WORKING FOR A HEALTHY FUTURE

HISTORICAL RESEARCH REPORT

Research Report TM/71/11
1971

An investigation into the effectiveness of the audiometric enclosure and equipment at the MRDE Medical Centre

Murphy JW

HISTORICAL RESEARCH REPORT
Research Report TM/71/11
1971

An investigation into the effectiveness of the audiometric enclosure and equipment at the MRDE Medical Centre

Murphy JW

INSTITUTE OF OCCUPATIONAL MEDICINE
Research Avenue North, Riccarton, Edinburgh, EH14 4AP
Tel: +44 (0)870 850 5131 Fax: +44 (0)870 850 5132
e-mail publications@iomhq.org.uk

Internal Report No. 71/17
I.O.M. Report No. TM/71/11

AN INVESTIGATION INTO THE EFFECTIVENESS OF THE AUDIOMETRIC ENCLOSURE AND EQUIPMENT AT THE MRDE MEDICAL CENTRE

by

J.W. Murphy, Assistant Ergonomist, Institute of Occupational Medicine

Report approved by Dr. I. Evans, April 1971

National Coal Board
MINING RESEARCH AND DEVELOPMENT ESTABLISHMENT
Ashby Road, Stanhope Bretby, Burton-on-Trent, Staffs.
and
INSTITUTE OF OCCUPATIONAL MEDICINE
Roxburgh Place, Edinburgh, EH8 9SU

CONTENTS

APPENDICES

Tables

Figures

SUMMARY

A study of the audiometric booth and equipment in use at the MRDE Medical Centre revealed that the sound insulation of the booth was defective in certain respects, while the provision of additional equipment at low cost would improve the efficiency of the audiometric service. Recommendations for a change in testing procedure, to produce more reliable information on audiometric thresholds, are made.

AN INVESTIGATION INTO THE EFFECTIVENESS OF THE AUDIOMETRIC ENCLOSURE AND EQUIPMENT AT THE MRDE MEDICAL CENTRE

by

J. W. Murphy

1. INTRODUCTION

In the interests of ensuring that no worker with any hearing defect is exposed to undue noise intensities, it has been the practice to audiometrically screen applicants for certain positions at MRDE, notably the industrial staff who will work in the Rotary Test Laboratory. Certain of these applicants have to be rescreened on medical advice, the second screening taking place about nine months after the first. Regular screening of all staff exposed to the noise hazard is a possibility in the near future.

Audiometric screening is achieved by exposing the subject to a sound of known frequency and intensity and recording his response. The intensity of the sound is reduced in discrete steps until the subject reports that he can no longer hear the sound. This intensity level is known as the descending absolute threshold. A threshold is also obtained for the same frequency by starting below threshold and moving to higher intensities in discrete steps until the subject reports that he can just hear the test sound. The threshold of hearing is taken as the average of this ascending threshold and the former descending threshold. This procedure is repeated for the frequencies 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz, 6 kHz and 8 kHz. Right and left ears are tested independently. The screenings have been carried out with a Peter's Screening Audiometer, placing the subject inside an audiometric booth. (For details, see Appendix 1.)

Exposure to noise can result in two forms of threshold shift or deafness, permanent threshold shift and temporary threshold shift. The main distinguishing feature between the two is that when a subject is removed from the noise source, temporary shifts disappear with rest from this noise. This would not occur with a permanent threshold shift.

In an industrial situation, where the subject is exposed to the noise daily, weekends are the time at which temporary shifts should be most reduced. Screenings should therefore take place on a Monday morning, before the subject is exposed to further noise.

During screening procedures at MRDE, the Medical Staff had noted the audiometric booth to be less effective than it might be. It was at their request that this survey was carried out.

2. NOISE SURVEY

To quantify the noise levels within the booth, a noise survey was made using a Bruel and Kjaer 2203 Sound Level Meter with a 1613 Octave Filter Set. As any repeat screenings should be performed on Monday mornings, the measurements were made at this time of the week. During measurement, the effect of non-continuous **intrusive** noises (e.g. doors slamming) were disregarded and only the continuous noise was measured. The results are summarised in Table 1.

To ensure that a given audiometric tone is not masked by ambient noise at the same frequency, the ambient noise must not be above the maximum limits calculated by the method of Taylor and others[1]. On the assumption that it is required to measure -10 dB hearing level, a level which is only bettered by 6.7% of the young, adult population, such limits may be calculated for the MRDE equipment. The data for headset attenuation utilised in the calculations are given in Appendix 2; the calculated limits are shown in Table 2.

The data from Tables 1 and 2, together with data on the ambient noise external to the MRDE booth, are plotted in Figure 1. From this Figure it can be seen that below approximately 1 kHz, the ambient noise in the booth is sufficient to cause masking of the test tones. Between 1 kHz and 2 kHz the input of further ambient noise, for example a door slamming or people passing by, might easily raise the ambient noise levels above the limits and hence cause masking in that region.

Thus, from purely physical considerations, the screening equipment and booth are unsatisfactory below 2 kHz.

3. ALTERATIONS TO EQUIPMENT

There are two main alterations which may be made; the one is to change the headset used for one which gives greater sound attenuation; the other is some alteration to the booth construction.

3.1 Headset

Alfred Peters and Sons Ltd can provide a headset with greater attenuation characteristics than the TDH39 headset currently used (characteristics given in Appendix 2). Limits calculated using these attenuation figures are shown in Table 3 and a comparison with the noise spectrum and former limits is made in Figure 2.

For supplying the headset and recalibrating the audiometer, Peters quote a charge of £15. Although they will not guarantee the headset-audiometer combination to conform to the ISO standards, the resulting combination is sufficiently precise for normal screening audiometry.

It can be seen from Figure 2 that the provision of the headset alone goes a long way towards improving the performance of the equipment.

3.2 Booth

An improvement in attenuation may be possible by altering parts of the booth's construction. It is important to note that it is constructed of Burgess panels. These panels are supplied as sound-absorbing panels and therefore do not have as great an attenuation as true attenuating panels. Notwithstanding this it was felt by the author and PERA (who were consulted for advice) that a small further improvement could be gained by making the following changes.

3.2.1 Sealing

All the joints between the panels should be sealed using a dense sealing substance, e.g. mastic, and the cracks on the exterior of the booth caused by these joints should be mechanically sealed, e.g. by welding a plate across the gaps.

3.2.2 Flooring

A floating floor of glued $\frac{3}{4}$-in tongue-and-groove board surmounted by a rubber underlay and a carpet should be built into the booth. All gaps between the floor and the walls of the booth should be sealed with mastic and the complete unit then mounted on blocks of 'sorbo' rubber to insulate it from the floor of the room. The static deflection of this rubber should be approximately $\frac{1}{4}$, and a trial and error method will be needed to gain this deflection.

In general, both the new headset and the booth alterations would be considered desirable[2].

4. ALTERATIONS TO THE TESTING PROCEDURE

4.1 Position of subject

The subject being tested was normally placed facing the wall across the shorter dimension of the booth. Because of the perforations on the wall (see Figures 3 - 5) there may be difficulty in visually fixating and concentration may thereby suffer. This can be remedied by seating the subject at one end of the long axis of the booth, to face the other end.

4.2 Signal by Subject

The subject was instructed on hearing any tone to press a button which sounded a buzzer outside the booth to indicate to the operator that the tone had been heard. Ideally, the subject would keep the button pressed until the tone stopped and would then release the button, thus indicating to the operator the start and finish of the tone. The noise of the buzzer, however, intrudes into the booth. It would be preferable for the buzzer to be replaced by a light placed near to the audiometer, with a duplicate light within the subject's line of sight. Thus, on hearing a tone, the subject can press the button, and signal to the operator by means of the light that he has heard the tone, without having the buzzer interfere with hearing. Equally, he could keep the button pressed until the tone stopped, when on releasing it he would signal to the operator that he had observed the tone to stop.

In this way, the substitution of a light for a buzzer will enable the subject's intentions to be more exactly interpreted and thus provide more reliable threshold determination.

5. REFERENCES

1. Taylor W., et al. Ann. Occup. Hyg., Vol 7, 1964, pp 345 - 352

2. Healiss K. Private Communication from PERA, 1971.

APPENDIX 1

CONSTRUCTION OF THE AUDIOMETRIC BOOTH AND DETAILS OF THE AUDIOMETRIC APPARATUS

The layout of the booth is shown in Figure 6. The booth is constructed of Burgess sound-absorbing panels; each long side consists of two panels; each of the ends of a single panel. The corners are finished by means of 102-mm x 76-mm (4-in x 3-in) timber to which the panels are screwed (see Figure 3). The two panels which form each of the long sides are bolted together (see Figure 4). Details of the door catch can be seen in Figure 5. There is no separate floor to the booth.

Figures 3 and 4 show some of the gaps in the construction. Figure 4 also shows the headset cable where it pierces the wall. This has been blocked-off with tow, a dense packing medium.

The booth is located in one of a set of works offices which are situated some 7.6 m (25 ft) from the main workshops building and with some 3.05-m (10-ft) difference in floor levels.

The audiomometer used is a Peter's AP-21-B Screening Audiometer which uses a Telephonics headset of TDH39 earphones with MX41/AR rubber cushions.

APPENDIX 2

ATTENUATION CHARACTERISTICS OF HEADSETS

Octave Band Mid-frequence (Hz)	125	250	500	1 k	2 k	4 k	8 k
Attenuation of Telephonics TDH39 with MX41/AR Cushions (dB : re 2×10^{-5} N/m^2)	2	4	11	21	29	33	21
Attenuation of Sharp's Headset with Liquid Seals (dB : re 2×10^{-5} N/m^2)	17	20	35	46	41	53	39

Table 1. Ambient Sound Pressure Levels per Octave Band Recorded in the Audiometric Booth

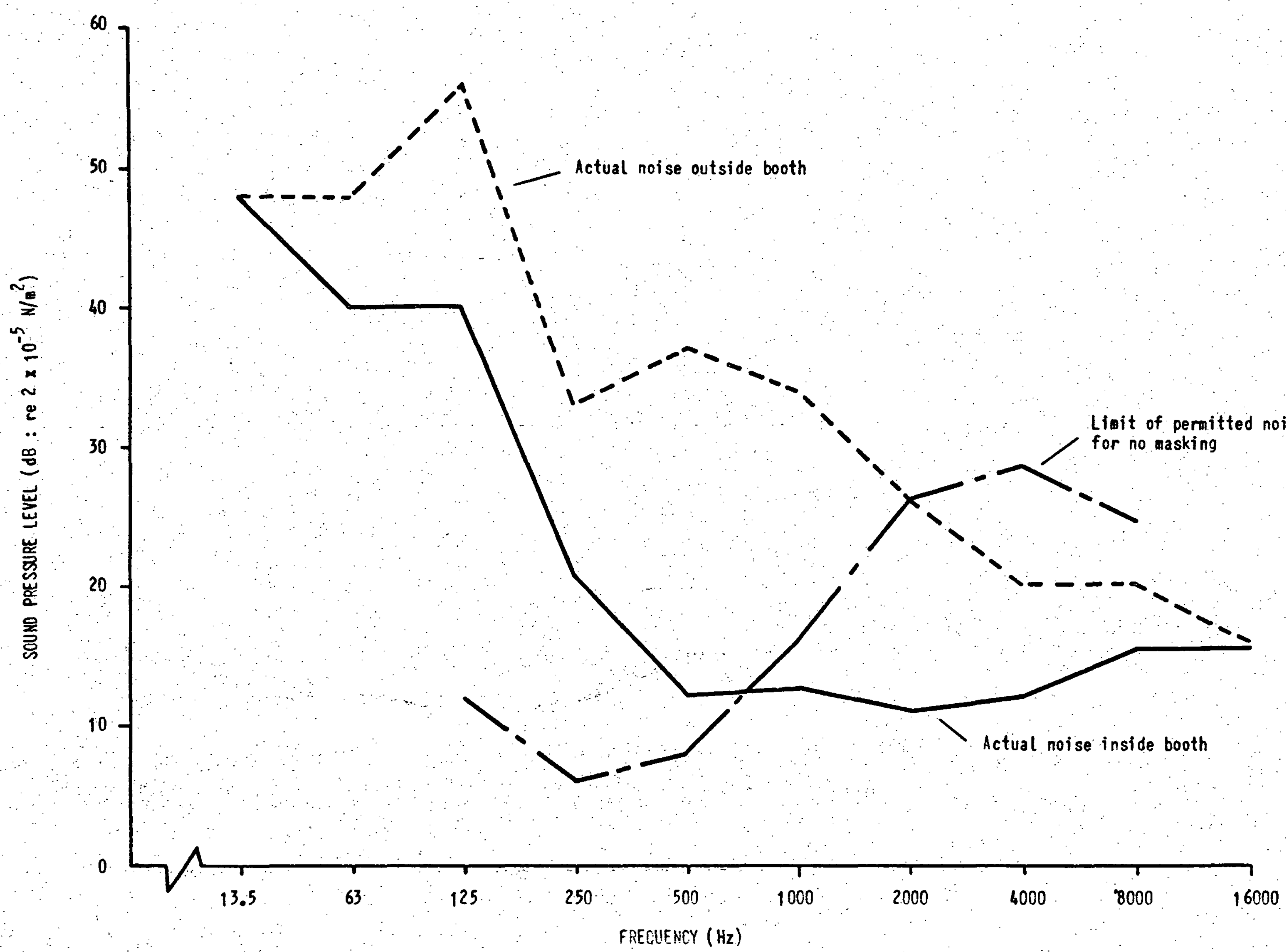
Octave Band Mid-frequency (Hz)	31.5	63	125	250	500	1 k	2 k	4 k	8 k	16 k
Ambient Sound Pressure Level (dB : re 2 x 10^{-5} N/m^2)	48	48	40	20.5	12	12.5	11	12	15.5	15.5

Table 2. Maximum Permitted Ambient Sound Pressure Level per Octave Band for the Measurement of -10 dB Hearing Level with no Masking

Octave Band Mid-frequency (Hz)	125	250	500	1 k	2 k	4 k	8 k
Limiting Ambient Sound Pressure Level (dB : re 2 x 10^{-5} N/m^2)	12	6	8	16	26	28.5	24.5

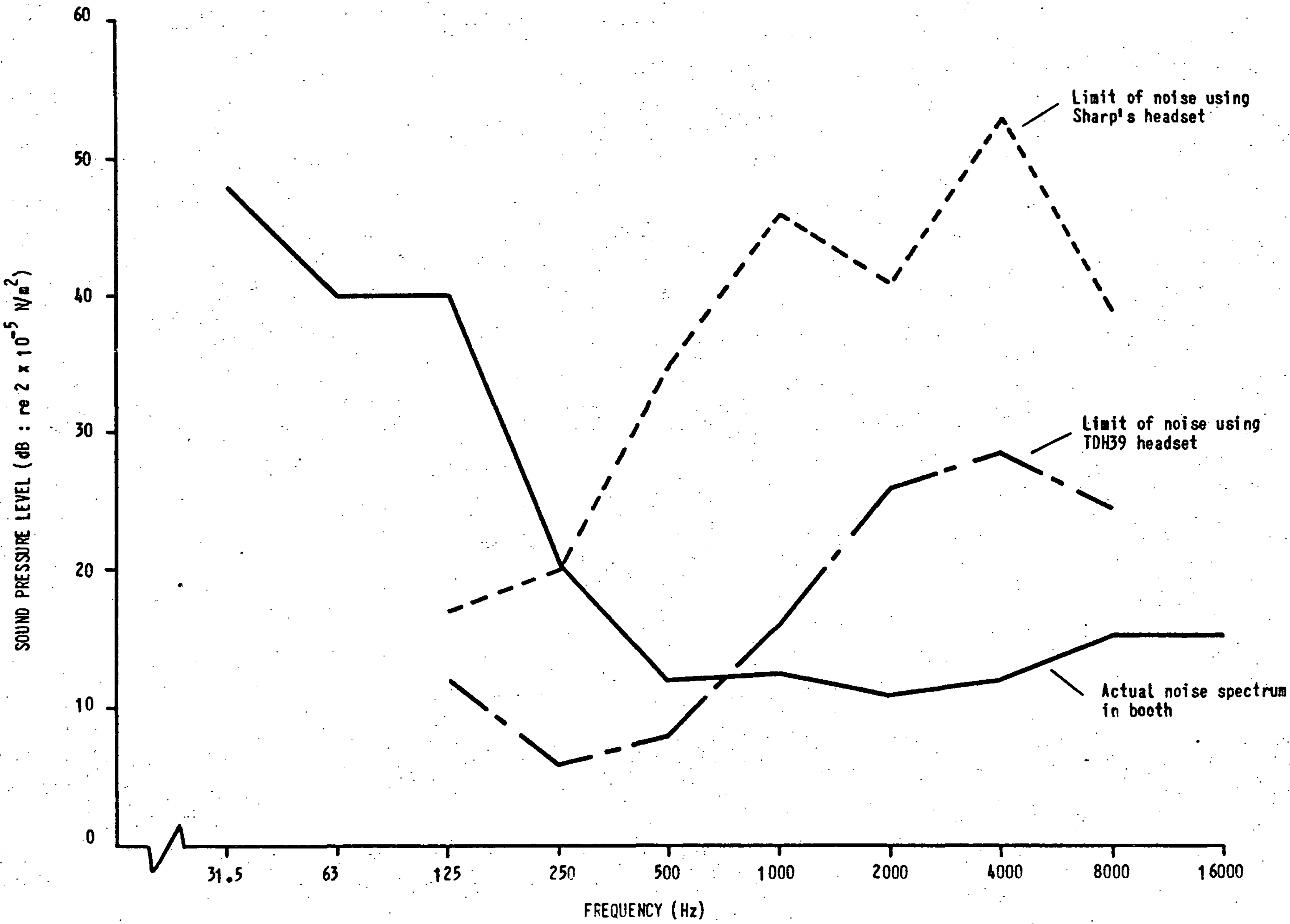
Table 3. Maximum Permitted Ambient Sound Pressure Level per Octave Band for the Measurement of -10 dB Hearing Level with no Masking, using Sharp's Headphones

Octave Band Mid-frequency (Hz)	125	250	500	1 k	2 k	4 k	8 k
Limiting Ambient Sound Pressure Level (dB : re 2 x 10^{-5} N/m^2)	17	20	35	46	41	53	39



IR71/17

FIGURE 1. GRAPHS OF MAXIMUM PERMITTED NOISE IN BOOTH AND ACTUAL NOISE INSIDE AND OUTSIDE BOOTH



IR71/17

FIGURE 2. GRAPHS OF NOISE SPECTRUM IN AUDIOMETRIC BOOTH AND ACTUAL NOISE LIMITS USING SHARP'S AND TDH 39 HEADPHONES

FIGURE 3. CORNER JOINTS OF THE AUDIOMETRIC BOOTH (637/1)

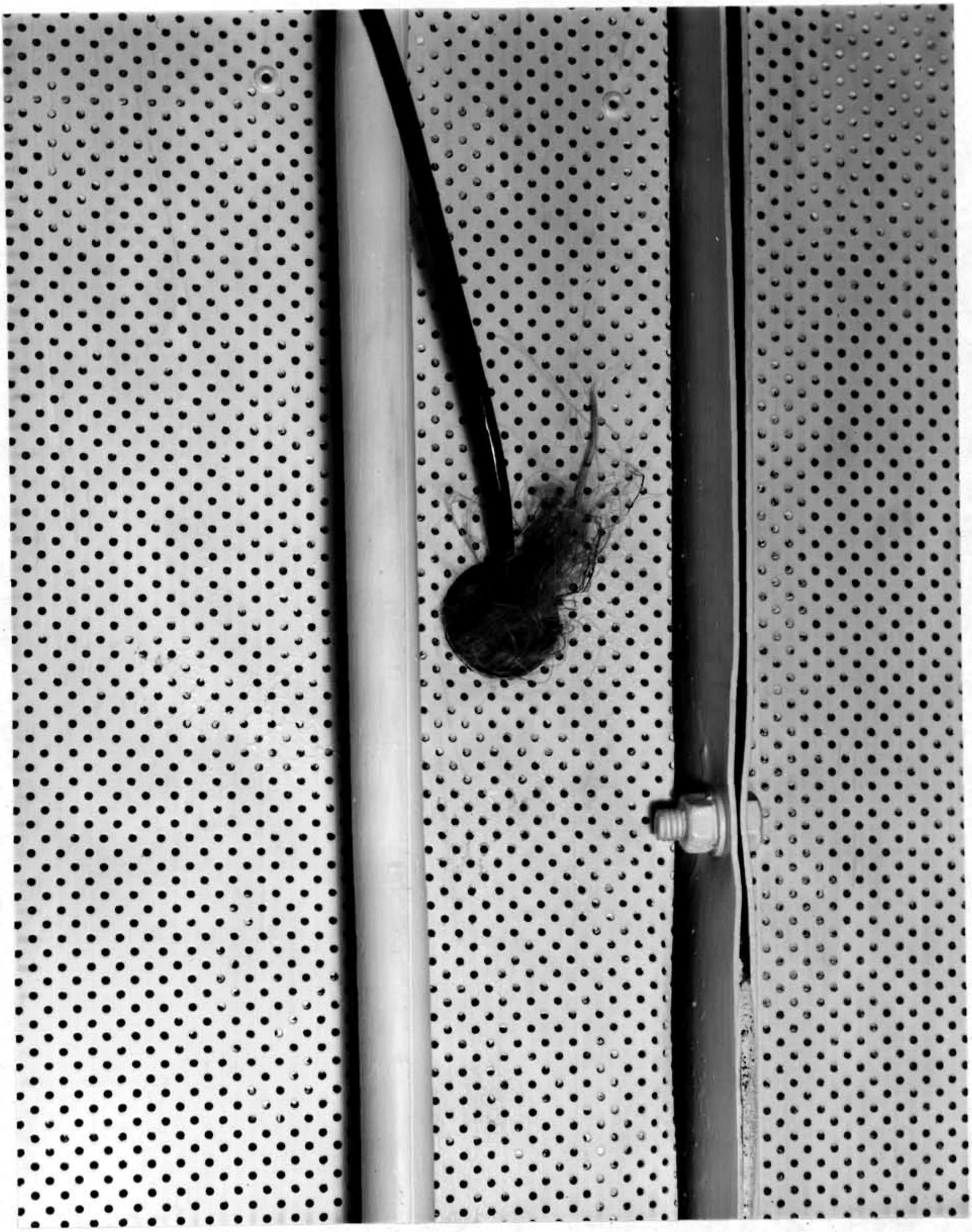


FIGURE 4. SIDE JOINTS OF THE AUDIOMETRIC BOOTH (637/3)

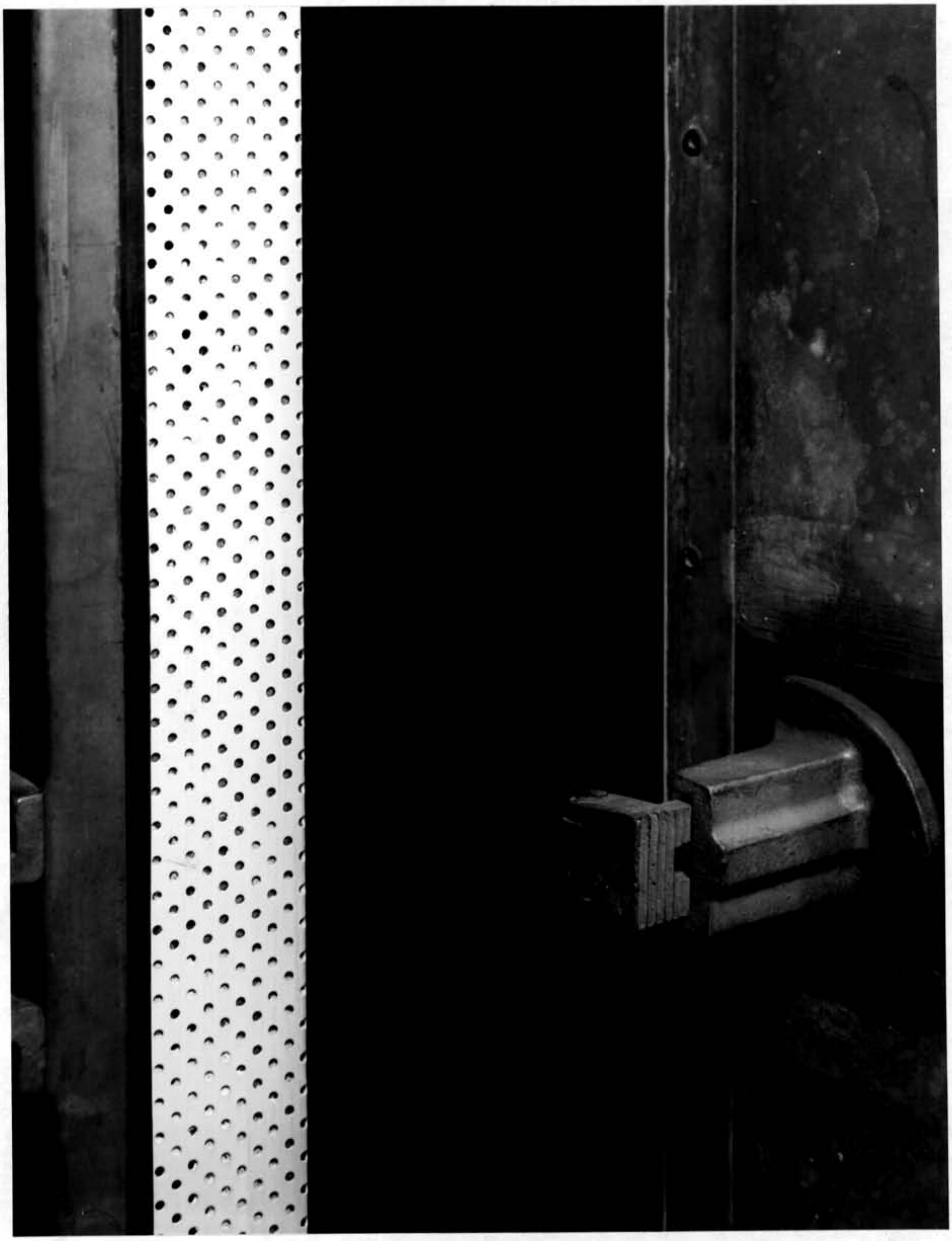


FIGURE 5. DOOR AND CATCH OF THE AUDIOMETRIC BOOTH (637/2)

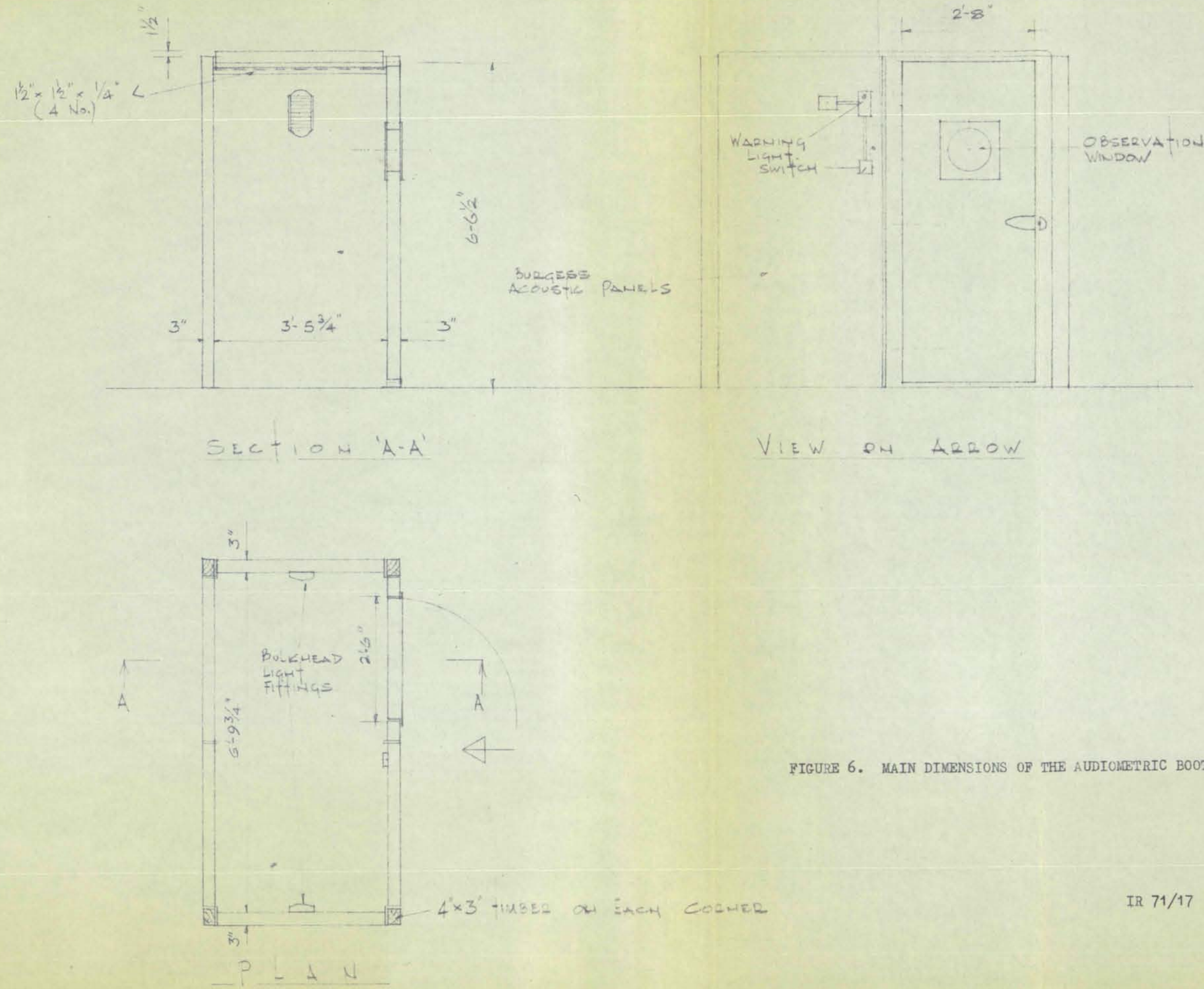


FIGURE 6. MAIN DIMENSIONS OF THE AUDIOMETRIC BOOTH

HEAD OFFICE:

Research Avenue North,
Riccarton,
Edinburgh, EH14 4AP,
United Kingdom
Telephone: +44 (0)870 850 5131
Facsimile: +44 (0)870 850 5132

Tapton Park Innovation Centre,
Brimington Road, Tapton,
Chesterfield, Derbyshire, S41 0TZ,
United Kingdom
Telephone: +44 (0)1246 557866
Facsimile: +44 (0)1246 551212

Research House Business Centre,
Fraser Road,
Perivale, Middlesex, UB6 7AQ,
United Kingdom
Telephone: +44 (0)208 537 3491/2
Facsimile: +44 (0)208 537 3493

Brookside Business Park,
Cold Meece,
Stone, Staffs, ST15 0RZ,
United Kingdom
Telephone: +44 (0)1785 764810
Facsimile: +44 (0)1785 764811

Email: iom@iom-world.org