MEASUREMENT OF SOUND INSULATION PROPERTIES OF AIR HANDLING UNITS

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INTRODUCTION.

Manufacturers of Air Handling Unit equipment are frequently asked to meet special requirements for sound insulation when supplying equipment to particular clients. Equipment specifications issued to the manufacturer usually give precise details of the materials to be used and the method of construction rather than the required sound insulation across the frequency range of interest, although in some conditions both requirements must be met.

Previous research by the authors [1] into the capabilities of insulated casework panels and framework has revealed an uncertainty in determining the sound insulation properties of panels due to the increased sound pressure level of a band sound source when it is placed inside an enclosure. Measurement of the insertion loss is inadequate for detailed analysis of the enclosure's casing and framework insulation.

This paper examines measurement techniques which can be used to assess the enclosure's internal sound pressure levels and compares the actual measured values with calculated theoretical values in an attempt to validate the procedures used. The procedures were designed to be applicable in situations of site testing and surveys of acoustic conditions in semi-reverberant environments, e.g. plantrooms.

TEST APPARATUS and CONDITIONS

The acoustic enclosure used was a standard Metair model MTR air handling unit having approximate overall dimensions of 1130mm high x1130mm wide x 1130mm long. This gave a nominal panel size of 1000mm square on each face of the cube. The construction of the unit was as follows.

Framework: fully welded pentapost structure manufactured from 16 gauge mild steel and having a grey primer undercoat and a hammer blue finish.

Base Panel: double skinned nominal thickness 50mm manufactured from 20 gauge galvanised mild steel inner skin with an 18 gauge galvanised steel outer skin, fully insulated with 200kg/m³ Rockwool and bolted in place.

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Side and Top Panels: double skinned nominal thickness 25mm manufactured from a 20 gauge galvanised mild steel inner skin with a 18 gauge stucco aluminium outer skin, fully insulated with 200kg/m³ Rockwool.

Any gaps between the panels and the pentapost framework were sealed with neoprene duct tape.

The sound source suspended inside the enclosure by 4mm hauser laid cord was a 1 kW direct drive single phase fan blower which had a generous wide band sound spectrum coverage at reasonably high sound power levels. The sound power level spectrum was measured according to BS 4196 Part 5 (ISO 3745).

The semi-reverberant room in which the tests took place was of dimension 7.5m long x 6.06m wide x 3.17m high giving a total overall volume of 144 m³.

TEST PROCEDURE

To simulate a typical on-site situation the air handling unit complete with the sound source was placed in the centre of the semi-reverberant room. A full acoustic analysis of the sound pressure and power levels of the sound source had been already achieved by following the measurement procedure in BS4196 part 5 pages 14,15 in anechoic (free field) conditions.

A series of measurements was made in the semi-reverberant room in order to establish the following:

1) The sound pressure level spectrum of the unit with Armaflex insulation in the pentapost and all the panels in place. Measurements were taken at 1m distance from the centre of all five 25mm panels.

2) The sound pressure level spectrum of the sound source with all the panels removed. Measurements were taken at the same positions as in procedure 1).

3) The sound pressure level spectrum of the sound source inside the enclosure with all the panels on and the pentapost framework insulated with Armaflex. Measurements were taken inside the enclosure using 5 position points for the microphone in a horizontal traverse of the enclosure.

4) The reverberation time of the enclosure to aid prediction of the enclosure's effect on the internal sound pressure levels. Measurements were taken inside the enclosure using 5 position points as in 3). Reverberation times were taken from 125Hz to 8KHz and averaged over the 5 positions.

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Testing of the semi-reverberant room itself was done to establish:

5) The reverberation time of the room and the room effect on the measured levels of breakout noise from the unit. Test procedures 1,2 and 3 were used to define empirically the insertion loss of the panels and the difference to the internal sound source due to the enclosure being in place.

Test procedures 4 and 5 enabled data to be gathered which together with the confirmation of the absorption coefficients of the 20 gauge galvanised mild steel panel inner skins and the sound power levels of the source would enable a prediction of the sound pressure level achieved in the enclosure and thus with measurements taken in procedure 1) the insertion losses of the panels with the pentapost insulated with Armaflex.

RESULTS

The reverberation times of the enclosure were used to estimate the average absorption coefficients for the internal surfaces of the enclosure. These were then used to predict the sound pressure level spectrum inside the enclosure due to the broad band source. The predicted levels showed close agreement with the measured values, as shown in Table 1.

Octave band	125	250	500	1k	2k	4k	8k
Predicted level dB re 20 uPa	88.0	100.6	101.6	113.2	102.6	98.4	90.4
Measured level dB re 20 uPa	89.1	98.2	97.7	114.4	101.2	95.7	88.0

TABLE 1 : Sound levels inside the enclosure

Octave band	125	250	500	1k	2k	4k	8k
Measured level no panels dB re 20 uPa	68.9	79.3	83.2	91.8	84.9	78.4	71.3
Measured level panels on dB re 20 uPa	61.5	61.0	58.7	71.3	66.8	61.3	57.0

TABLE 2 : Sound levels inside the room

Table 2 shows the sound pressure level spectra measured in the semi-reverberant room with and without the panels on the enclosure. Attempts were made to correlate the measured levels without the panels with the levels predicted from the reverberation times of the room, but present results show some uncertainty in determining the room effect.

CONCLUSIONS

Sound pressure levels inside the enclosure predicted from current theory showed good agreement with the measured values. Since the absorption coefficients of the internal surfaces of the enclosure were not available, they were estimated from the measured reverberation time, possibly introducing errors.

A similar procedure was adopted in order to estimate the room effect of the semi-reverberant room, but little agreement was found with current theory. The reverberation times of the room were measured several times with different measuring systems, but consistent results were not achieved. Also, no agreement was shown with the reverberation times predicted from the sound pressure level measurements.

Investigation into the room effect is continuing in an attempt to correlate predicted and measured values.

REFERENCES

[1] Whitfield, W. A. and Fairhall, D. M.
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