AD-A123 098 MEASUREMENTS OF THE ATTENUATION OF AN ARMY HEADSET(U) 1/1
ROYAL AIRCRAFT ESTABLISHMENT FARNBOROUGH (ENGLAND)
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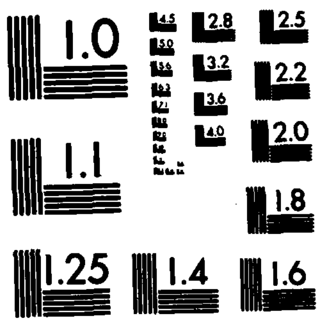

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ROYAL AIRCRAFT ESTABLISHMENT

Technical Memorandum FS 449

Received for printing 5 January 1982

MEASUREMENTS OF THE ATTENUATION OF AN ARMY HEADSET

by

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SUMMARY

Acoustic attenuation measurements have been made on a headset currently in use in British armoured military vehicles, which is reported to demonstrate good low-frequency noise attenuation. The results of the tests are reported and discussed with reference to the use of this form of earmuff assembly in a helicopter crew helmet, since helicopter cabin noise is predominantly low-frequency in nature.

1 INTRODUCTION

One of the aims of the Human Engineering Division is the improvement of methods of reducing aircraft cabin or environmental noise levels at the ears of aircrew as high noise levels can reduce speech intelligibility, mask warning signals and audio cues and generally degrade aircrew performance.

This Memorandum describes the results of semi-objective acoustic attenuation measurements made on a headset presently used in British armoured military vehicles. The headset is reported to have good low-frequency attenuation and since military aircraft generally exhibit high levels of low-frequency noise, it was decided that an investigation of the attenuation of this headset might lead to improvements in flying helmet attenuation. However, it should be noted that while the physical dimensions of this headset exclude its use in the present generation of aircrew flying helmets, they do not exclude its use in aircraft where headsets are normally worn (eg Nimrod) or in its application to a helicopter crew helmet.

The semi-objective method of measuring the attenuation of earmuffs was used in this case and has been discussed in detail in Ref 1. A previous Memorandum[2] describes similar tests performed on other earmuff assemblies.

Differences among the data are discussed and conclusions drawn concerning the merits of the headset.

2 EQUIPMENT AND EXPERIMENTAL PROCEDURE

The apparatus and methods used were very similar to those used in previous tests and described in detail in Ref 2. Therefore, only a brief summary will be given here, except where there were substantial differences in either apparatus or method.

2.1 Noise generation and fields

The noise fields used during this work were generated using the equipment and arrangement shown in Fig 1. The positioning of the loudspeakers in the semi-reverberant room was such as to produce the necessary diffusity of the noise field within a cube of 30 cm side at the centre of the room.

As in previous tests[2], the noise field was essentially a pink noise spectrum raised at high frequencies to allow for the analysis equipment to cope with the wide dynamic range of occluded spectra.

Care was taken to assure the protection of the hearing of subjects. The A-weighted level of the sound field was 97 dB(A), lasting for approximately 15 minutes. Calculation shows this to be equivalent to 82 dB(A) for eight hours, well within the maximum recommended industrial noise dose of 90 dB(A) for eight hours and over a working lifetime[3].

2.2 Noise measurement and analysis equipment

Measurements of the noise fields reaching the subjects' ears were made using Knowles Type BT1759 electret microphones. One microphone was fitted to each ear at the entrance to the ear canal and a flat lead, to minimize earshell leakage, fed the signal to the analysis equipment.

Analysis of all signals was performed using a Bruel and Kjaer Type 2131 Digital Frequency Analyzer, remotely controlled by a Hewlett-Packard Type 9825T desktop computer.

2.3 The headset

The headset under test was a SON III Type 8563, fitted with foam-filled seals and incorporating telephones and a communications microphone.

On the back of each earmuff is a two position valve labelled 'open' and 'closed'. When the valve is in the closed position, the earmuff acts as a conventional muff in that it represents a sealed cavity around the ear of the wearer. However, when the valve is open, it uncovers three small triangular holes in the shell of the muff, each of approximately one square centimetre in area. The purpose of these valves is to enhance direct speech communication without the need to remove the headset from the head of the wearer.

2.4 Subjects

Ten male subjects, drawn from the research staff at RAE, were used in the tests. All had short haircuts and were clean-shaven. Analysis of the results of previous experiments[4] has suggested that the use of 10 subjects results in sufficient statistical confidence for the measured parameters.

2.5 Procedure

In all cases, the attenuation was calculated from the insertion loss, this being the difference in dB between occluded and unoccluded spectra. The measured noise field was the average of four, 8 seconds spectra.

2.5.1 The tests

Each subject was fitted with a miniature microphone at each ear, seated with his head at the centre of the noise room, exposed to the noise field described in section 2.1, and the unoccluded spectrum at each ear measured.

The headset, with valves closed, was then fitted to the subject, care being taken to ensure a good fit and that the flat microphone lead produced minimal leakage. The noise field was regenerated and the subject adjusted the fit of the headset so that the noise reaching his ears was a minimum (as previously instructed). When the subject was satisfied with the fit of the headset, the occluded spectrum at each ear was measured. The noise field was turned off and the experimenter opened the valve on each earmuff, taking care not to disturb the fit of the headset. Another occluded spectrum at each ear was then measured. Finally, the unoccluded spectrum at each ear was re-measured for purposes of ensuring that the noise field had not changed during the course of the experiment. In all cases, the noise field remained constant with time. Accordingly, the mean of the two unoccluded spectra for each ear was used in calculations of earmuff attenuation.

3 RESULTS

The mean attenuation spectra obtained for each muff in the valve-open and valve-closed configurations are shown in Figs 2 and 3 respectively, together with the associated standard deviations. Fig 4 shows the comparison between the mean attenuation spectra for each of the two valve configurations and Fig 5 compares the data obtained in the valve-closed position with those obtained for a pair of B2 production earmuff assemblies (Mk 4 helmet). The latter data were obtained using the same subjects and under identical test conditions. The following points may be observed from the figures:

(a) When the valves are closed, the right muff demonstrates greater values of attenuation than does the left muff over the majority of the frequency range of interest. A Students 2-tailed t-test revealed that these differences were statistically significant at the 1% level at frequencies up to 315 Hz. Above this frequency, the differences are non-significant.

(b) In the valve-open configuration, there are no statistically significant differences between left and right muffs as indicated by a 2-tailed Students t-test at the 1% level of significance, with the exception of the 1/3 octave bands centred at 630, 1000, 1250 and 8000 Hz.

(c) Comparison of the attenuation of the headset with the valves open and with the valves closed, shows statistically significant differences at all test frequencies, using a 2-tailed Students t-test at the 1% level of significance.

(d) Comparison of the headset attenuation when the valves are closed, with that of a pair of B2 production earmuffs, indicates that at low and mid-frequencies up to 1250 Hz, this headset exhibits greater values of attenuation than do the B2 muffs. Above 1600 Hz, the converse is true. Again, these differences are significant at the 1% level using a 2-tailed Students t-test.

4 DISCUSSION AND CONCLUSIONS

The results of these tests firstly indicate that although there were no differences between left and right muffs in the valve-open configuration, there were differences of a statistically significant nature when the valves were closed. In an attempt to explain these differences, a subsidiary experiment was performed in which the external valves of the earmuffs were acoustically sealed with the valves in the closed position. The attenuation of each earmuff was measured using the objective test method detailed in Ref 2, in which measurements of occluded and unoccluded spectra are made using the Bruel and Kjaer Type 4153 Artificial Ear. The results of these tests indicated excellent agreement between left and right muffs, suggesting that the differences observed between the earmuffs in the main experiment can most probably be attributed to inefficient sealing of the left earmuff valve in this particular headset.

The second conclusion is that as is to be expected, the headset demonstrates low values of attenuation when the valves are open, thus facilitating direct voice communication. There remains some attenuation at higher frequencies, but this would not cause problems at normal speech frequencies.

Finally, these tests confirm earlier suggestions regarding the low-frequency attenuation characteristics of this headset (see section 1), which are higher than those of the B2 production earmuff assembly, which was tested under identical conditions. This is due to the increased volume of these earmuffs compared with the B2s, since it is well established that at low frequencies, attenuation is proportional to the enclosed volume of air[5].

The original interest in this headset was in its low frequency attenuation and its application to a helicopter crew helmet, since helicopter cabin noise is predominantly low-frequency in nature. The significant increase in low-frequency attenuation would be an important factor in the passive reduction of helicopter cabin noise, and some consideration is being given as to whether this type of earmuff assembly could form the basis of a helicopter crew helmet. Additionally, headsets of this type, which will allow normal communications or good noise attenuation, could be a useful asset in aircraft where these are conflicting requirements (eg rear cabin crew in Nimrod, operating sonar equipment).

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No.	Author	Title, etc
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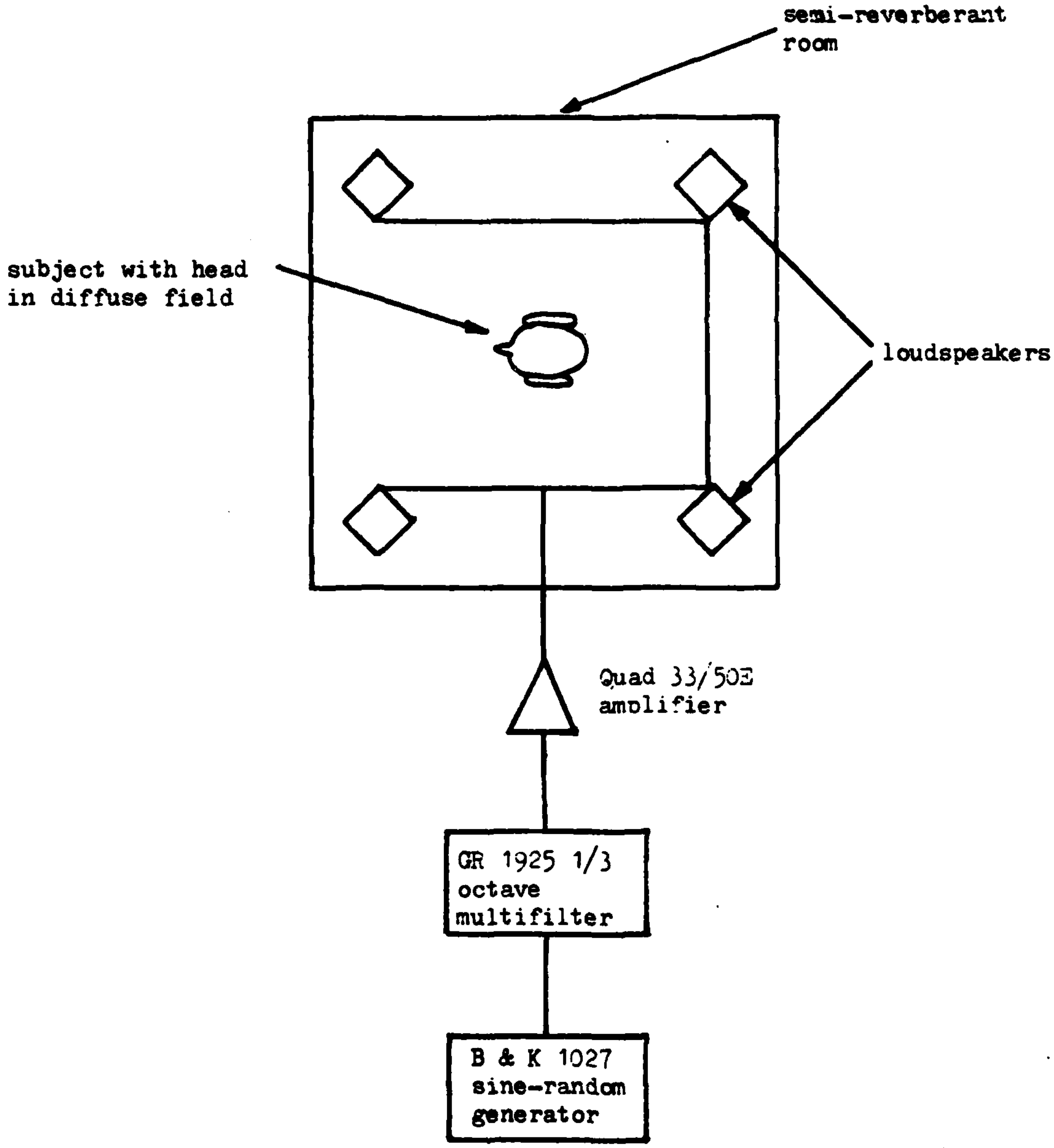

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Fig 1 Equipment used to generate noise fields

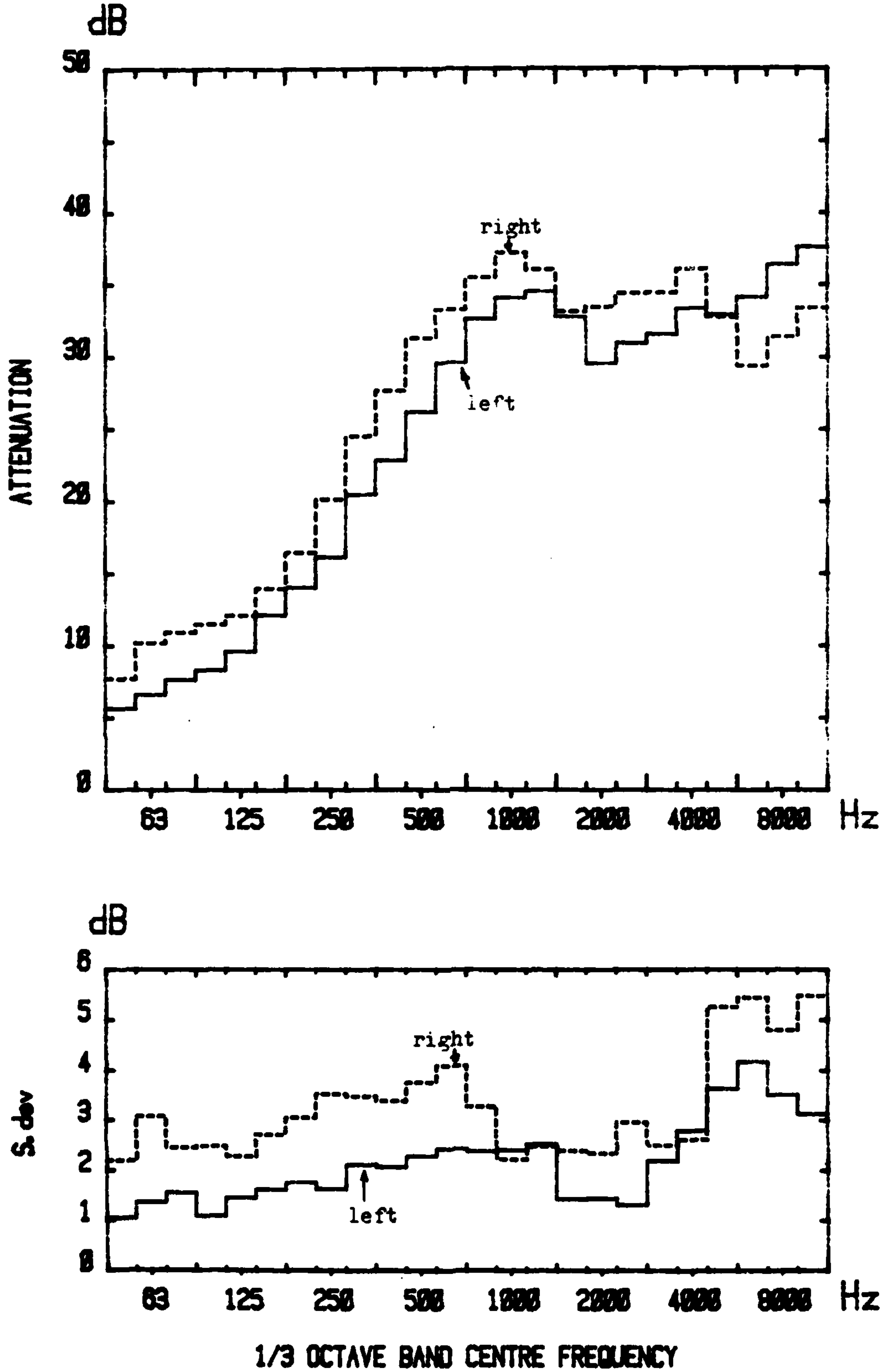

Fig 2 Mean attenuation spectra for headset with vents closed

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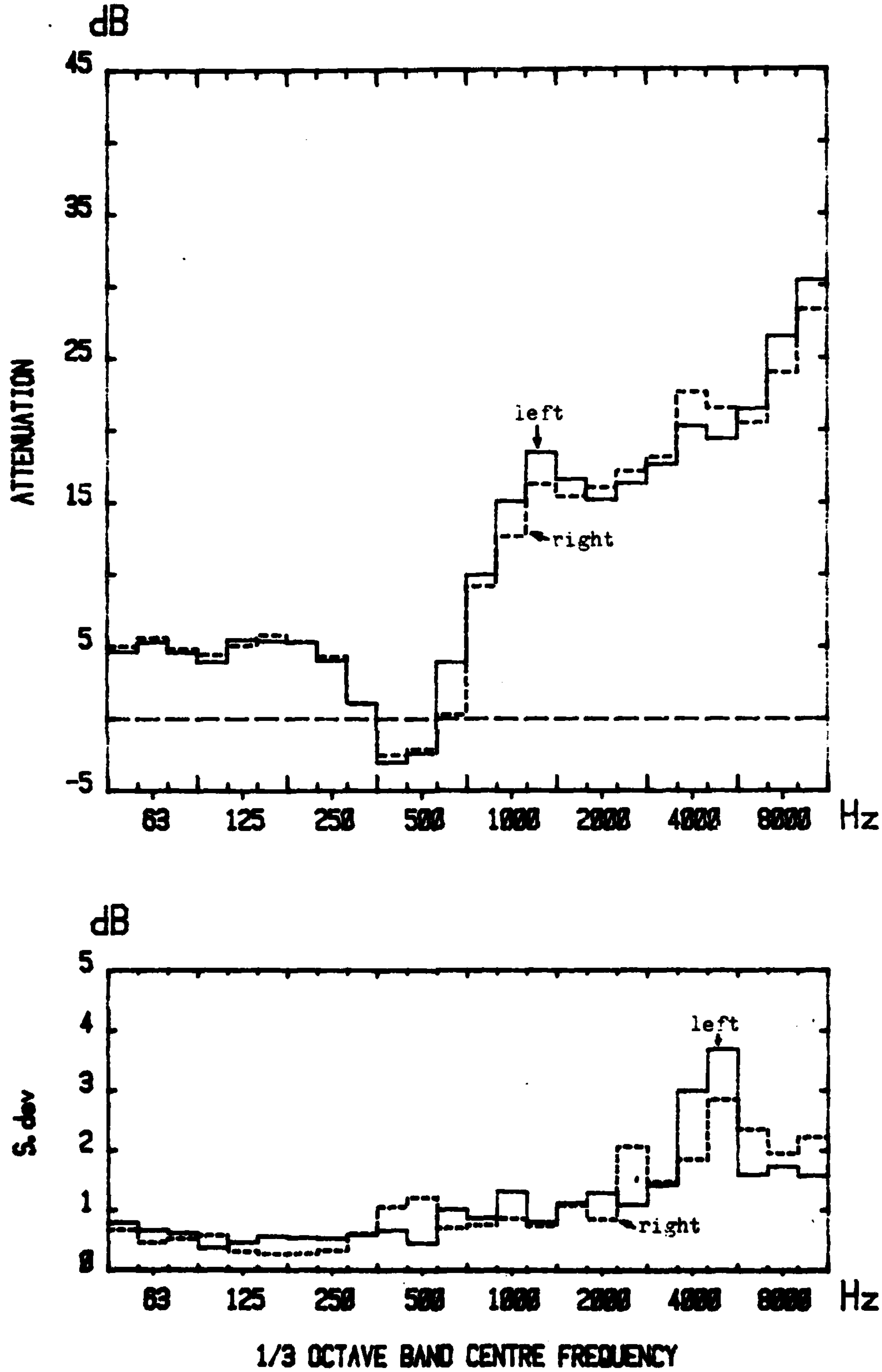

Fig 3 Mean attenuation spectra for headset with vents open

Fig 4

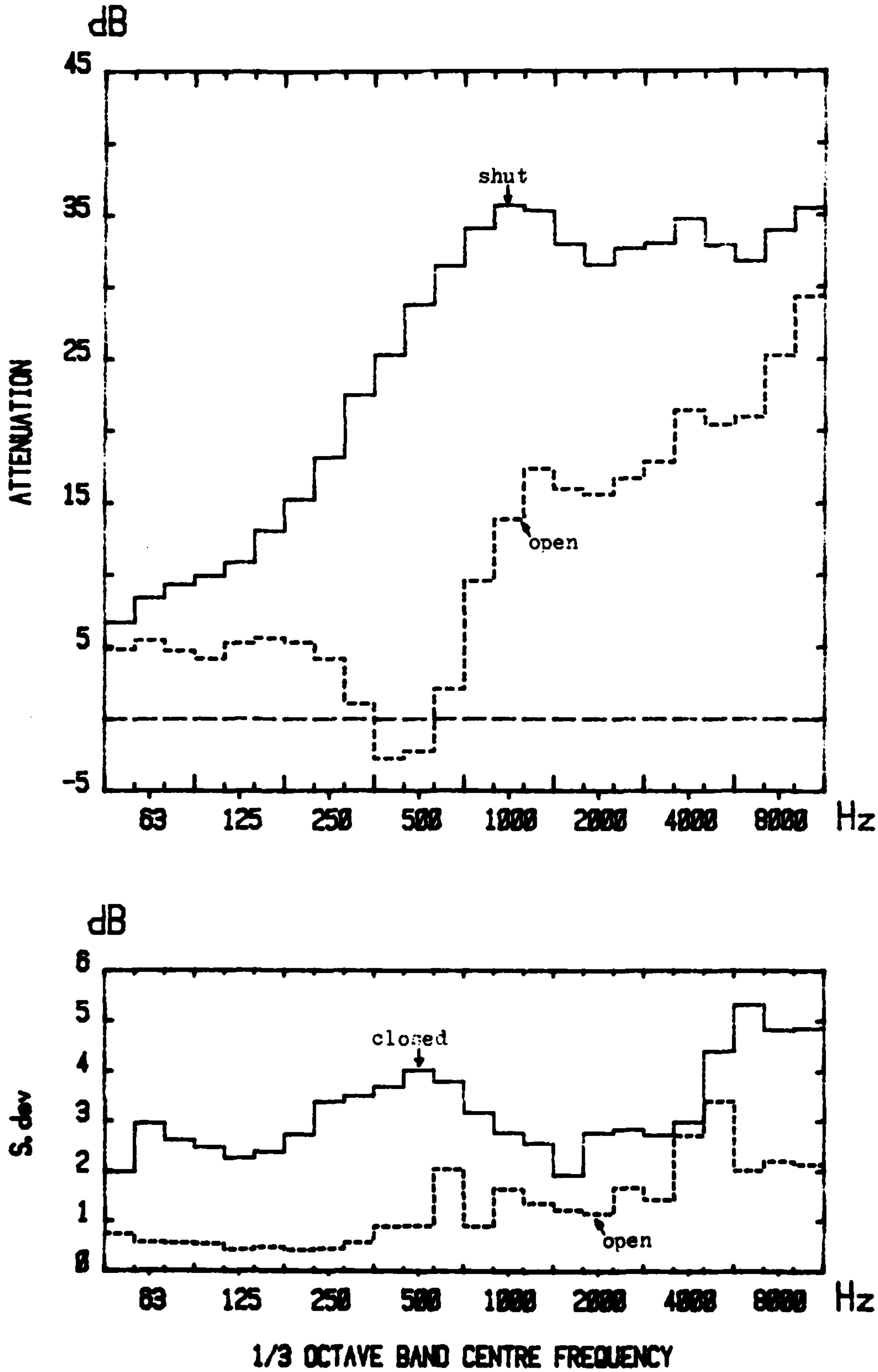

Fig 4 Mean attenuation spectra for headset with vents closed and open

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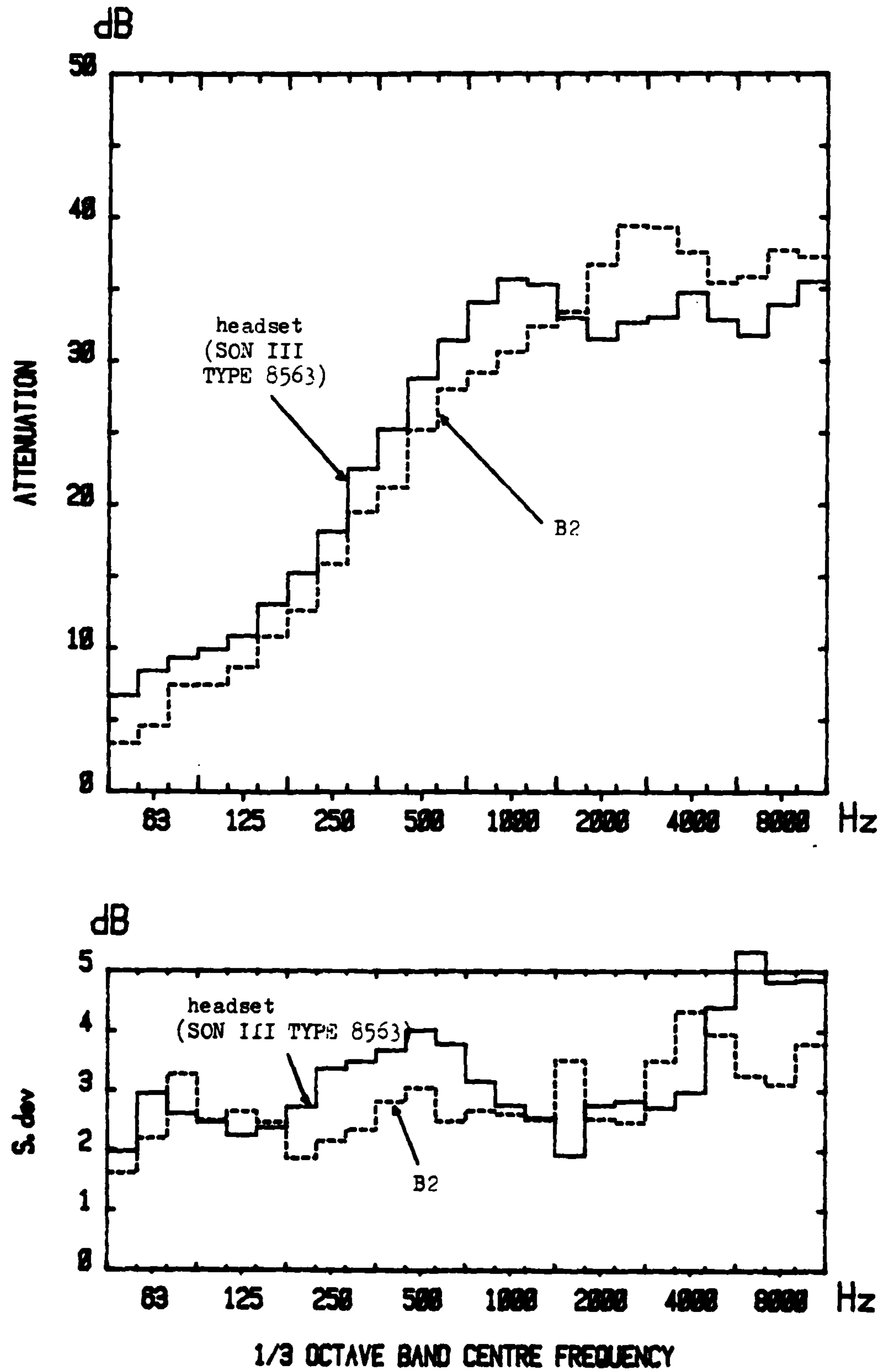

Fig 5 Comparison of mean attenuation spectra for SON III headset and B2 muffs

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1. DRIC Reference (to be added by DRIC)	2. Originator's Reference	3. [illegible] Reference	4. [illegible]
	RAE TM FS [illegible]	N/A	[illegible]

5. DRIC Code for Originator	6. Originator (Corporate Author) Name and Location
7673000W	Royal Aircraft Establishment, Farnborough, Hants, UK

5a. Sponsoring Agency's Code	6a. Sponsoring Agency (Contract Authority) Name and Location
N/A	N/A

7. Title Measurements of the attenuation of an army headset

7a. (For Translations) Title in Foreign Language

7b. (For Conference Papers) Title, Place and Date of Conference

8. Author 1. Surname, Initials	9a. Author 2	9b. Authors 3, 4	10. Date	Pages	Refs.
Cogger, M.K.	Wood, S.A.		[illegible]	[illegible]	[illegible]

11. Contract Number	12. Period	13. Project	14. [illegible]
N/A	N/A		

15. Distribution statement
(a) Controlled by –
(b) Special limitations (if any) –

16. Descriptors (Keywords) [illegible]
Acoustic attenuation. [illegible]. [illegible].

17. Abstract

[illegible]

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