TØI report
458/1999

Assessment of annoyance caused by vibrations in dwellings from road and rail traffic

Proposal for a Nordtest Method

Ronny Klæboe
Evy Öhrström

ISSN 0802-0175
ISBN 82-480-0122-9

Oslo, November 1999

Title: Assessment of annoyance caused by vibrations in dwellings from road and rail traffic. Proposal for a Nordtest Method

Author(s): *Ronny Klæboe; Evy Öhrström*

TØI report 458/1999
Oslo, November 1999
53 pages
ISBN 82-480-0122-9
ISSN 0802-0175

Financed by:
Nordtest

Project: 2314 Reactions to vibrations in dwellings, indicators and methods

Project manager: Ronny Klæboe

Quality manager: Marika Kolbenstvedt

Key words:
Environmental survey; Socio-vibrational survey; Exposure-effect relationships; Annoyance assessment; Standard;

Summary:
Socio-vibrational studies for assessing annoyance due to vibrations are to designed and conducted differently by different researchers and in different countries. This lack of standardisation is an important obstacle for authorities and researchers wishing to profit from research and results in other countries or who wish to perform analyses on extended data sets.
This report describes a project to to establish a common Nordic Method for assessing annoyance due to vibrations in dwellings from road and rail traffic in socio-vibrational and social surveys.
Important common aspects and differences between a survey in Sweden 1992 and a socio-vibrational survey in Norway 1998 were summarised and evaluated as a departure point for a first draft proposal. After discussions the proposal has been revised. The finalized proposal is included as part 2 of the report.

Tittel: Måling av grad av plage fra vibrasjoner i boliger fra veg- og skinnegående trafikk. Forslag til en Nordtest-metode

Forfatter(e) *Ronny Klæboe; Evy Öhrström*

TØI rapport 458/1999
Oslo: november, 1999
53 sider
ISBN 82-480-0122-9
ISSN 0802-0175

Finansieringskilde:
Nordtest

Prosjekt: 2314 Opplevelse av samferdselsrelaterte vibrasjoner, indikatorer og metoder

Prosjektleder: Ronny Klæboe

Kvalitetsansvarlig: Marika Kolbenstvedt

Emneord:
Miljøundersøkelse; Vibrasjonsundersøkelse; Virkningskurver; Plage; Standard;

Sammendrag:
Undersøkelser som måler folks grad av plage fra vibrasjoner utformes og gjennom-føres på vidt forskjellige måter av ulike forskere og i ulike land. Denne manglende standardiseringen er et viktig hinder for myndigheter og forskere som ønsker å dra nytte av resultater i andre land og som ønsker å stille sammen resultater fra flere undersøkelser.
Rapporten beskriver arbeidet med å komme fram til et forslag om en felles Nordisk Metode for å gjennomføre vibrasjons-undersøkelser.
En sammenligning av metodikk og resultater fra en vibrasjonsundersøkelse i Sverige i 1992 og i Norge i 1999, ble lagt til grunn for et forslag til metodikk som senere er diskutert og revidert med bakgrunn i ulike erfaringer i de Nordiske landene.
Det endelige forslaget til ny Nordisk metode foreligger som del 2 av rapporten.

Language of report: English

The report can be ordered from:
Institute of Transport Economics, the library
P O Box 6110 Etterstad N-0602 Oslo, Norway
Telephone +47 22 57 38 00 Telefax +47 22 57 02 90
Price NOK 150

Rapporten kan bestilles fra:
Transportøkonomisk institutt, biblioteket
Postboks 6110 Etterstad, 0602 Oslo
Telefon 22 57 38 00 - Telefaks 22 57 02 90
Pris 150

Forord

Det er både kostbart og vanskelig å få samlet gode data om folks reaksjoner på grunn av vibrasjoner i bolig fra tunge kjøretøy eller fra togsett, trikk og T-bane som passerer. Dagens praksis, der det brukes vidt varierende plagespørsmål og varierende eksponeringsmål i ulike land, gjør det vanskelig å utnytte resultater som er vunnet i andre land og av andre forskergrupper.

En felles metode for måling av plagegrad for de nordiske landene vil bidra til en bedre utnyttelse av knappe forskningsressurser og bidra til å framskaffe et bedre og mer omfattende datamateriale om denne miljøeffekten. Dette innebærer i neste omgang at myndighetene får tilgang til et bedre grunnlag for samferdsels- og miljøplanleggingen.

Arbeidet med å komme fram til en Nordisk Metode er finansiert ved midler fra Nordtest. Arbeidet bygger imidlertid på både et svensk og norsk datamateriale som er finansiert gjennom midler fra de respektive lands samferdsels- og miljøetater. Rapporten og forslaget til metode er utarbeidet av Forskningsleder Ronny Klæboe ved Transportøkonomisk institutt og Docent Evy Öhrström, Göteborgs Universitet, Avdelningen för Miljömedicin. Metoden er diskutert og revidert etter diskusjoner i en referansegruppe der Gruppeleder Hannu Nykänen, VTT Automation i Finland og Senior forsker Hans Bendtsen fra Vegdirektoratet i Danmark har bidratt. Cand Scient Iiris Turunen-Rise fra Norges Byggstandardiseringsråd har deltatt som observatør og bidratt vesentlig i diskusjonen og i utformingen av standarden.

Arbeidet har dratt nytte av diskusjoner i The International Organization for Standardization (ISO/TC43/WG49) under ledelse av Ronald DeJong og av arbeidet innenfor Internoise og ICBEN for å utvikle en standard for måling av støyplage.

Sekretær Trude Rømming har stått for den endelige tekstbehandling og layout.

Oslo, november 1999
TRANSPORTØKONOMISK INSTITUTT

Knut Østmoe
instituttsjef

Marika Kolbenstvedt
avdelingsleder

Content

Content part II

TØI rapport 458/1999
Forfattere: Ronny Klæboe, Evy Öhrström
Oslo 1999, 53 sider

Sammendrag:

Måling av grad av plage forårsaket av vibrasjoner i bolig

Mens det er definert en rekke internasjonale standarder for objektive støy- og vibrasjonsmål, så mangler metoder og standarder for å måle folks reaksjoner til støy- og vibrasjonsbelastninger. Slik manglende standardisering betyr at resultater fra undersøkelser som måler forekomsten av vibrasjonsplager og /eller virkningskurver i ulike land er vanskelige å sammenligne.

Det blir derfor vanskelig å benytte resultater som er oppnådd andre steder til bedre å anslå hvor stor effekt vibrasjoner i boligen fra tunge kjøretøy eller tog, t-bane og trikk, vil ha på folk, hvilke verdier for vibrasjoner en bør fastsette i retningslinjer og grenseverdier for vibrasjoner. Dette igjen gjør at en i praktisk planlegging får dårligere verktøy til hjelp for å avgjøre når en skal tillate ny infrastruktur eller boliger, og hvilken effekt tiltak for å motvirke vibrasjoner vil ha.

I forbindelse med utformingen av en ny Norsk Standard for måling av vibrasjoner i bolig fra veg og skinnegående trafikk, fikk Transportøkonomisk institutt i samarbeid med Universitetet i Gøteborg, Institutt for Miljømedisin også i oppgave å foreslå en ny Nordisk Metode for å måle graden av plage fra vibrasjoner i bolig. De nordiske landene har felles interesser og måter å se på ting. Dette har ikke minst gjort seg gjeldende gjennom dette prosjektet. Dette forslaget har gitt et godt grunnlag for å utvikle en Nordtest metode og gir tiltro til at den blir fulgt i framtidige undersøkelser.

Første del av rapporten beskriver arbeidet som har gått forut for det forslaget til Nordisk metode som legges fram. Denne delen inneholder tre kapitler. Det første beskriver bakgrunnen for prosjektet og det andre resultatene fra en sammenlignende studie av to vibrasjonsundersøkelser. I det tredje kapittelet gjennomgås noen av valgene som ligger til grunn for utformingen av den nye nordiske metoden.

Den nordiske metoden som presenteres i annen del av denne rapporten er et forsøk på etablere en standardisert måte å måle graden av folks plage fra vibrasjoner i boliger fra veg og skinnebående trafikk ved hjelp av vibrasjonsundersøkelser og spørreskjemaundersøkelser generelt. Forslaget har trukket fordel av arbeidet i ICBEN og Internoise som samler mange støyforskere internasjonalt. Mange forskere har enkeltvis og samlet gjort en stor innsats for å etablere felles måter å måle grad av støyplage og hvor mange elementer kan overføres til gjennomføringen og utformingen av vibrasjonsundersøkelser.

Samtidig er det argumenter mot å gå for langt i standardiseringsbestrebnelsene. Landene er forskjellige, har forskjellige kultur, forskjellige plage-begreper og

Rapporten kan bestilles fra:
Transportøkonomisk institutt, Postboks 6110 Etterstad, 0602 Oslo
Telefon: 22 57 38 00 Telefax: 22 57 02 90

forskjellige språk. Organiseringen av vibrasjonsundersøkelser er forskjellig og undersøkelser i ulike land gjennomføres ofte med ulike metoder. Faren for å bryte for sterkt med godt innarbeidede rutiner og praksis er derfor absolutt til stede.

Forslaget som legges fram til ny nordisk metode tar derfor bare for seg hvordan de viktigste elementene i vibrasjonsundersøkelser må utformes for at resultater som er oppnådd i en undersøkelse også kan være av nytte også for andre.

Forslaget til Nordtest Metode tar opp:

Utvalgsmetodikken som vil avhenge av om det er snakk om en generell undersøkelse for å etablere virkningskurver, eller om det er før-etterundersøkelser.

Plagespørsmålene der det stilles krav til at det skal benyttes et spesifisert spørsmål med verbalt formulerte kategorier for å angi grader av plage. Det kan eventuelt fordeles over to spørsmål der en først spør om vibrasjonene kan merkes, og deretter om grad av plage. I tillegg gis det mulighet for å stille spørsmål der en bruker en tallskala fra 0 til 10. "Merker ikke vibrasjoner" er brukt som nullpunkt i disse plagespørsmålene. Forslaget inneholder også et frivillig spørsmål om endringer i vibrasjonsbelastningen for bruk i før-etter-undersøkelser.

Beskrivelsen av undersøkelsen, der en fastsetter at denne skal foreligge som en tekstfil (altså ikke som en rapport). Rapporten skal inneholde en beskrivelse av selve vibrasjonsundersøkelsen, spørreskjema, prosedyrer og delområder som inngår.

Spesifisert datafil. En detaljert spesifikasjon for a definere og utveksle data fra undersøkelsen er lagt ved som del av metoden.

Når andre forskere er interessert i tilgang til data fra flere undersøkelser vil en slik spesifikasjon lette bruken av data. Når det er vanskelig å stille dataene direkte til disposisjon, og de som sitter på primærdataene må utføre kjøringer for andre, vil en detaljert spesifikasjon gjøre det lettere å definere hvilke rekodinger av variable som skal iverksettes og hvilke analyser som skal kjøres.

Andre elementer i lokale undersøkelser bør overlates til den enkelte forsker.

TØI report 458/1999
Authors: Ronny Klæboe Evy Öhrström
Oslo 1999, 53 pages English language

Summary:

Assessment of annoyance caused by vibrations in dwellings

While a range of international standards defining noise, vibration and other environmental measures have been established, standards or methods for measuring people's reactions to these same environmental effects are lacking. This lack of standards and common methods reduces the comparability of prevalence statistics and exposure-effect relationships developed by different researchers and in different countries.

It is therefore difficult to assess from results obtained elsewhere what effect vibrations in dwellings from passing trucks, trams, subways and trains have on people and what limits and guidelines for vibration exposure should be. This again results in inferior tools for deciding when to allow new infrastructure or dwellings to be built, and when not, what impact different efforts to reduce vibrations will have etc.

In connection of the development of a new Norwegian Standard NS 8176 defining a new vibration exposure measure, The Institute of Transport Economics in co-operation with the University of Gothenburg, Department of Environmental Medicine was also given the task of suggesting at new Nordic Method for assessing vibration annoyance. The Nordic countries have a common interests and outlook. This is a good basis for establishing a common Nordic Method and the work with the proposal has indeed shown that researchers from the Nordic countries think alike with respect to the methodological issues involved. This has produced a good foundation for a Nordtest Method and inspires confidence in that it will be applied for future socio-vibrational surveys.

Part I of this report describes the work that has preceded the proposed Nordic Method. It consists of three chapters. The first chapter describes the background for the project. The second chapter describes the results of a comparative study of two socio-vibrational studies, while the third chapter describes some of the choices that lie behind this proposal for a new Nordic Method.

The Nordic Method presented in Part II of this report, is an effort to establish a standard way of assessing people's annoyance with vibrations in dwellings from road and rail traffic by means of socio-vibrational and social surveys. It draws heavily on concurrent efforts within the ICBEN and Internoise communities for standardising the measurement of environmental noise annoyance in residential areas. Many researchers and research group working with socio-acoustic surveys have made substantial contributions towards the establishment of national and

The report can be ordered from:
Institute of Transport Economics, PO Box 6110 Etterstad, N-0602 Oslo, Norway
Telephone: +47 22 57 38 00 Telefax: +47 22 57 02 90

international standards. Many of the issues of importance in noise annoyance assessment are also of importance when conducting socio-vibrational research.

There are also reasons for not going to far with respect to the degree of standardisation. The countries are culturally different, utilise different annoyance concepts and different languages. The organisation of research and survey practices also vary between the countries. Established practises and compatibility issues with respect to previous local research are thus important counter arguments against too detailed standardising of socio-vibrational surveys.

This Nordic Method deals therefore only with the most important elements that are necessary for results from a socio-vibrational study to be compatible with results from others. The issues that are important are

The sampling considerations, that will vary depending on whether the survey in question is for developing exposure-effect relationships or before-after studies.

The annoyance questions, where only a verbal annoyance question is required. Both a version utilising a filter question and an unfiltered question is allowed. In addition the proposal contains an optional question utilising a numeric 11 point scale from 0 to 10. "Do not notice the vibrations" is the low anchoring point for both the verbal and the numeric annoyance question. The proposal also contains a question about changes in the vibration load for use in before-after surveys..

The survey description, that is to be produced in the form of a textfile and not a report. The report describes the survey, survey procedures, the questionnaire, the survey sites, and other information.

The specification of a survey data file output: When possible the data material can be made directly available for the interested researcher. When this is difficult the researcher in charge of the survey data may accept requests for the results of specific coding and statistical analyses from fellow researchers. The specified format will make such requests easier to define and easier to comply with.

Other parts of the design, conduct, content and reporting are left to the researchers discretion.

Part I
Preparatory work and design choices

1 Background

1.1 Common methods for assessing annoyance are lacking

While a range of international standards defining noise, vibration and other environmental measures have been established, standards or methods for measuring people's reactions to these same environmental effects are lacking. This lack of standards and common methods reduces the comparability of prevalence statistics and exposure-effect relationships developed by different researchers and in different countries.

1.2 Nordtest Project for assessing annoyance with vibrations

In connection with the development of a new Norwegian Standard NS 8176 defining a new vibration exposure measure, The Institute of Transport Economics in co-operation with the University of Gothenburg, Department of Environmental Medicine was given the task of suggesting at new Nordic Method for assessing vibration annoyance by Nordtest.

More precisely the Nordic Method was to provide, if possible, a common procedure for assessing people's annoyance with vibrations in dwellings from road and rail traffic by means of socio-vibrational and social surveys. The method should consist of three parts

- Common questions
- Common methodology
- Common data file output format

1.3 Study of two socio-vibrational studies taken as starting point

The first stage of the work with the proposal for a Nordic Method was a simple comparison (Klæboe 1999) of the Norwegian socio-vibrational study in 1998 (Klæboe and Fyhri 1999) with a socio-acoustic study that was undertaken in Sweden in 1992 (Öhrström and Skånberg 1995). In both studies a vibration exposure measure $v_{w,95}$ defined in NS 8176 (NBR 1999) was calculated for each respondent (Madshus, Bessason, and Hårvik 1996) (Hårvik 1998)dwelling by the Norwegian Geotechnical Institute.

The objectives of the two studies, data collection methods, annoyance questions and control for modifying factors etc differed. In both environmental studies exposure-effect relationships were estimated and evaluated, and the effect of modifying factors explored.

The purpose of the comparative study of the two studies was to examine what effect the methodological choices had on the type of results obtained. There was also a discussion of the statistical analyses of exposure effect relationships and the quality of the relationships. Such relationships between a given vibration exposure and its effect with respect to annoyance are the foundation for many environmental limits and guidelines.

As the report from this preliminary stage of the process (Klæboe 1999) was written in Norwegian, the main results from the study on similarities and differences in research methodology, results and statistical analyses in the two studies are summarised in chapter 2.

1.4 Draft proposal, discussion and revision

The second stage of the development of the proposal was the development of a draft proposal for the Nordic Method, the discussion and further development of this draft in the reference group for the project.

This second stage has benefited greatly from work in ISO/TC43/ WG49 chaired by Ronald deJong working on a standard for noise annoyance assessment.

The work in the ISO work group was started as a continuation of the efforts within the ICBEN and Internoise communities for standardising environmental noise annoyance assessment in residential areas. Many researchers and research groups (Fields 1993; Fields & al 1997; Namba & al 1996) have made substantial contributions towards the establishment of national and international standards for noise annoyance assessment. Parts of the input to these proposals with respect to noise annoyance assessment have been adapted for use in this Nordic Method for vibration annoyance assessment.

This second stage of the work consisted mainly of clarifying different parts of the proposal and selecting a suitable level of standardisation. Questions related to the work is discussed in Chapter 3, while the Method proposal is presented as part II of the report.

2 Comparative study of two surveys

This chapter reiterates in English the conclusions from a comparative study of two socio-vibrational studies presented in the report in Norwegian from the first stage of this project (Klæboe 1999). The surveys that were compared was a primarily socio-acoustic survey (Öhrström and Skånberg 1995) also containing questions on annoyance with vibration and a socio-vibrational study (Klæboe and Fyhri 1999). The comparison was made on the basis of 1497 respondents in the Norwegian study and 898 respondents in the Swedish study. For each of dwellings of these respondents a vibration exposure measure $v_{w,95}$ was calculated by the Norwegian Geotechnical Institute (Hårvik 1998).

Due to problems with the input to the vibration calculations that were added to the primarily socio-acoustic Swedish study and differences in measurement standards the quality of the vibration exposure measure was not satisfactory. Many of the results below should still hold.

2.1 Data acquisition by postal and telephone surveys

While the Norwegian survey was undertaken with telephone interviews, the Swedish study was undertaken with the help of postal questionnaires. Choice of data acquisition method depends not only on methodological concerns but also timeframe available and how research activities are organised, access to cheap labour (=students) etc. The choice of data collection method has however consequences with respect to non-response and for how questions are developed.

2.1.1 Higher response rate in postal survey

The sample in the Swedish study was drawn from specific sub-areas using the population register as a sampling frame. This gives good control with non-response. The response rate was 70%, which must be considered satisfactory. The Norwegian study was undertaken as a telephone survey using a professional marketing organisation for the actual interviews. The response rate is about 50% which is usual for these type of surveys, but markedly lower than in the postal Swedish survey. There are also some minor problems with respect to the sampling frame (Klæboe and Grue 1999).

2.1.2 Question formats depend on survey type

The differences in data acquisition have also an effect on how the questions that are used for obtaining people's answers are constructed.

In telephone surveys it is seldom[1] possible to present things visually, and questions must not be too long or complicated. In postal surveys the visual presentation of the questions and the answer categories make for a much easier processing, and also makes it easier to pose more questions than in a telephone survey. In personal interviews answer cards can be used to present the alternatives clearer.

In the Swedish postal survey unfiltered versions of the annoyance question were used, while in the Norwegian survey the annoyance question were filtered and distributed over two distinct questions.

One conclusion of this part of the comparison was that if both types of data acquisition methods were to be allowed, alternative ways of presenting the annoyance question adapted to the different data acquisition methods might be useful. See also section 2.6

2.1.3 Both surveys introduced as community surveys

Both studies are introduced as general community studies with respect to neighbourhood quality.

In connection with an earlier Norwegian survey into annoyance with aircraft noise (Kolbenstvedt, Klæboe, and Kjørstad 1990), the importance of presenting the survey as a community study and not an "aircraft-noise"-study was tested by obtaining answers with both type of introductions. When the survey was presented as an aircraft noise study, annoyance with aircraft noise increased rapidly.

For postal surveys the possibility of peeking ahead poses a threat with respect to keeping the objective hidden. The usually more and more focused questions on vibration annoyance will indirectly reveal the real purpose of the questionnaire.

A comparison of exposure-effect curves in the postal and telephone survey did however not indicate that there was a higher degree of annoyance in the postal survey than in the telephone survey. This suggests that a postal survey can still be successful in obtaining the "correct" when the latter part of the survey contains enough other questions, are presented separately later on etc to disguise its focus.

2.2 Verbal annoyance questions used in both surveys

In both the Norwegian and the Swedish study verbal annoyance questions with 5 response alternatives are used. The response alternatives distinguish between whether the vibrations are noticeable or not, and for those who are noticeable, between 4 categories of annoyance. None of these surveys used numeric annoyance questions.

Logistic regression models linking people's degrees of annoyance with the vibration exposure the were subject to in their dwellings show that there is a distinct relationship between these two variables, and that the answer categories in

[1] Sometimes information can be sent to the respondent before the interview

both the Swedish and Norwegian study seem to provide an even spread of answers. There should therefore be no need to revise response categories.

2.3 NS8176: $v_{w,95}$ used as vibration exposure measure

Both surveys were analysed with respect to the vibration measure $v_{w,95}$ defined in the newly established NS 8176 (Norwegian Council for Building Standardization 1999) for vibration measurement. The analyses of the Norwegian and on the Swedish data to see whether a linear or logarithmic functional form of $v_{w,95}$ provide the best fit, showed in both cases that the logarithmic form -- $\log_{10}(v_{w,95})$ – was the best for explaining peoples reactions.

There was not sufficient diversity with respect to the number of passages associated with the different areas and the different vibration exposure values to analyse whether such a measure should be incorporated into the vibration exposure measure. Studies conducted internationally suggest that peoples reactions are dependent on the number of passages and their duration and not only the vibration acceleration or velocity, but that this dependency is less than that of noise exposure measures.

In the Swedish area Säffle having a low number of train passages each day, but with high values of the vibration exposure measure $\log_{10}(v_{w,95})$ people are less annoyed than they "should have been" according to the exposure effect relationships estimated for all areas. This suggests that when traffic is very high or very low the vibration exposure measure utilised should be modified.

2.4 Demographic variables of little importance

In both studies the modifying effect of demographic and individual variables have been tested. Gender, age, small children, employment, and civil status are not important for the exposure effect relationships. It is the objective vibration exposure situation that dominates people's responses.

(Noise sensitivity is however an important modifying effect for how people experience annoyance, and questions on attitudes and coping behaviour might be more important for explaining individual differences in response than demographic variables).

2.5 Noise exposure modifies exposure-effect relationships for vibrations

In both studies people's noise annoyance has an important independent modifying effect on people's annoyance with vibrations. Multivariate logit models including both exposure to noise and to vibrations as independent variables, show an interaction between these two exposures on both annoyance with noise and vibrations as dependent measures.

When possible independent measures of noise exposure should therefore be obtained in socio-vibrational studies.

2.6 Problems associated with filtering responses

In connection with noise annoyance assessment in ISO/TC43/WG49 there has been a discussion of whether filter questions whether people can hear noise from a given source, are misinterpreted and result in people being exposed to fairly high noise levels being listed as "not hearing" the "noise".

A comparison of the Norwegian survey using filter questions for the assessment of vibrational annoyance and the Swedish not using filter questions could not detect such an effect.

2.7 Comparisons of response categories using ordinal logit models

Using ordinal logit models (McKelvey and Zavoina 1975) it is possible to obtain a measure of the distance between annoyance categories with respect to the vibration exposure measure utilised. This distance is the increase of the vibration exposure value that is necessary for the same fraction of people choosing the response category as the chose the previous response category. For such a comparison to be useful, it is however necessary to have a common departure point. The transition between not noticeable and noticeable provides such a departure point for such comparisons.

3 Method proposal

As there already has been done a great deal of work within the Internoise and ICBEN communities for a method of noise annoyance assessment, the proposal for a common Nordic method for assessing annoyance from vibrations. has been forged by making a series of decisions on the different issues that have been discussed within these communities and the ISO working group for defining a noise assessment standard. As most of these decision have to be judgement calls, based on limited research and experience, the description of these decisions are only meant to provide some of the background and the rationale for the different decisions.

3.1 Focus on compatibility issues and not general guidelines

While there is a need for methods to aid people not familiar with environmental surveys in the design, conduct, quality assurance, analyses and reporting from vibration surveys, providing such a general guideline is a daunting task and well beyond the reach of a small project.

We have instead concentrated on making the most important responses in these types of environmental surveys (the answers on the annoyance questions) more compatible. This will by itself result in more compatible results. In many cases simple results from the surveys are not be sufficient for answering more specific questions or assessing the effect of modifying factors. The proposal therefore provides guidance as to how data from socio-vibrational surveys can be specified in a manner that allows access to the data for other researchers than the ones conducting the survey itself.

This also means that the intended target group for this Nordic Method proposal are researchers that already have had experience with designing and conducting surveys and that many issues that would be natural to specify in depth for the novice, in the standard are only mentioned in passing.

3.2 More detailed description of sampling issues

Most surveys in the Nordic countries will be surveys targeted towards definite sites where there are vibration problems and where new infrastructure or new dwellings necessitates dealing with the vibration problem. In addition to these socio-vibrational surveys there will also be more general socio-vibrational surveys in order to establish exposure-effect relationships.

The proposal for Nordic Method caters to both these type of surveys and also distinguishes between the requirements depending both on the type of the survey

undertaken, and whether the data can be part of an extended data set with pooled data from several surveys. This makes it easier to apply the method to surveys with other objectives than establishing exposure-effect relationships.

3.3 Choice of ambition level

The level of ambition chosen for the proposal is crucial for the success of the Nordic Method. If the Method is too strict and to different from established practises it will not be felt as a support, but as a straightjacket. One obvious result is that researchers would refrain from utilising the method. If the proposal is not strict enough, the differences in methodology between different surveys will still be too diverse to be compatible.

The proposal given in Part II of this report has tried to balance these two concerns by concentrating on the items that are really required for a survey to be both compatible and useful. To bring forth more results and give room for better methods for improving on both annoyance assessment and vibration exposure measures, this Nordic Method also contains a survey data file output specification. This specification can be used to analyse different data sets and compare results obtained by partly differing methodologies and also for evaluating alternative exposure measures etc.

3.4 Open data file format instead of specified post processing

Based on the difficulties within the ISO/TC43/WG49 group to achieve a consensus on the choice of the number of annoyance questions required and of how to score and merge five point verbal and eleven point numeric annoyance scales, this proposal does not specifying such post-processing.

This has the disadvantage of delaying such decisions to the future, and becomes dependent on the researcher in charge of the survey being able to comply with later requests for such coding and merging of the information. As the whole meaning of this standard is for researchers to reach for compatibility, we have faith that the Nordic research communities will do whatever is practical and within reason to comply with such requests.

The open data file format has the advantage that the Nordic Method can be put to use immediately and hopefully provide results necessary for making research based decision on how to best utilise the information in the two annoyance questions etc.

3.5 Response for "do not notice" required

Within the ISO/TC43/WG49 concerns have been raised about using filter questions whether the "noise" from (source) can be "heard" or not. People report that they cannot hear "noise" when the actual sound levels they are exposed to means that the sound is clearly perceptible. The question must therefore be mis-

interpreted and excludes people moderately annoyed from answering the annoyance questions. People exposed to relatively high sound levels from the source in question are listed as not "hearing" the noise.

This type of filter question has been routinely used in the Nordic countries without having caused problems in interpreting the results. A simple comparison of the Swedish survey not having such a filter question and the Norwegian having a filter showed no evidence of such an effect (Klæboe 1999). (The lack of good quality vibration exposure data could mean that such an effect just was not detectable.)

More importantly the problem of people misinterpreting a filter question is not the case for vibrations, as the question is whether the vibrations are noticeable or not. In fact the transition between noticeable and not noticeable should be less dependent on differences between countries, culture and language than between different degrees of annoyance.

Categories capturing the transition between not-noticeable and noticeable vibrations are therefore included in this Nordic Method for both the verbal question using a filter, and the one that is unfiltered. The numeric rating scale has "Do not notice" as an anchoring point.

"Perceiving" vibrations in a field situation is different from perceiving vibrations in an experimental situation. Visual cues, structure sound etc will be different for different groups of people depending on how the have decorated their room and pinned movable items down.

3.6 Only a verbal annoyance question required

For noise annoyance assessment there has been a discussion on whether to require one or two annoyance questions and what form the two questions should take. An argument for using multiple questions is the increased reliability of combining information from two questions. Providing the same question with different answer formats and directionality might also enhance the validity of the question.

This is the reason why the use of both a verbal and a numeric annoyance scale has been proposed for noise annoyance assessment.

Arguments against the use of multiple annoyance questions are of course cost and that respondents will object to being asked the same questions over and over again – especially when there are additional annoyance questions to be answered.

As all the Nordic countries have used verbal categories for distinguishing between degrees of annoyance, and have little experience with the numeric question, it was decided to make the numeric rating optional.

3.7 Four instead of five degrees of annoyance

In order to reduce the number of verbal categories people have to choose from, the verbal annoyance question has only 4 response categories. Together with the

response "not noticing" this makes up a 5-point scale. (This five-point scale is different from 5 point scales being proposed for noise annoyance assessment where the lowest category is "Not annoyed")

From the exposure-effect relationships derived in the Norwegian vibrational study in 1998 where nobody had higher vibration exposure values $v_{w,95}$ over 4 mm/s, there seems to be little need for a verbal category of "extremely annoyed" see Figure 3.1.

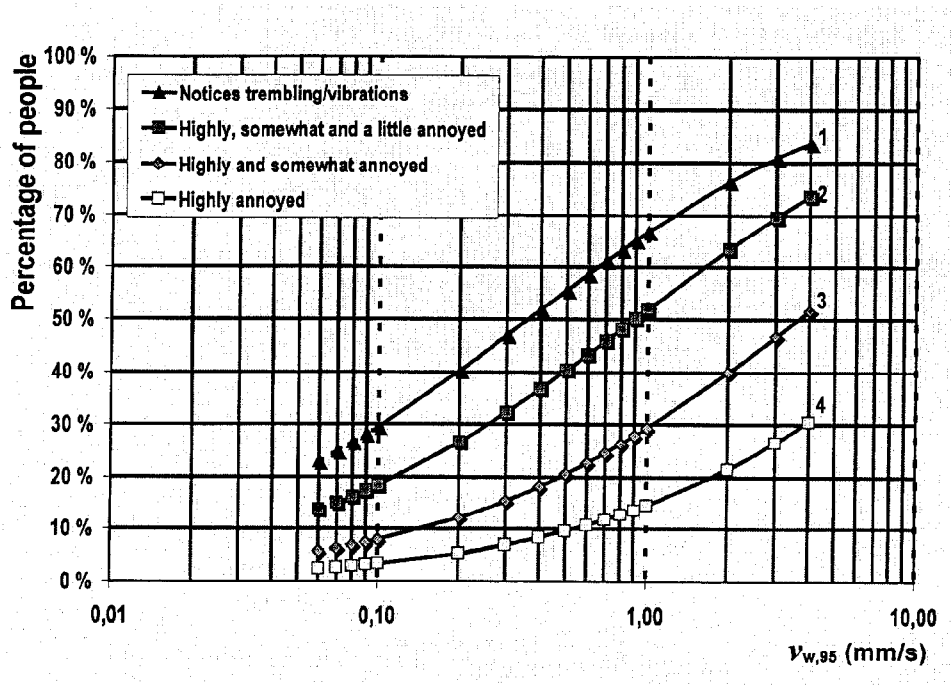

Figure 3.1: People reporting different degrees of annoyance by the strength of the vibrations $v_{w,95}$. *Logarithmic scale. Norwegian Vibration Survey 1998. N=1427. Percentages.*

If many respondents are exposed to vibration values $v_{w,95}$ exceeding 4 mm/s, one might consider also making use of the optional numeric rating scale in addition to the verbal annoyance question. The numeric annoyance rating is meant to allow a finer gradation of answers, and the high anchoring point is "extremely annoyed" and not "highly annoyed". The low anchoring point is however the same as in the verbal annoyance question and fixed at "not noticing"

3.8 Survey for use in before-after questions

As many of the surveys that will be undertaken in the Nordic countries will be before-after studies to assess the effect of changes in exposure, the proposal contains one question assessing peoples perception of whether and how the situation has changed. When data from these types of surveys are combined with survey results from other areas and general vibration surveys, such studies will enhance the quality of exposure-effect relationships.

3.9 Text file instead of printed report format

The proposal specifies that a description of the survey, the questionnaire, the procedures used, the sites, the vibration exposure measures used and other information should only be provided by means of a text file format.

Several of the required items have as their origin a recommendation for presenting results from socio-acoustic surveys (Fields & al 1997). The requirement differs however both in content and in that the description need not be presented in form of a report. Usually the text file will be put together by copying different parts of the printed report.

(The recommendation by Fields & al should also be considered in connection with the actual survey reports).

3.10 Inclusion of surplus information

The provision of a common survey data file output format containing information on other aspects of exposure, unusual aspects of the sites etc. should make it possible to perform analyses controlling for such factors and hopefully extending exposure-effect relationships to a wider range of situations. Including indicators for type of annoyance question etc. should also provide information on what type of modifications that are required for improving the methodology for socio-vibrational studies.

4 Literature

Fields, J M. 1993
Effect of personal and situational variables on noise annoyance in residential areas. *Journal of the Accoustical Society of America* 93(5), 2753-2763.

Fields, J M & al . 1997
Guidelines for reporting core information from community noise reaction surveys. *Journal of Sound and Vibration* 206(5), 685-695.

Hårvik, L. 1998
Norsk standard for vibrasjoner fra samferdsel NS8176. Dosedata fra norsk og dose-responsdata fra svensk sosiologisk undersøkelse. Oslo, NGI. Rapport 515159-1.

Klæboe, R and Fyhri, A. 1999
Befolkningsreaksjoner på vibrasjoner i bolig - vibrasjoner fra landbasert samferdsel. Oslo, Transportøkonomisk institutt. TØI rapport 443/1999.

Klæboe, R. 1999
Metodikk for undersøkelse av befolkningsreaksjoner på vibrasjoner i bolig. Delrapport til Nordtest. Oslo, Transportøkonomisk institutt. TØI arbeidsdokument SM1010/1999.

Klæboe, R and Grue, B. 1999
The Sampling Method in the 1998 Norwegian Travel Survey. An analysis of estimator properties using WesVar. Oslo, Institute of Transport Economics. TØI working report 1135/1999.

Kolbenstvedt, M, Klæboe, R and Kjørstad, K N. 1990
Flytrafikk, bomiljø og helse - resultater fra en intervjuundersøkelse rundt Fornebu 1989. Oslo, Transportøkonomisk institutt. TØI rapport 65/1990.

Madshus, C, Bessason, B and Hårvik, L. 1996
Prediction model for low frequency vibration from high speed railways on soft ground . *Journal of Sound and Vibration* 193(1), 195-203.

McKelvey, R D and Zavoina, W. 1975
A statistical model for the analysis of ordinal level dependent variables. *Journal of Mathematical Sociology* 4, 103-120.

Namba, S & al . 1996
Report of the committee of the social survey on noise problems. *Journal of the Acoustical Society of Japan* 17(2), 109-113.

Norwegian Council for Building Standardization. 1999
Vibration and shock Measurement of vibration in buildings from land-based transport and evaluation of effects on human beings. Norwegian Standard NS 8176. Oslo, Norwegian Council for Building Standardization.

Öhrström, E and Skånberg, A. 1995
Effekter av exponering för buller och vibrationer från tågtrafik-undersökning i 15 tätorter. Göteborg, Göteborgs Universitet. Avdelningen för Miljömedicin. 1/95.

Part II

Assessment of annoyance caused by vibrations in dwellings from road and rail traffic by means of socio-vibrational and social surveys

Content part II

1 Introduction

While a range of international standards defining noise, vibration and other environmental measures have been established, standards or methods for measuring people's reactions to these same environmental effects are lacking. This lack of standards and common methods reduces the comparability of prevalence statistics and exposure-effect relationships developed by different researchers and in different countries.

Exposure-effect relationships are the foundation on which most guidelines and limits to reduce environmental annoyance are built. Standardisation of the effect measurement is thus important for comparing such relationships. The lack of a common data representation of key survey data and of a survey data interchange format are other obstacles to precisely defined post-processing and pooling of data from different surveys.

Especially for vibrations in dwellings, there are relatively few socio-vibrational studies using a common exposure measure and it is important to establish a common effect measure to be able to extract as much information from such studies as possible.

In connection of the development of a new Norwegian Standard NS 8176 defining a new vibration exposure measure, The Institute of Transport Economics in co-operation with the University of Gothenburg, Institute of Environmental Medicine was given the task of suggesting at new Nordic Method for assessing vibration annoyance.

The Nordic Method presented here is an effort to establish a standard way of assessing people's annoyance with vibrations in dwellings from nearby road and rail traffic by means of socio-vibrational and social surveys. It draws heavily on concurrent efforts within the ICBEN and Internoise communities for standardising the measurement of environmental noise annoyance in residential areas. Many researchers and research group working with socio-acoustic surveys have made substantial contributions towards the establishment of national and international standards.

The Nordic countries are close geographically and geo-politically and have a common interests and outlook. This is a good basis for establishing a common Nordic Method.

There are however a number of reasons for not standardising every detail:
The countries are culturally different, utilise different annoyance concepts and different languages. The organisation of research and survey practices also vary between the countries. Established practises and compatibility issues with respect to previous local research are thus important counter arguments against too detailed standardising of socio-vibrational surveys.

It is also possible to argue that research driven ventures never can be fully standardised – one should "aim for innovations". In more practical terms many research projects have multiple objectives and limited funds -- perhaps more so in small countries. Design compromises and economic considerations are therefore necessary. This Nordic Method is also based on a limited amount of methodological research and limited experience with the new vibration exposure measures defined in NS 8176.

To aim for complete agreement on all details of survey methodology is therefore counterproductive. Demanding such degree of agreement will only result in delays in producing the Nordic Method, non-adherence and a reduced amount of empirical results that can be used for driving the process further.

This Nordic Method deals therefore only with the most important stumbling blocks for these types of surveys. These are the sampling considerations, the actual annoyance questions, the text file output describing the survey, procedures, sites and objective measures, and the data file output from the surveys. Other parts of the design, conduct, content and reporting are left to the researchers discretion.

A detailed data output format is specified in this Nordic Method. When possible the data material can be made directly available for the interested researcher. Alternatively the researcher in charge of the survey data may accept requests for the results of specific coding and statistical analyses from fellow researchers. The use of predefined variable names and coding, will make such requests easier to define and easier to comply with. For researchers using the same type of statistical software, command files may be supplied from the requesting researcher. This also means that different researchers do not need to decide on specific data post-processing procedures before utilising this Nordic Method.

This Nordic method has also been designed to aid the formation of second generation methods by defining a data output format for survey results that in addition to allowing pooling, also includes surplus information on exposure and survey sites. This should allow results obtained by means of partly differing methodologies to be compared and result in an evolution.

Pooled data and surplus exposure information should make comparisons of different types of results attained by partly differing methodologies easier to make by means more comprehensive modelling. Hopefully this will aid the further evolution of both this Method and also result in more comprehensive vibration exposure measures.

2 Scope

This Nordtest Method is a guide to the content, conduct, text file output describing the survey, procedures, sites and objective measures, and the data file output of socio-vibrational and social surveys measuring annoyance due to vibrations in dwellings from road and rail traffic.

The main purpose of this Nordic Method is to:

- improve the degree of compatibility between survey results from different studies and enhance their usability for authorities and scientists
- improve the quality of results
- allow results from socio-vibrational research to be accumulated in a common database
- pave way for future revisions of this method and improved vibration exposure measures

The Method is not a general guideline, but specifically aimed at clarifying methodological issues and recommending solutions for accomplished researchers.

3 Field of application

3.1 Survey types where the method is applicable

This Nordtest Method applies to all socio-vibrational or social studies where people's annoyance due to vibration in dwellings from road and rail traffic are measured by means of questionnaires or interviews.

All parts of the method apply to socio-vibrational studies. Only the annoyance questions: sections 7.6 and 7.7 are directly applicable to social surveys.

3.2 Limitations

This Nordic Method is not intended for specifying how to conduct and design socio-vibrational and social surveys in general. This Nordic Method specifies instead methodological issues that should be considered and dealt with for compatibility reasons, and in some cases provides alternative solutions of dealing with an issue.

The conduct and design of socio-vibrational and social surveys may deviate from this Nordic Method without being inferior with respect to their specific purposes.

4 References

In addition to the references associated with the assessment of annoyance due to vibrations in dwellings from road and rail traffic, references are also given to standards, calculation procedures and reports associated with the vibration exposure measures and noise exposure measures that are to be described in Chapter 8 and/or included as part of the survey data file output – see Chapter 9.

4.1 Standards

NS 8176:1999E	Vibration and shock – Measurement of vibration in buildings from landbased transport and guidance to evaluation of effects on human being.
ISO 2631-1:1985	Evaluation of human exposure to whole-body vibration – General requirements.
ISO 2631-2:1989	Evaluation of human exposure to whole-body vibration – Part 2: Continuous and shock-induced vibration in buildings (1 to 80 Hz)
ISO 2041:1994	Vibration and shock – Vocabulary
ISO/CD 15666	Assessment of noise annoyance by means of social and socio-acoustic surveys *(in preparation)*
NT ACOU 082	Buildings: vibration and shock, evaluation of annoyance. Nordtest, Finland (1991).
SS 460 48 61:1992	*Vibration och stöt - Vägledning för bedömning av komfortstörningar i byggnader.* (Vibration and shock – Guidelines for the evaluation of disturbances of comfort in buildings).

4.2 Calculation procedures and reports

Banverket BVPO 724:001/1997

Beregningsmodel for vejtrafikstøj. Revideret 1996. Rapport nr. 178, 1998. Miljøstyrelsen og Vejdirektoratet.

Måling af vejtrafikstøj. Vejdirektoratet og Miljøstyrelsen 1982.

Lavfrekvent støj, infralyd og vibrationer i det eksterne miljø. Orientering fra Miljøstyrelsen nr. 9, 1997.

5 Definitions

5.1 Socio-vibrational surveys

Surveys designed to measure people's reactions to vibrations in buildings from road and rail traffic for different vibration exposure situations and/or to establish exposure-effect relationships.

The main characteristic of socio-vibrational surveys when compared with social surveys is that they provide information about the actual vibrations each person is exposed to and of their time histories (number of passages etc). In addition to providing general knowledge on exposure-effect relationships, socio-vibrational studies are often targeted at assessing the effects of changes in vibration exposure or the effect of mitigating efforts for specific dwellings, sub-areas etc.

5.2 Social surveys

Social surveys are here defined as: General surveys of living conditions or broader environmental studies where responses usually are not linked to objective measures of vibration exposure.

Social surveys are prevalence studies that provide information on the level of annoyance with vibrations in dwellings from road and rail traffic for different, usually administratively defined, subsets of the population. Results from social surveys serve as important references for socio-vibrational studies.

Distinguishing characteristic of social surveys are that they have a broader subject area than people's reactions to vibrations and most often lack objective vibration values. The results from social surveys are usually not suitable for developing exposure-effect relationships, and their design are often the result of many compromises in order to achieve an overall optimal quality.

5.3 Vibrations

In this Nordic Method vibrations are everywhere to be understood as vibrations in dwellings from nearby road and rail traffic. Traffic from trucks is not included when part of the construction work and industrial of content, but are included when they move from one site to another.

5.4 Vibration measures

Definitions of various physical vibration measures used can be found in standards like ISO 2631, ISO 2041, NS 8176 , SS 460 48 61 etc.

Vibrations in dwellings are composed of vibrations in three orthogonal directions, at different frequencies and with different time histories depending on the source.

The statistical maximum weighted vibration velocity $v_{w,95}$ or acceleration $a_{w,95}$ as defined in NS 8176, or weighted continuous or intermittent velocity or acceleration as given in ISO 2631 –1 and –2 are such measures.

5.5 Vibration exposure measure

A vibration exposure measure is either a vibration measure or a composite measure combining a vibration measure with indicators of the time history of the vibrations. The form of the composite is chosen to reflect the relative importance of its different parts for explaining and predicting people's reactions. Vibration exposure measures should have a functional form that best captures the changes in people's reaction when the different elements of the composite vary. The choice of vibration exposure measures vary in different countries and an international agreement has been difficult to achieve.

5.6 Annoyance

Annoyance is here used in a broad sense to capture a general negative reaction caused by vibrations in dwellings from nearby road or rail-traffic. The different Nordic countries use different concepts and words for "annoyance" see Annex A.

An operational definition for the purpose of this Nordic Method is that annoyance is what the annoyance question(s) measures.

5.7 Annoyance question

Question or questions with or without filter questions utilised for eliciting people's annoyance to vibrations including the response that the vibrations are not noticeable.

5.8 Filter questions

Filter questions are questions that are posed before the actual annoyance question. Filter questions are used to select only the people who are affected by the environmental effect one wishes to measure people's reaction to.

5.9 Exposure-effect relationships

Exposure-effect relationships describes the proportion of people that report or experience an effect at different values or intervals of the chosen vibration exposure measure. Exposure-effect relationships may also be described statistically by means of the estimated relationship between an exposure and an effect based on a stochastic model.

5.10 Modifying factors

Modifying factors are factors that influence the relationship between exposure and effect. Such factors can be external – such as the presence of additional environmental problems and in particular noise emitted from the vibrations source, or internal -- such as the degree of sensitivity to noise or vibrations.

6 Sampling

Socio-vibrational surveys fall in to two main categories. They are either general surveys with the purpose of estimating exposure-effect relationships or specific surveys to assess annoyance in specific sub-areas associated with a given vibration exposure. Often such studies are in the form of before-after studies that assess annoyance changes after changes in road or rail traffic or as a result of vibration or noise counter-measures.

Sampling requirements differ depending on the type of socio-vibrational survey that is undertaken, and whether the data set is to be utilised separately or is to be analysed as part of an expanded pooled data set. The different requirements are described in the following sections. Only the requirements for the type of survey being conducted are applicable.

Sampling design for more specific purposes such as quality assurance, extending results obtained in one survey to another country, site etc. are not covered here,

Sampling design for social surveys in general is also not covered here.

6.1 Systematic sampling for establishing exposure-effect relationships

The primary aim of the sampling procedure in socio-vibrational surveys designed for establishing exposure-effect relationships is not to capture a representative sample of people, but to ensure that the sample consists of a set of people that are exposed to different vibration exposure situations and that vary with respect to the important modifying factors that are included in the statistical analyses.

Respondents should be selected so that one obtains responses spread evenly over the parts of the vibration exposure scale applicable to these types of vibrations. There should be an overrepresentation of responses from people exposed to vibrations where previously developed exposure-effect relationships have shown that relatively small changes in the vibration exposure measure is associated with relatively large changes in annoyance.

The sampling procedure is thus systematic in that it seeks to maximise information content and not representativity. It deliberately avoids often occurring values and focuses on providing rich information over the whole range of variation in vibration exposure and in modifying variables. Such variation is sought with respect to the study areas, types of dwellings, groups of people, psychological factors, noise exposure and other modifying factors. The objective is to provide the necessary information to identify the effect of the modifying factors and estimate their impacts.

The quality of the sampling procedure is thus determined by the quality and completeness of the statistical models one can build on the basis of the socio-vibrational survey, the associated vibration exposure measures and sub-area and dwelling descriptions.

When different survey samples are pooled, the quality is determined by the stochastic models based on the pooled, not the individual, survey samples. Depending on whether single survey sample or pooled survey samples are to be used, important modifying variables should either be excluded or included in the survey.

6.1.1 Sub-area selection when data are analysed separately

Several sub-areas should be selected that vary with respect to vibration exposure and important modifying variables that are modelled.

If a sub-area is atypical, such as if there has been excessive media-coverage the sub-area should preferably be excluded from the sub-area selection. Sub-areas having other significant environmental or social problems or that are extraordinarily popular on account of environmental or other qualities should also be excluded.

6.1.2 Sub-area selection when data are part of a pooled data set

Supplementary samples to an existing data set will often focus on sub-areas or respondents that are exposed to vibration situations or have values for modifying factors that are not well represented in the existing data set.

Distinguishing characteristics such as media coverage and other specific features could very well be the meat that meta-analysis could build on for assessing their effect. Such analyses could extend and adapt exposure-effect relationships to a wider range of situations. In these cases what is needed is not the exclusion of the data, but the deliberate inclusion of such sub-areas with the proviso that the distinguishing characteristics are described in a way that makes them amenable to such analyses.

6.1.3 Probability sampling within sub-areas

When possible there should be established a sampling frame for the people living within each sub-area and probability based sampling techniques utilised for drawing people. This randomisation will reduce the risk of unidentified modifying factors from unduly influencing results.

Probability sampling methods will also allow methods from sampling statistics to be used for statistical inference from sub-area samples to sub-area populations. (Stratification by distance to the road/track could be considered when most of the dwellings are located away from the road/track.)

6.2 Representative sampling for assessing prevalence

The primary aim of sampling for this type of socio-vibrational surveys is to provide estimates of the prevalence of annoyance in different segments of the population. When possible a sampling frame listing all people in the target

population should be established and probability based sampling techniques utilised for selecting respondents. In this case results derived from cross-tabulations can be generalised from the sample to the population by means of sampling statistical methods.

Selection of sub-areas for prevalence studies are often sites where vibration exposure is expected to change/or the subject of interventions. Such sub-areas might be supplemented with control areas for effect studies.

When representative sampling is used in before-after studies, the effects with respect to annoyance of

- changes in the exposure to vibrations
- vibration countermeasures
- changes in effect modifiers

can be deduced from extending results from the respective sample statistics to the population as a whole by use of samplings statistics in the before and after situation.

When estimates of annoyance changes in before-after studies are not based on sampling statistics but by applying results from estimated exposure-effect relationships, the sampling procedures must be made according to the requirements of section 6.1.

Often sampling designs are compromises between both sets of requirements.

6.3 Non-response

The problems associated with non-response are slightly different in studies establishing exposure-effect relationships than in prevalence studies. For both types of study non-response is an increasing problem due to the increasing number of market surveys, opinion polls etc. Introductory letters and other means for reducing non-response are therefore strongly recommended.

6.3.1 Non-response in exposure-effect studies

Non-response is in exposure-effect studies primarily a problem when non-respondents differ from respondents in ways that are not captured by differences in exposure or by modifying factors in the sample that are modelled.

6.3.2 Non-response in prevalence studies

In socio-vibrational surveys for establishing the prevalence of annoyance, or before after studies for assessing changes in annoyance, in the population by means of sampling statistics, non-response reduces the quality of such inferences.

Non-response can be related to among other factors: age-group, how much people stay at home, attitudes towards the vibration source, and health effects associated with the vibration exposure.

When possible Geographical information systems or other systems showing how non-response varies with distance to the track/road should be used.

6.4 Definition of the response rate

The definition of non-response is with respect to the sampling frame utilised.

When people are not in the correct age group, do not live in the survey areas or in other ways are detected during the interviewing process to fall outside of the defined sampling frame, the must be excluded. As they should not have been selected in the first place, this should not be counted as non-response.

If a person is not reachable this is part of the non-response. People who refrain from answering on account of language problems are also part of the non-response. If another person in the household answers the questions in lieu of the person that was selected, the results should be excluded from the data file and considered a part of the non-response.

7 Test method

7.1 Principle

A verbal and a numeric rating question is provided for obtaining direct magnitude estimations of the degree of annoyance. Only the verbal version is required.

The advantage of using both ratings lies in the increased reliability by the use of the two questions and the increased validity by using somewhat different answering formats.

7.1.1 Magnitude estimation by categorical rating:

Direct magnitude estimation of annoyance with vibrations in dwelling by road and rail traffic by

Choice between 5 response categories listed in decreasing order of annoyance. The choice is elicited by means of

- one single annoyance question with 5 response categories
- the combination of
  a filter question on the noticeability of vibrations and an
  annoyance question with 4 response categories.

7.1.2 Magnitude estimation by numeric rating

In addition annoyance might optionally be measured by the choice of a numeric value on a 11 point scale from 0 to 10.

7.1.3 Questions about changes in annoyance with vibrations

In before-after studies, separate questions about how people assess the changes in vibration annoyance from the before-situation to the after-situation should usually be posed. One should try to not use leading questions and consider using a time frame instead of referring to the actual measure or changes.

Changes in annoyance due to changes in exposure, vibration countermeasures or changes in modifying factors are usually accompanied by other types of changes in the environment. Questions probing these indirect effects should preferably also be included in a before-after study.

7.2 Equipment

The questionnaire for use in either postal surveys or in personal or telephone interviews should be formalised and used in a consistent manner. Instructions for the training of non professional survey takers should be clearly defined and reported while it suffices to report the special interviewing instructions for professional marketing firms. Optionally descriptions of the on-line filtering and quality assurance should be given. The actual content of these items are left to the discretion of the researcher, but should be described in the text file output as described in Chapter 8.

Answer cards may be used for the annoyance questions when conducting personal interviews. In postal surveys the numerical ratings may be provided by pencil marks, answer boxes, crossing out or circling numbers etc. on visually presented scales.

7.3 Testing environment

The testing environment depends on the type of survey that is to be undertaken as has been described in Chapter 6 dealing with the sampling design. The requirement is therefore not in the form of a specific testing environment, but rather that there should be a description in the text file output – see Chapter 8, of the different testing environments present in the study. Preferably variables capturing the differences in the testing environment should be included in the data file output from the survey – see Chapter 9.

In particular annoyance with vibrations is modified by noise exposure associated with the source of vibrations. When separate noise measurements are not available, a minimum requirement is that distance to this noise source is known and included in the data file.

If other noise sources or other modifying factors are of importance for the responses in a sub-area or for a known group of respondents this should also be noted in the test report. When the data file lacks an variable capturing the modifying factor in question, an indicator corresponding to the description should be added to the survey file in order to identify the data records containing results associated with the particular noise situation or level of other modifying factors. If the situation is not applicable to the whole sub-area the indicator should be associated only with the records affected.

7.4 Pre-conditioning of test samples

The questionnaire often consists of different segments.

1. Introduction
2. General questions on environmental quality/plans or wishes to move
3. Annoyance questions for each of the vibration sources
   and of other environmental problems (noise, air pollution etc)
4. Daily disturbances and inconveniences
5. Subjective health questions if any, and sensitivity to noise and vibration
6. Background information
7. On dwelling: building, floor, window types, room location, length of residence
8. On person: demographics, attitudes/coping styles.

7.4.1 Placement of the annoyance questions

The vibration annoyance questions should be introduced before other questions revealing that the survey has focus on vibrations in dwellings. The recommended placement is after the introduction and the section of the questionnaire dealing with different environmental qualities.

7.4.2 Introduction

When people are made aware of the purpose of a socio-vibrational or social survey measuring prevalence, there is a risk that the questions register too high annoyance levels from vibrations due to the focusing effect of such an introduction.

The introduction should therefore specify the survey as a general community survey, and there should be posed some introductory questions probing a variety of environmental concerns. When necessary the party commissioning the study should not be disclosed.

For questionnaires distributed in written form, there should be an introduction specifying the questionnaire as a general community survey.

When possible the latter part of the survey should include questions on other environmental effects so as not to completely identify the surveys main purpose for people who peek ahead.

When not possible, a two-stage acquisition process, instructions or techniques for people to answer sequentially without previewing latter parts etc should be considered.

These procedures are meant to mask the purpose of the survey, and where this is not possible to at least ensure that the survey is framed in a way that guides people towards answering the different questions with reference to the living environment as a whole.

7.5 Test procedure and data processing

This method does not specify whether there should be used filter questions or not. The choice of which version of the annoyance question to use will in part depend on whether the survey is undertaken by means of written questionnaires or by verbally posing the questions over the telephone or in personal interviews.

Especially when there are many annoyance questions, filter questions can reduce both the cost of telephone or personal interviews and the strain on the respondent of answering.

More importantly, distributing the annoyance question over two separate questions reduces the problem of information overload – especially when the questions are posed verbally over the telephone.

Some researchers have reported that filter questions whether the noise from (source) can be heard or not, used in connection with noise annoyance assessment can be misinterpreted and exclude people moderately annoyed from answering the annoyance questions. As a result people exposed to relatively high sound levels from the source in question might be listed as not "hearing" the noise. In the Nordic countries there has not been reports of such effects.

For vibration annoyance the difference between noticing and not noticing vibrations is clear, and provides an important reference point for comparing reactions in different countries.

Categories capturing the transition between not-noticeable and noticeable vibrations are therefore included in this Nordic Method for both alternative verbal questions. The numeric rating scale has "Do not notice" as an anchoring point.

7.6 Verbal annoyance questions

The verbal annoyance question is required. Either the version with or without the filter question may be used.

7.6.1 English version with filter

Do you notice tremors or vibrations from (source) when indoors or not ?

If yes: When you think about the last 12 months or so, do you consider these tremors or vibrations: highly annoying, moderately annoying, a little annoying or not annoying?

The wording "...12 months or so..." A period of approximately a year is recommended to encourage respondents to give their general reactions to the environment rather than to mentally try to average their reactions over exact 12 months. The length of the time period may need to be different for different surveys. If there have been recent changes in the noise environment, or the focus of the study is on a particular time or if it is not possible to provide a reliable vibration exposure measure for a long time period, then some shorter period may need to be specified.

7.6.2 English version without filter

When you think about the last 12 months or so, how do you consider tremors or vibrations from (source) when indoors: highly annoying, moderately annoying, a little annoying, not annoying or do you not notice vibrations at all?

7.7 Numeric annoyance rating question

This question is optional

Introduction: *To be able to compare results with those from other countries we want you to answer the same question using a numeric scale also:*

When you think about the last 12 months or so when indoors, how would you rate your annoyance with tremors or vibrations from (source)? Pick a number from 0 to 10 where 0 denotes not noticeable and 10 denotes extremely annoyed.

Visual scales such as the one below, may be used in connection with postal questionnaires or presented by means of answer cards. The actual design can differ, but the endpoints should be identified and the result should be a whole number.

Do not notice 0 1 2 3 4 5 6 7 8 9 10 Extremely annoyed

7.8 Questions for changes in annoyance with vibrations

7.8.1 Filter version

This question is optional. Depending on the context the wording of the question may have to be changed. The response categories should be kept when possible.

When compared with (time frame) ago, has the situation indoors with respect to vibrations from (source) changed?

If yes: *Is the situation today: "markedly better", "somewhat better", "somewhat worse" or "markedly worse" than before?*

7.8.2 Without filter

When compared with (time frame) ago, how has the indoor situation changed with respect to vibrations from (source)? Is it "the same" -- or is it "markedly better", "somewhat better", "somewhat worse" or "markedly worse" than before.

(Alternatives may be presented visually.)

7.9 Applicability

The annoyance questions probe people's general feelings of annoyance due to vibrations in dwellings from road and rail traffic. If necessary with more specific

annoyance questions with respect to vibrations in different rooms, for different body postures etc, these should be placed **after** the general question.

The unfiltered version of the verbal annoyance question will usually be utilised when the answer categories are presented visually on a questionnaire or by means of answer cards. The filtered version will usually be used when posing the questions verbally in telephone or personal interviews.

The optional numeric rating will usually only supplement the general verbal question for assessing vibration annoyance, and not be used with less important vibration sources or for more specific parts of the annoyance.

7.10 Measurement of noise annoyance

Annoyance with noise associated with the source of vibrations and other noise sources should be measured using procedures equivalent to the ones described in this Nordic Method for measuring annoyance with vibrations in dwellings from road and rail traffic.

After a Standard or Nordic Method for noise annoyance assessment has been accepted, the new standard or method may be used for noise annoyance measurements.

7.11 Questions on disturbances and other vibration effects

These questions are optional. When used they should preferably be coded as given in Annex B. Other types of coding is permitted as long as the variable names and code alternatives are reported in the survey text file output see Chapter 8.

How people notice vibrations.

- Items rattling/klinking.
- House vibrates.
- Windows vibrate
- Furniture moves
- Bodily perceptions
- Others .....

Disturbances

- Sleep/rest
- Radio/TV usage
- Communication/Concentration
- Others ...

Anxiety

- Fear for self/children

- Fear for property damage
- Others ...

Specific vibration annoyance questions

- When during 24h is the vibrations most annoying
- Which types of sources are annoying
- Are there specific problems associated with road surface / rail surface

8 Survey text file output

The survey text file output is provided as a convenient method for describing the survey, survey procedures, exposure measures utilised, site descriptions, modifying factors applicable to sub-areas or groups of respondents, definition of new variables etc.

The content of the text file output is described in Table 8.1 should be provided using a document interchange format or that of a simple text file. The program and version number used for producing the file with the information should be noted.

Information about the survey period, country, and vibration source(s) should be given both in the text file output file and on the data file output, - see Chapter 9.

Table 8.1: Information that should be provided as a text file

Topic area	Item	Topic	*Information*
Overall survey design	0	Survey identifier	Name of survey, survey no, year started, research institution
	1	Survey date	Dates of interviews
	2	Sub-area location	Map or description of study sub-area locations relative to the vibration source
	3	Sub-area selection	Sub-area selection & exclusion criteria
	4	Sub-area characteristics	Unusual aspects/changes in vibrations noise lately (increasing-decreasing). Non-response by distance (prevalence studies)
	5	Study purpose	State study goals
Social survey sample	6	Sample selection	Respondent selection procedures and exclusion criteria (age, length of residence, etc.)
	7	Sample size	Response rate, Non-response defined by eligible people in sampling frame
Social survey data collection	8	Survey methods	Interviewer & questionnaire instructions
	9	Questionnaire wording	Reproduction of complete questionnaire(s), contact letters, & interview & follow-up procedures
Variables/coding not in Annex B	10	Variable names, labels, coding alternatives	Values of variables coded in the direction of increasing annoyance.
Vibration exposure	11	Vibration exposure measure	Reference to the method for measuring or calculating vibration exposure
	12	$v_{w,95}$& $a_{w,95}$ calculations	When applicable, procedures for translating exposure measure to those described in NS 8176
	13	Uncertainty	Uncertainty given in the relevant measurement or calculation standards
Noise exposure	14	Noise measures used	Reference to standards, methods and calculation procedures

9 Data file output

This Nordic Method requires data from the respondents, dwelling, sub-areas and exposure information to be provided according to naming and coding conventions listed in Annex B on a current data medium and in a standard data exchange format.

The data file output specification makes it possible to gain compatibility for non-essential items by reusing variables and coding. The specification also makes it easier for fellow researchers to require specific coding or post processing of data and make possible the pooling of data from different surveys.

Detailed specification of the required items for the data file and the specification of numerous optional items are provided in Annex B. Except for the few required items the data file format is open. It is possible to add other variables and other forms of coding as long as these are described in the survey text file output – see Chapter 8.

9.1 Respondent anonymity

In social surveys information identifying the respondent is usually not required. In socio-vibrational surveys and other environmental surveys there is however need for the research organisation to know each persons address in order to provide objective vibration exposure measure or other measures at each persons dwelling.

Data that through address or other information can be traced to a person, has to be handled with care. Gathering and use of such data are regulated and may require concessions. Respondent addresses, geographical coordinates or other information making it possible to for people having access to the data file output to identify persons should not be included.

Respondent anonymity is only breached when identifying and sensitive information are linked. When using professional marketing organisations having concessions to collect person data special data handling procedures can therefore maintain respondent anonymity - see Annex C.

The same procedures should be used when the data acquisition and analyses are undertaken by the same organisation to minimise the risk of respondent anonymity being breached if unauthorised persons gain access to the research institutions data file.

9.2 Required data file items

9.2.1 Survey und sub-area information

- Survey identification information and survey period
- Sub-area identifier and identifier for parts of sub-areas associated with modifying factors influencing exposure-effect relationships and described in survey description text file output.

9.2.2 Responses to the vibration annoyance questions

- Verbal annoyance question
- Numeric annoyance question -- when used
- Question on changes in vibration annoyance -- when used

9.2.3 Vibration exposure and distance to road or railway track

- $v_{w,95}$ or $a_{w,95}$ for each source -- when available or can be calculated
- Distance from dwelling to the road/railway track

9.2.4 Noise levels when available:

- 24h equivalent noise level outdoors (Noise at most exposed side -- free field)
- 24h maximum noise level outdoors (Noise at most exposed side -- free field)
- Distance from the dwelling to the noise source associated with the vibrations. (Usually same as in 9.2.3 but may vary if more distant special features of road surface/railroad tracks cause vibrations but not necessarily noise.)

10 Acceptance or rejection of the results

The socio-vibrational survey should be subjected to normal quality assurance procedures at the research institution. These includes quality control of data and the procedures used for obtaining them. Often the quality assurance is formalised, and a fellow researcher goes through the procedures used and the results.

If such quality assurance has been performed and the output of the survey meets the requirements in this Nordic Method, the results are automatically accepted.

ANNEXES

A National annoyance questions

A.1 Norwegian version with filter

Merker du i boligen risting eller vibrasjoner fra (kilde) ?

Hvis ja: "Når du tenker på de siste 12 månedene eller så, synes du vibrasjonene er: meget plagsomme, en del plagsomme, litt plagsomme eller ikke plagsomme?

A.2 Norwegian version without filter

Når du tenker tilbake på de siste 12 måneder eller så i bolig, er vibrasjoner/risting fra (kilde) meget plagsomme, en del plagsomme, litt plagsomme, ikke plagsomme eller merker du ikke vibrasjonene i det hele tatt?

A.3 Norwegian numeric rating question

Introduksjon: *For å kunne sammenligne ditt svar med svar fra andre land vil vi be deg angi hvor plaget du er ved hjelp av en tallskala:*

Når du tenker på de siste 12 månedene eller så når du oppholder deg i boligen, hvor plaget er du av vibrasjoner risting fra (kilde) på en skala fra 0 til 10. Tallet 0 betyr at du ikke merker vibrasjonene og 10 betyr at du er ekstremt plaget.

A.4 Norwegian change question

Når du sammenligner med (tidsangivelse) har situasjonen endret seg med hensyn på vibrasjoner fra (kilde)?

Hvis Ja: Er situasjonen i dag merkbart bedre, noe bedre, noe verre eller merkbart verre enn tidligere?

Without filter

Når du sammenligner med (tidsangivelse) er situasjonen med hensyn på vibrasjoner fra (kilde), den samme som før, eller merkbart bedre, noe bedre, noe verre eller merkbart verre enn tidligere.

A.5 Swedish version with filter

Lägger Du märke till vibrationer eller skakningar från (källa) i Din bostad?

Om ja: När Du tänker på de senaste 12 månaderna eller så, tycker Du att Du: störs mycket, ganska mycket, ej särskilt mycket eller störs Du ej?

A.6 Swedish version without filter

Om Du tänker på de senaste 12 månaderna eller så när Du vistas i Din bostad: medför vibrationer eller skakningar från (källa) att Du: störs mycket, ganska mycket, ej särskilt mycket, störs ej eller märker Du inte vibrationerna alls?

A.7 Swedish numeric rating question

Introduktion: *För att kunna jämföra Ditt svar med svar från andra länder vill vi be Dig ange hur störd Du är med hjälp av en sifferskala:*

Om Du tänker på de senaste 12 månaderna eller så när Du vistas i Din bostad: Hur störd är Du av vibrationer eller skakningar från (källa) på en skala från 0 till 10? Talet 0 betyder att Du inte märker vibrationer och 10 betyder att Du är oerhört störd.

A.8 Swedish change question

Filter version

Om Du jämför med (tidsreferens) sedan, har situationen inomhus med avseende på vibrationer från (källa) förändrats?

Om ja: *Är situationen idag: »mycket bättre», »något bättre», »något sämre» eller »mycket sämre» än (tidsreferens).*

Non filter

Om Du jämför med (tidsreferens) sedan, hur upplever Du situationen inomhus med avseende på förändringar av vibrationer från (källa)? Är situationen » densamma» – eller är det »mycket bättre», »något bättre», »något sämre» eller »mycket sämre» än (tidsreferens).

A.9 Danish version with filter

Mærker du rystelser eller vibrationen (kilde) når du opholder dig i boligen ?

Hvis ja: Når du tænker på de sidste 12 måneder eller så, synes du så disse vibrationer er meget generende, er noget generende, er lidt generende, ikke er generende eller mærker du slet ikke vibrationer?

A.10 Danish version without filter

Når du tænker på de sidste 12 måneder eller så, synes du så rystelser eller vibrationen (kilde) når du opholder dig i boligen meget generende, er noget generende, er lidt generende, ikke er generende eller mærker du slet ikke vibrationer?

A.11 Danish numerical rating question

Når du tænker på de sidste 12 måneder eller så når du opholder dig i din bolig, hvor generet er du af vibrationer eller rystelser fra (kilde) på en skala fra 0 til 10. Tallet 0 betyder at du ikke mærker vibrationer og 10 betyder at du er ekstremt generet.

A.12 Danish change question

Filter version

Når du sammenligner med (tidsangivelse) har situationen ændret sig med hensyn til vibrationer fra (kilde)?

Hvis Ja: Er situationen i dag mærkbart bedre, noget bedre, noget værre, mærktbar værre end tidligere ?

Non filter

Når du sammenligner med (tidsangivelse) er situationen med hensyn til vibrationer fra (kilde)?, den samme som før, eller mærkbart bedre, noget bedre, noget værre, mærktbar værre end tidligere ?

A.13 Finnish version with filter

A.14 Finnish version without filter

A.15 Finnish numerical rating question

A.16 Finnish change question

B Data file output specifications

B.1 Introduction

This Annex gives a specification of the content of the data file from a socio-vibrational survey. The data file output has very few required items – see Section 0, but many optional ones.

The reasons for including the optional items is to give the researcher an opportunity of to use the same coding and thus gain comparability also for non-essential survey results.

The data file format is open. When the data format provided is not suitable, new variables may be defined and other types of coding may be used as long as the name of the new variable and the coding is reported in the text file output from the survey – see Chapter 8.

B.2 Data file format

The requirement for the data-file is that it is in a format amenable to being exchanged between different statistical packages and other tools for analysing the data. Any format that is in wide use can be utilised. The descriptions of variable names and coding are here specified using the syntax of one popular Statistical package SPSS from SPSS Inc. Other statistical packages with other types of syntax may also be used for this purpose.

	A	B	C	D	E	F	G	H	I
1	**Variable label**	**Variable na**		**Coding and value labels**		**Comments**	**Missin**	**NVU98**	**UiG 92**
2									
3									
4									
5	**Survey information**			**---- Constant for all records in sample----**					
6	Survey identifier	Surveyno		Unique number NNN		Can be provided by Nordtest/Institute of Transport Economics			
7	Survey year	Survyear		NNNN				x	x
8	Country	SCountry		1 'Denmark' 2 'Finland' 3 'Norway' 4 'Sweden'		(Country also equal language)		x	x
9	Season	S_Season		1 'Winter' 2 'Spring' 3 'Summer' 4 'Autumn'.				x	x
10	Survey type	S_type		1 'Postal' 2 'Telephone interviews' 3 'Personal Interviews'				x	x
11	Uses filter question	S_filter		0 'No' 1 'Yes'				x	x
12	Min age respondent	SMin_age		Age in whole years NN				x	x
13	Max age respondent	SMax_age		Age in whole years NN				x	x
14									
15	**Respondent information**			**Coding is in direction of increasing annoyance for alternatives thought to be monotonically related**					
16	**Annoyance Vibrations**	**Prefix AV**							
17	**Annoyance with vibrations from road traffic**								
18	Verbal rating	AV_RD_V		0 'Does not notice' 1 'Not annoyed' 2 'A little annoyed' 3 'Somewhat annoyed' 4 'Highly annoyed'				x	
19	Numeric rating	AV_RD_N		NN {0..10}					
20	Verbal rating of change in annoyance	AV_RD_C							
21	**Annoyance with vibrations from railroad traffic**								
22	Verbal rating	AV_RW_V		0 'Does not notice' 1 'Not annoyed' 2 'A little annoyed' 3 'Somewhat annoyed' 4 'Highly annoyed'				x	x
23	Numeric rating	AV_RW_N		NN {0..10}					
24	Verbal rating of change in annoyance	AV_RW_C							
25	**Annoyance with vibrations from light rail traffic**								
26	Verbal rating	AV_LR_V		0 'Does not notice' 1 'Not annoyed' 2 'A little annoyed' 3 'Somewhat annoyed' 4 'Highly annoyed'					
27	Numeric rating	AV_LR_N		NN {0..10}					
28	Verbal rating of change in annoyance	AV_LR_C							
29	**Annoyance with vibrations from subway traffic**							x	
30	Verbal rating	AV_SW_V		0 'Does not notice' 1 'Not annoyed' 2 'A little annoyed' 3 'Somewhat annoyed' 4 'Highly annoyed'					
31	Numeric rating	AV_SW_N		NN {0..10}					
32	Verbal rating of change in annoyance	AV_SW_C							
33	**Annoyance with vibrations from tram traffic**							x	
34	Verbal rating	AV_TR_V		0 'Does not notice' 1 'Not annoyed' 2 'A little annoyed' 3 'Somewhat annoyed' 4 'Highly annoyed'					
35	Numeric rating	AV_TR_N		NN {0..10}					
36	Verbal rating of change in annoyance	AV_TR_C							
37									
38	Main source of vibrations	AV_Src		1000 'Road' 2000 'Rail' 3000 'Light Rail' 4000 'Subway' 5000 'Tram'					
39	**Annoyance with vibrations from main source**								
40	Verbal rating	AV_MS_V		Max (of above)				x	x
41	Numeric rating	AV_MS_N		Max (of above)					
42	Change in annoyance	AV_MS_C		Max (of above)					
43									

	A	B	C	D	E	F	G	H	I
1	**Variable label**	**Variable na**		**Coding and value labels**		**Comments**	**Missin**	**NVU98**	**UiG 92**
44	**Disturbances Vibrations**					**Prefix DV**			
45	**How vibrations are noticed/How often**					From main source			
46	House trembles/vibrates	DV_house		0 'Never' 1 'Some times' 2 'Often, many times a day' 9 'Not applicable'				x	
47	House trembles/vibrates	DV_hous2		0 'No' 1 'Not especially disturbing' 2 'Moderately disturbing' 3 'Highly disturbing'					x
48	Vibrations felt bodily	DV_body		0 'Never' 1 'Some times' 2 'Often, many times a day' 9 'Not applicable'				x	
49	How often are vibrations felt	DV_Often		0 'No' 1 'Yearly' 2 'Monthly' 3 'Weekly' 4 'Daily' 5 'Several times a day'					
50	Things move or fall down	DV_TmoDVes		0 'Never' 1 'Some times' 2 'Often, many times a day' 9 'Not applicable'				x	
51	Furniture/kitchen items rattle	DV_rattle		0 'Never' 1 'Some times' 2 'Often, many times a day' 9 'Not applicable'				x	
52									
53	Time of most disturbance	DVTOD_RD		0 'None' 1 '06-07' 2 '08-11' 3 '12-17' 4 '18-21' 5 '22-06'					
54	Time of most disturbance	DVTOD_RW		0 'None' 1 '06-07' 2 '08-11' 3 '12-17' 4 '18-21' 5 '22-06'					x
55	Time of most disturbance	DVTOD_LR		0 'None' 1 '06-07' 2 '08-11' 3 '12-17' 4 '18-21' 5 '22-06'					
56	Time of most disturbance	DVTOD_SW		0 'None' 1 '06-07' 2 '08-11' 3 '12-17' 4 '18-21' 5 '22-06'					
57	Time of most disturbance	DVTOD_TR		0 'None' 1 '06-07' 2 '08-11' 3 '12-17' 4 '18-21' 5 '22-06'					
58									
59	Time of year	DV_TOY		1 'Winter' 2 'Spring' 3 'Summer' 4 'Autumn'.					x
60	Type of train	DV_TYPE		0 'None special' 1 'Local passenger' 2 'InterCity' 3 'Freight trains' 9 'Do not know'					x
61									
62	**Disturbances from vibrations**								
63	TV picture disturbed	DVPictTV		0 'No' 1 'Not especially disturbing' 2 'Moderately disturbing' 3 'Highly disturbing'					x
64	Difficulty getting to sleep	DVsleep		0 'Never' 1 'Some times' 2 'Often, many times a day' 9 'Not applicable'				x	
65	Difficulty getting to sleep	DVsleep2		0 'No' 1 'Not especially disturbing' 2 'Moderately disturbing' 3 'Highly disturbing'					x
66	Wakes up at night	DVwake		0 'Never' 1 'Some times' 2 'Often, many times a day' 9 'Not applicable'				x	
67	Wakes up at night	DVwake2		0 'No' 1 'Not especially disturbing' 2 'Moderately disturbing' 3 'Highly disturbing'					x
68	Wekes too early	DVwearly		0 'Never' 1 'Some times' 2 'Often, many times a day' 9 'Not applicable'				x	
69	When resting	DVrestd		0 'Never' 1 'Some times' 2 'Often, many times a day' 9 'Not applicable'				x	
70	When resting			0 'No' 1 'Not especially disturbing' 2 'Moderately disturbing' 3 'Highly disturbing'					x
71	Afraid of property damage	DVpcmg		0 'Never' 1 'Some times' 2 'Often, many times a day' 9 'Not applicable'				x	
72	Generally afraid/anxious	DVafraid		0 'Never' 1 'Some times' 2 'Often, many times a day' 9 'Not applicable'				x	
73	When using telephone	DVtlph		0 'Never' 1 'Some times' 2 'Often, many times a day' 9 'Not applicable'		Usually a combination of noise (and vibration)		x	
74	When using telephone	DVtlph2		0 'No' 1 'Not especially disturbing' 2 'Moderately disturbing' 3 'Highly disturbing'		Usually a combination of noise (and vibration)			x
75	During conversations	DVconvd		0 'Never' 1 'Some times' 2 'Often, many times a day' 9 'Not applicable'		Usually a combination of noise (and vibration)		x	
76	During conversations	DVconvd2		0 'No' 1 'Not especially disturbing' 2 'Moderately disturbing' 3 'Highly disturbing'		Usually a combination of noise (and vibration)			x
77	When using radio/watching TV	DVr_TV		0 'Never' 1 'Some times' 2 'Often, many times a day' 9 'Not applicable'		Usually a combination of noise (and vibration)		x	
78	When using radio/watching TV	DVr_TV2		0 'No' 1 'Not especially disturbing' 2 'Moderately disturbing' 3 'Highly disturbing'		Usually a combination of noise (and vibration)			x
79	Areas outside no fun to use	DVnoto		0 'No' 1 'Not especially disturbing' 2 'Moderately disturbing' 3 'Highly disturbing'		Usually a combination of noise (and vibration)	Sysmis		x
80	Outdoor resting	DVresto		0 'No' 1 'Not especially disturbing' 2 'Moderately disturbing' 3 'Highly disturbing'		Usually a combination of noise (and vibration)	Sysmis		x
81									

	A	B	C	D	E	F	G	H	I
1	**Variable label**	**Variable na**		**Coding and value labels**		**Comments**	**Missin**	**NVU98**	**UiG 92**
82	**Annoyance noise**					**Prefix AN**			
83	**Annoyance with noise from road traffic**								
84	Road Traffic noise annoyance	AN_RD		0 'Does not hear' 1 'Not annoyed' 2 'A little annoyed' 3 'Somewhat annoyed' 4 'Highly annoyed'					
85	Road Traffic noise annoyance indoor	AN_RDi		0 'Does not hear' 1 'Not annoyed' 2 'A little annoyed' 3 'Somewhat annoyed' 4 'Highly annoyed'		Indoor		x	x
86	Road Traffic noise annoyance outdoor	AN_RDo		0 'Does not hear' 1 'Not annoyed' 2 'A little annoyed' 3 'Somewhat annoyed' 4 'Highly annoyed'		Outdoor			
87	**Annoyance with noise from railroad traffic**								
88	Rail Traffic noise annoyance	AN_RW		0 'Does not hear' 1 'Not annoyed' 2 'A little annoyed' 3 'Somewhat annoyed' 4 'Highly annoyed'					
89	Rail Traffic noise annoyance indoor	AN_RWi		0 'Does not hear' 1 'Not annoyed' 2 'A little annoyed' 3 'Somewhat annoyed' 4 'Highly annoyed'		Indoor		x	x
90	Rail Traffic noise annoyance outdoor	AN_RWo		0 'Does not hear' 1 'Not annoyed' 2 'A little annoyed' 3 'Somewhat annoyed' 4 'Highly annoyed'		Outdoor			
91	**Annoyance with noise from light rail traffic**								
92	Light Rail Traffic noise annoyance	AN_LR		0 'Does not hear' 1 'Not annoyed' 2 'A little annoyed' 3 'Somewhat annoyed' 4 'Highly annoyed'					
93	Light Rail Traffic noise annoyance	AN_LRi		0 'Does not hear' 1 'Not annoyed' 2 'A little annoyed' 3 'Somewhat annoyed' 4 'Highly annoyed'		Indoor			
94	Light Rail Traffic noise annoyance	AN_LRo		0 'Does not hear' 1 'Not annoyed' 2 'A little annoyed' 3 'Somewhat annoyed' 4 'Highly annoyed'		Outdoor			
95	**Annoyance with noise from subway traffic**								
96	Subway Traffic noise annoyance	AN_SW		0 'Does not hear' 1 'Not annoyed' 2 'A little annoyed' 3 'Somewhat annoyed' 4 'Highly annoyed'					
97	Subway Traffic noise annoyance	AN_SWi		0 'Does not hear' 1 'Not annoyed' 2 'A little annoyed' 3 'Somewhat annoyed' 4 'Highly annoyed'		Indoor		x	
98	Subway Traffic noise annoyance	AN_SWo		0 'Does not hear' 1 'Not annoyed' 2 'A little annoyed' 3 'Somewhat annoyed' 4 'Highly annoyed'		Outdoor			
99	**Annoyance with noise from tram traffic**								
100	Tram noise annoyance	AN_TR		0 'Does not hear' 1 'Not annoyed' 2 'A little annoyed' 3 'Somewhat annoyed' 4 'Highly annoyed'					
101	Tram noise annoyance	AN_TRi		0 'Does not hear' 1 'Not annoyed' 2 'A little annoyed' 3 'Somewhat annoyed' 4 'Highly annoyed'		Indoor		x	
102	Tram noise annoyance	AN_TRo		0 'Does not hear' 1 'Not annoyed' 2 'A little annoyed' 3 'Somewhat annoyed' 4 'Highly annoyed'		Outdoor			
103									
104	**Annoyance with noise from main source**							x	
105	Noise annoyance main source	AN_MS		0 'Does not hear' 1 'Not annoyed' 2 'A little annoyed' 3 'Somewhat annoyed' 4 'Highly annoyed'					
106	Noise annoyance main source	AN_MSi		0 'Does not hear' 1 'Not annoyed' 2 'A little annoyed' 3 'Somewhat annoyed' 4 'Highly annoyed'		Indoor		x	x
107	Noise annoyance main source	AN_MSo		0 'Does not hear' 1 'Not annoyed' 2 'A little annoyed' 3 'Somewhat annoyed' 4 'Highly annoyed'		Outdoor			
108									
109	**Noise annoyance from other sources**								
110	Noise/Sounds from neighbours	AN_Nbh		0 'Does not notice' 1 'Not annoyed' 2 'A little annoyed' 3 'Somewhat annoyed' 4 'Highly annoyed'					x
111	Noise/Sounds from neighbours	AN_Airc		0 'Does not notice' 1 'Not annoyed' 2 'A little annoyed' 3 'Somewhat annoyed' 4 'Highly annoyed'					x
112	Noise/Sounds from neighbours	AN_Indu		0 'Does not notice' 1 'Not annoyed' 2 'A little annoyed' 3 'Somewhat annoyed' 4 'Highly annoyed'					x
113									
114	**Air pollution annoyance**					**Prefix AA**			
115	Exhaust	AA_exh		0 'Does not notice' 1 'Not annoyed' 2 'A little annoyed' 3 'Somewhat annoyed' 4 'Highly annoyed'					x
116	Dust	AA_Dust		0 'Does not notice' 1 'Not annoyed' 2 'A little annoyed' 3 'Somewhat annoyed' 4 'Highly annoyed'					x
117	Dust/Soot from Industri	AA_SSInd		0 'Does not notice' 1 'Not annoyed' 2 'A little annoyed' 3 'Somewhat annoyed' 4 'Highly annoyed'					x
118	Odour	AA_ODInd		0 'Does not notice' 1 'Not annoyed' 2 'A little annoyed' 3 'Somewhat annoyed' 4 'Highly annoyed'					x
119	Woodburning	AA_Wdb		0 'Does not notice' 1 'Not annoyed' 2 'A little annoyed' 3 'Somewhat annoyed' 4 'Highly annoyed'					x
120									

	A	B	C	D	E	F	G	H	I
1	**Variable label**	**Variable na**		**Coding and value labels**		**Comments**	**Missin**	**NVU98**	**UiG 92**
121	**Respondent**					**Prefix R_**			
122	Identifier	R_mixid		Compute mixid=Surveyno * 10 000 + id				x	x
123	Date interviewed	R_Dintvw		yymmdd				x	
124	Gender	R_Gender		1 'Male' 2 'Female'		Often from register or noted by interviewer		x	x
125	Civil status	R_Civsta		1 'Unmarried/Lives alone' 2 'Married/cohabiting' 3 'Separated' 4 'Divorced' 5 'Widowed'				x	x
126	Age	R_Age		Age in whole years				x	x
127	Age group	R_Agegr1		0 '0-9' 1 '10-19' 2 '20-29' 3 '30-39' 4 '40-49' 5 '50-59' 6 '60-69' 7 '70-79' 8 '80+'.		compute Age_grp= trunc(Age/10).		x	x
128	Child under 10	R_Chld10		0 'None' 1 'One or more children under 10 years of age'				x	x
129	Number of children < 16	R_ChldN1		N				x	
130	Number of children < 18	R_ChldN2		N					x
131	Personal income	R_IncP		Euro 2000: NNNNNN		Convert to Euro and use price index to fix at Euro2000			
132	Household Income	R_IncHH		Euro 2000: NNNNNN		Convert to Euro and use price index to fix at Euro2000			
133	Years of Education	R_Educ		NN				x	x
134	Education level	R_Educ3		1 'Obligatory' 2 'Further education' 3 'Higher Education'					recode
135	Occupation	R_Occ		1 'Working ' 2 'At home' 3 'Pupil/Student ' 4 'Retired' 5 'Without work' 6 'Other ' 9 'Do not know'			9		
136	Not-working	R_Nwork		0 'Member of the Workforce' 1 'Non-member of Workforce'				x	x
137	Working schedule	R_WrkScd		1 'Normal' 2 'Half-time' 3 'Evening' 4 'Night' 5 'Varies'					x
138	Years of residense	R_ResYrs		NN					x
139	Years of residense grouped	R_RyGrp		1 '0-1' 2 '2-5' 3 '6-9' 4 '10-19' 5 '20+'				x	x
140	Size of household eligible	R_HSize		# Household menbers in sampling frame		When 1 person is selected irrespective of #		x	
141									
142	**Sensitivities**					**Prefix SNS**			
143	Noise	SNS_noise		0 'Non sensitive' 1 'Somewhat sensitive' 2 'Sensitive'					x
144	Cold	SNS_cold		0 'Non sensitive' 1 'Somewhat sensitive' 2 'Sensitive'					x
145	Heat	SNS_heat		0 'Non sensitive' 1 'Somewhat sensitive' 2 'Sensitive'					x
146	Dust -air pollution	SNS_Dust		0 'Non sensitive' 1 'Somewhat sensitive' 2 'Sensitive'					x
147	More								
148	**Chronic illness**					**Prefix CI**			
149	Diabetes	CI_Diab							x
150	Heart disease/Hypertension	CI_Heart							x
151	Asthma/Lungs	CI_Asth		0 'No' 1 'Yes'					x
152	Allergy	CI_Alrgy		0 'No' 1 'Yes'					x
153	Muscle aches	CI_Mscl		0 'No' 1 'Yes'					x
154	Backpain, neck	CI_BackN		0 'No' 1 'Yes'					x
155	Accident	CI_Traum		0 'No' 1 'Yes'					x
156	Difficulty hearing	CI_Herng		0 'No' 1 'Yes'					x
157	Other chronic diseases	CI_Other		0 'No' 1 'Yes'					x
158	Others... expand as needed								
159	**Current illnesses**					**Prefix II**			
160	Headaches	II_Head		0 'Seldom/Never' 1 'Monthly' 2 'Weekly' 3 'Daily'					x
161	Very tired	II_Tired		0 'Seldom/Never' 1 'Monthly' 2 'Weekly' 3 'Daily'					x
162	Stomach uncomfortable	II_Stom		0 'Seldom/Never' 1 'Monthly' 2 'Weekly' 3 'Daily'					x
163	Depressed	II_Depr		0 'Seldom/Never' 1 'Monthly' 2 'Weekly' 3 'Daily'					x
164	Wish to be left alone	II_Reti		0 'Seldom/Never' 1 'Monthly' 2 'Weekly' 3 'Daily'					x
165	Others								

	A	B	C	D	E	F	G	H	I
1	**Variable label**	**Variable na**		**Coding and value labels**		**Comments**	**Missin**	**NVU98**	**UiG '92**
166	**Dwelling information from survey**					**Prefix_DW**			
167	Floor	DWFloor		0 'Basement' 1 'First floor' 2 'Second floor' 3 'Third floor' etc. 9 '9+'				x	
168	Type of ownership	DWOwner		0 'Rents' 1 'Owned by family member/company' 2 'Long-term Lease' 3 'Owned'					x
169	House type	DWType		1 'Villa' 2 'Villa p hor' 3 'Villa p vert' 4 'Villa-row'					x
170	Basement	DWBasmnt		0 'No' 1 'Basement' 2 'Basement above terraine'					x
171	Ground	DWgrndt		1 'Rock' 2 'Morene' 3 'Clay'					x
172	Window type	DWWtype		1 '3-layer non separable' 2 '3-layer separable' 3 '2-layer' 4 'Single layer'					x
173	Balcony, outdoor area, garden	DWBalcG		0 'No' 1 'Yes'					x
174	Happy with dwelling	DWSatisf		0 'Very happy' 1 Happy 2 'Not Especially happy' 3 'Not happy' 4 'Very unhappy'					x
175									
176	Wants to move	DWMove		0 'No' 1 'Yes'					x
177	Reason for moving	DWMoveR		1 'Other reasons' 2 'Family reasons' 3 'Environmental reasons'					x
178									
179	**Dwelling information from register/obsservation**					**Prefix DWREG**			
180	Ground conditions reg/chart	DWREGgnd		From register/geological charts: 1 'Clay' 2 'Morene' 3 'Rock'					
181	Building construction	DWREGBC		1 'Concrete' 2 'Tile' 3 'Wood'					
182									
183	**Sub-area indicators and modifying factor indicators**					**Prefix SA_**			
184	Sub_Area	SA_no		Surveyno*1000+SA_no					
185	Sub_area	SA_1001		Conditions should start their numbering from Surveyno*1000. Number as in textfile output					
186		SA_1002							
187		etc							
188	**Vibration exposure**								
189	NS 8176 VW from road	vw95_RD		NN.N				x	
190	NS 8176 VW from railway	vw95_RW		NN.N				x	x
191	NS 8176 VW from light rail	vw95_LR		NN.N					
192	NS 8176 VW from subway	vw95_SW		NN.N				x	
193	NS 8176 VW from tram	vw95_TR		NN.N				x	
194	**Distance to road/track**								
195	Distance to road	Dist_RD		NNN		To neares lane/track		x	
196	Distance to road	Dist_RW		NNN		To neares lane/track		x	(X)
197	Distance to road	Dist_LR		NNN		To neares lane/track			
198	Distance to road	Dist_SW		NNN		To neares lane/track		x	
199	Distance to road	Dist_TR		NNN		To neares lane/track		x	
200									
201	Log10 (NS 8176 VW from road)	Lvw95_RD		Log 10 of vw95				x	
202	Log10 (NS 8176 VW from railway)	Lvw95_RW		Log 10 of vw96				x	x
203	Log10 (NS 8176 VW from light rail)	Lvw95_LR		Log 10 of vw97					
204	Log10 (NS 8176 VW from subway)	Lvw95_SW		Log 10 of vw98				x	
205	Log10 (NS 8176 VW from tram)	Lvw95_TR		Log 10 of vw99				x	
206									
207	NS 8176 VW from main source	Lvw95_MS		Log 10 of vw99				x	(x)
208	Main source of vibrations	Src_vib		1000 'Road' 2000 'Rail' 3000 'Light Rail' 4000 'Subway' 5000 'Tram'				x	x
209									

	A	B	C	D	E	F	G	H	I
1	**Variable label**	**Variable na**		**Coding and value labels**		**Comments**	**Missin**	**NVU98**	**UIG 92**
210	**Other exposure Information**					**Prefix X**			
211	Exposed to vibrations from more than one source	X_Multi		0 'Single source' 1 'Multiple sources' 9 'Not determined'			9		
212									
213	Number of trucks	XRD_TNT		Total					
214									
215	Number of trains	XRW_TNT		Total					x
216	Number of freight trains	XRW_GNT		NNN					x
217	Number of trains	XRW_TND		Day					x
218	Number of freight trains	XRW_GND		NNN					x
219	Number of trains	XRW_TNE		Evening					x
220	Number of freight trains	XRW_GNE		NNN					x
221	Number of trains	XRW_TNN		Night					x
222	Number of freight trains	XRW_GNN		NNN					x
223									
224									
225	**Noise exposure**								
226	A-weighted 24 equivalent noise levels free field	Leq24RD							
227	A-weighted 24 equivalent noise levels free field	Leq24RW							x
228	A-weighted 24 equivalent noise levels free field	Leq24LR							
229	A-weighted 24 equivalent noise levels free field	Leq24SW							
230	A-weighted 24 equivalent noise levels free field	Leq24TR							
231		Leq24MS							
232									
233									
234	A-weighted Maximum noise levels	Lmax_RD							
235	A-weighted Maximum noise levels	Lmax_RW							x
236	A-weighted Maximum noise levels	Lmax_LR							
237	A-weighted Maximum noise levels	Lmax_SW							
238	A-weighted Maximum noise levels	Lmax_TR							
239	Structure-borne noise?								
240	Main source of noise	Src_nois		1000 'Road' 2000 'Rail' 3000 'Light Rail' 4000 'Subway' 5000 'Tram'					x
241	Lmax main noise source	Lmax_MS		Max(sources)					x

C Data handling to preserve anonymity

Data that are traceable to a respondent require special concessions for the party doing the data collection here called the **data collector**. To minimise the risk that employees not involved with the actual data acquisition can trace responses back to a person, it is necessary to follow certain data handling procedures when providing files for analyses. When obtaining a concession for acquiring person-information such data handling procedures should usually be documented and accepted.

The data handling procedures can also be utilised when a marketing organisation is **data collector** or when the research organisation is **data collector** but uses consultants for calculating vibrations, noise exposure etc.

C.1 Data handling procedure

The data collector should always provide the survey results in two separate files with different record identifiers (keys) and where the files are **sorted independently**: The two files are:

- File 1 containing only address and dwelling information.
- File 2 only containing survey results, answers to health and annoyance questions

Each file has a different public key (identifier associated with each record). Only the **data collector** knows the linkage between the two public keys.

After File 1 has been used for the calculation of objective vibration exposure measures, the results from the vibration calculation are added to file 1 by the organisation in charge of these measurements or calculations. The file is thereafter sent back to the **data collector.**

The **data collector** then links these results to file 2 with help of the private key linking file 1 and file 2 and known only to the **data collector**. To hide in what order the merging process has taken place (sorting on the private key) the **data collector** sorts file 2 once more before turning the data over to the research organisation in order that privacy be maintained. If not sorted in this way, the linkage between file 1 and file 2 will be indirectly revealed through the actual ordering of the file.

Identifying information is kept separately, and sorted differently from the file with the actual survey results, when these procedures are followed.

C.2 Reducing measurement precision to preserve anonymity

If the exposure measurements or calculations are given with high numeric precision, the respondents may be indirectly identified by knowledge of the content of file 1 and 2.

In such cases privacy may be maintained by reducing numeric precision by rounding, adding an error term or aggregating results. Such procedures should be described in the survey description text file.