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Quality assured implementation of ISO 9613 in software

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ABSTRACT

Uncertainty in prediction is usually considered to be related to the accuracy of the input data and the accuracy of the prediction method. This paper addresses another very important kind of uncertainty that is related to the (un)clearness of the prediction method and the interpretations software developers are forced to make while implementing ambiguous prediction algorithms. For most noise calculation standards there are no quality requirements and no test cases. The ultimate benefit of quality requirements would be that the calculated results with different software programs, using the same data input, can be expected to show just about the exact same results within a narrow margin, hereby avoiding incorrect comparisons between 2 different software implementations. This all changed in 2015 with the release of ISO/TR 17534-3. Since then the uncertainty when implementing the ISO 9613 method in software according to the quality requirements described in ISO/TR 17534-3, can be strongly reduced. This paper describes the findings of DGMR, member of the ISO 17534 working group, while using the recommendations of TR3 for the implementation of ISO 9613 in software.

1 INTRODUCTION

The ISO 9613-2 standard is a well-known method for the calculation of industrial environmental noise. The standard was published in 1996 and since then has been implemented in numerous commercial software applications. The standard however, does not contain quality requirements for software implementation, such as test cases and recommendations on interpretations of potential unclear algorithms. Therefore, the calculated results of different implementations for the exact same situation cannot be expected to be the same. When comparing different software implementations of ISO 9613-2 the results of different applications can differ up to 5dB for simple situations and up to 10dB for complex situations. This makes the result of noise prediction software even more uncertain. Not because of bugs or errors in the software, but because of unclear text and ambiguous algorithms in the standard. For many years now this has been an inconvenient truth in the world of noise prediction. At the Forum Acusticum congress in 2005, special focus was put on uncertainties while implementing noise prediction standards. More papers on quality requirements for software implementation were presented in the years following. This has all contributed to the new quality standard ISO 17534 in 2015. In TR3 (ISO/TR 17534-3) test cases and recommendations for implementation of ISO 9613-2 are described in detail. This should make ISO 9613-2 unambiguous and should make it straight forward to implement in software.

This paper describes the findings of DGMR, member of the ISO 17534 working group, while using the recommendations of TR3 for the software implementation of ISO 9613.

2 THE EFFECT OF QA

The main goal of ISO 17534 is to minimalize the differences in calculated results of different implementations of noise prediction standards. To examine the effect of ISO 17534, 2 commercial software implementations were compared using the 19 test cases described in TR3. One of the packages being the new software developed by DGMR. Both software packages are available with and without the recommendations of TR3. The comparison could therefore be made for 2 cases; with and without the recommendations of TR3. The results of the comparisons are shown in table 1.

Tabel 1: Absolute differences in dB between 2 software packages with and without QA for ISO 9613

Test case	1-10	11	12	13	14	15	16	17	18	19
With QA	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	2.4
Without QA	<=0.2	3.9	1.8	2.4	0.3	3.8	0.9	15.6	2.6	0.1

As displayed in Table 1 there is a significant positive effect when applying QA. The large difference of 15.6 dB in test case 17 is now reduced to 0.0 dB. The reason for this is the new unambiguous rubber band method to calculate lateral detours. In ISO 9613 the left and right detours are in many cases unclear and ambiguous. One could choose to select the screen that has highest screening effect. In TR3 the combined effect for all screens, according to the rubber band method, is always used as shown in Figure 1 and Figure 2.

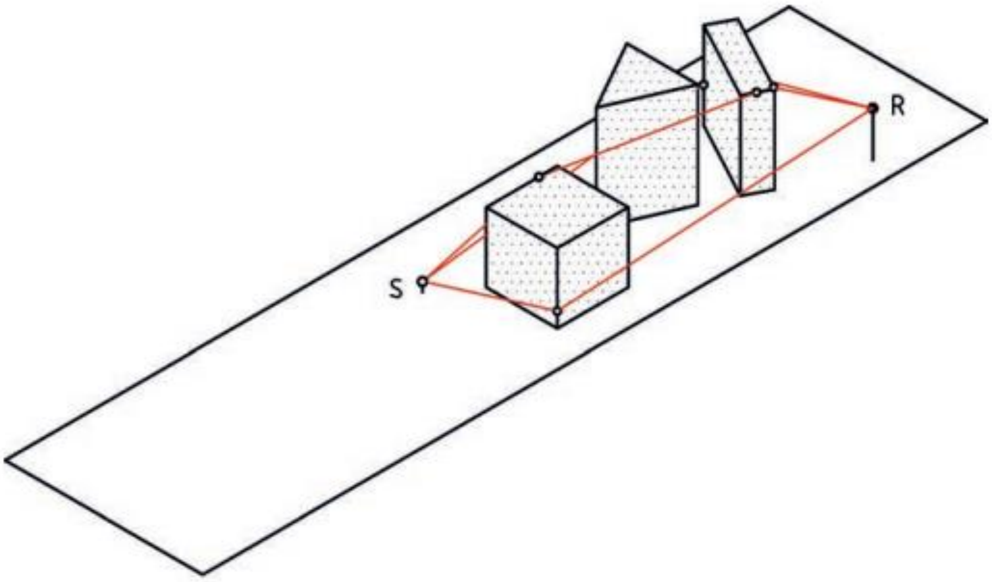

Figure 1: 3D-presentation of test case 17

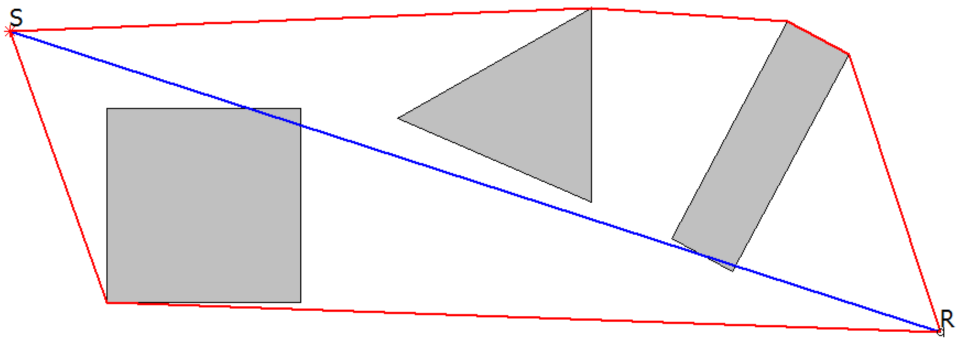

Figure 2: The red lines show the lateral detours using the rubber band method for test case 17.

The exception of 2.4 dB for test case 19 is caused by a contradiction between TR3 and ISO 9613-2. This is further explained below in chapter 3.4.

3 ISO/TR 17534-3, POINTS FOR IMPROVEMENT

In this paragraph, points for improvement are presented. These points have been discussed bilaterally with other members of the ISO 17534 working group, but have not yet been published by the working group. An overview is given in table 2.

Table 2: points for improvement ISO/TR 17534-3

Subject	ISO/TR 17534-3	ISO 9613	Recommendation DGMR
Nominal frequency	62.5	63	63
Negative detour	No	Yes	Yes
T08 – L/R detour screen	Yes and No	Not defined	No (factor 8)
T09 – R detour screen	Yes and No	Not defined	No (factor 8)
T19 – Reflections per octave	500 Hz– 8000 Hz	Only 8000 Hz	Only 8000 Hz

3.1 Nominal frequencies

In Chapter 1 of ISO 9613-2 it is stated that calculations are to be executed with nominal mid band frequencies 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz and 8000 Hz for the octave bands. However, in all test cases of TR3 the results for 63 Hz can only be replicated when using 62.5 Hz. This is not according to ISO 9613-2.

3.2 Negative detour

The use of the rubber band method seems to indicate that no barrier effect will be calculated in case of a negative detour (the top barrier is below the direct line source – receiver). This is not according to ISO 9613-2.

3.3 Test cases T08 and T09

In test case T08 of TR3 the left and right detours are calculated. According to the factor 8 criteria in TR3 these should be omitted. Also in test case T09 of TR3 the right detour is calculated. According to the factor 8 criteria in TR3 this should be omitted.

3.4 Test case T19

In test case T19 a reflection is calculated in a barrier which is located on a slope and which length is larger than its height. According to the test results of TR3, there is a reflection contribution for 500 Hz until 8000 Hz octave bands. However according to ISO 9613-2 this reflection should only occur for the 8000 Hz octave band due to the low height of the reflecting facade in respect to the wave length.

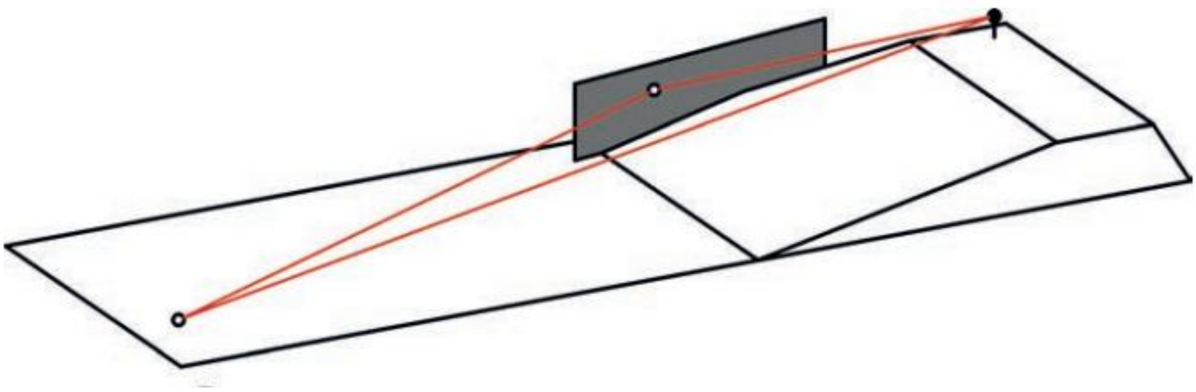

Figure 3: 3D-presentation of test case 19

When trying to replicate the wrong test results stated in TR3 we found the following:

- The test case results in TR3 are calculated with an incorrect use of the definition of lmin in formula 19 of ISO 9613-2. According to ISO 9613-2 the definition of lmin is “the minimum dimension (length or height) of the reflecting surface.” In this test case the value lmin should be determined by the height of the barrier and not by the length, thus, reflections are only possible for 8000 Hz.
- Even if the length is used as lmin value, the results of the test case still cannot be exactly replicated as the TR3 test results give no reflection contribution for 250 Hz. Only when adding an extra node to the barrier where it crosses the height line at the bottom of the slope the results can be replicated. This because an extra node splits the barrier in 2 barriers, each with a shorter length.
- The software used to calculate the test results in TR3 obviously used only the length of the barrier for the lmin value and also added a node to the barrier.

This omission has already been reported to, and acknowledged by, the ISO 17534 working group.

For the other software package used in this comparison the option to include the recommendations of TR3, obviously also de-activated the wave length criterion for the height of reflecting barriers and automatically included a node to the barrier.

4 CONCLUSION

The ISO 17534 standard fulfils its aim. The differences in results between separate software implementations of ISO 9613 are strongly reduced when using the recommendations of ISO 17534-3. A similar positive affect can be expected when using this approach for other methods such as the new CNOSSOS-EU. The ISO/TR 17534-3 report however does contain some obvious errors. These could easily be fixed in a revision of ISO/TR 17534-3. Recently a call for review has been started for ISO 9613 itself. This is off course an excellent opportunity to integrate the QA recommendations of ISO 17534-3, including the points for improvement of this paper, directly in the revised ISO 9613.

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