# Report on the use of the GR1986 acoustic calibrator

FRANZ WEISS

NOISE EVALUATION SUB-SECTION

Internal Report
No.22
January 1980

NAL
NATIONAL
ACOUSTIC
LABORATORIES

COMMONWEALTH
DEPARTMENT
OF HEALTH

NATIONAL ACOUSTIC LABORATORIES

COMMONWEALTH DEPARTMENT OF HEALTH

INTERNAL REPORT NO. 22

JANUARY 1980

# REPORT ON THE USE OF THE GR1986 ACOUSTIC CALIBRATOR

FRANZ WEISS

NOISE EVALUATION SUB-SECTION

MILLERS POINT, SYDNEY, NSW

## REPORT ON THE USE OF THE GR1986 ACOUSTIC CALIBRATOR

Prepared by: Franz Weiss, Noise Evaluation, January 1980.

### INTRODUCTION

The 1986 Calibrator is capable of calibrating microphones and sound level meters at 6 different frequencies and 5 different calibrated levels. The device will also test the fast and slow dynamic characteristics of an S.L.M. True r.m.s. detection can also be checked.

### Section 1. Explanation and Description of Front Panel Functions.

#### 1.1 Frequency

This rotary switch sets the output frequency of the calibrator to one of six standard centre frequencies. The range is 125Hz to 4kHz in octave steps.

#### 1.2 Power - Level

This turns the device on and sets output level to a level between 74dB and 114dB in 10dB steps. If the battery is "flat" no signal is delivered to the transducer.

#### 1.3 Calibrated - Variable S.P.L.

In the "calibrated" position functions 1 and 2 operate as described above. In the "Variable" position the dynamic characteristics and the r.m.s. capability of the S.L.M. under test are assessed. The "frequency" function is disabled, and the output level of the calibrator is no longer calibrated as selected by the level switch (function 2).

To test the dynamic characteristics of an S.L.M. the standards usually prescribe that when a 1000Hz burst of a level and a particular duration is applied, the deflection of the meter shall fall within a certain range of the reading corresponding to a steady signal with the same amplitude as the burst. The range of reading specified is different for "fast" and "slow" characteristics. The burst length is also different.

When the Variable switch is in the set fast/slow position, 1000Hz is automatically selected for output frequency. The S.P.L. Adjust knob (see 1.4 below) can be used to set any desired level. Note that the "level" switch (function 2) can still be used to change output levels by 10dB. When the positions "fast" or "slow" are selected with the Variable S.P.L. knob bursts of appropriate length and with amplitude as set by the S.P.L. adjust knob, and the level switch are supplied. In the "fast" mode 200ms long pulses are provided every 2 seconds; in "slow" mode, 500ms long every 10 seconds. In both cases the background level is 20dB below the burst level.

To test over shoot, the manufacturers suggest setting the desired level with the "set fast/slow" facility changing to "fast", and during an "off" period quickly changing back to "set fast/slow" to obtain the steady reading.

The "set crest factor" function on the "calibrated S.P.L. Variable S.P.L." switch works in a similar fashion to the "set fast/slow" function except that the signal frequency is 2000Hz and the 114dB level range is disabled. When an appropriate steady state level is set, then in crest factor mode a 5.5ms pulse with a 40Hz repetition rate is provided. The crest factor of this signal is 3.

1.4 S.P.L. Adjust

To be used with the "set fast/slow" and set crest factor functions as described above.

NOTE: By changing an internal jumper, the automatic selection of 1kHz for the "fast" and "slow" and 2kHz for the "crest factor" functions can be overridden, allowing the frequency switch to be used as usual.

## Section 2. Using the Calibrator

### 2.1 Outputs

Two outputs are provided; acoustic and electric. The acoustic output is via an electro-magnetic transducer. The transducer clips into a small compartment in the main body of the calibrator when not in use. The transducer has to be used with with adaptors for different microphones. For 1 inch Bruel and Kjaer microphones an "O" ring is required, for half-inch microphones a small plastic shell.

An electrical output is provided by via a miniature P.M.G. type jack. It can be used for direct electrical calibration of sound level meters.

### 2.2. Absolute Calibration

The biggest drawback in the use of this calibrator is that correction factors have to be applied for free field and pressure microphones and at different frequencies. Two correction factors in two different tables have to be applied for B&K 1" microphones.

### 2.3 Field Use

The calibrator is not of rugged construction and is not supplied with a carrying case (a case is available at extra cost) so portability is limited.

### 2.4 Manual

The manual supplied is quite comprehensive from both service and operations viewpoints.

## Section 3. Accuracy of Specifications

When testing a Sound Level Meter for compliance with a standard, the signals provided by the calibration source must be held to closer tolerances than those specified for the sound Level Meter. The specifications of the GR 1986 will be discussed in regard to this criterion.

### 3.1 Sound Pressure Level Accuracy

The Sound Pressure Level accuracy of the GR 1986 is claimed to be ±0.25dB at 114dB for frequencies other than 4000Hz. (Except when using the 1⅛" adaptor when it is ±0.5dB at 100Hz). At 4000Hz the tolerance is ±0.5dB. At levels other than 114dB tolerance is increased by 0.1dB.

AS 1259 Part 2-1976 (for Precision Sound Level Meters from now on referred to as "the standard"), clause 9.7 states that the meter shall be calibrated at a one-third octave band centre frequency between 200 and 1000Hz. S.P.L. is to be 80dB, temperature 20°C, relative humidity 65% and pressure 1000mB. The reading is to be within 1dB of the true level. The GR 1986 will provide a level of 84dB at three different frequencies in the 0.35dB, therefore it should be usable for this test.

Referring again to the standard, clause 9.6 states that attenuation range changes shall introduce an error of less than 0.5dB with respect to a reading at 80dB. A range change accuracy of 0.1dB is claimed, so the GR 1986 can be used for this calibration. Note that the standard recommends that this test be carried out at 31.5Hz, 1000Hz and 8000Hz. The GR 1986 can only perform this test at 1000Hz.

### 3.2 Environmental Conditions

Specifications for accuracy under changes in temperature, pressure and humidity are given. The operating temperature range is given as being -10°C to +50°C with a ±0.02dB/°C temperature coefficient, except at 4000Hz. The coefficient is not given for 4000Hz. The operating relative humidity range is given as being 0% to 90%. (See also Section 2.1). No correction figures are given for humidity effects. A graph is given for pressure corrections from 1013 mbar to 500 mbar.

The temperature and humidity ranges are the same as those over which a precision S.L.M. is required to operate as described in clauses 8.7 and 8.8 of the standard.

No specification is given for the effect of vibration or magnetic and electric fields.

### 3.3 Frequency Accuracy

The output frequencies of the calibrator are specified to within 3%. When using it to check weighting curves, it should be noted that an error in frequency can produce an apparent amplitude error. For example, the "A" weighting curve slopes at about 8dB per octave between 100Hz and 200Hz. A 3% change in frequency at 125Hz corresponds to 0.3dB change in amplitude.

### 3.4 Tone-Burst and Crest Factor Modes

No accuracy specifications are claimed in the general specifications. In the maintenance section of the manual a procedure (using a particular instrument, a GR 1192 frequency meter) is given for testing the timing functions, and tolerance limits are given. The limits are given in terms of the GR 1192 readings. Since a GR 1192 meter is not available at the Laboratories, no comment can be made on the tolerances.

The checking of crest factor burst height involves some internal measurement. The height of the burst is to be 6.58dB above the continuous level, +0.07dB, -0.09dB.

## Section 4 Evaluation of GR 1986 Calibrator S/N 01774

Table 4.1

| Description | Type | Serial Number |
|---|---|---|
| Frequency Meter | Fluke 1900A | 1974-C |
| Microphone | B & K 4133 | 557865 |
| " | B & K 4134 | 592303 |
| " | B & K 4135 | 532832 |
| " | B & K 4136 | 652160 |
| " | B & K 4144 | 563584 |
| " | B & K 4145 | 563924 |
| Oscilloscope | Textronix 7623A | |
| Pistonphone | B & K 4220 | 536172 |
| " | B & K 4220 | 210334 |
| Sound Level Meter | B & K 2203 | 508106 |
| " | B & K 2209 | 454429 |
| Voltmeter | Fluke 8800A | 480038 |

### 4.2 Frequency Check

Frequency was measured at the electrical output of the calibrator, using the Fluke 1900A. All frequencies were found to be within tolerance.

Table 4.2

| Nominal Frequencies (Hz) | Claimed Output * (Hz) | Measured (Hz) |
|---|---|---|
| 125 | 125.9 | 126.9 |
| 250 | 251.2 | 254.5 |
| 500 | 501.2 | 505.2 |
| 1000 | 1000 | 996.7 |
| 2000 | 1995 | 1992.9 |
| 4000 | 3981 | 3971.8 |

* Recommended frequencies as per ANSI S16-1960 and ISO R266. Not the same as AS1259 Part II - 1976.

4.3 Attenuator Check

This was carried out using the Fluke 8800A as an AC voltmeter to measure the electrical output of the calibrator.

Table 4.3

| Range \ Frequency (Hz) | 4k | 2k | 1k | 500 | 250 | 125 |
|---|---|---|---|---|---|---|
| 114 | 232.39 | 232.25 | 232.24 | 232.27 | 232.59 | 233.91 |
| 104 | 73.56 | 73.51 | 73.5 | 73.51 | 73.62 | 74.04 |
| 94 | 23.24 | 23.22 | 23.23 | 23.22 | 23.26 | 23.39 |
| 84 | 7.38 | 7.37 | 7.37 | 7.37 | 7.38 | 7.42 |
| 74 | 2.35 | 2.35 | 2.35 | 2.35 | 2.35 | 2.37 |

All voltages in mV. Accurate to ±(0.1% +0.1mV)

Within the accuracy of the measuring voltmeter, the attenuator settings are within tolerance. Note the rise ( 0.6dB) at 125Hz.

4.4 Tone Burst and Crest Factor Modes Check

These were checked using the oscilloscope. For the "fast" and "slow" modes the tone bursts were found to be of the claimed length, with a measuring uncertainty of 5%. The amplitude of the burst remained at the same level as the continuous tone, within the limits of reading error on the oscilloscope.

For "crest factor" mode, the amplitude of the tone burst was found to be within 2% (less than the measuring uncertainty) of the value which gives the same r.m.s. level as the continuous tone. The tone burst was 11 periods long as claimed and repeated at 25 ms intervals (5% uncertainty for time interval measurement, as before).

4.5 Accuracy of Sound Pressure Level

This test was carried out using two different Precision Sound Level Meters and six different microphones. Two pistonphones were used to calibrate the systems, one pistonphone checking the other; the difference between them was less the 0.1dB.

For the purposes of this test, free field microphones responses were adjusted for pressure response and coupler volume using figures given in the GR 1986 manual, and finally for individual free field frequency response variations using the calibration curve supplied with each B & K microphone.

Pressure microphone responses were adjusted by applying the GR supplied volume corrections and then by applying figures derived from the pressure response curve supplied with each microphone.

Note the pressure to free field corrections in the GR handbook are only typical values. The actual correction may be somewhat different.

The results are presented in the tables 4.5.1. to 4.5.6. Attenuator ranges are not indicated on the Tables. The test was only performed at the 114dB output level. The corrected values are nominally 4dB in all cases.

Table 4.5.1.

Microphone Type 4136

| Frequency (Hz) | Corrected Meter Reading 2203 (dB) | Corrected Meter Reading 2209 (dB) |
|---|---|---|
| 4k | 4.2 | 4 |
| 2k | 4.1 | 4.1 |
| 1k | 4 | 4 |
| 500 | 4.2 | 4.1 |
| 250 | 4.2 | 4.2 |
| 125 | 4.3 | 4.3 |

Table 4.5.2

Microphone Type 4134

| Frequency (Hz) | Corrected Meter Reading 2203 (dB) | Corrected Meter Reading 2209 (dB) |
|---|---|---|
| 4k | 4.15 | 4.15 |
| 2k | 3.9 | 4 |
| 1k | 3.8 | 4 |
| 500 | 4 | 4.1 |
| 250 | 4 | 4.1 |
| 125 | 4.2 | 4.2 |

Table 4.5.3

Microphone Type 4144

| Frequency (Hz) | Corrected Meter Reading 2203 (dB) | Corrected Meter Reading 2209 (dB) |
|---|---|---|
| 4k | 4.35 | 4.35 |
| 2k | 3.95 | 3.95 |
| 1k | 4 | 4 |
| 500 | 4.1 | 4.1 |
| 250 | 4.35 | 4.3 |
| 125 | 4.35 | 4.35 |

Table 4.5.4

Microphone Type 4135

| Frequency (Hz) | Corrected Meter Reading 2203 (dB) | Corrected Meter Reading 2209 (dB) |
|---|---|---|
| 4k | 4 | 4 |
| 2k | 4 | 4 |
| 1k | 4 | 4 |
| 500 | 4.1 | 4.1 |
| 250 | 4.1 | 4.2 |
| 125 | 4.3 | 4.4 |

Table 4.5.5

Microphone Type 4133

| Frequency (Hz) | Corrected Meter Reading 2203 (dB) | Correcter Meter Reading 2209 (dB) |
|---|---|---|
| 4k | 4.1 | 4.1 |
| 2k | 4 | 4 |
| 1k | 3.8 | 3.9 |
| 500 | 4 | 4 |
| 250 | 4 | 4 |
| 125 | 4.2 | 4.2 |

Table 4.5.6

Microphone Type 4145

| Frequency (Hz) | Correcter Meter Reading 2203 (dB) | Correcter Meter Reading 2209 (dB) |
|---|---|---|
| 4k | 4 | 4.3 |
| 2k | 3.4 | 3.6 |
| 1k | 3.9 | 4.1 |
| 500 | 4 | 4.2 |
| 250 | 4.2 | 4.2 |
| 125 | 4.6 | 4 |

The accuracy of the attenuators of the Sound Level Meters is specified to be within 0.2dB. S.P.L's produced by the two pistonphones are specified to within 0.2dB. Allowing for a reading error of 0.2dB, total measurement tolerance is 0.6dB. (Note: Before the test both Sound Level Meters were checked electrically for frequency linearity and attenuator accuracy. The frequency responses were flat, and the attenuator indications were well within tolerance).

With a total measurement tolerance of 0.6dB and a claimed tolerance of 0.25dB for the calibrator (except at 4kHz, 0.5dB), examination of the figures in the Tables 4.5.1 to 4.5.6 indicates that the GR1986 calibrator produces S.P.L's within the claimed specification. However there seems to be a slight rise in output level at 125Hz. (See section 4.3).

## Section 5 Conclusions

The GR1986 has been evaluated to determine whether it is suitable for calibrating Sound Level Meters according to AS1259 Part 2, 1976. The claimed specifications indicate that it is, and from the tests carried out on a GR1986 supplied to N.A.L., the specifications are valid.

The GR1986 is a versatile instrument. As well as supplying absolute acoustic calibration signals at five sound levels and six frequencies, it is capable of testing dynamic response and true R.M.S. detection at several different sound levels. This versatility simplifies the testing of Sound Level Meters considerably.

However two reservations must be held about the use of the GR1986. Firstly it is not recommended that the calibrator be used for absolute calibration of free field microphones, since the pressure-to-free field corrections given are only typical values. The actual correction for the individual microphone may be somewhat different. This is especially the case with the B&K one inch microphone at and above 1000Hz, and the B&K half inch microphone at and above 2000Hz. Secondly the calibrator should not be used to check steeply sloping frequency responses (See Section 3.3).

It should be noted that when using any acoustic calibrator, it must be ensured firstly, that the transducer is properly coupled to the microphone, and secondly (especially at low calibration levels) that external effects such as noise and vibration are minimised.