Official Title: Nucleus® Hybrid™ L24 Implant System New Enrollment Study

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PROTOCOL

Nucleus® Hybrid™ L24 Implant System
New Enrollment Study

P130016

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Version 8

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Study Sponsor

Cochlear Americas

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Lone Tree, CO 80124

Investigator Responsibilities

I, the undersigned, am responsible for the conduct of the study at the site below and by my signature below, I confirm that I have read, understand and will strictly adhere to the study protocol, “Nucleus® Hybrid™ L24 Implant System: New Enrollment Study.”

Clinical Investigational Site

Primary Investigator’s Name (print)

Title

Signature

Sponsor Representative

Title

Signature

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1 Clinical Investigational Synopsis

Title	Nucleus® Hybrid™ L24 Implant System: New Enrollment Study
Study Sites	Up to 25 North American centers.
Study Duration	Estimated at 5-7 years.
Study Time	3 years postactivation for each subject.
Study Population	Minimum of 50 newly implanted individuals aged 18 years or older at the time of implantation.
Design Overview	A prospective, multicenter, repeated-measures, single-arm, open-label clinical study.
Primary Objective	To evaluate the long-term safety and effectiveness of the Nucleus Hybrid L24 Implant in a group of adult implant recipients.
Study Intervals	Preoperative candidacy assessment/ Baseline evaluation. Surgery. Initial activation. 3 months postactivation. 6 months postactivation. 12 months postactivation. Annual evaluation thereafter through 3 years postactivation.
Primary Safety Endpoint	Report device- or procedure-related adverse events compared with those from the pivotal IDE with regard to type, frequency, and seriousness.
Primary Effectiveness Endpoint	Report of clinical performance using an open-set monosyllabic word recognition measure in quiet over the 3-year study period.
Secondary Effectiveness Endpoint	Report of clinical performance using an open-set sentence measure in noise over the 3-year study period.

2 Terms, Definitions, and Abbreviations

Term/Abbreviation	Definition
Acoustic Stimulation	Pre- or postoperative condition referring to the use of acoustic hearing alone, with or without amplification.
Acoustic Component (AC)	An optional component for the sound processor, used with the Hybrid L24 implant, which provides amplification in the low frequencies for those patients who have residual hearing sensitivity postoperatively.
AzBio Test[1]	A sentence-level speech recognition test, for this study, delivered in background noise at a predetermined signal-to-noise ratio.
Bilateral Acoustic Stimulation	Preoperative condition referring to the use of bilateral acoustic hearing, with or without amplification.
Bimodal Mode	Use of acoustic hearing, with or without amplification, in addition to electric hearing via a cochlear implant or Hybrid implant in the *contralateral (opposite)* ear.
BTE	Behind-The-Ear
CI	Cochlear Implant
CNC Word Recognition Test[2]	Consonant-Nucleus-Consonant Test: A monosyllabic word-level test given in quiet and calculated both as a words correct score.
Cochlear Implant Alone	Stimulation delivered by the Hybrid L24 implant alone.
Combined Mode	Use of acoustic hearing bilaterally, with or without amplification, in addition to electric hearing via a cochlear implant or Hybrid L24 implant.
CRF	Case Report Form
Device Use Questionnaire (DUQ)	"In-house" device usability metric, administered to determine subjective preference and satisfaction with regards to device use in various listening environments.
EDC	Electronic Data Capture
Everyday Listening Condition	Postoperative best bilateral listening condition, typically referring to either Combined Mode or Bimodal Mode.

[1] Spahr, A, Dorman, M., Litvak, L, Van Wie, S, Gifford, R *et al.* (2012). Development and validation of the AzBio sentence lists. Ear & Hearing 33(1): 112-117.

[2] Consonant-Nucleus-Consonant Test; Peterson, F.E. & Lehiste, I. (1962). Revised CNC word lists for auditory tests. Journal of Speech & Hearing Disorders, 27(1): 62-70.

Term/Abbreviation	Definition
HL	Hearing Loss/Hearing Level
HUI[3]	Health Utility Index
Hybrid Mode	Combination of acoustic and electric hearing in the *same* ear.
MAP	A program that defines the individualized fitting parameters of recipients for a specific coding strategy.
National Acoustic Laboratories (NAL)	Refers to a procedure for fitting hearing aids.
Nucleus Custom Sound	Clinical programming software for Nucleus Implant Systems.
Nucleus Sound Processor	BTE sound processor that is used to provide electric only or electric plus acoustic information when used in the Hybrid Mode.
Signal-to-Noise Ratio (SNR)	The level relationship (ratio) of the target (signal) to the noise (e.g., if the target speech is 65 dBA and the noise is 60 dBA then the SNR = +5 dB).
Speech, Spatial, and Qualities of Hearing Scale (SSQ)[4]	A validated metric used as a self-assessment of hearing in everyday life across three hearing domains: speech hearing, spatial hearing, and qualities of sound.

[3] Furlong W.J., Feeny D.H., Torrance G.W., Barr, R.D. (2001) The Health Utilities Index (HUI) system for assessing health-related quality of life in clinical studies. Ann Med., Jul;33(5), 375-384.

[4] Gatehouse, S. & Noble, W. (2004). The Speech, Spatial and Qualities of Hearing Scale (SSQ). International Journal of Audiology, 43(2), 85-99.

3 Background

3.1 Regulatory History

The Hybrid L24 Implant System (P130016) was the subject of a pivotal clinical trial (IDE G070191) from 2007-2012. The data on the 50 subjects enrolled in the study, in support of safety and effectiveness of the device, was submitted in June 2013 as part of PMA #130016. As part of the PMA approval, a Post-Approval Study to monitor the long-term (3 years) safety and effectiveness of the device in a cohort of newly implanted subjects was designed. A concurrent post-approval study was also initiated to continue 5-year follow up in the original pivotal clinical trial subjects (Nucleus Hybrid Extended Duration Post Approval Study).

3.2 Device Description

The Nucleus Hybrid L24 implant system consists of the follow core components:

- Nucleus Hybrid L24 Implant,
- Nucleus Sound Processor,
- Nucleus Custom Sound™ programming software.

3.2.1 Nucleus Hybrid L24 Cochlear Implant

The Nucleus Hybrid L24 Cochlear Implant that will be used in this study is the same as that used in the pivotal IDE study (#G070191). There have been no changes to this internal system component.

3.2.2 Nucleus 6 (CP910/920) Sound Processor

The Cochlear Nucleus 6 Sound Processor is a BTE processor (Figure 1), with a modular design that incorporates a main signal processing module (the “sound processor”) with built-in directional microphones, a battery module (2 zinc air or rechargeable), radio frequency (RF) coil and coil cable. This sound processor was developed to provide acoustic (optionally) and electrical stimulation to hearing-impaired candidates who have some low-frequency residual hearing. The Nucleus 6 Sound Processor is functionally the same as the previous generation Freedom Hybrid Sound Processor. It is one of the commercially available sound processors for recipients of all current Nucleus cochlear implants, including the Hybrid L24 implant.

Figure 1: Labeled components of the Nucleus 6 Sound Processor

3.2.3 Nucleus 7 (CP1000) Sound Processor

The Nucleus 7 Sound Processor is a behind-the-ear (BTE) sound processor that is functionally the same as the previous generation Nucleus 6 Sound Processor, and like that device, can also be programmed to allow acoustic stimulation. The Nucleus 7 Sound Processor hardware consists of a single-push-button control, a replaceable top microphone cover that contains a pair of permanently mounted covers, and an integrated coil and coil cable. There is no accessory port on the Nucleus 7 Sound Processor, but it is compatible with Cochlear's existing range of wireless accessories. The Nucleus 7 Sound Processor was approved by the FDA as part of P970051/S151 on June 13, 2017.

The Nucleus 7 Sound Processor is compatible with:

- A wireless programming adaptor for wireless programming sessions.
- Hybrid receivers in three receiver sizes.
- Cochlear's range of Wireless Accessories (Cochlear Phoneclip, Cochlear Mini Microphone, Mini Microphone 2 and 2+, and Cochlear TV Streamer).
    - These accessories are also compatible with the CP910 and CP920 Sound Processors and certain GN ReSound Hearing Aids, meaning that bimodal streaming is available.

In addition, the CP1000 Sound Processor can be linked to GN Resound hearing aids via the fitting software to enable bimodal pairing to Apple devices providing access to bimodal control and direct audio streaming.

Figure 2: Image of the Nucleus 7 Sound Processor in cochlear implant configuration

Due to the anticipated time needed to enroll and implant at least 50 subjects as well as the total required duration of this Post-Approval Study it is possible that new sound processor technology may be introduced during the course of this clinical study. If new technology is released, is proven to be functionally equivalent to the Nucleus 6 or Nucleus 7 Sound Processor and demonstrates performance at least as good as that from the Nucleus 6 and Nucleus 7 sound processors, subjects may be given the option to upgrade to the new technology as part of this investigation.

3.2.4 Acoustic Component

Acoustic stimulation is delivered via an acoustic module, called the Acoustic Component. The Acoustic Component (Figure 2) connects to the sound processor to deliver acoustic amplification in a similar way to that from a conventional hearing aid. The retention of the acoustic component to the ear can be either via a custom earmold or a non-custom dome. However, it is highly recommended that a custom earmold be made and fit for optimal low-

frequency amplification to be delivered via the acoustic component. Programming of the sound processor and acoustic component is achieved via Custom Sound™ software.

Figure 2: Nucleus 6 Sound Processor with Acoustic Component. Shown is the dome retention system. The Acoustic Component can also be used with a custom earmold.

3.2.5 Custom Sound Clinical Programming Software

Programming of the sound processor is achieved via Custom Sound™ software. Custom Sound permits the characterization of both electric and acoustic parameters required for Nucleus 6 Sound Processor programming. The general approach for the electric programming is the same as that for traditional cochlear implant recipients except that the software provides more flexible frequency boundary assignments for the 22 channels of the Nucleus Hybrid cochlear implant. The software provides the ability to specify the cut-off frequency at which acoustic stimulation ends and electrical stimulation begins. In addition, the software provides a user interface for the clinician to program amplification characteristics (gain and maximum output, frequency by frequency) for the subject's low-frequency range of hearing.

4 Indications for Use

The Nucleus Hybrid L24 Implant System is indicated for unilateral use in patients aged 18 years and older who have residual low-frequency hearing sensitivity and severe to profound high-frequency sensorineural hearing loss, and who obtain limited benefit from appropriately fit bilateral hearing aids.

- Typical preoperative hearing of candidates ranges from normal to moderate hearing loss in the low frequencies (thresholds no poorer than 60dB HL up to and including 500 Hz), with severe to profound mid- to high-frequency hearing loss (threshold average of 2000, 3000, and 4000 Hz ≥ 75dB HL), and moderately severe to profound

mid- to high-frequency hearing loss (threshold average of 2000, 3000, and 4000 Hz ≥ 60dB HL) in the contralateral ear.
- The CNC word recognition score will be between 10% and 60% inclusively, in the ear to be implanted in the preoperative aided condition and in the contralateral ear will be equal to or better than that of the ear to be implanted but not more than 80% correct.
- Prospective candidates should go through a suitable hearing aid trial, unless already appropriately fitted with hearing aids.

A Cochlear Nucleus Hybrid L24 cochlear implant is not indicated for individuals who have the following conditions:

1. Deafness due to lesions of the acoustic nerve or central auditory pathway.
2. Active middle-ear disease, with or without tympanic membrane perforation.
3. Absence of cochlear development.
4. A duration of severe to profound hearing loss of 30 years or greater.

5 Purpose of Study

The purpose of the Nucleus Hybrid L24 Implant System: New Enrollment Study is to gather supplementary long-term safety and effectiveness data in a newly implanted population. This real-world experience may allow the Sponsor to learn about sub-groups of patients, evaluate training programs, and further explore the type and frequency of adverse events beyond that which could be captured during the original clinical trial.

6 Study Objective and Hypothesis

The objective of the Nucleus Hybrid L24 Implant System: New Enrollment Study is to assess the safety and effectiveness of the Hybrid L24 System in a newly implanted population through 3 years postactivation.

The primary study hypotheses are 1) that the majority of subjects will show improved objective and subjective benefit with the Hybrid L24 Implant when compared with the preoperative aided condition and 2) the type and frequency of adverse events in the study population will be similar to that seen in the pivotal IDE study group.

7 Study Design

The Nucleus Hybrid L24 Implant System New Enrollment Study will be conducted as a repeated-measures single-subject experiment. A single-subject research design (in which each subject serves as his or her own control) is appropriate since it accommodates the heterogeneity that characterizes hearing-impaired populations. Blinding or masking procedures are not included in the design as it is not possible to conceal the presence or absence of an implant from the recipient and/or clinical investigators. To minimize order effects and test bias, word and sentence lists assigned to the various test conditions will be

randomized across conditions and the order in which test conditions are completed will also be randomized.

This protocol is slightly revised from the original protocol under the pivotal IDE. Some measurements and test conditions that will not provide novel information have been removed to maximize compliance with a 3-year protocol.

8 Study Population

Subjects will include a minimum of 50 newly implanted individuals, 18 years-of-age and older, who will be implanted with the Hybrid L24 cochlear implant from up to 25 investigational centers.

Data collected from two additional sources, including the Nucleus Hybrid Extended Duration post approval study and/or a retrospective review of standard of care clinical records will be included for a total population of up to 85 subjects for effectiveness analysis and 150 individuals for safety analysis.

9 Inclusion/Exclusion Criteria

The inclusion criteria are identical to the Indications for Use in labeling since the Hybrid L24 Implant is FDA approved and commercially available. See the Indications for Use section of this protocol for additional information.

Exclusion criteria include those from the Indications for Use in addition to the following:

- Unwilling and/or unable to comply with the investigational requirements.
- Not proficient in English.

10 Sample Size Calculation

Data collected in this study will include 50 newly implanted subjects. These data, combined with that from other sources, in total should provide efficacy information on up to 85 subjects and safety information on up to 150 subjects. The three sources of data include:

1) A minimum of 50 subjects from this New Enrollment post-approval study.
2) Thirty-five subjects from the Hybrid Extended Duration post-approval study.
3) Eighteen subjects from the pivotal IDE study who did not participate in the Hybrid Extended Duration study many of whom were followed for safety beyond the 1-year pivotal study until PMA review and approval.
4) A minimum of 65 subjects who were implanted outside of this New Enrollment post-approval study following device approval and commercial availability using standard of care techniques.

In addition to this study of 50 newly implanted Hybrid L24 subjects, there are up to 35 eligible subjects drawn from the original cohort of 53 subjects in the Hybrid L24 pivotal IDE study (including 3 subjects from the Continued Access supplement to the pivotal IDE study) to be followed longitudinally to a 5-year postactivation end point. To be more specific, of the 53 IDE subjects, 10 subjects were explanted and/or discontinued participation, 4 declined participation in the post approval study, and 4 were followed at implant centers who declined participation in the post approval study. However, these 18 subjects in total were followed for safety following completion of the 1-year postactivation evaluation up until approval of the Hybrid L24 in late 2012. At the time this protocol was originally written, at least 6 additional subjects had already met the 5-year postactivation interval but were seen for a one-time baseline evaluation.

For characterizing the incidence of adverse events over time, such as the occurrence of low-frequency hearing loss, a total of 150 subjects would provide a precision (defined as the half-width of a two-sided 95% confidence interval) of approximately 11.9% or smaller. This calculation is based on an exact binomial confidence interval. Additionally, speech performance can be well characterized with a cohort of 50 subjects as demonstrated by the original Hybrid L24 PMA data; the larger sample size here will provide more statistical precision. In particular, with this planned sample size for the combined cohorts, speech performance data on between 50 and 100 subjects will provide a precision of between 4.7% and 8.2% based on a standard deviation of approximately 29% as observed in the Hybrid L24 PMA data for the change in CNC and AzBio scores from preoperative to 3 years.

11 Primary and Secondary Endpoints

The primary safety and effectiveness endpoints for this post-approval study will occur at the 3-year postactivation interval upon completion of study follow-up requirements.

11.1 Primary Effectiveness Endpoint

The primary effectiveness endpoint for this study will include the within-subject differences, as measured using the Consonant-Nucleus-Consonant (CNC) test (Peterson and Lehiste, 1962) in two listening conditions:

- the implant ear alone and,
- when using both ears together through 3 years postactivation.

Scores on this speech test will be obtained at the study candidacy/baseline evaluation and postoperatively at 3 months, 6 months, and 12 months postactivation and annually, thereafter, until study completion 3 years from the initial activation of the device. This metric is consistent with those used in the *Post Approval Study – Extended Duration Monitoring of Subjects with the Cochlear Nucleus Hybrid L24 Cochlear Implant System*.

11.2 Secondary Effectiveness Endpoint

The secondary effectiveness endpoint for this study will include the within-subject differences for a sentence recognition test:

- Sentence recognition in noise will be measure in the best unilateral condition as evaluated with the AzBio test (Spahr et al., 2011)

At Baseline all subjects will be evaluated with the AzBio sentences at both a +5 dB and a +10 dB signal-to-noise ratio (SNR) in all conditions.

Postoperatively, subjects will be evaluated with the AzBio sentences in the implant ear at a +5 dB SNR. For subjects who have residual hearing this will be in the Hybrid condition and for those without residual hearing this will be in the electric only condition. If the subject scores ≤ 20% correct when tested in the implanted ear at +5dB SNR then the remaining conditions (electric only if the subjects has residual hearing and both ears together) will be tested using a +10 dB SNR. If the subject scores > 20% correct, then remaining conditions will continue to be tested using a +5 dB SNR.

In an attempt to standardize speech assessment methods across commercial implanting centers, the above metrics were chosen based on the Minimum Speech Test Battery (MSTB) published in 2011 as a joint effort of the cochlear implant industry and the audiologic/otologic professional community. These test materials are provided free of charge to any cochlear implanting center and include calibration and instructions for use.

11.3 Primary Safety Endpoint

For the purposes of this study, anticipated adverse events, serious adverse events, and unanticipated adverse device effects directly related to the use of the investigational product and/or the procedure to place the investigational device will be recorded.

An adverse event will be considered to be device-related or procedure-related when, in the judgment of the Primary Investigator, there is a logical connection between the use and/or placement of the device and the occurrence of the event. Adverse events associated with cochlear implantation in previous investigations include tinnitus, dizziness, swelling, facial nerve stimulation, and open- and/or short-circuit electrodes, among others.

Device-specific adverse events include loss of hearing sensitivity in the implanted ear (defined as a loss of hearing that results in a pure-tone average (PTA) of > 90 dB for frequencies 125-1000 Hz), total loss, and/or explantation.

A serious adverse event (SAE) is any untoward medical occurrence which:

- Results in death;
- Is life-threatening;
- Requires in-patient hospitalization for > 24 hours or prolongation of hospitalization which is not specifically required by the protocol;
- Results in permanent impairment of a body function or permanent damage to a body structure; or
- Requires medical or surgical intervention to preclude permanent impairment of a body function or permanent damage to a body structure.

For an event that meets the definition of a SAE, if the Primary Investigator judges that there is a logical connection between the use of the device and/or the procedure to place the device and the occurrence, the SAE will be recorded as device-related and/or procedure-related.

Device-related adverse event rates will be reported as the number and frequency of events with corresponding 95% exact binomial confidence limits, as well as the number of events per patient-time (e.g., events per 10 patient years). These values will be qualitatively compared to the same rates observed in the pivotal IDE study; no formal statistical comparisons will be conducted.

11.3.1 Secondary Safety Endpoint

Secondary safety endpoints will include the following:

- Cumulative Safety Assessment: Adverse events recorded per protocol with start dates prior to initial activation and each follow-up time interval will be tabulated.
- Procedure-Related Adverse Event Assessment: Procedure-related events occurring during the follow-up period will be tabulated.
- Device-Related Adverse Event Assessment: Device-related events occurring during the follow-up period will be tabulated.
- The above two classes of events (procedure and device related) will be summarized as rates. The numerator for each rate will be the number of subjects with at least one procedure- or device-related adverse event. The denominator will be the total number of subjects.
- Rates (overall and procedure and device related) will also be summarized by type.
- Time to first adverse event (including total losses of residual hearing) will be summarized using Kaplan Meier plots. Exploratory proportional hazards regression models will be used to determine whether demographics and baseline characteristics are associated with risk for adverse events over follow-up. Hazard ratios and 95% confidence intervals for these analyses will be cited.

12 Study Duration

Annual data collection will continue until each subject reaches his or her 3-year postactivation interval. As most cochlear implant patients routinely return for annual follow-up/programming visits, this is not anticipated to place a burden on sites or subjects. The target retention rate is at least 80% at 3 years. It is expected that participation will involve a 63- to 66-month commitment for each subject in order to allow for candidacy assessments, preoperative baseline evaluations, implantation of the device, and postoperative testing.

All efforts will be put forth to ensure near complete follow-up, with particular focus on the assessment of the primary outcome and occurrence of adverse events. Regular reminders of subject follow-up due dates will be provided to participating centers to facilitate scheduling of follow-up visits. In the event that a follow-up due date is missed the Sponsor will instruct the

participating center to make three attempts to contact the study subject and inform them of the need to be tested. The third and final attempt will be in writing and if no response is received then the subject may be considered lost to follow-up.

13 Overview of Study Procedures

Preoperatively, candidates will be assessed in the unaided and aided (i.e., with hearing aids) conditions to evaluate their appropriateness for entrance into the study and to establish baseline measures. Postoperatively, speech perception testing will be completed using the implanted ear alone (hybrid mode if the subject has residual hearing and electric only mode for all subjects), and both ears together (combined or bimodal mode). In addition, subjects will be asked to complete subjective questionnaires to measure overall health status, device use, and satisfaction. The degree of preservation of low-frequency hearing will be assessed as part of the safety data at each study interval.

Subjects will be assessed for study purposes preoperatively as well as at intervals corresponding to the initial activation of the device (typically 3 to 5 weeks postoperative), 3 months postactivation, 6 months postactivation, 12 months postactivation and annually thereafter until the 3-year postactivation interval has been reached. Each subject will be asked to remain in the study for 3 years or until the Sponsor formally closes the study. Non-study follow-up evaluations may also take place at the discretion of the study site as part of routine care (e.g., to address device programming needs).

This protocol is slightly revised from the original protocol under the pivotal IDE. Some measurements and test conditions that are considered to not provide novel information have been removed to increase compliance with a 5-year protocol.

14 Investigational Procedures

14.1 Subject Identification

To maintain confidentiality, the subject's name will not be recorded on any study document other than the Informed Consent Form. All individuals who provide informed consent (who sign the Informed Consent form), are considered to be consented into the study and will be assigned a unique identifier. A unique alphanumeric code will identify the subject throughout the course of the study. For example, US01-HNE-0000, where:

- US = United States
- 01 = a sequential number corresponding to the order in which a subject is enrolled into the study for a given study site
- HNE = an abbreviation for the study, in this case HNE for Hybrid New Enrollment
- 0000 = a unique, numeric study site identification

14.2 Release of Medical Information

All subjects must sign a release that authorizes access of medical records to the study Sponsor, investigators, monitors and the Food and Drug Administration (FDA), prior to proceeding with any screening evaluations.

14.3 Informed Consent

The risks and benefits of participating in this study shall be explained to the subject as outlined on the Informed Consent Form. After reviewing the Informed Consent Form the potential subject will be given the opportunity to ask questions about the Informed Consent Form and/or the study prior to signing. The subject will then be given a copy of the signed Informed Consent Form.

Note: The Informed Consent document must be reviewed and signed by the relevant parties prior to any study-related evaluation taking place. Testing completed as part of normal clinical practice, such as the audiogram, is acceptable. However, such testing must be completed per the requirements laid out in the Procedures Manual and/or Case Report Forms (e.g., threshold measurement at inter-octave frequencies).

14.4 Description of Test Measures

14.4.1 Audiometric Thresholds

Unaided audiometric thresholds will be obtained for each ear, with insert earphones, using the standard audiometric technique for pure-tone air-conduction testing (refer to Appendix A for required specifications and calibration requirements).

Aided audiometric thresholds will be obtained for each ear in the sound field using narrow band noise and the standard audiometric technique with the speakers positioned at 0° azimuth relative to the subject's head.

Testing, for both ears, will include the following:

- Air conduction thresholds: 125, 250, 500, 750, 1000, 1500, 2000, 3000, 4000, 6000, 8000Hz;
- Bone conduction thresholds: 250, 500, 750, 1000, 1500, 2000, 4000Hz

Note: Clinician will need to confirm the subject's response to any pure-tone stimulus presented at 125 and 250 Hz as auditory "heard" versus vibrotactile "felt" and record the response accordingly.

- Aided thresholds at 125[5], 250, 500, 750, 1000, 1500, 2000, 3000, 4000 Hz
- Tympanometry in each ear

[5] Testing at 125Hz is optional given that many sound field systems are not calibrated at this frequency.

Note: As these subjects may have measurable low-frequency hearing, it is important that appropriate consideration be made for masking or plugging the contralateral ear during unilateral testing in the sound field. See Appendix B for details on masking procedure.

14.4.2 Speech Perception Assessment

14.4.2.1 Speech Understanding in Quiet

The CNC Word Test (Peterson & Lehiste, 1962) is a validated test used clinically and in research to assess the performance of adults with hearing aids or cochlear implants on open-set word recognition ability. The test consists of 10 recorded lists of 50 monosyllabic words in CD format. For this study, two lists will be administered in quiet at a level equal to 60 dBA in the sound field and scored as a total number of words correct, which will be expressed as a percentage correct for this study. Subjects will be tested using a configuration of speech at 0° azimuth.

Preoperatively, the following test conditions will be assessed for CNC words in quiet:

1. Best unilateral for each ear.
2. Best bilateral.

The following test conditions will be assessed for CNC words in quiet postoperatively:

1. Implant Ear, best unilateral (Hybrid mode if hearing has been preserved or CI alone if not).
2. Best bilateral (Hybrid + Contralateral Acoustic, referred to as Combined mode or CI alone + Contralateral Acoustic, referred to as Bimodal mode).

14.4.2.2 Speech Understanding in Noise

The AzBio Sentence Test (Spahr et al, 2012) is a validated test used clinically and in research to assess the open-set sentence recognition in speech-spectrum noise of adults with hearing aids or cochlear implants. It consists of 15 lists of 20 sentences each. AzBio sentences are spoken by different talkers in a conversational style with limited contextual cues that the listener can use to predict or ‘fill in’ unintelligible words. The sentences will be presented at a fixed level of 65 dBA in speech-weighted noise at a fixed signal-to-noise ratio (+5 dB and/or +10dB). Each list includes 5 sentences from each of 4 different male and female talkers. The average level of intelligibility of each list is 85% +/- 1%. Each word in the sentence counts towards the overall score. Subjects will be tested using a configuration of speech and noise at 0° azimuth.

The following test conditions will be assessed for AzBio Sentences in noise:

1. Implant Ear, best unilateral listening mode (Hybrid Mode or Electric Only).
2. Implant Ear, Electric Only.
   (NOTE: If the best unilateral listening mode corresponds to <u>Electric Only</u> in condition 1 above, condition 2 will not be necessary).

3. Best Bilateral (Hybrid Mode + Contralateral Acoustic, referred to as Combined Mode or Electric Only + Contralateral Acoustic, referred to as Bimodal Mode).

At all postactivation intervals each subject's default MAP parameters, including rate of stimulation, number of maxima, and pulse width will be maintained for testing. The signal processing algorithms ASC +ADRO will be utilized with all other signal processing algorithms turned off.

14.4.3 Subjective Questionnaires

14.4.3.1 Speech, Spatial, and Qualities of Hearing Questionnaire (SSQ)

The SSQ (Gatehouse & Noble, 2004) will be used as a subjective self-assessment in three categories (speech hearing rating scale, spatial hearing rating scale, and sound qualities rating scale). The SSQ is considered a closed-ended self-report assessment of outcome.

14.4.3.2 Device Use Questionnaire (DUQ)

This questionnaire was developed by the Sponsor for use in the pivotal IDE and is used to collect information regarding device usability, subjective preferences, and satisfaction with regards to device use in various listening conditions. The original version has been modified in order to only ask questions not otherwise addressed in the SSQ.

14.4.3.3 The Health Utility Index Mark 3 (HUI3)

The HUI (Furlong, W., Feeny, D., Torrance, G.W., Barr, R.D., 2001) is a validated, 15-item population-based health utility instrument that postulates the domains of health as hearing, vision, speech, emotion, pain, ambulation, dexterity, cognition, and self-care.

14.4.3.4 The Hybrid Post-Market Cost of Ownership Survey

The Hybrid Post-Market Cost of Ownership Surveys will be used to collect self-reported short and long term costs of cochlear implantation. This questionnaire is a modified version of that developed in South Africa (Kerr G, 2012). The data may be used in Health Economic and Quality of Life modeling.

15 Preoperative Procedures (within 90 days prior to surgery)

15.1 Informed Consent

A preoperative interview will be conducted by the surgeon and/or audiologist to inform the candidate about all aspects of implantation with the Nucleus Hybrid L24 implant, study expectations, surgical procedure, and the postoperative evaluation schedule. The risks and benefits of surgery and implantation shall be explained to the subject as outlined on the Informed Consent Form. These include the risks associated with general anesthesia, as well as other risks such as loss of residual hearing, facial paralysis, dizziness, meningitis, postoperative discomfort, and skin flap complications. The potential limitations and advantages of implantation shall also be explained.

After reviewing the Informed Consent Form the candidate will be given the opportunity to ask questions about the Informed Consent Form and/or the study prior to signing the Informed Consent Form. The candidate will be offered the opportunity to take the form home to discuss with family members should they choose to do so. If they sign the Informed Consent Form, the candidate will then be given a copy of the signed Informed Consent Form to take home.

Note: The Informed Consent document must be reviewed and signed by the relevant parties prior to any study-related evaluation taking place. Testing completed as part of normal clinical practice, such as the audiogram, is acceptable. However, such testing must be completed per the requirements laid out in the Procedures Manual and/or Case Report Forms (e.g., threshold measurement at inter-octave frequencies).

15.2 Fitting and Use of Hearing Aids

To be considered for the study, subjects will be assessed using appropriately fitted behind-the-ear (BTE) or in-the-ear (ITE) hearing aids in each ear. There may be some individuals with very good low-frequency hearing, who prefer and perform comparably with no amplification in one or both ears. For the purposes of this study, subjects will use either their own hearing aids or be fitted with new/replacement aids for candidacy assessment. See Appendix C for additional details. The decision to replace hearing aids will be based on the clinical judgment of the audiologist. All speech perception criteria must be met ***in the aided condition***, even if amplification provides no additional subjective and/or objective benefit over natural acoustic hearing.

If the subject does not use hearing aids on a daily basis, does not own hearing aids, or uses hearing aids that are not appropriately fitted, loaner hearing aids are to be provided and fit. The subject will undergo a hearing aid trial of sufficient length and using hearing instruments with characteristics chosen based upon the clinician's best judgment prior to being further assessed for study candidacy. The specific procedures surrounding the hearing aid trial should be determined by the clinician based on their clinical judgment and consistent with standard clinical protocol. The study Procedures Manual will provide references for hearing aid fitting strategies and guidance on amplifying areas of useful residual hearing. Taking a conservative approach, useful hearing will be defined by hearing thresholds better than 90 dB HL for this study. At the end of the trial period, aided word recognition will be re-assessed to ensure that candidacy criteria are met.

15.3 Medical/Surgical History

The subject's relevant medical/surgical history is to be briefly reported and is required in order to determine that the subject is medically suitable for implantation. Information to be collected may include the subject's general medical history, medications, radiological information (i.e., x-rays), otologic history, and otologic surgical history. This information may be obtained from the subject directly and/or the subject's medical record.

15.4 Candidacy Assessment

The candidacy evaluation has two components:

1. Preoperative Candidacy Evaluation will be completed to determine if the subject meets the inclusion and exclusion criteria to qualify for enrollment in the study. The Informed Consent Form must be signed prior to any study related evaluation taking place.
2. The Preoperative Baseline Assessment will be completed to establish baseline measures after candidacy has been determined but prior to surgical implantation of the Hybrid L24 device. Information gathered during these preoperative procedures will be reported on the appropriate Case Record Forms (CRFs). There will be no predetermined time period required between candidacy and baseline assessment. However, candidacy must be re-assessed if more than 90 days have elapsed prior to the surgery date.

15.4.1 Preoperative Candidacy Evaluation

Candidacy evaluation will include verification of appropriate amplification per above under "Fitting and Use of Hearing Aids," unaided and aided audiometric thresholds, as well as unaided and aided speech discrimination assessment.

15.4.1.1 Audiometric Assessment

Unaided audiometric thresholds will be obtained for each ear, ***with insert earphones***, using the standard audiometric technique for pure-tone air-conduction testing. Aided audiometric thresholds will be obtained for each ear in the sound-field using narrow band noise and the standard audiometric technique with the speakers positioned at 0° azimuth relative to the subject's head. As these subjects have relatively good low-frequency hearing bilaterally, perhaps within normal limits at some frequencies, it is important that appropriate consideration be made for masking/plugging the contralateral ear during aided testing.

Testing, for both ears, will include the following:

- Air conduction thresholds at 125, 250, 500, 750, 1000, 1500, 2000, 3000, 4000, 6000, and 8000 Hz;
- Bone conduction thresholds at 250, 500, 750, 1000, 1500, 2000, and 4000 Hz;
- Aided thresholds at 125, 250, 500, 750, 1000, 1500, 2000, 3000, and 4000 Hz;
- Tympanometry in each ear.

15.4.1.2 Speech Perception Candidacy Testing

Two lists of the CNC word test will be administered at 60 dBA in the unilateral aided condition for each ear with the opposite, non-test ear plugged.

Candidates must demonstrate a lack of word understanding, defined by an aided CNC Word recognition score between 10% and 60%, inclusive (i.e., 10% ≤ score ≤ 60%) in the ear to be implanted and ≤ 80% in the contralateral ear.

In cases where low-frequency hearing is such that amplification may not be required, word recognition testing will be required to verify that amplification provides no significant benefit. To do so, the CNC word recognition test must be completed for each ear ***aided and unaided*** in the sound-field at the same presentation level, 60 dBA. ***The non-test ear will be plugged for all test conditions***.

15.4.1.3 Hearing History and Counseling

Information regarding subject hearing-history (etiology, onset of hearing loss, duration of severe to profound hearing loss, amplification use) will be obtained and reported on the appropriate Case Report Form. In addition, patients will be carefully and extensively counseled to ensure that their expectations from implantation are reasonable and appropriate (as determined by the Investigator).

15.4.1.4 Candidacy Determination

Once the candidacy evaluation is completed the Investigator is required to submit the candidacy CRFs for review by the Sponsor's study manager, or designee. The data will be reviewed, and candidacy assessed by the study manager or designee. Approval or disapproval will then be provided by the Sponsor to the Investigator.

15.5 Preoperative Baseline Evaluation

Baseline auditory function will be established using a battery of speech perception and self-assessment measures. These measures should only be completed in the event that the candidate subject has undergone the procedures above and meets the audiometric and word recognition requirements outlined above, under "*Candidacy Assessment."* Additionally, initiation of these measures should only occur upon completion of any hearing aid trial period the candidate requires. Any aided speech perception test conditions completed prior to the completion of the hearing aid trial will need to be repeated. Considerable baseline testing is required, and study sites may choose to complete the testing over more than one study visit to avoid subject fatigue effects.

For the study, subjects will be required to make use of the best-listening mode (i.e., unaided or aided for each ear). The best-listening mode, in this context, will be based on the mode in which the subjects score significantly better, based on binomial comparisons of the CNC word scores obtained aided and unaided for each ear, during the candidacy assessment. The Sponsor will provide these to the testing clinician as part of Investigator training. Resultant aided/unaided configurations for a given individual might be:

- aided bilaterally,
- aided unilaterally, or
- unaided bilaterally.

15.5.1 Baseline Aided Speech Perception Measures:

1. The CNC Word Test (two lists per condition, at 60 dBA) will be used to assess speech perception in quiet, in the best listening modes:

a. unilaterally[6] for each ear (plug/mask the opposite ear) and,
b. bilaterally.

2. The AzBio sentence lists (two lists at 65 dBA, one a +5 dB SNR and one at +10 dB SNR with both presented from the same speaker at 0° azimuth, in the best listening modes:

   a. unilaterally for the ear to be implanted (plug/mask the opposite ear) and,
   b. bilaterally.

15.5.2 Self-Assessment/Subjective Questionnaires

The following self-assessment/subjective questionnaires will also be completed as part of the Baseline assessment:

- SSQ.
- DUQ.
- HUI3.
- Hybrid Post Market Cost of Ownership Survey.

16 Surgical Procedure

The surgical procedure for the Nucleus Hybrid L24 implant is described in the Surgeon's Guide provide with each implant (part 427182 ISS5 MAR14).

17 Postoperative Procedures

17.1 Summary of Postoperative Procedures

Following surgical implantation of the device and a healing period, typically 3-5 weeks, the implant will be activated. Shortly thereafter (usually 2-4 weeks after activation) a follow-up visit may take place to "fine-tune" sound processor programming. No formal study testing will be required at the programming follow-up.

A combination of audiometric testing, speech perception assessment, subjective questionnaire assessment, and psychophysical and electrical impedances measures will be completed at the intervals below. For details on the procedures to be followed at each specific interval, please see Section 20: Summary of Data Collection Visits.

- Initial activation.
- 3 months postactivation.

[6] Typically, CNC word testing will be completed unilaterally at the Candidacy Evaluation and repeated during Baseline testing only if a hearing aid trial is required.

- 6 months postactivation.
- 12 months postactivation.
- Annually thereafter, until the 5-year postactivation interval.
- Pre re-implantation, if applicable.

17.2 Detailed Postoperative Procedures

17.2.1 Initial Activation

17.2.1.1 Audiometric Testing

Test frequencies will include the following:

- Air conduction thresholds at 125, 250, 500, 750, 1000, 1500, 2000, 3000, 4000, 6000, and 8000 Hz;
- Bone conduction thresholds at 250, 500, 750, 1000, 1500, 2000, and 4000 Hz;
- Implant soundfield thresholds at 125, 250, 500, 750, 1000, 1500, 2000, 3000, and 4000 Hz.

Test conditions will include:

- Unaided audiometric thresholds for each ear, ***with insert earphones***, using the standard audiometric technique for pure-tone air-conduction testing.
- Audiometric thresholds will be obtained in the sound-field using the standard audiometric technique with the speakers positioned at 0° azimuth relative to the subject's head in the following condition:
    - Hybrid Mode (Implant + Acoustic, ipsilateral) if the subject demonstrates preserved low-frequency hearing,
    - Electric Only, if the subject demonstrates a profound loss of low-frequency hearing.

- Tympanometry in each ear.

If any significant change in unaided thresholds is noted then the amplification fitting(s) should be re-evaluated and adjustments made, if necessary, using the same procedures outlined in the Preoperative Evaluation. A significant change for this purpose only is defined as a shift of more than 10 dB (for the better or worse) at two or more aidable frequencies.

17.2.1.2 Sound Processor Fitting

The subject will be fitted with the Nucleus 6 Sound Processor.[7] This commercially approved processor is functionally equivalent to the Nucleus Freedom Hybrid sound processor used in

[7] The Nucleus 6 Sound Processor is the commercially approved sound processor at the time of study initiation. Given the long duration of this study it is possible that a new processor that is at least functionally equivalent to the Nucleus 6 may be introduced during the course of the study in which case subjects will be fit with the most current commercially approved processor available.

the pivotal IDE in that it permits acoustic stimulation to be provided via an auxiliary acoustic module, called the Acoustic Component (AC). The AC connects to the sound processor via a speaker unit attached to the earhook of the sound processor, thereby delivering acoustic amplification in a similar way to a conventional Receiver-in-the-ear (RITE) hearing aid.

Threshold (T) and comfort (C) values will be measured for the electrical stimulation on at least 5 channels per the streamlined fitting method. Impedance telemetry results using common ground (CG) and monopolar (MP1, MP2 and MP1+2) stimulation modes will also be recorded. This information will be used to program the sound processor and also to monitor the device.

The basic programming approach will be to assign frequency channels to the Hybrid electrode array that supplement the acoustic sensitivity. In other words, the frequency assignment of the electrical stimulation will begin at the frequency where acoustic hearing is no longer useful. For this purpose, hearing thresholds poorer than 85 dB HL will be considered not useful from an amplification perspective and not aidable acoustically. For example, if the subject's hearing in the implanted ear is more than 85 dB HL for frequencies at and above 1000 Hz (i.e., useful acoustic hearing up to 750 Hz), the lower frequency boundary for electric stimulation will be set as close as possible to 750 Hz (i.e., the last aidable frequency). That is, electrical stimulation would be provided in this case for inputs from around 750 to 8000 Hz and acoustic for frequencies at and below 750 Hz. However, the chosen boundary between acoustic and electric hearing in addition to the amount of overlap between the two signals may be adjusted by the programming audiologist based on current research as well as patient performance and preference.

17.2.1.3 Acoustic Component (AC) Fitting

The acoustic component will be appropriately fit using the National Acoustics Laboratories' hearing aid fitting strategy (as used preoperatively for the acoustic hearing aids) to assess the degree to which real-ear targets are met for each subject. Fitting methodology with the AC is unchanged from that of conventional acoustic hearing aids.

17.2.1.4 Fitting a Contralateral Hearing Aid

A hearing aid will be supplied by GN Resound for subjects implanted in the study for use in the contralateral ear if they choose to accept it. This hearing aid or any other hearing aid being used by a study subject in the contralateral ear should be optimized and the fit verified prior to any postactivation testing in the best bilateral condition.

17.2.2 Programming Follow-up

It is not unusual for T- and C-levels to change during the initial postactivation period. This optional follow-up evaluation will allow the subjects' T- and C-levels to be checked as well as any programming adjustments to be made based on the subjects' initial experience with the device. No clinical data will be required at this or any other interval outside of those defined by the study evaluation schedule. However, it will be required that an Adverse Event (AE) Form be completed should any event meeting the definition of a device-related AE occur.

17.2.3 Postactivation Evaluations

17.2.3.1 External Equipment Check

Prior to any speech perception testing, an assessment of the external hardware, including the Sound Processor and Acoustic Component, will be made. If any clinically significant change in unaided thresholds is noted, then the amplification fitting(s) will be re-evaluated and adjustments made if necessary.

17.2.3.2 Hearing Aid Verification

A hearing aid check will be completed by the clinician to verify that the contralateral hearing aid and the Acoustic Component for the Nucleus Sound Processor in the implanted ear, if used, are functioning appropriately prior to conducting aided testing.

If any significant change in unaided thresholds is noted, then the amplification fitting(s) should be re-evaluated and adjustments made if necessary. As noted above, significant change for this purpose only is defined as a shift of more than 10 dB (for the better or worse) at two or more aidable (i.e., those frequencies where threshold are < 90dB HL) frequencies. See Appendix C for additional information on fitting the contralateral hearing aid.

17.2.3.3 Audiometric Testing

Unaided audiometric thresholds will be obtained for each ear, with insert earphones, using the standard audiometric technique for pure-tone air-conduction testing.

- Air conduction thresholds at 125, 250, 500, 750, 1000, 1500, 2000, 3000, 4000, 6000, and 8000 Hz;
- Bone conduction thresholds at 250, 500, 750, 1000, 1500, 2000, and 4000 Hz.

Assessing aided thresholds after the initial activation will only be conducted if there is a change in unaided hearing. A significant change is defined as a shift of more than 10 dB (for the better or worse) at two or more aidable (i.e., < 90 dB HL) frequencies.

Aided audiometric thresholds, if required, will be obtained using narrow band noise, in sound-field employing the standard audiometric technique with the speakers positioned at 0° azimuth relative to the subject's head. With these subjects having relatively good low-frequency hearing bilaterally, perhaps within normal limits at some frequencies, it is important that appropriate consideration be made for masking/plugging the contralateral, non-test, ear during aided testing. Testing, for each ear, will include the following:

- Aided thresholds at 125, 250, 500, 750, 1000, 1500, 2000, 3000, and 4000 Hz.

17.2.3.4 Self-Assessment/Subjective Questionnaires

The following self-assessment/subjective questionnaires will also be completed as part of the postactivation intervals. For the specific schedule please refer to Section 18 of this document.

- SSQ
- DUQ

- HUI3
- Hybrid Post Market Cost of Ownership Survey

17.2.3.5 Speech Perception Testing

The CNC Word Test in quiet at 60 dBA will be administered in the following listening conditions:

1. Implant Ear, best unilateral listening mode (Hybrid Mode or Electric Only, if ipsilateral low-frequency hearing is not maintained).
2. Best bilateral listening (Hybrid Mode + Contralateral Acoustic, referred to as Combined Mode or Electric Only + Contralateral Acoustic, referred to as Bimodal Mode, if ipsilateral low-frequency hearing is not maintained).

The AzBio sentence test will be administered in noise, target presented at 65 dBA (+5 dB SNR and/or +10 dB SNR) for the following listening conditions:

1. Implant Ear, best unilateral listening mode (Hybrid Mode or Electric Only, if low-frequency hearing is not maintained).
2. Implant Ear, Electric Only.
   (Note: If the best unilateral listening mode corresponds to Electric Only in condition 1 above, condition 2 will not be necessary).
3. Best bilateral listening (Hybrid Mode + Contralateral Acoustic, referred to as Combined Mode or Electric Only + Contralateral Acoustic, referred to as Bimodal Mode, if low-frequency hearing is not maintained).[8]

Note 1: Testing in the first implant ear condition (Hybrid Mode or Electric Only) will be completed at a +5 dB SNR. If the resulting score is ≤ 20% correct, then the remaining conditions will be tested using a +10 dB SNR. If the resulting score is > 20% correct, then the SNR for subsequent conditions will remain at +5 dB.

Note 2: For the Implant Ear, Hybrid and/or Electric Only modes (i.e., conditions 1 and 2, above) the contralateral ear will need to be occluded for speech perception testing.

17.2.3.6 Psychophysical and Electrical Impedance Measurements

The following routine psychophysical and electrical impedance measurements will be obtained at the 3-month, 6-month, 12-month, and annual postactivation intervals up to 3 years postactivation:

- Electrical thresholds measured in Current Level on at least 5 channels.

[8] The intent of speech perception testing is to evaluate performance when the subject is using the implant (study) ear as well as when using the implant ear plus the contralateral ear. Testing with both ears will be completed as such regardless of what technology (i.e., implant, hearing aid, or no technology) is used in the contralateral ear. Given the possibility of residual acoustic hearing in the ipsilateral and/or contralateral ears it is possible that amplification may not be needed for Hybrid stimulation and is therefore not required.

- Electrical maximum comfort levels measured in Current Level on at least 5 channels.
- Impedance telemetry results using common ground (CG) and monopolar (MP1, MP2, and MP1+2) stimulation modes.

18 Summary of Data Collection Visits

	Candidacy /Baseline Evaluation	Initial Activation (IA)	3 mo Post IA	6 mo Post IA	12 mo Post IA	2 year Post IA	3 year Post IA
Informed Consent	X						
Otologic & Medical History	X	X	X	X	X	X	X
HA Check/ AC Verification	X	X	X	X	X	X	X
Unaided Hearing Thresholds	X	X	X	X	X	X	X
Tympanometry	X	X	X	X	X	X	X
Aided Audiometric Thresholds	X	X	X*	X*	X*	X*	X*
Processor Hardware Check		X	X	X	X	X	X
CNC test (implant ear and both ears)	X		X	X	X	X	X
AzBio +5dB and/or +10dB SNR Implant Ear Hybrid Mode, Implant Ear Electric Only & Best Bilateral)	X		X	X	X	X	X
DUQ	X			X	X		

	Candidacy /Baseline Evaluation	Initial Activation (IA)	3 mo Post IA	6 mo Post IA	12 mo Post IA	2 year Post IA	3 year Post IA
SSQ	X			X	X	X	X
HUI	X			X	X		
Hybrid Post-Market Cost of Ownership Survey	X			X	X		

**Note: Aided audiometric thresholds will be required at each annual interval so long as unaided hearing has been preserved at the time of testing.*

19 Re-Implantation with a Long Electrode

19.1 Evaluation PRIOR to Re-implantation with a Long Electrode

Some individuals have elected to have the Nucleus Hybrid L24 cochlear implant removed and replaced with a standard, long electrode array cochlear implant. This has typically been in cases where individuals have experienced a profound or complete loss of residual hearing and achieve less than expected speech perception outcomes (6 of the 50 subjects implanted as of November 8, 2013 under this IDE).

In order to ensure that accurate information is gathered for any subject electing to undergo explantation and re-implantation with a long array, additional data will be collected prior to re-implantation. This evaluation will include the following information and will follow the procedures described in the annual evaluation schedule:

- Audiometric testing,
- Speech perception testing,
- Psychophysical and electrical impedance measurements,
- Otologic/medical questionnaire.

If explantation occurs, in addition to being considered an anticipated serious adverse event, an MDR will be filed per 21 CFR Part 803.

19.2 Evaluation FOLLOWING Re-implantation with a Long Electrode

Subjects who elect to be implanted with a standard cochlear implant in the test ear in place of the Nucleus Hybrid L24 cochlear implant will be required to complete the study protocol as outline above. That is, they will be asked to follow the same postoperative schedule and

procedures up to what would have been their 5-year postactivation interval with the Hybrid device.

20 Adverse Events

An Adverse Event (AE) is the development of an untoward medical occurrence or the deterioration of a pre-existing medical condition following or during exposure to an investigational product, whether or not considered causally related to the product or the surgical procedure to implant it. An untoward medical condition can be symptoms (e.g., nausea), signs (e.g., tachycardia, fever) or clinically significant abnormal results of an investigation (e.g., laboratory findings, chest x-ray).

Adverse events that occur during this study may be associated with the implant procedure, including those from general anesthesia, or specifically associated with the use of the device. An adverse event will be considered to be device-related when, in the judgment of the Primary Investigator, there is a logical connection between the use of the device and the occurrence of the event, above and beyond the study procedure itself. Adverse events associated with cochlear implantation in previous investigations include tinnitus, dizziness, swelling, facial nerve stimulation, and open and/or short circuit electrodes, among others.

A **Serious Adverse Event (SAE)** is any untoward medical occurrence which:

- Results in death;
- Is life-threatening;
- Requires in-patient hospitalization for > 24 hours or prolongation of hospitalization which is not specifically required by the protocol;
- Results in permanent impairment of a body function or permanent damage to a body structure; or
- Requires medical or surgical intervention to preclude permanent impairment of a body function or permanent damage to a body structure.

If the Primary Investigator judges that there is a logical connection (caused or contributed to) between the use of the device and the occurrence, the event will be evaluated for reporting requirements under 21 CFR 803 and filed as an MDR, if applicable.

An **Unanticipated Adverse Device Effect** (UADE) is “any serious adverse effect on health or safety or any life-threatening problem or death caused by, or associated with, a device, if that effect, problem, or death was not previously identified in nature, severity, or degree of incidence in the investigational plan or application (including a supplementary plan or application), or any other unanticipated serious problem associated with a device that relates to the rights, safety, or welfare of subjects” [FDA 21 CFR 812.3(s)]. The Sponsor will promptly conduct an investigation upon notification by an Investigator of a UADE and will notify the FDA and all reviewing IRBs and participating Investigators within 10 working days after the sponsor first receives notice of the effect. Thereafter, the Sponsor will submit such additional report concerning the effect as requested by the FDA.

20.1 Assessment and Reporting of Adverse Events

Adverse event reporting will be consistent with complaint reporting for similar approved technologies under 21 CFR 820.198 as the Hybrid L24 is an approved device. The Sponsor expects an increase in the percent of AEs reported per the installed base given the required reporting under this protocol.

For this study, anticipated adverse events, serious adverse events, and unanticipated adverse device effects directly related to the use of the investigational product and/or the procedure to place the investigational device will be recorded. In this context

As for loss of hearing sensitivity at the implanted ear, these data will be trended in a similar fashion to the pivotal protocol (G070191) but will not be considered an adverse event unless the loss reaches a profound level (pure-tone average of greater than 90 dB HL for frequencies 125-1000 Hz), total loss, and/or explantation. Should an explantation occur, the Sponsor will treat this as a serious injury with reporting occurring under the Medical Device Reporting regulations (21 CFR Part 803) in addition to inclusion in the annual update report on the Post-Approval Study.

20.1.1 Investigator's Responsibilities

Throughout the course of the study, all efforts will be made by the Investigators to remain alert to possible AEs. The first concern will be the safety and welfare of the subject and for providing appropriate medical intervention, as indicated. Detailed information regarding adverse device effects (ADEs) will be recorded by the Investigator at the time an adverse device effect occurs using an *Adverse Event Questionnair*e, provided as part of the Case Report Forms (CRFs) for the study. Adverse device effects will be recorded from the day of enrollment (Day 0) to termination of study or when the subject exits the study, whichever is last, even if the event was acknowledged as a risk factor in the *Informed Consent Form*.

Adverse device effects will be recorded on an *Adverse Event Questionnaire* and will include the following information:

- Date of onset.
- Date reported to the investigational site.
- Description of the event.
- Seriousness.
- Investigator's assessment of the relationship of the AE to the device and/or procedure.
- Treatment.
- Outcome.

20.1.2 Unanticipated Adverse Device Effects

Unanticipated adverse device effects (UADEs) must be reported directly to the clinical center's reviewing IRB and the Sponsor, Cochlear Americas, within 10 working days of knowledge of the event, or as dictated by the specific IRB policy, whichever is sooner. Information regarding the UADE will be recorded on the *Unanticipated Adverse Device Effect Report,* provided with the CRFs for the study.

20.1.3 Adverse Event Follow-up

All ADEs must be followed until resolution, or until the condition stabilizes. The Primary Investigator is responsible to ensure that follow-up includes any supplemental investigations as may be indicated to elucidate as completely as possible the nature and/or causality of the ADE. This may include additional laboratory tests or investigations, or consultation with other health care professionals. Cochlear or its designee may request that the Investigator perform or arrange for the conduct of supplemental measurements and/or evaluations. AE follow up information will be recorded using a *Follow Up to a Previously Reported Adverse Event Questionnaire,* provided with the CRFs for the study.

20.1.4 Sponsor's Responsibilities

All ADEs will be reported annually to FDA in accordance with the IDE regulation [FDA 21 CFR Part 812.150(b)(5)]. All unanticipated adverse device effects (UADEs) will be reported to FDA within 10 calendar days of the event in accordance with FDA 21 CFR Part 812.46(b) and 812.150(b)(1) as well as 21 CFR 803.

Cochlear Americas or its designee will notify all participating Investigators of any new information that alters the current risk-benefit assessment of the study device or that would be sufficient to consider changes in management of the Nucleus Hybrid L24 cochlear implant or in the overall conduct of the trial.

21 Protocol Deviations

A protocol deviation refers to a study-related activity that is not in compliance with the investigational protocol. Deviations that are required to protect the life or well-being of a subject do not require prior approval from the Sponsor and should be implemented immediately. In these cases, the deviation must be reported to the IRB and Sponsor within 5 (five) days of the event.

If a subject is unable to return for follow-up before the closure of a study visit window (+/- 90 days for postactivation study visits), or if protocol-defined assessments or parts thereof are omitted or completed incorrectly, the event is to be noted on the Protocol Deviation Log provided to the Investigator in the study Regulatory Binder. Depending on the type or severity of the deviation the Investigator may be required to notify the IRB and/or Sponsor if the deviation impacts safety or performance of the subject or data integrity.

22 Study Completion

22.1 Completed Subjects

Each subject in the study will be considered completed when all assessments up to and including the 3-year postactivation interval have been performed in accordance with the study protocol. To be considered a primary endpoint success, subjects must retain their originally implanted device.

22.2 Discontinued Subjects

Any subject may voluntarily discontinue the study at any time without prejudice. The Investigator may discontinue a subject from the study at any time if (s)he considers that remaining in the study compromises the subject's health or the subject is not sufficiently cooperative. In either event, reason(s) for discontinuation should be recorded on a study withdrawal form, provided as part of the CRFs for the study.

Possible reasons for study discontinuation include the following:

- AE necessitating discontinuation from the study.
- The subject is lost to follow-up.
- Voluntary decision to withdraw consent made by the subject.[9]
- Investigator decision.[10]
- Other reason.

In case of a subject lost-to-follow-up, the Investigator must attempt to contact the subject (or relative/family contact) by phone, email or letter at least three times. If attempts are unsuccessful, the 'subject withdrawal' form is to be completed in the study file and reported, as appropriate, in required reports to the Sponsor, IRB, and FDA.

22.3 Premature Study Termination

The Sponsor reserves the right to discontinue the study for any safety, ethical, or administrative reason at any time. Subjects already implanted with the device being studied will continue to be supported, independent of any decision made about study continuation.

22.4 Annual Target Follow-Up Rates

All efforts have been put forth to ensure near complete follow-up, with particular focus on the assessment of the primary outcome and occurrence of adverse events. Regular reminders of

[9] Withdrawal of consent is defined as the subject's voluntary decision to revoke consent to continue participation in the study.

[10] Subject withdrawal from the study is defined as an Investigator decision. The Investigator may elect to withdraw a subject from the study at any time if he/she considers that remaining in the study compromises the patient's health or if the Investigator considers the subject lost to follow-up.

subject follow-up due dates have been provided to participating centers to facilitate scheduling of follow-up visits. The 3-year target retention rate for this study is at least 80%.

23 Data Analyses

Statistical Analysis for this study is addressed in detail in the document entitled “Statistical Analysis Plan for Nucleus® Hybrid™ L24 Implant System New Enrollment Study Post Approval Study.”

23.1 Analysis of Safety

- Adverse events and serious adverse events will be expressed as events per patient-time.
- All adverse event rates will be reported as the number and frequency of events with corresponding 95% exact binomial confidence limits and the number of events per patient-time (e.g., events per 10 patient years), and compared to the adverse events from G07019 (Hybrid L24 pivotal study).
- Time to first adverse event (including total losses of residual hearing) will be summarized using Kaplan Meier plots. Exploratory proportional hazards regression models will be used to determine whether baseline factors are associated with risk for adverse events over follow-up. Hazard ratios and 95% confidence intervals for these analyses will be cited.

Safety analyses will include data from three cohorts for a target minimum of 150 subjects. These data will be gathered from this newly implanted subject population, the Nucleus Hybrid extended duration post-approval study population, and a retrospective review of standard of care clinical data.

23.2 Analysis of Effectiveness

The significance of the mean differences in speech recognition scores between preoperative and the postactivation interval will be analyzed using maximum likelihood based on repeated measures linear regression models. In particular, repeated measures mixed models with subject as a random effect will be used that accounts for the within-subject correlation, allowing for comparisons between candidacy/baseline and follow-up endpoints. The analyses will incorporate the 8 time intervals: baseline, 3 months post initial activation (IA), 6 months post IA, 12 months post IA, and annually up to 3years post IA. Follow up time intervals will be treated as categorical, thus no test score trajectory pattern will need to be captured by the models. If there is significant evidence that the assumption of normality does not hold (i.e., $p < 0.05$ from a Shapiro-Wilk test of normality), then ranked data will be used in the repeated measures models.

Analysis of effectiveness will include up to 3 years of outcomes data on a minimum of 50 newly implanted subjects, depending on attrition, in addition to 35 subjects who participated

in a parallel study, the Nucleus Hybrid Extended Duration post-approval study, which is now completed.

23.3 Additional Analysis

The primary analyses for each of the effectiveness endpoints will be based on the unilateral listening condition. As an additional exploratory analysis, the analysis for each effectiveness endpoint will also be analyzed under the other tested conditions (i.e., best bilateral – combined or bimodal).

23.4 Annual Review of Subject Characteristics

Both safety and effectiveness data will be reviewed on an annual basis to compare the characteristics of subjects who remain enrolled in the study versus those who were lost to follow up. Baseline covariates to be explored and compared with study outcomes, specifically hearing loss and effectiveness measures, include:

- age at implantation,
- gender,
- duration of hearing loss,
- duration of severe to profound hearing loss (if applicable),
- preoperative speech perception score,
- preoperative low-frequency pure-tone average,
- postoperative speech perception score (CNC and AzBio Sentences) at the last evaluation,
- type and frequency of adverse events,
- distance from the implant center.

24 Risk Benefit Statement

The Hybrid L24 Implant System represents a new treatment option for a patient population that has few current therapeutic alternatives for high-frequency sensorineural hearing loss. High-frequency sound, crucial for speech discrimination, is provided electrically by the Hybrid L24 Implant while residual low-frequency hearing is amplified by the acoustic component. The two modes of stimulation are processed and provided simultaneously by the externally worn Nucleus Sound Processor.

Subjects with high-frequency hearing loss who participated in the pivotal Hybrid L24 clinical study (G070191) were able to combine both low-frequency (acoustic) and high-frequency (electric) information, from one or both ears, provided by the Hybrid L24 Implant System. Results indicated significant speech perception improvements in quiet and in noise when compared to preoperative performance. At the primary study endpoint (6 months postactivation), 100% of subjects showed equal or greater speech perception performance when listening with both ears (Hybrid + hearing aid in the opposite ear); greater than or equal to 90% of subjects showed equal to or greater speech perception performance when listening in the Hybrid Mode (electric and acoustic in the same ear). More recently, with the

conclusion of the Hybrid extended duration study these outcomes appear to have remained stable for the 35 pivotal study subjects followed through 3 and 5 years postactivation.

As documented in the pivotal IDE study results, a percentage of individuals will lose their preoperative low-frequency acoustic hearing subsequent to implantation of the Hybrid L24 Implant. This known risk is disclosed in the Hybrid L24 implant system labeling and is strongly recommended as an integral component of preoperative surgical and device counseling. Irrespective of the postoperative hearing status, most individuals can still be expected to receive substantial functional and speech recognition benefit on a daily basis when compared to their preoperative listening configuration of two hearing aids. The pivotal IDE study results also demonstrated the absence of unreasonable risk of illness or injury associated with the use of the device for its intended uses and conditions of use.

For those subjects consenting to participate in this post-approval study the probable benefits to health from use of the Hybrid device for its intended uses and conditions of use, when accompanied by adequate directions and warnings against unsafe use, outweigh any probable risks.

To characterize the clinical significance of residual low-frequency loss and assess the benefit-risk profile of the Hybrid L24 implant, an analysis of subjects' effectiveness endpoint will be performed based on splitting subjects by their degree of low-frequency hearing loss. This will follow the analysis of the Hybrid L24 PMA data with subjects experiencing moderate, moderately-severe, or severe low-frequency hearing loss (Group 1) and subjects experiencing profound or total low-frequency hearing loss (Group 2) described separately for their long-term speech performance.

25 Good Clinical Practices Statement

This trial will be conducted in compliance with all applicable U.S. Federal Regulations and Good Clinical Practice (GCP) standards. This trial will be conducted in compliance with the protocol as approved by the FDA and each Investigative Site's Institutional Review Board (IRB). Any deviations from the protocol will be reported to the Sponsor and in accordance with the IRB's institutional guidelines.

26 Access to Study Documents and Study Monitoring

The Sponsor will designate appropriately trained monitors to review the progress of this supplemental study and assure the quality and integrity of data accumulated. Clinical monitors, as representatives of the Sponsor, have the obligation to provide site qualification and initiation visits as well as regular site visits. All data generated and the source documents from which they originated are open to inspection by the Sponsor or its representative, the FDA, and other regulatory agencies.

27 Quality Control and Assurance

Sponsor employees and/or their contracted representatives utilize Standard Operating Procedures (SOP) designed to ensure that clinical study procedures and documentation are consistently conducted/prepared to the highest quality standards. Safety data adjudication will be conducted by the Sponsor's Chief Medical Officer, in accordance with these SOPs. These SOPs require compliance with federal regulations and Good Clinical Practice guidance.

28 Institutional Review Board

Prior to the initiation of the study, the Protocol, the Informed Consent Form, and other supporting documentation must be submitted to the Institutional Review Board (IRB) for approval after FDA conditional or final approval. A copy of the IRB approval letter for the Protocol, the Informed Consent, and the Investigator Agreement must be submitted to the Sponsor prior to the consent of the first subject. The study site must maintain an accurate and complete record of all reports, documents, and other submissions made to the IRB concerning this protocol.

A list of the IRB members, their titles or occupations, and their institutional affiliation, or an IRB assurance number and their contact information must be provided to the Sponsor or its designee prior to release of study supplies. Additionally, the Chair of the IRB must be identified.

FDA/relevant health authority regulations require that all advertisements for subject recruitment be approved by an IRB prior to implementation. The complete text and format must be submitted to the Sponsor or its designee for approval prior to IRB submission.

29 Informed Consent Process

It is the responsibility of the Investigator to inform each subject prior to the initial study evaluation, of the purpose of this clinical trial, including possible risks and benefits, and document the informed consent process in the subject's chart.

A sample informed consent form containing the required elements of informed consent is provided by the Sponsor to the IRB once FDA approved. Any changes made to this sample by the Investigator and/or institution must be approved by the Sponsor, or its designee, prior to final submission to the IRB. After approval by the Sponsor, the final informed consent must be approved by the IRB. Prior to entry into the study or initiation of any study-related procedures, each subject must read, sign, and date the informed consent form. The person executing the consent must also sign and date the consent form. One original informed consent form is to be retained by the study site and a copy is to be given to the subject.

30 Confidentiality

In accordance with Good Clinical Practices (GCPs) and with the Health Insurance Portability and Accountability Act of 1996 (HIPAA) all information concerning the subjects in the study must be treated as strictly confidential by all persons involved in the study.

The Investigator acknowledges that any and all information acquired from the Sponsor or its designee or developed or acquired in connection with the study are strictly confidential. The Investigator will not disclose any confidential information to any third party nor use confidential information for any purpose without first obtaining the consent of Sponsor in writing. Such consent shall be deemed to have been given for disclosure to any person for whom the Investigator is responsible at his/her center, but only so far as required for the purposes of the study, and, in the case of disclosures to staff, only if such staff are bound by obligations of confidentiality no less strict than those set out herein.

31 Protocol Amendments

The Sponsor will document modifications to the protocol in the form of a written amendment. Amended protocols must be acknowledged by Investigator signature and date upon receipt. Protocol modifications that impact subject safety or the validity of the study must be approved by the FDA and IRB before implementation. In the case of a medical emergency, to remove immediate apparent hazard to subjects, a change may be made preferably after discussion with the Sponsor or its designee. In these instances, the IRB and FDA will be notified as soon as possible.

32 Data Management

All study data will be entered into an Electronic Database Capture (EDC) system. Study personnel requiring access will have their own Login/Password. Access to clinical study information will be based on an individual’s role and responsibilities. The application provides hierarchical user permission for data entry, viewing, and reporting options. For optimum security, all communications between the users and the EDC operate on a secured socket layer (SSL) using 256-bit encryption. The web servers are protected by a managed firewall from potential web and network attacks and the network is guarded by an intrusion detection and protection surveillance system against malicious threats.

This application is designed to be in full compliance with International Conference on Harmonization and Good Clinical Practices (ICH-GCP), FDA CFR 21 Part 11 Electronic Record and Electronic Signatures, the FDA's “Guidance: Computerized Systems Used in Clinical Trials (May 2007), and the Privacy Rule of the Health Insurance Portability and Accountability Act of 1996 (HIPAA).”

As part of the data entry and validation process, the data stored in the EDC is checked against the source data, and also against edit check queries to confirm that the data received is within expected ranges. If any data is missing or is outside of expected limits, a query is created and sent to the site coordinator so that data may be verified and corrected. All changes made to a form are stored in an audit trail.

33 Record Keeping and Retention

Data generated for the study should be stored in a limited-access file area and be accessible only to representatives of the study site, the Sponsor and its representatives, and FDA/relevant health authorities/regulatory agencies. All reports and communications relating to study subjects will identify subjects only by subject unique identification code. Complete subject identification will be kept by the Investigator. This information will be treated with strict adherence to professional standards of confidentiality.

An Investigator must in reasonable time, upon request from any properly authorized officer or employee of FDA/relevant health authority or regulatory agency, permit such officer or employee to have access to requested records and reports, and copy and verify any records or reports made by the Investigator. Upon notification of a visit by the FDA, the Investigator will contact the Sponsor or its designee immediately. The Investigator will also grant Sponsor representatives the same privileges offered to FDA/relevant health authority or regulatory agents/officers/employees.

The Investigator must provide the Sponsor or its designee with the following documents at the time of site qualification and prior to study initiation and retain a copy in the site study file:

- Signed and dated curriculum vitae for the Principal Investigator.
- A copy of the original approval for conducting the study by the IRB. Renewals, with continuance of the study, must be submitted at yearly intervals or as required by IRB policy and a copy of the approved and dated renewal provided to the Sponsor.
- A copy of the IRB approved informed consent form along with any modifications initiated by the Sponsor over the course of the study.
- An IRB member list and Federal Wide Assurance (FWA) Number.
- A signed Financial Disclosure Form for each Investigator.
- An Investigator Agreement for this protocol signed and dated by each Investigator.

In addition to the documents listed above, the study site will also retain the following items and make them available for Sponsor review upon request.

- Certifications, applicable study equipment (audiometers, etc.) calibration records and laboratory reference ranges for all local laboratories used for this study. The Sponsor will verify all equipment requirements at the study qualification and/or initiation. Sites with outdated and/or non-compliant equipment will either not be approved for study participation or will be advised to discontinue study-related activities should non-compliance be noted during regular study monitoring visits.

- All original informed consent forms with required signatures

- All IRB correspondence (i.e., informed consent [including any approved revisions], protocol, AEs, advertisements, newsletters)

- Copy of the Study Monitoring Log Sheet

- Clinical and non-clinical supply shipment forms and device accountability logs
- Copies of all correspondence pertaining to the study between Sponsor and the site
- Copies of all SAEs reports submitted to the Sponsor
- Copies of all FDA progress reports submitted to the site by the Sponsor
- Site Delegation Signature Log

All study-related records must be maintained for at least 2 years after shipment and delivery of the last device for investigational use and FDA/health authorities or regulatory agencies have been notified of study closure. The Sponsor will notify the principal Investigator when records are no longer needed. The Investigator will not discard any records without notifying the Sponsor. If the Principal Investigator moves from the current investigational site, the

Sponsor should be notified of the name of the person who will assume responsibility for maintenance of the records at the investigational site or the new address at which the records will be stored. The Investigator will notify the Sponsor as soon as possible in the event of accidental loss or destruction of any study documentation.

34 Reporting Requirements for Interim and Final Reports

Interim post-approval study status reports will be submitted to the FDA every 6 months for the first two years of the study and annually, thereafter. This schedule will continue for the duration of the study until the final post-approval study report to be filed within 3 months after study completion.

35 Study Report and Publication

A description of this clinical trial will be available on http://www.ClinicalTrials.gov, as required by U.S. Law.

The aggregate data resulting from this study will be the proprietary information of the Sponsor and may be made public after all data have been analyzed and the study results are available. None of the data resulting from this study will be allowed to be presented or published in any form, by the Investigator or any other person, without the prior written approval of the Sponsor. At the end of the study, a clinical study report will be written by the study Investigators or their designee and reviewed by the Sponsor.

36 References

Byrne, D., Parkinson, A., & Newall, P. (1990). Hearing aid gain and frequency response requirements for the severely/profoundly hearing-impaired. Ear & Hearing, 11, 40-49.

Ching, T., Dillon, H., & Byrne, D. (1998). Speech recognition of hearing-impaired listeners: predictions from audibility and the limited role of high-frequency amplification. Journal of Acoustic Society of America, 103, 1128-1140.

Dillon, H. (1999). NAL-NL1: A new prescriptive fitting procedure for non-linear hearing aids. The Hearing Journal, 52(4), 10-16.

Furlong W.J., Feeny D.H., Torrance G.W., Barr, R.D. (2001) The Health Utilities Index (HUI) system for assessing health-related quality of life in clinical studies. Ann Med., Jul;33(5), 375-384.

Hogan, C. & Turner, C.W. (1998). High-frequency amplification: benefits for hearing-impaired listeners. Journal of Acoustic Society of America, 104, 432-441.

Minimum Speech Test Battery (MSTB), (2011).

Gatehouse, S. & Noble, W. (2004). The Speech, Spatial and Qualities of Hearing Scale (SSQ). International Journal of Audiology, 43(2), 85-99.

Peterson, G.E. & Lehiste, I. (1962) Revised CNC lists for auditory tests. J Speech Hearing Disorders, 27, 62-70.

Robinson K., Gatehouse S., & Browning, G.G. (1996) Measuring patient benefit from otorhinolaryngological surgery and therapy. Annals of Otology, Rhinology and Laryngology, 105, 415-422.

Spahr, A.J., Dorman, M.F., Litvak, L.L., Van Wie S., Gifford, R.H., Loizou, P.C., Loiselle, L.M., Oakes, T., Cook, S. (2012) Development and Validation of the AzBio Sentence Lists. Ear & Hearing, 33, 112-117.

Turner, C.W. (2006). Hearing loss and the limits of amplification. Audiology & Neurotology, 11(suppl), 2-5.

Turner, C.W. & Brus, S.L. (2001). Providing low- and mid-frequency speech information to listeners with sensorineural hearing loss. Journal of Acoustic Society of America, 109, 2999-3006.

37 Appendix A: Procedural Considerations

- All pre- and postimplantation testing will be completed using an audiometer, such as a Grason Stadler GSI 61 (Grason Stadler, Inc., Milford, NH, U.S.A.) or equivalent, calibrated to American National Standards Institute (ANSI) standards with maximum output for frequencies of 0.5 to 4 kHz of no less than 120 dB HL.

- Speech and hearing evaluations will be completed in, at a minimum, a single-walled sound booth capable of accommodating a calibrated, 90-degree, speaker orientation.

- Stimuli will be administered using either insert earphones and/or sound field speakers. Applicable ANSI standards are: ANSI/ASA S3.6-2004; **ANSI S3.1-1999** (R 2003).

- Pure-tone threshold exploration will be completed using the adaptive Hughson & Westlake procedure (1944).

- Sound field calibration will be completed as recommended by Katz (2002). The sound level meter should be set to the “A scale” and “slow” settings. The sound level meter will be placed in the center of sound booth, approximately 1m from the loudspeaker face, at the height of which would represent the center of an average subject’s head. The calibration noise (test specific, but preferably speech spectrum noise) will be administered through the audiometer output to the loudspeaker within the sound booth. The sound level meter detects the audiometer output through the loudspeaker. With the VU meter on the audiometer set to 0 while, the dial on the audiometer is adjusted until the sound level meter within the sound booth detects the desired output.

38 Appendix B: Instructions for Masking

1. Pure-tone threshold is established in the test ear.
2. Masking noise is introduced to the non-test ear at the initial masking level (10dB above the established threshold in the non-test ear). Pure-tone threshold then is re-established.
3. Level of the masking tone or noise is increased subsequently by 5 dB. If there is a response to the tone in the presence of the noise, the level of the noise is increased by 5 dB. If there is no response to the tone in the presence of the noise, the level of the tone is increased by 5 dB steps until a response is obtained.
4. A plateau has been reached when the level of the noise can be increased over a range of 15 to 20 dB without shifting the threshold of the tone. This corresponds to a response to the tone at the same hearing level when the masker is increased in three to four consecutive levels.
5. Masked pure-tone threshold corresponds to the hearing level of the tone at which a masking plateau has been established.

39 Appendix C: Hearing Aid Fitting Guidelines

Step 1 Create Hearing Aid Program

Method:

1. Using the hearing aid software, create a hearing aid program using the recipients' audiogram.

Step 2 Obtain Real Ear Unaided Response

Method:

1. Calibrate the probe tube.
2. Position the patient one meter in front of the speaker.
3. Place the probe tube in the ear canal approximately 25 to 30 mm past the tragal notch.
4. Select recorded speech at conversational level, 65 dB SPL.
5. Ensure the cochlear implant sound processor is turned OFF.
6. Using a prescriptive algorithm (e.g., NAL-NL1 or NAL-RP), obtain REUR.

Step 3 Obtain Real Ear Aided Response

Method:

1. With the probe tube in place, insert the hearing aid. Ensure that it is ON and detected by the hearing aid software. Ensure the cochlear implant sound processor is turned OFF.
2. Select recorded speech at conversational level, 60 dB SPL.
3. Allowing for subjective report, adjust hearing aid software to match real ear target gain and maximum output.

Step 4 Balance hearing aid and cochlear implant loudness (if applicable)

Method:

1. With the hearing aid connected to the hearing aid software, turn the cochlear implant sound processor ON.
2. Select recorded speech at conversational level, 60 dB SPL.
3. Ask the patient to point to which side is loudest or if the sound is balanced.
4. Use the conversational recorded speech to adjust the gain in the hearing aid software as needed to balance the loudness the between the two devices.
5. Repeat for soft speech (50 dB SPL).
6. Adjust the compression ratio and/or compression threshold in the hearing aid as needed so that soft speech is audible and equal in volume.
7. Repeat for loud speech (85 dB SPL).

Adjust the maximum power output of the hearing aid as needed so that loud sounds do not exceed the patient's loudness discomfort level.