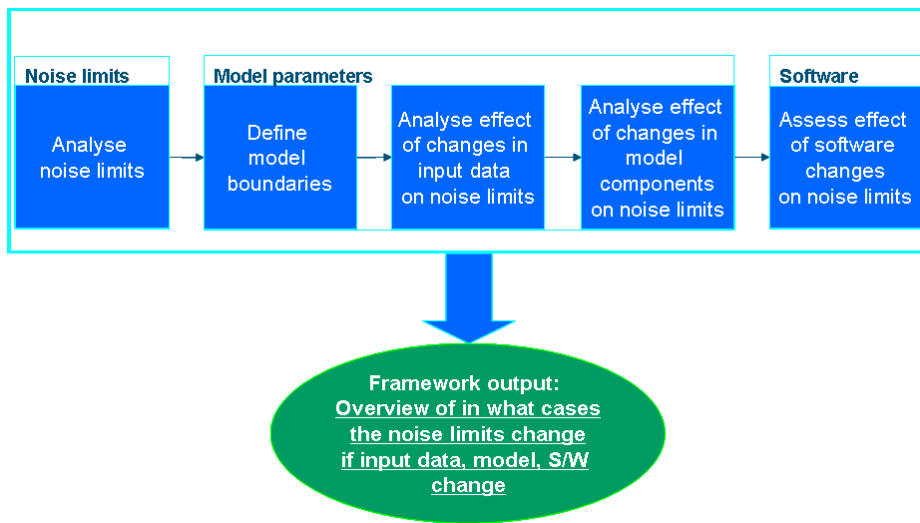




Executive summary

To update or not to update noise limits, that is the question



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Author(s)
A.M. Kruger-Dokter
A.B. Dolderman

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In many countries, airport noise or land use planning policy is supported by noise limits or contours. Should these limits or contours be changed – and if so, how – when a different (noise) modelling method or updated noise calculation data become available or are prescribed? This paper tries to formulate an answer to this question. NLR conducted research to formulate a method with several possible approaches to change noise limits in these situations.

Description of work

The research was triggered by recent changes in noise limits in the

Netherlands. NLR considered these specific changes - how were these limits updated and what was the reasoning behind it? From that starting point, NLR formulated a more general method that can be applied in different or future situations to update noise limits in a structured and transparent way. The method describes how to create an overview of a noise model. First the type of noise limit involved is characterised. A next step is to list all input data and modelling components of the model. Based on this information, choices can be made on when and how to update the limits (or contours)

This report is based on a paper presented at Internoise 2011, Osaka, Japan, September 4-7, 2011.

Results and conclusions

In most cases, when the modelling components change, the noise limits should also be changed. When the input data change, the type of noise limit determines whether it can stay as-is or it needs to be changed as well. However, the split between model and input is not always easily made and political or other motives can lead to different approaches. The NLR study offers suggestions how to deal with this.

Applicability

This paper presents an overview of possible approaches to update noise models or noise limits in a

structured and transparent way. This paper does not go into detail for the Dutch situation or prescribe which approach should be followed in the Netherlands. An important recommendation of this study is to reach consensus on how the limits should be interpreted – preferably when they are set for the first time. This prevents discussions about whether the limits should be seen as fixed numbers (values containing an intrinsic value, never to be changed) or as outcomes of calculations based on a selected scenario.



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The contents of this report may be cited on condition that full credit is given to NLR and the authors.

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1 INTRODUCTION

Most countries have airport noise or land use planning policies in place to protect their citizens from aircraft noise. These policies often use maximum noise (annoyance) levels or contours indicating where aircraft noise occurs. In many cases, these values or zones are calculated based on a certain scenario that represents planned airport operations in terms of number of flights, operational concept, routes, flight schedule, etc. This scenario is fed into a noise model to calculate the noise output expressed in either noise (annoyance) levels or contours. These outcomes of the calculations are then set as noise limits or noise zones. Analysis of the actual traffic that occurred shows whether the actual noise levels are in line with the limits or zones calculated with the forecast scenario. If large differences occur, the limits or zones on which the policy is based, and with them the policy itself may have to be updated.

In the Netherlands specifically, maximum noise levels are enforced on a yearly basis. This is done by comparing the legal maximum levels to the actual levels as calculated by feeding actual air traffic into the noise model. This comparison is documented and published every year.

When trying to answer the question in what situations noise limits and zones could or should be changed and how this should be done, NLR first encountered another question, namely: what type of noise limits or zones are we talking about and with what purpose in mind have they been defined? Part of this first question can easily be answered in a technical manner; another part may be subject to political considerations.

Earlier, NLR conducted research in the area of changing noise limits [Ref. 1], which was focused on a set of Dutch noise criteria. The current paper proposes a more general, standard process framework for a broader range of limits and a broader range of model parameter changes (input, model, software). The purpose of the framework is to be able to update noise limits in a way that is as transparent and reproducible as possible. The paper focuses on the technical aspects but acknowledges in a short chapter the existence and relevance of political and societal influences.

NLR realises that every potential change of noise limits requires detailed knowledge of the noise model, input data and political context concerned. However, the framework described in this paper may provide useful insight and a structure to define the work to be done. NLR is looking forward to discuss specific situations to possibly extend or improve the framework.

2 PROBLEM ANALYSIS

This chapter starts out with an example for illustration purposes: the specific case of the update of noise criteria in the Netherlands in 2007 (section 2.1). This update triggered the NLR research meant to set up a standard method for a broader range of noise limits and possible changes. This broader range defines the scope of the research undertaken by NLR and is described in section 2.2.

2.1 Trigger for this research: change of criteria in the Netherlands

In the Netherlands in 2007 a set of model parameters were changed in the noise model used for enforcement of aircraft noise around Schiphol airport. Noise limits were updated accordingly [Ref. 2]. The following changes in model parameters were considered:

1. New noise limit metric;
2. New manner to model lateral spreading of routes;
3. Updated population database;
4. Updated dose-response relationships.

First, the noise metric in which the noise limits were expressed, the Dutch noise metric K_e (Kosten unit), was changed to the internationally used L_{den} (for the 24-hour day period). For the night period metric a similar transition took place (from L_{Aeq} to L_{night}). The L_{den} value can not directly be derived from the K_e value, due to the fact that the L_{den} is based on equivalent noise levels and the K_e is based on maximum noise levels. Secondly, the modelling of lateral spreading of routes was changed from using a standard distribution around modelled routes to using a so-called hybrid modelling approach. The hybrid modelling approach uses radar tracks when available to model lateral spreading. Thirdly, the population database with locations of dwellings and inhabitants around Schiphol airport was updated to include new residential areas and population data. Fourthly, the dose-response relationships were updated based on the results of new surveys with people living in the vicinity of Amsterdam Airport Schiphol.

The noise limits to be updated in 2007 are important criteria in the Netherlands, the so-called ‘criteria of equivalent protection’ (“criteria voor gelijkwaardige bescherming”), from which the enforcement noise limits (“grenswaarden”) around Schiphol airport are derived. The criteria set maximum values for:

- Number of dwellings within the 58 dB(A) L_{den} contour;
- Number of severely annoyed people within the 48 dB(A) L_{den} contour;
- Number of dwellings within the 48 dB(A) L_{night} contour;
- Number of people severely disturbed in their sleep within the 40 dB(A) L_{night} contour;
- Number of dwellings within the $1 \cdot 10^{-6}$ third party risk contour (as this criterion considers third party risk and not noise, it is not addressed any further in this paper).

The scenario that was used to set these criteria was reused in 2007 to recalculate the criteria with the new information (metric, model component, population database and dose-response relationship). In the Netherlands, an important distinction is made between the different kinds of noise limits. The criteria described above are not enforced themselves, but used to set the noise limits for enforcement around Schiphol airport. The enforcement noise limits are local noise limits in so-called enforcement points (“handhavingpunten”, 35 points for L_{den} and 25 points for L_{night}) around Schiphol airport. These noise limits are set by law and based on a specific scenario (“grenswaardenscenario”) that is investigated in an environmental impact assessment. One of the most important aspects to be addressed in such a study is whether the investigated scenario meets the criteria of equivalent protection. In other words, if the airport foresees that for instance a different operational concept will result in exceeding one or more of the enforcement noise limits, it can initiate an environmental impact

assessment. This environmental impact assessment would then investigate whether a scenario that combines the new operational concept with the foreseen number of flights, aircraft types, etc. is able to meet the criteria of equivalent protection. If the scenario does meet the criteria, the L_{den} and L_{night} noise values in the enforcement points for this scenario become the new enforcement noise limits.

This highlights the essential concept of the use of different types of noise limits with their own purpose and updating procedures. The criteria of equivalent protection are not meant to change when the operational concept (or other reality based input data) changes. The enforcement noise limits can be changed when something in reality changes, be it by a detailed, careful procedure resulting in new legislation. If the model or a model component changes, both criteria and limits need to be updated.

2.2 Broadening the scope of the research

The situation and updating process as described in section 2.1 were the scope of previous NLR research [Ref. 1]. When trying to formulate a standard framework to update noise limits with a broader and more general scope, the following questions came up as relevant:

- What happens when other types of noise limits are used?
- What happens when other model parameters (e.g. input data or model components) are changed?
- What happens in case of software changes?
- What happens when an entire model is replaced?

2.2.1 Other types of noise limits

The Dutch criteria for equivalent protection are quite specific and have a specific use. In order for the framework to be more general, other types of noise limits and also noise zones should be considered. The framework should therefore also be able to work for other noise limits and zones.

2.2.2 Other changes in model parameters

With model parameters, NLR means input data (e.g. number of air traffic movements) or model components (e.g. the way routes are modelled). The changes in input data and model component described in section 2.1 are not the only changes possible. The framework should facilitate documentation of and give guidelines for changes in other input data and model components as well. Also, in order to know what a relevant model parameter change is, it is important to know the boundaries of the model. Therefore the framework will first require the definition of the boundaries of the model in scope and will facilitate documentation of all relevant model parameter changes.

2.2.3 Software changes

Before an aircraft noise model, in essence a set of algorithms, can be put to use, it needs to be implemented in software. Software can be used to set noise limits, to calculate noise levels that actually occurred and to calculate noise levels for prognosis scenarios. It is possible that in a country several different (commercial) software products are used to perform part or all of these tasks.

A new software version can include amongst others the addition or improvement of functionality, bug fixes or a change to the calculation core. After any software update, it is essential that it is thoroughly tested before it is put to use. Not only the areas impacted by the change but also the software as a whole should be (regression) tested. In addition, existing noise limits calculated with the previous version of the updated software might have to be updated as well. Software changes are therefore also taken into account in this research.

2.2.4 Replacement of an entire (aircraft noise) model

The European directive 2002/49/EC is currently in the process of being updated such that it prescribes specific noise models for all noise sources in scope. Its objective is to protect European citizens from community noise by mandating the member states to produce noise maps and action plans every five years, using harmonised noise calculation methods. For aircraft noise the ECAC/CEAC Doc.29 3rd edition will be prescribed for the next round of noise mapping in 2017. For the enforcement of aircraft noise at Schiphol airport in the Netherlands, a different national model is currently used [Ref. 3-4]. The Dutch Ministry of Infrastructure and Environment aims to also use Doc.29 for the enforcement of airport noise at Schiphol in the future, although it will be prescribed by the European Commission only in the context of the directive. This means that both the criteria of equivalent protection and the enforcement noise limits will have to be updated using the new calculation model. As the replacement of the aircraft noise model therefore becomes a probable reality in the near future in the Netherlands, it was also included in the scope of this research.

2.2.5 Scope of this research

Combining the scope of the previous NLR research [Ref. 1] and the considerations in sections 2.2.1 upto 2.2.4, the scope of this research (and the structure of the suggested framework) is:

1. Analysis of the noise limits;
2. Analysis of the effect of changes in model parameters:
 - a. Definition of model boundaries (what is in and what is out of scope);
 - b. Analysis of the effect of changes in input parameters;
 - c. Analysis of the effect of changes in model components or replacement of the entire model;
3. Assessment of the effect of software changes.

Besides this technical scope description, the scope of this research is also limited to the technical aspects of the question when noise limits should be updated. Political and societal aspects play an important role in this process as well, but these have not been researched in detail. However, their existence and relevance are addressed in a short chapter (5).

3 FRAMEWORK

This chapter describes the different components of the standard framework to update noise limits. Chapter 4 takes two types of noise limits used in the Netherlands (as described in section 2.1) to illustrate the use of the framework.

An important requirement for the definition of the standard method was that technical (model) updates may not lead to a reduction of operational capacity, nor may they lead to a reduction of protection against aircraft noise. This requirement enables the right incentive for the aviation sector: smaller noise impact leads to a higher operational capacity and higher noise impact reduces this capacity.

Considering the frequency of updating noise limits, NLR suggests to decide upon a fixed frequency of for instance every five years at which noise limits are updated. It is not preferable to change noise limits too frequently because it takes time to put the limits into legislation and it is generally believed that changing noise limits too often undermines the general public’s trust. However it is also undesirable to use limits that are based on input parameters, noise metrics or models based on outdated techniques or standards.

Deciding on a fixed frequency will manage stakeholders’ expectations and will improve stability, predictability and transparency of the updating process. For instance, a new population database could become available at the right moment before a planned update. Model changes that are validated before a planned adjustment can be implemented. If model changes are still in the validation process at the moment of a planned adjustment, they can be implemented the next time after their validation has been finalised.

Figure 1 shows the process flow of the framework. The process steps are generally described in the remainder of this chapter.

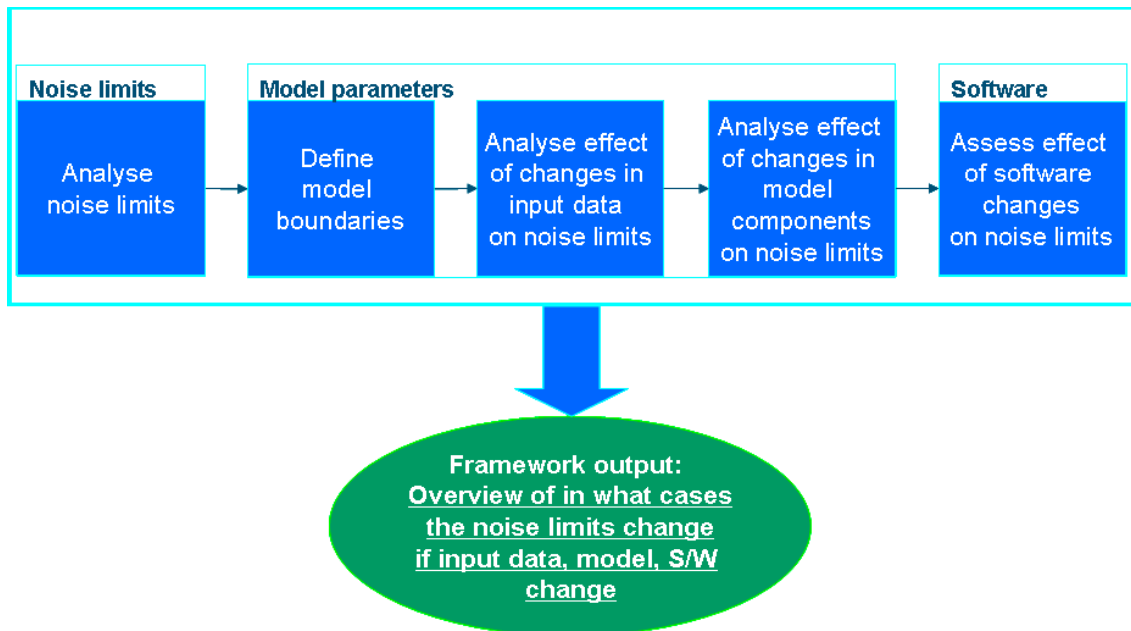


Figure 1 Process flow of the framework

All process steps together result in the output as depicted in Figure 1. For the purpose of giving an example, all steps have been executed for two types of Dutch noise limits used around Schiphol airport in chapter 4.

3.1 Analyse the noise limits

When defining a noise enforcement system and setting noise limits, explicit thought should be given to the following questions:

1. What is the purpose of the noise limit?
2. Is the limit fixed and never to be changed or is the limit the outcome of a calculation?
3. If the limit is an outcome of a calculation, with what model components, sub models, software implementation was the limit determined?
4. Should the limit change when changes in specific input parameters (flight schedule, population database) occur?

Formulating and agreeing upon answers to these questions will prevent difficult discussions during the use of the noise policy or enforcement system when new insights arise. Having this technical discussion upfront may also contribute to the definition of the policy, enforcement system and noise limits such that they better fit their purpose.

3.2 Analyse the effect of changes in model parameters

With model parameters, NLR means input data or model components. Before the model parameters can be identified, it is important to define the boundaries of the model in scope. If for instance only the noise exposure model is considered, adjacent models (such as runway use or noise impact models) can be placed out of scope. Changes in models that are out of scope can then be ignored. However, these changes might also impact the noise limits. A balance needs to be found between making the framework very complex by placing a large amount of models in scope and keeping it very simple with a very narrow scope, thereby possibly ignoring model changes that impact the noise limits.

The framework prescribes first defining the model in scope. Then all input data and model components and the effect that changing any of these has on the noise limits in use are listed.

3.3 Assess the effect of software changes

For software changes it is not so easy to mandate whether or not they should lead to updating the noise limits. In the recent past in the Netherlands, several updates of the software used to calculate the noise limits have been implemented, without updating the limits. An important objective of the framework described in this paper is to increase the awareness of how software changes should or should not lead to updating the limits. Software changes should not be seen as a separate process that can be executed without considering the potential effect on the limits. When the software used for aircraft noise calculations is updated, time should also be spent to analyse the impact of the change on the different types of calculations (noise limits, actual noise or forecasts) and on the different types of noise limits.

3.4 The output of the framework

After all process steps an overview is created to provide all stakeholders with consistent and necessary information about if a certain type of noise limit should change if either the metric, input data, model components or software changes. This is the green ellipsoid in Figure 1 and is done for every type of noise limit considered. Besides the outcomes of the above exercises, the overview also consists of a summary of the existing situation, e.g. what software (versions) are currently used (for every type of noise limit considered as well). Section 4.4 uses (part of) the Dutch noise limits and software in use to illustrate what this overview may look like.

For the different types of noise limits in use, this outcome may be different. NLR identified the following possible outcomes:

1. The noise limits are fixed and never change.

2. Every change in model parameter leads to updated noise limits.
3. If reality (usually input) changes, the noise limits do not change. If the model or a model component changes, the noise limits should be changed.
4. A combination of outcome 2 and 3: in general noise limits only change when a model (component) is updated, but some input parameters are specified such that they will also lead to updating the noise limits.

Figure 2 presents these options in a matrix structure. To make this figure more explicit for the Dutch noise limits introduced in section 2.1, the enforcement noise limits lead to outcome 2 and the criteria of equivalent protection lead to outcome 4. This indicates that different types of noise limits may have to be updated under different conditions.

	Possible outcomes of the framework			
	1. Noise limit is fixed	2. Noise limit to be updated for every change	3. Noise limit to be updated for model change, not for input data change	4. Noise limit is a combination of options 2. and 3.
Change of metric	N/a	To be updated	To be updated	To be updated
Change in input data	Not to be updated	To be updated	Not to be updated	To be updated for some, not all input data
Change in model component	Not to be updated	To be updated	To be updated	To be updated
Change in software	Not to be updated	To be updated	To be discussed	To be discussed

Figure 2 Results of the framework

The relationship between Figure 1 and Figure 2 is as follows: the process framework depicted in Figure 1 should be followed for all types of noise limits to be considered. This may therefore lead to different outcomes (in the green ellipsoid in Figure 1). These different outcomes are presented in Figure 2.

4 THE FRAMEWORK PUT TO USE FOR TWO DUTCH NOISE LIMITS

Now that the general framework has been defined, this chapter takes two Dutch noise limits used at Amsterdam Airport Schiphol (see section 2.1) as an example to use the framework. The following sections illustrate the purpose of the framework set up in the previous chapter:

- To describe and document which noise limits are in use, what they establish and on what calculation settings they are based;
- To describe and document the noise metric, input data and model components and what changes in these parameters should result in updating the noise limits;
- To describe and document which and how software changes should result in updating the noise limits;
- To create a clear overview of all of the above, enabling all stakeholders to reach consensus on when and how to update limits in the future.

The tables and overview can be used as templates for situations in other countries or for other airports.

4.1 Analyse noise limits for Amsterdam Airport Schiphol in the Netherlands

Table 1 contains the outcome of step one ‘Analyse noise limits’ in the process framework (described in section 3.1) when the two main Dutch noise limits¹ around Schiphol airport are considered. Objective of Table 1 is to describe and document which noise limits are in use, what they establish and on what calculation settings they are based.

Table 1 – Analysis of two types of noise limits at Schiphol airport

Question	Criteria of equivalent protection	35 Lden and 25 Lnight enforcement noise limits
1. What is the purpose of the noise limit?	Dutch noise limits, not used for enforcement, but to validate new future scenarios that will be used to calculate the Lden and Lnight enforcement noise limits.	The Lden and Lnight noise limits for enforcement are maximum noise values in 35 Lden and 25 Lnight locations.
2. Is the limit fixed and never to be changed or is the limit the outcome of a calculation?	These criteria are considered as the outcome of a calculation with a dedicated scenario.	These limits are considered outcomes of a dedicated scenario described in legislation.
3. If the limit is an outcome of a calculation, on which aspects (sub models, software implementation) is the outcome based?	The outcome is based on calculation results using the Dutch model (see section 4.2.1) and has been calculated with software A version xx.	The outcome is based on calculation results using the Dutch model (see section 4.2.1) and has been calculated with software A version xx.
4. Should the limit change when changes in specific input parameters (e.g. flight schedule, population database, etc.) occur?	For the last change of the criteria an update of the population database has led to an update of the criteria.	If e.g. the operational concept is foreseen to be changed, it can be incorporated into a new scenario. If the results of this new scenario do not exceed the criteria for equivalent protection, it may result in updated Lden and Lnight enforcement noise limits.

¹ The term ‘noise limits’ is used here in a general sense. Both the criteria of equivalent protection and the enforcement noise limits are considered as specific Dutch examples of ‘noise limits’.

4.2 Analyse the effect of changing model parameters

This section first describes the boundaries model considered in scope and then discusses the effect of changes of input data and the effect of changes of model components on the noise limits considered.

4.2.1 Define model boundaries

The Dutch model as discussed in this paper is a series of sub models that are structured in a software tool that is regularly used in the Netherlands for noise calculations around Schiphol Airport. Input and output of this model are as shown in Figure 3. The outputs of every sub model are fed into the next sub model as input together with specific inputs per sub model.

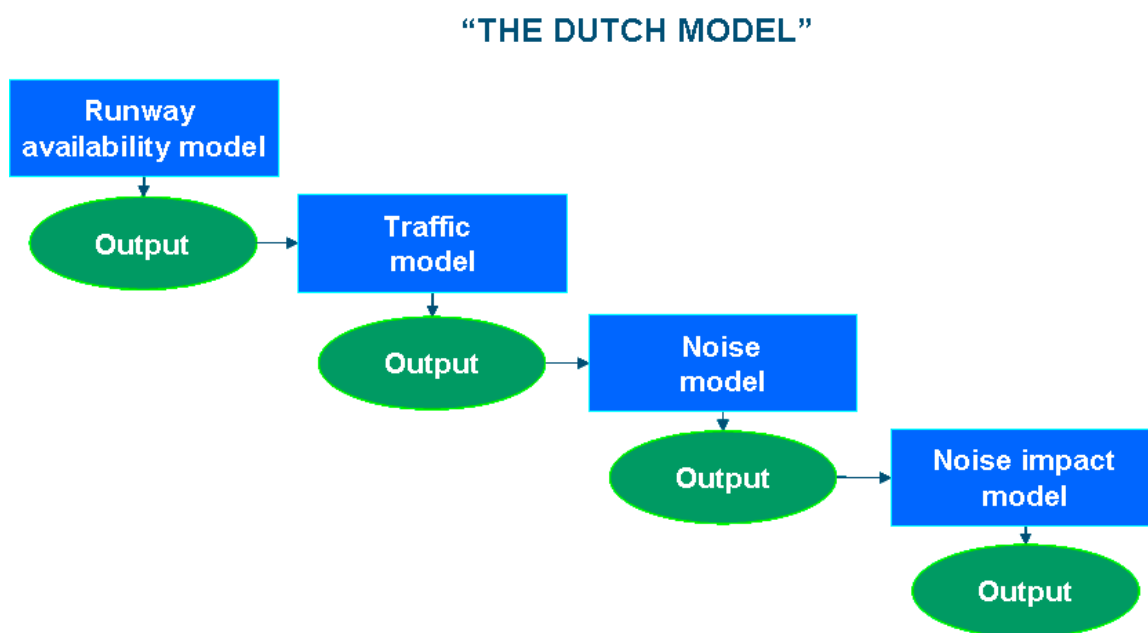


Figure 3 “The Dutch model” consists of a series of sub models

In the first sub model, the runway availability is calculated based on the runway configuration, weather conditions, preference tables, etc. Output of this model is the runway availability in a given period, e.g. for a year per 20-minute period. This runway availability together with a flight schedule and other parameters are fed into a traffic model that calculates the distribution of traffic on the runways and routes. This traffic distribution becomes input for the noise model that also uses noise and flight profiles, and routes to calculate noise levels in grid points around the airport. Finally, these noise levels are fed into a noise impact model, which, using dose-response relationships and population data, calculates numbers of dwellings and of severely annoyed people within certain contours.

When this paper mentions “the Dutch model” the combination of subsequent sub models in Figure 3 is meant². Of course noise models with different structures or boundaries may be used in different countries. The model in Figure 3 is merely used as an example in this paper.

² The Dutch model in its entirety as depicted in Figure 3 is not prescribed by Dutch law. However a noise calculation standard is prescribed in Dutch legislation for the third sub model ‘noise model’ [Ref. 3].

4.2.2 Analyse the effect of changing input data

As an example Table 2 shows part of the existing input data for the Dutch noise model. For the Dutch enforcement system, the framework has not been explicitly used before. Therefore, for some changes of input data, Table 2 presents what has happened in the past and not necessarily what has been agreed upon for future updates. The objective of Table 2 is to describe and document the input data and what changes in these data should result in updating the noise limits.

Table 2 – Effect of changing input data on noise limits

Change of... (Input data)	Effect of change on criteria of equivalent protection	Effect of change on 35 Lden and 25 Lnight enforcement noise limits
Flight schedule	None – criteria not to be updated.	If incorporated in a scenario that meets the criteria of equivalent protection, a change in flight schedule could change the noise limits.
Aircraft performance data	None – criteria not to be updated if it considers an addition of a new aircraft type or a new flight profile.	If incorporated in a scenario that meets the criteria of equivalent protection, a change in performance data changes the noise limits.
Aircraft noise data	None – criteria not to be updated if it considers an addition of a new aircraft type or new noise data.	If incorporated in a scenario that meets the criteria of equivalent protection, a change in noise data changes the noise limits.
Population data	Criteria updated in the past for updated population data, because aviation sector can not influence location of dwellings.	N/a (No population data needed to calculate these noise limits).
Dose-response relationships – the changed reality of how people are annoyed by aircraft noise	Criteria updated in the past for updated dose-response relationships. Potentially difficult to distinguish between change in reality and in the model.	N/a (No dose-response relationships needed to calculate these noise limits).
....		
Etc.		

4.2.3 Analyse the effect of changing model components

Table 3 shows a list of part of possible changes of model components that lead to updates of the noise limits. Replacing the entire model by Doc.29 is included as an entry in this table. The same remark that was made for changes in input data is true for changes in model components: the framework defined in this paper has not been explicitly used before in the Netherlands. Therefore, for some changes of model components, Table 3 shows what has happened in the past and not necessarily what has been agreed upon for future updates. The objective of Table 3 is to describe and document the model components and what changes in these parameters should result in updating the noise limits (including changes in noise metric, as this will most likely mean changing the model).

Table 3 – Effect of changing model components on noise limits

Change of... (Model component)	Effect of change on criteria of equivalent protection	Effect of change on 35 Lden and 25 Lnight enforcement noise limits
Noise metric	Criteria to be updated for the new metric.	Enforcement limits to be updated for the new metric.
Lateral ground spreading	Criteria to be updated with the new model component.	Enforcement limits to be updated with the new model component.
Dose-response relationships – model component, e.g. the metric used to express the dose	Criteria to be updated based on the new dose-response relationship model component (e.g. the metric).	Enforcement limits to be updated based on the new dose-response relationship model component (e.g. the metric).
Aircraft performance data – model component	Criteria to be updated with the new model component (this includes the correction of errors).	Enforcement limits to be updated with the new model component (this includes the correction of errors).
Aircraft noise data – model component	Criteria to be updated with the new model component (this includes the correction of errors).	Enforcement limits to be updated with the new model component (this includes the correction of errors).
Replacement of the entire model	Need to recalculate the criteria.	Need to recalculate the enforcement noise limits.
...		
Etc.		

Some aspects show up in both Table 2 and in Table 3, such as dose-response relationships, aircraft performance data and aircraft noise data. It is important to distinguish between what changes in reality and what changes in the model. Generally, if something changes in reality, input data will have to be changed. If something changes in the model, nothing changes in reality. A change in reality that is relevant for dose-response relationships is when people are really more or less annoyed by aircraft noise. This change would be registered in Table 2. However also the metric in which the dose is expressed could change. That change would typically be accounted for in Table 3, as it is a change of the model.

For aircraft performance and noise data, a new aircraft type to be included in the database would be put in Table 2, as a new aircraft type is a change in reality. However if existing data is updated or improved, without anything actually changing in reality, these changes could typically be put in Table 3.

This difference between changes in reality and changes in the model (technical or administrative changes) is important for some types of noise limits. For Amsterdam Airport Schiphol the criteria of equivalent protection are updated for model changes, but not for most changes in reality. The exception is that when the aviation sector can not influence an aspect of reality, e.g. the location of dwellings, a change of that aspect also leads to updating the criteria. This way the sector is not punished or rewarded for changes that they can not influence. The enforcement noise limits would be updated for changes in input data and for model changes, under the condition that the scenario used for the update does not exceed the criteria of equivalent protection.

4.3 Assess the effect of software updates

In the Netherlands, several software products are in use to calculate aircraft noise limits

and contours. Specifically, different software implementations of the same Dutch calculation method [Ref. 3-4] are used to first calculate the noise limits and then to calculate actual noise levels occurred for enforcement purposes. This may result in the situation that if one of the two software products is updated, an unwanted effect on the enforcement process might occur. To be more explicit: after an update of the software to calculate the actual noise, the noise limits might be exceeded, whereas this would not have happened with the previous version of the software (or the other way around). NLR recommends that whenever possible the same software to be used for the calculation of the actual noise and the noise limits. However, if this is not possible and only one of the two software products is changed, a first step is to see if the change is also relevant for the other software version and can be done within the same enforcement period of time. If this is also not possible, the change should be carefully assessed. Several outcomes of this assessment are possible:

1. The software change in the actual noise software does not have any effect on the enforcement process. In this case the noise limits do not have to be updated and the noise limit software can remain unchanged.
2. The software change in the actual noise level software does not have an effect on the enforcement process this enforcement period, but might have an effect later, in a different situation. In this case the noise limits should be updated using updated noise limit software, but this may be done in this enforcement period or later.
3. The software change in the actual noise level software causes the actual noise levels to exceed the noise limits during this enforcement period. In this NLR advises not to allow such a software change during the enforcement period, but to postpone it until both software products (to calculate the limits and the actual values) can be updated in the same enforcement period.
4. The software change in the actual noise software is the correction of an error. The error has never existed in the software to calculate the noise limits and this software will therefore not be updated accordingly. This could possibly lead to large problems trying to explain to the public that not only will the noise limits be exceeded this year, but also that actual noise limits have been calculated incorrectly in the past.
5. Etc.

Summarising: software changes and their effect on noise limits and the enforcement process should always be carefully assessed. Standard guidelines can not easily be given, although it is an option to mandate the update of the limits if a certain delta in the enforcement limits is exceeded. For instance if a software update leads to a change in noise level in an enforcement point of more than 0,01 dB(A) Lden, the enforcement noise limits need to be updated. This idea should be worked out in more detail with relevant stakeholders.

4.4 Framework output: create an overview of the Dutch situation

Having analysed and listed all components of the framework, a summarising overview for noise enforcement around Schiphol airport can be created. This overview can have various levels of detail for different audiences, but for the general public, policy makers and politicians, the level of detail displayed here below may be sufficient. It can as such provide insight, be the basis for decisions and make sure that everybody is on the same page when discussing the noise limits and changes to them.

Noise limits

- Criteria of equivalent protection to be updated when:
 - o Population data change;
 - o Dose-effect relationships change;
 - o Etc.
- Enforcement noise limits (Lden and Lnight) to be updated when:

- Operational concept changes;
- Requirement: results of scenario used to update enforcement noise limits should not exceed criteria of equivalent protection;
- Etc.

Models

- Runway availability model;
- Traffic model;
- Aircraft noise model [Reference 3-4];
- Noise impact model;

Input data

- Dutch noise and profile data (“Appendices”) version xx;
- Airport scenarios based on operational plan Schiphol airport and market forecast;
- Population database version 2008;
- Etc.

Model components

- Lateral noise attenuation
- Spherical spreading
- Atmospheric absorption
- Reflection
- Route modelling
- Etc.

Software

- To calculate criteria and enforcement noise limits: Software A, version xx;
- To calculate actual noise values for enforcement: Software B, version xx;
- Etc.

5 POLITICAL AND SOCIETAL ASPECTS

The research on which this paper is based has focused on the technical aspects that play a role when changes in model parameters lead to changes in noise limits. However, political and societal aspects can not be ignored. After a technical analysis, whether and how noise limits should be changed will probably always depend on government views and on what society finds acceptable.

Still the framework described in this paper can be very useful to provide the technical overview of the situation and what would be the way forward from a technical point of view. Politicians can take it from there up into the political arena. It is also well possible that e.g. technically a distinction can not easily be made between input data and model component (see section 4.2.3). In that case the framework can be used to specify the dilemma and then be handed over to policy makers or politicians to decide on the matter. If political choices have to be made, this should be made explicit. It is then clear that a decision is taken not on a technical but on a political basis.

Besides this, NLR believes that support from the general public would increase if a change in attitude about models and noise limits took place. Often, technical discussions about noise enforcement and modelling are considered as ways to increase the operational capacity for the aviation sector. Neither models nor noise limits should be considered as fixed but as living entities. Because noise limits are determined using noise models, an improvement or change of the model should in most cases lead to a change of the limits as well. NLR promotes a more open way of communicating about this process.

6 CONCLUSIONS

NLR defined a standard framework that can be used to decide whether or not noise limits or zones should be updated – and if so how. Using a set of relevant questions it provides an overview of the noise limits concerned and in what situation they should be updated. The framework consists of three components.

First, thought is given to the meaning of the noise limits or zones (to be) used: are they fixed and never to be changed, or do they depend on the scenario, the model or the software implementation? In the latter case they could be changed every time one of these three aspects is changed.

Second, model boundaries are set and all input data and model components are listed. Depending on the type of noise limit/zone, it is defined for all these model parameters whether or not to update the limit.

Third, it is suggested to perform an assessment when any part of the software used for calculation of actual noise values, calculation of noise limits or forecasting is changed. It could well have no impact at all on the noise limits or on enforcement. In that case it is not necessary to change noise limits and the new software could just be taken into operation. However, software change could also have a large impact. This at least needs to be assessed, after which appropriate action needs to be taken. The appropriate action varies from not updating the limits and just using the new software to updating all noise limits with the new software or postponing a software change to a later enforcement period.

Possible outcomes of the proposed process are (see also Figure 2):

1. The noise limits are fixed and never change.
2. Every change in model parameter leads to updated noise limits.
3. If reality (usually input) changes, the noise limits do not change. If the model or a model component changes, the noise limits should be changed.
4. A combination of option 2 and 3: in general noise limits only change when a model (component) is updated, but some input parameters are specified such that they will also lead to updating the noise limits.

If the choice whether or not to update a limit is difficult to make from a technical point of view, it can be lifted to the political level. In that situation, it should be made explicit that the choice (to be) made is political. Neither models nor noise limits should be considered as fixed but as living artefacts. Because noise limits are determined using noise models, if the model is improved or changed, in many cases the limits should change as well. NLR is a strong advocate of using the proposed framework to update models and noise limits every five years based on available validated model updates and to clearly and openly communicate about this.



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