Fitting FM Systems with Advanced Digital Signal Processing Hearing Aids

Mary Hostler

Introduction: Background to UK Provision of FM Systems.

Setting up FM systems in the UK has traditionally been the role of the Teacher of the Deaf (ToD) or Educational Audiologist. Most FM systems are purchased by Education services and are considered to be an “educational aid”, an essential piece of equipment to facilitate the inclusion of hearing impaired children into mainstream education. Personal hearing aids are provided by the National Health Service (NHS) and usually fitted in a hospital Audiology clinic. In areas where there has traditionally been close co-operation between Health and Education the separation of the provision of these two parts of the child’s “amplification package” has not been a problem. A third agency, Social Services, may also be involved in relation to the provision of Assistive Listening Devices such as loops, telephone amplifiers, alarm systems etc.

The cost of FM systems and financial constraints within Services for Hearing Impaired children means that most Education services draw up a policy on candidacy locally. There are areas where most hearing aid wearers will be considered for provision of an FM system and the systems may be fitted as early as 12 months, when the child becomes more mobile, and their use in all appropriate listening situations will be encouraged, including home use. In contrast, some areas only introduce FM systems when children start full time education, and their use is restricted to school. In some areas the more severely and profoundly deaf children get priority for having an FM system.

There is thus considerable variation in provision around the country. Some areas have as few as 12% of their hearing aid wearers using FM systems whereas in other areas up to 90% of hearing aid wearers have them. (Royal National Institute for Deaf people (RNID) records from sites joining the Modernising Children’s Hearing Aid Services (MCHAS) project, 2003, also Phonak UK survey, 2002)

Rationales for Setting Up FM Systems

Until recent years, most children in the UK have been fitted with high quality linear hearing aids. The normal procedure for fitting FM systems has for many years been the “equal output” approach. This refers to the method which has been described by Wood et al., 1990, ASHA, 1994, Rowson and Bamford, 1995, McCracken and Laode-Kemp, 1997, and Dillon, 2001. This method of setting up or ‘balancing’ FM systems involves adjusting the FM receiver volume
control so that 75dB SPL input to the FM transmitter microphone gives an output equal to that obtained with 65dB SPL input to the hearing aid microphone. There are variations on this approach with respect to the levels chosen – e.g. Wood et al (1990) suggest using 65dB SPL and 80dB SPL and NAL (Dillon, 2001) suggest using 70dB SPL and 85dB SPL. The rationale is that the output has the same signal level and spectrum when the FM transmitter is used as when the hearing aid alone is used. This ‘goal’ means that a consistent level is delivered to the child’s ear whether the speech is from the teacher, his/her own voice or someone else in the classroom. This method is most suitable when the FM system and hearing aid are to be used in FM-only mode or when a system that gives automatic FM precedence is used. When systems are used which automatically mute the hearing aid microphone when the teacher is talking into the FM transmitter (by a 10–20 dB reduction), both the FM microphone and the hearing aid microphone can be set individually to an optimum level. The desired precedence for the FM microphone is achieved by muting the hearing aid microphones. (Examples are the Phonic Ear Solaris FM plus, Dynamic microphone muting on the Connevans fm Genie and the automatic reduction of microphone sensitivity on the Sennheiser Mikroport.) There are also systems available with manual muting of the hearing aid microphones. If the ‘equal output’ method is used when the system is operating in a combined mode, then in a noisy classroom the teacher’s voice coming through the FM system can be “lost” among the competing noise, as it is being delivered to the child’s ear at the same output level as the competing noise, if the noise levels reach 65dB SPL. Many children whose systems were set up with an “equal output” approach would in practice turn their radio receiver volume control up to try and hear the teacher better.

To make the use of an FM system more effective, and the teacher’s voice more audible above any competing noise, an advantage to the FM signal is desirable. This could be achieved by increasing FM output or by decreasing the output from the hearing aid microphones, or by a combination of both – older children may do both, according to their listening circumstances and their listening level preference. In devising a fitting procedure, there is a real difficulty in achieving a good compromise between the sensitivity of the two microphone paths in the combined mode. (Dillon, 2001)

The output from the FM path could be increased relative to the output from the hearing aid microphone, but this must be done bearing in mind that if the level is too high the teacher’s voice may sound too loud and will be higher than desired sensation levels even if it is still below the child’s loudness discomfort level. Also, trying to achieve too much FM advantage will cause some hearing aids to distort. The ASHA (2000) guidelines suggest that a 10dB FM advantage is a suitable goal, and describe a procedure to achieve this with linear hearing aids.

**MCHAS Project**

In 2000, the Modernisation of Children’s Hearing Aid Services project (www.mchas.man.ac.uk) began a series of feasibility studies in eleven pilot sites across England. There is a broad context to the modernisation targets being introduced, but one major goal is the routine fitting of advanced Digital Signal Processing (DSP) hearing aids to all children requiring amplification. One of the key tasks during the pilot studies was to explore the issues arising from management of the DSP hearing aids “in the field” by ToDs, as well as the setting up of FM systems, bearing in mind that the majority of hearing aids would now be advanced DSP aids fitted nonlinearly, i.e. using a strategy of Wide Dynamic Range Compression (WDRC).

A wide consultation process took place before and during the First Wave studies, and guidelines for testing the hearing aids and setting up FM systems were written. These were piloted during the feasibility studies and have now been incorporated into the training process for the “rollout” of modernisation across the UK. “Rollout” to Second wave (42 sites) was completed in March 2003, and “rollout” to the rest of England is currently underway (approximately 80 more sites). The aim is that all hospitals will be fitting DSP aids by 2005 (to newly diagnosed babies and children, and switching over existing hearing aid wearers from linear analogue hearing aids)

**FM Advantage Approach**

After the consultation exercise it was agreed to change the approach to fitting FM systems from the usual practice of “equal output” matching to a new procedure called FM advantage. Two new procedures were developed, one for linear and one for nonlinear hearing aids. The new procedure for linear hearing aids aims to give a 5dB FM advantage. A 10dB FM
advantage was not chosen as too many of the hearing aids tested were producing high distortion when this was attempted. The procedure for nonlinear hearing aids will be the focus of this paper. In deciding on the new procedures, it was recognised that ToDs were still going to be fitting the FM systems for the foreseeable future, so any fitting procedure had to be easily and generally applicable, rather than involving a lot of individualised adjustment of the system. It was also recognised during the First wave studies that more up to date test equipment having multicurve function and a pulsed or modulated speech shaped test stimulus available would make the testing of DSP hearing aids easier and also facilitate the setting up of FM systems. Funds were therefore made available through the project for new test boxes for Education services, as well as funding to Health Authorities for equipment costs for the audiology clinic, the DSP hearing aids and the training to select, fit, verify and evaluate them. Training on FM systems has also been included in the process, so that Health personnel (i.e. the hospital based audiologists) are familiar with the fitting of FM systems and with the issues faced by ToDs in managing the systems “in the field”. All the training is done jointly with Health and Education personnel attending together, as good communication between the two is absolutely fundamental to the successful management of the DSP hearing aids.

Wide Dynamic Range Compression (WDRC) Hearing Aids

The FM advantage procedure for any hearing aid which is nonlinear – i.e. which is fitted using a WDRC strategy, is based, fundamentally, on the “equal gain” approach described in the ASHA (2000) guidelines. The “10dB FM advantage approach” recommended in the ASHA (2000) guidelines was found to be unworkable with WDRC hearing aids, because as soon as the radio receiver volume was increased to try and obtain a 10dB advantage, the hearing aid processor would apply more compression and reduce the output level from the hearing aid. A higher Volume Control (VC) setting on the radio receiver, instead of increasing the FM advantage, only produced an increased level of background noise from the radio receiver. (Every 1dB increase in the VC can result in a 4dB increase in the background noise level if the aid has 4:1 compression, for example).

With non-linear (WDRC) DSP hearing aids the fitting rationale ensures that whatever the input level to the hearing aid microphone, the signal will be audible and comfortable (because it applies higher gain to quiet input signals, lower gain to loud input signals). When the teacher’s voice enters the FM transmitter microphone at the higher level, the hearing aid makes an automatic and immediate adjustment to ensure that it is comfortable (applies lower gain). The environmental sounds going in to the hearing aid microphone (classroom noise, child’s own voice, others near him) are also subjected to the lower gain, so the FM advantage is preserved. Once the teacher stops talking the gain increases again, automatically and immediately, and the appropriate amplification is applied to signals entering via the hearing aid microphone.

The systems with FM precedence should therefore not be set to give FM precedence when they are used with DSP aids. The larger gain reduction to the microphone which would result will be unnecessary and children may not like being so completely detached from their environment if their hearing aid microphone mutes too much. The DAI input connection for many DSP aids is not across the microphone (because many aids are multi-microphone) so FM precedence via hearing aid microphone muting will not be possible in these cases anyway.

The FM advantage procedures are described in detail in a booklet which was produced as one of the MCHAS guidelines (Evans, D., 2001). Developing the new procedures was motivated by the wish to ensure better FM Advantage in classrooms and by the wish to maximise the benefits of FM use by utilising the way the WDRC hearing aids work to obtain a beneficial signal to noise ratio.

The FM signal enters before any DSP, in parallel with the microphone input (see diagram on next page).

The loudest input in a real world situation will always be the FM input, bearing in mind that the teacher wears the transmitter close to the mouth. The input level used in the UK has traditionally been 75 dB SPL, to reflect the level going into the transmitter. Dillon (2001) believes this is an underestimate. For the FM advantage procedure, a revised figure of 80dB SPL input was chosen as the input to use in the final step of the procedure. This level should ensure that the transmitter AGC will be triggered (the UK FM systems we tested had an AGC kneepoint around or below 80dB SPL) It was also felt that the final curve obtained would more closely reflect the level that will occur in a classroom situation.
Practicalities Before Testing

There are several practicalities to remember before starting the test procedure:

Firstly, the ToD must understand the different programs on a particular hearing aid and check which hearing aid program is intended for FM use. There is no standardisation between manufacturers on this issue. With two of the DSP hearing aids available on the NHS, FM has to be enabled in the software before it will work at all. On some hearing aids, FM will come through automatically when the audio input shoe is connected, on the basic listening program, but it can also come through on other listening programs. On one of the aids it will come through automatically when the shoe is connected as FM+M on the T program and as FM only on program 2! It can become very confusing for ToDs who may be dealing with many different types of hearing aid so clear information is essential from the hospital audiologist fitting the hearing aids. The decision on how to program the FM options (where this is possible) should be made in conjunction with the parents, ToDs, audiologist and the child, so that individual needs and circumstances can be taken into account.

There are also several general assumptions made, which must apply if the FM advantage procedure is to be successfully employed. These are:

- The hearing aid(s) have been separately assessed as working normally.
- The hearing aid(s) are recognised as being correctly fitted for the user (thus they should have been fitted and verified according to MCHAS guidelines. This is important as the maximum output of the hearing aid and FM system are not checked as part of the FM fitting procedure, it is assumed that if this is correctly set for the hearing aid, then the output with the FM system will not exceed this).
- The FM Advantage setting up procedures are carried out with the hearing aid left at the normal user settings.
- A suitably quiet area is available for working in.
- The test box is set to display output.
- The test box has been re-levelled (if it does not use a control microphone).
- A lapel microphone is used for the procedure (or the test box must be re-levelled with the transmitter in the chamber).
- A pulsed or modulated speech shaped test stimulus is preferred – otherwise it is possible to use whatever is available and work by comparison, bearing in mind the possible effects of noise reduction, feedback manager, and other problems with the use of pure tone stimuli when testing complex multi channel hearing aids.
- The whole system (hearing aid and FM together) must be checked by listening to it, to ensure that the batteries, leads, shoes and aerial are all working properly and without intermittency.

FM Advantage Test Procedure

The FM advantage procedure can then be followed:

1. Connect the hearing aid to the test box 2cc coupler and obtain a Frequency Response Curve (FRC) with an input to the hearing aid microphone of 65dB SPL. (this is curve 1)
2. Connect the radio system to the hearing aid with the appropriate lead and Direct Audio Input (DAI) shoe. Place the hearing aid and coupler outside the test box. Ideally they should be in a foam-insulated chamber of some kind, especially if ambient noise is a problem, and there is no microphone muting option available. Placement on a soft surface will also avoid vibrations being picked up, which could affect the test results. Place the FM transmitter microphone inside the test box, on the target spot where the hearing aid microphone was placed. In smaller test chambers it is best to use a lapel microphone if possible: place this in the chamber, with the transmitter unit outside.

3. Switch on the FM transmitter and the FM receiver.

4. Keep the input level to the FM transmitter microphone in the test box at 65dB SPL and press start to obtain a FRC.

5. Rotate the VC or screw on the FM receiver until the FRC matches, as closely as possible, the one obtained in step 1 above. (this is curve 2) It is important to adjust the VC upwards, and match the curves at the lowest possible setting of the VC. Continuing to increase the VC does not result in more fm advantage, as the compressor in the hearing aid will react to a higher signal by turning the gain down. With some FM receivers it will be possible to adjust tone controls to obtain a closer match.

6. Change the input level to the FM transmitter microphone in the test box to 80dB SPL and press start to obtain a FRC. (this is curve 3) This curve should be above curves 1 & 2.

7. Print out the three FRCs for records.
Curve 3 should show a close match across frequencies in terms of the shape, but should be at a higher level (the amount this curve is above the others depends on the compression characteristics set in the hearing aid, so it cannot be specified or predicted by the ToD). The FM advantage actually pertaining at the child’s ear will be more than that observed from the three FRCs. This is because whilst the 80dB SPL input signal is only getting a small amount of gain, so are any simultaneous inputs at lower levels, but these cannot be recorded simultaneously. Hence the 80dB SPL curve is being compared with a curve showing the output from the hearing aid microphone obtained with a 65dB SPL input level, which would have had a higher gain applied.

The level of distortion for the overall system should be checked with a listening test.

Issues: DSP Hearing Aid Features

There have been a number of issues raised from the use of FM systems with DSP hearing aids which relate to features of the DSP hearing aids. Some of these will be discussed below.

Multi Channels

This feature, common to all the new NHS DSP hearing aids, gives rise to potential problems when testing for distortion. ToDs have traditionally included distortion measures in their electroacoustic test battery. However with DSP hearing aids with multiple channels, the measurement of distortion is problematic (unless the hearing aid can be reprogrammed to “test mode”, which most ToDs cannot do, as they do not carry around the equipment to reprogram the DSP hearing aids). If the 1st harmonic is in one frequency band or channel, and the second and third harmonics are in another band receiving less compression, the distortion ratio (which is how most portable test boxes measure distortion) may appear high. The distortion cannot be heard when the aid is listened to and disappears when the aid is set to linear mode. It is a testing artefact and does not represent a problem for the listener. What happens is that 2nd and 3rd harmonics above the crossover frequency will be subject to the same amount of compression as the frequencies that the listener wants to hear. They are likely to cause no more nor less confusion in this frequency region than they would in linear mode. The problem is the compression in the 1st harmonic causing the ratio between the higher harmonics and the first harmonic to increase, e.g. if in linear mode the 1st harmonic is at 100dB and the 2nd at 80 dB the distortion would be 10%. If the 1st harmonic is compressed to 90 dB and the 2nd is not compressed and stays at 80 dB the distortion value would go up but there would still be only 80 dB from the 2nd harmonic in the higher frequency band. (Rowson, 2001)

Feedback Cancellation, Noise Reduction

If these features are activated on the DSP hearing aids, and the ToD working “in the field” does not have NOAH, hearing aid software, hipro box, and programming leads to deactivate them, then there are likely to be problems if the only test signals available are either pure tones or broadband noise signals. These are steady state signals and may cause the hearing aid noise reduction to kick in and reduce the gain of the hearing aid, or the feedback cancellation may try to eliminate the pure tone stimulus. There may also be problems with “blooming” effects (Volanthen, 2000) when using pure tone stimuli. The most satisfactory solution to these problems is to use a test box with a pulsed or modulated speech shaped noise signal. The MCHAS project provides funding for Education Services to purchase new test boxes with appropriate test signals to facilitate the electroacoustic testing of DSP hearing aids and the setting up of FM systems by ToDs “in the field”.

Programs Used for FM

The lack of standardisation on the question of DAI function is a problem for ToDs. There are some DSP hearing aids which require the FM function to be activated in the software and others which have automatic detection of the DAI shoe without any software adjustments being necessary. The programs which can receive DAI vary between hearing aids. The NHS has tried to encourage manufacturers to provide FM+M as a default (with automatic detection of the DAI shoe) on the basic listening program by awarding more points for this as a “highly desirable” feature on paediatric hearing aids being considered for the NHS contract. However, the situation remains that with a variety of different options on the different hearing aids, good communication between Health and Education services is of paramount importance to
ensure that the best options are selected for each child's needs and circumstances.

Quality of Shoe Connection

A perennial problem (not specific to DSP hearing aids, but not improved by the choice of DSP over analogue) in the effective day to day management of FM systems is the poor quality of some of the DAI shoes and shoe connections. This can be particularly costly when there is a wireless receiver in use, as the whole receiver can be lost if the europlug socket becomes loose or if the DAI shoe detaches from the hearing aid too easily. Intermittency and poor FM reception are also likely when the DAI shoe connection is not robust and of a good quality design. The lack of standardisation on whether different shoes are required (one for conventional FM systems and one for wireless receivers) is also regrettable and makes day to day management for the ToD more costly and problematic than it need be.

Issues: Use of the Phonak MLx Wireless Radio Receiver

Adapting or Ordering Compatible Hearing Aid

There are DSP hearing aids available which need to be adapted to make them MLx compatible, or MLx compatibility needs to be requested when they are purchased.

MLx Function Switch

This may work as indicated (i.e. it may switch between FM only or FM+M) or it may give FM+M on both settings, with a lower output (typically of 5–6 dB) on the FM only setting. Another possibility is that the switch will reflect how FM use has been configured in the hearing aid software, i.e. if FM only has been selected in the software both switch positions will give FM only. Similarly, if FM+M has been selected in the software, then both switch settings will give FM + M function. Obviously, this has implications for helping the hearing impaired child to use the system effectively.

Transparency

It is usually expected that the connection of an FM system to a hearing aid should not alter the frequency response shape when compared with the hearing aid alone. (There may be some exceptions to this: e.g. where there is a very steeply sloping hearing aid response) Also, the output obtained when the FM system is connected should be able to be matched with that of the hearing aid alone (e.g. in an “equal gain” approach, the FRCs and output for FM + hearing aid are matched with the FRC for hearing aid alone at a 65dB SPL input level). This is called “transparency”.

When the MLx is tested following the FM advantage guidelines, there is often a lack of transparency with the hearing aid response when the FRC with 65dB SPL input to the FM system is run. As there is no way to adjust the relative strength of the FM signal, ToDs need to be prepared to evaluate the MLx carefully with each child to ensure that the child's performance with the MLx receiver is not significantly worse than it would be with a conventional radio receiver which could be appropriately adjusted and give more FM advantage. This issue should be resolved with the imminent release of a programmable MLx. The new wireless receiver from Oticon and Starkey (Lexis) will also have adjustment capability.

Below are some example FRCs obtained from the Danalogic ll 283D hearing aid. The three gain curves run at 50, 65 and 80 dB SPL inputs clearly show the nonlinear functioning of the hearing aid. The FM advantage procedures were followed to set up a conventional FM system and the resulting three curves are shown. When the MLx receiver was coupled with this hearing aid the curve obtained with a 65dB input through the FM system was about 7–8 dB lower than that obtained with the hearing aid alone. This does not mean that the MLx cannot be used: as the 80dB curve shows, the child can still get a useful signal through the system under realistic operating conditions. However, the FM advantage is less than can be achieved with the conventional system and this should be borne in mind when considering the use of the MLx with any particular child. The situation varies from aid to aid and even within the same type of aid, especially if very different frequency responses are programmed. It is worth checking that the child's responses with the MLx are adequate before issuing this system for use in the classroom. The Danalogic ll 283D has to have DAI enabled in the software, and if FM+M is selected (which would be most likely for a child user) then, as previously mentioned, the MLx receiver will
Figure 6. An example of poor transparency using the MLx receiver.

Test results from the Danalogic II 283D, from GN ReSound.
Gain curves at 50dB, 65dB and 80dB SPL input levels show that the aid is nonlinear.

The same hearing aid coupled to an fm Genie conventional FM system, using the FM advantage approach.
There is reasonable transparency between curves 1 & 2 and curve 3 is above these two.

The same hearing aid coupled to an MLx receiver.
Curve 2 is about 7–8dB below curve 1. The output for curve 3 is about 5dB less at most frequencies than with the fm Genie receiver.

only deliver FM+M regardless of how its function switch is set.

Phonak Handymic Size

A small issue, but one which may influence the accuracy of the test results when an FM system is set up, is the fact that some transmitters, such as the Handymic, are too big to fit into the test chamber of a portable test box properly and do not have a lapel microphone which could be used. Or, if they can physically be placed in the test chamber, the acoustic properties of it may change significantly, requiring the test chamber to be re-levelled. When this is done the first FRC (of the hearing aid response with 65dB input) will be lost, unless it has been printed off.

Discrepancies in the test results, of a similar but usually smaller nature can also be observed when a lapel microphone is used for testing. When the test box is initially levelled the 2cc coupler is placed in the test chamber alongside the measuring micro-
phone. When the FM transmitter lapel microphone is placed in the chamber the 2cc coupler with the hearing aid attached will be outside the test chamber. A mass of the same volume as a 2cc coupler (e.g. a discharged type C battery!) ideally should be placed in the test chamber with the transmitter lapel microphone.

Issues: Electromagnetic Interference

A number of DSP hearing aid users reported occasional loud noises when using their FM system during the First and Second waves of the MCHAS project. The occurrences were unpredictable, and the noise was mostly noticed when the transmitter was turned off.

The sound was a 'whooshing' noise, rather like a brief burst of white noise. We have identified the cause to be ElectroMagnetic Interference (EMI) generated by DSP hearing aids.

EMI Testing of DSP Aids

Tests were carried out in a Radio Frequency (RF) screened chamber. The hearing aid was placed in the test chamber with the direct input shoe and lead connected.

All the DSP hearing aids available on the UK NHS contract during both First and Second waves of the MCHAS project (2001–2003) and those currently on contract were selected for investigation, although only a few of them had been reported as presenting interference problems. The results showed that only three of the DSP hearing aids tested had no measurable electromagnetic interference problems (Pont, Bamford and Hostler, 2003). The study served to raise awareness of this problem with audiologists, ToDs and hearing aid manufacturers, and proposed several solutions for ToDs and users to try when dealing with this problem. These include:

- Keeping the FM transmitter on when the receiver is in use, and when sound is temporarily not needed, using a transmitter microphone mute facility.
- Switching off FM receiver when not needed

Prototype leads to reduce the EMI travelling down the DAI lead are also in development. The manufacturers of all the DSP hearing aids tested have been informed of the results, and there have been improvements by one major manufacturer in the levels of EMI on their hearing aids on the current NHS contract (Nov 1st 2003), although the interference has not been totally eliminated. None of the hearing aids on the current contract has such high levels of interference as those measured during the First and Second waves of the MCHAS project.

Summary and Conclusions

The FM advantage procedure for setting up FM systems appears to be working successfully for DSP hearing aids with WDRC. Empirical data are required to investigate more systematically the use of FM systems by hearing impaired children and the

![Diagram of the test rig (Pont, 2003).](image-url)
relative benefits of different procedures for setting up the FM systems.

Some significant issues have been identified in relation to the fitting of FM systems with complex DSP hearing aids. These range from day to day management difficulties for ToDs “in the field” because of poor DAI shoes or unnecessarily confusing differences in the way direct audio input facility can be configured in the software of the different hearing aids, to more technical problems such as electromagnetic interference from the processor clocks within the DSP hearing aids.

Future Developments

- Further studies on the measurement of electromagnetic interference, the distortion issue, and empirical field studies in sites using the FM advantage procedures are already underway.
- Improvements to the MCHAS guidelines to include more on the “real world” evaluation of FM systems are needed and the whole area of hearing aid evaluation is currently being explored.
- Evaluation of the new programmable Phonak MLx and the Oticon/ Starkey Lexis wireless receiver with all the new NHS DSP hearing aids is planned when these receivers become available in the UK.
- Efforts are being made to include FM systems within an NHS contract, so that more equitable provision can be achieved across the UK.

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References

Pont, Bamford, and Hostler 2003. DSP Hearing Aids, Personal FM Systems and Interference: Is there a problem?
Rowson, V. 2001. Notes on distortion in DSP WDRC Hearing Aids and FM Systems (Personal communication)
Appendix 1

DSP Hearing aids available through the NHS during the MCHAS project. (Some of these hearing aids are commercially available under different trade names.)

Nov 2000 (First wave MHAS-P studies):
Starkey Gemini AV13MM
Oticon Digifocus II
A&M Selectra
GN Res. Danalogic 163D
Widex P37
Philips Spaceline D71 S40

Nov 2002
4 x Phonak aids: Aero 211, 211 AZ, Supero 411 and 412

April 2003:
GN Res Danalogic 163D
Oticon Spirit
Phonak Aero 211,211AZ
A&M Select
“baby” aid: Starkey Gemini 312
Philips Spaceline D71 S40
GN Res Danalogic 283D
Oticon Spirit 700
Phonak Supero 412
Widex Senso P37
A&M Triano SP

Nov 2003
Starkey Strata 312
Oticon Spirit II Direct
Siemens Prisma 2M
Phonak Aero 211AZ
Oticon Spirit II Power
Phonak Aero 311AZ
GN ReSound Danalogic II 283D
Phonak Supero 413AZ
Siemens Prisma 2 DSP
Appendix 2 – FM systems in the UK

The UK FM frequencies are 173–175MHz
The following FM systems are the most commonly used in the UK:

- Connevans CRM 220 and Fm Genie
- Phonic Ear 475 and Solaris
- Sennheiser Mikroport 2013 PLL
- Phonak Microvox, Microlink and MLx

Participant Surveys

1st audience question –
to attendees from the USA

Who fits your FM systems?

- A – Teacher of the Deaf
- B – Audiologist
- C – Other professional

Total: 192

2nd audience question

Do you have more reported
occurrences of noise interference
from fm users using

- A – DSP hearing aids?
- B – Analogue hearing aids?
- C – Cochlear implants?
- D – They are all the same in relation to
reports of noise interference

Total: 141