

Hearing Protector Attenuation Testing



AS/NZS 1270:2002
Accredited Lab No. 5472

HearingTech Pty Ltd

Series 160

From: 25th to 29th February 2008

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1

Introduction

The National Acoustic Laboratories (NAL)¹ was commissioned by HearingTech Pty Ltd 15 Hoban Ave, Montmorency, Victoria certify ELACIN Compact FlexComfort Custom Earplugs in accordance with Australian and New Zealand Standard AS/NZS 1270:2002.

These devices were:

- 080203 – ELACIN Compact FlexComfort Custom Earplugs with Solid Inserts.
- 080204 – ELACIN Compact FlexComfort Custom Earplugs with ML 01 Filters.

24 pairs ELACIN Compact FlexComfort Custom Earplugs were supplied for testing. Mechanical tests were performed on 24 pairs and Attenuation tests were performed using 22 pairs, with solid inserts and ML 01 filters

AS/NZS1270: 2002 specifies a minimum of sixteen test subjects for testing earmuffs and twenty subjects required for testing earplugs.

22 test subjects were selected in conformance with AS/NZS1270: 2002 (twelve male and ten female subjects).

Testing was carried out from the 25th to 29th February 2008 the results of both the mechanical and attenuation tests are presented on pages 12 and 13 of this report

¹ *The National Acoustic Laboratories is a division of Australian Hearing, a Commonwealth Government Authority*

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Test Environment

All commercial hearing protectors tested by the National Acoustic Laboratories (NAL) except for disposable earplugs, are subjected to a series of both physical and attenuation tests carried out in accordance with Australian and New Zealand Standard AS/NZS 1270-2002 (Acoustics – Hearing Protectors)

Test Facility

The test room meets the requirement of the standard in both the background noise levels and the uniformity of the sound field produced in the subject's position. Both of these sets of parameters were determined from acoustic measurements using certified equipment.

Test Procedure

The attenuation of a hearing protector is determined by measuring each subject's hearing threshold with and without a hearing protector fitted. The difference between these two thresholds is the so-called real-ear attenuation of the protector. A number of test subjects must be used to obtain an accurate estimate of the attenuation. The AS/NZS 1270 standard specifies at least sixteen subjects for earmuffs and earmuffs mounted on helmets, and at least 20 test subjects for earplugs, semi-insert devices, or when earplug/earmuff combinations are being tested. NAL has adopted the same number of test subjects (i.e. sixteen and twenty respectively) in its testing procedure. All test subjects are between the age of eighteen years and forty years old and undergo a hearing test before they are accepted (rejection occurs if their audiogram shows any hearing thresholds below 20dB HTL).

During the hearing protector testing free field hearing thresholds are measured using a fixed-frequency "Bekesy" technique. This is implemented using a computer with signal acquisition/generation hardware and a computer program to automate the test procedure and compile data from the test series.

A pulsed signal comprising a 1/3 octave filtered pink noise of known sound pressure level is presented to the subject. The subject presses a response switch to reduce the sound level (at 2.5dB per second) until they hear the sound disappear, then release the switch increasing the sound level (again at 2.5dB per second) until they hear it again. After five cycles the hearing threshold is determined from the mean of the maximum and minimum values of the last three cycles. Test frequencies are selected automatically in a 1/1-octave step sequence from 125Hz to 8kHz.

The test series recorded with each subject comprise a minimum of two practice open-ear thresholds, one reference open-ear threshold, and an occluded-ear threshold (with hearing protector device) for each device tested.

Real-ear attenuation of a particular device is calculated by subtracting the reference open-ear threshold from the occluded ear threshold for that device.

Test Setup

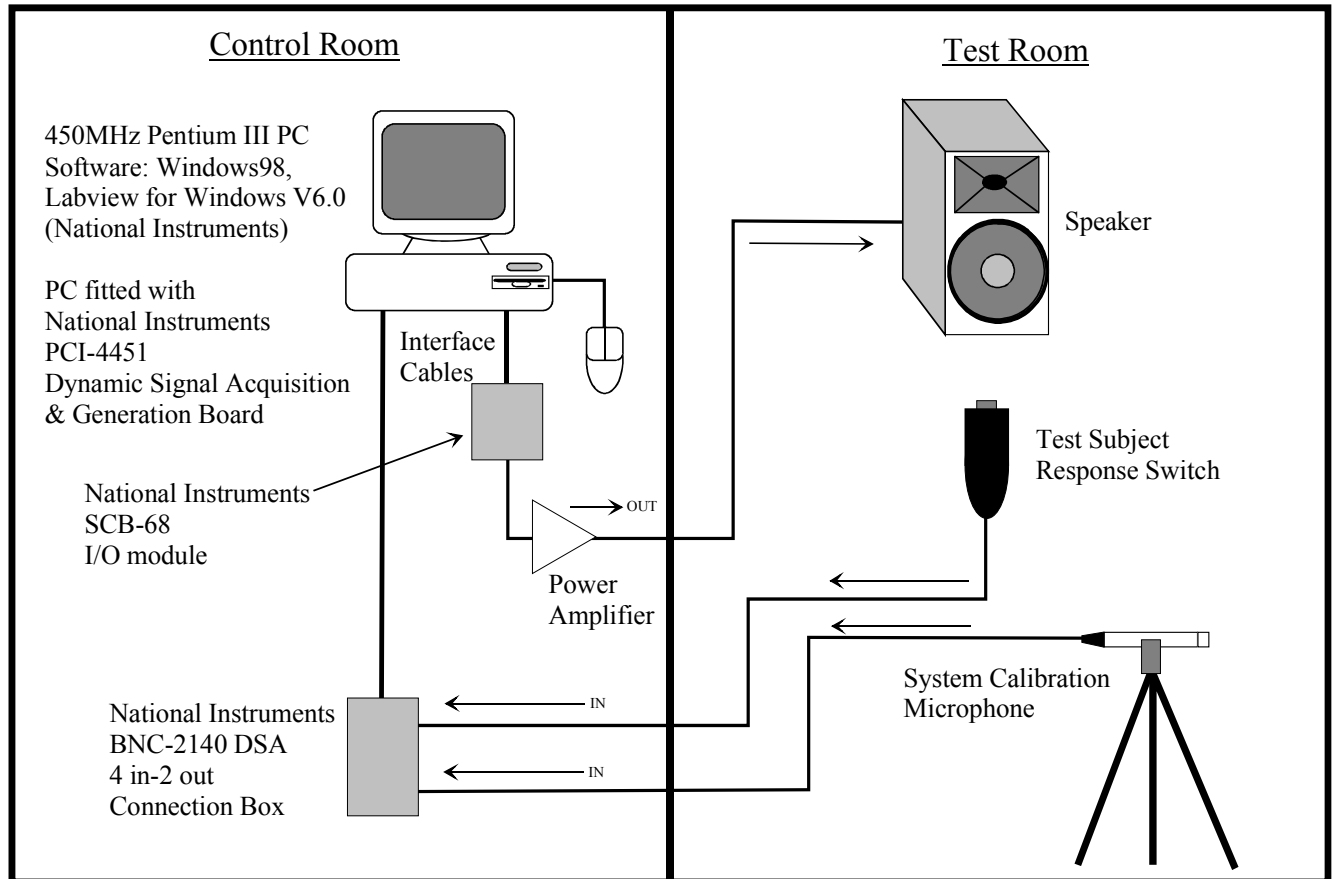


Figure 1 Showing Schematic of Test Equipment

Figure 1 shows the automated test set-up used for attenuation measurements. The test room is parallelepiped in shape with painted concrete walls and carpet covering the floor. The speaker is located in the corner of the room, facing the wall and shielded from the test subject by a glass barrier to shield the test subject from any direct sound. Narrow band sound absorbing panels and Perspex diffusers are placed inside the room ensure that the room meets the reverberation time and sound field diffusion and directionality requirements of the AS/NZS 1270: 2002 Standard.

Before testing commences, the test room sound field is calibrated to ensure a constant sound pressure level is produced across the entire test frequency range. The subject is seated in the middle and slightly towards the rear of the room approximately four metres from the speaker and can be seen by the person conducting the test at all times. A 75dB wide-band noise is available to assist the test subject in adjusting the hearing protector for optimal noise reduction.

Computation of Results, SLC₈₀ and Class

The mean real-ear attenuation and standard deviation at each octave frequency for each device is computed from the test results from all the test subjects using the following formulae: (AS/NZS1270: 2002 p27)

$$\text{Mean} := \frac{\sum_{i=1}^N X_i}{N} \qquad \text{Standard_Deviation} := \sqrt{\frac{\sum_{i=1}^N d_i^2}{N-1}}$$

Where: X_i is the attenuation of the i th subject
 d_i is the difference between the mean and the i th subjects attenuation

Standard deviation values indicate the degree of variability of performance of the hearing protector, the larger the value, the greater the variability.

The SLC₈₀ (Sound Level Conversion) value is defined as the difference between the C-weighted sound level of the environment in which the hearing protector is worn and the A-weighted sound level reaching the wearer's ears. The SLC value determined by NAL incorporates a mean minus one standard deviation correction to ensure that the stated degree of noise reduction is obtained on 80% of occasions. For this reason it is called SLC₈₀, the subscript indicating the percentage protection rate.

To compute SLC₈₀, one subtracts the value of the mean minus the standard deviation values from the "Specified Band Levels For Calculation Of SLC₈₀" for each octave band (see Table 1).

Table – 1 Determination of SLC₈₀ (AS/NZS 1270:2002, Appendix-A, pp30-31)

Octave Band Centre Frequency, Hz	125	250	500	1000	2000	4000	8000
(1) Specified Band Level dB	71	81	89	93	95	93	86
(2) Mean-minus-standard deviation, (from test results) dB	6.1	8.4	15.1	26	34.2	34.9	24.3
Attenuated Level (1 – 2) dB	64.9	72.6	73.9	67	60.8	58.1	61.7

SLC₈₀ value is 100 minus the logarithmic summation of all the attenuated level values.

$$\begin{aligned} \text{SLC}_{80} &:= 100 - 10 \log \left(10^{\frac{64.9}{10}} + 10^{\frac{72.6}{10}} + 10^{\frac{73.9}{10}} + 10^{\frac{67}{10}} + 10^{\frac{60.8}{10}} + 10^{\frac{58.1}{10}} + 10^{\frac{61.7}{10}} \right) \\ &= 100 - 77.3 \\ &= 23 \text{dB (rounded to nearest decibel)} \end{aligned}$$

Hearing protector class is determined from the following table (see table 2)

Table – 2 Specified SLC_{80} for Determination of Class (AS/NZS1270: 2002, Appendix-A, pp30-31)

Class	Specified SLC_{80} dB
1	10 to 13
2	14 to 17
3	18 to 21
4	22 to 25
5	26 or greater

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Mechanical Testing

Hearing protectors must be subjected to a series of mechanical tests and an attenuation test in order to be certified under the AS/NZS 1270: 2002 standard. Each device must pass the mechanical tests to qualify continuation on to the attenuation measurements. Table 3 shows the mechanical test requirement for each type of hearing protector device.

Table 3 showing required tests (marked with an “X”) for each type of hearing protector.

Type Of Test	Hearing Protector Type				
	Disposable or User Formable Earplugs	Other Earplugs	Ear Canal Caps	Earmuff	Helmet Mounted Earmuffs
A: Physical Examination	X	X	X	X	X
B: Preparation	X	X	X	X	X
C₁: Clamping Force (Test 1)	-	-	X	X	X
D: Dry Heat	-	X	X	X	X
E: Low Temperature Drop Test	-	-	X	X	X
F: Headband Flexing	-	-	X	X	X
C₂: Clamping Force (Test 2)	-	-	X	X	X
G: Attenuation Test	X	X	X	X	X

Here are more detailed descriptions of the mechanical tests “A” to “E” in Table-3 (AS/NZS 1270:2002, Section -2 pp 6-8, & Section -3 pp 9-16).

A: Physical Examination - The hearing protector shall be examined visually to ensure:

- ◆ all parts are free from sharp edges and irregularities that could be a potential hazard or cause discomfort to the wearer.
- ◆ there is no significant damage or distortion present in the device.

B: Preparation - The hearing protector shall be prepared for use according to the manufacturers instructions.

C₁- C₂: Clamping Force - A clamping force measurement is required from each sample of the hearing protector device before and after the temperature tests and the headband flexing (“D” & “E”). Results from the second clamping force test must not vary by more than 20% from the first and will be stated in “Newtons” on the final report.

D: Dry Heat - The hearing protectors are placed in an environmental test chamber and the temperature ramped up to 50°C at a rate of approximately 1°C per 2.5 minutes. This temperature must be maintained for at least 16 hours.

E: Low Temperature Drop Test - The temperature in the environmental test chamber is ramped down to -6°C at a rate of approximately -1°C per 2.5 minutes. This temperature must be maintained for at least 4 hours. Each sample of the hearing protector device must be removed from the environmental test chamber and in the case of head and neckband hearing protectors, dropped once from a height of 1.5 metres on to a 10mm thick steel plate. For helmet mounted hearing protectors each sample is swung once on a 1.0 metre long pendulum against a vertically mounted 10 mm steel plate.

F: Headband Flexing – Each hearing protector is placed on a device designed to flex the hearing protector clamping mechanism through its “normal” operating range over 1000 cycles

Samples Submitted for Testing

Table-4 Hearing protector devices submitted for testing.

Device Details		Number	Mechanical Test	Mechanical Test Result	Attenuation Test
HP 1 & HP 2	ELACIN Compact FlexComfort Custom Earplugs Solid Inserts & ML 01 Filters	080203/04	080203/04	Passed	080203/04

Notes on Mechanical Testing

All the devices were examined and prepared for testing accordance with Section-3 of AS/NZS 1270-2002. All the earplugs were subjected to dry heat temperature test.

None of the devices showed any evidence of mechanical failure before, during and after testing.

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Fitting Instructions

Under the test procedures detailed in Section 4.5 of the AS/NZS 1270:2002 standard, the tester must not influence the subject in any way regarding the selection, adjustment or fitting of the device under test. Because of this prohibition, the only information available to the subject is that provided by the manufacturer. This section details the information supplied by the manufacturer/supplier and used by the subjects to assist them to fit and adjust the device.

Fitting of the devices was demonstrated and supervised by a representative of HearingTech. However, the following fitting instructions are supplied with the custom earplugs.

ELACIN Compact FlexComfort Custom Earplugs

Fitting instructions for this device as supplied are shown below.



UK ELACIN custom made hearing protection

IMPORTANT: PLEASE READ THESE INSTRUCTIONS CAREFULLY BEFORE USING THE DEVICES

GENERAL

ELACIN custom made hearing protection devices have been developed to protect your hearing optimally and comfortably. Each pair of hearing protection devices is issued with an identification number. Through this number the manufacturer can trace the name of every user.

USE

Check prior to each use whether the hearing protection devices are clean. If necessary remove any earwax from the auditory canal of the hearing protection devices using the cerumen pen supplied. The hearing protector with the blue marking and/or the letter L is intended for your left ear. The hearing protector with the red marking and/or the letter R is intended for your right ear.

INSERTION

ELACIN Compact / Compact FlexComfort / ClearSound

1. Hold the hearing protector in such a way that your thumb rests on the tab and against the filter.
2. Rotate the hearing protector so that your thumb is on top of the device and bring it next to your ear.
3. Insert the hearing protector exerting slight pressure, rotating it backwards as you insert it into your auditory canal. The tab is now at the top, in a horizontal position, while your thumb points downward.
4. Keeping your index finger on the tab, wiggle the earpiece a bit until it fits comfortably in your ear.

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Test Results

Detailed in this section are the test result certificates for each of the device listed in Table 5

Table 5 Test Results

Test Certificate Number	Report Page	Device Details
080203	12	ELACIN Compact FlexComfort Custom Earplugs with Solid Inserts.
080204	13	ELACIN Compact FlexComfort Custom Earplugs with ML 01 Filters.

Test Certificate – ELACIN Compact FlexComfort Custom Earplugs with Solid Inserts.

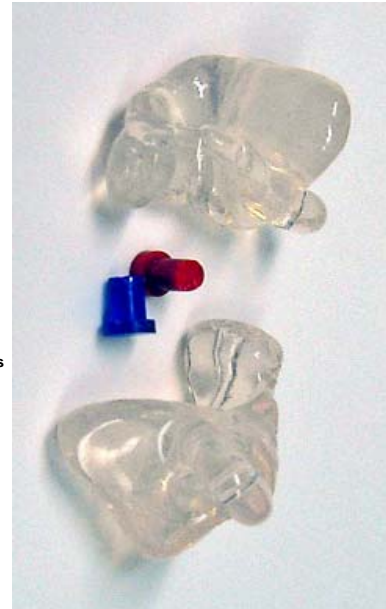
*This Certificate details the results of Hearing Protector testing carried out by
The National Acoustic Laboratories*

NAL Certificate No: 080203 **Test Series:** 160
ELACIN Compact FlexComfort
Device Tested: Custom Earplug fitted with Solid Markers

Manufactured By: HearingTech Pty Ltd

Date Tested: 25th to 29th February 2008

Test Commissioned By: HearingTech Pty Ltd



Description of Device Tested: Custom Moulded soft silicon (FlexFit) Earplugs. A moulded tab with hole allows insertion and removal, a cord can be fixed via the hole. The right and left earpieces are fitted with red and blue solid markers, respectively.

This hearing protector device has been tested mechanically, and its sound attenuation was measured in accordance with Australian and New Zealand Standard AS/NZS 1270-2002.

Mean Reference Thresholds re 20uPa						
125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
34.3	24.4	12.9	10.7	10.7	8.0	15.8

Subject ID	Real-ear attenuation values (dB) at designated octave frequencies						
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
S1	31	25	25	24	29	37	34
S2	35	27	23	25	35	27	41
S3	30	33	35	26	37	34	48
S4	25	30	34	29	35	35	42
S5	41	37	34	36	46	36	44
S6	26	29	29	27	33	26	40
S7	32	27	29	34	33	36	35
S8	36	34	45	39	33	28	34
S9	36	39	42	37	32	31	46
S10	25	23	22	23	39	28	21
S11	24	28	25	31	38	38	44
S12	25	24	22	22	29	33	35
S13	17	23	22	23	34	39	35
S14	32	26	30	28	26	20	33
S15	27	29	31	26	36	39	47
S16	24	21	25	27	34	36	29
S17	30	22	27	27	34	36	44
S18	24	24	29	24	28	19	24
S19	31	27	28	31	32	38	33
S20	26	32	25	32	41	40	39
S21	30	30	31	29	39	35	40
S22	27	31	35	26	34	39	37
Mean	28.7	28.0	29.4	28.4	34.4	33.1	37.4
Standard Deviation	5.3	4.8	6.2	4.7	4.5	6.0	7.1
Mean minus SD	23.4	23.2	23.2	23.7	29.9	27.1	30.3



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Registered Lab No. 5472

SLC₈₀ Rating	27	Newtons	Average total mass of device = 8g Approx
CLASS	5		
Clamping Force	N/A		

Signatory: **Dated:**
 (Gordon Jarvis, NAL Research, Acoustic Test Facility)

Test Certificate – ELACIN Compact FlexComfort Custom Earplugs with ML 01 Filters.

*This Certificate details the results of Hearing Protector testing carried out by
The National Acoustic Laboratories*

NAL Certificate No: 080204 **Test Series:** 160
ELACIN Compact FlexComfort
Device Tested: Custom Earplug fitted with LM 01
 Filter

Manufactured By: HearingTech Pty Ltd

Date Tested: 25th to 29th February 2008

Test Commissioned By: HearingTech Pty Ltd



Description of Device Tested: Custom Moulded soft silicon (FlexFit) Earplugs. A moulded tab with hole allows insertion and removal, a cord can be fixed via the hole. The right and left earpieces are fitted with LM 01 black/red and black/blue filters, respectively.

This hearing protector device has been tested mechanically, and its sound attenuation was measured in accordance with Australian and New Zealand Standard AS/NZS 1270-2002.

Mean Reference Thresholds re 20uPa						
125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
34.3	24.4	12.9	10.7	10.7	8.0	15.8

Real-ear attenuation values (dB) at designated octave frequencies							
Subject ID	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
S1	29	24	26	22	27	34	28
S2	27	27	23	23	29	25	42
S3	24	27	31	32	38	32	43
S4	24	26	52	26	35	33	42
S5	33	34	28	37	41	37	38
S6	30	32	29	28	32	25	45
S7	28	27	26	30	33	34	35
S8	29	28	31	33	35	20	40
S9	21	30	28	25	33	29	46
S10	24	23	23	23	42	28	28
S11	30	33	27	26	38	36	52
S12	25	25	25	22	32	31	38
S13	19	24	24	22	37	35	37
S14	35	27	32	29	31	19	28
S15	32	32	32	31	35	30	50
S16	19	20	23	28	33	38	29
S17	29	23	27	24	32	29	45
S18	25	24	28	24	28	16	29
S19	28	29	28	29	35	37	33
S20	27	31	27	31	39	36	36
S21	28	32	30	25	37	34	42
S22	28	33	32	25	35	40	38
Mean	26.9	27.6	28.7	27.0	34.4	30.7	38.2
Standard Deviation	4.1	4.0	6.0	4.0	3.8	6.5	7.1
Mean minus SD	22.8	23.6	22.7	23.0	30.6	24.2	31.1



Accredited for AS/NZS 1270:2002
Registered Lab No. 5472

SLC₈₀ Rating	26	Average total mass of device = 8g Approx
CLASS	5	
Clamping Force	N/A	
		Newtons

Signatory: **Dated:**
 (Gordon Jarvis, NAL Research, Acoustic Test Facility)

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Summary

All the devices were tested for both mechanical and attenuation characteristics in accordance with AS/NZS 1270:2002 Acoustics – Hearing Protectors.

Table 6: Test Result Summary

Device	Type	Test Certificate Number	SLC₈₀ Rating	Class
HP 1	ELACIN Compact FlexComfort Custom Earplugs with Solid Inserts.	080203	27	5
HP 2	ELACIN Compact FlexComfort Custom Earplugs with ML 01 Filters.	080204	26	5

All the devices were examined and prepared for testing in accordance with Section 3 of AS/NZS 1270-2002. All the devices were subjected to dry heat temperature test.

24 pairs of Custom Earplugs were supplied for testing. Mechanical tests were performed on 24 pairs and attenuation tests were performed on 22 pairs. None of the devices showed any evidence of mechanical failure before during and after testing.

AS/NZS1270: 2002 specifies a minimum of sixteen test subjects for testing earmuffs and twenty subjects required for testing earplugs.

22 test subjects were selected in conformance with AS/NZS1270: 2002 (twelve male and ten female subjects).

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References

1. *Attenuation and Use of Hearing Protectors*. Eighth Edition, National Acoustic Laboratories 1994.
2. *Australian and New Zealand Standard AS/NZS 1269:1998 Occupational Noise Management*. Standards Australia, Sydney.
3. *Australian and New Zealand Standard AS/NZS 1270:2002, Acoustics – Hearing Protectors*. Standards Australia, Sydney.