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instructions for
**Model M-7B
 NOISE DOSIMETER**



*for automatic measurement of
 noise exposure*



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NOTE

Your new M-7B Dosimeter fully meets the requirements of the OSHA Hearing Conservation Amendment and has the following capabilities:

1. 80-140dBA dynamic range.
2. 30dB crest factor for impulsive noise measurements.
3. User-selectable threshold of 80 or 90dB with jumper (located under the battery compartment on the circuit board.)

MODEL M-7B NOISE DOSIMETER

GENERAL DESCRIPTION

The Quest Model M-7B Noise Dosimeter is a lightweight, pocket-sized self-contained instrument that measures cumulative exposure to noise. The unit is primarily intended to measure noise exposure in accordance with the



Figure 1. M-7B Noise Dosimeter

Occupational Safety and Health Administration (OSHA) noise criterion based on a permitted exposure time doubling for each 5 decibel lowering in the "A" scale weighted sound. This is referred to as a 5 dB exchange ratio. The maximum OSHA noise levels expressed in dB(A) vs. exposure time are shown in the following table.

Duration of Exposure (Hrs./Day)	Equivalent Maximum Noise Level (dB(A))
*(32)	(80)
*(16)	(85)
8	90
6	92
4	95
3	97
2	100
1-1/2	102
1	105
1/2	110
1/4	115
*1/8	120
1/16	125
1/32	130

*Refer to the current governing OSHA requirements.

In industrial environments where noise levels vary continually, manual computation of noise dose involves tedious day-long measurement with a sound level meter and stop watch in order to determine the noise exposure as computed by the formula:

$$D = \frac{C_1}{T_1} + \frac{C_2}{T_2} + \dots + \frac{C_n}{T_n}$$

where D is noise dose, C is the actual duration of time at a given noise level, and T is the maximum exposure time per day at that noise level as shown in the OSHA table above. The M-7B noise dosimeter automatically performs the entire task of measuring, timing, and computing the noise dose. The computed dose is read directly at the end of the measurement period as the percentage of the daily allowable dose.

The M-7B measures and accumulates noise and produces a continuous reading of the percentage of the allowable exposure to which the wearer has been subjected. In addition, the unit can be used for short term sample tests with the readout quickly converted both to the equivalent dB(A) sound level and to the maximum time a worker can be in the noise environment. Refer to Conversion Chart, page 11.

Being a small device permits a person to wear it in a shirt pocket or on a belt. The microphone is clipped to the shirt collar near the ear, thereby perceiving and accumulating approximately the same dosage as the ear. The unit can also be mounted on a tripod for an area survey.

The noise accumulated over the day or test period is read on a five digit L.E.D. display by depressing the READ button. The display reads in percent of the daily exposure allowed by OSHA. Readings extend from 000.01 to 999.99 and change in .01 increments. A reading of 100.00 indicates an exposure of 100% (OSHA criterion number 1) and is the maximum allowable exposure for one day. If the exposure readout exceeds 999.99, the display will go into a blanked mode where only the decimal point will light. Such an indication thus means the exposure limit was exceeded.

Noise levels above 115 dB(A) activate an internal electronic latch and are indicated by a small light below the exposure display when the READ button is depressed. A one second time delay prevents activation of the latch by impulse noises.

The M-7B on delivery, is always calibrated to the requirements of the prevailing OSHA law unless otherwise indicated by the user. The unit can, however, be set to other range and threshold levels, and can also be converted to a Model M-8B Noise Dosimeter which is based on a 3 dB equal energy exchange ratio. Minor internal changes are required for this conversion.

The M-7B can be used in virtually all environments: industry, construction, mining, transportation — anywhere there is noise.

SPECIFICATIONS

Noise Level Range: 80 to 130 dB(A) range ref. 20 μ Pa. Threshold and 8-hour criteria level are set to prevailing OSHA requirements or to special user needs.

Exposure Readout: Integral 5-digit L.E.D. display (to 999.99%).

Criterion Level: 90 dB(A) for 8 hours produces a 100% readout. Can be modified to other criterion levels as necessary for application.

Threshold Level: 80 dB. Can be changed to 90 dB with jumper. Can be adjusted to other levels.

Exchange Rate: 5 dB time doubling per OSHA requirements.

Crest Factor: 30 dB within dynamic span.

Dynamic Span: 80 to 140 dB.

Frequency Response: "A" Scale, 20 Hz to 10 kHz.

Standards: ANSI S1.25 -1978 Type 2.

Detector: True RMS, SLOW response.

115 dB(A) Indication: Indicates reception of sound level above 115 dB(A). Can be adjusted to other limits.

Accuracy: At 110 dB(A), 1 kHz input, 23°C, atmospheric pressure of 760 mmHg; counter reading is within $\pm 7\%$ of theoretical accumulation. This corresponds to ± 0.5 dB.

Linearity: From Low Threshold Cut-Off to 130 dB, ± 0.5 dB (measured at 1 kHz with reference to 110 dB).

Microphone: PZT ceramic, 8 mm diameter, 30 inch cable with spring clip for attaching microphone to shirt collar.

Calibration: External calibration adjustment available. May use Model CA-32 Timed Sound Calibrator, Model CA-12B Sound Calibrator, Model CA-15B Calibrator, or other calibrators that will adapt to the 8 mm microphone. This calibration adjustment is meant for minor adjustments only (± 1 dB). A more thorough internal calibration is necessary for larger adjustments.

Temperature Range: Operating within ± 1 dB, -10°C to +50° C Storage: -40° C to +60° C. (battery removed)

Operating Humidity: 0% to 95% Relative Humidity.

Magnetic Field Effect: Dosimeter will accumulate exposure equal to a level less than 80 dB(A) in a magnetic field of 4000 A/M (50 oersteds) at 50 or 60 Hz. If field effects and actual noise are below threshold cut off, no accumulation will result. A 400 A/M field induces the equivalent of 50 dB noise signal.

Vibration Effects: Vibration of the M-7B without the microphone has essentially no effect on the dosimeter accuracy at an acceleration of 0.1 g. However, the microphone will act as an ac-celerometer if vibrated. A sinusoidal acceleration of 0.1 g at 500 Hz in a direction perpendicular to the plane of the microphone diaphragm (WORST CASE) will generate an equivalent sound level of approximately 85 dB. Frequencies below 500 Hz with the same acceleration have less effect due to the "A" scale weighting.

Battery: One 9 Volt Alkaline battery (NEDA 1604) will provide power for 100 hours under normal operating conditions. Low temperature reduces battery life: approximately 70 hours at 30°F; 25 hours at 0°F.

Battery Status Indicator: When pressing READ button, the BATT light in the display window indicates sufficient battery power for 8 hours of operation.

Belt/Pocket Clip: Holds the dosimeter in a shirt pocket or on a belt.

Tripod Mount: Threaded insert provided on the Belt-Pocket Clip will accept a standard 1/4-20 tripod mounting screw.

Size: 4-3/4 x 2-1/2 x 1-1/4 inches. Weight: 9 ounces (including battery).

Construction: Solid state integrated circuitry in a rugged aluminum housing.

Conversion Capability: Should there ever be a requirement or OSHA law change, the M-7B can be converted from 5 dB to a 3 dB or 4 dB exchange ratio.

CONTROLS AND DISPLAY

ON-OFF Switch — A 2-position slide switch that turns the unit on and off but does not destroy the memory. It does reset the 115 dB(A) latch. After turning the M-7B on, wait for at least 10 seconds before using or calibrating it to let the unit stabilize.

READ Button — A push button that illuminates the 5-digit display, the 115 dB(A) indicator (if latched on), and the battery status indicator (if battery has sufficient power for 8 hours of operation).

RESET Button — A recessed push button that resets the 5-digit display when pressed simultaneously with the READ button.

Calibration Adjustment -- A screwdriver adjustment (located near the microphone cable outlet) that varies the amplifier output.

Display -- The L.E.D. display contains the 115 dB(A) indicator light, the battery (BATT) indicator light, and a 5-digit percentage readout of exposure.

Threshold Setting — 80 or 90 dB, user selectable with jumper wire located within the battery compartment on the circuit board.

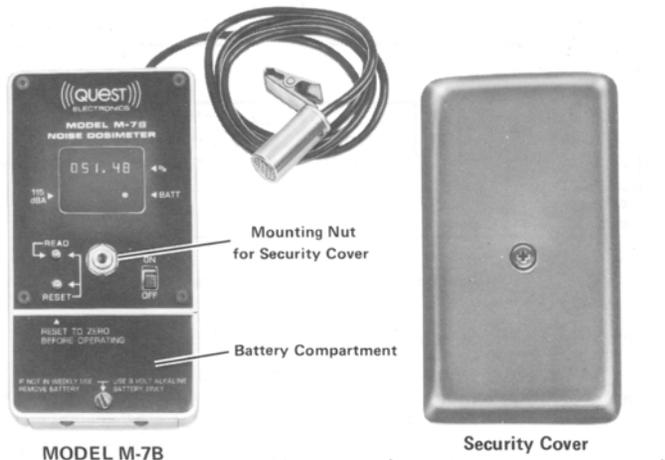


Figure 2.

PRINCIPLES OF OPERATION

General

The M-7B Noise Dosimeter uses a small omnidirectional ceramic microphone buffered by a high impedance FET input stage. The electronics utilize low power integrated circuitry for long battery life and maximum stability and reliability over a wide range of environmental conditions. A block diagram of the M7-B is shown in Figure 3.

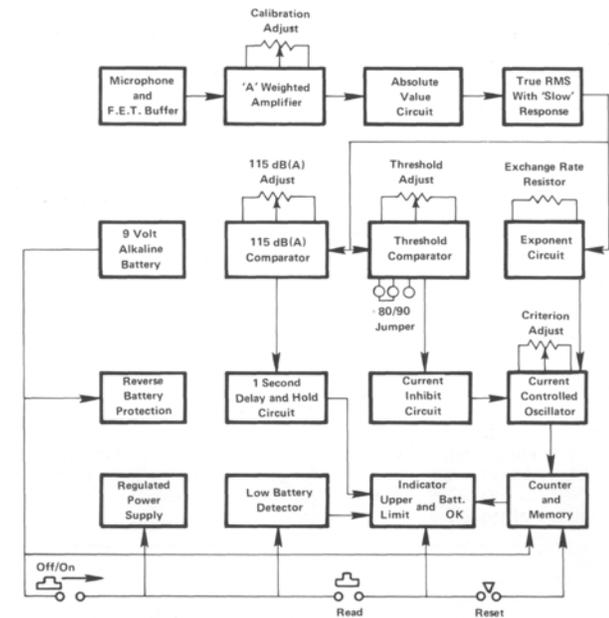


Figure 3. Block Diagram, M-7B Noise Dosimeter

Weighting Characteristics

In accordance with OSHA requirements, the M-7B has an "A" scale weighting characteristic as shown in Figure 4. Since the human ear does not respond well to low frequencies, the "A" weighting electronically designed into the dosimeter measures noise in a similar manner as the ear hears the sound or is affected by it. Therefore, the exposure or dosage reading on the M-7B accumulates at a slower rate with low frequency

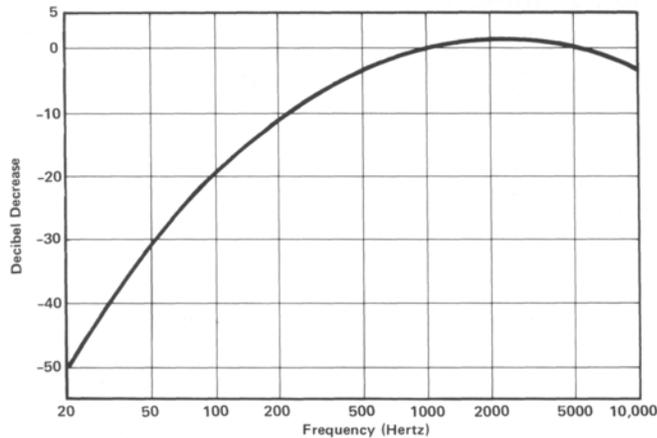


Figure 4. Frequency Response Characteristic for "A" Scale Weighting

noise than with high frequency noise at the actual decibel level.

Microphone Characteristics

The microphone used on the M-7B dosimeter is a Model 1845 ceramic microphone designed for use in sound level measuring instruments. An integral FET amplifier and controlled acoustical construction provide the transduction sensitivity level, frequency range, and flat frequency response necessary for ANSI S1.4-1983 Type 2 sound level meter requirements. Overall diameter is 8 mm. Typical sensitivity is 70 dB below 1 volt per microbar measured at 1 kHz. Figure 5 is a diagram of typical microphone response.

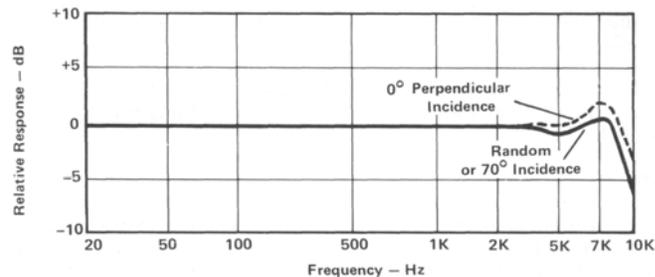


Figure 5. Model 1845 Microphone Response - Perpendicular and Random Incidence

Internal Electrical Noise

The internal electrical noise of the M-7B is equivalent to an acoustic level of approximately 40 dB. With the dosimeter lower threshold set at 80 dB(A) or higher, internal electrical noise thus has no effect on the reading.

115 dB(A) Indicator

When using the M-7B, if the microphone is exposed to more than 115 dB(A) for a minimum of one second, the indicator circuitry will latch on, and the indicator light will go on when the READ button is pressed. This indicator is reset only when the M-7B is turned off for at least a few seconds and then turned on again.

Memory

The memory consists of a CMOS counter that retains the accumulated counts or an overflow indication of exceeding counter capacity. The memory content is not lost by turning the power switch off. Only the removal of the battery or use of the RESET button can erase the memory.

OPERATING PROCEDURE

The M-7B is designed to be worn as a personal monitor. However, the unit also can be tripod-mounted and used as an area monitor. Before mounting the M-7B, it should be checked to see that battery power is adequate and that the unit is properly reset to zero. The unit should then be checked for calibration accuracy before putting into service. The high readout resolution (counting in 0.01% increments) permits very rapid, accurate short term measurements and also rapid calibration. If you use the dosimeter for an all-day measurement, the two digits behind the decimal point become insignificant.

Battery Test

Turn unit ON. Press and hold READ button for 5 seconds. The 5-digit display and the indicator light labeled BATT should light and remain on for at least 5 seconds to indicate that the battery has sufficient power to operate the M-7B for at least 8 hours. If not, replace battery. If the display is in the blanked mode with only a decimal point lit, depress the RESET button while holding the READ button. This will reset the counter to 000.00.

Battery Replacement

Loosen slotted captive screw from battery compartment. Lift the battery flap to expose the battery. Be sure unit is turned off and then carefully remove the battery from its cavity and unclip the connector. REPLACE WITH 9 VOLT ALKALINE BATTERY ONLY!

Take care to observe polarity of battery and connector. Be sure a good electrical connection has been made. Then replace the battery and the cover.

NOTE

When battery is connected, the counter memory can come on in any state. Be sure to reset it before use.

Taking a Measurement

Turn the unit on. Be sure to reset the counter and the 115 dB(A) indicator, and attach the M-7B to either the belt or the shirt pocket using the spring clip on the case. If desired, the detachable security cover may be used to prevent tampering with the dosimeter. Clip the microphone to the shirt or jacket collar high on the shoulder. (Refer to "Effects of Operator's Presence", page 10). Place the cable in the best position available, possibly under the shirt, to prevent it from being entangled with other objects.

NOTE

If area noise rather than personal noise is to be monitored, reset the counter and 115 dB(A) indicator and attach the M-7B to a tripod using the 1/4-20 threaded insert on the spring clip. Suspend the microphone away from solid surfaces, and at an angle equivalent to random incidence (approximately 70° to the direction of the sound source). With the unit turned ON, the M-7B is now measuring and integrating noise levels between the lower threshold limit and 140 dB(A) maximum.

Take the exposure measurement, either a short term sample or an all day monitor, as needed. If noise levels vary considerably, monitor the noise for the full work day.

At the end of the exposure period, depress the READ button. The noise dose for the duration of the measurement period is displayed along with the 115 dB(A) indication (if 115 dB(A) was exceeded). Also, the BATT indicator should light for a minimum of one second, indicating that the battery power was sufficient during the measurement period.

After the data has been read, the unit can be turned off. This does not destroy the count in the memory but does reset the 115 dB(A) latch. If the M-7B will not be used again for a week or more, it is best to remove the battery to prevent further drain.

Noise Exposure Conversion Chart

When the M-7B is used to take a measurement for the full work day, the dosage for that day appears directly in the display. For example, if the reading for 8 hours was 200.00 (200% of allowable

exposure), it would mean that the wearer had received twice the maximum dosage for the day. If the measurement is taken for 4 hours of an 8 hour work day, the counter should read less than 050.00 (50% of the allowable exposure) to be within the specified limits. Regardless of the length of the work day, the M-7B indicates the percentage of allowable noise that has been received up to that time.

After taking a measurement for some determined time period, the readout exposure can be converted to the equivalent dB(A) level for the entire time period, and can also be used to determine the allowable exposure time per day by using the Conversion Chart in Figure 6. This chart is also provided as a handy separate slide rule "Noise Exposure Calculator" with each M-7B.

The Chart in Figure 6 is used to convert the dosimeter reading to both Equivalent OSHA Exposure in dB(A) and to the Allowable Exposure Time per Day in Hours. The chart is based on an allowable exposure of 90 dB(A) for 8 hours — which is indicated by a dosimeter reading of 100.00. In the example above the dosimeter reading of 200.00 is converted by referring to the diagonal line representing a measurement period of 8 hours. Find the intersection of this line with the line representing a counter reading of 200.00. The vertical line through this intersection indicates that the equivalent OSHA exposure, shown at the top of the Chart, is 95 dB(A) and that the allowable exposure time per day, shown at the bottom of the chart, is 4 hours.

Conversions for other counter readings and measurement periods are made in a similar manner by using the appropriate counter reading and diagonal measurement period line.

SHORT DURATION MEASUREMENTS can be taken if the noise level for the period under measurement is representative of the entire day. Also, a period of measurement should be long enough to accumulate a reading of at least 000.50 to insure accuracy.

As another example, a measurement is taken for 5 minutes and the total count accumulation is 005.60. Find the 5 minute period of measurement line on the Conversion Chart. Next, locate the intersection of this diagonal line and the 005.60 counter reading at the left. The top of the Chart indicates the equivalent dB(A) level is 102 dB(A), and the bottom of the Chart shows 1.5 hours is the allowable exposure time per day.

Effects of Operator's Presence

Any object or surface can act as a reflector of sound. An operator or person wearing the dosimeter is also a reflector and affects the microphone performance. The M-7B is calibrated to read correctly with the microphone in a random incidence sound field without the

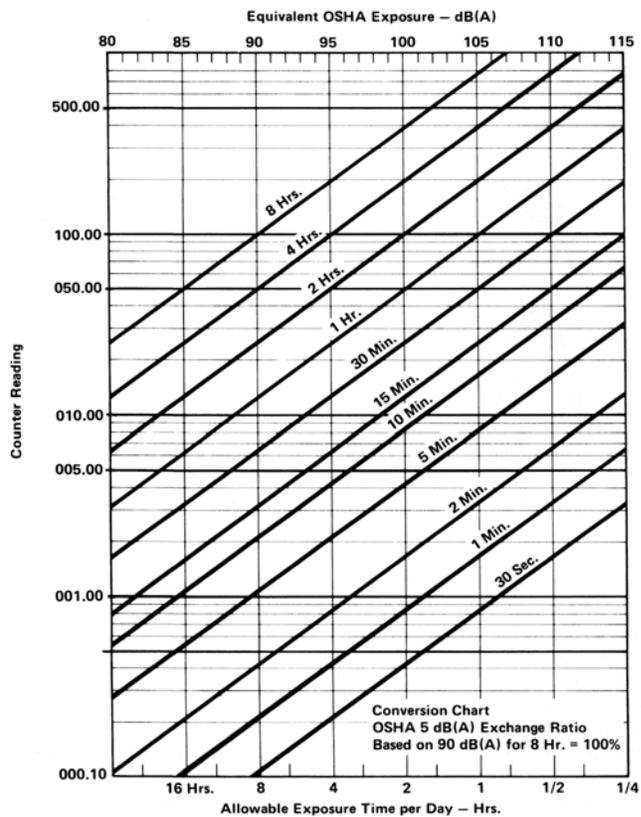


Figure 6.

presence of reflecting objects. Placing the microphone in a shirt pocket or in the chest area could thus tend to produce large errors — as much as several decibels. The best location is several inches above the person's head. In this location the microphone can receive sound from all directions with essentially no reflecting surfaces near enough to cause notable error. However, this location is impractical. The most practical location — and the one recommended — is the shirt collar, high on the shoulder and away from the neck as far as practical.

If the dosimeter is mounted on a tripod and used as an area monitor, the microphone should be suspended away from the tripod and M-7B chassis (see Figure 7). It is recommended that a thin rod be used to hold the microphone with the cable extended the full 30 inches. The microphone should be pointed upward forming approximately a 70° angle with the horizontal direction of the noise source.



Figure 7. M-7B Tripod Mounted for Area Monitor

Considerations of Measurement and Accuracy

The M-7B is intended to be used for fluctuating noise environments. The M-7B or any other properly designed dosimeter should produce greater accuracy in the measurement of exposure than any sound level meter method of measurement and calculation. The dosimeter avoids the potential error created by the human factor in trying to time and interpolate a moving meter needle.

Microphone location affects the instrument reading and has been discussed under "Effects of Operator's Presence". It is important to place the microphone near ear level at a location that minimizes body reflective and shielding effects.

Threshold discontinuity can cause notable differences in readings on various dosimeters even with slightly different locations of the microphone when the actual noise level is in and around the threshold point of the dosimeter. When the noise is at or slightly below the threshold, the dosimeter may or may not be accumulating. You could imagine a noise level at the threshold where one device has just turned on and another where the unit was just off. The first

would accumulate a sound while the second would not. This same problem occurs with a sound level meter where the operator must make a judgment whether the noise is just above or below the threshold.

If total accumulation of the dosimeter exceeds 10 times the permitted dosage (just past a reading of 999.99), the unit readout will go into a blanked condition with only the decimal point lit. This indicates that the limit of the counter was exceeded, and thus prevents reading the dosimeter incorrectly which would occur if the unit were recording noise the second time around on the counter.

Peak noise levels exceeding 140 dB(A) will be internally "clipped" and act as if they were 140 dB(A). However, since OSHA requirements limit noise to 115 dB(A), this upper limit is not likely to enter into the measurement. Actual peak noise should be measured with a peak reading and hold meter such as the Quest Model 215-35 Peak-Hold Meter.

Impulsive noise and noise with large crest factors. The M-7B accurately measures impulsive noise with crest factors (peak to RMS ratio) of 30 dB within a dynamic span of 80 to 140 dB.

Use with Windscreen

To prevent wind from blowing across the microphone and causing an erroneous measurement of sound level, the Model WS-5 Windscreen (for 8 mm microphones) should be used (see Figure 8). It is recommended that the windscreen be used at all times in that it helps support the microphone in an upright position when worn. It will also help protect the microphone under dusty, oily, and humid conditions. The windscreen is made of reticulated polyurethane foam. The screen is simply pushed onto the microphone when needed. The acoustic attenuation effect of the windscreen on the dosimeter is very small and for all practical purposes can be neglected. Maximum attenuation occurs at high frequencies and is approximately 0.5 dB at 8 kHz, .25 dB at 5 kHz, and 0 dB at frequencies below 2.5 kHz.



Figure 8. M-7B Illustrating Proper Placement of Microphone with Windscreen

CALIBRATION AND MAINTENANCE

The M-7B should maintain its accurate calibration for many months of use. However, to insure consistently accurate operation, it is recommended that the unit be returned to the factory at least once a year for complete checkout and calibration. The calibration standards for equipment in Quest's Laboratory are traceable to the U.S. National Bureau of Standards.

For OSHA measurement, the M-7B should be checked daily with an acoustic calibrator before being used. It is recommended that one of the Quest calibrators, such as the CA-12B, CA-15B or CA-32 Field Sound Calibrators, be used with the proper 8 mm microphone adapter.

IMPORTANT!!

The OSHA Hearing Conservation Amendment has not changed the 90dB(A)-8 hour criterion. The amendment requires you now look for a TWA for 8 hours of 85dB which is an exposure of 50%. To properly calibrate the M-7B for the new OSHA Hearing Conservation Amendment, follow the calibration procedure for 90dB(A)-8 hour criterion level.

NOTE

Because of the "slow" response time constant built into the M-7B, a "trail-off" or decay or count rate can be noted in the readout with the abrupt removal of a high level sound. This trail-off is proper and can last for several seconds. The dose value given in the following paragraphs includes this trail-off.

1. Using the Quest CA-32 single-level, single-frequency, precision timed calibrator:

Place the 8 mm adapter into the CA-32. Then insert the M-7B microphone. Holding the microphone firmly and squarely into the CA-32, turn the calibrator so that the controls are facing upwards. Switch on the CA-32. Turn on the M-7B, wait at least 10 seconds, and reset the count to 000.00. Press the Calibrator START button. The 32 SEC. light will come on for exactly 32 seconds indicating the duration of the 110 dB output. When the light goes out, press the READ button on the M-7B. For a 90 dB(A)-8 hour criterion level, (OSHA), the readout should be *between 001.64 and 002.15, based on a ±1 dB tolerance, with 001.87 being exact.* If the count is too high, turn the gain adjust screw (near the microphone cable outlet) slightly counterclockwise. Then recheck calibration.

2. Using the Quest CA-12B single-level, single frequency calibrator (Optional):

Place the 8 mm adapter into the CA-12B. Then insert the M-7B microphone. Be sure the microphone rests squarely on the inner rim. Turn on the M-7B and the CA-12B. Wait 10 seconds for the M-7B to stabilize. Then, while using a timing device such as a wrist watch or a stop watch, reset the M-7B to 000.00, time for one minute for a 90dB(A)-8 hour criterion level, and turn off the calibrator. At the end of the timed period the readout should be *between 002.98 and 003.94, based on a ±1 dB tolerance, with 003.42 being exact*. If the count is too high, turn the gain adjust screw (near the microphone cable outlet) slightly counterclockwise. If the count is too low, turn the screw slightly clockwise. Then recheck calibration.

3. Using the Quest CA-15B multi-frequency calibrator (Optional):

The various frequency settings of this calibrator permit the operator to check the M-7B at 125 Hz, 250 Hz, 500 Hz, 1 kHz, and 2 kHz. The M-7B incorporates "A" scale weighting so that it responds to noise levels in a manner similar to the human ear. See Figure 4. Thus when frequencies are changed, the M-7B count rate also changes. The following table shows the acceptable range of counter readings at each of the test frequencies.

Use 1 minute for OSHA 90 dB(A)-8 hr. Criterion Level
(Use 1/2 minute for 85 dB(A)-8 hr. Criterion Level)

Frequency at 110 dB	Actual dB(A) to Counter	M-7B Counter Reading			Tolerance Allowed -dB
		Minimum	Mean	Maximum	
125	93.9	000.26	000.37	000.51	±2.5
250	101.4	000.79	001.04	001.36	±2.0
500	106.8	001.79	002.20	002.69	±1.5
1K	110.0	002.98	003.42	003.94	±1.0
2K	111.2	003.30	004.05	004.94	±1.5

To check the M-7B turn it on, wait at least 10 seconds, depress the READ button, and reset the counter to zero. Turn the CA-15B Calibrator on to desired frequency with the 8 mm adapter in the calibrator cavity. Place the M-7B microphone into the calibrator cavity. When you are ready to time, switch on the M-7B for exactly one minute, or 1/2 minute, as appropriate. At the conclusion of the one minute test, pull the microphone out and away from the calibrator. Read the M-7B exposure value and compare it with the readings in the calibration table after the M-7B has stopped counting.

Calibrate the M-7B with the adjusting screw using the 1 KHZ preferred frequency only. Then, the other frequency-dependent readings will fall within acceptable limits. If they do not, then the unit should be more thoroughly checked at the Quest Laboratory facility.

ACCESSORIES

MODEL WS-5 WINDSCREEN

Refer to page 13 for instructions on how to use the windscreen with the M-7B microphone.

TRIPOD

Quest supplies two models of tripods for use with the M-7B as an area monitor, with the model TP-2 being generally recommended. Figure 7 shows the M-7B mounted on a tripod.

Model	Closed Height	Extended Height
TP-1	20 inches	55 inches
TP-2	10 inches	51 inches

Service Policy

The Quest product you have purchased is one of the finest acoustic instruments available. It is backed by our full one year warranty which seeks complete customer satisfaction. This is your assurance that you can expect prompt courteous service for your equipment from the entire Quest service organization.

Should your Quest equipment need to be returned for repair or recalibration, please contact the Service Department at (800)245-0779 (USA) or Fax (262)567-4047 for a Return Authorization Number. The RA number is valid for 30 days, and must be shown on the shipping label and purchase order/cover letter. If you are unable to return instruments in that time call for a new RA number. Send it prepaid and properly packed in the original shipping carton directly to Quest Technologies, 1060 Corporate Center Drive, Oconomowoc, WI 53066 U.S.A.

Repair or replacement work done under warranty will be performed free of charge, and the instrument will be returned to you prepaid. Your copy or a photocopy of the Quest Registration Card will serve as proof of warranty should the factory require this information.

If for any reason you should find it necessary to contact the factory regarding service or shipping damage, please direct your calls or letters to the attention of the Service Manager, Quest Technologies, (262) 567-9157 or (800) 245-0779. Office hours are from 7 AM to 6 PM (Central Standard Time) Monday through Friday.

For service or recalibration outside the U.S.A., please contact your local Quest Dealer or fax Quest U.S.A. at 1-262-567-4047.