

# *fm* **ADVANTAGE**

## **Procedures for the setting up of fm radio systems for use with hearing aids**

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if you would like to receive updates and  
associated information relevant to these procedures.

Connevans would like to acknowledge  
the help of Manchester University, in particular  
Mary Hostler, Wendy McCracken, Viv Rowson,  
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**These fm Advantage procedures give step by step instructions for using a hearing aid test box to set up hearing aids for use with fm radio systems.**

Whether the hearing aid is digital or analogue is not important, the relevant factor is whether the hearing aid is operating in linear\* or non linear mode\*\*.

There are two alternative setting up procedures for fm radio systems for use with direct input hearing aids. The first is for hearing aids operating in linear mode and the second for hearing aids operating in non linear mode. A further two procedures cover the setting up process for hearing aids using telecoil 'T' pickup for use with inductive neck loops.

Two important pieces of practical advice that should be given are

- 1) To underline the importance of performing a realistic listening test before the equipment can be considered to be correctly set up.
- 2) Programmable hearing aids can be set up with greatly differing characteristics and facilities, we would advise obtaining details of the programmes that have been set on each particular aid together with which programme is intended to be used with an fm radio system.

**General assumptions:**

- a) The hearing aid(s) have been separately assessed as working normally.
- b) The hearing aid(s) are recognised as being correctly fitted for the user.
- c) The fm Advantage setting up procedures are carried out with the hearing aid left at the normal user settings.
- d) A suitably quiet area is available for working in.
- e) The hearing aid test box should be set to display output rather than gain and has been 'levelled' today.
- f) We would advise the use of a lapel microphone for ease of testing. However if transmitter internal microphones are used in practice we would also advise that you perform control measurements to establish that a typical lapel microphone has a similar response to the internal microphone<sup>1</sup>. Physically putting the whole transmitter into the sound chamber is usually quite difficult and the test box would require re-levelling with the transmitter inside.
- g) Using a multicurve hearing aid test box with a test stimulus suitable for digital hearing aids is the ideal facility, however these procedures may also be adapted for use with virtually all hearing aid test boxes.
- h) If you have digital hearing aids that are to be tested and if your hearing aid test box has a stimulus suitable for testing digital aids we would suggest that this stimulus is actually used for testing all hearing aids thus avoiding the need to change settings.

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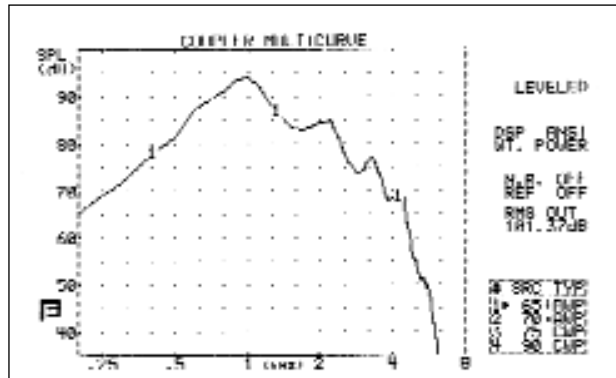
\* 'Linear' is when an SPL change at the input is equally reflected at the output. e.g. a 5dB change at the input gives a matching 5dB change at the output. Note: Hearing aids with a Wide Dynamic Range Compression (WDRC) facility can be set to operate in a linear mode (i.e. WDRC off) so it is important to always check how an aid has been set up. Hearing aids with either output limiting compression, linear peak clipping or soft peak clipping are regarded as being linear for the purposes of these procedures.

\*\* 'Non linear' is when an SPL change at the input is not reflected at the output. e.g. a 10dB change of input does not give a 10 dB change of output. Hearing aids with WDRC or full range compression are 'Non Linear'.

## Procedure 1: Linear Analogue aids and digital aids operating in linear mode

**Objective.** To ensure that the sound from the radio system transmitter has an advantage over the general room noise picked up by the hearing aid but that distortion is not caused by overloading.

- 1) Set the hearing aid test box to display output SPL.
- 2) With a 65dB SPL test box signal obtain a test box output response, curve 1, for the hearing aid at normal user volume.



- 3) Take note of the hearing aid output at the curve peak – say ??? dB SPL.
- 4) Taking care to not alter the hearing aid user settings, remove the hearing aid and coupler from the chamber.<sup>12</sup>
- 5) Place the radio system microphone in the test chamber, turn on the transmitter and close the chamber lid.

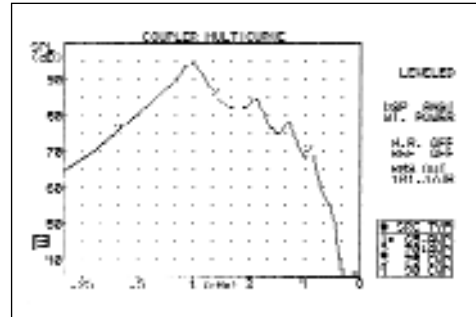


- 6) Connect the radio system receiver to the hearing aid and turn on. If hearing aid microphone manual muting<sup>2</sup> or muting shoes are available we would advise using this facility otherwise it will be necessary to muffle<sup>3</sup> the hearing aid microphone to reduce the problems of false readings from unwanted pickup<sup>4</sup>.

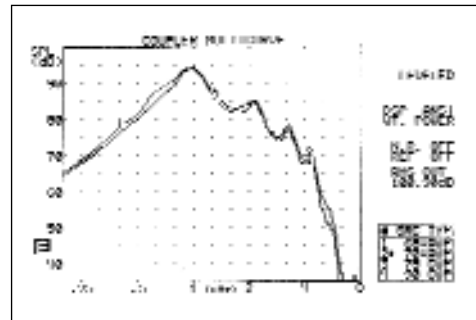


- 7) If you have a multicurve testbox select a new curve, curve 2.

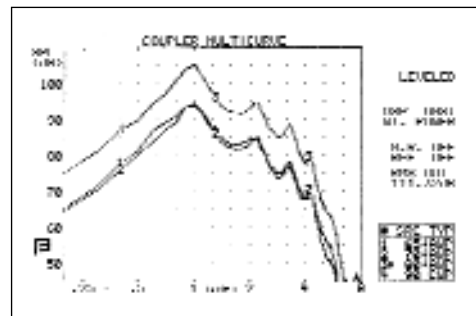
- 8) Set a 70dB SPL test box signal (at the frequency of the curve peak if using a puretone) and turn on the test stimulus.
- 9) Adjust the radio system receiver output volume control to give ??? dB SPL.
- 10) Obtain a test box response for the hearing aid and radio system combined (curve 2). To help clarity we have temporarily turned off curve 1.



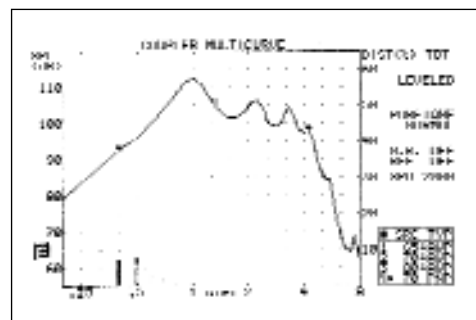
- 11) Compare this curve with the original response (curve 1) of the aid alone. Adjust the radio system receiver tone and output controls as required to give a best overall match. Repeating steps 9 & 10 until you achieve this.



- 12) If you have a multicurve testbox now select a new curve, curve 3.
- 13) Set an 80dB SPL test box signal.
- 14) Obtain a test box response for the hearing aid and radio system combined (curve 3).



- 15) The output curve 3 for the higher input should be 10dB higher than curve 1. A rise of 5dB or less would indicate a potential problem<sup>5</sup> because a part of the system is in compression.
- 16) The level of distortion for the overall system should be checked against agreed limits<sup>6</sup>. It will be necessary to change the test box to a pure tone stimulus to carry out distortion measurements<sup>7</sup>. If using a multicurve test box select a new curve for making this measurement; curve 4. Note that some test boxes may require changing to single curve mode to make distortion measurements. We suggest using a 70dB pure tone stimulus for the distortion measurement. It is advisable to keep an annotated printout for quality monitoring purposes.
- 17) **A listening test is essential to ensure that the system is functioning correctly with no intermittent connections.**

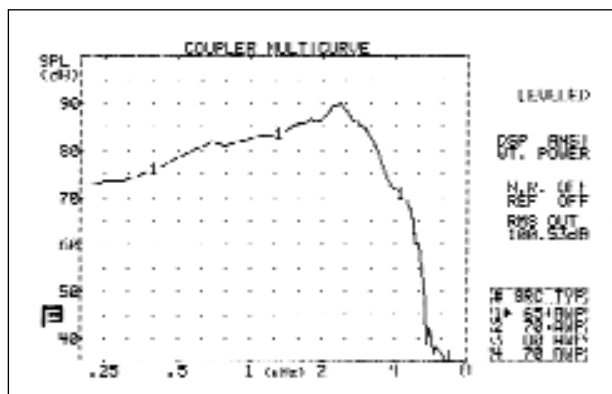


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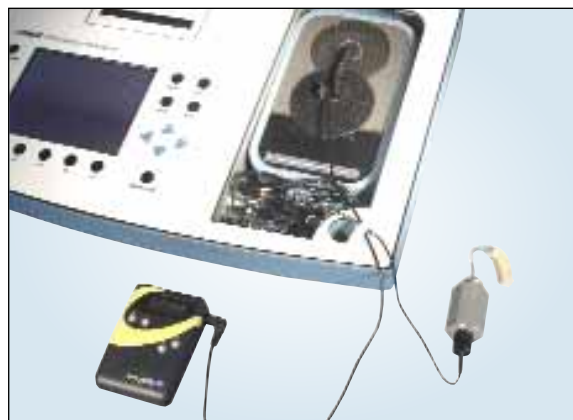
## Procedure 2: Non linear analogue aids and digital aids operating in non linear mode

**Objective.** To ensure that the sound from the radio system transmitter has an advantage over the general room noise picked up by the hearing aid and that the overall system functions as intended.

- 1) Set the hearing aid test box to display output SPL. Ideally a non constant tone stimulus such as DSP composite or similar, should be used. If a pure tone or constant composite tone stimulus is used this procedure is still valid but the curves obtained should be interpreted with caution<sup>8</sup>.
- 2) With a 65dB SPL test box signal obtain a test box output response, curve 1, for the hearing aid at normal user volume.



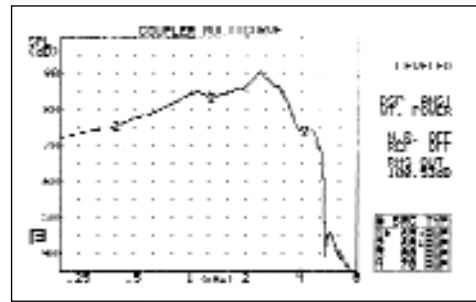
- 3) Take note of the hearing aid output at the curve peak – say ??? dB SPL.
- 4) Taking care to not alter the hearing aid user settings, remove the hearing aid and coupler from the chamber.<sup>12</sup>
- 5) Place the radio system microphone in the test chamber, turn on the transmitter and close the chamber lid.



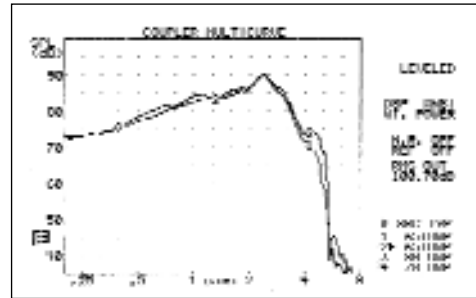
- 6) Connect the radio system receiver to the hearing aid and turn on. If hearing aid microphone manual muting<sup>2</sup> or muting shoes are available we would advise using the facility otherwise muffle<sup>3</sup> the hearing aid microphone to reduce the problems of false readings from unwanted pickup<sup>4</sup>.



- 7) If you have a multicurve test box select a new curve, curve 2.
- 8) Leave the test box signal set at 65dB (at the frequency of the curve peak if using a puretone) and turn on the test stimulus.
- 9) Starting at a low level adjust the radio system receiver output volume control upwards to give ??? dB SPL, being careful not to exceed this level.<sup>13 & 14</sup>
- 10) Obtain a test box response for the hearing aid and radio system combined (curve 2), to help clarity we have temporarily turned off curve 1.

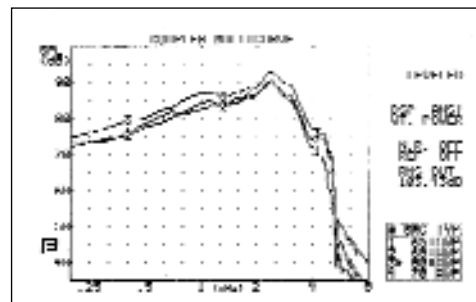


- 11) Compare this curve with the original response (curve 1) of the aid alone. Adjust the radio system receiver tone and output controls as required to give a best overall match. Repeating steps 9 & 10 until you achieve this. Overbalancing the system can lead to increased noise, if necessary turn down the fm volume and repeat the adjustment turning up more slowly.



- 12) If you have a multicurve test box now select a new curve, curve 3.
- 13) Set an 80dB SPL test box signal.

- 14) Obtain a test box response for the hearing aid and radio system combined<sup>9</sup> (curve 3).
- 15) The result for curve 3 is very difficult to predict as it depends how the non linear hearing aid WDRC compression characteristics have been configured. The 80dB signal is intended to show how the overall system operates with realistic input levels. Care should be taken to ensure that the overall system is functioning as intended.



- 16) The level of distortion for the overall system should be checked with a listening test.
- 17) It is advisable to keep an annotated printout for quality monitoring purposes.

**The listening test is essential to ensure that the system is functioning correctly with no intermittent connections.**

If following setting up of a non-linear hearing aid using the FM Advantage procedure a user is more aware of, or distracted by, background noise than they were before there are two possible reasons:

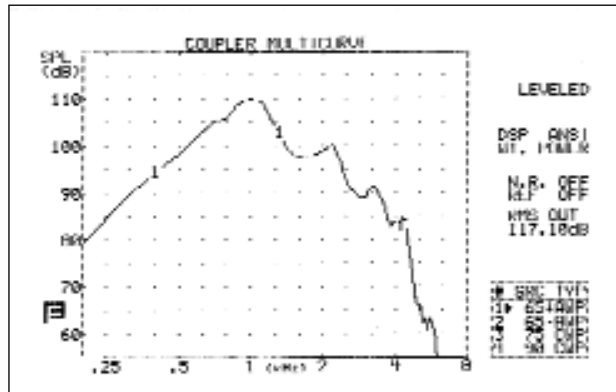
- a) If the background noise is worse through the fm system than the hearing aid alone, then the fm system has been overbalanced. The remedy is to re-balance taking more care to adjust up to and not beyond a level; or use the 65/70dB protocol instead.
- b) If the background noise is distracting for the user with or without the fm system then the prescription is at fault. There is too much low level gain, which is the same as saying that the compression characteristic is not optimum for the reduced dynamic range of the user. The remedy is to review the prescription and hearing aid settings.

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### Procedure 3: Linear Analogue aids and digital aids operating in linear mode using telecoil 'T' pickup for use with an inductive neck loop

**Objective.** To ensure that the sound from the radio system transmitter has an advantage over the general room noise picked up by the hearing aid but that distortion is not caused by overloading.

- 1) Set the hearing aid test box to display output SPL.
- 2) With a 65dB SPL test box signal obtain a test box output response, curve 1, for the hearing aid at normal user volume.



- 3) Take note of the hearing aid output at the curve peak – say ??? dB SPL.
- 4) Taking care to not alter the hearing aid user settings, remove the hearing aid and coupler from the chamber.<sup>12</sup>
- 5) Place the radio system microphone in the test chamber, turn on the transmitter and close the chamber lid.

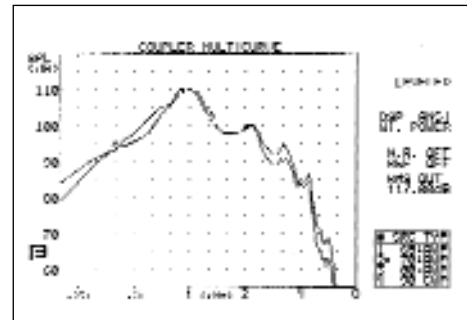
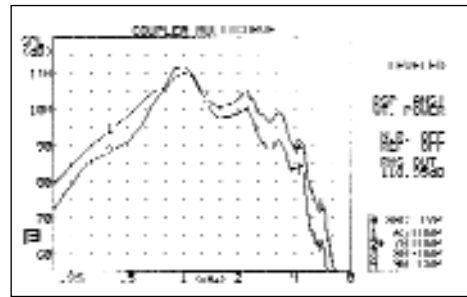


- 6) When measuring the response of a hearing aid telecoil 'T' pickup correct physical positioning is very critical. Magnetic field strength varies with distance, position and orientation<sup>10</sup>. The 'T' response of a hearing aid and fm radio aid system needs to be measured in the same way that the system is used by the user. In the absence of a non metallic manikin a convenient human is a good substitute!
- 7) Fit the radio system receiver and neck loop, switch the hearing aid to 'T' (taking care to not alter the volume setting) and place the hearing aid over the ear, in the usual position, with the coupler still attached<sup>11</sup>. It is wise to ask the wearer to support the 2cc coupler.



- 8) If you have a multicurve test box select a new curve, curve 2.

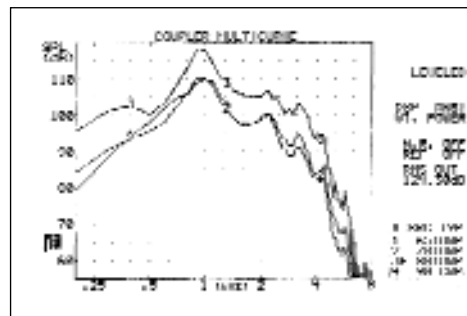
- 9) Set a 70dB SPL test box signal.
- 10) Adjust the radio system receiver output volume control to give ??? dB SPL.
- 11) Obtain a test box response for the hearing aid and radio system combined (curve 2).
- 12) Compare this curve with the original response (curve 1) of the aid alone. For the particular aid tested you can see that with the radio system there is an apparent low frequency cut and high frequency boost. Assuming this is not advantageous adjust any radio system receiver tone and output controls to give a best overall match. Repeat steps 9 & 10 until you achieve this.
- 13) This pair of curves shows the matching improvement obtained by adjusting the tone controls.



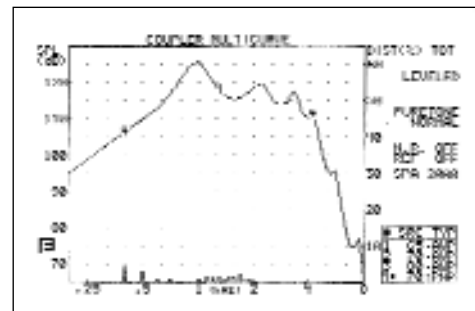
- 14) If you have a multicurve test box now select a new curve, curve 3.
- 15) Set an 80dB SPL test box signal.

- 16) Obtain a test box response for the hearing aid and radio system combined (curve 3). It can be seen that the particular aid used for these procedures is 'struggling' at low frequencies with the increased input level.

A decision as to whether this is acceptable will need to be made. If necessary try changing the fm radio system and or hearing aid. Appendix 4 shows how to test an fm radio system on its own.



- 17) The output curve 3 for the higher input should show a 10dB higher curve than curve 1. A rise of 5dB or less would indicate a potential problem<sup>5</sup> because a part of the system is in compression.
- 18) The level of distortion for the overall system should be checked against agreed limits<sup>6</sup>. It will be necessary to change the test box to a pure tone stimulus to carry out distortion measurements<sup>7</sup>. If using a multicurve test box select a new curve for making this measurement, curve 4: some test boxes may require changing to single curve mode to make distortion measurements. We suggest using a 70dB pure tone stimulus for the distortion measurement. It is advisable to keep an annotated printout for quality monitoring purposes.



- 19) **A listening test is essential to ensure that the system is functioning correctly with no intermittent connections.**

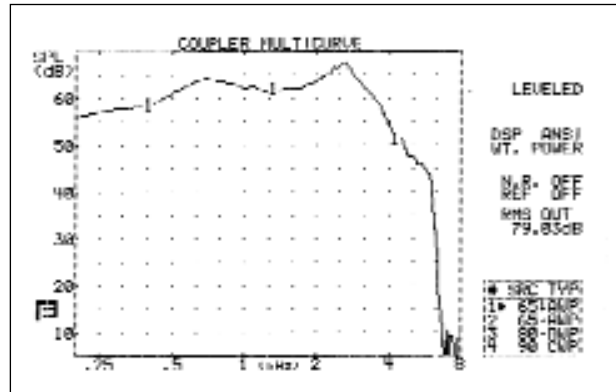
NOTES – see page 10



## Procedure 4: Non linear analogue aids and digital aids operating in non linear mode using telecoil 'T' pickup for use with an inductive neck loop

**Objective.** To ensure that the sound from the radio system transmitter has an advantage over the general room noise picked up by the hearing aid and that the overall system functions as intended.

- 1) Set the hearing aid test box to display output SPL. Ideally a non constant tone stimulus such as DSP composite or similar, should be used. If a pure tone or constant composite tone stimulus is used this procedure is still valid but the curves obtained should be interpreted with caution<sup>8</sup>.
- 2) With a 65dB SPL test box signal obtain a test box output response, curve 1, for the hearing aid at normal user volume.



- 3) Take note of the hearing aid output at the curve peak – say ??? dB SPL.
- 4) Taking care to not alter the hearing aid user settings, remove the hearing aid and coupler from the chamber.<sup>12</sup>
- 5) Place the radio system microphone in the test chamber, turn on the transmitter and close the chamber lid.



- 6) When measuring the response of a hearing aid telecoil 'T' pickup correct physical positioning is very critical. Magnetic field strength varies with distance, position and orientation<sup>10</sup>. The 'T' response of a hearing aid and fm radio aid system needs to be measured in the same way that the system is used by the user. In the absence of a non metallic manikin a convenient human is a good substitute!
- 7) Fit the radio system receiver and neck loop, switch the hearing aid to 'T' (taking care to not alter the volume setting) and place the hearing aid over the ear, in the usual position, with the coupler still attached<sup>11</sup>. It is wise to ask the wearer to support the 2cc coupler.



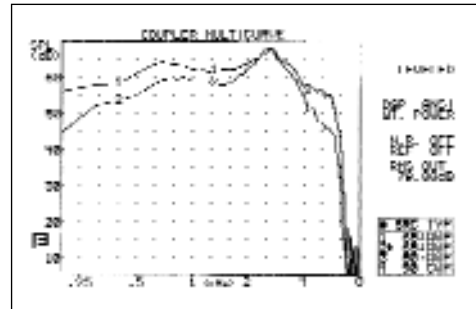
- 8) If you have a multicurve test box select a new curve, curve 2.
- 9) Leave the test box signal set at 65dB.
- 10) Starting at a low level adjust the radio system receiver output volume control upwards to give ??? dB SPL, being careful not to exceed this level.<sup>13 & 14</sup>

- 11) Obtain a test box response for the hearing aid and radio system combined (curve 2).

- 12) Compare this curve with the original response (curve 1) of the aid alone. Adjust the radio system receiver tone and output controls as required to give a best overall match. Repeat steps 9 & 10 until you achieve this.

Overbalancing the system can lead to increased noise, if necessary turn down the fm volume and repeat the adjustment turning up more slowly.

As the particular aid used to produce the curves for this procedure had a peak at around 3 KHz we were not able to establish a particularly neat curve fit using the tone controls. In which case we would advise allowing the user to set their own preference and subsequently obtain a curve to see how the user has chosen to set the controls.

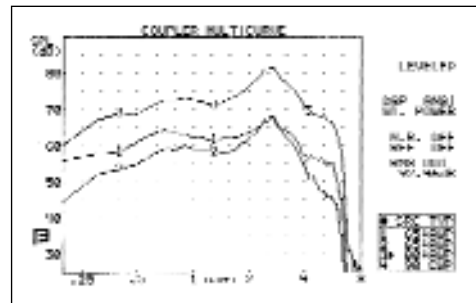


- 13) If you have a multicurve test box now select a new curve, curve 3.

- 14) Set an 80dB SPL test box signal.

- 15) Obtain a test box response for the hearing aid and radio system combined<sup>9</sup> (curve 3).


- 16) The result for curve 3 is very difficult to predict as it depends how the non linear hearing aid AGC/compression characteristics have been configured. The 80dB signal is intended to show how the overall system operates with realistic input levels. Care should be taken to ensure that the overall system is functioning as intended.



- 17) The level of distortion for the overall system should be checked with a listening test.
- 18) It is advisable to keep an annotated printout for quality monitoring purposes.

- 2 Hearing aid manual muting is the ability of the radio system to reduce the sound pickup of the hearing aid's own microphone, typically by 10-20 dB. Manual muting would be set either by a switch on the radio system receiver or by using a muting shoe.
- 3 Muffling can be as simple as using some blu-tak, foam or a cloth around the hearing aid or as complex as using a second sound deadened chamber to put the hearing aid into.
- 4 A live hearing aid microphone will pick up sound from the chamber, this sound will interact with the sound via the radio system falsifying readings and probably indicating non existent distortion.
- 5 A linear aid connected to an fm radio system would not normally be expected to be in compression with an input level as low as 75dB. If this occurs it is necessary to identify the cause of the problem. Testing the hearing aid alone with inputs of 70, 75, 80 & 85 dB SPL will show how the hearing aid is functioning. Appendix 4 shows how to test a radio system on its own and inputs of 70, 75, 80 & 85 dB SPL will show how the radio aid is functioning.
- 6 Distortion of 10% or greater should be regarded as unacceptable. If the distortion of the hearing aid alone is acceptable the radio system can be tested on its own as in appendix 4. If necessary try re-running the procedure using 65dB & 75dB sound inputs, which will reduce the possibility of overloading the hearing aid, and recheck the amount of distortion. Should you be unable to set an fm advantage it may be necessary to have the prescribed hearing aids re-assessed.
- 7 Output curves from a speech weighted stimulus (ie composite tone) will be different from output curves from a pure tone stimulus – so do not be surprised at differing graphs.
- 8 Using traditional test boxes which have a tone or composite test stimulus to test DSP hearing





**The listening test is essential to ensure that the system is functioning correctly with no intermittent connections.**

*NOTES – see below.*

## **Notes**

- 1 If an fm radio system transmitter with integral microphone is to be tested, because of the physical effect of placing the case into the measuring chamber, it is necessary to re-level with the transmitter in the chamber and then level again when it is removed.

In practice it is much easier to use an external microphone for performing measurements however we would advise validating this approach as follows.

- a) Level the test box as usual.
- b) Set a 70dB SPL test box signal.
- c) Place the fm radio system lapel microphone (only) into the test chamber and obtain a response curve for an overall hearing aid and radio system.
- d) Print out the curve.
- e) Be careful not to change any hearing aid or radio system settings
- e) Disconnect the lapel microphone and place the transmitter into the chamber.
- f) Re-level the test box with the transmitter inside the chamber.
- g) Using the same 70dB SPL input obtain a response curve for the overall hearing aid and radio system.
- h) Print out the curve.

Comparing the two curves will indicate any differences of the two approaches.

aids (such as the Selectra) which have VAD (Voice Activated Detection) or noise suppression activated in the software will probably give apparently strange results which can be coped with if they are understood.

A DSP hearing aid with noise suppression activated will interpret a constant pure tone as 'unwanted noise' and reacts by reducing the gain of that channel. After turning on a test tone the predictable situation is to see the gain of the hearing aid reduce as you watch it – typically 10dB. So if you are taking readings for setting the radio system simply wait for the output to settle; both for the hearing aid alone and hearing aid with radio system. When using a composite tone stimulus you will see the response gently 'sag' as you watch it – again this is not a problem if you wait for it to settle.

Frequency response plots using a pure tone source can give misleading results. It depends on the speed of the tone sweep compared to the time constants in the non linear hearing aid. The fmAdvantage method has been written with the philosophy of comparison. See what the hearing alone does, add the radio system and then see how the overall system is performing. The output graphs may not represent the response presented to a human ear but they will allow you to ensure that a fm radio system is matched to a hearing aid.

Turning off the VAD or noise suppression feature would certainly simplify matters, however as that requires reprogramming the hearing aid it is an unrealistic day to day operation.

- 9 When obtaining results with a pure tone stimulus some test boxes also display distortion. If you are testing programmable multichannel hearing aids and see high levels of 'mid frequency' distortion DO NOT PANIC. You will almost certainly find that a listening test will show that the aid is not really distorting. The apparent distortion is simply because of the way a test box calculates distortion.

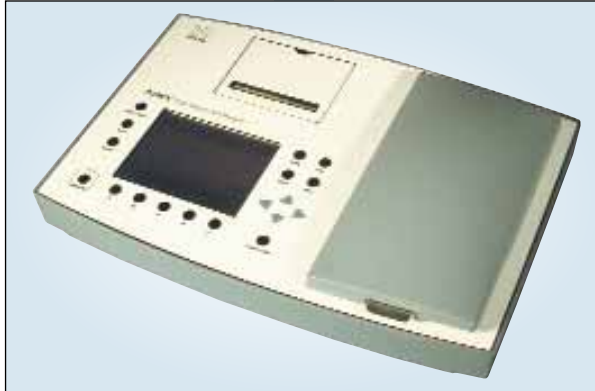
In basic terms the amount of distortion is calculated as a percentage between wanted and unwanted signal. With programmable aids because different frequency slices can have different gains the usual calculations become meaningless.

- 10 Performing a test with the hearing aid in the middle of a neck loop placed on a table is the equivalent of the hearing aid being fitted in the throat!
- 11 If the test box has real ear measurement facilities the chamber microphone will already have a long lead otherwise you need to obtain a suitable extension lead.
- 12 When removing the hearing aid and 2cc coupler from the test box chamber do not place directly onto a hard surface always place onto a piece of foam.
- 13 When using the fm Advantage protocol with non linear hearing aids beware of overbalancing, with a compression ratio of 4:1 (i.e. 10dB output change for 40dB input change) an overbalance error of 1 dB on the output is the same as increasing the background noise by 4dB.
- 14 When using the fm Advantage protocol with non linear hearing aids the fm Advantage protocol gives additional headroom and gain for the fm system but this is at the expense of apparent background noise level.



## Appendix 1 – background information

- 1) Radio systems have traditionally been set up with a balancing procedure using 65dB into the hearing aid and 75dB into the radio system transmitter. The 10dB difference accounted for as being the gain provided by the transmitter microphone being close to the speaker. Having 'balanced' the radio system it has been very common for the user to actually want the transmitter sound 'a little louder'; this fm Advantage Method now reflects this common practice.
- 2) The hearing aid test box used for the graphics in these procedures is a Fonix FP35 with DSP composite tone option.



- 3) The fm radio aid system used for the graphics in these procedures is a Connevans fmGenie.



## Appendix 2 – helpful comments

- 1) For hearing aid test boxes that require levelling – although most 'remember' their levelling characteristics – we would advise levelling the test box for each session of use.
- 2) When using radio systems with a neck loop there are a number of points worth remembering.
  - a) Multiturn neck loops tend to provide a better drive signal than single single turn neck loops – in output level, frequency response and distortion.
  - a) Single turn or thin neck loops which have a matching transformer can introduce distortion, at higher volume levels, due to saturation of the transformer.
  - c) Just because a hearing aid is working to specification on the 'M' setting does not mean that it also working to specification on the 'T' setting.

## Appendix 3 – checking hearing aid test box integrity.

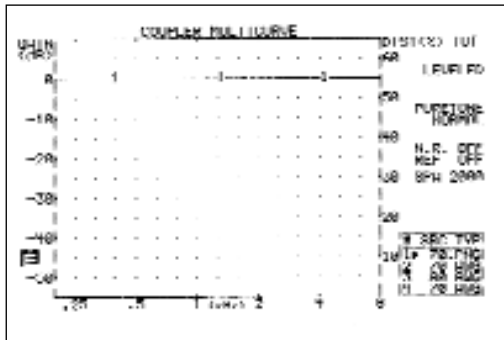
If you have any doubt that your hearing aid test box is levelling correctly there is a very straightforward procedure to check what is happening.

- 1) Set the hearing test box to show gain.
- 2) Remove the 2cc coupler.
- 3) Place the test box microphone 'on the spot' as you would for levelling a test box.

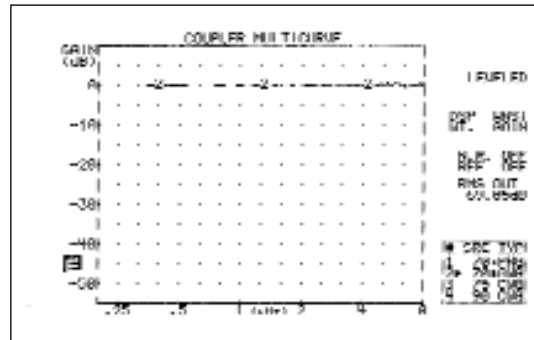


- 4) Select (say) 70dB.
- 5) Obtain a curve.

If the test box is correctly working you should obtain a flat line with zero gain.

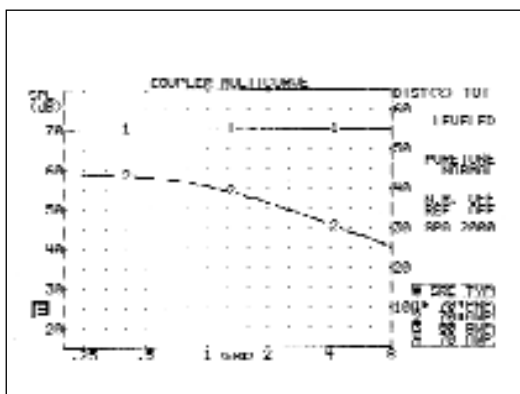


70dB pure tone stimulus



70dB composite DSP stimulus

You may find it interesting to repeat this procedure for the different stimulus options (eg pure tone, composite, dsp composite) and note any variations. If the results are recorded in different curves and if you reselect the system options to display 'output SPL' the speech weighting of a composite tone versus pure tone can be seen as shown in the graph below.

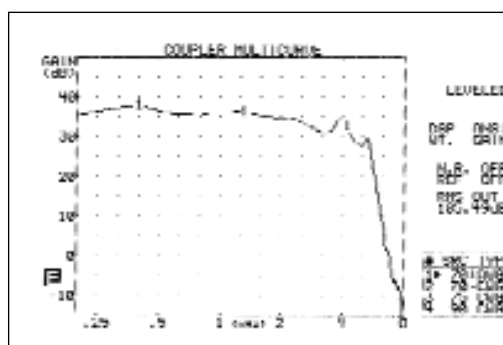
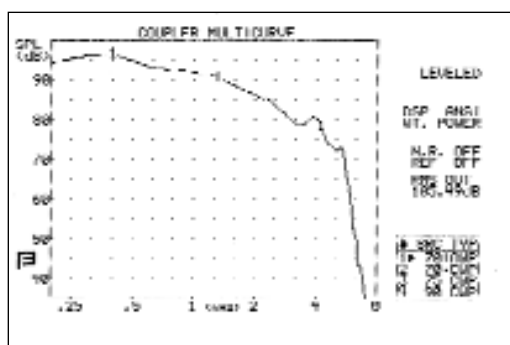


## Appendix 4 – testing a radio aid system on its own

An fm radio aid system can easily be tested without a hearing aid by using a wideband body aid earpiece of 100 Ohms or greater with a suitable lead. The fm radio aid system can then be tested using a body aid earpiece coupler fitting. An important technical note is that the shape of curves below indicate the response of the earpiece and the 2cc coupler used for the test rather than actually showing the virtually flat output response of the radio system used in the test.



The following two graphs are for the same radio aid system/earpiece/coupler combination, the first shows SPL and the second gain.

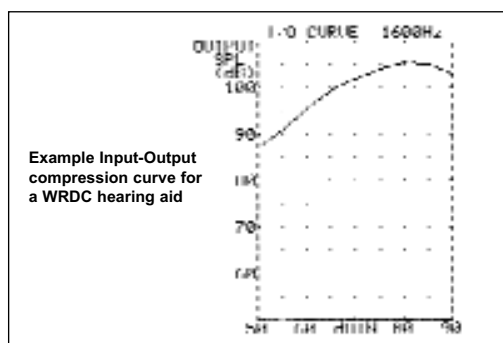
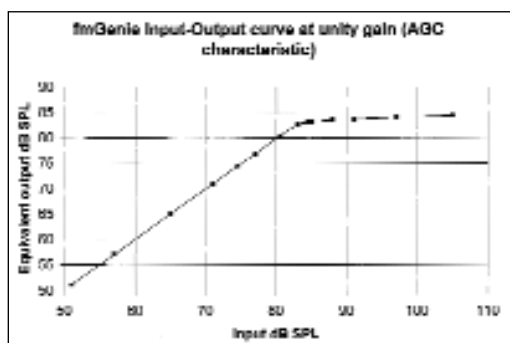


## Appendix 5 – viewing AGC or compression characteristics

All fm radio aid systems have Automatic Gain Control or AGC. This is required by all national radio regulatory authorities in order to control the use of valuable radio spectrum.

There are many forms of AGC. fm radio aid systems use 'soft limiting' in which changes of sound level at the input are directly reflected at the output up to a certain value known as the 'knee point'. For example, at an input sound level of 60dB SPL, a 5dB increase of sound at the input results in a 5dB increase of output. Above the 'knee point' the AGC circuit controls the gain so that the output remains virtually constant.

To limit output, some linear hearing aids use 'peak clipping' (also known as hard limiting) or output limiting compression – the input/output curves always being linear for normal sound input. In the case of non linear hearing aids the output is always limited by some form of compression. Compression is a process where there is less change at the output than occurs on the input, it is usually a continuous process where there is no 'knee point'. For example a 10dB increase on the input may only give a 2dB increase on the output.



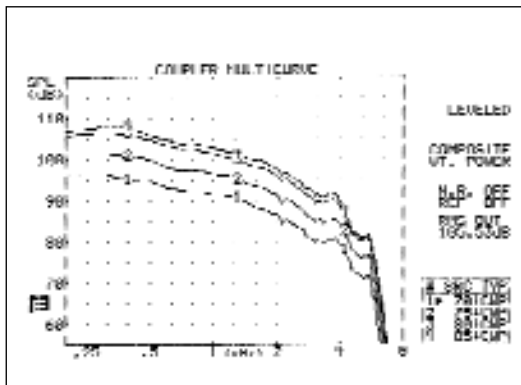
Technical note: Compression circuitry can be set so that quiet sounds are made louder and loud sounds are made quieter either side of a particular level. However for a typical hearing aid the point where compression increases the sound output would not be seen as it would be below normal speech levels



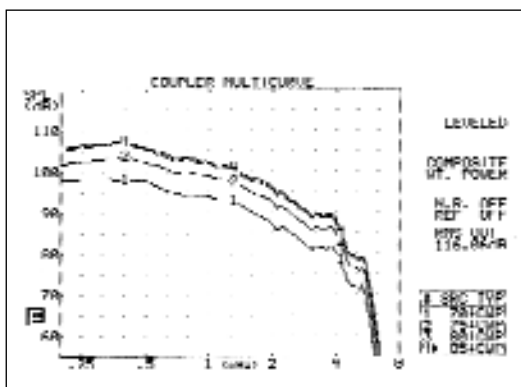
There is a very great difference between the hard peak clipping type of limiting used in some linear hearing aids that causes much distortion and the soft limiting used in radio aid systems that does not.

Checking the AGC characteristics of a radio aid system is much easier than you may think. Appendix 4 demonstrates how to test a radio aid system on its own. To see the AGC characteristic of a radio system simply step through a range of input levels and note how the output changes.

The printout below showing output SPL with a composite tone stimulus shows how the output of an fmGenie changes with 5dB increments at the input. You will see that using a speech weighted composite tone the AGC knee point is approximately 80dB SPL.

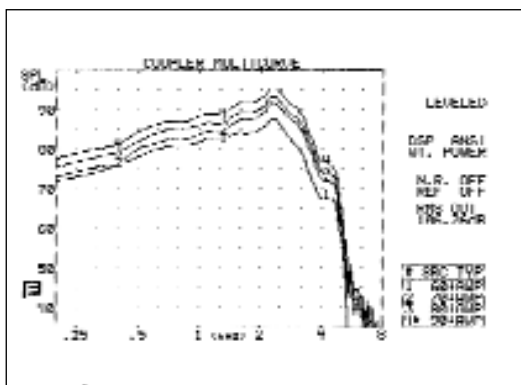


Repeating the experiment for a CRM-220, using a composite tone stimulus, the curves show that the AGC knee point slightly lower than the knee point for the fmGenie probably at about 78dB.



Note that the actual value of AGC knee point that is measured will depend on the type of stimulus. A composite tone stimulus will indicate a lower dB SPL value than a pure tone stimulus due to the different crest factors.

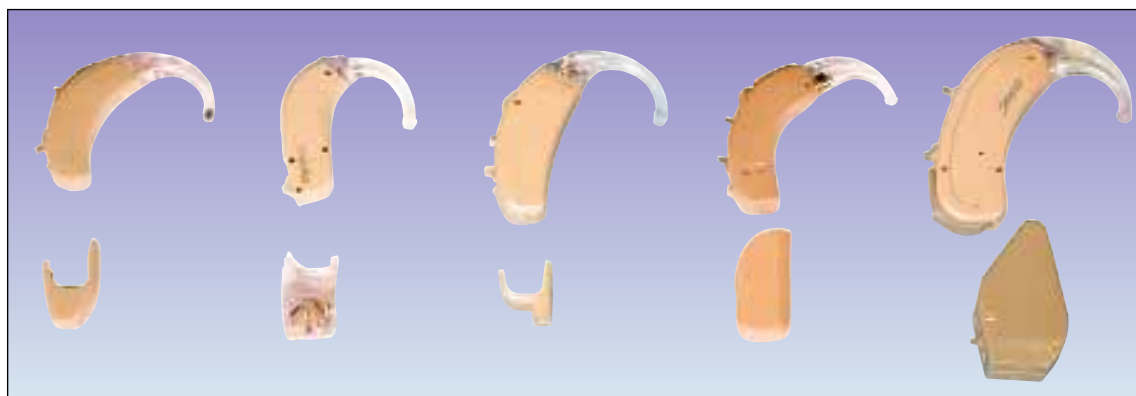
The compression used in non linear hearing aids 'compresses' the signal so that you have less change at the output than you have at the input. As an example the curves below (for a Digifocus II) show how for an input increase of 10dB the output only increases by 2 or 3dB. For the overall 30dB input change of 60 to 90dB the output increases only (approx) 7dB at 1KHz.



## Appendix 6 – digital direct input hearing aids used in the Modernising Hearing Aid Service Project – MHASP

The Modernising Hearing Aid Service Project is funded by the Department of Health, overseen by the RNID and evaluated by MRC IHR Nottingham.

### 1st wave – circa 2000



<p><b>A&amp;M Selectra</b> Direct input shoe: Connevens pt no. DASS1</p>	<p><b>Oticon Digifocus II</b> Direct input shoe: Connevens pt no. DOC0MFM</p>	<p><b>Philips Spaceline D71S</b> Direct input shoe: Connevens pt no. DP71</p>	<p><b>Starkey Gemini A-13</b> Direct input shoe: Connevens pt no. D-13DAI</p>	<p><b>Widex P37 VC</b> Direct input shoe: Connevens pt no. DWSP3FM</p>
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### 2004



<p><b>Danalogic 283D</b> Direct input shoe: Connevens pt no. DGNR780D</p>	<p><b>Oticon Spirit II Power</b> Direct input shoe: Connevens pt no. DOAP600</p>	<p><b>Oticon Spirit IID</b> Direct input shoe: Connevens pt no. DOFM5</p>	<p><b>Phonak Aero 211AZ</b> Direct input shoe: Connevens pt no. DAS5AC</p>
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<p><b>Phonak Aero 311AZ Forte</b> Direct input shoe: Connevens pt no. DAS5AC</p>	<p><b>Phonak Supero 413AZ</b> Direct input shoe: Connevens pt no. DAS4</p>	<p><b>Siemens Prisma 2DSP</b> Direct input shoe: Connevens pt no. DASTRI</p>	<p><b>Siemens Prisma 2M</b> Direct input shoe: Connevens pt no. DAMSELECT</p>
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