THE ANV MEASUREMENT SYSTEMS SOUND INSULATION TESTING SYSTEM

INSTRUCTION MANUAL FOR FIELD TESTING OF WALLS, FLOORS & STAIRS

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1. INTRODUCTION

1.1 General Introduction

Approved document E [1] sets out the UK governments requirements for sound insulation of dwellings in Tables 1a, 1b and 2.

The standards are for both airborne sound insulation and impact sound insulation.

The standards for field tests (as opposed to laboratory tests) are:

- BS EN ISO 140: Part 4 1988 – Field measurements of airborne sound insulation between rooms [2]; and
- BS EN ISO 140: Part 7 1988 – Field measurements of impact sound insulation of floors [3]

1.2 Outline of Airborne Sound Insulation Testing

The airborne sound insulation of a wall or floor is determined by:

- generating a loud steady noise in a room on one site of the wall or floor (the source room);
- measuring the average sound pressure level produced in the source room;
- measuring the average sound pressure level in a room on the other side of the wall or floor being tested (the receiver room);
- measuring the average sound pressure level in the receiver room with the noise in the source room switched off;
- measuring the reverberation time of the receiver room (this is achieved by measuring the time is takes for the sound to die away after a noise source in the receiver room is switched off); and
- calculating the sound insulation value for comparison with the standards set out in Tables 1a and 1b of Approved Document E.

The measurements are all made in third octave bands between 100 and 3150 Hz. The parameter to be calculated is a single figure, the airborne sound insulation $D_{nT,W} + C_{tr}$.

The $D_{nT,w}$ is the weighted standardised level difference which is calculated from the standardised level differences (D_{nT}) measured for each third octave band. The D_{nT} for each third octave band is calculated by:

- measuring the logarithmic average sound pressure level in the source room;
- measuring the logarithmic average sound pressure in the receiving room;
- correcting the measured receiving room level to counteract any potential influence from background noise;
- adjusting the receiver room levels to take into account the difference between the measured receiver room reverberation time (in each third octave band) and the reference reverberation time (0.5 seconds RT_{60}); and
- subtracting the receiver room level (corrected for the influence of background noise and adjusted for reverberation time) from the source room level to give the D_{nT} for each third octave band.

For a single pair of rooms, this process is repeated (at least) twice with the noise source placed at two different positions in the source room. The D_{nT} results for each third octave band are then arithmetically averaged to give an average D_{nT} for each third octave band.

The results of this process produce a set of figures which can be expressed as a graph of standardised level difference (D_{nT}) against frequency. This graph is then compared to a family of reference curves, which are given for 1 dB intervals, to determine the single D_{nTw} figure for the construction. In comparing the measured D_{nT} values to the reference curves, where the measured D_{nT} at a specific frequency is less than the reference curve value this is described as an adverse deviation. The size of the adverse deviation in each third octave band is evaluated in dB. The method of comparison is to find the highest reference curve for which the sum of the adverse deviations over all the third octave bands is less than 32. This is illustrated by Figure 1.

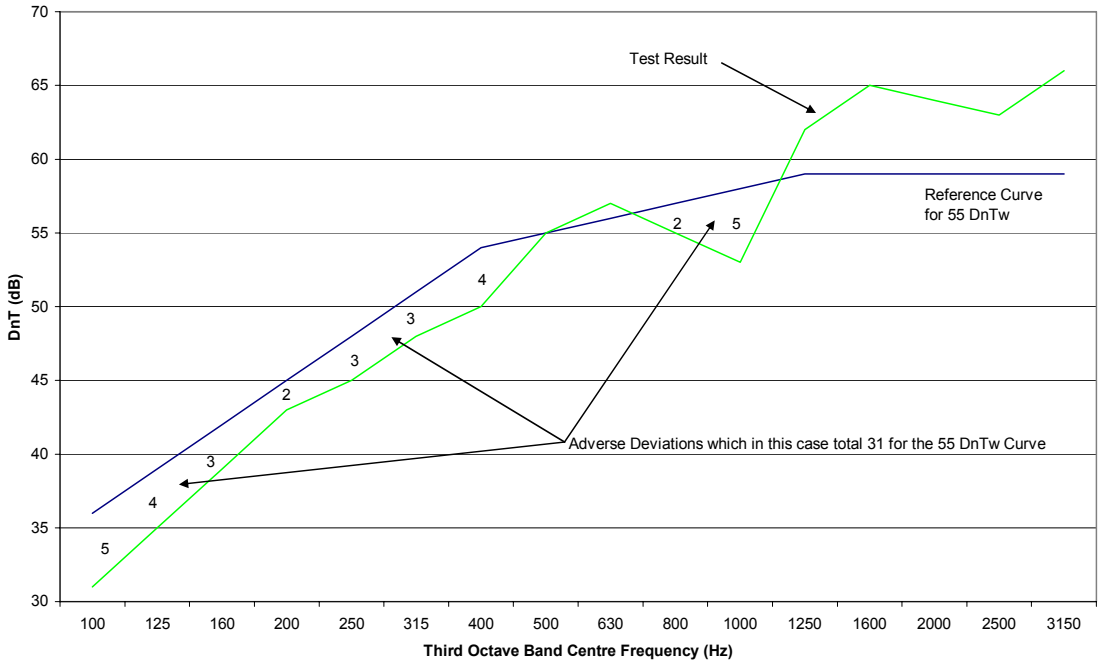

Figure 1: Comparison of Test Results with Reference Curve to Give Single Figure D_{nTw}

The second element of the single figure value for airborne sound insulation which has to be calculated for comparison with the standards set out on Approved Document E is the Spectrum Adaptation Term, C_{tr}. For presentation of the results in strict accordance with the requirements of ISO 140: Part 4 1998 it is also necessary to calculate another Spectrum Adaptation Term, C.

These spectrum adaptation terms express how much the airborne sound insulation afforded by the wall or floor being tested would vary from the $D_{nT,w}$ figure if the noise source was A-weighted pink noise (C) or urban road traffic noise (C_{tr}).

For example, a result given as:

$D_{nT,w}$ (C;C_{tr}) = 55 (-2, -8)

means that the airborne sound insulation of the tested element was 55 dB in terms of the standardised level difference (i.e. by comparison with the reference curve shown in Figure 1) but the element would only provide 53 dB(A) of attenuation (55-2) for pink noise that had been put through an A-weighting filter and 47 dB(A) of attenuation (55-8) for urban road traffic noise. The single figure required for comparison with the sound insulation limits in Tables 1a and 1b of Approved Document E in this case would be 47 dB ($D_{nT,w}$ + C_{tr}).

For a separating wall or floor to achieve the necessary performance standard, the sound insulation value must be at least the minimum value set out in Table 1a or 1b of Approved Document E.

1.2 Outline of Impact Sound Insulation Testing

The impact sound insulation of a floor and ceiling construction is determined by:

- generating impact noise by placing a tapping machine on the floor of the source room;
- measuring the average sound pressure level the room below the floor being tested (the receiver room);
- measuring the average sound pressure level in the receiver room with the noise in the source room switched off;
- measuring the reverberation time of the receiver room (this is achieved by measuring the time is takes for the sound to die away after a noise source in the receiver room is switched off); and
- calculating the impact sound insulation value for comparison with the standards set out in Tables 1a and 1b of Approved Document E.

The measurements are all made in third octave bands between 100 and 3150 Hz. The parameter to be calculated is a single figure, the impact sound insulation $L'_{nT,W}$.

The $L'_{nT,w}$ is the weighted standardised impact sound pressure level which is calculated from the standardised impact sound pressure level (L'_{nT}) measured for each third octave band. The L'_{nT} for each third octave band is calculated by:

- generating impact noise using a calibrated impact noise sound source (a tapping machine) in the source room;
- measuring the logarithmic average sound pressure in the receiving room;
- correcting the measured receiving room level to counteract any potential influence from background noise; and
- adjusting the receiver room levels to take into account the difference between the measured receiver room reverberation time (in each third octave band) and the reference reverberation time (0.5 seconds RT_{60}).

For a single pair of rooms, this process is repeated (at least) four times with the tapping machine placed at (at least) four different positions in the source room. The

L'_{nT} results for each third octave band are logarithmically averaged to give an energy average L'_{nT} for each third octave band.

The results of this process produce a set of figures which can be expressed as a graph of standardised impact sound pressure level (L'_{nT}) against frequency. This graph is then compared to a family of reference curves, which are given for 1 dB intervals, to determine the single L'_{nTw} figure for the construction. In comparing the measured L'_{nT} values to the reference curves, where the measured L'_{nT} at a specific frequency is more than the reference curve value this is described as an adverse deviation. The size of the adverse deviation in each third octave band is evaluated in dB. The method of comparison is to find the lowest reference curve for which the sum of the adverse deviations over all the third octave bands is less than 32. This is illustrated by Figure 2.

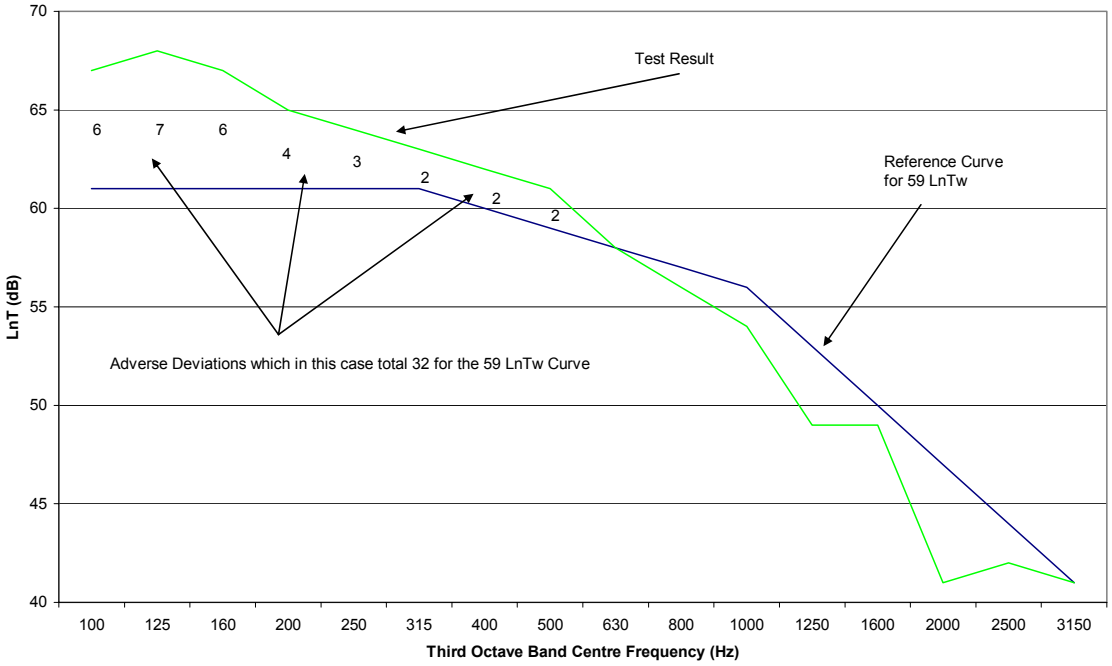

Figure 2: Comparison of Test Results with Reference Curve to Give Single Figure L'_{nTw}

The single figure required for comparison with the impact sound insulation limits in Tables 1a and 1b of Approved Document E in this case would be 59 dB $L'_{nT,w}$.

For a separating ceiling, floor or stair construction to achieve the necessary performance standard, the impact sound value must be no higher than the value set out in Table 1a or 1b of Approved Document E.

2. Measuring the Noise Levels

2.1 Preparing the NA-27

Switch on the NA-27 and, after self-testing is completed, press Set-up. The measurements can be carried out with the instrument in either Lx or Leq mode but carrying out the measurements in Leq mode will probably result in less redundant data being stored by the instrument. It will also ensure that Leq noise levels are automatically stored. Choose a suitable measurement time. In sound insulation testing short samples are used (the standards allow for a minimum of 6 seconds) and we would suggest setting the instrument to a 1 minute measurement period (the measurement can be manually stopped if a shorter period is required).

Press Memory and choose the Manual memory block. It is not necessary to clear the memory block to use the ANV Measurement Systems Sound Insulation Software but, provided no data which will be required is stored in the instrument's Manual memory block, it is suggested that Block Clear is performed and the memory location set to 1.

Pressing Memory again will restore the instruments main display. Set the following parameters on the instruments keys:

- use the A/C/Flat button to choose Lp (i.e. Flat);
- select Fast timeweighting;
- use the SLM, 1/1, 1/3 button to select 1/3 octave measurements; and
- choose and appropriate measurement range (this will probably need to be changed between source room, receiver room and background noise measurements).

2.2 Sampling Strategy for Average Noise Levels

It is necessary to measure the average noise levels in the receiver room (both airborne and impact sound insulation testing) and the source room (airborne testing only). It is also necessary to measure the average background noise level in the receiver room. The averaging is log averaging (i.e. individual measurements have to be logarithmically averaged to give an overall L_{eq} noise level in each third octave band).

The standard allows for averaging between stationary microphone positions or the use of a continually moving microphone.

At least 5 stationary positions are to be used and there must be a minimum distance of at least:

- 0.7m between microphone positions;
- 0.5m between the microphone positions and the walls/floor/ceiling (or a sound diffusers if employed); and
- 1.0m between any microphone position and the sound source.

We would recommend that the Average Noise Levels are stored in the following NA-27 Manual Memory locations:

NA-27 Manual Memory Locations	Data to be stored
1 – 5	Receiving Room Background Levels
6 – 10	Receiving Room Source Position 1
11-15	Source Room Source Position 1
16-20	Source Room Source Position 2
21-25	Receiving Room Source Position 2

Storing the readings in these locations will simplify the data when it comes to the Level Difference section of the SI Test Spreadsheet.

3. Downloading the Data from the NA-27

- Open up the SI Test Spreadsheet for within Excel

  C:\SoundInsulation\SITestwithimpact.xls

- To download the level difference data from the Rion NA-27 install the NA-27 Excel Add-in into Microsoft Excel

- Connect the NA-27 to the serial port using the data download cable

- Select the **NA-27 Data Import Sheet** worksheet tab
  Note: The NA-27 Excel Add—in should already be pre-loaded into Excel (No need to carry out the first 3 steps)
- Click on "NA-27" on the toolbar

- Set the correct parameters
  e.g. Type of Memory: Manual,
  Start Address: 1,
  End Address: 25
  and click "Start Downloading"

- Click "Exit Program"

- Save the data to the hard-drive (Note: Select a new file name for the spreadsheet)

4. Using the ANV Measurement Systems Sound Insulation Testing Spreadsheet

- Go to the Level Difference page

- Click on the locate Leq data and locate the data previously downloaded

- The data will now have been pulled into the SI spreadsheet

- Now still on the Level Difference page, type in the memory locations into the Measurement number column i.e. 1, 2, 3, 4, 5 for Receiving Room Background

Column; 11, 12, 13, 14, 15 for Source Room Source Position 1. (Save the spreadsheet at this stage)

Reverberation Time Measurement

- Use the Rion S-NA software to gather the reverberation time measurements (See Appendix A. Making the Reverberation Time Measurements)
- Export Reverb time data to text file (Export the set of measurements gathered in the previous step, ensuring that the data separator is a comma.)
- Open up the SI test spreadsheet again (with the level time data now contained within it)
- Click on the "Reverberation Time" button on the "Reverberation Time" worksheet and locate the reverberation time data, stored in the previous step.
- The average reverberation time RT60 will be displayed in cells B60:V60
- Go to the “Sound Insulation Results” worksheet and click on the "DnTw Values" button to display the results in the line graph

Appendix A: Making the Reverberation Time Measurements

Note: Reverberation time calculations are best performed after the Level Difference data has been stored. At least 6 reverberation time data sets are required for the SI Test Spreadsheet.

First, connect the NA-27 to the PC, then open the software and click on the icon “Start a new measurement”.

Choose the appropriate set-up, as follows

Reverberation measurement range at a given noise duration, using a noise component (i.e. Hand clap) for excitation:

Reverberation time range	Sampling time (ms)	Experiment duration (s)	Noise duration (s)	Range RT20(s)	Range RT30(s)
0,15 – 2	2	3	1	0,15 – 2,4	0,1 – 1,7
0,3 – 6 5	5	7,5	3,5	0,2 – 6	0,6 – 15
0,6 – 15	10	15	7	0,6 – 18	0,4 – 12,8

RT20 is a 20 dB interval (-5 dB to –25 dB in respect of the stationary level)

RT30 is a 30 dB interval (-5 dB to –35 dB in respect of the stationary level)

When RTxx is selected, an interval can be chosen between 15 dB and 45 dB by means of the xx set-up. If e.g. RT25 is chosen, that means the interval is from –5 dB to –30 dB in respect of the stationary level.

Mark: The xx set-up is of use, when RTxx is selected as interval. It will be inactive when RT20 or RT30 is selected.
A longer noise duration means the maximum measurable reverberation time will be shorter and vice versa.

On the page “General information” date and time from the PC will be displayed. In the fields “Name”, “Location”, “Description
”, and “Remarks” data concerning this measurement can be entered. (Note: Do NOT add any remarks to the reverb time data. This will cause an error in the SI Test spreadsheet).

Click on the icon “Start reverberation measurement”. The NA-27 is now waiting for the trigger level to be exceeded, either by switching on the noise generator for a few seconds or by firing the pistol.

Warning: don’t let the trigger level be exceeded by background noise.

After the NA-27 has stopped sampling, the data are being transferred to the PC.
When using a noise generator for excitation, this will take approximately 28 sec. for 1/1 octave bands and 1 min. 20 sec. for 1/3 octave bands.
(Pistol respectively 15 sec. and 45 sec.)

After the data transmission has taken place, the page “Measurement values” is displayed on the screen. A choice has to be made either to add this measurement to the set of measurements or not to add it.

Next the PC asks if another measurement has to be performed. If the answer is “No”, it is possible to continue performing measurements later on.

On the page “Averages” a survey is shown of the set of measurements, the average measurement values and the standard deviation.
The page “Measurements” shows the measurement values of each separate measurement in detail.
The page “Graph” shows a line diagram of each reverberation curve.

Performing measurements in this series can be continued by clicking on the icon “Start reverberation measurement” again.

A measurement can be removed from a set of measurements by clicking the icon “Remove currently selected measurement”.
Selecting a certain measurement can be performed by going to the page “Averages” and clicking on one measurement, or by selecting a measurement in the pages “Measurements” or “Graph”, using the “Previous” and “Next” buttons.

By clicking on the icon “Current set of measurements” a set of measurements can be saved. It is advised to this regularly to avoid accidental loss of data.

Exporting data can be performed by clicking on the icon “Export this set of measurements”.

Printing data can be performed by clicking on the icon “Print this set of measurements”.

By clicking on the icon “Stop reverberation measurements” the program is exited. Before closing the program, the question is asked if data have to be saved. It is possible to continue adding measurements later on to a series of measurements that was saved earlier.

Note: A set of 6 reverberation time measurements must be made for the SI Test Spreadsheet to function.

Appendix B: NA-27 Setup Parameters for carrying out Airbourne SI Test

Setup Menu

Measure Mode: LEQ
Leq Time: 1M

Memory Menu

For storing Level Difference Data:
Memory Block: Manual
For Storing Reverb Time Data
Memory Block: AUTO1
Check that the circular marker is set to 001 under the directory heading
(at the start of the test)

Main Measurement Screen

Make sure the instrument is in 1/3 Octave Mode (Toggle the SLM, 1/1, 1/3 Button)

Set the Level Range to 50-120 (Use the LT Up and LT Down buttons)

Set the Instrument to Linnear (Toggle the Freq Weight button)