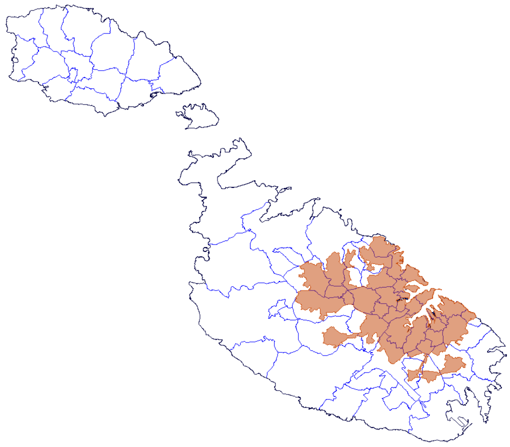
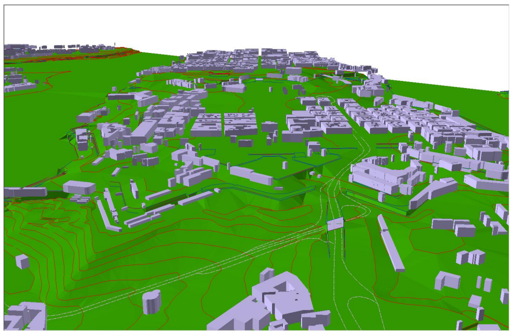
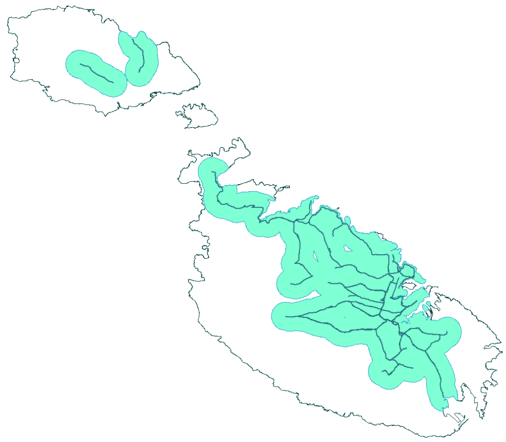
Consultancy and Field Surveys to Implement the EU Noise Directive 2002/49/EC in Malta

Contract Ref. No.: 2332/2009







Strategic Noise Mapping in Malta

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Acustica Ltd

DARH2 Acoustics & Civil Engineering Ltd

Report for

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Malta

Consultancy and Field Surveys to Implement the EU Noise Directive 2002/49/EC in Malta

Contract Ref. No.: 2332/2009

Strategic Noise Mapping in Malta

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Strategic Noise Mapping Process

This report forms a technical annex to the report 536-1-27 "Implementation of the Directive 2002-49-EC in Malta" which sets outs the main strategy and methodology for the future monitoring and management of environmental noise in Malta.

The END requires Member States to collect information on long term noise exposure due to road, rail, aircraft and industrial noise sources through the use of strategic noise mapping. This monitoring of environmental noise is undertaken with the aid of 3D noise assessment models and noise mapping software. Noise measurement equipment may then be utilised to help validate the source emission levels modelled within the software, and/or to validate the receptor immission levels at the noise sensitive locations.

The objective of this technical annex is to set out the basis of a process for undertaking strategic noise mapping under the Environmental Noise Regulations, which meets the requirements of the Directive.

The approach set out may be summarised as a seven stage process:

- Stage 1 - Define Areas to be Mapped
    - The area to be mapped:
        - Agglomeration: a continuous urban extent with a high population density; and
        - Major roads: sections of road with an annual traffic level above 3 million vehicles.
- Stage 2 – Define Noise Calculation Methods
    - The Regulations define the EC Recommended Interim Methods.
- Stage 3 – Develop Dataset Specification
    - The noise mapping process requires a wide range of input datasets, many of which need to be spatially referenced. The dataset specifications provide an organised means of centrally managing and combining the different spatial datasets and attribute databases. The required data can include items such as ground contours, building outlines, road centrelines, and traffic flow data.
- Stage 4 – Produce Datasets
    - Within this stage the raw GIS datasets will be collected, collated and catalogued with the aim of carrying out a gap analysis and audit against the specifications drawn up within Stage 3.
- Stage 5 - Develop Noise Model Datasets
    - Tuning dataset resolution to acoustic calculation requirements; and
    - Appending datasets to best exploit capabilities of the calculation kernel.
- Stage 6 - Noise Level Calculations

- Running of the noise calculations over the entire area to be mapped, using all the data from the model area; and
- Production of noise results datasets developed from the calculation process.

- Stage 7 - Post Processing and Analysis
    - No. of people exposed within noise bands;
    - No. of people exposed within noise bands in dwellings with special noise insulation;
    - No. of people exposed within noise bands in dwellings with a quiet façade;
    - Total area exposed within noise bands; and
    - No. of dwellings exposed within noise bands.

This report provides a review of the background, aims and objectives of the Regulations. It also sets out a recommended approach to noise action planning, and a framework process for the assessment of options for action. It also sets out a first proposal for indicative noise levels, as assessed by the strategic noise mapping, above which the framework process would be followed.

Finally, attention is drawn to the minimum requirements of an Action Plan, as defined within the Regulations and Directive, and offers a practical approach to how these requirements may be met.

This document should be read in conjunction with the following:

- Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise, Official Journal of the European Communities (OJEC) L189/12-25, 18 July 2002;
- Assessment and Management of Environmental Noise Regulations, S.L.504.63, L.N. 193 of 2004, as amended by L.N. 426 of 2007;
- Commission Recommendation 2003/613/EC of 6 August 2003 concerning the guidelines on the revised interim computation methods for industrial noise, aircraft noise, road traffic noise and railway noise, and related emission data, Official Journal of the European Union (OJEU) L212/49-64, 22 August 2003;
- EC recommended RM2007 "Reporting Mechanism proposed for reporting under the Environmental Noise Directive 2002/49/EC";
- Acustica report 536-1-27 "Implementation of the Directive 2002-49-EC in Malta", 2011;
- Acustica report 536-1-29 "Noise action Planning in Malta", 2011;
- European Commission Working Group Assessment of Exposure to Noise (WG-AEN), Position Paper, Good Practice Guide for Strategic Noise Mapping and the Production of Associated Data on Noise Exposure, Version 2, 13th August 2007;

- European Commission Working Group Assessment of Exposure to Noise (WG-AEN), Position Paper, Presenting Noise Mapping Information to the Public, March 2008; and
- European Environment Agency Technical Report No 11/2010 “Good practice guide on noise exposure and potential health effects”, ISSN 1725-2237, October 2010.

This technical annex is appropriate for use under the current text of the Regulations and Directive at the time of writing. It may need to be updated in future should the Regulations or Directive be amended in a way which changes the requirements for strategic noise maps. Similarly, should Maltese noise policy change, this may also lead to a need to change the approach described within this report.

This report should not be considered as a legal document, nor does it purport to provide comprehensive legal advice or guidance on all acoustical matters. If, in any circumstance, the recommendations contained in this guidance seem to be at variance with the Directive, or Regulations, then the text of the Directive must be applied in the first instance, or the Regulations in the second. In many situations it may be necessary to seek expert advice and assistance.

1 Introduction

1.1 Background

This report forms a technical annex to the report 536-1-27 *"Implementation of the Directive 2002-49-EC in Malta"* which sets outs the main strategy and methodology for the future monitoring and management of environmental noise in Malta.

The END requires Member States to collect information on long term noise exposure due to road, rail, aircraft and industrial noise sources through the use of strategic noise mapping. This monitoring of environmental noise is undertaken with the aid of 3D noise assessment models and noise mapping software. Noise measurement equipment may then be utilised to help validate the source emission levels modelled within the software, and/or to validate the receptor immission levels at the noise sensitive locations.

The objective of this technical annex is to set out the basis of a process for undertaking strategic noise mapping under the Environmental Noise Regulations, which meets the requirements of the Directive.

A glossary of acoustic and technical terms used is set out in Appendix A

1.2 Why prepare a Strategic Noise Map?

Directive 2002/49/EC of the European Parliament and of the Council relates to the assessment and management of environmental noise, and is commonly referred to as the Environmental Noise Directive or END.

The aim of the Directive is:

> *"to define a common approach intended to avoid, prevent or reduce on a prioritised basis the harmful effects, including annoyance, due to exposure to environmental noise".*

The underlying principles are[1]:

- Monitoring the environmental problem;
- Informing and consulting the public;
- Addressing local noise issues; and
- Developing a long-term EU strategy.

And to that end three stages are set out:

- Undertake strategic noise mapping to determine exposure to environmental noise; this monitors the environmental problem by observing and collecting data;
- Ensure information on environmental noise and its effects is made available to the public; this is in line with the principle of the Aarhus Convention[2]; and

[1] *European Commission, The Directive on Environmental Noise*. Available from: http://ec.europa.eu/environment/noise/directive.htm [Accessed February 2011]

- Adopt action plans, based upon the noise-mapping results, with a view to preventing and reducing environmental noise where necessary and particularly where exposure levels can induce harmful effects on human health and to preserving environmental noise quality where it is good. The Directive does not set any limit value, nor does it prescribe the measures to be used in the action plans, which remain at the discretion of the Member states and competent authorities.

The information on the results of the Strategic Noise Mapping assessment, and the proposal set out within the Action Plans, are reported to the EC to provide evidence to support the development of long-term EU strategy. This may include objectives to reduce the number of people affected, and provides a framework for developing existing Community policy on noise reduction from sources.

The Directive defines noise mapping, strategic noise maps and action plans as:

- 'noise mapping' shall mean the presentation of data on an existing or predicted noise situation in terms of a noise indicator, indicating breaches of any relevant limit value in force, the number of people affected in a certain area, or the number of dwellings exposed to certain values of a noise indicator in a certain area;

- 'strategic noise map' shall mean a map designed for the global assessment of noise exposure in a given area due to different noise sources or for overall predictions for such an area;

- 'action plans' shall mean plans designed to manage noise issues and effects, including noise reduction if necessary.

The END requires Member States to produce strategic noise maps for the main sources of environmental noise, i.e. major roads, major railways, major airports and agglomerations with a population of more than 250,000 persons in 2007 and those with a population of more than 100,000 persons in 2012 and subsequent rounds.

For the second round of strategic noise mapping and action planning under the END the population threshold for assessment of agglomerations is reduced from 250,000 to 100,000 persons, and the traffic flow thresholds for major roads and major railways are reduced from 6 million to 3 million and 60,000 to 30,000 vehicle passages per year respectively. The flow threshold for major airports remains at 50,000 movements per year.

This change in assessment thresholds will result in a significant increase in the coverage of the strategic noise mapping, several Member States have estimated a fivefold to sevenfold increase in the length of qualifying major roads for example.

The Directive is transposed separately in each Member state of the EU into local legislation. In Malta, the END is transposed by the *"Assessment and Management of Environmental Noise Regulations, 2004"*, L.N. 193 of 2004 (Regulations). The Regulations were made by the Minister for Rural Affairs and the Environment under the Environmental Protection Act, 2001 (CAP. 435), subsequently amended in 2005. Following the passing of CAP 504, *Environment and Development Planning Act*, 2010,

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[2] *Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Envrionmental Matters.* Available from: http://www.unece.org/env/pp/ [Accessed July 2010]

the regulations were subsequently renumbered as Subsidiary Legislation 504.63 of 2007, *Assessment and Management of Environmental Noise Regulations*, 2004.

The Regulations designate the Malta Environment and Planning Authority (MEPA) as the competent authority for the making of strategic noise maps, the publication of information on environmental noise, and the drawing up on action plans. This is in line with the activities of the Authority, which is responsible for environmental enforcement, whilst the Department of Rural Affairs and the Environment was responsible for environmental policy in 2004. The Department is now the Ministry for Resources and Rural Affairs, and environmental policy is now understood to be the responsibility of the Office of the Prime Minister.

The Malta Environment & Planning Authority (MEPA) is the national public body responsible for environmental regulation and spatial planning in Malta. Established in 2002, the Authority operates under the mandate of the Environment Protection Act (2001) and the Development Planning Act (2001).

MEPA falls under the portfolio of the Office of the Prime Minister (OPM) and is managed by a Board appointed by the government.

1.3 Scope of the strategic noise maps

The Strategic Noise Maps are to be made as part of the first phase of work under the Directive. The Regulations set out to:

> *"define a common approach intended to avoid, prevent or reduce on a prioritised basis the harmful effects, including annoyance, due to exposure to environmental noise."* [3]

The Regulations are to apply to environmental noise to which people are exposed, in particular in built-up areas, in public parks or other quiet areas in an agglomeration, in quiet areas in open country, near schools, hospitals, and near other noise-sensitive buildings and areas. [4]

The Regulations shall not apply to noise that is caused by the exposed person himself, noise from domestic activities, noise created by neighbours, noise at work places or noise inside means of transport or due to military activities in military areas. [5]

In the context of the Regulations, environmental noise is defined as unwanted or harmful outdoor sound created by human activities, including noise emitted by means of transport, road traffic, rail traffic, air traffic, and from sites of industrial activity. [6]

Furthermore the Strategic Noise Maps are not to cover the whole of Malta; rather the areas covered by the Strategic Noise Maps are defined as those areas which are affected by environmental noise. This is further discussed in Section 3.1 below. [7]

1.4 Timetable

The following timetable applies with regard to strategic noise mapping for the first round:

[3] Article 2 (1)
[4] Article 3 (1)
[5] Article 3 (2)
[6] Article 4
[7] Article 8 (1)

- **30 June 2005** – Report to be submitted to the European Commission (EC) by MEPA designating the major roads, major railways, major airports and agglomerations relevant to the 1st round of the END – ENDRM DF1[8];

- **18 July 2005** – Report to be submitted to the EC by MEPA identifying the competent bodies for strategic noise maps, action plans and data collection – ENDRM DF0 and DF2[9];

- **18 July 2005** – Report to be submitted to the EC by MEPA identifying noise limit values in force or planned and associated information – ENDRM DF3[10];

- **30 June 2007** – MEPA to have completed strategic noise maps for the preceding calendar year (2006) for all designated agglomerations, major roads, major railways and major airports[11];

- **30 December 2007** - Report to be submitted to the EC by MEPA containing strategic noise maps related data as listed in Annex VI for major roads, railways, airports and agglomerations concerned by 1st round in respect of the 2006 calendar year – ENDRM DF4[12];

- **30 December 2008** – Report to be submitted to the EC by MEPA designating major roads, major railways, major airports and agglomerations designated as relevant to the 2nd round of the END – ENDRM DF5[13];

- **18 January 2009** - Report to be submitted to the EC by MEPA providing details of any noise control programmes that have been carried out in the past and noise-measures in place – ENDRM DF6[14];

- **18 January 2009** – Report to be submitted to the EC by MEPA providing summaries of action plans related data as listed in annex VI for major roads, railways, airports and agglomerations concerned by 1st round, and any criteria used in drawing up action plans – ENDRM DF7[15];

The EC recommended Reporting Mechanism for the END, is documented in the report *Reporting Mechanism proposed for reporting under the Environmental Noise Directive 2002/49/EC*, EC DG Environment, October 2007 (ENDRM)[16]. More recently the submission of reports has moved to the European Environment Agency (EEA) EIONET Reporting Obligations Database (ROD) online system, which contains up to date guidance, report templates and online checking tools to support submission of the required reports[17].

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[8] END Article 7 (1)
[9] END Article 5 (4)
[10] END Article 5 (4)
[11] END Article 7 (1)
[12] END Article 10 (2)
[13] END Article 7 (2)
[14] END Article 10 (2)
[15] END Article 10 (2)
[16] Available from:
http://circa.europa.eu/Public/irc/env/d_2002_49/library?l=/reporting_mechanism/reporting_mechanism&vm=detailed&sb=Title [Accessed February 2011].
[17] EIONET Obligations Database (ROD): http://rod.eionet.europa.eu/ [Accessed February 2011].

The above timetable is to be repeated on a 5 year cycle. This results in strategic noise mapping information being submitted for future rounds in 2012, 2017, 2022, 2027 etc with Action Plan reports being submitted one year after each.

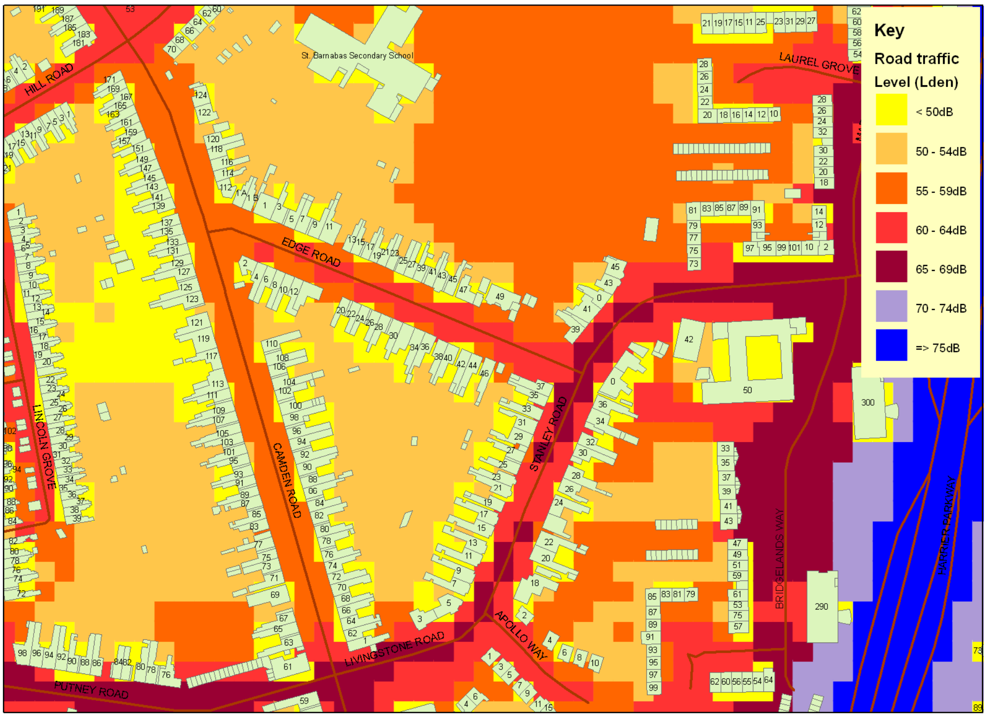

Figure 1.1: A graphical presentation of strategic noise mapping results

1.5 Overview of Strategic Noise Mapping

A strategic noise map is designed for the assessment of noise exposure in a given area, resulting from strategic noise sources such as roads, railways, airports and industry. Just as a landscape map may have contours indicating how ground level height changes across an area, a noise map can illustrate how environmental noise levels change across an area. Figure 1.1 shows a typical graphical presentation of a strategic noise map (from WG-AEN Position Paper on Presenting Noise Mapping Information to the Public).

The purpose of strategic noise mapping is primarily threefold:

- to provide the European Commission (EC) with strategic estimates of noise exposure across Europe to assist in the future development of European noise policy;
- to provide information to the public and decision makers on noise exposure locally, nationally and internationally; and
- to develop action plans for the purpose of managing noise exposure, by reducing noise levels where necessary, or preserving quiet areas where appropriate.

Strategic noise maps are normally produced by computer modelling techniques which calculate the noise level at specific points resulting from the sound emanating from the particular sources. The modelling software utilised source data such as traffic flow, type of road and rail, types of vehicles and the nature of industrial processes. The source data is positioned within a three dimensional (3D) computer model of the area of assessment. The 3D model includes features which can directly affect sound transmission, such as potential barriers, buildings, topography, weather conditions and how acoustically reflective or absorbent different surfaces can be. The calculations produce noise levels at receptor points on a 10 metre grid at a height of four metres above the ground, there will be approximately 10,000 receptor points every 1 km^2, or approximately 25,900 receptor points every square mile.

The process of making strategic noise maps is similar to the methodologies used within noise modelling for environmental impact assessments associated with major developments, such as major extensions to the road network, or expansions to airports. The key difference tends to be the significantly greater area to be covered by the strategic noise mapping within one assessment, and therefore the amount of information required to develop the required computer models. The amount of time and resources required to collect the necessary source and 3D data, build the models, run the calculations and derive the reporting information should not be underestimated. It is typical for a large regional or national scale project to take an experienced team between 6 and 12 months to complete the process.

1.6 Report Outline

This report is set out as follows:

- Chapter 1: Introduction
- Chapter 2: Requirements for Strategic Noise Maps
- Chapter 3: Overview of the Strategic Noise Mapping Process
- Chapter 4: Stage 1 – Define Areas to be Mapped
- Chapter 5: Stage 2 – Define Noise Calculation Methods
- Chapter 6: Stage 3 - Develop Dataset Specification
- Chapter 7: Stage 4 - Produce Datasets
- Chapter 8: Stage 5 – Develop Noise Model Datasets
- Chapter 9: Stage 6 – Noise Level Calculations
- Chapter 10: Stage 7 – Post Processing and Analysis
- Chapter 11: Noise Level Measurements
- Chapter 12: Reporting Requirements

Further information is set out in the Appendices at the end of the document.

2 Requirements for Strategic Noise Maps

2.1 Designated Bodies

The Regulations state that the designated competent authority is the Malta Environment and Planning Authority[18]. The Minister responsible for the environment retains the power to designate other bodies or persons as the competent authority for different provisions and different purposes of the Regulations.

2.2 General Requirements for Strategic Noise Maps

The Strategic Noise Maps are to form the basis of Action Plans. These Action Plans must refer to places near the major roads[19], and within any relevant agglomeration[20], which means those places affected by noise from the major sources, as shown by the results of the noise mapping, and all locations within any relevant agglomeration.

Note 1: Noise from major sources is regarded as affecting an area if it causes either an L_{den} value of 55dB or greater, or an L_{night} value of 50dB or greater, anywhere within an area. Which means that the noise maps produced for major roads must cover all areas exposed above these noise levels due to regional, national or international roads[21].

Box 1
General requirements for Strategic Noise Mapping

Strategic Noise Maps must

- Meet the objectives of Article 1(a) of the Directive;
- Meet the minimum requirements in Annex IV of the Directive;
- Show the situation in the preceding calendar year;
- Be completed for the L_{den} and L_{night} indicators;
- Include all relevant roads, airports and industrial sites affecting an agglomeration;
- Include all areas affected by designated major roads;
- Be completed using data no more than three years old; and
- Be completed using a method of assessment recommended in Part II of the Second Schedule of the Regulations.

Strategic Noise Maps must meet several general requirements, set out below:

- The Strategic Noise Maps must present data on an existing or predicted situation in terms of a noise indicator, including breaches of any relevant limit value in force, the number of people affected in a certain area, or the number of dwellings exposed to certain values of noise indicator in a certain area[22].

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[18] Article 4
[19] Article 9 (1) (a)
[20] Article 9 (1) (b)
[21] Article 4
[22] Article 4

- The Strategic Noise Maps must satisfy the minimum requirements of Annex IV of the END[23]. See Section 2.3 below.

- Strategic Noise Maps must be completed for the L_{den} and L_{night} noise indicators[24]. See Section 3 below.

- Strategic Noise Maps must be completed using the assessment methods in Annex II of the Directive, or methods laid down in Maltese legislation[25].

Additionally, Strategic Noise Maps may be completed for supplementary noise indicators if require for the purposes of acoustical planning and noise zoning[26].

2.3 Annex IV of the Directive

Annex IV of the Directive sets out the minimum requirements for Strategic Noise Mapping alongside a number of articles of information and guidance. These minimum requirements are shown in Box 2. The production, presentation and reporting of the strategic noise mapping must meet all of the requirements set out in Annex IV of the Directive.

Box 2

Annex IV from the END

Strategic noise mapping must at least meet the following requirements:

- Strategic noise mapping will be used for the following purposes:
    - the provision of the data to be sent to the Commission in accordance with Article 10(2) and Annex VI,
    - a source of information for citizens in accordance with Article 9,
    - a basis for action plans in accordance with Article 8.

  Each of those applications requires a different type of strategic noise map.
- Minimum requirements for the strategic noise maps concerning the data to be sent to the Commission are set out in paragraphs 1.5, 1.6, 2.5, 2.6 and 2.7 of Annex VI.
- For the purposes of informing the citizen in accordance with Article 9 and the development of action plans in accordance with Article 8, additional and more detailed information must be given, such as
    - a graphical presentation,
    - maps disclosing the exceeding of a limit value,
    - difference maps, in which the existing situation is compared with various possible future situations,
    - maps showing the value of a noise indicator at a height other than 4 m where appropriate.

  The Member States may lay down rules on the types and formats of these noise maps.
- Strategic noise maps for local or national application must be made for an assessment height of 4 m and the 5dB ranges of L_{den} and L_{night} as defined in Annex VI.
- For agglomerations separate strategic noise maps must be made for road-traffic noise, rail-traffic noise, aircraft noise and industrial noise. Maps for other sources may be added.

[23] Article 8 (3)
[24] Article 6 (1)
[25] Article 7 (1) & (2)
[26] Article 6 (2) & (3)

Appendix E sets out guidance on how the minimum requirements set out in Annex IV of the Directive may be incorporated into a report on the strategic noise mapping process.

In the following paragraphs, guidance is given on how the various elements of Annex IV might be met.

A strategic noise map is the presentation of data on one of the following aspects:

- **an existing, a previous or a predicted noise situation in terms of a noise indicator,**
- **the exceeding of a limit value,**
- **the estimated number of dwellings, schools and hospitals in a certain area that are exposed to specific values of a noise indicator,**
- **the estimated number of people located in an area exposed to noise.**

This defines a strategic noise map as a broad range of indicated results, covering actual assessed noise exposure levels, but also estimated numbers of exposed noise sensitive locations and people. The presentations listed link to the information which is to be reported to the EC using the recommended reporting mechanism, ENDRM 2007 via EIONET/ROD. At present there are no statutory noise limit values in Malta, therefore this form of presentation would not currently be used.

Strategic noise maps may be presented to the public as:

- **graphical plots,**
- **numerical data in tables,**
- **numerical data in electronic form.**

This defines the means by which the indicated results may be presented to the public.

Strategic noise maps for agglomerations shall put a special emphasis on the noise emitted by:

- **road traffic,**
- **rail traffic,**
- **airports,**
- **industrial activity sites, including ports.**

Within agglomerations, where immission levels are above the reporting thresholds of 55 dB L_{den} and 50 dB L_{night}, roads, railways and airports with annual movement totals below those of designated major sources are to be included within the assessment of noise exposure. Industrial sites, including ports, are also to be assessed within agglomerations, whereas there is no requirement under the Directive to assess noise exposure due to industrial sites outside agglomerations.

Strategic noise mapping will be used for the following purposes:

- **the provision of the data to be sent to the Commission in accordance with Article 10(2) and Annex VI,**
- **a source of information for citizens in accordance with Article 9,**
- **a basis for action plans in accordance with Article 8.**

Each of those applications requires a different type of strategic noise map.

This provides a clear statement that the strategic noise maps drawn up under the requirements of the Directive are to be used to provide information for three main ends, and that each of these ends places a differing need on the strategic noise mapping. The strategic noise mapping process must provide all the information required for the following purposes:

- Article 10(2) and Annex VI refer to the information which is to be submitted to the EC using the recommended reporting mechanism, ENDRM 2007 via EIONET/Reportnet;
- Information to be presented to the public, see section 13.2 of this report;
- Action Plans are to be based upon the results of the strategic noise mapping[27], which requires the strategic noise mapping to deliver the coverage, and noise indicators, relevant to the assessment criteria used within the Action Plans, and in particular to identify the most important areas.

These requirements are discussed further in the next two points.

Minimum requirements for the strategic noise maps concerning the data to be sent to the Commission are set out in paragraphs 1.5, 1.6, 2.5, 2.6 and 2.7 of Annex VI.

The requirements set out within the relevant paragraphs of Annex VI of the Directive are now incorporated within the recommended reporting mechanism ENDRM 2007/EIONET data flow 4. The reporting templates provide for the submission of three types of data to the EC under DF4; data for which there is a legal obligation under the END, data for which there is a recommendation from the END, DG ENV or EEA, and data which is fully optional. Provided that all the data fields are completed and returned for which there is a legal obligation under the END, these minimum requirements will have been met. The minimum requirements include the following information for each type of noise source to be assessed:

- The numbers of people exposed in specified L_{den} and L_{night} noise level bands within agglomerations;
- The numbers of people exposed in specified L_{den} and L_{night} noise level bands outside agglomerations; and

[27] Article 9 (1) (b)

- The total area and total number of dwellings exposed to major sources in specified L_{den} noise level bands, including those within agglomerations.

The requirements for information to be reported to the EC, as set out above, are a series of data tables providing numbers of people, dwellings or area by noise level bands and noise indicators.

For the purposes of informing the citizen in accordance with Article 9 and the development of action plans in accordance with Article 8, additional and more detailed information must be given, such as:

- **a graphical presentation,**
- **maps disclosing the exceeding of a limit value,**
- **difference maps, in which the existing situation is compared with various possible future situations,**
- **maps showing the value of a noise indicator at a height other than 4 m where appropriate.**

The Member States may lay down rules on the types and formats of these noise maps.

The tables of results to be reported to the EC are to be used for the purposes of informing the citizens, under END Article 9, and developing Action Plans, under END Article 8. In order to provide information to the public in a clear comprehensible and accessible format, END Article 9 (2), it is also stated that graphical maps should be used as a means of presenting the results. Comparisons with limit values, with potential future scenarios, and with other assessment heights are also introduced as they may be relevant for a clearer public understanding, or to help support the Action Plans.

Strategic noise maps for local or national application must be made for an assessment height of 4 m and the 5 dB ranges of L_{den} and L_{night} as defined in Annex VI.

This sets out the common assessment height for strategic noise maps, and again references the noise level bands which are to be reported, as set out in Annex VI.

For agglomerations separate strategic noise maps must be made for road-traffic noise, rail-traffic noise, aircraft noise and industrial noise. Maps for other sources may be added.

It is the minimum requirement that for all locations within agglomerations there should be strategic noise maps produced for roads, railways, aircraft noise and industrial sites. Strategic noise mapping of other sources may be undertaken should it be relevant within the agglomeration, and relevant to the needs of an Action Plan.

The Commission may develop guidelines providing further guidance on noise maps, noise mapping and mapping softwares in accordance with Article 13(2).

To date the Commission has not developed official guidelines on strategic noise maps, noise mapping and mapping software. The EC, EEA and UK Department for Environment, Food and Rural Affairs (Defra) have supported the work of the European Commission Working Group Assessment of Exposure to Noise (WG-AEN) by funding research and workshops which have aided the development of position papers and a catalogue of noise mapping software. There are two WG-AEN position papers which provide extensive guidance on strategic noise mapping in the context of the Directive, and on presenting noise mapping information to the public:

- Good Practice Guide for Strategic Noise Mapping and the Production of Associated Data on Noise Exposures, Version 2, 13 August 2007[28] (WG-AEN GPG v2);
- Presenting Noise Mapping Information to the Public, March 2008[29]; and
- Mapping Software Catalogue, April 2008[30].

[28] Available from: http://ec.europa.eu/environment/noise/pdf/gpg2.pdf [Accessed February 2011]
[29] Available from: http://circa.europa.eu/Public/irc/env/noise_map/library?l=/wg-aen_001_2008doc/_EN_1.0_&a=d [Accessed February 2011]
[30] Available from: http://circa.europa.eu/Public/irc/env/noise_map/library?l=/catalogue_versapr08xls/_EN_1.0_ [Accessed February 2011]

3 Overview of the Strategic Noise Mapping Process

3.1 Introduction

The main structure of the strategy is to present a staged approach to the delivery of the strategic noise mapping. The approach set out may be summarised as a seven stage process, as shown in Figure 3.1 below.

Each stage of the process is defined by preceding stages such that requirements and specifications are captured ahead of the datasets. These datasets are then processed and concatenated to develop the model datasets, which are checked and tested prior to the final assessment of noise levels.

It is recommneded that the data processing is commenced within a GIS environment, then passed to the specialist noise mapping software environment for final sign-off and the assessment of noise levels. The results of this assessment are then passed back to the GIS environment for post processing, analysis and mapping. Step 5 "Develop Noise Model Datasets" starts within the GIS environment, and will be completed within the noise mapping software.

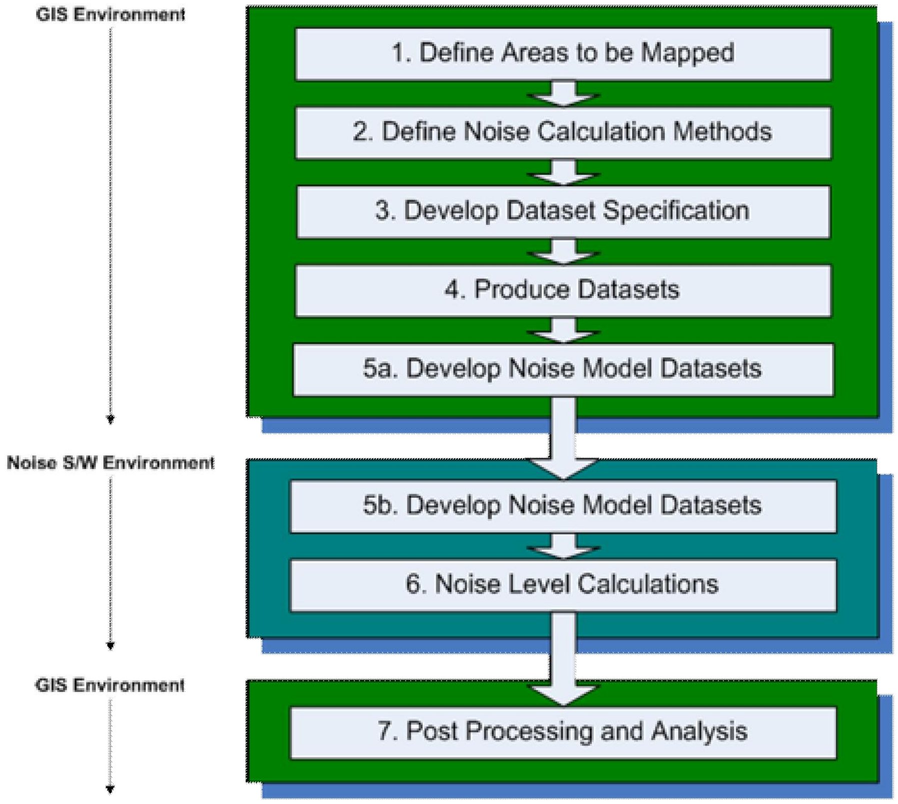

Figure 3.1: Overview of noise mapping process

Following the assessment of noise levels the analysis will be undertaken using datasets developed to present dwelling and population locations in order to deliver the statistics required by the EC for the reporting requirements of the Directive.

3.2 Stage 1 - Define Areas to be Mapped

The key first stage in any spatial data project is to gain an understanding of the area under review; in this case there are two types of area of interest:

- The area to be mapped:
  - The specific geographical area for which noise calculation results are required;
  - For agglomerations this is generally a clearly defined boundary set out within Regulations, or is to be identified by the competent authority. In Malta it has been designated as part of the strategic noise mapping for the first round; and
  - For major roads the area is less specific as it is effectively designed by a minimum noise level which is of interest to be reported to the Commission.
- The area to be modelled:
  - In order for the noise levels on the edge of any agglomeration area to be calculated accurately, it is important to consider the noise sources, and propagation screening objects, from an area beyond and outside the actual area to be mapped; and
  - For major roads the noise source is specifically located, and the area to be modelled in generally the same area as the area to be mapped.

At the end of the stage there will be:

- A specification for the geographical area for which the input datasets are required; and
- A specification for the geographical areas for which noise levels will be calculated.

Further discussion on defining the noise mapping and noise modelling areas is set out below in Section 4.

3.3 Stage 2 – Define Noise Calculation Methods

The Regulations set out criteria to determine the calculation methods which may be used for the production of the strategic noise maps.

The methods set out within Annex II of the Directive are to be used, or methods laid down in local legislation, provided that the competent authority demonstrates that these give equivalent results to the EC recommended methods from Annex II of the Directive.

Further discussion on the selection of method of assessment is set out in Section 5 below.

3.4 Stage 3 – Develop Dataset Specification

Stages 1 and 2 will provide a clear description of what data the chosen calculation methods use, and for what locations it is required. This information combines with the chosen data management strategy to draw up a series of dataset specifications for each of the layers of spatial and attribute data which are required within the noise mapping process.

The dataset specifications provide an organised means of centrally managing and combining disparate generic spatial datasets and attribute databases. It will also enable multiple organisations and stakeholders to supply data into a data repository to support interoperability and combining of work efforts.

The noise mapping process requires a wide range of input datasets, many of which need to be spatially referenced. An overview of the type of datasets which will be required in order to carry out the noise level calculations is shown below:

- 3D Model Environment:
  - DTM – 3D terrain model;
    - Contours;
    - Break lines;
    - Embankments & Cuttings;
    - Topography;
  - DEM – 3D elevation model
    - Building heights;
    - Bridges / Underpasses; and
    - Barriers.
- Road source:
  - Carriageway centreline;
  - Traffic flow;
  - Traffic speed;
  - %HGVs;
  - Road surface type; and
  - Road texture depth.
- Industry source:
  - Location;
  - Process type; and
  - Noise emission level.
- Aircraft Source:

    - Flight track;
    - Aircraft type; and
    - Power level along flight track.

The analysis environment will typically require a number of datasets, including several not required for the noise calculation process:

- Information on residential population numbers;
- Population distribution information;
- Identification of buildings as dwellings or other noise sensitive premises, such as schools and hospitals; and
- Location of premises with special noise insulation measures.

Further discussion on setting up dataset specifications suitable for strategic noise mapping is set out below in Section 6.

3.5 Stage 4 – Produce Datasets

Within this stage the raw GIS datasets will be collected, collated and catalogued with the aim of carrying out a gap analysis and audit against the specifications drawn up within Stage 3.

The areas which are to be addressed at this point are:

- An appraisal of the available data against the specification, looking into issues such as:
    - Coverage, projection, resolution, accuracy, attributes, maintenance regime, format, metadata, fitness for purpose.
- A gap analysis is then carried out, resulting in details of the data required that is not currently available, and proposing mechanisms for the completion of the input datasets.

Following the appraisal and gap analysis, the input datasets may be completed in line with the recommended approach. This could be via a number of different routes:

- Extended licensing of existing datasets for additional coverage or improved currency;
- Data capture programs to fill gaps in the available datasets;
- Interpolation or processing of raw datasets to produce relevant derived data products; or
- Use of default datasets in line with WG-AEN GPGv2 Toolkits.

Further discussion on the production of strategic noise mapping datasets is set out in Section 7 below.

3.6 Stage 5 - Develop Noise Model Datasets

At the end of Stage 4 the input datasets will be completely populated for the total coverage of the area to be modelled. At this point the project will have a series of generic GIS datasets.

GIS data is collected for multiple purposes and this will generally not be specifically for the needs of acoustic calculation, hence it is seldom optimised for such a use. This leads to two generalised groups of issues which need to be resolved for the data to be optimised for the noise calculations:

- Tuning dataset resolution to acoustic calculation requirements; and
- Appending datasets to best exploit capabilities of the calculation kernel.

This processing may be carried out within a GIS environment, or within the noise modelling software, but will be designed in collaboration between GIS and noise modelling specialists in order to produce an optimised noise modelling dataset ready for the calculation process.

Further discussion on developing the noise model datasets is set out in Section 8 below.

3.7 Stage 6 - Noise Level Calculations

At this stage the final GIS input datasets will be transferred into the noise calculation software. The elements of this stage are:

- Final manipulation of the input datasets to optimise for the calculation kernel;
- Selection of the user specified calculation settings within the software tool;
- Running of the noise calculations over the entire area to be mapped, using all the data from the model area; and
- Production of noise results datasets developed from the calculation process.

The resultant noise level datasets will then be passed into a GIS system, for map production, secondary analysis and reporting.

Further discussion on the noise calculation process is set out below in Section 9.

3.8 Stage 7 - Post Processing and Analysis

Following the production of noise level results within Stage 6 the calculated levels will be analysed in combination with other datasets in order to produce the results required by the Directive and the Commission.

The analysis to be carried out then delivers a number of sets of results including:

- No. of people exposed within noise bands;
- No. of people exposed within noise bands in dwellings with special noise insulation;
- No. of people exposed within noise bands in dwellings with a quiet façade;
- Total area exposed within noise bands;
- No. of dwellings exposed within noise bands; and

- Documentation on the process undertaken to produce the reported analysis results, including metadata for electronic datasets.

Further discussion on the post processing and analysis of the noise calculation results is set out in Section 10 below.

3.9 Reporting and Publication

Finally the results of the strategic noise mapping are to be submitted to the EC using the templates from the EC recommended reporting mechanism, ENDRM 2007 and utilising the EEA EIONET/ROD system, along with metadata and a supplementary report on the noise mapping process. The results are also to be made available to the public in line with the requirements of the Regulations.

Further discussion on these aspects is set out in Section 11 below.

4 Stage 1 – Define Areas to be Mapped

4.1 Criteria for Mapping

Under the Regulations there is a requirement to assess the noise levels from roads, industry and airports at locations within any agglomerations. There is also a requirement to assess the noise levels near designated "major roads" at affected locations outside any agglomerations.

For the first round in 2007 the strategic noise mapping must be undertaken for:

- Agglomeration with more than 250,000 inhabitants within their territories:
    - The air agglomeration of Greater Valetta was reported to the EC in 2005 under DF1. The definition of a noise agglomeration was reviewed and revised as part of the work for the first round strategic noise mapping;
- "major roads"
    - Sections of regional, national or international roads above a flow threshold of 6,000,000 vehicle passages per year (approximately 16,400 per day).

For subsequent rounds, starting in 2012, the strategic noise mapping must be undertaken for:

- Agglomeration with more than 100,000 inhabitants within their territories:
    - The air agglomeration of Greater Valetta was reported to the EC in 2005 under DF1. The definition of a noise agglomeration was reviewed and revised as part of the work for the first round strategic noise mapping;
- "major roads"
    - Sections of regional, national or international roads above a flow threshold of 3,000,000 vehicle passages per year (approximately 8,200 per day).

Note 2: Noise from major sources is regarded as affecting an area if it causes either an L_{den} value of 55dB or greater or an L_{night} value of 50dB or greater anywhere within an area. Which means that the noise maps produced for major roads, major railways and major airports must cover all areas exposed above these noise levels from the relevant sources.

4.2 Area to be Mapped

The areas to be mapped are determined by the requirements set out within the Regulations, which replicate the requirements set out in the Directive.

The agglomerations are defined as areas. The assessment of noise should be undertaken for all the relevant sources for all locations within those areas. Therefore inside agglomerations all roads, railways, industrial areas and aircraft movements should be modelled as sources, regardless of the level of traffic flow, if the noise level exposure of residential dwellings, noise sensitive locations, or quiet areas will exceed 55dB L_{den} and/or 50dB L_{night} at any location within the agglomeration.

The "major railways" are effectively defined by the locations of the sources. The assessments for these major sources must extend to all places near these major sources. Places should be considered near to these sources if the noise exposure resulting from the sources will exceed either 55dB L_{den} or 50dB L_{night}.

4.2.1 *Agglomerations*

The Directive requires all agglomerations with a population of more than 250,000 inhabitants within their territories to be mapped in 2007. The Directive does not set out how an agglomeration is to be defined, rather that is left to the Member States to determine. The Regulations do not set out a definition for an agglomeration, nor do they describe how an agglomeration is to be determined, however they do define an agglomeration as:

> *"part of a territory, delimited by the competent authority having a population in excess 100,000 persons, and a population density such that the competent authority considers it to be an urbanised area"*[31].

There are a number of ways of determining the possible extent of an agglomeration relevant to the END. These include:

- Use of the air quality Directive agglomeration;
- Population density criteria at Local Authority level;
- Population density criteria at Census Output Area level;
- Extent of Urban Fabric as identified in the Corine landcover dataset; and
- Any of the above could be combined with information on the location of open spaces, public parks, hospitals, schools or other noise sensitive locations if there is a desire to include them specifically within any agglomeration boundary.

Note 3: The definition of a noise agglomeration was reviewed and revised as part of the work for the first round strategic noise mapping, and details may be found in the Acustica report 536-4-xx "Strategic Noise Mapping of Malta for the First Round of the END".

Within agglomerations, including the model buffer area, it is required to include all roads, railways, industrial areas and aircraft movements as modelled sources, without applying a traffic flow level filter, if the source will result in a noise level exposure of residential dwellings, noise sensitive locations, or quiet areas which exceeds 55dB L_{den} and/or 50dB L_{night}.

4.2.2 *Extent of Airports*

Within agglomerations there is a requirement to assess the noise levels from all airports with civil movements, whether they are designated major airports or not. Malta International Airport does not fall within the agglomeration boundary, and a screening study undertaken as part of the first round strategic noise mapping determined that the airport flight movements did not result in a noise exposure in excess of 55dB L_{den} or

[31] Article 4.

50dB L_{night} at locations outside the boundary of the airfield and within the agglomeration boundary.

There is also a requirement to assess the noise levels from "major airports" at any location outside any agglomerations. A "major airport" is defined as one with in excess of 50,000 total movements per year, an average of approximately 137 movements per 24 hours. Malta International Airport does not have sufficient aircraft movements to be designated as a "major airport" under the Directive, there were 24,711 aircraft movements in the 2006 assessment year, therefore it would not be mapped on this basis.

4.2.3 Extent of Industry

Within the agglomeration there is a requirement to assess the noise levels from sites of industrial activity such as those defined in Annex I to Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control[32].

Within the agglomerations there may be a number of sites which may be considered industrial, or areas of industrial processes. From a practical perspective, these industrial sites should be mapped if they are thought to result in a noise exposure in excess of 55dB L_{den} or 50dB L_{night} at residential or noise sensitive locations outside the boundary of the site.

Following the determination of any relevant agglomeration boundary, it will be crossed referenced with information on the location of IPPC licensed industrial sites to determine if any sites fall within the agglomeration, and could therefore require mapping.

A screening assessment would then be undertaken at this stage to determine if any of the identified industrial areas within the agglomeration resulted in a noise exposure in excess of 55dB L_{den} or 50dB L_{night} at residential or noise sensitive locations.

There is some debate between EC MS and the Commission as to whether ports fall within the scope of the Directive inside agglomerations. In Malta, ports are declared under the Ports and Shipping Act, 1993, CAP 352, which includes the definition:

- ""port" means the place declared to be a port by or under article 3, and includes wherever appropriate a yachting centre unless a separate provision is made in respect of such centre;"

From a practical perspective, it is considered appropriate to undertake a screening study to review any noise complaints, and any noise measurement information, from the vicinity of any ports and form a view as to whether it is considered likely that noise sensitive locations within the agglomeration will be exposed above the END reporting thresholds of 55dB L_{den} or 50dB L_{night} before undertaking any action to include the ports within the assessment.

4.2.4 Extent of Roads

Within agglomerations there is a requirement to assess the impact of all relevant roads. As noted in WG-AEN GPG v2 the END implies that all roads have to be taken into account and mapped within agglomerations.

[32] Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control, O.J. No. L 257 of 10 October 1996, p. 26-40.

There is also a requirement to assess the noise levels from "major roads" at any locations outside any agglomerations. For the first round of the Directive, a "major roads" is defined as a regional, national or international road with a total flow above 6,000,000 vehicle passages per year, approximately 8,220 vehicle passages per average 24 hours during the 2006 assessment year.

4.3 Area to be Modelled

The above definition of extents identify the area of any agglomeration for which noise results are required, and the linear extents of major noise sources outside of agglomerations.

Following this it is possible to determine the areas to be modelled, as this defines the areas for which input datasets are required for the strategic mapping process.

In addition to the recommendations below, it is considered appropriate to consider WG-AEN GPG v2 Toolkit 1 when forming an estimate of the area to be mapped.

4.3.1 Agglomerations

The strategic noise mapping of agglomerations should provide an assessment of the noise levels from all relevant sources within the agglomeration, for all locations within the agglomeration.

For locations near to the boundaries of the agglomeration, there are most likely noise sources outside the agglomeration which have an influence on noise level assessment within the agglomeration. Some roads, industrial sites and aircraft movements located outside the boundary of an agglomeration, may contribute significantly to noise levels within the agglomeration. Such sources must be included for consideration within the modelled area when noise mapping an agglomeration.

The area outside the agglomeration for which model datasets are required is commonly referred to as the buffer. It is not possible to state a simple distance for an appropriate buffer which is suitable in all cases, as roads with low traffic flows may only influence noise levels within an agglomeration when a few hundred meters away, conversely a major highway may have an influence over 2 km away.

It is recommended that the buffer around the agglomerations will be 2 km wide, as this will ensure that all relevant noise sources are captured in all cases, and fits with the precautionary principle of environmental assessment. Where more specific local information is available it may be possible to reduce this buffer to a minimum of 1 km where major sources are absent from areas within the initial 2 km buffer. Where major sources are present there should be a minimum of a 2 km buffer in the vicinity of the major sources. All the input datasets required for modelling inside the agglomeration boundary will also be developed for the buffer area around the agglomeration, see Sections 6 and 7 for further details.

4.3.2 Major Roads

The noise emissions from "major roads" are defined by the locations of the sections of road above the flow threshold.

As major roads are designated with knowledge of the traffic movement information, it is possible to undertake an assessment of the emission level of the road sections, and carry out an initial assessment of propagation in open conditions within noise mapping software (i.e. without ground terrain, buildings, barriers etc) to estimate the distance of the 55dB L_{den} and 50dB L_{night} noise contours from the sources. This estimated distance may then be multiplied by 1.5, in GIS, in order to set the buffer distance for the model area. This is preferable to using a fixed distance for the buffer over the whole model area, as this is likely to either lead to a buffer which is too small, or produce an unnecessarily large model area.

Experience indicates that the maximum required buffer distance, from the source to the edge of the model area, may be in the order of 3 km, with it possible in some situations, for sections of major road just above the flow threshold, to have a minimum buffer distance of 1 km.

5 Stage 2 – Define Noise Calculation Methods

5.1 Methods of Assessment

The Regulations transpose the two options set out within the Directive. The primary reference is to the EC recommended interim computation methods which are set out in Annex II of the Directive. Reference is also made to the potential use of methods which are laid down in local legislation[33].

As the Directive calls for the assessment to be undertaken using common noise indicators of L_{den} and L_{night}[34] it states that the EC recommended Interim methods, and national computational methods, will need to be adapted in order to provide annual average assessments of L_{den} and L_{night}[35]. The EC published the recommended adaptation of the EC recommended Interim methods in August 2003[36].

It is therefore important to note that the strategic noise mapping must be undertaken using the adapted methods, not the published national standard version of the method. For this reason it is important to expressly state both the core methodology and list the relevant adaptations included within the method of assessment used for the strategic noise mapping.

Whilst the Directive facilitates the use of adapted national methods, and the Regulations reflect this by allowing the use of methods laid down in local legislation, it is important to note that the Directive is specific in the requirement for any selected national assessment method to demonstrate equivalent results to the EC Interim methods[37]. The use of the EC recommended Interim methods therefore avoids this test of equivalence.

For the first round of the Directive, based upon a 2006 assessment year, the choice for each source is clearly between the EC recommended Interim method, and the adapted national method. Going forward there is currently ongoing work aiming to develop the proposed EC common approach, currently dubbed CNOSSOS-EU. This new common method may become the mandatory method of assessment for the strategic noise mapping in 2017, but the second round of strategic noise mapping in 2012 is to be undertaken using the same methods as the first round in 2007.

5.2 Aircraft Noise

The EC recommended Interim method is:

- For AIRCRAFT NOISE: ECAC.CEAC Doc. 29 'Report on Standard Method of Computing Noise Contours around Civil Airports', 1997. Of the different approaches to the modelling of flight paths, the segmentation technique referred to in section 7.5 of ECAC.CEAC Doc. 29 will be used.

This should be used in accordance with the adaptations set out in:

[33] END Article 6 (2)
[34] END Article 5 (1)
[35] END Article 5 (1) and Annex II 2.1 and 2.2
[36] Commission Recommendation of 6 August 2003 concerning the guidelines on the revised interim computation methods for industrial noise, aircraft noise, road traffic noise and railway noise, and related emission data, 2003/613/EC, O.J. No. L 212 of 22 August 2003, p. 49-64.
[37] END Article 6 (2)

- Commission Recommendation 2003/613/EC of 6 August 2003.

The method of assessment including the recommended adaptations is referred to as ECAC Doc 29 Interim.

A number of commercial noise mapping software systems provide support for the EC adapted Interim method of ECAC Doc. 29, for further information refer to the WG-AEN "Mapping Software Catalogue", April 2008[38].

There is no Maltese legislation which currently sets out an official "national method" for the assessment of aircraft noise.

It should be noted that aircraft noise modelling undertaken across Europe regularly makes use of the Federal Aviation Authority (FAA) Integrated Noise Model (INM) software[39]. From version 7.0a of INM uses algorithms consistent with the European Civil Aviation Conference (ECAC) Doc 29 (3rd Edition, December 2005) "Report on Standard Method of Computing Noise Contours around Civil Airports"[40]. It should be noted, however, that this does not necessarily provide equivalent results to the EC adapted Interim method as it is based upon ECAC Doc 29 3rd Edition 2005, whereas EC adapted Interim method is based upon ECAC Doc 29 1997, and INM does not include the adaptations set out in Commission Recommendation 2003/613/EC.

The use of INM as an alternative to the EC adapted Interim method has been noted in other Member States, including the UK where Defra issued guidance on the noise mapping of airports[41].

Should aircraft noise assessment be required in the future, it is recommended that the EC adapted Interim method, ECAC Doc 29 Interim, should be used for the assessment of aircraft noise under the Regulations. In line with the common approach in a number of other EC MS[42] the most current version of the FAA INM software would be used as a means of undertaking the assessment.

The aircraft noise calculations only take into consideration noise from aircraft movements; i.e. from start-of-roll, acceleration down the runway, the period when the aircraft is airborne and deceleration along the runway after touchdown, including reverse thrust if employed. All ground noise sources such as taxing aircraft, auxiliary power units and aircraft undergoing engine testing would be excluded from the modelling. If it is known, or considered likely, that residential properties or noise sensitive locations are exposed to noise levels in excess of either 55dB L_{den} or 50dB L_{night} from these ground operations, it is recommended that they are modelled and assessed as part of the industry noise model in line with guidance in WG-AEN GPG v2.

5.3 Industrial Noise

The EC recommended Interim method is:

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[38] Available from: http://circa.europa.eu/Public/irc/env/noise_map/library?l=/catalogue_versapr08xls/_EN_1.0_ [accessed February 2011]

[39] Available at: http://www.faa.gov/about/office_org/headquarters_offices/apl/research/models/inm_model/ [accessed February 2011]

[40] Available at: http://www.faa.gov/about/office_org/headquarters_offices/apl/research/models/inm_model/ [accessed February 2011]

[41] "Airport technical guidance: the Environmental Noise (England) Regulations 2006" Available at: http://www.defra.gov.uk/environment/quality/noise/environment/background.htm [accessed February 2011]

[42] JRC Final Report, Assessment of the equivalence of national noise mapping methods against the interim methods, Contract no. 07-0303/2007/477794/MAR/C3, December 2008

- "For INDUSTRIAL NOISE: ISO 9613-2: 'Acoustics — Abatement of sound propagation outdoors, Part 2: General method of calculation'.
- Suitable noise-emission data (input data) for this method can be obtained from measurements carried out in accordance with one of the following methods:
    - ISO 8297: 1994 'Acoustics — Determination of sound power levels of multisource industrial plants for evaluation of sound pressure levels in the environment — Engineering method',
    - EN ISO 3744: 1995 'Acoustics — Determination of sound power levels of noise using sound pressure — Engineering method in an essentially free field over a reflecting plane',
    - EN ISO 3746: 1995 'Acoustics — Determination of sound power levels of noise sources using an enveloping measurement surface over a reflecting plane'.

This should be used in accordance with the adaptations set out in:

- Commission Recommendation 2003/613/EC of 6 August 2003.

The method of assessment including the recommended adaptations is referred to as ISO 9613 Interim.

There is no Maltese legislation which currently sets out an official "national method" for the assessment of industrial noise.

The ISO 9613-2 methodology is a means of calculating sound propagation outdoors, and generally regards noise from point sources. The three referenced measurement methods provide a means of determining the sound power levels of industrial sources. These measurement methods are appropriate when the industrial noise sources are to be assessed in some detail within the strategic noise mapping, which may be appropriate where there are known issues with a particular industrial site, or during the Action Plan process where there are proposed specific mitigation measures which need to be considered within the assessment model.

The Interim Method report, AR-INTERIM-CM[43], considers some of the practical issues surrounding the required input data to utilise the ISO 9613-2 method in strategic noise mapping. It is suggested that:

"The choice of input data from the set of available data can be based upon:

- *the desired accuracy;*
- *the practical possibilities; and*
- *the established time frame."*

[43] "Adaptation and revision of the interim noise computation methods for the purpose of strategic noise mapping", Final Report, 25 March 2003. Available at: http://circa.europa.eu/Public/irc/env/noisedir/library?l=/material_mapping/recommended_computation/reports_interim&vm=detailed&sb=Title [accessed November 2008]

Section 5.2.3 then sets out three potential sound power level formats for the modelling of the industrial premises total noise emission.

- Format 1: Global Sources
- Format 2: Zonal Sources
- Format 3: Individual Sources

These formats have an increasing level of accuracy, which is borne from an increasing requirement for source data accuracy and resolution. This is discussed further in Section 7.4 below.

Where the number of industrial sites to be assessed is significant, or the number of sources on site is large, the discussion within AR-INTERIM-CM alongside the practical guidance, and a decision making hierarchy, within WG-AEN GPG v2 Toolkit 10, enable competent authorities and noise mapping practitioners to make informed decisions regarding the relative costs of the approaches to be considered, in the context of the benefits realised from higher degrees of resolution to the strategic noise maps, and thus lower uncertainty in the results obtained.

The noise mapping of industrial sites should include relevant ground operations from airports within agglomerations, along with the noise from commercial port operations. For guidance on the assessment of noise from ports the NoMEports project has published a "Good Practice Guide on Port Area Noise Mapping and Management"[44] (NoMEports GPG).

It is recommended that the EC adapted Interim method, ISO 9613 Interim, is used for the assessment of industrial noise levels for the Regulations. The source noise levels used within the calculations should be derived via a methodology in line with the Regulations, or the WG-AEN GPG v2 Toolkit 10. The modelling of area sources should be informed by the AR-INTERIM-CM report, and any modelling of ports should consider the NoMEports GPG.

5.4 Road Traffic Noise

The EC recommended Interim method for use under the Regulations, is described within the following documents:

- 'NMPB-Routes-96 (SETRA-CERTU-LCPCCSTB)', referred to in 'Arrêté du 5 mai 1995 relatif au bruit des infrastructures routières, Journal Officiel du 10 mai 1995, Article 6' and
- French standard 'XPS 31-133'.
- For input data concerning emission, these documents refer to the 'Guide du bruit des transports terrestres, fascicule prévision des niveaux sonores, CETUR 1980'.

Used in accordance with the adaptations set out in:

- Commission Recommendation 2003/613/EC of 6 August 2003.

[44] "Good Practice Guide on Port Area Noise Mapping and Management", April 2008. Available at: http://nomeports.ecoports.com/ [accessed February 2011]

The method of assessment including the recommended adaptations is referred to as XPS 31-133 Interim.

Note 4: There is an English translation of the original French text within the reports produced under the AR-INTERIM-CM research project.

Note 5: Some caution should be exercised when reading AR-INTERIM-CM as not all of the recommended adaptations were confirmed within the Commission Recommendation 2003/613/EC of 6 August 2003. Only the adaptations within 2003/613/EC should be utilised for strategic noise mapping under the Directive.

There is no Maltese legislation which currently sets out an official "national method" for the assessment of road traffic noise.

It is recommended that the EC adapted Interim method, XPS 31-133 Interim, is used for the assessment of road traffic noise levels under the Regulations. Details of the methodology and its application should be sought from the AR-INTERIM-CM and NANR 93 project reports.

6 Stage 3 - Develop Dataset Specification

6.1 Overview

In order to be able to develop the datasets required for a 3D model environment to support the assessment of noise from roads, railways, industry and aircraft, it is first necessary to develop a dataset specification. A specification is based upon the various features contained within a noise model, and based on the object definitions required by the noise calculation software to be used within the project for the specific method of assessment being used.

In general, the calculation of noise levels takes place in two stages within the noise mapping software:

- The assessment of the level of noise emitted from a source, the "source noise emission"; and
- The assessment of the attenuation of the emitted noise en-route from the point of emission to the receptor, the "propagation attenuation".

After the assessment of noise levels across the area of the strategic noise mapping, it is then necessary to undertake statistical analysis to determine the area, dwelling and population exposure data required to be reported to the EC.

Following this concept, the input dataset required can be classified into:

- **Source input data** which defines the position and characteristics of the noise sources;
- **3D model pathway input data** which defines the environment within which propagation occurs; and
- **Population input data** which defines the location of the population exposed to the long term environmental noise sources.

There is also a requirement for a specification for the output datasets:

- **Output data** which defines the information to be supplied to the EC.

The following discussion on 3D model pathway data is predominantly concerned with the assessment of noise from roads and industry as these may be undertaken within a common model environment within a commercial noise mapping software package. Whilst it is possible to undertake the assessment of aircraft noise to ECAC Doc 29 Interim within such a common model, it is common practice to undertake such modelling using the FAA INM software, where much of the 3D model pathway data is not considered within the assessment.

6.2 Developing a Dataset Specification

Ideally the approach to developing a series of dataset specifications for a complex spatial modelling environment would be to be able to work from a coarse level (abstract) to a detail level (concrete) in the design process.

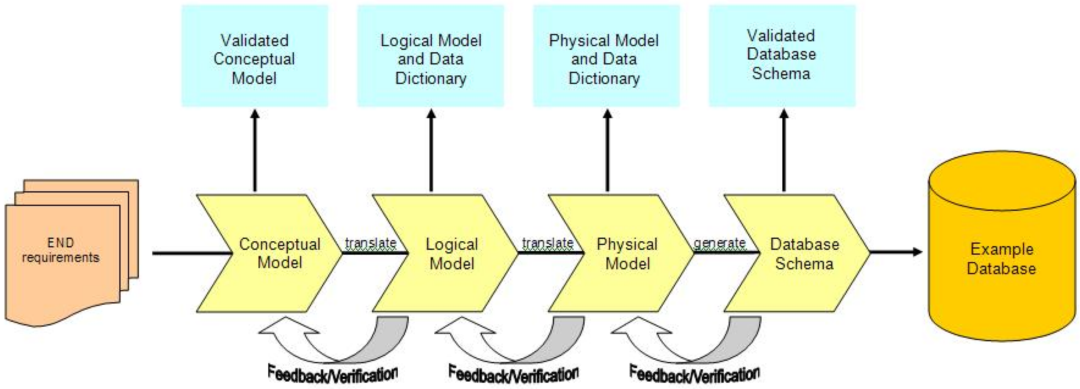


Figure 6.1: Schematic of Approach

There should be a number of stages along the process, including the design of a conceptual model, design of the logical model, and design of a physical model, and then the use of the physical model to generate a physical data schema. This design process has an iterative approach; changes in any one model being fed back into higher and lower models, in order to retain consistency in the set of models.

The first stage is to establish a conceptual model which can be used to guide the development of subsequent stages in the development of a dataset for strategic noise mapping. The data requirements of strategic noise mapping are expansive, and in order to make them more manageable it is useful to break the data requirements into the following categories:

- 3D model pathway input data:
    - data required for the common 3D pathway model;
    - may be used by all models regardless of the source of the noise; and
    - required for major source models, and agglomeration models;
- Road source input data;
- Railway source input data;
- Industry and ports source input data;
- Aircraft source input data;
- Population exposure input data:
    - required to analyse the noise exposure from the results of the strategic noise mapping;
- Noise model output data; and
- Contextual data – necessary to display noise mapping within context.

Acustica report 536-3-14 "Noise Mapping Data Schema", June 2010, sets out the results of developing the conceptual model through to the physical models on the basis of using the LimA noise mapping software tool used for the first round strategic noise mapping.

7 Stage 4 - Produce Datasets

7.1 Process

Stages 1 to 3 have lead to a definition of the area for which data is required, and the design of a database schema suitable to support the END noise mapping process. At this stage the data schema is to be populated using the datasets available to MEPA and the other stakeholders to the process.

The general aim of this stage of the process is to undertake an initial collection of the raw GIS, electronic and paper datasets. It is then necessary to collate and catalogue the information available, and carry out an audit against the specifications drawn up within Stage 3. The audit process provides a gap analysis highlighting any data shortcomings and provide an indication of the processing requirements of the data.

The general areas which are addressed at this point are:

- Appraisal of the available data against the specification, looking into issues such as:
  - Coverage, resolution, accuracy, attributes, maintenance regime, format, metadata, fitness for purpose.
  - A gap analysis to result in details of the data required which is not currently available; and proposes mechanisms for the completion of the input datasets.

Following the appraisal and gap analysis, the input datasets need to be completed in line with the approved approach. This could be via a number of different routes:

- Data capture programs to fill gaps in the available datasets;
- Interpolation or processing of raw datasets to produce relevant derived data products; and
- Use of default values in line with WG-AEN GPGv2.

The WG-AEN GPG v2 provides a number of Toolkits which provide a series of options for sources of genuine data, or guidance on interpolation or use of default datasets. Many WG-AEN GPG v2 Toolkits provide quantified accuracy statements where the impact on the acoustic quality of the results is indicated alongside the description of the option in order for the quality of the strategic noise mapping to be estimated. In general it is recommended that the best approach available, with the lowest uncertainty, should be used where possible.

7.2 3D Model Pathway Environment

The assessment of noise levels from industry and roads requires the development of a 3D model environment. The assessment of noise from aircraft requires a 3D terrain model.

The 3D model environment is required for the whole coverage area for agglomeration models, and for the model area for major sources outside the agglomerations.

The required input data is owned and managed by a number of different stakeholders, and each needs to be approached with a request to supply data into the project. The stakeholders include MEPA, MEPA Mapping Unit, MEPA Planning Unit, Transport Malta, the Police, the Department of Health and the National Statistic Office.

7.3 Aircraft Noise Modelling

It is generally the case that the airport operators will be the major source of information required for the assessment of noise from aircraft in flight. In some cases it may be possible to access air traffic control data which provides electronic datasets for the path, flight code and destination of all movements arriving and departing the airport.

In other cases some information may be available from flight logging systems, such as flight code, destination and departure/landing time, whilst other data may be held by airline companies or in secondary datasets, such as aircraft types and mean flight tracks.

The airport should also be able to supply the various location points required for the runway coordinates, and data such as start of roll locations.

Should aircraft noise modelling be required in the future, it is recommended to follow the guidance on the application and use of the EC recommended Interim method, ECAC Doc 29 Interim, within the ECAC Doc 29 report, AR-INTERIM-CM49 report, and the user manual for the FAA INM software.

7.4 Industrial Noise Modelling

The type of information required for industrial site modelling is determined by the choice of approach. There are three common approaches to modelling the industrial noise emission sources, as discussed within the AR-INTERIM-CM report[45]:

- Format 1: Global Sources;
- Format 2: Zonal Sources; and
- Format 3: Individual Sources.

These approaches have an increasing level of detail and potential accuracy, but also an increasing level of work, time and cost implications. Figures 7.1 to 7.3 are taken from the AR-INTERIM-CM final report to illustrate the differing approaches possible.

[45] "Adaptation and revision of the interim noise computation methods for the purpose of strategic noise mapping", Final Report, 25 March 2003. Available at: http://circa.europa.eu/Public/irc/env/noisedir/library?l=/material_mapping/recommended_computation/reports_interim&vm=detailed&sb=Title [accessed February 2011]

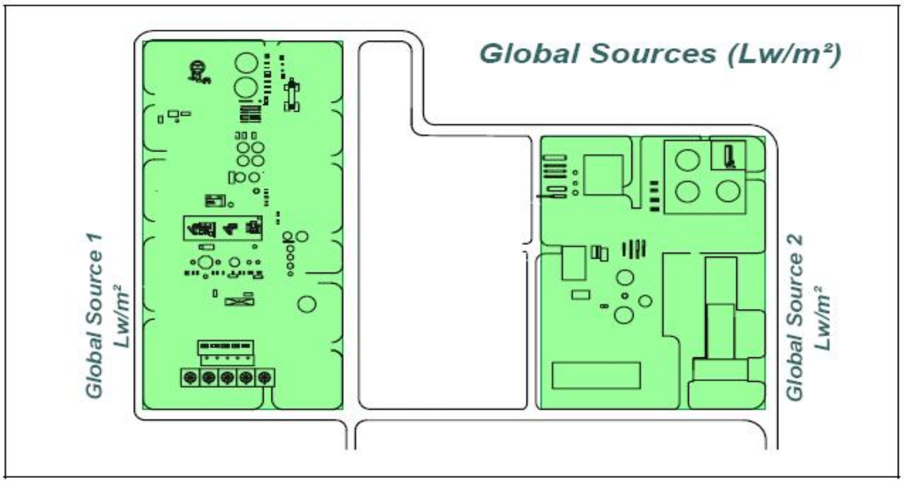


Figure 7.1: Global sources

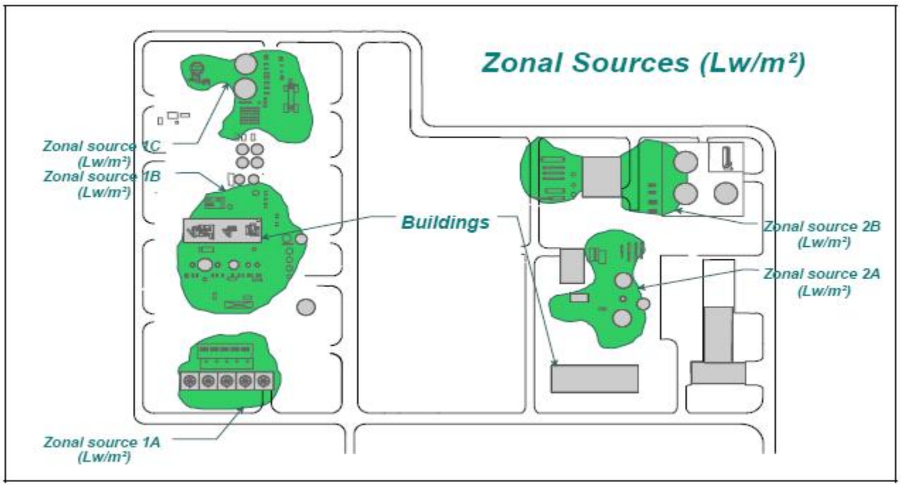


Figure 7.2: Zonal sources

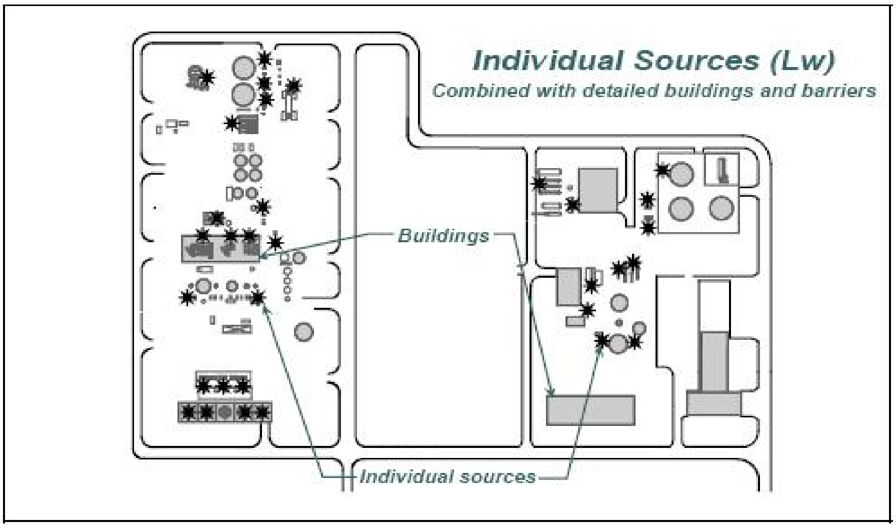


Figure 7.3: Individual sources

It is recommended that the first step is to draw up a list of the industrial sites to be included within any assessment within the agglomeration. With knowledge of the areas to be modelled, the requirements of each of the approaches may be considered alongside the information available for each site.

It is recommended that the guidance within the AR-INTERIM-CM report on modelling industrial noise is considered alongside WG-AEN GPG v2 Toolkit 10 when undertaking the modelling of industrial sites.

7.5 Road Traffic Noise Modelling

The information required for the source emission model for road traffic relates to the vehicles using the section of road, and their interaction with the road surface. Road traffic noise contains components from the vehicle, such as engine, exhaust, transmission and aerodynamic noise, plus noise from the tyre/road interface which is determined by the tyre construction and the road surface texture.

The road centrelines are to be modelled as the location of the emission, and this is generally midpoint between the two opposing carriageways for a standard two-way road, or the centre of the carriageway for a one-way road.

The road centreline objects are attributed with information on the road surface, and the vehicle flow parameters. The road centreline object must be split each time one of these attributes changes in order to be compatible with most noise mapping systems.

The road surface data is required for each road section, and may be captured by CPX or statistical pass by measurements, or by visual inspection. WG-AEN GPG v2 Toolkit 5 provides guidance on the range of methods available, along with quantified accuracy statements associated with the use of each method.

The road gradient is typically derived from interfacing the road centrelines with the terrain model within GIS or within the noise mapping software.

For each road section, traffic flow data is required for two vehicle categories, light and heavy, for the three time periods; day, evening and night. For each vehicle category, for each time period, it is also necessary to know the mean vehicle speed, and the flow type; continuous, pulsed, accelerating or decelerating.

WG-AEN GPG v2 Toolkits 2, 3 and 4 provide guidance on the methods available for determining input data for road traffic flow, average traffic speed and composition of traffic. They also provide quantified data accuracy guidelines to help illustrate the potential impact upon calculation uncertainty associated with the various options.

Traffic flow data is available from Transport Malta information derived from manual traffic counts and automated traffic counts. Care needs to be taken in consolidating these various sources, as they may hold data in different formats, including 24 hours, 18 hours, AADT, am peak, pm peak, off peak, weekday, weekend, 7 day etc. It is required to apply factors to flows to provide a common base situation, and undertake linking of traffic flow data to the road centreline geometry.

Following the consolidation of the input data, and the linking to the road centreline geometry, it is recommended to pass the dataset back to transport Malta for review and sign off prior to use within the noise model.

7.6 Data Capture Through Field Survey

The above sections provide some discussion on the use of the WG-AEN GPG v2 Toolkits to help fill data gaps through the use of assumed default values. It is recommended to review the potential for addressing data gaps by undertaking field survey to capture data, which is likely to provide a lower level of uncertainty than the use of WG-AEN GPG v2 Toolkits.

Where data gaps are identified, steps can be taken to review the importance of the missing data to the overall quality of the assessment. The two Defra funded research studies into uncertainty in noise mapping, NANR 93[46] and NANR 208[47], contain report documents which provide guidance and advice on the data requirements for strategic noise mapping for the assessment of noise from roads and railways.

Where missing data is identified as having the potential for a significant impact upon the uncertainty of the assessment, the potential use of field surveys should be reviewed.

The type of information which could be captured by field survey may include:

- Noise barriers in the following locations:
    - alongside major roads;
    - adjacent to industrial sites; and
    - determine location and relative height.
- Road surface type;
    - Categories as per the assessment method.
- Building heights:
    - See categories below.
- Additional road information:
    - junctions;
    - bridges;
    - flyovers;
    - underpasses; and
    - tunnels.

It remains possible that building height data may be available from detailed surveys, or aerial radar or LiDAR scans. In the absence of such data the WG-AEN GPG v2 Toolkit 15.2 suggests a default building height of 8m is assumed for all buildings.

A field survey could provide information of a higher quality for the modelling assessment, and either count building stories for each building polygon in the model, or

[46] NANR 93: WG-AEN's Good Practice Guide and the Implications for Acoustic Accuracy, May 2005. Available at: http://www.defra.gov.uk/environment/quality/noise/research/wgaen-gpguide/index.htm [accessed February 2011]

[47] NANR 208 – Noise Modelling, Final Report, May 2007. Available at: http://www.defra.gov.uk/environment/quality/noise/research/nanr208/index.htm [accessed February 2011]

visually estimate the building height within a small range of building height classes, such as:

Category	Modelled height	Range for Estimate
A	8.0	Up to 10m (default)
B	12.0	10 - 14m
C	16.0	14 - 18m
D	20.0	18 – 22m
E	24.0	>22m

8 Stage 5 – Develop Noise Model Datasets

8.1 General GIS Datasets

Modern large scale, wide area noise mapping projects are increasingly using digital spatial datasets, which are predominantly generated and managed within GIS database environments. Whilst this removes excessive manpower requirements for manual digitisation of the model data into the noise mapping software, it does generate a series of new problems which could adversely affect either the time required for the project, the accuracy of the spatial model within the noise package, or the concluding final accuracy for the results generated.

Set out below is a review of the typical problems associated with the use of generic GIS datasets within noise modelling, along with some of the available approaches to addressing the issues which should be considered:

- **Lack of Acoustic Intelligence**

  The traditional process of a trained acoustician skilled in the use of the calculation methodology, marking up paper plans and digitising this "sampled" data into a noise mapping package are eliminated and extensive coverage areas are now possible by reusing existing GIS data. Unfortunately, this does mean that almost none of the digital data supplied for noise mapping purposes has ever been assessed to determine as to whether it is fit for the purpose of noise mapping.

  On the one hand, this can lead to users, without an understanding of the calculation methodology, retaining excessive data accuracy and resolution in the context of the inherent uncertainty within the calculation system, this leads to overly large datasets, and excessive calculation times, for a perceived increase in resolution which does not provide greater accuracy. Conversely, it can also lead to datasets being utilised which do not offer a sufficient level of resolution or accuracy to support properly a reasonable standard of noise assessment.

- **Excessive Data Load**

  The resolution of many supplied datasets can be too high within the context of a noise mapping project. The resolution of modern digital cartographic datasets, particularly items such as building outlines, is not necessary within strategic noise mapping projects, so data simplification helps to reduce data volumes within the final model, and subsequently decrease calculation times. Similar issues may well exist with road centreline definitions, barriers, cutting, embankments etc.

- **Fractured Link Data**

  Road and rail centrelines datasets can often suffer from fractured link node models, with a series of polylines describing one flow link. To simplify the model, reduce errors, and increase calculation speeds, concatenation of the links should often be investigated.

- **Traffic Flow Direction**

It often proves difficult to gain access to digital datasets accurately describing road flow direction, which is required for correct identification of one way roads.

- **Gradient Correction**

  The correct assessment of gradient often requires the "draping" of the road/rail centreline onto the underlying digital terrain model (DTM). This process should always be managed, rather than left to automatic interpretation during the calculation runs as small links within polylines can result in localised excess gradient.

- **Road/Rail Structure Geometry**

  Cuttings, embankments and flyovers can be constructed from the linear polyline features received from surveys or mapping agencies. This enables complex 3D geometry to be constructed simply in order to deal accurately with road structures. Bridges can also be automatically generated from road axis data, even using 3 D road polyline objects.

- **Ground Height Definitions**

  Ground and model object height definitions can be managed in a variety of different formats, relative, absolute, single point, 3D polylines, TIN, meshes.

8.2 Base Model - Digital Ground Model

An accurate ground model is important in developing an effective noise model. It is necessary for the determination of the (1) bare ground surface and (2) the assessment of relative building heights, especially within detailed urban areas.

The key components of an optimised Digital Ground Model for noise modelling are:

- As a series of equal height contour lines;
- 3D polylines to describe the edges of features such as cuttings and embankments which would act as screens to sound propagation; and
- Bridges to carry road and rail emission lines over cuttings or junctions.

These elements need to be economically described within the dataset, with a minimum of redundant nodes, and provide a degree of spatial accuracy which impacts upon the acoustic accuracy of the results at or below a level equivalent to the other datasets.

Some types of data optimisation pre-processing steps which are likely to be carried out are:

- Line smoothing - this uses an algorithm to remove redundant node information (within a tolerance of say 0.5 or 1m horizontal displacement). This can be an important factor for improving model performance without loss of overall model accuracy and hence enabling the production of effective noise models.
- Editing of the ground contour model in the agglomerations often needs to have been carried out – this requires editing/removal of spurious contours and/or adding key bridge features. This process concentrates on acoustically important features which are not well defined by the available contour data. These include

bridge overpass, underpasses and cuttings located on/near principal road and rail routes.

8.3 Base Model - Buildings

In addition to the ground model, the buildings layer is one of the most important layers necessary for the development of an accurate and effective noise model. There are a number of issues relevant to noise modelling which can typically arise within buildings datasets. These aspects are discussed below:

8.3.1 Building Height

Building height attribution can present issues such as:

- Lack of real building height data;
- Zero height buildings;
- Excessively high buildings; and
- Inconsistencies in building heights along terraces.

8.3.2 High Number of Building Polygons

In complex datasets the individual construction of each building unit as a unique polygon object has many beneficial uses for address based, or population based analysis. Within noise modelling, it is not necessary to have information regarding the connecting walls within blocks of building, or terraces of house, as this is redundant information as far as the noise propagation is concerned, and will thus extend the calculation time without providing benefit to the results obtained.

8.3.3 Building Objects Located on Road Features

Extensive previous work with a number of mapping products suggests that there can often be issues with objects in the buildings layer being located across the road or rail emission lines, and broken road and rail centrelines which do not extend below bridges.

Checks are often required when developing a buildings layer to identify and correct features such as those below which often find themselves in the buildings theme:

- Footbridges between buildings;
- Footbridges over rivers;
- Footbridges over roads;
- Electricity pylons; and
- Elevated road signs.

Although these represent a small number of objects, the presence of these features can introduce noticeable error into the final noise maps, but caution does need to be exercised, as sometime buildings do correctly straddle road or railway emission lines, so they cannot all be removed without due consideration.

8.4 Base Model – Topography

There most likely source of ground cover information is the CORINE data set, which is a 1:100,000 scale European-wide digital land cover product derived from Landsat TM imagery. The minimum size of a CORINE land parcel is 25 hectares;

Recent experience testing the use of CORINE land cover datasets compared to high resolution UK datasets such as OSI Largescale and OS MasterMap has raised issues regarding the complexity of the raw dataset in the context of noise propagation modelling. Test calculations have indicated that the simplified CORINE dataset can be used within agglomerations with very little change in calculated noise level.

8.5 Base Model - Barriers

The WG-AEN GPG v2 presents quantified accuracy statements for road traffic noise calculations. One of the key outcomes was an understanding of the importance of correctly identifying the height attributes of potential screening objects in the vicinity of the road corridor, particularly the edges of cuttings, or the tops of barriers.

8.6 Noise Source Layer – Aircraft

The assessment of noise from aircraft in flight may be undertaken within the same noise mapping software system used for the road, railway and industrial noise calculations, or may be undertaken using the FAA INM software.

8.6.1 INM Projection System

When using the FAA INM software one of the main areas to be addressed correctly is the re-projection of data from metres in the Malta Grid to decimal degrees in the WGS84 projection used within INM. All data associated with runway definitions and study centre point would need to be translated accurately, along with terrain data.

8.6.2 Routes and Dispersion

The routes taken by arriving and departing aircraft depend upon many factors including:

- Destination;
- Aircraft Type;
- Operational Characteristics;
- Noise Abatement Tracks / Departure Rules; and
- Runway Usage.

In some cases it is possible to use flight track data directly exported from the airport air traffic control logging system. This is able to provide actual flight routes for all aircraft movements arriving or departing the airfield.

In other cases this information may not be available, in which case it is necessary to set up a series of mean arrival and departure routes for each of the runways in use, along with an estimate of the dispersion around this mean track to consider how the aircraft become spread out from the mean as distance from the airfield increases.

Figure 8.1 illustrates how the modelling of mean tracks and dispersion routes may produce a flight track model.

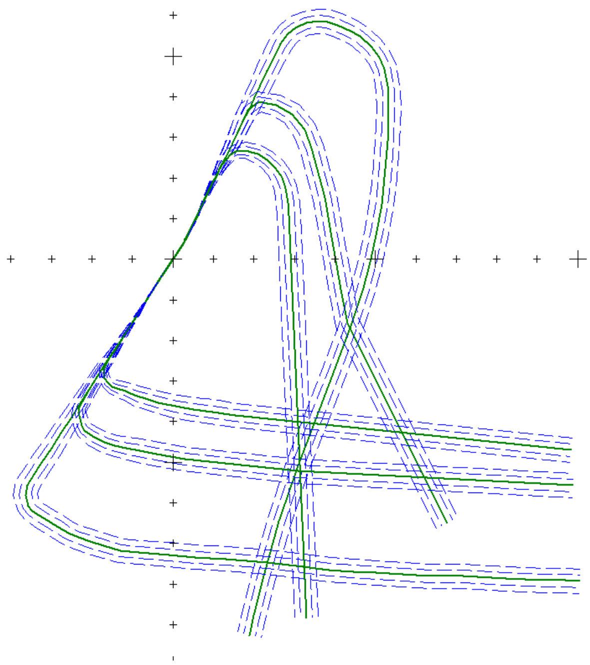


Figure 8.1: Modelled mean flight tracks and dispersion

8.6.3 Assigning Aircraft to Routes

The assigning of aircraft to routes may be handled automatically when such data is logged within the airport systems; however this is not available in all cases, in which case a degree of manual processing is required.

In order to determine the noise emission from the departing aircraft, information on aircraft type is used in addition to the flight profile and the take-off weight, which is generally related to the stage length of the flight i.e. distance to be flown.

In addition to this information, it is also necessary to establish an annual average distribution of arrivals and departures (in the day evening and night periods), across the various runways in use at the airport. This distribution is generally not even as it may be related to weather conditions, prevailing wind and any noise preferential routes or local agreements.

8.6.4 Aircraft Substitutions

The available databases cover the emission data for most major aircraft types, however, they are not exhaustive and therefore the required emission data may not be available for all aircraft which are to be modelled. In these cases it is normal practice to use substitutions of the unknown aircraft with types for which the required emissions data is available. These substitutions may be based upon certification data, engine type or number of seats etc.

The impact of aircraft selection and substitutions upon the uncertainty of the noise contours depends upon the contribution of each aircraft type to the noise contours, and hence the proportion of these aircraft making up the overall movements. In general it is appropriate to undertake an assessment to determine the overall contribution of each aircraft type by determining the noise level for an individual aircraft, combined with its number of movements. It is generally important to ensure that dominant aircraft types are correctly identified, or substituted with caution, the overall impact of some aircraft types with very few movements can be very small in the context of an annual average assessment.

8.7 Noise Source Layer – Industry/Ports

The strategic noise mapping of industrial sources under the Directive may be undertaken using a highly detailed approach where each noise source within a site is described, along with all buildings, barriers, topography etc, or may be undertaken is a more simplified manner. WG-AEN GPG v2 provides a number of differing approaches to modelling industrial noise sources.

The information required, and the issues which may be encountered will be determined by the input data available, and the requirements of the action planning process. In general the types of issues which may arise include the following factors.

8.7.1 Noise Emission Levels

Sound power levels are required for each of the modelled sources, with any necessary day, evening and night variance considered. Detailed approaches could consider octave band noise sources, whilst more general approaches may only consider overall A-weighted source terms.

8.7.2 Noise Source Location

Detailed point, line or area sources, or generalised emission areas, require accurate location with respect to the 3D ground model

8.7.3 Objects within the Industrial Site

It may often be difficult to gain a current description of the location of relevant buildings, barriers and screens within the industrial site. These items are relevant to both detailed and generalised approaches to assessment.

8.8 Noise Source Layer - Roads

Although the ground model, buildings and ground cover data layers are key components of the noise modelling process, spatially accurate and populated source term information (i.e. road traffic flow and condition data) is crucial to the development of an effective noise map to meet the purposes of the END.

There are a number of issues relating to the use of generalised GIS datasets for road traffic noise sources are discussed below.

8.8.1 Road Traffic Flows

Gaining access to road traffic flow parameters for all the required roads can be problematic. In the absence of such information, default values may be assigned to the input datasets. One potential approach for determining default values could be the approach outlined in the WG AEN GPG v2 Toolkit 2, Tool 5 to assess assumed traffic flow levels using a graduated approach.

8.8.2 *Other Road Attributes*

In addition to road traffic flow, there are several additional attribute fields which will be important to the effective development of road noise maps within the agglomeration areas and the strategic road corridors. These are:

- Road Direction;
- Road Nature/Class;
- Road Surface Type;
- Traffic Speed; and
- Split of light and heavy vehicles.

8.8.3 *Height Attribute*

An efficient road layer will also contain information on the relative height of each road segment. This is particularly important for road sections which cross bridge features.

The attribution is normally the result of GIS processing to create and attribute correctly road segments which either: (a) traverse a bridge or (b) follow ground contours. Using the output of the cutting process, a manual exercise is typically required to correctly assign attribute values to each of the road segments.

Figure 8.2: An example of an accurate digital road network model (brown) and an inaccurate road traffic network model (green). (After WG-AEN GPG v2 p19.)

8.8.4 *Geometry*

As discussed in WG-AEN GPG v2 available road traffic network models which hold information of vehicle flows and speeds are often based upon a link-node format where nodes may be located in approximately relevant geometrical locations such as junctions, whereas the links are generally straight lines between the nodes, unlike real roads. An example is shown in Figure 8.2 above.

In this situation it is required to match across the traffic flow information from the geometrically inaccurate flow model over onto the geometrically accurate road centreline dataset. This is normally a semi-automated method which may require a high level of manual intervention and checking.

9 Stage 6 – Noise Level Calculations

The main focus of initial considerations regarding the assessment of noise levels for strategic noise mapping under the Directive may well centre on the calculations to be undertaken at this stage of the process. As discussed above, experience of large area city and regional noise mapping projects suggests that the data capture, and data processing stages are the most time consuming, costly and labour intensive. The noise calculations at this stage may be more specialised in nature, but when operating a good commercial software solution rely more on machine time for processing, rather than staff time.

Set out below is a discussion on some aspects which should be considered when undertaking the calculations.

9.1 User Defined Calculation Settings

There are many aspects of the noise calculations which may be controlled by use of the user defined settings. These can range from specifying grid resolution (i.e. grid cell spacing at which noise was calculated) to determining how many reflections should be considered. Other calculation settings can be defined as 'efficiency settings' which aim to simplify aspects of the assessment in order to reduce processing time, these generally aim to provide improvements in processing efficiency, or scalability.

The use of these user controlled calculation parameters can have a significant effect upon the uncertainty associated with the calculated results, and due care and process checks should be included in order to ensure that the settings in use do not introduce unacceptable levels of uncertainty.

Efficiency settings are designed to reduce calculation time by employing different techniques which either reduce the number of calculations required, or reduce the complexity and detail of the calculations. Despite the benefit in reducing calculation time, efficiency settings can introduce uncertainties into the calculated noise levels.

In general efficiency settings are designed to simplify or ignore aspects of the source to receiver propagation path assessment based upon criteria set by the user and the software developer. This introduces a compromise between uncertainty and calculation time. In general, a fast calculation will introduce more uncertainty into the noise levels than a slower calculation.

Some efficiency settings perform better than others both in isolation and in parallel. As a result, it is recommended that investigations are carried out using test areas to identify the appropriate calculation settings to be used for the final calculations. These should strike a balance between time saving, and uncertainty introduced into the noise level results.

9.1.1 Use of Test Calculations

It is recommended that prior to final calculation runs being commenced, that a test area (or areas) of the model is used to investigate the optimal calculation settings to be used. A suitable model area is recommended to be 5 x 5 km in area, with a calculation area defined as the central 1 x 1 km area. The test model should be representative of the model as a whole, and provide a range of propagation situations.

It is recommended that the settings associated with the standard are reviewed and set; these include aspects such as search radius for reflections, minimum source to receiver distance, number of reflections etc. These should remain the same throughout the tests.

The settings which the developer suggests may provide efficiency benefits should then be set to their most accurate value, which will normally result in the highest quality calculation taking the longest time. These settings should then be varied one at a time, and the results grids statistically compared with the base case to assess the uncertainty in calculated results.

By running multiple tests, for multiple parameters in a number of settings, it is possible to compare the costs (uncertainty in results) with the benefits (time saving) and select a preferred set of calculation parameters. It is recommended where possible that the 95% confidence interval of the results is kept within 1.0dB of the base case results.

9.2 Calculation Hardware Environment

In addition to defining the appropriate settings for the calculation parameters, the calculation process can be further optimised using a combination of:

- Calculation Tiling;
- Multiple Calculation Servers; and
- Hardware Environment.

All three of these optimisation techniques may be utilised during the calculation of noise levels.

9.2.1 Calculation Tiling

Calculation tiling is a technique which allows one large calculation area and model to be split into smaller areas, which can then be calculated simultaneously on several computers or one by one. Generally it has been found that the smaller the tile size, the faster the calculations will run due to the smaller dataset in process, however this could lead to many hundreds of model tiles.

The tiles would generally be configured with a central calculation area, say 1 x 1 km, plus a buffer of data, say 2 km all around to make a 5 x 5 km model area, to ensure that the tiled results combine in a seamless manner.

The LimA noise mapping software handles this distribution of processing in an automated manner. There are significant advantages of tiling calculations over a single model calculation. These are:

- **Reduced Calculation Times:** By splitting the calculation up into tiles, this allows a noise model to be distributed across multiple calculation servers. Smaller models also process more quickly per grid point than larger models.
- **Calculation Redundancy:** Tiling increases calculation redundancy significantly with respect to a single calculation. In the event of hardware failure only one tile will fail rather than a single large calculation.

9.2.2 Multiple Calculation Servers

The use of multiple calculation computers also improves calculation time by allowing automation of calculations, and parallel processing of multiple model tiles. The LimA noise mapping software systems contain tools which can be licensed which will automatically distribute multiple parallel processing jobs across multiple processors, across multiple computers if available.

9.2.3 Hardware Environment

If the computer hardware in use is only expected to be undertaking noise mapping calculations then the hardware environment may also be optimised for calculations based on the requirements of the noise mapping software. This has been achieved by turning off all the unnecessary system services to improve the available physical memory and CPU to the calculation core. Testing across multiple CPU manufacturers and architecture designs also lead to dramatic differences in processing time not solely related to CPU clock speeds.

9.3 Pre-flight Checks

Prior to the final calculations being commenced, it is recommended that a series of pre-flight checks are undertaken to confirm that the model will be processed without problems.

Final datasets should be loaded into the noise mapping software tool, and a number of single receptor calculations undertaken to confirm that the relevant files load and process without issues.

It is also useful to undertake a 100m x 100m grid calculation across the model, as this will test any model tiling or automatic distribution of processing across multiple machines, but will also assess 1% of the grid points from the final run, which will help to provide a good indication of likely processing times.

Using current computer hardware, an initial estimate of processing time may be gained by using processing times of around 0.25 seconds per grid point for assessments of road traffic noise in agglomerations, industry and major sources often process more rapidly.

9.4 Post Calculation Checks

Following the completion of the calculation run it is important that checks are carried out to verify that the noise levels produced are in line with expectations. It is recommended that graphical maps representing the noise levels, as noise contour maps, are produced in order for any gaps, errors, or anomalies to be identified.

A number of noise mapping software tools also produce output log files which should be reviewed to ensure that all the necessary input datasets were loaded, and that the calculations were processed without errors.

10 Stage 7 – Post Processing and Analysis

After the completion of the noise calculations the noise level results will be available as derived datasets from the noise modelling process.

The noise results generated can now be mapped, presented graphically, and used as the basis for supplementary analysis in order to derive the required information for reporting to the Commission.

10.1 Noise Grid Processing

The grids of noise assessment results delivered form the noise mapping software may have a number of aspects which require attention prior to the processing of the various stages of statistical analysis.

Noise results grids may contain:

- Empty grid points or default data values for grid points located inside buildings where an assessment of noise level is not considered appropriate;
- Default data values for grid points located outside the boundary of the area to be mapped; and
- Result values to more than two decimal places.

To prepare the grids of noise results, it is recommended that the results files are verified, and relevant pre-processing undertaken:

- Interpolation of grid values to assign indicated noise levels to points with blank or default values;
- Masking of results grids to the extent of the area to be mapped; and
- Rounding of the results to two decimal places.

These processed noise results grid files may then be used for the following:

- Production of 5dB noise contour bands for graphical mapping of results; and
- Production of reclassified grids into a set of 5dB categories.

The 5dB bands are:

L_{den}	<55, 55 – 59, 60 – 64, 65 – 69, 70 – 74, >=75
L_{night}	<50, 50 – 54, 55 – 59, 60 – 64, 65 – 69, >=70

Note 6: all class boundaries are .00, i.e. 55-59 is actually 55.00 to 59.99. This is in line with the approach of a number of the commercial noise mapping software packages. This can require the use of a database program such as MS Access, MS SQL or MySQL where class boundaries can be programmed. The default behaviour in MS Excel should not be used for this analysis as it rounds at .49 and .50, however the ROUNDDOWN function can be used to apply the class boundaries.

10.2 Area Analysis

The EC recommended reporting mechanism, ENDRM 2007/EIONET/ROD, requires information on the total area, inside and outside agglomerations, (in km^2) exposed to L_{den} and L_{night} higher than 55, 65 and 75dB for major roads, major railways and major airports.

The reclassified grid files may be used to calculate these areas as each grid point represents an area of 100 m^2.

10.3 Dwelling Analysis

The Directive requires information on the total number of dwellings (in hundreds) exposed to L_{den} and L_{night} higher than 55, 65 and 75dB for major roads, major railways and major airports.

It also requires information on the estimated number of people (in hundreds) living in dwellings that are exposed to noise in 5dB bands for the various scenarios mapped. This will require population census data with a specified date.

For these reasons it is necessary to develop a dwellings dataset. Although the Directive refers to "dwelling" in a number of places[48], there is no definition within the Directive.

The residential dwellings dataset is intersected with the façade calculation results files in GIS, in order to assign the noise exposure band to each façade of the building. The population exposure assessment may then be undertaken using the most exposed façade identified in line with the recommendations within WG-AEN GPG v2. The buildings may then be summarised to provide the total numbers of dwellings required.

10.4 Population Analysis

The Directive requires information on the estimated number of people (in hundreds) living in dwellings that are exposed to noise in 5dB bands for major roads, major railways and major airports, and for airports, industry, railways and roads within agglomerations.

The 5dB bands are:

L_{den}	<55, 55 – 59, 60 – 64, 65 – 69, 70 – 74, >=75
L_{night}	<50, 50 – 54, 55 – 59, 60 – 64, 65 – 69, >=70

The residential population dataset is to be intersected with the façade calculation results files in GIS, in order to assign the noise exposure band to each façade of the building. The population exposure assessment may then be undertaken using either the most exposed façade identified in line with the recommendations within WG-AEN GPG v2, or the German VBEB method which distributes the population around the various building facades. The population exposure statistics may then be summarised to provide the information required by the EC.

[48] END Article 3 (q), Annex I (1), Annex III, Annex IV (1) and Annex VI (1.5, 1.6) and (2.5, 2.6)

11 Reporting Requirements

11.1 Reporting Mechanism

The Member States within the EC need to submit the results of the strategic noise mapping and action planning to the Commission. As the designated competent authority it is the responsibility of MEPA to report the results of the strategic noise mapping and action planning to the Commission.

To this end the EC have published the recommended Electronic Noise Data Reporting Mechanism (ENDRM)[49] for reporting under the END, which sets out 11 Data Flow templates covering the Member State (MS) reporting obligations set out in the Directive. The Data Flows cover the first and second round implementations of the END with deadlines ranging from 2005 to 2014.

The ENDRM has now been enacted within the EEA EIONET system on Reportnet[50]. This now contains the most up to date version of the guidance, templates and metadata requirements for reporting under the END.

The information reported to the EC under the various data flows may be updated at any time by MEPA.

11.2 Information to the Public

Within the context of the Regulations, and the Directive, the strategic noise maps are to serve as a public statement of the extent to which environmental noise currently affects the area covered by the maps, and to provide the basis of evidence for the development of noise action plans.

To this end information for the public on strategic noise maps, should be clear and comprehensible, and include a summary setting out the most important points[51].

Dissemination to the public should be via any appropriate means, including through the use of available information technologies[52], and should be in accordance with relevant Regulations, see Note 7.

> **Note 7:** On dissemination, the Directive states that it should be in "accordance with relevant Community legislation, in particular Council Directive 90/313/EEC of 7 June 1990 on the freedom of access to information on the environment", which has subsequently been repealed and replaced by Directive 2003/4/EC of 28 January 2003 on public access to environmental information. Directive 2003/4/EC is transposed into Maltese law as S.L. 435.61, Freedom of Access to Information on the Environment Regulations, L.N. 116 of 2005.

European Commission Working Group Assessment of Exposure to Noise (WG-AEN) have developed a Position Paper on "Presenting Noise Mapping Information to the Public", March 2008[53]. This provides clear guidance, advice and examples of best

[49] Available at: http://circa.europa.eu/Public/irc/env/d_2002_49/library?l=/reporting_mechanism/reporting_mechanism&vm=detailed&sb=Title [accessed July 2010]
[50] Available at: http://www.eionet.europa.eu/reportnet [accessed July 2010]
[51] END Article 9 (2)
[52] END Article 9 (1)
[53] Available from: http://circa.europa.eu/Public/irc/env/noise_map/library?l=/wg-aen_001_2008doc/_EN_1.0_&a=d [accessed July 2010]

practice on how to publish noise mapping information. One important aspect which the position paper covers is the need for suitable supporting information and explanation alongside the noise mapping results in order for the relevance and context of the results to be conveyed.

11.3 Revision

The Regulations introduce a continuing obligation on MEPA to review (and revise, if necessary) the Strategic Noise Maps every 5 years[54]. Should such a review be necessary, then the process described above shall be followed and the revised strategic noise maps shall be re-published and re-submitted to the EC.

Therefore, ahead of the delivery of R2 strategic noise maps in 2012, and each subsequent 5 years, MEPA have an obligation to undertake a review of the strategic noise maps and, where necessary, revise them. For the basis of this review of R1 strategic noise maps ahead of R2, MEPA should consider that a revision of the strategic noise maps is required if it is known, or thought likely, that greater than 10% of the exposed population within the area of an action plan have experienced a change in the prevailing noise situation of greater than 1dB(A) L_{den} or L_{night}.

It is recommended that the review comprises consideration of the following aspects:

- Has there been a significant increase or decrease in traffic volumes (25% = 1dB) on any individual road?
- Have there been any significant new infrastructure developments? E.g. bridges, bypasses or runways;
- Have there been any significant new developments? E.g. regeneration or housing developments;
- Have additional road segments come into the "major" category due to the change in traffic flows or flow thresholds?
- Have any major policy decisions caused a noise impact which should be shown in revised maps? E.g. noise action plan measures;
- Have there been any significant changes to the vehicle fleet? i.e. cars, %HGVs, aircraft.
- Have noise emissions from industrial sites within agglomerations altered?

This process has the potential to conclude that a revision of the strategic noise maps is not required in certain areas; therefore no further work needs to be undertaken for that location and the R1 noise level results may be published as the R2 noise level results. It should be noted that this is not consider to be a likely outcome as the change in flow threshold from 6 million to 3 million vehicles between the first and second rounds will significantly change the network of major roads to be mapped.

The review and its outcome should be documented within the report on strategic noise mapping. When revision of the strategic noise maps are deemed necessary for any of the above reasons, the revised strategic noise maps should be re-published by MEPA in line with the approach set out above.

[54] Article 12 (4)

12 Noise Level Measurements

The strategic noise mapping process described above is the primary means of monitoring environmental noise under the Directive. There is no mandatory requirement to undertake measurements as part of the process, however there may be situations where this approach is perceived as desirable.

It is suggested that there are two types of noise measurement procedures which may be used to support the strategic noise mapping assessment:

- Input data capture and verification of the modelled source emissions levels; and
- Validation of the strategic noise mapping.

12.1 Input Data capture and Verifying Modelled Source Emissions Levels

The application of measurements for use in capturing input data for strategic noise mapping was also emphasised in the Commission Recommendation of 6 August 2003 concerning the guidelines on the revised interim computation methods for industrial noise, aircraft noise, road traffic noise and railway noise, and related emission data. Herein specific measurement procedures were described for parameters used within the road and railway source terms, some acoustics, and others non-acoustic such as speed.

The source emissions levels (defined as a sound power level, L_w, usually expressed as octave band levels or overall dB(A)) values, cannot be determined directly using measurement techniques due to the wide range of application in terms of flows, speed, ratio of heavy vehicles and road surface types. Therefore it is more typical to undertake sound level or sound intensity measurements in order to ascertain the relevant values of specific input parameters required for the assessment of the emission level.

12.1.1 Road Traffic Source Emissions Levels

In order to determine road traffic source emissions levels for use within the END strategic mapping assessment, the following procedures are recommended[55]:

> *"The noise emission level of a vehicle is characterized by the maximum pass-by sound level in dB(A), L_{Amax} measured at 7.5m from the centreline of the trajectory of the vehicle. This sound level is determined separately for different vehicle types, speeds and traffic flows. The slope of the road is identified. The road surface is not explicitly taken into account. To remain compatible with the original measurement conditions, measurements should be made for vehicles driving on either of the following road surface types: cement concrete, very slim bituminous concrete 0/14, half-granulated bituminous concrete 0/14, superficial seal 6/10, superficial seal 10/14. A surface correction is later added according to the scheme. It should be noted that the proposed road surface correction is not tied to and were determined in complete independence of any specific French road surface data. The aforementioned road surface types were used in France in the 1970s when the noise emission measurements for the Guide du Bruit were conducted. The vehicle speed should be measured with a Doppler radar (accuracy of approximately 5% at slow speeds). The traffic flow is determined either by*

[55] AR-INTERIM-CM (CONTRACT:B4-3040/2001/329750/MAR/C1)
Adaptation and revision of the interim noise computation methods for the purpose of strategic noise mapping; Wölfel Meßsysteme et al. EC DG Environment, March 2003

measurement or by subjective observation (accelerated, decelerated or fluid).”

This brief summary of the measurement procedure clearly shows that in addition to the acoustic noise measurements, there is also a necessity for additional specialist measurement equipment such as traffic counters, meteorological stations, Doppler radar guns and as well specific techniques for the measurement of the road surface correction.

Example of road traffic analyser

Figure 12.1: Portable traffic analyser

There are a wide variety of options for undertaking traffic flow counting surveys. Before undertaking such an automated survey, it would be necessary to confirm that the possible measurement equipment will provide all the necessary information for the purposes of the noise calculations. It would be advisable that Transport Malta undertakes traffic counts, and that MEPA liaises with Transport Malta and provides details of the input data requirements for the strategic noise mapping, such as road vehicle categories, speed data requirements, and time periods of assessment.

An example of a temporary road traffic analyser [56] is shown on Figure 12.1.

Measurement of road surface characteristics

For the purpose of measuring the acoustic characteristics of road surfaces, there are currently two recommended methods:

- ISO 11819-1:1997 Acoustics -- Measurement of the influence of road surfaces on traffic noise -- Part 1: Statistical Pass-By method, and
- ISO/CD 11819-2 Acoustics -- Measurement of the influence of road surfaces on traffic noise -- Part 2: Close-proximity method.

The later Part 2, provides a comfortable method for recording noise characteristics of a road surface as a function of distance. The method is highly suitable for road maintenance authorities to acoustically assess road surfaces. The design of the trailer excludes the effects of background noise during the measurement and makes it suitable for application in a noisy environment[57].

[56] http://www.sterela.fr/systemes-electroniques.asp?idcat=1 [Accessed February 2011]
[57] http://www.mp.nl/leaflets/leaflets.php?langID=2&page=CPX [Accessed February 2011]

Figure 12.2: CPX Trailer

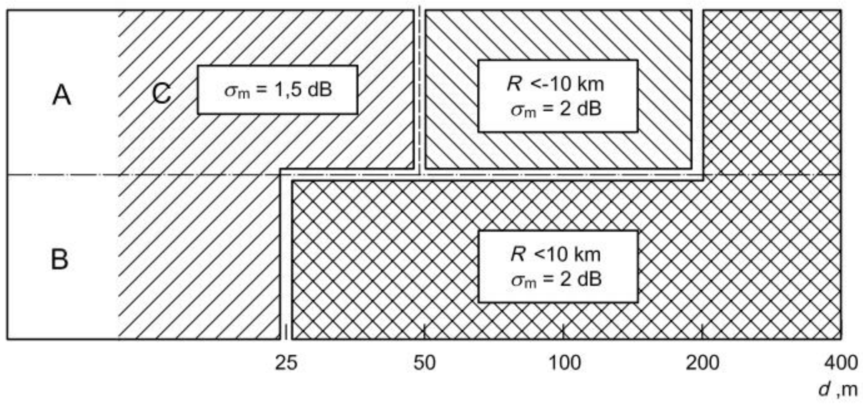
Additionally, if it is necessary to acquire all the characteristics of the road surfaces, not just the acoustics characteristics, it is possible to use ISO 13472:

- ISO 13472-1:2002 Acoustics -- Measurement of sound absorption properties of road surfaces in situ -- Part 1: Extended surface method
- ISO 13472-2:2010 Acoustics -- Measurement of sound absorption properties of road surfaces in situ -- Part 2: Spot method for reflective surfaces
- ISO 13473-3:2002 Characterization of pavement texture by use of surface profiles -- Part 3: Specification and classification of profilometers
- ISO/TS 13473-4:2008 Characterization of pavement texture by use of surface profiles -- Part 4: Spectral analysis of surface profiles
- ISO 13473-5:2009 Characterization of pavement texture by use of surface profiles -- Part 5: Determination of megatexture,

Measurement of the meteorological data

As the "Nouvelle Methode Prevision de Bruit de Trafic" (NMPB) is a L_{eq}-based method, and predicts propagation effects for both neutral meteorological conditions and downwind conditions according to ISO 9613-2 (ISO 1996), it is necessary to include such meteorological parameters within the noise measurement procedure.

ISO 1996-2:2007 also provides the definition of a so called "meteorological window" that describes the set of weather conditions during which measurements can be performed with limited and known variation in measurement results due to weather variation. On the basis of the measurement site (source-receiver distance, height) and meteorological data the soundpath radius of curvature R, which describes radius approximating the curvature of the sound paths due to atmospheric refraction, must be determined.



Key

A high

B low

C no restriction

Figure 12.3: Sound path radius of curvature, R, and the associated measurement uncertainty contribution, expressed as the standard deviation, σ_m, due to weather influence, for various combinations of source/receiver heights (A to C) over porous ground

It should be noticed that according to the ISO 1996 it is mandatory to measure meteorological parameter (temperature, humidity, wind speed and direction) at heights from 0.5 up to 11 m. It can therefore be seen that even for short term measurements, a portable meteorological stations is required.

Figure 12.4: Example of the meteorological station mounted on the 10m mast.

German standard DIN 45642:2004: Messung von Verkehrsgeräuschen (Measurement of traffic noise)

One possible option is to use the German standard DIN 45642:2004: Messung von Verkehrsgeräuschen (Measurement of traffic noise) which covers the emission and immision noise measurements of the road, rail and water traffic. The requirement for the proper placement of the noise emission point is presented in Figure 12.5

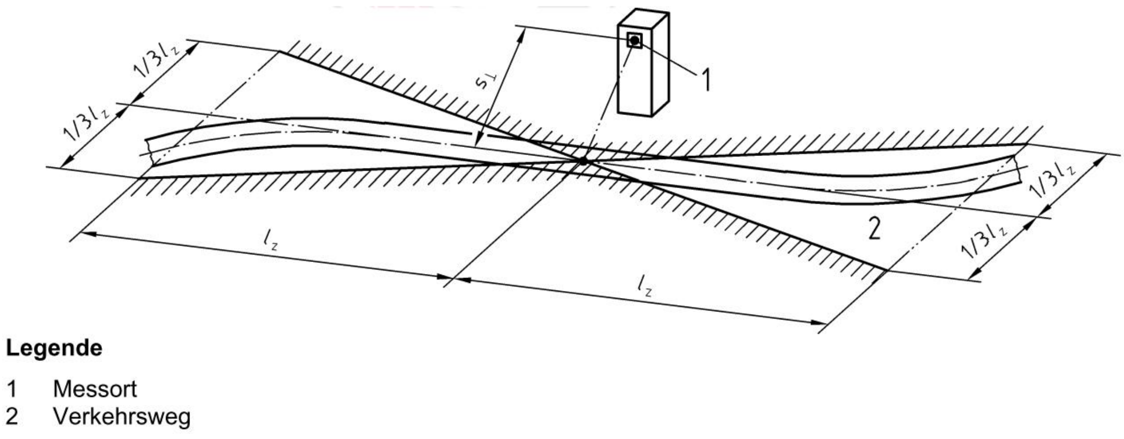


Figure 12.5: Graphical determination of the required position of the noise emission assessment point according to the DIN 45642

12.1.2 Industry Source Emissions Levels

There are two primary influencing factors on the quality of the results which may be obtained for strategic noise mapping of industrial sources. On the one hand the nature of the sound power levels that acoustically describe the industrial sound sources; and on the other hand the precision with which the geometry of the industrial zone and its surroundings have been transformed into the computer model. The most precise approach will be based upon the actual measured and calculated sound power levels of the entire industrial installations or, if possible, even of discrete individual sound sources. It should be borne in mind that unless the source emission data is previously available, almost every strategic noise mapping project of industrial sources will not be able to determine the individual source sound power levels in this way due to time and budget constraints in the context of the benefit to the quality of the assessment which such measures will introduce.

Currently it is possible to use four different approaches for obtaining data about sound power levels of industrial sources for use with the interim method (ISO 9613-2)[58].

[58] Adaptation and revision of the interim noise computation methods for the purpose of strategic noise mapping - WP 3.4.2: Industrial noise - Guidance on noise emission measurement methods

Input Data		Accessibility	Precision
From	**As**		
Type 1: Public database	L_w/m² for entire site	Public	Rudimentary estimate
	L_w for individual source		
Type 2: Theoretical exploitation conditions	L_w/m² or L_w	Public	Pre-established limit
Type 3: Environmental Impact Assessment (EIA)	L_w/m² or L_w	Public	Estimate after calculation
Type 4: Noise measurements of the actual situation	L_w/m² or L_w	Usually not public	Best possible approach to actual situation

For the purpose of the strategic noise mapping of industrial sources, there are three possible methods of measurement:

- ISO 3744:1994 Acoustics -- Determination of sound power levels of noise sources using sound pressure -- Engineering method in an essentially free field over a reflecting plane
- ISO 3746:1995 Acoustics -- Determination of sound power levels of noise sources using sound pressure -- Survey method using an enveloping measurement surface over a reflecting plane, ISO 3746:1995/Cor 1:1995
- ISO 8297:1994 Acoustics -- Determination of sound power levels of multisource industrial plants for evaluation of sound pressure levels in the environment -- Engineering method

Standards ISO 3744 and ISO 3746 are much more suitable for determining the sound power level of individual sound sources of limited dimensions (despite the fact the there are no restrictions relating to the volume of the sound sources for the application of that two norms). Noise measurements in accordance with ISO 3744 and ISO 3746 of source groups or entire companies, to which measuring heights of 20m and more would apply, are neither realistic nor cost-effective. Therefore it can be concluded that ISO3744 & ISO3746 can be applied to separate sound sources, insofar as they are not located too close to one another.

Within the framework of the END, it is advisable to determine global sound power levels of entire industrial companies without for this purpose examining their internal distribution over individual sources. For this purpose, sound pressure measurements can be carried out around the entire installation. For measuring the sound power levels of larger installations and entire companies, ISO 8297 (and methods derived from it) are highly suitable. Sound pressure measurements are carried out on a previously defined measuring line located between 5 and 35 m equidistant around the installation. Depending on the height of the installation under study and the possibilities on site, the measuring height is +/- 5m. The average sound pressure level along the measurement contour is calculated on the basis of these measurements. Standard also describes in a step-by-step procedure the calculation of the sound power level for evaluating levels in the environment. This sound power level is the combination of the average sound pressure level, the area term for the enclosed measurement surface, and correction terms for proximity, microphone and sound attenuation. A common advantage to this method is that the competent authority, or its representatives, does not need agreed access to the industrial area, which can avoid conflict with the site owner, as well as being safer for the operatives undertaking the measurements.

The short graphical presentation of the measurement concept is given in Figure 12.6, with the photo taken during measurements[59].

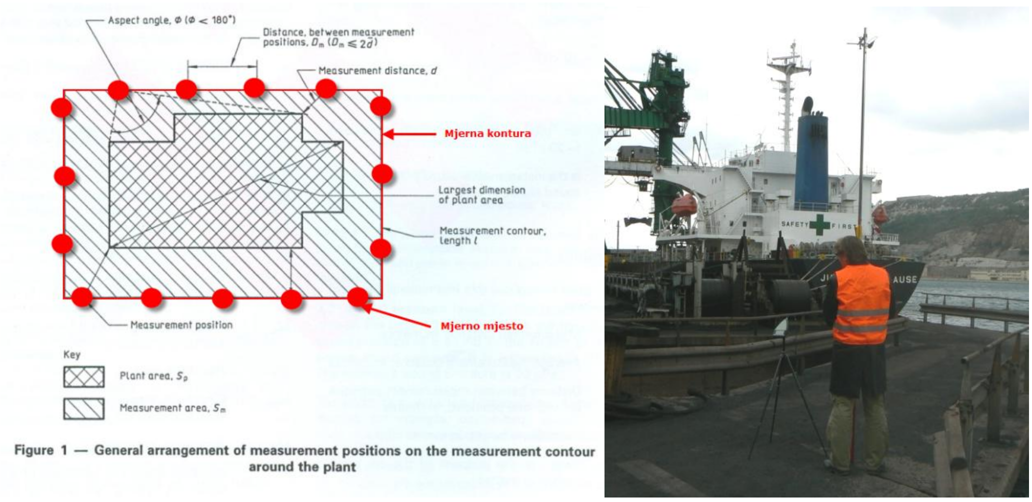


Figure 12.6: Graphical determination of the measurement contour (red line), measurement points (red points) and photo during measurements according to ISO 8297

12.2 Verification of Strategic Noise Mapping

Since the proclamation of the END, a wide group of environmental noise experts have discussed "methods", "software packages", "validation" or "verification". Before discussing any analysis regarding the possible verification of the strategic noise mapping process, it is important to distinguish between different noise prediction methods, and the software packages that implement the methods, with the results obtained during measurements. In most of the studies, the term "method" refers to the set of calculation algorithms that describes source emission and the term "software package" refers to the computer software that implements the methods. It is not uncommon for some prediction methods to be implemented in several software packages, and for some software packages to implement several methods. However, the term "validation" can be defined as an accuracy-test of noise prediction methods, while the "verification" of the strategic noise maps can be defined as an accuracy-test for the delivered strategic noise map. It is important to recall that, due to the above definitions, during verification of the strategic noise maps the whole mapping process is under assessment for accuracy.

Most popular approaches to the verification of strategic noise maps are so called "short-term" studies that are usually conducted in a small number of areas. The number of such areas are in most cases dependent upon various factors (sources interaction, population

[59] Port of Rijeka Noise Mapping project - Measurements of the sound power levels of the conveyer for bulk load (coal, sand, etc.), DARH 2, 2008.

density, terrain morphology etc..), and there are attempts to representatively distribute measurement locations across the large territory that has been mapped.

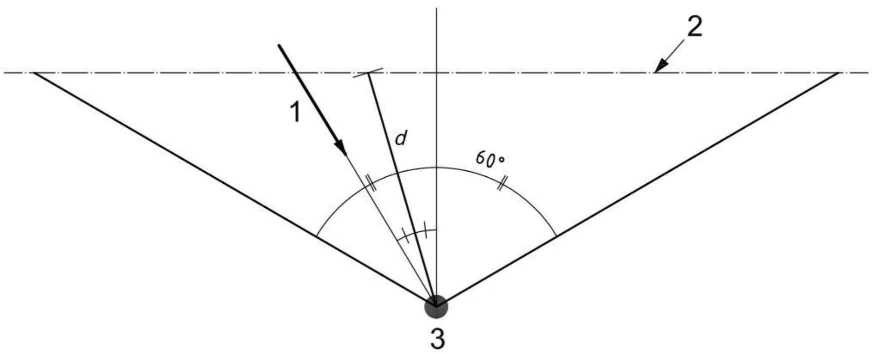
Noise levels are usually measured using sound level meters, type 1, with an outdoor microphone kit, placed at a height of 4 m above the underlying terrain. Noise levels should normally be measured in accordance with the

- ISO 1996-1:2003 Acoustics -- Description, measurement and assessment of environmental noise -- Part 1: Basic quantities and assessment procedures;
- ISO 1996-2:2007 Acoustics -- Description, measurement and assessment of environmental noise -- Part 2: Determination of environmental noise levels.

All the necessary details included in the acoustical model, established for the mapping process, should be acquired. These aspects include topographical information, relative heights of the buildings and obstacles, distances between the sources and receivers, relative aspects to any other obstacles. Such measures should generally be measured to within ±0.1m for vertical heights and ±1.0m for horizontal distances.

In the case of verification of the strategic road traffic noise maps, it is necessary to collect information about traffic data to within ±5%. It would also be required to use traffic measurement instruments for measuring volume, flow, speed and composition of traffic. The German method, for example, strictly recommends not conducting road traffic noise measurements during weekends, school and public holidays, or between 00:00 and 04:00 hours.

In order to verify the status of the upwind or downwind conditions it is necessary to perform simultaneously measurements of the air temperature, relative humidity, wind speed and direction. The average wind direction shall be in the interval ± 60 degrees around the normal from the road through to the microphone position. The effective source-receiver distance shall be determined along the bi-sector of the angle between the average wind speed vector and the normal from the road to the microphone position; see Figure 12.7.



Key
1 mean wind direction
2 centreline
3 measurement position

Figure 12.7: Favourable propagation conditions from a road and the effective source-receiver distance, *d*

Because of latter synchronizing between noise measurements and acquired meteorological data it is strongly recommended to conduct those measurements via a centralized computer. Special attention should also be paid to the possible averaging of the results at each test-site over a range of wind conditions, taking care to include as many days when the wind was blowing from the road to the receiver as when it was blowing from the receiver to the road. At the end of each measurement interval, the ISO 1996 standard recommends that some information needs to be recorded and reported:

a) time, day and place for measurements;

b) instrumentation and its calibration;

c) measured and, if relevant, corrected sound pressure levels (L_{eqT}, L_E, L_{max}), A-weighted (optionally C-weighted as well) and, optionally, in frequency bands;

d) measured N percent exceedance level ($L_{N,T}$) including the base on which it is calculated (sampling rate and other parameters);

e) estimate of the measurement uncertainty together with the coverage probability;

f) information on residual sound pressure levels during the measurements;

g) time intervals for the measurements;

h) thorough description of the measurement site, including ground cover and condition, and locations, including height above ground, of microphone and source;

i) description of the operating conditions, including number of vehicles/aircraft pass-bys specified for each suitable category;

j) description of the meteorological conditions, including wind speed, wind direction, cloud cover, temperature, barometric pressure, humidity and presence of precipitation and location of wind and temperature sensors;

k) method(s) used to extrapolate the measured values to other conditions.

The number of the test sites mainly depends upon the available budget and time frame. For example, the City of Velika Gorica (Republic of Croatia) with over 53,000 inhabitants has conducted verification of the delivered strategic noise map of the road traffic noise using 10 measurement sites, as presented on Figure 12.8.

Figure 12.8: Example of the verification of the delivered strategic noise map of the road traffic noise on the 10 measurement sites in the City of Velika Gorica (Republic of Croatia)

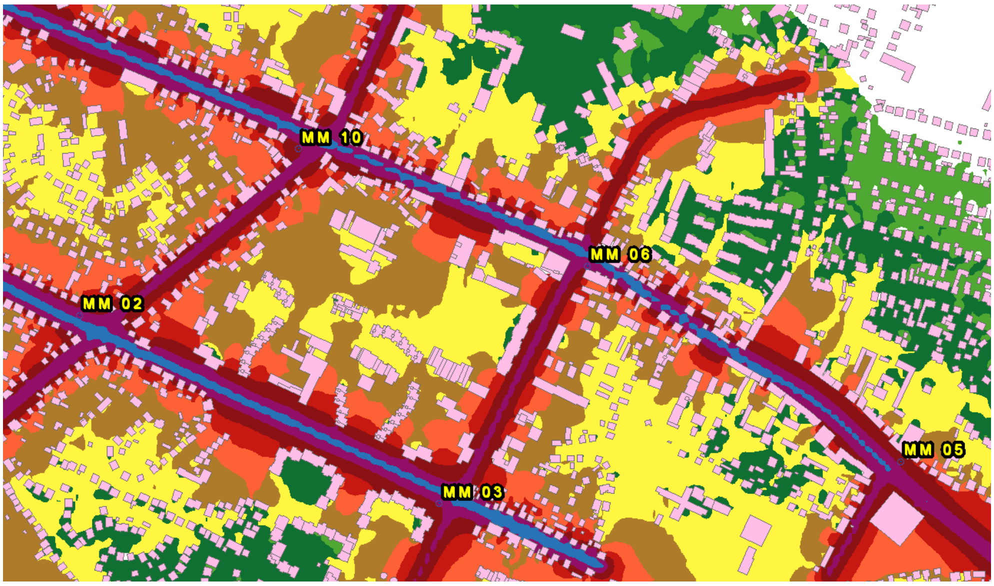


Figure 12.9: Example of the calculated noise classes during verification of strategic road traffic noise map in the City of Velika Gorica (Republic of Croatia)

With the presumption that at the time of verifying the strategic noise maps they are already finished, it is easy to arithmetically compare the properly measured noise levels with the noise levels calculated using the computer model (Figure12.9).

Appendix A: Glossary of Acoustic and Technical Terms

Term	Definition
Agglomeration	Major Continuous Urban Area as set out within the Regulations
Attribute Data	A trait, quality, or property describing a geographical feature, e.g. vehicle flow or building height
Attributing (Data)	The linking of attribute data to spatial geometric data
Data	Data comprises information required to generate the outputs specified, and the results specified
dB	Decibel
DEM	Digital Elevation Model
DSM	Digital Surface Model
DTM	Digital Terrain Model
DVD	Digital Versatile Disk
EC	European Commission
END	Environmental Noise Directive (2002/49/EC)
ESRI	Environmental Systems Research Institute
GIS	Geographic Information System
INM	Integrated Noise Model
Malta National Grid (MNG)	The official spatial referencing system of Malta
ISO	International Standards Organisation
Metadata	Descriptive information summarising data
NA	Not Applicable
Noise Bands	Areas lying between contours of the following levels (dB): L_{den} <55, 55 – 59, 60 – 64, 65 – 69, 70 – 74, ≥75 L_d <55, 55 – 59, 60 – 64, 65 – 69, 70 – 74, ≥75 L_e <55, 55 – 59, 60 – 64, 65 – 69, 70 – 74, ≥75 L_n <45, 45-49, 50 – 54, 55 – 59, 60 – 64, 65 – 69, ≥70 Notes: 1) It is recommended that class boundaries be at .00, e.g. 55 to 59 is actually 55.00 to 59.99 2) The assessment and reporting of the 45 – 49dB band for Lnight is optional under the Regulations
Noise Levels	Free-field values of L_{den}, L_d, L_e, L_n, and $L_{A10,18h}$ at a height of 4m above local ground level
Noise Level - L_d - Daytime	L_d (or L_{day}) = $L_{Aeq,12h}$ (07:00 to 19:00)
Noise Level - L_e - Evening	L_e (or $L_{evening}$) = $L_{Aeq,4h}$ (19:00 to 23:00)
Noise Level - L_n - Night	L_n (or L_{night}) = $L_{Aeq,8h}$ (23:00 to 07:00)
Noise Level - L_{den} – Day/Evening/Night	A combination of L_d. L_e and L_n as follows: L_{den} = 10 * log 1/24 {12 * 10^((L_{day})/10) + 4 * 10^(($L_{evening}$+5)/10)

Term	Definition
	+ 8 * 10^((L$_{night}$+10)/10)}
Noise Mapping (Input) Data	Two broad categories: (1) Spatial (e.g. road centre lines, building outlines). (2) Attribute (e.g. vehicle flow, building height – assigned to specific spatial data)
Noise Mapping Software	Computer program that calculates required noise levels based on relevant input data
Noise Model	All the input data collated and held within a computer program to enable noise levels to be calculated.
Noise Model File	The (proprietary software specific) project file(s) comprising the noise model
Output Data	The noise outputs generated by the noise model
Processing Data	Any form of manipulation, correction, adjustment factoring, correcting, or other adjustment of data to make it fit for purpose. (Includes operations sometimes referred to as 'cleaning' of data)
QA	Quality Assurance
RMR	The railway noise calculation method published in the Netherlands in 'Reken- en Meetvoorschrift Railverkeerslawaai '96, Ministerie Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, 20 November 1996'.
Spatial (Input) Data	Information about the location, shape, and relationships among geographic features, for example road centre lines and buildings.
WG - AEN	Working Group – Assessment of Exposure to Noise
XPS 31-133	The French road traffic noise calculation method published in 'NMPB-Routes-96 (SETRA-CERTULCPC-CSTB)', referred to in 'Arrêté du 5 mai 1995 relatif au bruit des infrastructures routières, Journal Officiel du 10 mai 1995, Article 6' and in the French standard 'XPS 31-133'.

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WG-HSEA	http://ec.europa.eu/environment/noise/health_effects.htm
WHO noise	http://www.euro.who.int/Noise
HARMONOISE	http://www.harmonoise.org/why.asp
IMAGINE	http://www.imagine-project.org/
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GOAL project	http://www.goal-graz.at
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SILVIA	http://www.trl.co.uk/silvia/Silvia/pages/index.html
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NOMEports	http://nomeports.ecoports.com
INQUEST	http://www.fehrl.org/inquest
HEATCO	http://heatco.ier.uni-stuttgart.de/
GLA Noise Strategy	http://www.london.gov.uk/mayor/strategies/noise

Appendix E: Guidelines on the Information to be contained in report on Strategic Noise Mapping

The report on Strategic Noise Mapping should at least include information to address the requirements of Annex IV of the Directive (see Box 2 and Section 2 of this report), and provide the information required for the Supplementary Report for DF4 (and DF8) of the ENDRM 2007. In addition the Strategic Noise Mapping Report should include information on the noise mapping process and any known issues or limitations encountered during the assessment of noise levels. In addition, MEPA should prepare a summary of the Strategic Noise Mapping Report (not exceeding 10 pages in length) which meets the requirements of the ENDRM 2007 Supplementary Report content.

The following is a framework setting out the information to be contained within a strategic noise mapping report. Any items not specifically mentioned in this framework, but which are mentioned in the main body of this report, the Regulations or Directive are still to be included.

Executive Summary

Table of Contents

1. Introduction

1.1 Background

1.2 Noise and Effects of Noise

1.3 Purpose and Scope of the END Directive

1.2 Purpose and Scope of the Regulations

1.4 Roles and Responsibilities of designated bodies

1.5 Key Phases

- Identification of areas required to be mapped.
- Preparation of strategic noise maps
- Publication of extent of noise impact
- Development of the noise action plans.
- Implementation of the plans (5 year time scale).

2. Overview of Strategic Noise Mapping Process

2.1 Project review

- Roles and responsibilities of parties undertaking the mapping
- Project timetable etc

2.2 Process overview

– Description of technical stages of project

3. Define Areas to be Mapped

3.1 Requirements of Directive

3.2 Requirements of Regulations

3.3 Approach to Definition of Mapping Extents

3.4 Maps and Statistics Describing Area to be Mapped

3.5 Approach to Definition of Model Extents including buffer

3.6 Maps and Statistics Describing Area to be Modelled

4. Define Noise Calculation Method

4.1 Requirements of Directive

4.2 Requirements of Regulations

4.3 Factors influencing selection of assessment method

4.4 Confirmation of method of assessment along with any required adaptations

5. Develop Dataset Specification

5.1 Input Data Requirements of Calculation Method – Conceptual Model

5.2 Data specification requirements of noise mapping software – Logical model

5.3 Data specification requirements of GIS – Physical model

5.4 Data specification for noise mapping – Database design

6. Produce Datasets

6.1 Identify data sources

6.3 Identify gaps, anomalies and uncertainties

6.4 Field survey work to reduce data gaps

7. Develop Noise Model Datasets

7.1 Develop input datasets to meet specification

- Document data manipulation required

7.2 Document use of WG-AEN GPG v2 Toolkits and assumptions to fill data gaps

7.3 Document data checks and QA

8. Noise Level Calculations

8.1 Documentation of noise mapping software system

- Software specification
- Calculation settings
- Use of efficiency settings

8.2 Approach to calculations

- Test calculations
- Any validation against measurements
- Use of multiple client, or tiling of model, and how model was split into sections

8.3 Results of noise calculations

9. Post Processing and Analysis

9.1 Post processing of noise level results

- Document any interpolation or manipulation of results required
    - Such as receptors within buildings
    - Any edge matching issues with tiles of results
    - Calculation of L_{den} from L_d, L_e and L_n
- Document means of generating 5dB noise level bands
- Document means of generating 5dB noise level band contours, if applicable

9.2 Area exposure assessment

- Document approach to area analysis
- Results of area analysis

9.3 Dwellings exposure assessment

- Document development of dwellings location dataset
- Document approach to dwellings analysis
- Results of dwellings analysis

9.4 Population exposure assessment

- Document development of population distribution dataset
- Document approach to population exposure analysis
- Results of population exposure assessment

10. Summary and Conclusions

Appendix A:

Glossary of acoustic and technical terms

Appendix B:

Bibliography and references

Appendix C:

Strategic noise map(s)

Appendix D: Colour Scheme for Presentation of Noise Level Bands

The colour bands below are for use in the production of noise level contour maps. The colour bands are based upon those set out within ISO 1996-2 (1987). Furthermore, the colour bands should be made semi-transparent such that the base mapping below remains partly visible such that orientation and location remains possible.

Table D-1: Noise Level Bands for Maps of L_{den}

Noise zone dB	Colour	Code	Red	Green	Blue
< 55	Transparent				
55 to 59	Orange	# FF 66 00	255	102	0
60 to 64	Cinnabar	# FF 33 33	255	51	51
65 to 69	Carmine	# 99 00 33	153	0	51
70 to 74	Lilac red	# AD 9A D6	173	154	214
≥75	Blue	# 00 00 FF	0	0	255

Table D-2: Noise Level Bands for Maps of L_{night}

Noise zone dB	Colour	Code	Red	Green	Blue
<45	Transparent				
45 to 49	Yellow	# FF FF 00	255	255	0
50 to 54	Ochre	# FF C7 4A	255	199	74
55 to 59	Orange	# FF 66 00	255	102	0
60 to 64	Cinnabar	# FF 33 33	255	51	51
65 to 69	Carmine	# 99 00 33	153	0	51
≥70	Lilac red	# AD 9A D6	173	154	214

Notes:

- Class boundaries be at .00, e.g. 55 to 59 is actually 55.00 to 59.99;
- The assessment and mapping of L_{night} values in the 45 to 49dB band is optional under the Directive; if results are not available, or are chosen not to be mapped, below 50dB L_{night}, the maps should show levels <50dB as transparent.