ROADMAP TO COMMON NOISE ASSESSMENT METHODS IN EUROPE (CNOSSOS-EU)

DG ENV – DG JRC Workshop

on

“AIRCRAFT NOISE”

19-20 JANUARY 2010, BRUSSELS

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**MEETING PLACE:** Albert Borschette Building, Ab - 3A, Bruxelles, Belgium

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**Drafted by:** F. Anfosso-Lédée  
**Reviewed by:** Meeting’s participants  
**Approved by:** S. Kephalopoulos
Tuesday 19\textsuperscript{th} January 2010 (09:30 – 18:00)

1- Opening (B. Gergely, DG ENV)

B. Gergely welcomed the Workshop’s participants and after a round-table of presentations, he presented the legal context of the Environmental Noise Directive (END) 2002/49/EC, the difficulties in END’s implementation, and the current and future steps including the ongoing review of END [see B\textit{Gergely}_END_JRC-Workshop_19-20\_Jan\_2010.pdf]. DG-ENV is responsible for the implementation of END. 95\% of the reports related to noise process due end 2007, were received at the EC. A work of clarification is ongoing with the MS. The data submitted to date are not comparable across EU. DG ENV hopes that things will be better in the future reporting also due to the use of the Common Noise Assessment Methods (CNOSSOS-EU) by the EU MS. The company Milieu has been contracted by DG ENV to review the END (review due by May 2010). In the meantime, quality assessment of reported data is performed by EEA/ETCLUSI. Finally, a new Administrative Arrangement with JRC (Ispra) is set to finalize the operational part of CNOSSOS-EU due in 2011.

2- Roadmap for CNOSSOS-EU (S. Kephalopoulos, DG JRC)

S. Kephalopoulos summarized the steps undertaken in 2009 by JRC on behalf of DG ENV [see S\textit{Kephalopoulos}_roadmap_CNOSSOS-EU_JRC-Workshop_19-20\_Jan\_2010.pdf]. In the context of the roadmap to prepare common noise assessment methods in EU, two major workshops have been organized, the first one in March 2009 on the target quality and input data requirements for noise assessment, and the second one in September 2009 on the pre-selection of the common noise assessment methods. He presented the ‘fit-for-purpose’ framework of the common noise assessment method (CNOSSOS-EU), i.e. a two-level assessment, the first one for strategic noise mapping (less demanding in terms of input data) and the second one for more specific assessment of action plans. He stressed that the use of CNOSSOS-EU is only mandatory for 1\textsuperscript{st} level of use, i.e. noise mapping, and optional for the 2\textsuperscript{nd} level of use (action planning). It is still open to discussion how this two-level framework can be applied for aircraft noise, as D. Rhodes reminded that there is another EU directive (2002/30/EC) not managed by DG ENV, that is more strict in terms of requirements.

The main conclusions of the workshop in March 2009 were: (1) increase comparability of results, (2) make guidelines for competent use, especially for input default values, (3) make a common software, (4) there is a need for open public database.

During the workshop in September 2009, the pre-selection of methods to be considered for CNOSSOS-EU was presented on the basis of a comprehensive literature survey on existing methods in EU, USA and Japan, and an assessment done according to a list of general requirements. For aircraft noise, it was concluded that ECAC Doc 29 and AzB should be further investigated, during the present ad-hoc meeting.

Recently, benchmark tests have been performed on some components of the pre-selected methods, and ad-hoc meetings were organized on road traffic noise and propagation (November 2009), railway noise (December 2009) and today, aircraft noise. A first draft of CNOSSOS was submitted in December 2009 for road, railway and industrial noise and completed by the sound propagation part in
January 2010. The second draft of CNOSSOS-EU including aircraft noise is due by 15 February 2010\(^1\).

In a next phase starting in May 2010, CNOSSOS-EU will be implemented in an open source code centrally managed and updated by EC. A helpdesk and training sessions for end users will be organized by EC.

**Discussion**

In the Good Practice Guidelines of CNOSSOS-EU, it is intended to have a two level “fit for purpose” framework of application: the first simplified level will allow overall impact assessments of exposure to noise in the context of strategic noise mapping as required by the END with some frequently used and acceptable assumptions; the second more sophisticated, more detailed level will allow more precise determination of noise levels to assess the effectiveness of action plans and potential new noise reduction measures. This two-level accuracy is unavoidable for road and railways because thousands of kilometres are to be mapped. But it may be unnecessary for aircraft noise. A two level approach also raises the potential that two different sets of contours could be produced for the same area, leading to potential communication problems. Additionally, as the accuracy of calculated noise levels in the case of aircraft noise is widely “driven” by the quality of the input data feeding the model, the two levels of details/sophistication mentioned above would more apply on the input data processing, rather than on the noise model itself to calculate the noise exposure (e.g. a noise model which would include both simplified and more sophisticated noise equations/ algorithms). During discussion, several aircraft noise experts expressed their support for only one single method for aircraft noise.

Concerns were expressed among the participants on the tight timetable and the availability of resources for maintaining the EU-software. JRC recognized that some additional support will have to be found, and contribution of Member States (M.S.) will be looked for. M.S. have to understand that the effort to achieve a good common noise assessment method is small compared to the huge amount of money needed for mitigating aircraft noise problems. However, this effort can be very cost effective on a longer term. In response, D.Rhodes suggested that the costs of providing common EU-software would be much higher than envisaged and noted that in many instances in the first round mapping the costs of preparing the noise maps had far outweighed the costs associated with developing actions plans.

Concerning the timetable, JRC should be ready to dispatch in 2011 an operational version of CNOSSOS-EU including a public software accompanied by guidelines for the competent use of it for the two-level application framework of CNOSSOS-EU.. DG ENV is currently looking for solutions to postpone the deadline for the 2\(^{nd}\) round of mapping. Mr Kephalopoulos underlined that the methods on which CNOSSOS-EU will be based are already existing, they were built on long term experience and common efforts. EU will assist MS in the practical aspects of the method application.

S. Arrowsmith expressed that a potential benefit is recognized across EU about a common assessment method. But there is also a common concern on the transition to this new situation and the effort of M.S. for maintenance has to be supported by EC.

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\(^1\) Currently delayed
The EC wishes to guarantee the development process of CNOSSOS-EU including the operational phase of the common methods (i.e., setup of good practice guidelines, implementation in software, validation of the methods and training of EU MS). EC’s first concern is to set up a common tool. The experts and the EU MS strongly support the preparation of common noise methods (but not necessarily common software). The alternatives are not satisfying: the use of interim methods not representing any more the state of the art in noise assessment or proof of “equivalency” of existing national methods (the JRC’s exercise on equivalency in 2008 has demonstrated that it is practically impossible to prove the equivalence between existing national methods against the interim ones). Further steps, like implementation, maintenance, further developments and the creation of a common database will be decided by EC after discussion with the M.S., including discussion on the resources issue.

3- Background memo for discussion (F. Anfosso, DG JRC)

Before the meeting, JRC has drafted and circulated a memo among the invited experts. The objective of this baseline document was to support and streamline the Workshop’s discussions. The document recalls the background of the END requirements, the choice of the basic description of the aircraft noise assessment method and suggests some necessary improvements of ECAC Doc.29 and AzB 2008 that could help in keeping the coherence between the modelling of all four main noise sources, and would also help in quantifying and reducing uncertainties. Each identified point was then discussed in detail during the meeting as stated in the agenda.

Discussion

It was requested that a point on the transition issue is added in the agenda. Contours for strategic noise mapping may be different from legal – national - contours used for enforcement in the individual EU MS, which can be difficult to explain to the public and the legislators.

It is a general concern of aircraft noise experts that having two different sets of contours in one MS may result in a public mistrust, which is the opposite of what the END aims at. However, some experts mentioned that the public is also used to being presented different contours, where the differences are usually explained by different input data (i.e., receiver height, traffic data, etc…). Other views expressed were that people tend to trust the measurements from monitoring systems around airports more than the contours presented by authorities, though it must also be recognised that measurement systems are not available at all airports covered by the Directive.

The Workshop’s participants have experienced that slight differences in noise assessments lead to significant consequences on the public affected – i.e. aircraft noise contours are very sensitive to changes in noise source data as well as to changes in operational data resulting from pre-processing. This is a major issue. The END states that the action plans should be based on the result of mapping. Some experts requested that when issuing the CNOSSOS-EU, the Commission should clarify whether strategic noise mapping just provides information or data upon which action plans and therefore legal actions will be based.
4- Propagation: can full 1/3 octave band calculation be made mandatory?

The CNOSSOS-EU method describes 1/3 octave band calculations for the other three noise sources (road traffic, railway traffic and industries). It is important to properly take into account the frequency dependent propagation effects. ECAC Doc.29 (and its associated ANP database) mostly provides, for each aircraft type, overall A-weighted noise levels (the NPDs). These are, however, complemented with spectral shape information (e.g. spectral class data, provided for groups of aircraft), which are defined in 1/3 octave bands. These are used to calculate frequency-dependent corrections, i.e. air absorption corrections (for when the atmosphere at the airport differs from the reference atmosphere accounted for in the NPDs). In general, the use of spectral class data instead of individual spectra (e.g. aircraft type-specific) is considered sufficient for the current applications, but could have some limitations if, in the future, more information on frequency content is needed for assessing environmental noise (e.g. specific consideration of low frequencies).

Aircraft noise experts highlighted that to develop the NPD data, manufacturers have already integrated the time history of the 1/3 octave band sound pressure levels (obtained during measurement campaigns for noise certification purpose). In this way, ECAC Doc.29 and the ANP database inherently uses data based on the full 1/3 octave analysis. The choice of using this scheme of integrated data was implicit when pre-selecting ECAC Doc29 for CNOSSOS-EU, and not the IMAGINE approach.

The following recommendation was made:

⇒ It should be explained in CNOSSOS-EU why the ECAC Doc29 method is a full 1/3 octave band method though it is expressed mainly through overall integrated A-weighted levels

D. Rhodes volunteered in writing explanation of the process.

S. Kephalopoulos announced that D. Rhodes, L. Cavadini and N. Van Oosten will be requested for a 1st round of drafting of the aircraft module of CNOSSOS-EU before other experts and the EU MS will be requested for further reviewing it in a second phase.

5- Propagation-meteorological parameters: can the adaptation of the ANP database to local meteorological parameters be made mandatory?

In connection with the discussion on the previous point, the following recommendations for CNOSSOS-EU were made:

⇒ To allow the use of local specific meteorological conditions for calculating aircraft flight performance.

⇒ To use the text of Annex D of ECAC Doc29 3rd Ed. Vol.2 as part of CNOSSOS-EU to account for, where necessary, the effect of local atmospheric conditions on the changing of the propagation (air absorption).
To explain in the Good Practice Guidelines of CNOSSOS-EU how to correct the average year conditions with the specific meteorological conditions.

It was mentioned that a research project in Germany called “Quiet Air Traffic II” (documentation available on [http://www.dlr.de/as/Desktopdefault.aspx/tabid-192/402_read-1633/](http://www.dlr.de/as/Desktopdefault.aspx/tabid-192/402_read-1633/)) has also investigated the error introduced by the traditional simplification of standardised atmosphere. Usually, non isotropic meteorological conditions lead to lower sound levels compared to standard isotropic solutions. Therefore, current assessments tend to over-predict noise exposition, at day and night.

6- Propagation:

   a. What is the effect of moving the receiver position to 4 m height? If relevant, which formulation and/or corrections to adopt?

The position for noise assessment as required by the END is 4.0 m high for all four noise sources (road traffic, railway traffic, industries and aircraft). However, the reference height in the ANP database is 1.2m, since the data is derived from the noise certification process which also uses a height of 1.2m. For the implementation of END, it is important that the 4 m high position is kept also for aircraft noise, for a better coherency between all sources of noise and also because in EU, most people live at 4 m or higher.

Before the meeting, U. Isermann had circulated a paper on this topic by Bütkofer and Thomann\textsuperscript{2}. In this paper, it is concluded that differences can be significant for low angles of incidence at large distances (above 2000 m), and for noise with dominant low frequency components: sound pressure levels at 1.2 m are lower than at 4 m height. However, in flyover situations, for propagation distance below 1000 m where no significant difference was observed between sound pressure levels measured at 1.2 m and 10 m height. The contours produced for aircraft noise mapping mostly reflect this flyover situation. Therefore, the aircraft noise experts in their expert view considered the effect of moving the receiver position from 1.2m to 4 m to be negligible, i.e. of the same order as the uncertainties of the measuring devices themselves.

This was demonstrated for absorbing ground only and the effect may be higher for reflecting ground. However, D. Rhodes showed on a test case he provided in 2008 that contours modelled with reflecting (in red) and absorbing (in blue) ground conditions are similar [Differences between Doc_29 and AzB_2008_D-Rhodes.doc]. Therefore, it was his view that no correction should be introduced at this stage. However, in a longer perspective, the 4 m high position could be gradually introduced in the ANP measurement procedure. At present, any correction would be arbitrary as no scientific data was reported so far. Although it may have significant consequences on

the number of people affected, it has to be considered that the uncertainties in modelling over-ground propagation result in significantly larger effects than the influence of receiver height. The suggestion of no correction was supported during the meeting by other aircraft noise experts.

The estimation of the difference between 1.2 m and 4 m high measurements could be proposed to be a topic of further investigations.

The following recommendations were made:

- **4.0 m is the required position in END for all four noise sources (road traffic, railway traffic, aircraft and industry)**

- **The existing evidence shows that in general the difference between 1.2 m and 4.0 m is well below 1 dB for soft grounds and angles of incidence above 15°. Over reflecting ground and for lower angles of incidence, there is no clear evaluation at the moment of the difference.**

- **Even if the difference is small, the number of affected people may vary significantly (possibly tens of thousands of people). Thus, any correction value or methodology chosen will need a strong evidence base.**

- **CNOSSOS-EU is therefore recommended to state that the height of the assessment point may have an influence but for the time being and in the transition time a default correction of zero will be accepted and existing NPD data at 1.2 m will be accepted (see above)**

**b. Is there any proof of irrelevance of ground reflection? If relevant, which formulation and/or corrections to adopt?**

It is commonly said that there are mainly soft grounds around airports. However, M. Paviotti has investigated on Google.maps© and observed that in many cases, runways are surrounded with reflecting surfaces [MPaviotti_Airports_in_EU_JRC-Workshop_19-20_Jan_2010.pdf].

U. Isermann noted that the soft ground corrections were derived in the 1960’s from measurements on flat terrains with no buildings around the airfields. Now built areas have extended. In specific cases like in Norway, corrections for reflections can be considered (fjord, mountains), but in most cases reflections on buildings are negligible. Actually, a combination of ground and meteorological effects is important. Aircraft noise experts are aware of that but still have no reliable method to account for these effects.

D. Rhodes completed that ground effects only affect noise levels and contours at low elevation angles. Furthermore, the whole propagation should be considered, not only the few meters before the receiver. Finally, the consequence of such a correction could be significant on the number of people affected: a +1 dB difference has a much greater consequence for aircraft noise than for road or railway noise sources.
I. Granoien mentioned that in NORTIM a correction for reflecting grounds is introduced: the concept of Fresnel zones is applied, and if the Fresnel zone is reflecting then a 3 dB correction is added.

A discussion followed on whether to introduce or not the NORTIM approach in CNOSSOS-EU. Some of the participants thought that no correction should be required before investigations are completed to verify what effect it has on noise contours. Other participants were in favour of introducing the proposed correction and advise to apply it in very specific fully reflecting situations. There was, however, no agreement on what constituted a reflecting surface, which is fundamental to the application of any method.

However, it was widely recognised by the participants that more research is needed before coming to a consensus. As it is the responsibility of the EU MS to protect their populations, the decision to take or not this correction into account should be at local (national) level instead of a European one.

The following recommendations were made:

- The existing evidence shows that in general a difference exists between different ground types because of the change in the absorption factor, and measurements confirm that it can be up to 2-3 dB in the overall (A) weighted level.

- It is also recognised that at the moment more evidence is needed to propose a correction for ground reflection, and that correction is suggested to be avoided because of: (a) the increase in the calculation times; (b) the difficulty to gather input values on ground type and (c) the impact that a fragmented noise contour may have when communicated to the public.

- CNOSSOS-EU is recommended to state that the ground absorption factor may have an influence and that in the transition time, the correction methodology described in the NORTIM software manual could be considered. The conditions when this correction methodology should be appropriately used will be specified in the guidelines of CNOSSOS-EU and implemented in its corresponding software.

- It was suggested this issue to be further investigated and other alternative approaches to be possibly considered as well before any methodology is considered for implementation.

3 After the meeting a different opinion was expressed for this recommendation, that is to remove the notion on considering the NORTIM methodology as interim.
7- Propagation: screening effects and reflection of vertical obstacles

   a. Is there any proof of irrelevance of absorption/reflection on vertical obstacles?

   b. If relevant which formulation and/or correction to adopt?

The presence of vertical reflecting objects close to the receiver may have an effect on noise, positive or negative, for low angles of incidence. As the EC is concerned about the number of exposed persons, these effects should not be neglected. Important reflections from buildings have been observed for helicopter noise but, according to the participants, this is a particular problem and corrections cannot be applied for general mapping. Furthermore, to take into account the buildings would require a fine grid definition, increasing tremendously the computation time. The currently available source data are not in an appropriate format to consider this effect. It would also required detailed information on building heights in the vicinity of airports, information that is not always available. For road and rail noise modelling where the source is at ground level, assumptions on building height were used, but these would not be valid where the aircraft source is often higher than the buildings themselves.

In NORTIM, there is a possibility to introduce a barrier for considering its diffraction effect but not for reflection. The diffraction effect would in most cases reduce, not increase noise levels and thus ignoring diffraction would generally be the more cautious approach.

The following recommendations were made:

⇒ It is recognised that the presence of vertical reflecting objects close to the receiver may have an effect on noise which sometimes can be positive or negative.

⇒ The inclusion of screening/reflections on obstacles would result in much longer calculation times (and is thus impractical to consider) due to a much finer resolution grid and more input data about these obstacles, which is not available in some MS. Therefore it is suggested not to consider these obstacles’ screening and reflection effects in CNOSSOS-EU.

8- Propagation: use of radar track

   a. Shall a description of the inaccuracy introduced by the assumptions on the standard profiles and tracks and the use of limited sub-tracks division be addressed?

   b. If yes, can the use of radar tracks become mandatory?

The participants recognised that using the radar data whenever available should be encouraged as it decreases drastically the inaccuracy which is otherwise introduced by using theoretical tracks.
However, at some small airports radar data is not available or because it would be cost prohibitive to analyse. In such cases this would not affect the noise contours because they only deal with small aircraft and thus the noise contours do not extend sufficiently far from the airport to require the use of radar data. For larger airports that do not use radar data, there are some good guidelines usually referring to typical flight procedures. In addition to this, it was highlighted that radar data only reflect the existing situation and procedures. When using them for strategic noise mapping, constant conditions over time have to be assumed with regard to the infrastructure, the paths and the procedures.

The vertical dispersion of the trajectories is, amongst other factors, linked to the weight of the aircraft. This is considered in the ANP database. Lateral (horizontal) dispersion of the ground tracks may be determined from radar data. In the absence of radar data, ECAC Doc. 29 provides guidance on lateral track dispersion for straight and turning flight tracks. The effects of lateral dispersion on noise contours have been investigated and as a result, a minimum of 7 track dispersion is recommended in ECAC Doc. 29. An investigation performed in France, in a medium size airport (Nantes) was reported: contours with radar data and with estimated and dispersed tracks were compared. The impact on the areas is not important but the shape of the contour changes which can have an effect on the exposed population. The report (in French) can be downloaded at http://www.stac.aviation-civile.gouv.fr/environ/bruit/bruitstac.php.

The participants recommended that ground track dispersion should be used in all cases, and that radar data should be used whenever available in the determination of both mean ground tracks and track dispersion. Guidance should be provided on how to calculate ground dispersion from these radar data. When radar data are not available, then guidance should be provided on the definition of mean ground tracks and dispersed tracks.

The following recommendations were made:

- **The horizontal track dispersion should be addressed in CNOSSOS-EU.**
- **The technique to be used to separate and obtain the sub-tracks will be defined in CNOSSOS-EU, specifying that the radar tracks have primarily to be used, when available.**
- **There is some knowledge on the inaccuracy introduced by the assumptions on the standard tracks dispersion.**
- **Appropriate guidance will be provided by experts of the AIRMOD group on the use of sub-tracks to be introduced in the CNOSSOS-EU together with the associated accuracy.**
9- Comparative presentation of ECAC Doc.29 3rd Ed. and AzB methods (U. Isermann)

U. Isermann presented a comparison between the ECAC Doc.29 3rd Edition and the new German AzB [see Uiserman azb&doc29_JRC-Workshop 19-20 Jan 2010 2.pdf]. He compared the segmentation models, the source models, the propagation models, the ground effect, the definitions of aircraft categories and flight procedures. He concluded that the AzB uses a more detailed acoustical algorithm (spectral calculation, non-generalised directivity) which will give modelling flexibility when its accompanying aircraft noise source database is populated with the relevant information. ECAC Doc.29 provides much more flexibility in generating individual (aircraft-specific) flight paths. The AzB is primarily designed to produce noise contours for future scenarios (hence needing a database structure suitable for air traffic forecasts), whereas ECAC Doc.29 and the large ANP database provides more functionality, e.g. for noise mitigation studies or studies on the effect of noise abatement flight procedures and operating restrictions (c.f. Directive 2002/30/EC). AzB additionally covers military and general aviation as well as helicopters and parts of ground operations. However, it only considers a limited number of groups of aircraft, whereas ECAC Doc. 29 contains a large number of individual airframe/engine combinations, via its associated ANP database. In principle, both models are easily extensible (AzB with respect to operational aspects, ECAC Doc.29 with respect to other fields of application).

A project is currently launched in Germany to combine the AzB, the current DIN standard and the ECAC Doc29 3rd Edition to give a final German standard (DIN 45689) in 4 to 5 years from now.

Wednesday 20th January 2010 (09:00 – 17:00)

10-Source: Noise Emission databases

a. Data verification and validation (V&V) process applied to the ANP datasets provided by the manufacturers (L. Cavadini)

L. Cavadini presented the ANP database [LCavadini_ANP_V&V_JRC-Workshop 19-20 January 2010.pdf]. This database provides the noise and performance characteristics of individual aircraft types. Noise data is provided in the form of tabulated NPD (Noise Power Distance) and spectral classes (spectral shapes for groups of aircraft). ANP data is processed and supplied by aircraft manufacturers, following specific ANP guidelines.

A verification and validation (V&V) process is systematically performed on new manufacturer submissions, which is mostly an internal check of consistency. The main steps are detailed below:

- 1st step is the V&V of NPD data by comparison of manufacturer supplied NPD data with data reprocessed with the simplified correction method from ICAO Annex 16 Volume I.
- 2nd step is the assignment of the spectral class to the new aircraft entry, using the individual spectra provided by the aircraft manufacturer as reference data. Comparisons are made on
different frequency-dependent effects (atmospheric absorption, ground effect and barrier effect) between using the spectral shapes and the individual spectra.

- 3rd step is the V&V of aircraft performance data by comparing with prior data from the manufacturer or data from other similar aircraft types.

- 4th step is the comparison with certification data.

**Discussion**

S. Arrowsmith recognised that the ICAO ANP database should be the starting point as it is very detailed, has the support from the industry, and there is a huge effort in making the data available to modellers. It was debated on how tight the spectral class should be defined, including criteria on initiating a new spectral class.

There are specific technical issues identified where improvements could be made. However, these require comprehensive long-term research efforts. Furthermore, improvements of the process should be made at an international level.

Updates of the ANP database with new entries are made by EUROCONTROL (for Airbus data) and Volpe (for Boeing and North American manufacturers’ data). So far, only Volpe has performed the V&V process for the final acceptance of the data. Europe would like to be more involved in this V&V process (need for international peer review) and see the process becoming more robust. There is space to improve this process on a global basis.

The next version of ANP, initially due before the end of December 2009, is expected to be published in February 2010⁴.

The potential for ageing and/or engine deterioration to affect an aircraft’s noise characteristics was discussed. It was noted that deterioration effects have been studied in terms of engine emissions where deterioration was found to be limited due to strict maintenance schedules governed by safety requirements. It was noted that noise certification tests are conducted towards the end of the airworthiness certification process and therefore more closely relate to an in-service aeroplane than a completely new one. In addition, it was also mentioned that no possibility exists to “tune” or temporarily modify the engine performance prior to noise certification demonstration.

Discussions to improve the process of data collection could be stimulated at a European level by stating that the input data is a critical element of a common noise assessment methodology. This would require an additional legal basis. Ultimately improvements would only be achieved through additional funding and resources being made available.

For other transportation sources, it was noted that certification tests also exist and are needed to check compliance with legal requirements but these data are not used for noise predictions for which independent measurements are made. Part of the reason for this is that for example with road noise, the costs of conducting additional independent controlled noise measurements are significantly lower than comparable tests would for aircraft. In addition, for aircraft noise, the certification tests are much more complex, with many situations, speeds, power settings, etc. These data are the best available at a reasonable cost. They contain aircraft performance data that is critical for noise prediction. The same

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⁴ Postponed after the meeting to the Summer 2010
procedure as for road and rail noise has been performed in the past, measuring thousands of noise levels but the results were only statistics and were not transposable to other situations, because no information on the source emission was available. The performance data is far more important for aircraft noise prediction than for the other noise sources, because it relates to both source emission, but also the physical location of the aircraft source.

b. Comparison between noise measurements and noise calculations (A. Malige)

A. Malige presented comparisons between noise measurements performed at monitoring stations of several main airports in France with noise predictions [AMalige_measuresVScalculation_JRC-Workshop_19-20_Jan_2010.pdf]. The presentation considered only noise measurements directly under the flight path, in order to exclude the effects of lateral attenuation. This is common practice since measurements obtained at low elevation angles are subject to significantly greater uncertainty due to the effects of ground surface elevation and type (as already noted) and the longer propagation distances involved generally result in greater variability due to refraction and scattering effects. For each movement, aircraft and engine type were known but aircraft speed/configuration/thrust engine were unknown. A fair agreement between measurements and calculation was observed, for take-off and for approach conditions. It was concluded that comparisons between measurements and calculations are useful to check a posteriori calculation results for the most common aircraft/engine types at specific locations, but also to detect specific issues, and select relevant departure profiles.


D. Rhodes presented the current status of the validation guide (Volume 3) of ECAC Doc.29 3rd Edition [DRhodes_Validation_JRC-Workshop_19-20_Jan_2010.pdf]. Volume 2 gives the best practice methodology. Volume 3 is not intended as a validation of Volume 2, but intends to provide guidance on the validation of modelling results against measurements. It can be considered as a “good practice guidelines” document for the determination of high quality measurements. It was stressed that the uncertainty associated with noise measurements is often greater than for the model output. These measurements are important, and could be used, if necessary, to derive corrections for local effects.

There is a lack of validation results in the literature because full scale measurements are very complex, a lot of parameters need to be measured and most of the results can not be published because of sensitive Flight Data Records. It was emphasized that all critical points in Volume 2 were validated over the last decades. There are still issues of lower concern for which validation is missing and work is ongoing to tackle these: reverse thrust noise and start of takeoff roll directivity.

However, in the examples presented, differences between measurements and predictions occur that could be attributed to particular aircraft variants or specific local effects. It was concluded that, in some places, local adjustments are still needed.

It was noted that one part of the validation process is to check that the model is correctly implemented in the software (software verification). ECAC Doc.29 is a recommendation and there is a some degree
of freedom for its implementation in software – Vol.2 was never intended as a programmer’s manual. However, benchmarking between two models developed from ECAC Doc. 29 Vol. 2 showed differences of about 0.2 dB. Other software that claim to accord with either ECAC Doc. 29 2nd edition or 3rd edition have in most cases not been independently verified.

S. Kephalopoulos announced that EC intends to provide a core reference software implementing CNOSSOS-EU. It will be a public transparent code and a certification procedure will be established to allow for the commercial use of this core software. For this purpose, it is proposed to setup a committee which will be in charge of updating and validating aspects of CNOSSOS-EU and its software implementation over time. The intention is to setup the CNOSSOS-EU reference software with the assistance of existing commercial software developers.

The participants pointed out that the development of this reference CNOSSOS-EU software seems ambitious with respect to the deadlines presented. However, they mentioned that for aircraft noise, an existing model called “STAPES” is already available. It was developed by European Commission, EASA and EUROCONTROL within a joint European project. Further efforts should concentrate on developing a more user-friendly version of STAPES in order to facilitate its use by the EU MS. As far as the aircraft module of CNOSSOS-EU is concerned, this could be based on the STAPES software.

The following recommendations were made:

- **EC is interested in assessing noise in residential areas and supports the definition of accurate guidelines that can allow for validation of predictions in such areas.**
- **For such validations, a common process for the collection and processing of noise measurements should be defined and agreed.**
- **More comparisons between measurements and calculations should be produced and published.**

### 11-Source: Light aircraft and helicopters

It is suggested that light aircraft and helicopters should be studied separately. Some light aircraft are already included in the ANP database (essentially US aircraft types) and are used for noise maps of small airports. In the short term, substitution rules could be proposed for missing small aircraft. Also German data are provided by the DIN45684 standard for small airfields that could be introduced in CNOSSOS-EU. Small aircraft are often difficult to model as their procedures are less well defined resulting in a wider distribution of flight tracks and greater variation in flight procedures and profiles. At major airports, the noise contribution from these aircraft can be neglected.

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5 STAPES (SysTem for AirPort noise Exposure Studies), project no. TREN/05/ST/F2/36- 2/2007-3/S07.77778, Draft Final Report, 2009, EUROCONTROL
For helicopters, a separate model is necessary. The manufacturers spent millions of euros to develop an appropriate model, called HELENA, within the Friendcopter EU project. However, it is not ready to be considered for CNOSSOS-EU as it has a limited database at present. N. van Oosten presented some outcomes of the project, showing a comparison between INM and Helena and measurements [NvanOosten_Rotorcraft_noise_model_JRC-Workshop_19-20_Jan_2010.pdf]. The asymmetric behaviour was highlighted.

The German AzB model accommodates helicopters, but their inclusion results in almost no effect on contours at major German civil airports. It was stated that the effect of helicopters on airport noise at civil commercial airports is very small. The problem of heliports in agglomerations is probably of greater importance. In this case, high building surroundings have to be taken into account. The question of relevance of heliports could be asked to the EU MS.

The following recommendations were made:

✦ It should be checked whether the light aircraft in DIN 45684 can complement the ANP with EU types of light aircraft.
✦ For other missing aircraft types, substitution rules have to be provided in the CNOSSOS-EU guidelines.
✦ As was shown by past EU projects, a separate model is required for helicopter noise based on completely different asymmetric principles. There is at the moment an alternative method (HELENA) with a limited database which is under development, hence not yet mature to be taken on board by CNOSSOS-EU.
✦ Provisionally, helicopters can be included as symmetric sources (like fixed wing aircraft) although this will introduce an error which might be significant depending on the specific situation. EU MS should be consulted on this issue.

12-Source: Directivity of aircraft: formulation to adopt

The following recommendation was made:

✦ The formulation in ECAC Doc.29, 3rd Edition should be considered in CNOSSOS-EU as it is.
13- Source: ground operations

a. Should it be taken into account?

b. If yes, is it possible to introduce AzB data in ECAC Doc29?

According to some of the participants, ground operations are considered in existing methods for political reasons but their inclusion has little effect on the contours, as in general, ground noise is much lower than air noise. Take-off roll and landing roll noise are excluded from ground operations as they are considered as part of “air” noise. In AzB 2008, taxiing and use of Auxiliary Power Units (APU) are defined as ground operations. Run-ups are not included.

In the UK, ground noise is part of action plans but is not considered for mapping. In the Netherlands, ground noise is considered as industrial noise and should be modelled only in cities. In most cases, airports are away from urban areas and, in practice, ground operations are never taken into account.

M. Paviotti suggested that this specific situation will be treated as industrial noise: the sound power will be taken from a specific database (i.e., INM/ANP), but the calculation scheme will be based on the HARMONOISE method.

As the development of a good database would require a significant research effort, it was also proposed that the question whether to consider ground noise or not should be discussed and decided upon with the EU MS.

The following recommendations were made:

⇒ From a technical point of view, noise from ground operations could be treated as industrial noise.

⇒ During the revision of the END, the EC will consult the EU MS to discuss whether and how ground operations should be included in CNOSSOS-EU.

⇒ Taxiing should be excluded from ground operations for strategic noise mapping since it is of marginal effect, but could be included as part of the aircraft ground operations for assessing specific effectiveness of action plans around airports.

14- Conclusions and Recommendations of the Workshop

The conclusions and recommendations were reviewed on the basis of the Table 1 in the “Background memo” provided before the meeting and updated during the meeting (see annex document).
The European Commission and EASA both recognise that worldwide resources to develop and maintain aircraft noise modelling tools are limited and as such it is critical to increase synergies among the stakeholders affected and maximise commonality of the methodology and input data. It is also important to equally recognise the complexity and effort expended in addressing specific issues needs to be proportionate to effect, i.e. population exposed.

Recommendations regarding the aircraft prediction methodology:

- **ECAC Doc. 29 3rd Edition** should be used as the basis when discussing the CNOSSOS-EU.

- **ECAC Doc. 29 3rd Edition** will be adopted as the common method for strategic noise maps of aircraft noise in EU (i.e. the aircraft module of CNOSSOS-EU), and a process will be put in place to consider proposed modifications/amendments of ECAC Doc. 29 3rd Ed.

- **European Commission** will take ownership and oversight of any process for maintaining, developing (including the software implementation) and disseminating the CNOSSOS-EU. It is strongly desirable to reach agreement at international level which could best be achieved through the ICAO environmental committee, CAEP, and involve all relevant European stakeholders (DG ENV, DG TREN, DG JRC, EU MS, EASA, EEA) associated to the implementation of the END.

- **A provision to permit modellers to use the updated versions of the CNOSSOS-EU including the aircraft noise module should be proposed if published in between any reviews of the END (e.g. Adaptation to Technical Progress process to be included in the review of the END).**

Recommendation regarding the database:

- **The ICAO ANP Database** is currently the best candidate for achieving a global consensus on an aircraft noise and performance input database.

- **However, standardisation on a transparent, comprehensive and accurate source of input data** would result in significant benefits in the quality of airport noise contour modelling.

- **Standardisation should ensure an exact same aircraft configuration and operation would produce consistent predicted noise impacts across all EU Member States, unless local adjustments are justified.**

- **A robust validation process of ANP data should be formalized at the ICAO level. In particular, significant improvements are required in the approval**
process for aircraft noise and performance data to ensure high quality model input, and to avoid potential discrimination between aircraft manufacturers.

Due to the international nature of the aviation industry, all data should be reviewed and approved against an agreed set of international requirements. This could build on existing European (EASA) - US (FAA) approval processes, such as that for aircraft noise certification, in order to benefit from significant synergies.

Some specific types of aircraft should be included. Ground operations should also be included, presumably by using the “industrial noise” module of CNOSSOS-EU.

An international agreement could best be achieved through the ICAO environmental committee, CAEP, and would involve all relevant stakeholders including the DG ENV, DG TREN, DG JRC, EASA and Member States.

Transition issues for Member States should also be taken into account in moving towards a common noise modelling methodology/database. As such, proposed future plans should be communicated as soon as possible.

Regarding the future of ECAC doc. 29 3rd Ed., Vol. 3:

Guidelines should be given on how experimental data, collected at a particular airport, can be used to build, complete and validate the source data base (ANP) included with the method.

It was suggested that Volume 3 under preparation should consider the recommendations made by the CNOSSOS-EU experts. However, the development of Volume 3 is a long process and the document will not be available when CNOSSOS-EU will be issued.

It was agreed that, the CNOSSOS-EU chapter related to aircraft noise will make an explicit reference to ECAC Doc.29, 3rd Edition. There is actually no need to copy/paste the ECAC Doc.29 document. EC is open to use internationally well established documents, and is willing to take part in international bodies in order to contribute to the decision process related to the aircraft noise assessment.

Next AIRMOD meeting is planned in March 2010 in Cologne, to be hosted by EASA. JRC will be invited to join and will be welcomed to present the outcome of this workshop: conclusions, decisions and a clear view on what could be the next issues for AIRMOD to work on, in order to support DG ENV for END purposes.

6 Postponed after the Workshop at a later date not yet decided
The participants were thanked for their active contribution and the meeting was closed at 17:00

Attached documents

- **Annex1**: Background Memo prepared by JRC
  (Ann1_background-memo_JRC-Workshop_19-20_Jan_2010.pdf)

- **Annex2**: Set of presentations made during the workshop:
  BGergely_END_JRC-Workshop_19-20_Jan_2010.pdf
  SKephalopoulos_roadmap_CNOSSOS-EU_JRC-Workshop_19-20_Jan_2010.pdf
  MPaviotti_Airports_in_EU_JRC-Workshop_19-20_Jan_2010.pdf
  Ulsermann_azb&doc29_JRC-Workshop_19-20_Jan_2010.pdf
  LCavadini_ANP_V&V_JRC-Workshop_19-20_January_2010.pdf
  AMalige_measuresVScalculation_JRC-Workshop_19-20_Jan_2010.pdf
  DRhodes_Air&Ground_Noise_JRC-Workshop_19-20_Jan_2010.pdf
  DRhodes_Validation_JRC-Workshop_19-20_Jan_2010.pdf
  NvanOosten_Rotorcraft_noise_model_JRC-Workshop_19-20_Jan_2010.pdf