SUGGESTIONS FOR CHANGE TO ISO 9614

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1. Introduction

A sound power measurement within a small semi anechoic chamber was undertaken in accordance with ISO Draft Standard 9614 [1] [2] employing a pressure - pressure finite difference probe system with real time band analysis (B & K sound intensity analyzing system type 3360 probe type 4177).

It was found that F_2, designed as an overall surface pressure-intensity indicator, was negative in a particular low frequency band. This result was inconsistent to it's ultimate use within a qualification criterion and in consequence an investigation into the cause was undertaken.

2. The Sound Power Measurement

Sound Power Measurement were undertaken on a small stable rectangular source (0.345m x 0.235m x 0.2m high) located in the centre of a bare concrete floor of a rectangular chamber otherwise lined with acoustic wedges. The chamber dimensions are 2.23m x 3.43m x 2.2m high and a conformai measurement surface 0.7m from each surface of the source was employed with a total measurement array of 320 points.

The acoustic wedges have normal incidence absorption coefficients equal to or greater than 0.97 from 100 Hz upwards, whilst their random incidence absorption is greater than unity.

The test facility is fully described in reference [3], whilst the semi automated measurement procedure employed is fully described in reference [4].

All measurements were undertaken in accordance with the requirements of the Draft Standard 9614, and the indicators prescribed by the standard were evaluated and the 125 Hz third octave band result for F_2 was negative.

The indicator F_2 is prominent in a check for measurement equipment adequacy by way of $L_d > F_2$ for Criterion 1 to be satisfied. L_d is always positive, F_2 is usually positive, but if negative, Criterion 1 is not the qualifying Criterion supposed.

3. Investigation

The most likely cause of F_2 being negative is overestimation of the intensity resulting either from phase mismatch errors or inadequate sampling within a standing wave field. It can be shown that the average Reactivity Index (I_{avg} - P_{avg}) resulting from adequate sampling throughout a standing wave may be written as:

$$L_{kavge} = 10 \log_{10}\left[10^{L_{kR}/10}\{1 \pm 10^{-(\delta_{PIO} + L_{kR})/10}\}\right] \qquad 1.$$

where δp_{IO} is the pressure intensity index (dB)

$$L_{kR} = 10 \log_{10}\left[\frac{2R}{R^2 + 1}\right](dB) \qquad 2.$$

and R is the standing wave ratio (non dimensional).

Following the phase mismatch analysis of Gade [5] the value L_{kavg} such that phase mismatch errors shall not exceed 0.5 db may be written as:

$$L_{kavge} = 10 \log_{10}\left[(1 \pm 0.1)\ 10^{L_{kR}/10}\right] \qquad 3.$$

this relationship shows that L_{kavge} should not exceed 0.4 dB for a maximum average overestimation of intensity, given when R=1. Further, the maximum value of R to cause (assuming adequate field sampling) L_{Kavge} to be + ve is R=1.6, this implies that no one measure within the field should yield L_K > 2 dB.

4. Suggested Solution

In the present analysis, F_2 equates to - L_{Kavge}, thus:

a) A lower limit should be imposed for the field indicator F_2 within Criterion 1 as:

   $L\,d > F_2$ with $F_2 \geq -0.4$ dB, subsequently,

b) if $-0.4 \leq F_2 \leq 0$,

   then the index (L_I - L_P) at any point shall be less than 2 dB in order to qualify the result.

5. References

1. International Standards Organisation (ISO) Draft Standard 9614 "Determination of the Sound Power Levels of Noise Source Using Sound Intensity Measurements at Discrete Points", ISO/DIS 9614-1, 1989.

2. Fahy, F.J., "Sound Intensity" Chapter 8, Pub. Elsevier Applied Science, London, New York, ISBN 1085166-319-3, 1989.

3. Guy, R.W., Li, J., "A Facility and Test Procedure Designed for Sound Power Measurement by the Point Intensity Technique", Applied Acoustics submitted for publication, June 1991.

4. Guy, R.W., "Running a Test in an Intensity Based Measurement Facility", Canadian Acoustics, Vol. 18, No. 3, 1990 p. 31-45.

5. Gade, S. "Validity of Intensity Measurements", Bruel & Kjea, Technical Review No. 4, 1985.