Nationaal Lucht- en Ruimtevaartlaboratorium
National Aerospace Laboratory NLR

NLR-TP-2001-318

Feasibility of coupling of an Airport capacity model to Airport noise model

L. Montrone, J.F.M. Wubben, A.J.C. Roeloffs and P. Vogel

This report is based on an article to be published in occasion of "The 2001 International Congress and Exhibition on Noise Control Engineering", The Hague, The Netherlands, 27-30 August 2001.

Division:	Air Transport
Issued:	July 2001
Classification of title:	Unclassified

Summary

This Technical Paper is based on a study developed as a co-operation between the Department of Transport and Environmental Studies (Lt) and the Airports Department (La) of the National Aerospace Laboratory NLR.

The study performed has been focused on the connection of the TAAM (Total Airport and Airspace Modeller) system, used for Airport capacity and punctuality studies, with two different noise models - INM (Integrated Noise Model) and the legal Dutch ENVIRA Model. This research was meant to be an effective answer to the constantly increasing demand from Amsterdam Airport Schiphol (AAS) and governmental policy makers for an integrated Airport analysis concept, including environmental and capacity issues. Moreover, anticipating the European standardisation in Airport noise models, the desire exited to compare the present Dutch noise model with the INM model.
First step in this research has been the realisation of the coupling between the TAAM model and both noise models. Then, noise calculations are performed with both noise models using the same input data. Finally, the L_{den} noise contours are compared and analysed.

The following paper provides a description of the coupling process developed and the presentation and analysis of the final results.

Contents

(9 pages in total)

The 2001 International Congress and Exhibition on Noise Control Engineering
The Hague, The Netherlands, 27-30 August 2001

Feasibility of coupling of an Airport capacity model to Airport noise models

L. Montrone, F.J.M. Wubben, A.J.C. Roeloffs, P. Vogel
National Aerospace Laboratory NLR – P.O. Box 90502 – 1006 BM – Amsterdam -The Netherlands

Abstract

In the last few years the demand from Amsterdam Airport Schiphol (AAS) and governmental policy makers for an integrated Airport analysis concept (including environmental and capacity issues) is constantly increasing in order to fulfil future strategically decision making. Therefore the NLR has founded the "Airport Scenario and Analysis Package" (ASAP). One of the work packages of ASAP is a study connecting the fast time simulation modeller TAAM (used for Airport capacity and punctuality studies) with two different noise models (the legal Dutch ENVIRA model and the US INM -Integrated Noise Model). Anticipating the European standardisation in airport noise models, the desire exists to compare the present Dutch noise model with the INM model. First step in this research has been the realisation of the coupling between the TAAM model and both noise models. Then, noise calculations are performed with both noise models using the same input data. Finally, the L_{den} noise contours are compared and analysed.
The paper provides a description of the coupling process developed and the presentation and analysis of the final results.

1 Introduction

Will it be possible, for Amsterdam Airport Schiphol (AAS), to grow any further in the future years? How will this growth be implemented in relation with the population and the environment? Those are important questions to which all the big Airports in the world need to find an answer. That is the reason why the "Airport Scenario and Analysis Package" (ASAP) has been ideated. This package enables an integrated Airport analysis including environmental issues (noise and emissions), capacity and punctuality issues and safety issues. One of the activities in this ASAP context is a study connecting the fast time simulation modeller TAAM (for Airport capacity and punctuality studies) with two different noise models, the legal Dutch ENVIRA model and the US INM. This coupling is desired for quick scan noise impact studies related with capacity and punctuality studies. Besides, anticipating the future standardisation of the European Airport noise models, the desire exists to compare the present Dutch noise model with the INM model for the Lden noise exposure descriptor. First step in this research was the realisation of the coupling between TAAM and both noise models. Then, noise calculations have been performed with both noise models based on the input data for Amsterdam Airport Schiphol. Finally, L_{den} noise contours are compared and analysed.

2 Conversion processes

This chapter provides a general description of the conversion processes implemented to import data from TAAM to INM and ENVIRA. In Figure 1 an overview of the information flow is given.

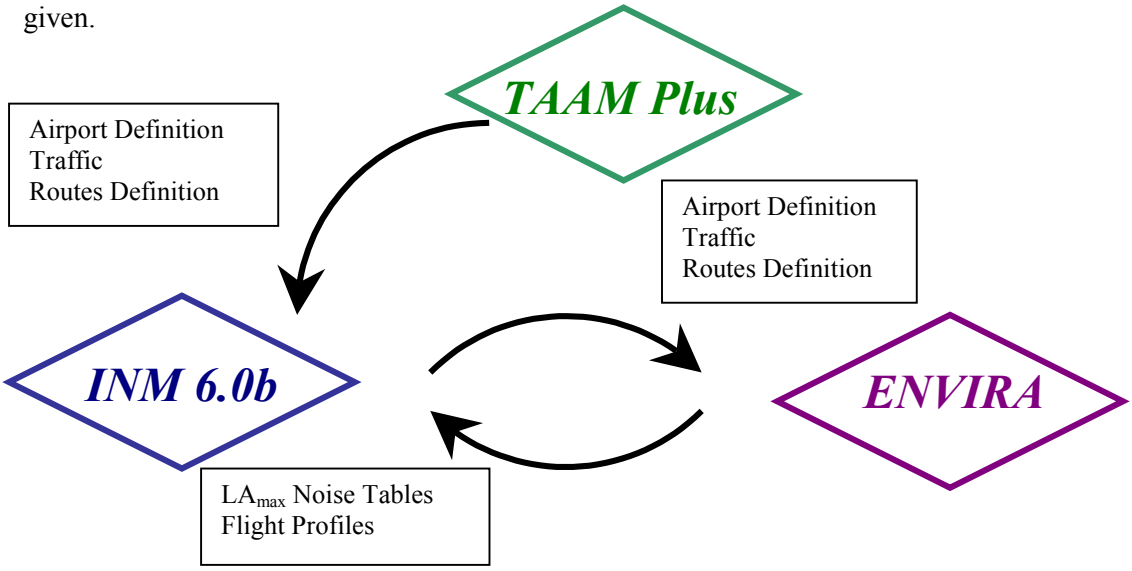

Figure 1 - Applied information Flow to connect TAAM, INM and ENVIRA

Although the TAAM system has an INM connection tool, in practice problems occurred. Therefore NLR decided to develop an external TAAM – INM converter [1,2]. The generation of unknown aircraft types, caused by differences in the aircraft definition list applied by the two systems, has been solved creating a new link between the two lists. A wrong designation of 'aircraft stages' (influencing the departure procedures) has been solved developing a new link between the distance category definition of the two systems. A wrong conversion of departure routes occurred (caused by the SID's definition in TAAM) and the Preston Group is working on a solution to solve this problem. A special algorithm has been developed in order to determine dispersible point tracks of both departures and arrivals. With the existing TAAM-INM connection tool dispersible arrivals and vector, not dispersible departures were only possible. The INM to ENVIRA conversion involves transfer of information concerning Airport Definition, the Traffic and the Routes Definition originating from TAAM. For the LA_{max} Noise Tables and Flight Profiles, both INM and ENVIRA use the original ENVIRA information [1,3, 4].

3 Simulation case and main differences ENVIRA-INM

The following step in the research was to run Lden noise calculations both in INM and ENVIRA, on the base of the previously described information flow. Figure 2 shows an overview of the calculation data set. Figure 3 shows the routes, which were used in the forecast scenario. By using exactly the same input data for both noise models, differences in results can only be due to differences in the algorithms of both models.

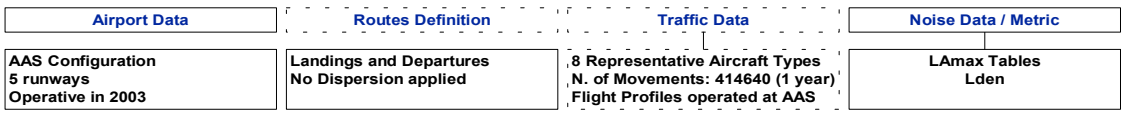

Figure 2 - Calculation data set

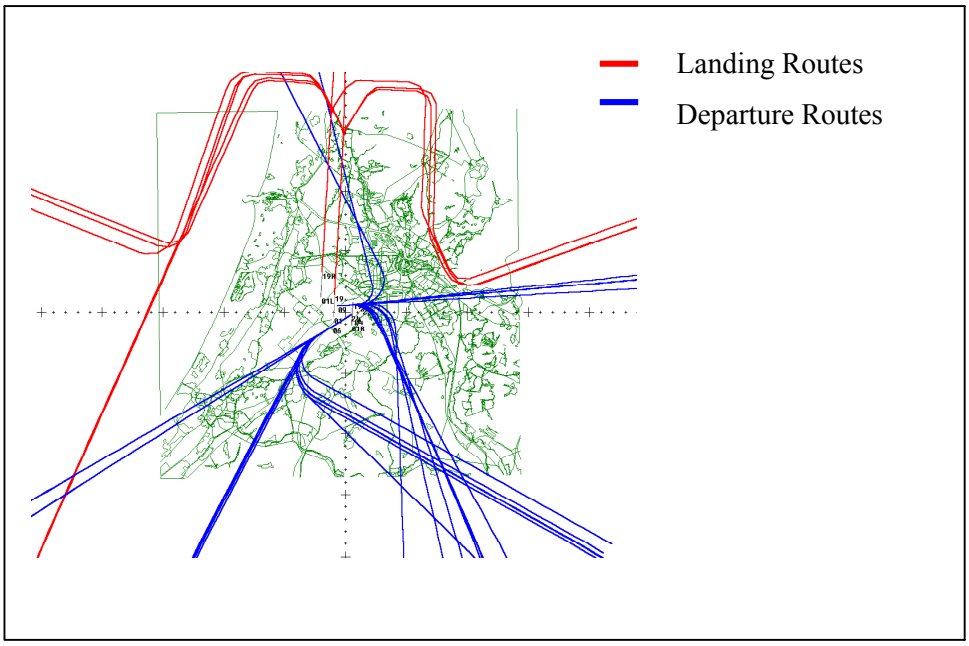

Figure 3 - Applied routes

The formula used for the Lden calculation, equation (1) below, is the same for both models:

$$(1)\ Lden = 10 \times \log_{10} \frac{1}{T}\left(\sum_{i=1}^{N} g(i) \times 10^{\frac{SEL_{tot}\,i}{10}} \right) - 75\ ;$$

T	reference time period
i	index denoting the i-th aircraft movement
N	number of movements in the reference period
g(i)	weighting factor for the i-th aircraft movement

The INM model is a segmentation model, which is based on given SEL values for infinite segments. In order to end up with appropriate input data, INM calculates SEL noise tables from LAmax noise tables with the following regression relation [1]:

$$(2)\ SEL_{tot\,i} = \sum_{m=1}^{M} \left[LA\max + 7.19 + 7.73 * \log_{10}\left(\frac{D_m}{1000} \right) \right];$$

D_m	distance, at track segment m, to the i-th airplane
M	total number of track segments

ENVIRA however is a simulation model, which calculates instantaneous noise immission levels versus time, by simulation of the flight using LAmax noise tables. The SEL value is calculated by subsequent integration of the instantaneous noise levels over time as given in equation 3 [3]:

$$(3)\ SEL_{tot\,i} = 10 * \log_{10}\left(\frac{1}{\tau} * \int 10^{\frac{LA\max}{10}}\, dt \right);$$

τ	reference time of 1 second

Another important difference between both models is the lateral attenuation correction. For INM the lateral attenuation of SAE AIR 1751 [5] is used while ENVIRA is based on SAE AIR 923 [6].

4 Results

Figure 4 and Figure 5 are showing the Lden calculated values in INM and ENVIRA. As expected, some differences are visible comparing the two graphics. Most of those differences can be explained by the different way of calculating the SEL values from the LA_{max} values. Part of them can be related with the different lateral attenuation model applied in the two systems.

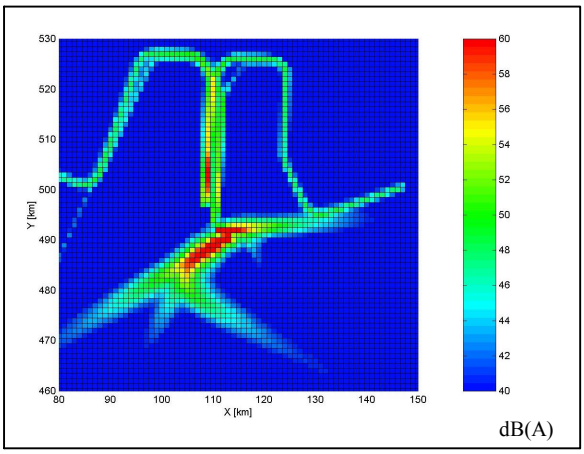

Figure 4 - Lden calculation in INM

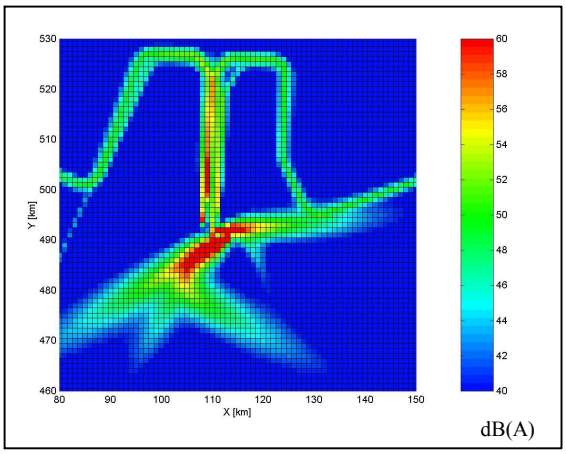

Figure 5 - Lden calculation in ENVIRA

5 Conclusions and Future Work

By development of external conversion tools, NLR has the disposal of a quick link between the TAAM system and two noise models for quick scan studies. The considerend noise models were the legal Dutch ENVIRA model and the US INM. The information flow applied in this research permit to have noise Lden calculations in ENVIRA and INM on the base of the same input data.

Results from noise calculations based on the same input data show differences between the results of the two models, which will be analysed in more detail in the near future.

References

1. G.G. Fleming, J.M. Gulding and others, “INM6.0 User’s Guide”, Journal, 1999
2. The Preston Group, “TAAM Plus Reference Manual”, Journal, 11-295 Version 1
3. Ministry of Transport, Public Works and Water Management, Ministry of Defence and Ministry of Housing, Spatial Planning and the Environment, “Regulations for the calculation of the Laeq noise exposure in dB(A) caused by structurally performed aircraft night movements”, Journal, 2000 (in Dutch only)
4. R. de Jong and F.J.M. Wubben, “Appendixes of the regulations for the calculation of noise exposure, version 5”, Journal, 1999 (in Dutch only)
5. “Prediction method for lateral attenuation of airplane noise during takeoff and landing”, SAE AIR 1751, February 1991
6. “Method for calculating the attenuation of aircraft ground to ground noise propagation during take-off and landing”, SAE AIR 923, August 1966