	-16.05	64.76
	7	89.19	0.73	-1.50	-10.81	-14.69	62.92	89.19	0.73	-1.50	-10.81	-14.69	62.92
	8	86.61	0.18	-1.50	-10.82	-13.73	60.74	86.61	0.18	-1.50	-10.82	-13.73	60.74
	9	84.03	-0.31	-1.50	-10.83	-13.07	58.32	84.03	-0.31	-1.50	-10.83	-13.07	58.32
	10	81.64	-0.76	-1.50	-10.83	-12.62	55.93	81.64	-0.76	-1.50	-10.83	-12.62	55.93
	11	99.67	-0.95	0.00	0.00	-48.87	49.85	99.67	-0.95	0.00	0.00	-48.87	49.85
	12	99.24	-0.95	0.00	0.00	-48.24	50.05	99.25	-0.95	0.00	0.00	-48.25	50.05
	13	99.26	-0.95	0.00	0.00	-48.56	49.75	99.26	-0.95	0.00	0.00	-48.56	49.75
	14	99.28	-0.96	0.00	0.00	-48.78	49.54	99.28	-0.96	0.00	0.00	-48.78	49.54
	15	99.31	-0.96	0.00	0.00	-48.99	49.36	99.31	-0.96	0.00	0.00	-48.98	49.36
	16	99.34	-0.97	0.00	0.00	-49.18	49.19	99.34	-0.97	0.00	0.00	-49.18	49.19
	17	99.39	-0.98	0.00	0.00	-49.40	49.01	99.39	-0.98	0.00	0.00	-49.39	49.02
	18	110.36	-1.02	0.00	0.00	-80.50	28.84	110.36	-1.02	0.00	0.00	-80.50	28.84
	19	107.94	-1.07	0.00	0.00	-73.94	32.94	107.94	-1.07	0.00	0.00	-73.93	32.94
	20	107.84	-1.35	0.00	0.00	-77.46	29.03	107.84	-1.35	0.00	0.00	-77.46	29.03
	21	107.29	-1.61	0.00	0.00	-78.77	26.91	107.29	-1.61	0.00	0.00	-78.77	26.91
	22	107.16	-1.93	0.00	0.00	-81.65	23.58	107.17	-1.93	0.00	0.00	-81.65	23.58
	23	90.54	-2.22	0.00	0.00	-55.10	33.22	90.54	-2.22	0.00	0.00	-55.10	33.22
	24	106.11	-2.27	0.00	0.00	-84.48	19.36	106.11	-2.27	0.00	0.00	-84.48	19.36
	25	109.82	-2.48	0.00	0.00	-90.00	17.34	109.82	-2.48	0.00	0.00	-90.00	17.34
	26	89.52	-2.66	0.00	0.00	-53.81	33.05	89.52	-2.66	0.00	0.00	-53.81	33.05
	27	92.01	-2.82	0.00	0.00	-62.50	26.69	92.01	-2.82	0.00	0.00	-62.50	26.69
	28	95.83	-2.95	0.00	0.00	-71.67	21.22	95.83	-2.95	0.00	0.00	-71.66	21.22
						Total SEL	**79.08**					**Total SEL**	**79.07**
4	1	100.33	8.10	-1.50	-10.01	-9.59	87.33	100.33	8.10	-1.50	-10.01	-9.59	87.32
	2	99.14	5.69	-1.50	-10.25	-7.78	85.30	99.14	5.69	-1.50	-10.25	-7.79	85.29
	3	97.58	4.15	-1.50	-10.60	-7.51	82.11	97.58	4.15	-1.50	-10.60	-7.51	82.10
	4	95.70	3.01	-1.50	-10.78	-9.13	77.31	95.70	3.01	-1.50	-10.78	-9.13	77.31
	5	93.61	2.11	-1.50	-10.79	-11.83	71.60	93.61	2.11	-1.50	-10.79	-11.83	71.60
	6	91.24	1.37	-1.50	-10.80	-12.88	67.42	91.24	1.37	-1.50	-10.80	-12.88	67.43
	7	88.86	0.73	-1.50	-10.81	-13.07	64.21	88.86	0.73	-1.50	-10.81	-13.07	64.21
	8	86.35	0.18	-1.50	-10.82	-12.90	61.31	86.35	0.18	-1.50	-10.82	-12.90	61.31
	9	83.85	-0.31	-1.50	-10.83	-12.64	58.57	83.85	-0.31	-1.50	-10.83	-12.64	58.57
	10	81.52	-0.76	-1.50	-10.83	-12.40	56.03	81.52	-0.76	-1.50	-10.83	-12.40	56.03
	11	95.13	-0.95	-1.50	-8.69	-40.62	43.37	95.13	-0.95	-1.50	-8.69	-40.62	43.37
	12	95.02	-0.95	-1.42	-6.85	-40.56	45.24	95.02	-0.95	-1.42	-6.85	-40.56	45.24
	13	95.03	-0.95	-1.24	-5.11	-40.86	46.87	95.03	-0.95	-1.24	-5.11	-40.86	46.87

	14	95.06	-0.96	-1.04	-3.66	-41.07	48.33	95.06	-0.96	-1.04	-3.66	-41.07	48.33
	15	95.08	-0.96	-0.82	-2.48	-41.25	49.56	95.08	-0.96	-0.82	-2.48	-41.25	49.57
	16	95.12	-0.97	-0.58	-1.57	-41.43	50.58	95.12	-0.97	-0.58	-1.57	-41.43	50.58
	17	95.18	-0.98	-0.28	-0.90	-41.63	51.38	95.18	-0.98	-0.28	-0.90	-41.62	51.38
	18	96.47	-1.02	0.09	-0.43	-51.92	43.19	96.47	-1.02	0.09	-0.43	-51.92	43.19
	19	93.58	-1.07	0.12	-0.40	-45.61	46.62	93.58	-1.07	0.12	-0.40	-45.61	46.62
	20	93.44	-1.35	0.26	-0.26	-49.15	42.94	93.44	-1.35	0.26	-0.26	-49.15	42.95
	21	93.29	-1.61	0.35	-0.14	-51.81	40.07	93.29	-1.61	0.35	-0.14	-51.81	40.08
	22	93.12	-1.93	0.40	-0.04	-54.72	36.82	93.12	-1.93	0.40	-0.04	-54.72	36.82
	23	88.84	-2.22	0.40	0.00	-52.51	34.51	88.85	-2.22	0.40	0.00	-52.50	34.51
	24	93.02	-2.27	0.36	0.00	-59.93	31.19	93.02	-2.27	0.36	0.00	-59.93	31.19
	25	92.96	-2.48	0.33	0.00	-62.01	28.81	92.96	-2.48	0.33	0.00	-62.01	28.81
	26	88.12	-2.66	0.30	0.00	-51.66	34.10	88.12	-2.66	0.30	0.00	-51.66	34.10
	27	89.93	-2.82	0.14	0.00	-59.27	27.98	89.93	-2.82	0.14	0.00	-59.27	27.98
	28	92.15	-2.95	0.08	0.00	-65.42	23.86	92.15	-2.95	0.08	0.00	-65.42	23.86
						Total SEL	**90.50**					**Total SEL**	**90.49**
5	1	102.05	8.10	-1.50	-8.69	-43.15	56.82	102.05	8.10	-1.50	-8.69	-43.15	56.81
	2	101.38	5.69	-1.50	-8.69	-40.16	56.72	101.38	5.69	-1.50	-8.69	-40.16	56.72
	3	100.70	4.15	-1.50	-8.69	-37.68	56.98	100.70	4.15	-1.50	-8.69	-37.68	56.98
	4	100.03	3.01	-1.50	-8.69	-35.20	57.65	100.03	3.01	-1.50	-8.69	-35.20	57.65
	5	99.35	2.11	-1.50	-8.69	-32.44	58.83	99.35	2.11	-1.50	-8.69	-32.44	58.83
	6	98.68	1.37	-1.50	-8.69	-29.17	60.69	98.68	1.37	-1.50	-8.69	-29.16	60.69
	7	98.00	0.73	-1.50	-8.69	-25.02	63.53	98.00	0.73	-1.50	-8.69	-25.02	63.53
	8	97.32	0.18	-1.50	-8.69	-19.38	67.93	97.33	0.18	-1.50	-8.69	-19.38	67.93
	9	96.71	-0.31	-1.50	-8.69	-11.09	75.11	96.71	-0.31	-1.50	-8.69	-11.09	75.12
	10	96.35	-0.76	-1.50	-8.69	-2.40	83.00	96.35	-0.76	-1.50	-8.69	-2.40	83.00
	11	96.24	-0.95	-1.50	-8.69	-7.51	77.59	96.24	-0.95	-1.50	-8.69	-7.51	77.59
	12	96.25	-0.95	-1.42	-6.85	-10.42	76.61	96.25	-0.95	-1.42	-6.85	-10.42	76.61
	13	96.27	-0.95	-1.24	-5.11	-14.35	74.62	96.27	-0.95	-1.24	-5.11	-14.35	74.62
	14	96.29	-0.96	-1.04	-3.66	-18.31	72.33	96.29	-0.96	-1.04	-3.66	-18.31	72.33
	15	96.32	-0.96	-0.82	-2.48	-22.17	69.88	96.32	-0.96	-0.82	-2.48	-22.17	69.88
	16	96.35	-0.97	-0.58	-1.57	-25.97	67.27	96.36	-0.97	-0.58	-1.57	-25.97	67.27
	17	96.41	-0.98	-0.28	-0.90	-29.88	64.36	96.41	-0.98	-0.28	-0.90	-29.88	64.36
	18	96.09	-1.02	0.09	-0.43	-39.66	55.07	96.09	-1.02	0.09	-0.43	-39.66	55.07
	19	93.18	-1.07	0.12	-0.40	-35.09	56.73	93.18	-1.07	0.12	-0.40	-35.09	56.74
	20	93.04	-1.35	0.26	-0.26	-41.15	50.55	93.04	-1.35	0.26	-0.26	-41.15	50.55
	21	92.88	-1.61	0.35	-0.14	-45.40	46.08	92.88	-1.61	0.35	-0.14	-45.40	46.08
	22	92.71	-1.93	0.40	-0.04	-49.46	41.67	92.71	-1.93	0.40	-0.04	-49.45	41.67
	23	91.07	-2.22	0.40	0.00	-52.03	37.21	91.07	-2.22	0.40	0.00	-52.03	37.21
	24	92.51	-2.27	0.36	0.00	-55.64	34.97	92.51	-2.27	0.36	0.00	-55.64	34.97
	25	92.55	-2.48	0.33	0.00	-58.26	32.15	92.55	-2.48	0.33	0.00	-58.26	32.15
	26	90.20	-2.66	0.30	0.00	-52.32	35.52	90.20	-2.66	0.30	0.00	-52.32	35.52
	27	91.90	-2.82	0.14	0.00	-60.51	28.71	91.90	-2.82	0.14	0.00	-60.51	28.71
	28	93.51	-2.95	0.08	0.00	-66.29	24.35	93.51	-2.95	0.08	0.00	-66.29	24.35
						Total SEL	**86.15**					**Total SEL**	**86.15**

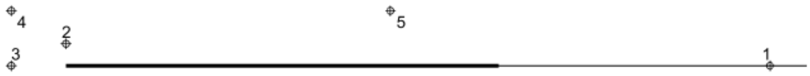
MD83 Standard Departure (Stage Length 5)

Location Points

Five location points are defined for which detailed calculation output is provided. The points are located at the following coordinates:

Point Id	X (m)	Y(m)
1	6500	0
2	0	200
3	-500	0
4	-500	500
5	3000	500

The locations are illustrated below in relation to the runway and start of roll location.



MD83 Standard Departure		ANCON 2						STAPES					
Point ID	Segment #	SEL extracted from NPD (dB)	Speed adjustment (dB)	Engine Installation (dB)	Lateral Attenuation (dB)	Delta_F (dB)	Finite Segment SEL (dB)	SEL extracted from NPD (dB)	Speed adjustment (dB)	Engine Installation (dB)	Lateral Attenuation (dB)	Delta_F (dB)	Finite Segment SEL (dB)
1	1	130.61	8.05	0.00	0.00	-90.00	48.65	130.61	8.04	0.00	0.00	-90.00	48.65
	2	130.32	5.59	0.00	0.00	-90.00	45.91	130.32	5.59	0.00	0.00	-90.00	45.91
	3	130.03	4.03	0.00	0.00	-90.00	44.06	130.03	4.03	0.00	0.00	-90.00	44.06
	4	129.74	2.89	0.00	0.00	-90.00	42.63	129.74	2.88	0.00	0.00	-90.00	42.63
	5	129.46	1.98	0.00	0.00	-90.00	41.44	129.46	1.98	0.00	0.00	-90.00	41.44
	6	129.17	1.23	0.00	0.00	-90.00	40.40	129.17	1.23	0.00	0.00	-90.00	40.40
	7	128.88	0.59	0.00	0.00	-90.00	39.48	128.88	0.59	0.00	0.00	-90.00	39.48
	8	128.59	0.04	0.00	0.00	-90.00	38.63	128.59	0.04	0.00	0.00	-90.00	38.63
	9	97.68	-0.19	0.00	0.00	-48.69	48.81	97.69	-0.19	0.00	0.00	-48.70	48.80
	10	97.29	-0.19	0.00	0.00	-46.58	50.52	97.27	-0.19	0.00	0.00	-46.54	50.54
	11	97.31	-0.19	0.00	0.00	-45.07	52.04	97.31	-0.19	0.00	0.00	-45.09	52.04
	12	97.33	-0.20	0.00	0.00	-43.09	54.04	97.34	-0.20	0.00	0.00	-43.09	54.04
	13	97.36	-0.21	0.00	0.00	-40.44	56.72	97.36	-0.21	0.00	0.00	-40.43	56.72
	14	97.41	-0.22	0.00	0.00	-36.54	60.64	97.41	-0.22	0.00	0.00	-36.55	60.64
	15	97.49	-0.24	0.00	0.00	-29.48	67.77	97.49	-0.24	0.00	0.00	-29.48	67.77
	16	97.47	-0.40	0.00	0.00	-34.23	62.84	97.47	-0.40	0.00	0.00	-34.22	62.84
	17	97.35	-0.83	0.00	0.00	-15.90	80.62	97.35	-0.83	0.00	0.00	-15.90	80.62
	18	97.30	-0.99	0.00	0.00	-0.15	96.16	97.30	-0.99	0.00	0.00	-0.15	96.16
	19	97.23	-1.21	0.00	0.00	-21.04	74.97	97.23	-1.21	0.00	0.00	-21.05	74.97
	20	97.11	-1.57	0.00	0.00	-34.61	60.93	97.11	-1.57	0.00	0.00	-34.61	60.94
	21	102.80	-1.87	0.00	0.00	-52.78	48.14	102.80	-1.88	0.00	0.00	-52.78	48.14
	22	95.34	-1.97	0.00	0.00	-49.85	43.52	95.34	-1.97	0.00	0.00	-49.85	43.52
	23	102.69	-2.12	0.00	0.00	-62.55	38.02	102.69	-2.12	0.00	0.00	-62.55	38.02
	24	99.72	-2.28	0.00	0.00	-64.31	33.14	99.72	-2.28	0.00	0.00	-64.31	33.14
	25	96.67	-2.41	0.00	0.00	-63.58	30.68	96.67	-2.41	0.00	0.00	-63.58	30.68
						Total SEL	**96.32**					**Total SEL**	**96.32**
2	1	106.50	8.05	-3.00	-4.81	-5.31	101.43	106.50	8.04	-3.00	-4.81	-5.31	101.43
	2	105.81	5.59	-3.00	-5.07	-2.89	100.44	105.81	5.59	-3.00	-5.07	-2.89	100.44
	3	103.68	4.03	-3.00	-6.33	-2.29	96.08	103.68	4.03	-3.00	-6.33	-2.29	96.08
	4	100.27	2.89	-3.00	-8.25	-8.85	83.06	100.27	2.88	-3.00	-8.25	-8.85	83.05
	5	96.80	1.98	-3.00	-9.90	-15.86	70.03	96.81	1.98	-3.00	-9.90	-15.85	70.03
	6	93.43	1.23	-3.00	-10.78	-15.71	65.18	93.43	1.23	-3.00	-10.78	-15.71	65.18
	7	90.38	0.59	-3.00	-10.80	-13.98	63.20	90.38	0.59	-3.00	-10.80	-13.98	63.20
	8	87.47	0.04	-3.00	-10.81	-12.72	60.98	87.47	0.04	-3.00	-10.81	-12.72	60.98
	9	100.79	-0.18	-3.00	-4.81	-43.81	48.99	100.80	-0.18	-3.00	-4.81	-43.82	48.99
	10	100.51	-0.18	-2.93	-2.68	-43.55	51.17	100.49	-0.18	-2.93	-2.68	-43.52	51.18
	11	100.52	-0.19	-2.68	-1.38	-43.96	52.32	100.53	-0.19	-2.68	-1.37	-43.97	52.31
	12	100.54	-0.19	-2.29	-0.72	-44.29	53.06	100.55	-0.19	-2.29	-0.72	-44.29	53.05
	13	100.57	-0.20	-1.82	-0.38	-44.60	53.57	100.56	-0.20	-1.82	-0.38	-44.59	53.57
	14	100.60	-0.21	-1.31	-0.20	-44.92	53.96	100.60	-0.21	-1.31	-0.20	-44.93	53.96
	15	100.65	-0.22	-0.84	-0.06	-45.29	54.23	100.65	-0.22	-0.84	-0.06	-45.29	54.23
	16	103.69	-0.28	-0.44	0.00	-57.92	45.06	103.69	-0.28	-0.44	0.00	-57.92	45.06
	17	101.11	-0.40	-0.41	0.00	-54.42	45.87	101.11	-0.40	-0.41	0.00	-54.42	45.88
	18	100.99	-0.83	-0.32	0.00	-57.52	42.32	100.99	-0.83	-0.32	0.00	-57.52	42.32
	19	100.86	-1.21	-0.25	0.00	-60.31	39.10	100.87	-1.21	-0.25	0.00	-60.31	39.10
	20	100.74	-1.57	-0.19	0.00	-62.84	36.14	100.74	-1.57	-0.19	0.00	-62.84	36.14
	21	94.10	-1.87	-0.15	0.00	-51.12	40.95	94.10	-1.88	-0.15	0.00	-51.12	40.95
	22	100.44	-1.97	-0.06	0.00	-70.03	28.38	100.44	-1.97	-0.06	0.00	-70.03	28.38
	23	95.10	-2.12	-0.05	0.00	-56.46	36.46	95.10	-2.12	-0.05	0.00	-56.46	36.46

	24	98.19	-2.28	-0.02	0.00	-67.03	28.87	98.19	-2.28	-0.02	0.00	-67.03	28.87
	25	102.26	-2.41	-0.01	0.00	-78.09	21.75	102.27	-2.41	-0.01	0.00	-78.09	21.75
						Total SEL	**104.66**					**Total SEL**	**104.66**
3	1	100.39	8.05	-3.00	-8.69	-23.86	72.89	100.39	8.04	-3.00	-8.69	-23.87	72.88
	2	99.06	5.59	-3.00	-9.27	-22.15	70.23	99.06	5.59	-3.00	-9.27	-22.16	70.22
	3	97.05	4.03	-3.00	-10.03	-21.56	66.49	97.05	4.03	-3.00	-10.03	-21.57	66.48
	4	94.72	2.89	-3.00	-10.74	-19.06	64.80	94.72	2.88	-3.00	-10.74	-19.07	64.80
	5	92.35	1.98	-3.00	-10.79	-16.39	64.16	92.36	1.98	-3.00	-10.79	-16.40	64.15
	6	89.85	1.23	-3.00	-10.80	-14.52	62.75	89.85	1.23	-3.00	-10.80	-14.53	62.75
	7	87.40	0.59	-3.00	-10.81	-13.23	60.95	87.40	0.59	-3.00	-10.81	-13.23	60.95
	8	84.90	0.04	-3.00	-10.82	-12.37	58.74	84.90	0.04	-3.00	-10.82	-12.37	58.74
	9	100.85	-0.18	0.00	0.00	-47.30	53.37	100.86	-0.18	0.00	0.00	-47.31	53.37
	10	100.43	-0.18	0.00	0.00	-46.61	53.63	100.40	-0.18	0.00	0.00	-46.57	53.65
	11	100.44	-0.19	0.00	0.00	-46.83	53.42	100.45	-0.19	0.00	0.00	-46.85	53.41
	12	100.46	-0.19	0.00	0.00	-46.95	53.32	100.47	-0.19	0.00	0.00	-46.96	53.31
	13	100.48	-0.20	0.00	0.00	-47.04	53.25	100.48	-0.20	0.00	0.00	-47.03	53.25
	14	100.52	-0.21	0.00	0.00	-47.10	53.21	100.52	-0.21	0.00	0.00	-47.11	53.21
	15	100.56	-0.22	0.00	0.00	-47.14	53.20	100.56	-0.22	0.00	0.00	-47.14	53.20
	16	109.41	-0.28	0.00	0.00	-72.75	36.38	109.41	-0.28	0.00	0.00	-72.75	36.38
	17	106.86	-0.40	0.00	0.00	-69.09	37.37	106.86	-0.40	0.00	0.00	-69.07	37.38
	18	106.74	-0.83	0.00	0.00	-71.91	34.01	106.75	-0.83	0.00	0.00	-71.92	34.00
	19	106.62	-1.21	0.00	0.00	-74.49	30.92	106.64	-1.21	0.00	0.00	-74.53	30.90
	20	106.50	-1.57	0.00	0.00	-76.87	28.06	106.49	-1.57	0.00	0.00	-76.84	28.09
	21	93.87	-1.87	0.00	0.00	-51.47	40.53	93.87	-1.88	0.00	0.00	-51.46	40.53
	22	105.12	-1.97	0.00	0.00	-81.07	22.09	105.12	-1.97	0.00	0.00	-81.07	22.09
	23	94.95	-2.12	0.00	0.00	-56.71	36.12	94.95	-2.12	0.00	0.00	-56.71	36.12
	24	98.46	-2.28	0.00	0.00	-67.85	28.33	98.46	-2.28	0.00	0.00	-67.85	28.34
	25	106.28	-2.41	0.00	0.00	-87.60	16.26	106.29	-2.41	0.00	0.00	-87.62	16.26
						Total SEL	**76.58**					**Total SEL**	**76.57**
4	1	97.67	8.05	-3.00	-10.01	-8.34	84.36	97.67	8.04	-3.00	-10.01	-8.34	84.36
	2	96.73	5.59	-3.00	-10.26	-6.55	82.52	96.73	5.59	-3.00	-10.26	-6.55	82.52
	3	95.34	4.03	-3.00	-10.64	-6.35	79.38	95.34	4.03	-3.00	-10.64	-6.35	79.38
	4	93.58	2.89	-3.00	-10.78	-8.41	74.28	93.58	2.88	-3.00	-10.78	-8.41	74.28
	5	91.59	1.98	-3.00	-10.79	-10.89	68.89	91.59	1.98	-3.00	-10.79	-10.89	68.89
	6	89.31	1.23	-3.00	-10.81	-11.77	64.96	89.31	1.23	-3.00	-10.81	-11.78	64.96
	7	87.05	0.59	-3.00	-10.81	-11.86	61.97	87.05	0.59	-3.00	-10.81	-11.86	61.97
	8	84.64	0.04	-3.00	-10.82	-11.69	59.16	84.64	0.04	-3.00	-10.82	-11.69	59.16
	9	96.71	-0.18	-3.00	-8.69	-40.16	44.69	96.72	-0.18	-3.00	-8.69	-40.16	44.69
	10	96.57	-0.18	-2.99	-6.84	-39.97	46.59	96.56	-0.18	-2.99	-6.84	-39.96	46.59
	11	96.58	-0.19	-2.94	-5.10	-40.18	48.18	96.59	-0.19	-2.94	-5.09	-40.19	48.18
	12	96.60	-0.19	-2.85	-3.65	-40.29	49.62	96.61	-0.19	-2.85	-3.65	-40.29	49.62
	13	96.63	-0.20	-2.69	-2.47	-40.37	50.90	96.62	-0.20	-2.69	-2.47	-40.36	50.91
	14	96.66	-0.21	-2.43	-1.56	-40.41	52.06	96.66	-0.21	-2.43	-1.56	-40.41	52.06
	15	96.70	-0.22	-2.03	-0.89	-40.44	53.12	96.70	-0.22	-2.03	-0.89	-40.44	53.12
	16	98.20	-0.28	-1.46	-0.43	-49.36	46.68	98.20	-0.28	-1.46	-0.43	-49.36	46.68
	17	95.64	-0.40	-1.40	-0.40	-45.89	47.56	95.64	-0.40	-1.40	-0.40	-45.89	47.56
	18	95.52	-0.83	-1.20	-0.29	-48.70	44.51	95.52	-0.83	-1.20	-0.29	-48.70	44.51
	19	95.41	-1.21	-1.02	-0.20	-51.28	41.70	95.41	-1.21	-1.02	-0.20	-51.28	41.70
	20	95.29	-1.57	-0.86	-0.12	-53.66	39.09	95.29	-1.57	-0.86	-0.12	-53.65	39.10
	21	91.74	-1.87	-0.71	-0.04	-48.20	40.91	91.74	-1.88	-0.71	-0.04	-48.20	40.91
	22	95.36	-1.97	-0.32	0.00	-61.34	31.73	95.36	-1.97	-0.32	0.00	-61.34	31.73

	23	92.53	-2.12	-0.28	0.00	-52.82	37.30	92.53	-2.12	-0.28	0.00	-52.82	37.31
	24	94.55	-2.28	-0.11	0.00	-61.01	31.16	94.55	-2.28	-0.11	0.00	-61.01	31.16
	25	96.27	-2.41	-0.06	0.00	-67.24	26.56	96.27	-2.41	-0.06	0.00	-67.24	26.56
						Total SEL	**87.63**					**Total SEL**	**87.63**
5	1	100.10	8.05	-3.00	-8.69	-45.60	50.85	100.10	8.04	-3.00	-8.69	-45.60	50.85
	2	99.81	5.59	-3.00	-8.69	-42.56	51.15	99.81	5.59	-3.00	-8.69	-42.56	51.15
	3	99.51	4.03	-3.00	-8.69	-40.01	51.84	99.52	4.03	-3.00	-8.69	-40.01	51.84
	4	99.22	2.89	-3.00	-8.69	-37.42	53.00	99.22	2.88	-3.00	-8.69	-37.42	53.00
	5	98.93	1.98	-3.00	-8.69	-34.48	54.75	98.93	1.98	-3.00	-8.69	-34.48	54.75
	6	98.64	1.23	-3.00	-8.69	-30.87	57.31	98.64	1.23	-3.00	-8.69	-30.87	57.31
	7	98.35	0.59	-3.00	-8.69	-26.13	61.12	98.35	0.59	-3.00	-8.69	-26.13	61.13
	8	98.06	0.04	-3.00	-8.69	-19.23	67.18	98.06	0.04	-3.00	-8.69	-19.23	67.18
	9	97.94	-0.19	-2.99	-6.84	-19.80	68.13	97.95	-0.19	-2.99	-6.84	-19.80	68.13
	10	97.95	-0.19	-2.94	-5.10	-15.89	73.83	97.95	-0.19	-2.94	-5.09	-15.89	73.84
	11	97.97	-0.19	-2.85	-3.65	-11.03	80.25	97.97	-0.19	-2.85	-3.65	-11.03	80.25
	12	97.99	-0.20	-2.69	-2.47	-5.41	87.22	97.99	-0.20	-2.69	-2.47	-5.41	87.22
	13	97.99	-0.20	-2.65	-2.30	-3.56	89.28	97.99	-0.20	-2.65	-2.30	-3.56	89.28
	14	98.02	-0.21	-2.43	-1.56	-9.17	84.66	98.02	-0.21	-2.43	-1.56	-9.17	84.66
	15	98.07	-0.22	-2.03	-0.89	-17.94	76.99	98.07	-0.22	-2.03	-0.89	-17.93	76.99
	16	97.57	-0.28	-1.46	-0.43	-29.19	66.22	97.57	-0.28	-1.46	-0.43	-29.19	66.22
	17	95.02	-0.40	-1.40	-0.40	-28.86	63.96	95.02	-0.40	-1.40	-0.40	-28.86	63.96
	18	94.90	-0.83	-1.20	-0.29	-35.67	56.92	94.90	-0.83	-1.20	-0.29	-35.67	56.92
	19	94.79	-1.21	-1.02	-0.20	-40.77	51.58	94.79	-1.21	-1.02	-0.20	-40.78	51.58
	20	94.67	-1.57	-0.86	-0.12	-44.89	47.24	94.67	-1.57	-0.86	-0.12	-44.89	47.24
	21	94.60	-1.87	-0.71	-0.04	-46.68	45.29	94.60	-1.88	-0.71	-0.04	-46.68	45.29
	22	94.37	-1.97	-0.32	0.00	-54.83	37.25	94.37	-1.97	-0.32	0.00	-54.83	37.26
	23	95.03	-2.12	-0.28	0.00	-52.96	39.66	95.03	-2.12	-0.28	0.00	-52.96	39.66
	24	95.97	-2.28	-0.11	0.00	-60.83	32.76	95.97	-2.28	-0.11	0.00	-60.83	32.76
	25	95.93	-2.41	-0.06	0.00	-64.61	28.86	95.93	-2.41	-0.06	0.00	-64.61	28.86
						Total SEL	**92.71**					**Total SEL**	**92.71**

APPENDIX F

CURRENT LIST OF STAPES AIRPORTS

Country	Airport	Airport Code
Belgium	Brussels	BRU
France	Paris Charles de Gaulle	CDG
France	Paris Orly	ORY
France	Toulouse	TLS
Germany	Berlin Tegel	TXL
Germany	Cologne / Bonn	CGN
Germany	Dusseldorf	DUS
Germany	Frankfurt	FRA
Germany	Hamburg	HAM
Germany	Hannover	HAJ
Germany	Stuttgart	STR
Italy	Bergamo	BGY
Italy	Milan Linate	LIN
Italy	Milan Malpensa	MXP
Italy	Naples	NAP
Italy	Rome Ciampino	CIA
Italy	Rome Fiumicino	FCO
Netherlands	Amsterdam	AMS
Portugal	Lisbon	LIS
Spain	Madrid	MAD
Spain	Valencia	VLN
Switzerland	Geneva	GVA
Switzerland	Zurich	ZRH
UK	Birmingham	BHX
UK	Glasgow	GLA
UK	London Heathrow	LHR
UK	Manchester	MAN

— END —

Appendix D - ECAC-ANCAT Working and Information Papers

GROUP OF EXPERTS ON THE ABATEMENT OF NUISANCES CAUSED BY AIR TRANSPORT

Seventy-third meeting

(Brussels, 20/21 February 2008)

Agenda Item 5 : **Modelling and interdependencies**

SysTem for Airport noise Exposure Studies (STAPES[1])

(Prepared by EC, EASA, EUROCONTROL and UK CAA)

SUMMARY

Following on from the ANCAT/72 MITG Report, this information paper contains a summary on the status of the EC-EASA-EUROCONTROL project to develop a European airport noise model known as STAPES.

ANCAT Members are requested to note the scope and current status of this project.

[1] The human ear has a beautifully designed built-in noise protection mechanism. Three tiny bones - the anvil, the hammer, and the **stapes** (the smallest bone in the body) - connect the eardrum and the cochlea. These little bones transmit sound vibrations from the eardrum to the cochlea, which detects the frequencies and intensities of impending sound and transmits them to the hearing centres of the brain. If the brain detects noise of an intensity that could damage the cochlea, the stapedius muscle contracts and partially pulls the **stapes** away from its connection to the cochlea which somewhat diminishes the sound energy transmitted to the cochlea. This mechanism is nature's way of providing some protection against hearing damage caused by excessive noise.

SysTem for Airport noise Exposure Studies (STAPES)

1. INTRODUCTION

1.1 Following on from the MITG report at ANCAT/72, it is now possible to confirm that the European Commission has issued a contract to EUROCONTROL to jointly fund and develop a working prototype of a European regional noise model, with technical support from EASA and UK CAA. Regular updates are being provided to AIRMOD and MITG in order to receive feedback on the model development process and use within CAEP.

1.2 An initial comparison of the 2002 EC Sondeo study and MAGENTA airports suggested that the 15 “Shell 1” European airports currently in MAGENTA only represent approx. 51%-62% of the European population exposed to significant levels of noise, depending on the noise contour level. This is a significant underestimation of the 90% level assumed in the analyses performed during previous CAEP work programmes.

1.3 The adoption of the Environmental Noise Directive (2002/49) and the Establishment Of Rules And Procedures With Regard To The Introduction Of Noise-Related Operating Restrictions Directive (2002/30), have created a requirement for a modelling capability which the European Commission can use to review these pieces of European legislation on a regular basis with an aim of improving their effectiveness. This tool will also support the requirement on EASA to perform Regulatory Impact Assessments, and on EUROCONTROL to analyse future operational proposals within SESAR. It will therefore have “dual use” capabilities, thereby avoiding duplication and maximising use of available resources.

1.4 The objective of this project is to develop the STAPES model in order to address the above issues and provide valuable input into both European and international policy-making and operational assessments, thereby ensuring European interests are better represented in decision-making forums such as CAEP.

2. COVERAGE OF EUROPEAN AIRPORTS

2.1 Based on the 2002 Sondeo analysis for the European Commission, EUROCONTROL data on air traffic movements, and Member State information supplied under the Environmental Noise Directive, a provisional list of 38 European airports has been identified to represent the assumed 90% European population exposed to significant noise levels in CAEP global assessments (Attachment A).

2.2 As part of the development of the STAPES model, up-to-date input data will be collected on these European airports. FAA are currently seeking consent from existing ACI airports in MAGENTA to release their data to all CAEP modellers for use in CAEP assessments only. Once completed, the additional European airport data is also expected to be made available for inclusion in the ICAO Airports Database under the same conditions.

3. STAPES MODEL

3.1 As part of the working prototype model development, a new noise engine is to be created which is fully compliant with current best practice (ECAC Doc. 29 3rd Edition). Results will be presented, at a macro European level, on the current and future population numbers within airport noise contour areas. The flexibility of the system will permit different input and outputs depending on the context of the analysis (e.g. European or international).

3.2 As part of the CAEP model evaluation process, a comparative summary table and a key methodology comparison table will be provided to MODTF. In terms of validation and verification (V&V) of the noise engine, extensive comparisons will be undertaken against the UK ANCON model, which has completed the MODTF evaluation process, and has demonstrated good agreement with MAGENTA. Specifically, the verification process will mimic that performed between ANCON and the INM, and will report on:

i) Whole airport comparisons

ii) Single event noise footprint comparisons

iii) Segment-by-segment data input/output comparisons

3.3 STAPES will also undertake the noise analysis performed as part of the trade-off assessment within the NOx stringency sample problem. This will be to the same extent as that done for ANCON (3 London airports).

4. POPULATION DATA

4.1 Population data is a key aspect to accurate European airport noise exposure assessments. Following a review of the available population databases, it has been concluded that the most accurate on a European basis is that supplied by EUROSTAT and the European Environment Agency. It is anticipated that the STAPES model will use this single source of European population data, based on satellite spatial analysis work, along with any relevant local census data.

5. TIMESCALES

5.1 Airport input data is expected to be an on-going task during 2008 in preparation for inclusion in CAEP/8 policy assessments.

5.2 Model development has already begun and, where possible, all evaluation input will be provided to MODTF at the 4-6 June meeting. This will include the single event noise level comparisons, which represents the most critical part of the V&V process since the single event noise calculation forms the 'heart' of the system. A significant part of STAPES evaluation work will be completed by the September 22-26 CAEP Steering Group meeting in order to inform participants of its status. The final V&V information will then be provided to MODTF at the November 4-6 meeting, if not before.

ATTACHMENT A – Airports for European Noise Exposure Assessments

Country	**Country**	**Airport**
UK	LHR	London Heathrow
Germany	TXL	Berlin Tegel
France	ORY	Paris Orly
Portugal	LIS	Lisbon
Germany	HAM	Hamburg
France	CDG	Paris Charles de Gaulle
UK	MAN	Manchester
Germany	FRA	Frankfurt
Belgium	BRU	Brussels
Spain	MAD	Madrid
Germany	HAJ	Hannover
UK	GLA	Glasgow
Germany	CGN	Cologne / Bonn
Italy	NAP	Naples
UK	BHX	Birmingham
Germany	DUS	Dusseldorf
Italy	FCO	Rome Fiumicino
Netherlands	AMS	Amsterdam
Ireland	DUB	Dublin
Italy	MXP	Milan Malpensa
Spain	PMI	Mallorca Palma
Luxembourg	LUX	Luxembourg
Spain	BCN	Barcelona
Germany	STR	Stuttgart
Denmark	CPH	Copenhagen
UK	EMA	London City
Switzerland	ZRH	Zurich
Czech Rep	PRG	Prague
Switzerland	GVA	Geneva
Poland	WAW	Warsaw
Hungary	BUD	Budapest
Italy	LIN	Milan Linate
Spain	VLN	Valencia
Italy	CIA	Rome Ciampino
Germany	NUE	Nuernberg
Germany	SXF	Berlin Schoenefeld
UK	BHD	Belfast International
Spain	BIO	Bilbao

GROUP OF EXPERTS ON THE ABATEMENT OF NUISANCES CAUSED BY AIR TRANSPORT

Seventy-fourth meeting

(London, 4/5 June 2008)

Agenda Item 6 : **Modelling and interdependencies**

SysTem for Airport noise Exposure Studies (STAPES[1])

(Prepared by EC, EASA, EUROCONTROL and UK CAA)

SUMMARY

Following on from the ANCAT/73 IP1, this information paper contains an update on the status of the EC-EASA-EUROCONTROL project to develop a European multi-airport noise model known as STAPES.

ANCAT Members are requested to note the progress and current status of this project.

[1] The human ear has a beautifully designed built-in noise protection mechanism. Three tiny bones - the anvil, the hammer, and the **stapes** (the smallest bone in the body) - connect the eardrum and the cochlea. These little bones transmit sound vibrations from the eardrum to the cochlea, which detects the frequencies and intensities of impending sound and transmits them to the hearing centres of the brain. If the brain detects noise of an intensity that could damage the cochlea, the stapedius muscle contracts and partially pulls the **stapes** away from its connection to the cochlea which somewhat diminishes the sound energy transmitted to the cochlea. This mechanism is nature's way of providing some protection against hearing damage caused by excessive noise.

SysTem for Airport noise Exposure Studies (STAPES)

1. INTRODUCTION

1.1 As highlighted in IP/1 at ANCAT/73, the objective of this project is to develop the STAPES model in order to provide valuable input into both European and international policy-making and operational assessments, thereby ensuring European interests are better represented in decision-making forums such as CAEP.

1.2 It is now possible to confirm that contracts are either in place, or due to be finalised soon, regarding the development of the STAPES noise engine and the collation of relevant airport data. Regular updates are being provided to AIRMOD and MITG in order to receive feedback on the model development process and use within CAEP.

2. COVERAGE OF EUROPEAN AIRPORTS

2.1 Based on the 2002 Sondeo analysis for the European Commission, EUROCONTROL data on air traffic movements, and Member State information supplied under the Environmental Noise Directive, a updated list of 27 European airports has been identified to represent the assumed 90% European population exposed to significant noise levels in CAEP global assessments (Attachment A).

2.2 As part of the development of the STAPES model, up-to-date input data will be collected on these European airports. FAA are currently seeking consent from existing ACI airports in MAGENTA to release their data to all CAEP modellers for use in CAEP assessments only. Once completed, the additional European airport data is also expected to be made available for inclusion in the ICAO Airports Database under the same conditions.

2.3 The airport input data development task will use, where possible, existing datasets which have already been processed for airport noise contouring purposes, and can therefore be incorporated into STAPES at a minimum processing cost. For airports which do not have the required airport data readily available, or have only partial information, these shall be derived from, or complemented with, the EUROCONTROL PRISME data warehouse for operations and/or Aeronautical Information Publications for ground tracks (i.e. create ‘manufactured’ airport decks). This will be based on the guidance/recommendations provided in ECAC Doc.29 3rd Edition, such as that for the definition of ground dispersion.

3. STAPES MODEL

3.1 STAPES is being developed to be fully compliant with the current best practise of ECAC Doc. 29R 3rd Edition, and will be able to accommodate relevant input for European and CAEP assessments. The EUROCONTROL project manager is already engaged in AIRMOD and MODTF.

3.2 In line with the CAEP model evaluation process, a comparative summary table and a key methodology comparison table will be provided to MODTF.

3.3 Development of the noise engine software has begun and, in terms of validation and verification (V&V), extensive comparisons will be undertaken against the UK ANCON model, which has completed the MODTF evaluation process and demonstrated good agreement with MAGENTA. The table below provides a breakdown of the STAPES development programme, including a short description of the associated module-specific validation and verification. In particular, the proposed step-by-step V&V of STAPES includes the performance of the NOx sample problem which will be carried out when the software has been developed and implemented.

WP	**Description**	**Associated V&V Process via comparisons with ANCON2**	**Delivery Date**
WP1	Single-Event Noise Calculation Module development (SEL only)	Noise levels of segments at specific locations (for jet aircraft with wing and tail-mounted engines plus a turboprop)	July 2008
WP2	Flight Path Segments Construction Module development (for point-tracks combined with fixed-point profiles)	Segment-by-segment comparisons	August 2008
WP3	Noise Contour Calculation Module development	- Initial contour/footprint comparisons (using a test grid of noise levels) - Single-event noise footprint comparisons, complementing the V&V results of WP1	August 2008
WP4	Cumulative Noise Levels Calculation Module development (on fixed-grid for DNL and Lden)	Grid and/or contour comparisons (using a test set of operations)	September 2008
WP5	STAPES Core Program development and implementation in the multi-processing environment	Noise contour comparisons for three London airports, through the performance of the NOx sample problem	October 2008

4. POPULATION DATA

4.1 The STAPES modelling system will use the EUROSTAT-JRC-EEA single source of population data for European assessments. For application in CAEP, it will utilise the MODTF agreed population databases: US Census data, EUROSTAT-JRC-EEA for EU and the Global Rural-Urban Mapping Project (GRUMP) data for regions outside of the US and EEA data coverage.

4.2 The population counting process will be automated to facilitate the rapid processing of noise contours in policy scenarios.

5. TIMESCALES

5.1 Airport input data is expected to be an on-going task during 2008 in preparation for inclusion in CAEP/8 policy assessments.

5.2 Model development has begun and final V&V information is still anticipated to be provided to MODTF at their November 4-6 meeting.

ATTACHMENT A – Airports for European Noise Exposure Assessments

Country	Code	Airport
Belgium	BRU	Brussels
France	CDG	Paris Charles de Gaulle
France	ORY	Paris Orly
France	TLS	Toulouse
Germany	TXL	Berlin Tegel
Germany	CGN	Cologne / Bonn
Germany	DUS	Dusseldorf
Germany	FRA	Frankfurt
Germany	HAM	Hamburg
Germany	HAJ	Hannover
Germany	STR	Stuttgart
Italy	LIN	Milan Linate
Italy	MXP	Milan Malpensa
Italy	NAP	Naples
Italy	CIA	Rome Ciampino
Italy	FCO	Rome Fiumicino
Luxembourg	LUX	Luxembourg
Netherlands	AMS	Amsterdam
Portugal	LIS	Lisbon
Spain	MAD	Madrid
Spain	VLN	Valencia
Switzerland	GVA	Geneva
Switzerland	ZRH	Zurich
UK	BHX	Birmingham
UK	GLA	Glasgow
UK	LHR	London Heathrow
UK	MAN	Manchester

GROUP OF EXPERTS ON THE ABATEMENT OF NUISANCES CAUSED BY AIR TRANSPORT

Seventy-sixth meeting

(Oslo, 28/29 April 2009)

Agenda Item 10 : Modelling and Interdependencies

SysTem for Airport noise Exposure Studies (STAPES[11])

(Prepared by EC, EASA, ECTRL and UK CAA)

SUMMARY

Following on from ANCAT/75 IP2, please find attached a brief summary on the current status of the European multi-airport noise model, known as STAPES, and the ongoing work to collate relevant European airport data.

[11] The human ear has a beautifully designed built-in noise protection mechanism. Three tiny bones - the anvil, the hammer, and the **stapes** (the smallest bone in the body) - connect the eardrum and the cochlea. These little bones transmit sound vibrations from the eardrum to the cochlea, which detects the frequencies and intensities of impending sound and transmits them to the hearing centres of the brain. If the brain detects noise of an intensity that could damage the cochlea, the stapedius muscle contracts and partially pulls the **stapes** away from its connection to the cochlea which somewhat diminishes the sound energy transmitted to the cochlea. This mechanism is nature's way of providing some protection against hearing damage caused by excessive noise.

1. STAPES MODEL

1.1 The EC, EASA and ECTRL, with technical support from UK, have successfully completed the development of a European multi-airport noise contour model, known as STAPES.

1.2 At the MODTF in Miami on 4-6 November 2008, ECTRL provided a presentation on the development work and capabilities of the STAPES model. The STAPES model evaluation work, which was performed in line with MODTF criteria, was also summarised. Following a question and answer session, and the provision of some minor additional data, STAPES was recommended by MODTF for use within CAEP policy assessments.

1.3 MODTF was surprised at the speed at which Europe had developed this robust capability and it has proven a good example of how European coordination in this area can reap large benefits. The project also demonstrates the quality of the ECAC Doc. 29 3rd Edition guidance as this was the primary reference used by software developers to aid them in coding the STAPES model from scratch.

1.4 MODTF will provide an update on model evaluation work at the upcoming Steering Group meeting (22-26 June), which will note the recommended use of STAPES, prior to presentation of initial CAEP/8 policy assessment results. A MODTF Information Paper for SG2009, providing background information on STAPES, is also expected.

2. EUROPEAN AIRPORT DATA COLLECTION

2.1 A critical part of the STAPES project is the collection of up-to-date information from key European airports (see Appendix 1) in order to ensure future modelling assessments are robust enough to support informed policymaking.

2.2 In order to initiate a spirit of cooperation with European airports, an initial EC-EASA-EUROCONTROL letter was sent out to all relevant airport focal points on August 18th 2008.

2.3 EUROCONTROL have reviewed their internal data warehouse and identified key data gaps, and are now in discussion with airport representatives in order to establish an efficient data flow process for immediate needs and future updates.

2.4 It is anticipated that the collation of European airport data, and integration into STAPES, will be completed during Summer 2009 and so this information will not feed into MODTF results for the SG2009 meeting. As such, the noise results for the European region in the NOx Stringency and Environmental Goals policy assessments are expected to change between the SG2009 and CAEP/8 meetings.

3. RECOMMENDATIONS

3.1 ANCAT are recommended to:

i) note that STAPES has been recommended by MODTF for use within CAEP policy assessments; and

ii) note that the noise results for the European region in the NOx Stringency and Environmental Goals policy assessments are expected to change between the SG2009 and CAEP/8 meetings.

- END -

GROUP OF EXPERTS ON THE ABATEMENT OF NUISANCES CAUSED BY AIR TRANSPORT

Seventy-seventh meeting

(Paris, 3/4 November 2009)

Agenda Item 7: Modelling and Interdependencies

SysTem for Airport noise Exposure Studies (STAPES[12])

(Prepared by EC, EASA, EUROCONTROL and UK CAA)

SUMMARY

The STAPES project has developed a multi-airport noise model capable of providing valuable input into both European and international policy-making assessments.

This paper provides a final overview of the work involved in model development, European airport coordination, population databases and input into the CAEP/8 work programme. The key conclusions were:

i) effective European coordination in the area of aviation environmental modelling can reap significant benefits in representing European interests within international forums;

ii) the region of Europe is more accurately modelled in CAEP/8 noise assessments than on any previous occasion; and

iii) Europe now has the capability to effectively contribute to noise related issues in the future CAEP work programmes (e.g. Environmental Goals, noise standard).

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[12] The human ear has a beautifully designed built-in noise protection mechanism. Three tiny bones - the anvil, the hammer, and the **stapes** (the smallest bone in the body) - connect the eardrum and the cochlea. These little bones transmit sound vibrations from the eardrum to the cochlea, which detects the frequencies and intensities of impending sound and transmits them to the hearing centres of the brain. If the brain detects noise of an intensity that could damage the cochlea, the stapedius muscle contracts and partially pulls the **stapes** away from its connection to the cochlea which somewhat diminishes the sound energy transmitted to the cochlea. This mechanism is nature's way of providing some protection against hearing damage caused by excessive noise.

1. INTRODUCTION

1.1 The European Commission issued a contract to EUROCONTROL in December 2007 to develop a European regional noise model, with technical support from EASA and UK CAA. The objective of the project, known as STAPES (SysTem for Airport noise Exposure Studies), was to develop a multi-airport noise model capable of providing valuable input into both European and international policy-making assessments, including CAEP/8.

1.2 Regular updates on the STAPES project have been provided to MITG and ANCAT during the previous two years and this IP provides a final overview following completion of the initial development work.

2. STAPES MODEL

2.1 In line with the planned schedule, a first version of the STAPES model was developed and delivered in October 2008. This model is compliant with the best practise modelling guidance within both ECAC Doc. 29 3rd Edition and ICAO Document 9911.

2.2 A thorough validation and verification (V&V) process was carefully applied to the model throughout its development cycle, in the form of extensive comparisons against the UK ANCON model, which had already completed the CAEP MODTF evaluation process and demonstrated good agreement with US FAA MAGENTA model.

2.3 At their meeting in November 2008, STAPES was recommended by MODTF for use within ICAO CAEP policy assessments, and this was subsequently endorsed by the CAEP Steering Group at their meeting in June 2009.

3. EUROPEAN AIRPORT COORDINATION

3.1 Based on a variety of information sources, including strategic noise maps of major airports submitted by EU Member States in line with the Environmental Noise Directive 2002/49, an initial list of airports for inclusion in STAPES was identified in order to represent approx. 90% European population exposed to significant noise levels (see Appendix 1).

3.2 While a significant amount of the required input data already existed within the EUROCONTROL PRISME data warehouse, a critical part of the STAPES project was the collection of up-to-date local information from European airports so as to ensure future modelling assessments are robust enough to support informed policymaking.

3.3 In order to initiate a spirit of cooperation with European airports, an initial EC-EASA-EUROCONTROL letter was sent out to all relevant airport focal points on August 2008. Good coordination with the majority of the airports has been established and an efficient data flow process for our immediate needs and future updates has been established.

4. POPULATION

4.1 As part of the CAEP/8 work, the STAPES project has also identified the EEA-JRC[13] population database as a more accurate single source of data for use on EU airports. This is complimented by census data and the GRUMP database for non-EU airports.

5. CAEP/8 WORK PROGRAMME

5.1 STAPES, in cooperation with ANCON, has contributed to the assessments of the European region for both the CAEP NOx Stringency and Environmental Goals assessment. Detailed results from this work within MODTF will be presented to CAEP/8 in February 2010.

5.2 As part of the STAPES work , it was identified that the US MAGENTA model was missing eight key European airports (Berlin Tegal, Birmingham, Glasgow, Hannover, Naples, Rome Ciampino, Stuttgart and Valencia). A significant amount data for the other European airports within MAGENTA was also out of date which led to new runways and flight track changes not being taken into account within the model. In addition, the STAPES analysis led to the complete removal of two European airports from the CAEP/8 Environmental Goals assessment. Firstly, incorrect runway usage and flight track data in MAGENTA has previously resulted in a significant overestimation of people exposed at a European airport. Correct data illustrated a reduction from approx. 230,000 to 14,000 people exposed to noise levels >55DNL. A second European airport in MAGENTA had closed in 2001 and been replaced by a new airport with less than 5,000 people >55DNL.

5.3 The below CAEP/8 Environmental Goals noise results on population exposed to >55DNL, with moderate technology and ops improvements, provide some insight into the differences due to the additional input from STAPES and ANCON on airports in the European region.

	With STAPES/ANCON		**Without STAPES/ANCON**		Delta
	Total Population	Ratio	Total Population	Ratio	Total Population
2006	2.625.080	1	2.014.901	1	+610.179
2016	3.196.275	1.22	2.534.390	1.26	+661.885
2026	3.432.300	1.31	2.826.835	1.40	+604.465
2036	3.811.323	1.45	3.159.053	1.57	+652.270

[13] European Environment Agency – EC Joint Research Centre

6. CONCLUSIONS

6.1 The main conclusions from the STAPES project are:

i) effective European coordination in the area of aviation environmental modelling can reap significant benefits in representing European interests within international forums;

ii) the region of Europe is more accurately modelled in CAEP/8 noise assessments than on any previous occasion; and

iii) Europe now has the capability to effectively contribute to noise related issues in future CAEP work programmes (e.g. Environmental Goals, noise standard).

Appendix 1 – Current list of STAPES airports

Country	Code	Airport
Belgium	BRU	Brussels
France	CDG	Paris Charles de Gaulle
	ORY	Paris Orly
	TLS	Toulouse
Germany	TXL	Berlin Tegel
	CGN	Cologne / Bonn
	DUS	Dusseldorf
	FRA	Frankfurt
	HAM	Hamburg
	HAJ	Hannover
	STR	Stuttgart
Italy	BGY	Bergamo
	LIN	Milan Linate
	MXP	Milan Malpensa
	NAP	Naples
	CIA	Rome Ciampino
	FCO	Rome Fiumicino
Netherlands	AMS	Amsterdam
Portugal	LIS	Lisbon
Spain	MAD	Madrid
	VLN	Valencia
Switzerland	GVA	Geneva
	ZRH	Zurich
Turkey	IST	Istanbul Ataturk
UK	BHX	Birmingham
	GLA	Glasgow
	LHR	London Heathrow
	MAN	Manchester

Appendix E - STAPES Presentation to ACI Europe

STAPES

(SysTem for AirPort noise Exposure Studies)

ACI Environmental Committee Meeting
9 October 2008
Brussels

Background

- Multi-airport noise contour modelling capability required to support cost-effectiveness assessments of policy options or operational concepts aimed at mitigating noise impacts:
  - European level (EC, EASA, ECAC/ANCAT, EUROCONTROL)
  - Global level (ICAO/CAEP)
- Noise impact quantified in terms of number of people exposed to varying levels of noise

The STAPES Project (1)

- European Commission and EASA have contracted EUROCONTROL to develop STAPES
  - Joint funding and IPR ownership
- STAPES will support:
  - EC and EASA Regulatory Impact Assessments
  - ICAO/CAEP policy option assessments
  - Assessments of operational concepts to be developed in the SESAR programme

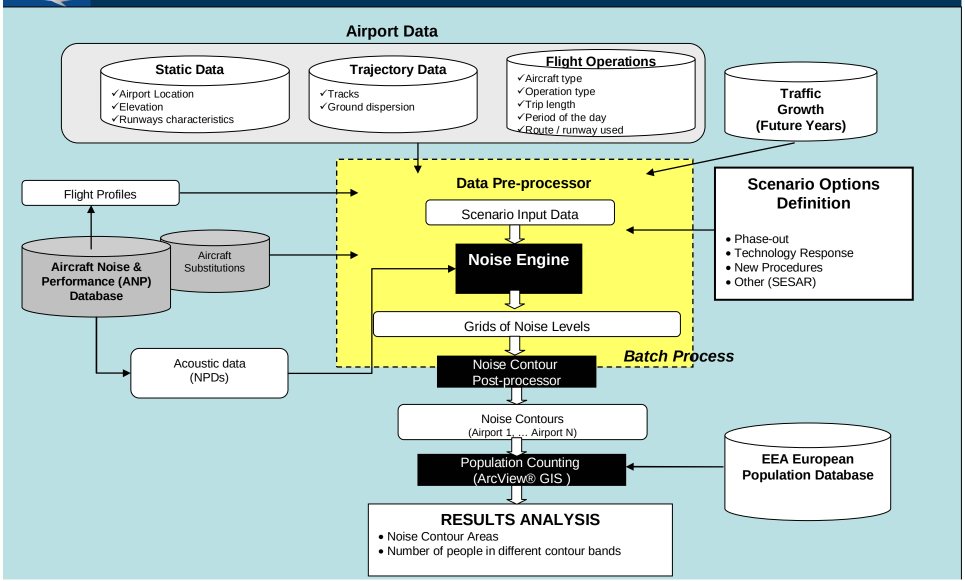
The STAPES Project (2)

- Main project elements:
  - Noise Model
  - Airport Data
  - Population Data

Noise Model

- Current Schedule
  - Oct. – finalisation of development programme
  - Nov. – completion of STAPES evaluation and approval for use in CAEP assessments
  - Dec. – delivery of first version
- ECAC Doc. 29R 3rd Edition compliant

Noise Model Architecture



Airport Data

- Initial STAPES version to include 26 European airports
  - Cover approx. 90% of European population exposed to significant aircraft noise levels (>55 Lden)
  - Brussels, Paris Charles de Gaulle, Paris Orly, Toulouse, Berlin Tegel, Cologne / Bonn, Dusseldorf, Frankfurt, Hamburg, Hannover, Stuttgart, Milan Linate, Milan Malpensa, Naples, Rome Ciampino, Rome Fiumicino, Amsterdam, Lisbon, Madrid, Valencia, Geneva, Zurich, Birmingham, Glasgow, London Heathrow and Manchester

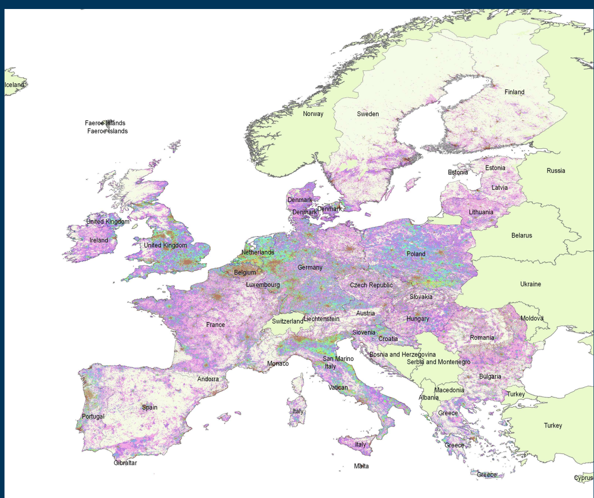
Airport Data

- Cooperation is essential to accurately represent the airports within STAPES
  - Joint EC-EASA-Eurocontrol letter requesting support for the STAPES project sent out on 18th August
  - Eurocontrol to liaise with focal points (airports/authorities) to collate and process existing local datasets
  - Offer of an exchange of relevant operational data
- Use of EUROCONTROL PRISME data warehouse and derived information from AIPs will be used to:
  - Fill in missing data
  - Validate (cross-check) readily available airport datasets

Airport Data Access / Results

- Airport data will be held on a secure server.
- Data will be made available to other modellers for use <u>solely</u> within ICAO CAEP work and only once <u>formal data protection agreements</u> are in place.
- Results will <u>not</u> be released on individual airport basis.

Population Data



- EEA-JRC Database
  - EU wide population based on satellite spatial analysis
- Census data