BRITISH ACADEMY OF AUDIOLOGY

British Society of Audiology
Promoting excellence in hearing and balance

BAA/BSA Joint Guidance

# Setting and verifying the frequency response of a hearing aid remotely for adults during periods of restricted service delivery.

Written by BAA Service Quality Committee and BSA Adult Rehabilitation Interest Group

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# Contents

## SECTION 1: Introduction and Scope

Remote hearing aid fitting can offer convenient and flexible access to amplification for carefully chosen populations when access to face-to-face clinical care is contraindicated and should be considered better practice than no care or significantly delayed care. It is essential that any deviation from best practice is based on the specific needs of the individual, balancing any risks of attending for a face-to-face appointment with the risks of a deviation from best practice. To do this a discussion between service user and the clinician is essential to ensure that individual informed choice is at the centre of any decision by the patient to proceed with remote hearing aid fitting as opposed to waiting for face-to-face fitting within the clinic. It should be recognised that remote hearing aid fitting involves clinically challenging skills and approaches that may fall outside of the routine practice of Audiologists who may require additional support and training in some areas.

This guidance has been developed to be used in conjunction with other guidance including 'A Guide to Remote Working in Audiology Services During COVID-19 and Beyond', BAA SQC/ManCAD (2020) and the Guidance on the verification of hearing devices using probe microphone measures (BSA, 2018). Readers are advised to read both of these documents before proceeding to read this document, particularly the section on RECDs in the BSA guidance.

Audiometric information is key to accurate hearing aid fitting. Remote hearing assessment is still a developing area and although there are a number of potential methods for remote assessment reported in the literature, well summarized by Saunders (2020), remote assessment is considered to be outside the scope of this document.

**Remote fitting and particularly verification of a hearing aid in the absence of a patient/client is complex and influenced by a number of factors, with no 'one pathway fits all' solution. In acknowledgement of the various local factors impacting a remote fitting pathway, this document aims to facilitate the development of informed local guidance/practice rather than to give a more traditional step-by-step protocol. Inclusion of 'how to' guidance within this document is not an endorsement of these practices forming a routine part of service delivery models but instead is a recognition of the need for alternative approaches during extreme situations such as a pandemic, and to meet the needs of certain populations with specific needs i.e., accessible amplification without clinic visits e.g., end of life care.**

It is important to remember that the effective use of hearing aids is achieved by providing rehabilitation support to the patients and their significant other(s) through patient centred care. A common criticism of clinical guidance is that it can become too prescriptive and lacks focus on patients' preferences (Greenhalgh et al. 2014). Although the guidance has a practical focus on probe microphone measurements it must be acknowledged this is only a starting point for hearing device fittings and should always include collaboration with the patient and not preclude further adjustment based on patient feedback and clinical judgement. For further information on various aspects of hearing healthcare, readers are referred to the BSA guidance on Common Principles of Rehabilitation for Adults in Audiology Services (2016).

This document makes the assumption that a full assessment of need and development of an individual management plan has been completed prior to any decision to proceed with remote hearing aid fitting. Consideration of hearing aid programmes and features, including volume control, will remain part of clinician/patient discussions, as with any hearing aid fitting

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## 1.2 Disclaimers

This document has been jointly produced by BAA and BSA. The document has been developed at pace to meet the immediate needs of audiology services during the Covid-19 pandemic. As such the document has gone through an expedited development process and has not been subject to the usual processes of the BSA PGG.

Although care has been taken in preparing this document, with reviews by members of BSA Council and members for the Adult Rehabilitation Interest Group (ARIG) the BSA does not and cannot guarantee the interpretation and application of it. The BSA cannot be held responsible for any errors or omissions, and the BSA accepts no liability whatsoever for any loss or damage howsoever arising.

The BAA Service Quality Committee takes great care to produce the highest quality documents and guidance through consultation and reviewing evidence. Each document is written with consideration of research evidence, clinical practice documentation, expert opinion and clinical consensus from which clinicians and managers can make informed decisions, within the scope of the document. In addition, the documents can help inform allied health professionals, government agencies and the hearing health-care industry about current best practice. The BAA disclaims any liability to any party for the accuracy, completeness, or availability of the documents, or for any damages arising from the use of the documents and the information they contain.

## SECTION 2: The Influence of Different Clinical Scenarios on Remote Fitting Options

Whilst this document does not aim to identify which patients will be appropriate for remote fitting (for guidance on this see BAA SQC/ManCad 2020), it does recognise that there will be a number of different clinical scenarios where remote hearing aid fitting is a relevant and potentially necessary option. The document attempts to support clinicians in understanding the options available and the benefits/disadvantages of different practice. Such factors impacting practice and guidance include:

a. Availability of audiometric information, including transducer used
b. Availability of previous Real Ear Measurements
c. Verification equipment available
d. Type and features of device being fitted
e. Type of earpiece, venting and tubing
f. Any relevant/local-national COVID-19 restrictions

COVID-19 specific pressures such as 'tier restrictions', infection control policy, room restrictions and public health guidance will have a particularly strong influence on local remote fitting protocols, leaving them prone to change as the COVID-19 situation varies (I.e., summer into winter). This document hopes to support and inform local protocol adaptions and raise awareness of how differing methods and practice relate to accuracy.

**See Appendix A for a summary of all the fitting options discussed in this document.**

### 2.1. Audiometric information available

Where audiometric information is available, clinical consideration will need to be given to any reported changes since assessment before proceeding with the fitting of aids. With access to reliable audiometric information, a number of methods can be used to set up hearing aids remotely without the patient being present. Different methods will have different advantages, disadvantages and levels of accuracy:

- 'Click and fit' using manufacturer default settings (section 3.1.3)
- Importing previously verified hearing aid settings if appropriate (section 2.5.1)
- Coupler verification using average RECD (section 2.3)
- Coupler verification using measured RECD (section 2.4)

For remote hearing aid fitting and verification, the advantage of using RECD over in-situ REAR is that the RECD measurement can be made at the assessment, so the subsequent fitting can be done entirely remotely. It is understood that in-situ REAR provides the more familiar verification method in most instances, and therefore the pathways described in this document will require staff training/support and should be under constant review/audit.

### 2.2 Effect of venting

The use of RECDs is recommended for devices that occlude the ear where the acoustic pathways of amplified and unamplified sounds entering and leaving the ear are predictable. Where large vents (≥3mm, Dillon, 2012) or open dome fittings are used, the pathways of amplified and unamplified sounds entering and leaving the ear are unpredictable. The only way to accurately measure the acoustic effects of a vented or open dome fitting is with in-situ REMs (Dillon, 2012).

**Recommendation: If vent size equals or exceeds 3mm, treat as an open fitting (see section 2.2). If vent size is less than 3mm, treat as a closed fitting (section 3.2) but block the vent prior to measuring RECD - block from the inside so as not to introduce resonances in the vent during the ear measurement**

## Background information: The effect of venting

Vented or open hearing aid fittings have three sound transmission paths (Dillon, 2012, Chapter 5); the vent-transmitted region, the amplified region and the mixed region (combined path). The only way to accurately measure the acoustic effects of these paths in a large vent or open fitting is with in-situ REAR. However, when fitting in a coupler, the software will attempt to predict the sound path in and out of the vent/dome, but these effects may differ when the aid is worn in the ear, especially if ear canal characteristics are unusual. For example, a measured RECD performed on a large vented earmould/open fitting would take into account the sound escaping via the vent/open dome but not the sound entering, resulting in a very negative low frequency RECD and hence more low frequency gain prescribed (Dillon, 2012). In short, the more 'open' the fitting, the more inaccurate coupler verification will be (whether a measured or predicted RECD is used).

### 2.3 Coupler verification using average RECD

When verifying a hearing aid in a coupler, an RECD is *always* incorporated into the prescribed gain (Dillon, 2012a). This can either be a predicted RECD (based on age, coupler type, tube type and occlusion of fitting), or a personalized measured RECD. Whilst, there is no recent evidence to suggest that coupler verification (using an average RECD) leads to better outcomes compared to 'click and fit'. A coupler fitting may offer a more 'standardized' approach between different hearing aids, and allow for the clinician to visualize audibility of speech in relation to the target and dynamic range, however, the manufacturer software may use averages which are more appropriate to the acoustic properties of the specific hearing aid/thin tube/dome. Therefore, services should make a decision locally on which approach they want to take.

Smaller/larger and unusual ear canals will have RECDs which are further from the averages used, and therefore for these ears it may be more important to use on-ear verification and/or measured RECD wherever possible (Dillon 2012).

### 2.4 Coupler verification using a measured RECD

Whilst it is acknowledged that in-situ Real Ear Measurements (REMs) are the recommended approach to verifying hearing aids in adults (BSA, 2018), a well-measured RECD can provide an equally accurate measure of in-situ hearing aid gain/output of a 'closed' hearing aid fitting (Seewald et al., 1999).

In general, for the purpose of the document it is assumed that the measured RECD was taken as part of the same pathway (I.e., at assessment) and therefore relatively recently. When using historic stored RECD's caution should be taken to assess for significant changes in ear canal acoustics (e.g., post-surgery), and/or when a markedly different earpiece (mould) was used for the on-ear RECD measurement.

## Background information: RECD

A measured RECD has two functions

1. An RECD will capture the acoustic characteristics of an individual ear in relation to the coupler to more accurately predict the sound pressure level the hearing aid will produce in the ear and therefore enable a more personalized coupler-based fitting (Moodie, Seewald and Sinclair, 1994). The more unusual the patient's ear size and shape, the more important a personalized, measured RECD becomes (Dillon, 2012a).

2. A potentially lesser-known function of an RECD is its part in accurately transforming Hearing Threshold Levels (HTLs) recorded in dB HL, into dB SPL at the eardrum. When HTLs are recorded with an insert transducer (foam tip and/or occluded mould) and an RECD is performed using the same RECD coupling (foam tip/occluded mould) and the appropriate coupler (Scollie, 2016), the dB HL recorded can accurately be transformed into dB SPL.

**In-situ Audiometry:** In-situ audiometry can be used to measure hearing thresholds directly in dB SPL. This negates the need for threshold conversion (point 2 above) but does not replace the need for a measure of acoustic hearing aid performance on the ear (point 1 above). However, in-situ audiometry in its most common form i.e., measured by a hearing aid through the earpiece, is variable due to transducer calibration and ear piece type/fit (Kiessling et al., 2015), and bone conduction cannot be measured.

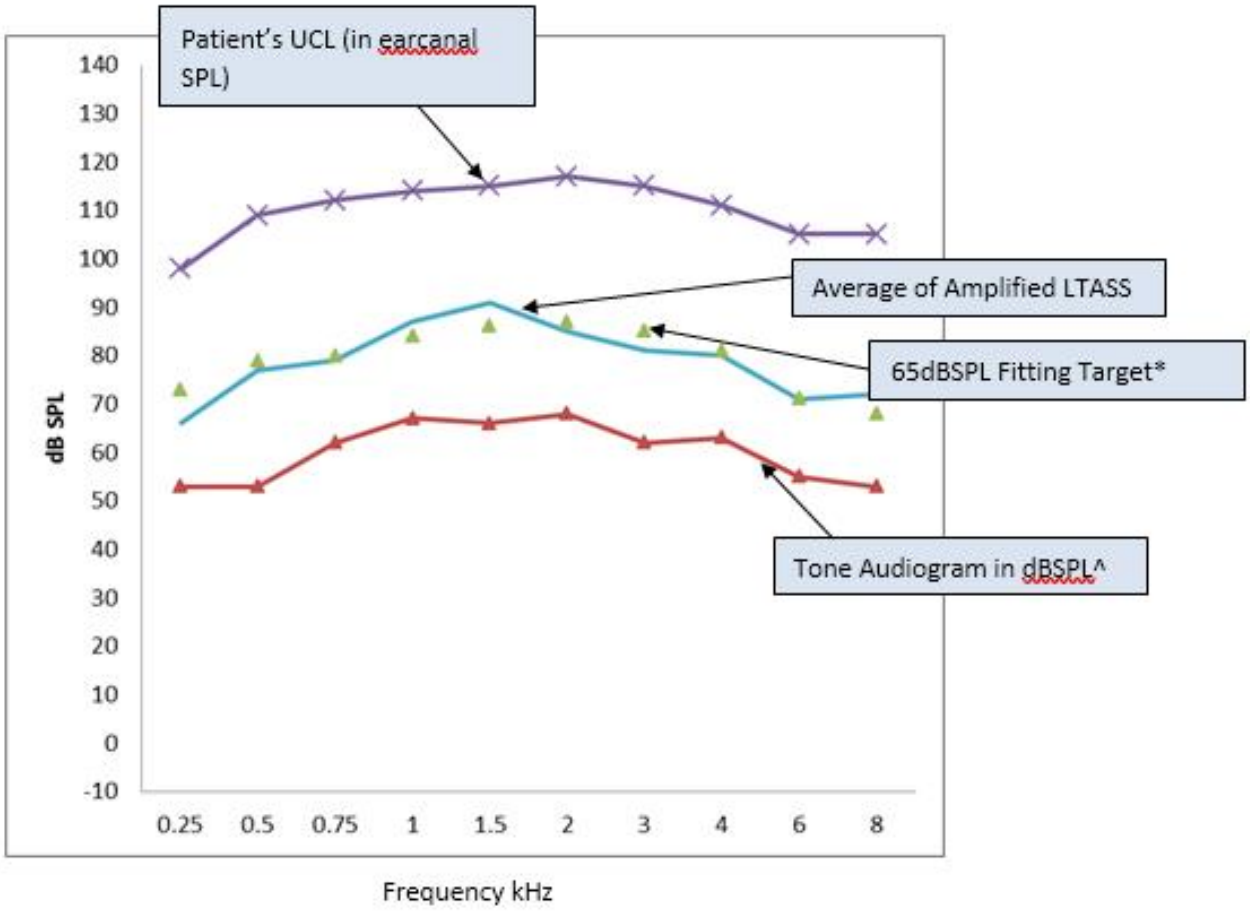
**Headphones versus inserts:** When headphones have been used to record HTLs; typically, an average real-ear-to-6cc transform (unless an individual's real-ear-to-dial difference is physically measured) will occur behind the scenes in the software to transform dB HL to dB SPL at the eardrum and plot the dB SPL tone audiogram (Baggato et al., 2005). This average approach to threshold conversion leads to minor errors for adults with standard shape and size ear canals, but these errors become larger as ear canal acoustics deviate away from standard. For this reason, if an RECD is intended to be used to verify the hearing aid fitting, insert earphones are recommended for the hearing assessment.

**See Figure 1 for a summary of how the RECD is incorporated into a hearing aid fitting.**

## Background information: RECD measurement accuracy

An accurate RECD measure is essential, as errors in the RECD are transferred to every measure made during hearing aid verification (Dillon, 2012a). It is acknowledged that adult audiology services in the UK may have limited experience measuring RECDs; a risk factor which could affect measurement quality. This needs careful consideration and risk assessment. Adequate theoretical and practical training should be undertaken before RECDs are attempted on patients (see Scollie, 2016). Harvey Dillon warns, '..*great care must be taken in the measurement and in the way the measurement is used. Otherwise, the measurement has the potential to create errors larger than the inter-person variations it seeks to allow for*' (Dillon, 2012, pg. 101). Manufacturers of both hearing aids and verification software can provide support, including training videos, on using their software, often through easy to access on-line platforms/academies. The availability and applicability of this information to remote fittings has increased in 2020 as a greater focus on adult RECD and remote verification has been necessitated. For further information and training on RECDs, including coupler type and venting please see Scollie (2016).

Figure 1: Summary of how an RECD is incorporated into the hearing aid fitting process.




* Tailored dBSPL prescription either using:

- Measured insert RECD taking into account acoustics of patient's ear + insert dBHL HTL's
- Age related average RECD + dBHL HTL's

^ Tone Audiogram in dB SPL transform calculated using one of the following formulas:

- Insert Audiogram in dBHL + Insert RETSPL + Measure RECD = Individualised dB SPL threshold (ear canal level)
- Insert Audiogram in dBHL + Insert RETSPL + Average RECD (if no RECD measured or insert vs mould/coupler mismatch) = Less tailored dBSPL threshold (ear canal level)
- Headphone Audiogram in dBHL + RETSPL + measured or average real-ear-to-6cc transform = Less tailored dBSPL threshold (ear canal level)

For further detail and explanation see Bagatto et al (2005), Clinical Protocols for Hearing Instrument Fitting in the Desired Sensation Level Method

## 2.5 Availability of previous Real Ear Measurement

### *2.5.1 Importing previously used settings.*

When a previous REM has been performed, the fine-tuning adjustments can often be imported to be used with the new hearing aids, particularly if the hearing aids are by the same manufacturer and the patient has been happy with their previous settings (e.g. assessed by patient reported outcomes measure) This will account for any previous verification and adjustments which have been undertaken. Where an 'import' is not available, coupler responses with the old/existing hearing aids measured at a variety of input signals (55,65 and 80dB for example), can be used as a starting point for the updated fitting. A volume control option would be important in this instance along with validation of the settings to ensure audibility and comfort.

If, however, the earpiece has changed significantly (e.g., from open to closed) or if the hearing thresholds have changed significantly, previous settings are not appropriate

### *2.5.2 What if previous hearing aid fitting using REMs/RECD was only done in one ear?*

Use of REM/RECD for the contralateral ear can be considered if available. Specific consideration will need to be given to appropriateness of use based on known or reported outer or middle ear abnormalities or surgery. The effect of different earpieces will also need to be considered.

If considered clinically appropriate the contralateral RECD can be applied and the hearing aid programmed as outlined in section 3.2.5.

### *2.5.3 Incorporating a measured REUR into the RECD*

The measured REUR should not be incorporated into the RECD as this can introduce further errors.

## Background information:

## Using measured REUR in hearing aid verification

Previously measured REUR can be used as the 'on-ear' component of an RECD by selecting the use of the 'measured' REUR. However, due to differences in how an on-ear RECD is measured when compared to an REUR (I.e., different stimulus level and type used to make the measurements) this particular application of the REUR is generally not recommended, as it may introduce more error than relying on averages.
Furthermore, as hearing thresholds are measured using transducers that occlude the ear and eliminate natural resonances (e.g., headphone or inserts), the REUR is not part of the threshold measure and so should not be incorporated back into the hearing aid fitting.

Please discuss this with your verification manufacturers for further information.

## 2.6 Type of hearing aid being fitted

### *2.6.1 Hearing aid with remote adjustment*

There are a number of devices currently available that enable user/clinician led remote adjustments following hearing aid fitting. These devices would seem to be the most appropriate choice for remote fitting, particularly where the follow up is likely to be delivered remotely.

### *26.2 Device without remote adjustment*

Extra consideration should be given when using devices without remote adjustment capability. Activating the volume control and/or fitting multiple programmes should be considered to enable the patients to choose preferred settings and configurations. It will be even more important to follow up the fitting through other methods (i.e. phone/video) and/or offer face-to-face review if required, as the hearing aid user will have less flexibility to adjust settings and obtain support remotely.

# SECTION 3: Fitting protocols

This section will refer to the terms 'open' and 'closed' fitting. It is recognised that clinicians may not be able to confirm whether a fitting is 'open' or 'closed' if they do not have access to the Real Ear Open Response (REOR).

## 3.1 Open/large vented fitting: Thin tube/wire and open dome/vented (3mm or more) or open earmoulds

### *3.1.1 This protocol is applicable to:*

New Direct Referral (DR) or reassessment adult patients where a recent audiogram is available and where the patient cannot attend for face-to-face fitting of thin tube/wire with open dome or vented/open earmould devices i.e., a fitting where the natural ear canal resonances are presumed to be retained.

### *3.1.2 Coupler fitting approach*

The use of RECDs is recommended for devices that occlude the ear where the acoustic pathways of amplified and unamplified sounds entering and leaving the ear are predictable. It is therefore recommended that coupler fitting is not carried out for open dome thin tube/wire devices or when the vent is 3mm or greater. See section 2.2 for full rationale.

### *3.1.3 Click fit/ Click and fit/ First fit/ pre-fit approach*

Click fit/ Click and fit/ first fit/pre-fit, fitting approaches all refer to the situation where the hearing aid is programmed using the hearing aid manufacturer software estimates of the gain required for a fitting based on an audiogram (AC only or AC and BC), age-appropriate, average RECDs, bilateral or unilateral amplification and predictions for the acoustical effects of coupling type, tube size, venting and earpiece type. For some prescription rules such as NAL-NL2 additional information about the patient such as gender, experience with amplification and language type (tonal or non-tonal) are also considered. These parameters must be entered correctly in order to optimize the default settings. The prescribed gain for 'click and fit' prescriptions will vary between

manufacturers, even for generic prescriptions such as NAL and DSL, as each manufacturer incorporates their own approach and averages during calculation.

Manufacturer, default 'click and fit' settings can be as much as 10 dB below target when measured in-situ, especially for soft, high-frequency input sounds (Munro et al., 2016; Amlani et al., 2017), although evidence with more recent hearing aid technology is lacking.

There are no individualized measurements with this approach apart from the audiogram. As a result, there is high likelihood of variability between manufacturers as each manufacturer incorporates their own set of averages/norms. Fine-tuning adjustments at this stage should be made with care. Remote fine tuning based on subjective feedback on sound quality/clarity/volume will enable adjustments in real-world listening situations (i.e., at home) which may benefit the patient more than fine-tuning in the clinic.

In summary, for open fittings, services need to make a decision locally on which approach they want to take but the recommendation given here is that Click fit/ Click and fit/ first fit/pre-fit fitting approaches are used for open dome thin tube/wire devices or when the vent is 3mm or greater for new Direct Referral (DR) adult patients where a recent audiogram is available and where the patient cannot attend for face-to-face fitting appointment.

#### *3.1.4 Acoustic Feedback*

Successful feedback management is a key factor in patient/client acceptance of amplification, however activating, or at least optimizing the acoustic feedback manager in the absence of the patient may be problematic. Marcrum et al., (2018) have shown that feedback reduction systems vary greatly across manufacturer with mean additional gain before feedback for 2000–4000Hz ranging from 5 to 16 dB and mean maximum stable gain for 2000–4000Hz ranging from 25 to 35 dB. In addition, they identified significant individual ear variation within manufacturer. Services are advised to use local knowledge or carry out in service audit to identify which devices provide optimum and stable gain, and to use this information to decide when the feature can be left disabled and when it should be activated (even if this done in a test box in the absence of the patient). Services may need to consider selection of an ear mould (rather than dome) and/or reducing high frequency gain to prevent/limit feedback. A volume control, App to control gain settings, or program option with reduced gain, may help patients/clients manage feedback while awaiting a time to see their audiologist. Hearing aids with remote access to the clinician and preferably remote feedback manager activation are preferable if the technology is available.

## 3.2 Closed fittings: Mould (vent ≤3mm) or thin tube/wire with closed dome

#### *3.2.1 RECD with closed fittings*

For adults with a closed fitting, an accurately measured RECD incorporated into coupler verification can be as accurate as in-situ REAR (Seewald et al., 1999; Munro and Hatton, 2000.). The accuracy of the RECD will depend on the RECD protocol used (i.e. transducer for HTL assessment, 'match' between ear measure and coupler measure) and other factors discussed below. The choice of RECD and local pathway maybe influenced by:

- Accessibility to equipment (i.e., transducer and coupler types)
- Staff skills and opportunity for training.
- Local policy including face-to-face restrictions/clinic time limits
- Subject to adaption as varying local pandemic/infection control policy influences practice.

### *3.2.2 RECD with an earmould versus RECD with an insert*

There are 2 types of coupler (HA1 or HA2) and 2 coupling types (insert or mould) to consider leading to 4 subtypes of RECD. Details surrounding the RECD subtypes, their merits and the transforms behind them are well described by Scollie, 2016. The 'gold standard' RECD described in ANSI S3.46-2013 and BS EN 61669:2016 uses the HA1 coupler.

When considering remote hearing aid fitting, the assessment appointment will often be undertaken without access to well-fitting earmoulds, particularly for new users. As a result, any hearing thresholds recorded will have been obtained from either headphones or preferably insert earphones, and the RECD measured using a foam-tip. This document will therefore assume that an insert and HA1 coupler is used for both the coupler and ear portion of the measured RECD in a remote fitting pathway. Section 3.2.5 and Figure 2 provides a step-by-step guide for measuring an RECD using an insert tip and HA1 coupler.

This measured RECD could then be applied to any type of closed fitting: ear mould, ITE, closed dome, as long as the patient's earpiece type and tube type/length are used during actual coupler verification i.e. hearing aid and earpiece attached with putty to a HA1 coupler.

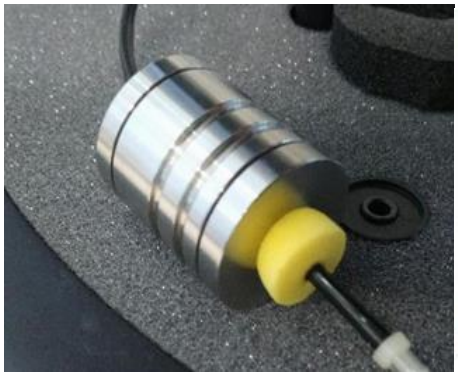
## Background information: Coupler and coupling types

Services in the UK maybe more familiar with the HA2 coupler (BSA, 2018) which is commonly used in paediatric audiology; with the occluded earmould being used for both the hearing assessment (via inserts) and on-ear RECD measurement. Research has shown that the longer ear mould tubing lengths associated with adult fittings can introduce RECD measurement error when utilising the HA2 coupler setup, with errors ranging between 5-8 dB dependant on frequency (Baggatto et al, 2005). As a consequence, for adult measured RECD's the use of a HA1 coupler set-up with insert is recommended in this document. Children/infant eamould tubing lengths are better represented by the standard tubing length of the HA2 coupler (plus ear mould simulator) and therefore are less susceptible to error. The correct use of HA2 and HA1 are therefore equally accurate in paediatrics, with the HA2 sometimes preferred due to the simplicity of the coupling and child/infant comfort during hearing assessment with custom moulds

### *3.2.4 Average RECD versus measured RECD*

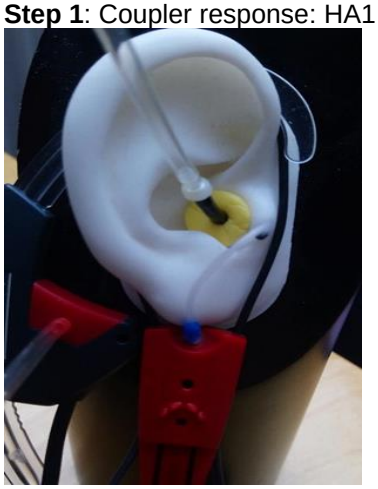
If RECD measurement is not possible/available, a coupler fitting using an average RECD or a click and fit could be used (with an understanding that for **both** approaches, the SPL prescribed may differ when the aid is worn in-situ, errors are dependent on the individual's ear canal size and shape relative to the average). When using an average RECD, a HA2 coupler can be used for simplicity for hearing aids with an earmould and HA1 for thin tube/wires and closed domes. Ensure the chosen coupler, vent size and acoustic characteristics are entered correctly into the verification software settings. Even for average RECDs, coupler verification allows audibility of speech to be visualized in relation to the target and dynamic range for counselling purposes.

## Figure 2: Step by step guide of how to measure an RECD with a closed fitting



HA1 with foam tip.

**Step 1**: Coupler response: HA1 with insert secured by putty/or specific adaptor



**Step 2**: Ear response: insert used.

**Step 3:** Coupler verification (lid would be closed during testing). Attaching the hearing aid in this way means the patient's tube length and thickness are considered in the verification process. Thin tube/wires can also be attached to the HA1 coupler (dome removed). An ITE could also be verified in the same way. Ensure the hearing aid position is correctly aligned, as per to manufactures guidance

### *3.2.5 Considerations when using a coupler to verify a closed fitting:*

Hearing aid and verification equipment manufacturers will have protocols available for you to reference with specific advice on their equipment. However, the points below compliment those documents and have a specific focus on thin tube coupler fittings:

1. Using a HA1 coupler, the dome or ear mould can be attached to the HA1 coupler using acoustic putty following local infection control practices. Take particular care to avoid acoustic leakage. Some manufacturers may offer an adaptor rather than putty option.
2. Follow BSA guidance (2018) including taking care to align the hearing aid in the correct position in relation to the speaker within the coupler box. Make sure the hearing aid doesn't move as you close the test box.
3. This guidance is primarily designed to support remote hearing aid fittings, and it is therefore likely that any mould/dome used in verification will be new and unworn by a patient. However, if you are considering verification using a HA1 coupler and acoustic putty on previously used earmoulds/domes then much stricter infection control would need to be initiated including replacement of the putty for each individual.
4. Guidance suggests using a small piece of acoustic putty on the tubing to help replicate the dampening effect of the tubing sitting against the hearing aid wearers head when in situ (Dillon 2012). See Figure 3 below.

Figure 3: Using putty to replicate the dampening effect of the tubing sitting against a hearing aid wearers head.

5. Ensure you update software settings to account for the coupler type to avoid additional errors.
6. Ensure relevant acoustic parameters are entered into both the verification and hearing aid fitting software (transducer used, coupler used, tubing, dome etc) otherwise the accuracy of the fitting will be affected.

7. Measure output against target at the different inputs following BSA, 2016. However, take care with the low frequency gain when verifying for thin tube/wire hearing aids. For low frequencies (1kHz and below) be cautious not to move too far from the click-fit starting point, even if the target is requesting much more low frequency gain. The clinician is advised to sense check the target against the hearing loss to spot a spurious element to the low frequency target. Manufacturers may also be able to advise on best practice regarding low frequency gain targets in their specific coupler.
8. Other alternative coupler types and coupling methods are available although the merits of these are outside the scope of this document. When considering these alternatives, it's important to understand how they work, and what they offer/do not offer before forming local protocol.
9. Run an OSPL-90 measure in the coupler to verify the MPO output of the hearing aid to help improve comfort to loud sounds.
10. The on-ear RECD component will usually be positive values when compared to the coupler values, expect a RECD of around 10 dB in the mid-frequencies. Check these common errors:
    a. If you measure negative high frequencies, check probe tube placement is not too shallow.
    b. If you measure negative low frequencies, check for leakage around the foam-tip/mould.
    c. The RECD software usually has visual indicators to help you check your 'on-ear' RECD measure is accurate. Speak to your manufacturer for supporting information and images.
11. Middle ear problems effect RECDs in the following ways:
    a. middle ear effusion will prevent sound entering the middle ear, resulting in a larger RECD. If middle effusion is persistent, you can use the measured RECD. If the effusion is transient, an average RECD may be more appropriate (or use the contralateral RECD if no effusion is present). A volume control with a large range is always recommended in this instance.
    b. A perforation will act as a vent and give a low frequency dip in the RECD. This not a concern as the effect of the perforation is unlikely to fluctuate. Take care if grommets are fitted as canal characteristics (and RECDs) will vary depending on the patency of the grommet.

## 3.3 Considerations for adult populations

Adults living with a Learning Disability, Dementia and/or Autism may find it difficult to self-report. Furthermore, use of a volume control may not be possible. Procedures should be put in place to minimize the risk of an inappropriate/uncomfortable fitting; RECDs should be a priority for this group, or if open fittings are provided, an in-situ REAR should be considered a priority.
The same is true for adults with atypical size and shaped ear canals e.g., post-surgery, stenosis, atresia. In these instances, ear canal characteristics will differ significantly from the average values used on coupler fittings or click and fit software fittings. For experienced users, previous REMs/settings can help guide the new fitting. Verification is just a start point, followed by fine-tuning based on patients' feedback (if available) and/or responses to speech and environmental sounds (for adults who can't self-report).

### Table 1: Summary of suggested verification approaches for patients with different needs.

| | **Patient considerations** | | |
|---|---|---|---|
| **Fitting type** | Pt **unable** to self-report and **cannot use a VC.** | Pt has **unusual** ear canal shape/size. | Pt is **able** to self-report and/or use a VC. **Typical** ear canal shape/size. |
| *Open dome or large vented EM* | Offer F2F in-situ REAR; particularly for new users with no previous REM. | Consider F2F in-situ REAR.<br>Provide a VC. | Use click and fit.<br>Provide a VC. |
| *Closed dome or closed EM* | Measure RECD; particularly for new users with no previous REM. | Measure RECD if possible; particularly for new users with no previous REM.<br>Provide a VC. | Use measured RECD if available or use average coupler.<br>Provide a VC. |

## SECTION 4: Conclusion

Remote hearing aid fitting can offer convenient and flexible access to amplification for carefully chosen populations when access to face-to-face clinical care is contraindicated and should be considered better practice than no care or significantly delayed care. Remote fitting and particularly verification of a hearing aid in the absence of a patient/client is complex and influenced by a number of factors, often with no 'one pathway fits all' solution. In acknowledgement of the various local factors impacting a remote fitting pathway, this document aims to facilitate the development of informed local guidance/practice rather than to give a more traditional step-by-step protocol. This guidance focuses on the practicalities of setting and verifying the frequency response of the hearing aid entirely remotely. In practice, services may wish to combine elements of remote care and face-to-face consultations in a manner which best suits each individual patient's needs, the equipment available, service set-up and staff skills/training opportunities (See Appendix A).

Whilst there is a focus on prescriptive measures in sections 2 and 3 for practical purposes it is acknowledged achieving beneficial outcomes for patients is heavily reliant on an approach to rehabilitation that goes beyond the sensory impairment, considers patients within their social context and addresses the most important needs of the individual. The principles of setting joint goals, making shared/informed decisions should be fully integrated with technological management as part of a patient-centred approach so that these elements do not form an additional, separate component to routine practice such as hearing aid assessment and fitting (Laplante-Levesque et al. 2010; Grenness et al. 2014).

### Summary of approaches

Hearing aids can be programmed within the clinic without the patient being present using a number of methods; 'Click and fit' or coupler fittings using average or measured RECD. Coupler fittings with measured RECD are the gold standard for verification of remote fittings with occluded earpieces. However, the benefit of coupler fittings (with measured or average RECDs) will diminish in fittings using open domes or large vented earmoulds. The only way to accurately measure the acoustic effects of a large vent or open fitting is with in-situ REMs i.e., an in-situ REAR. Therefore, when setting up open fittings remotely, 'click and fit' combined with careful validation is recommended. Factors affecting procedures and guidance are; audiometric information, transducer used to measure hearing, availability of previous Real Ear Measurements, type of device being fitted and type of earpiece, venting and tubing.

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## APPENDIX A: Flow chart of the entire fitting pathway