

A Historical Perspective on the Evaluation, Standardization and Certification of Personal Noise Dosimeters

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Today's Presentation

- Noise Dosimeter Development – Historical
 - Original Concept and Generations 1, 2, 3, & 4
- Evaluation of Noise Dosimeter Performance
 - Laboratory and Field
- Standards
 - ANSI
- Testing and Certification
 - NIOSH/MSHA

Noise Dosimeter Development

- 1954, AIHA – Rosenwinkel & Stewart – described a “new device which integrates sound energy over finite time periods.”
- 1955 – Stewart patent (assigned to MSA 1961) an instrument that would “sum the sound energy in the environment in such a way that the total variables of frequency, intensity and time would be accumulated together in a manner similar to the way the ear hears them.”

Noise Dosimeter Development

- 1956 – von Wittern and Von Gierke patent for a noise exposure meter for ‘indicating the total time that noise exceeded a certain predetermined levels.’
 - Measurements could be conducted over long periods of time, and the instrument worn by personnel under normal work conditions
- 1957 - Crouch, AIHA, ‘instrument that described the time the noise level was above a series of five adjustable sound pressure levels.’

Noise Dosimeter Development

- 1964 USAF – indicated an interest in developing a personal noise dosimeter that was light weight, pocket sized and provide a measure of average noise exposure during a normal working day.
 - Texas Research Associates prototype.
- 1965 – Church described a small personal instrument to record amount of time worker is above a selected level.
 - 3 trigger levels

Noise Dosimeter Development

- 1966 – Lagerholm and Toremalm described a dosimeter which had an adjustable tolerance level from 70 – 100 dB. A motor accelerated with increasing noise intensity above a preselected level in such a way that the registered value was a product of duration and intensity.
- 1970 – Botsford and Laks described a noise hazard meter to be worn by a roving workman that permitted evaluation of many exposures to irregular noise that were unassessable by then present methods.

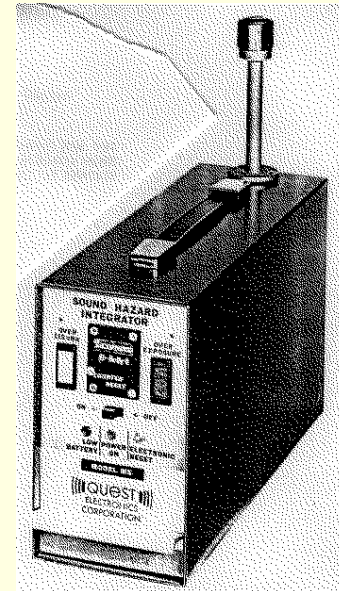
Noise Dosimeter Development

- The 1969 Coal Mine Safety and Health Act and the 1970 Occupational Safety and Health Act spurred the development of portable and person-worn instruments for the measurement of occupational noise exposure.

Noise Dosimeter Development Generation 1

- Pre-commercial and early commercial
- 1960-1971
- Portable or person-worn (unwieldy)
- Quest M-5 Sound Hazard Integrator,
Columbia Research SPL 101, GenRad 1934
- Usually had 1-1/8" Diameter microphone,
LED or mechanical readouts
- High battery drain which limited operating
time and portability

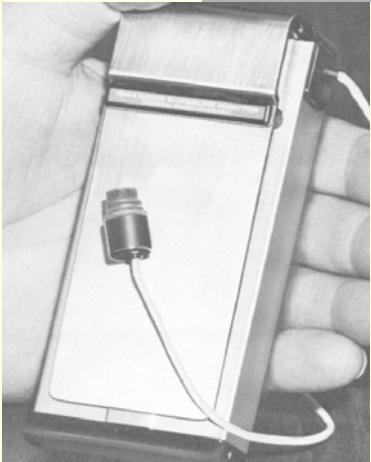
Generation 1



Noise Dosimeter Development Generation 2

- 1972-1980
- Until the first ANSI Noise Dosimeter Standard
- Either separate monitor-readout or self-contained
- Single function instrument, 1-inch dia. Microphone (integral or remote) & LED display
- Limited in dynamic range, frequency response, and crest factor capability.
- Single Threshold, weighting, and exchange rate.
- DuPont Model A, D-100, D-285, D-376, B&K 4425, Quest M-6 and M-7, GenRad 1944

Generation 2



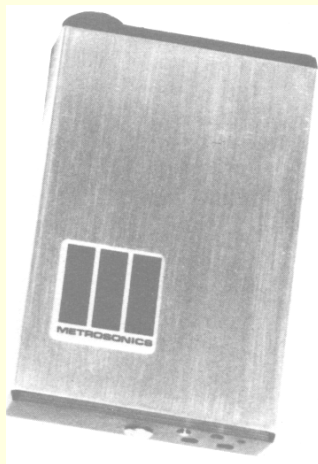
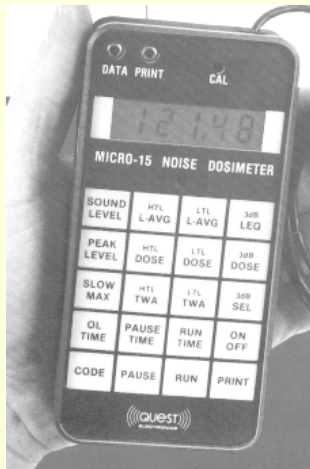
Noise Dosimeter Development Generation 3

- 1981 – 1992 redesign after laboratory and field evaluation
- Improved technology to handle impulse/impact sound
- Multiple thresholds, operating time, sound level meter usage, improved dynamic range, frequency response, and impulse/impact waveform response.
- ½-inch or smaller microphone, low battery drain, LCD display, more than one function, integral readout,
- Conform to ANSI S1.25-1978 Noise Dosimeter Standard.

Noise Dosimeter Development Generation 3

- Field calibration techniques of a short duration.
- Remote microphone mounted on shoulder.
- Bendix ADS-3000, DuPont (AMETEK) Mark-Series, GenRad 1954, Metrosonics DB-301, Quest Micro-15 and Q-series.

Generation 3



Noise Dosimeter Development Generation 4

- 1992 – current
- Multi-functions w/time history, various versions for various customers, multiple dosimeters in one housing (combination of weightings, threshold, exchange rate, criterion levels, etc.)
- Time-history function inclusion
- Computer interface
- Shoulder mounted microphone or entire instrument on shoulder

Noise Dosimeter Development Generation 4

- Remote interrogation
- Quest NoisePro series, Larson Davis Spark, Casella DB Badge,

Generation 4



Dosimetry and Technology

- Noise dosimeter companies have come and gone.
- Some features worked well in laboratory but failed in the field environment.
- New technology has always been incorporated into dosimeter design.
- New standards, rules, and regulations help spur the development of newer and better instrumentation.

Noise Dosimeter Performance

- How do dosimeters perform?
- No standards in early days
- How to test?
 - Acoustical vs electrical
 - Microphone and electronics separate
 - Black Box approach
- How to evaluate?
- How to evaluate features?

Noise Dosimeter Performance

- 1972 – Confer, et. al. – 4 manufacturers, important to evaluate threshold, and exposure to sound – 3 of 4 returned to mfg. for repair or recalibration.
- *“From our field experience with the noise dosimeters evaluated, we found only one type repeatedly indicated results that we would have expected from sound level meter readings. Improvements are needed in three of the four instruments to make them reliable field units.”*

Noise Dosimeter Performance

- 1973 – Leisure (NBS) conducted an evaluation on commercially available units for the USEPA on 6 personal and 2 stationary units from 8 manufacturers.
- Random incidence response, crest factor capability, exchange rate, performance over temperature, & dependence on battery voltage.
- Two manufacturers' units performed poorly.
- Need for a national standard and “*that users should be cautioned to carry out enough evaluation tests to ascertain that the devices are performing adequate for his purpose.*”

Noise Dosimeter Performance

- 1974 – Stewart, et. al., (USBM) – 8 brands (3 of each model) of commercially available dosimeters.
- Black Box approach in diffuse and free field
- A-weighting response, integration accuracy and other tests
- “There is a substantial variation in measured exposure as calculated by instruments among and within different manufacturers.”
- “...that some instruments exhibit nonlinearities in exposure calculations as a function of the dBA level.”

Noise Dosimeter Performance

- 1977 – Yen, et. al., (USBM) reported on a second evaluation based on Stewart's first study.
- Black Box Approach
- A-weighting frequency response, exchange rate, crest factor for tone burst and broad band noise spectra, battery life, threshold, and over-exposure indicator.
- Units with rechargeable battery are erratic, battery life meter preferable to light, standby mode desirable, higher maximum dose readout needed.
- Results used for MSHA Acceptability Criteria for Noise Dosimeters (1978)

Noise Dosimeter Performance

- 1978 – Fortner, et. al. (NIOSH) – 9 Noise dosimeter models
- Extensive acoustical, electrical and environmental tests
- A detailed summary is presented on whether or not the instruments met NIOSH’s proposed criteria.
- *“No single unit passed all of the tests.”*
- *“Recognized that all of the tests and criteria should not be equally weighted.”*

Noise Dosimeter Performance

- 1980 – Bucholtz and Yonovits examined the usefulness of noise dosimeters with respect to extended shifts
- *“..dosimeters performed as expected when exposed to acoustical stimuli for time periods exceeding eight hours.”*
- *The accuracy of the dosimeters in this study tended to fall within a range of ± 2 dB from the expected value irrespective of the threshold setting.”*

Noise Dosimeter Performance

- 1991 – Evans, et. al. (NIST) performed an evaluation for OSHA which evaluated the response of personal noise dosimeter to continuous and impulse-like signals for 10 commercially available models.
- 9 of 10 passed preliminary tests. 7 completed the evaluation.
- *“Except in a few isolated cases, the commercial dosimeters were in general agreement with the performance specifications of the appropriate ANSI Standard and with OSHA regulations.”*

Noise Dosimeter Performance

- There have not been any thorough, recent laboratory evaluations of current dosimeters because:
 - The cost to conduct such evaluations are quite extensive, expensive and many Federal Govt. agencies that conducted early evaluations no longer have the resources.
 - ANSI Standards are now in place
 - Most instrument users believe that when an instrument manufacturer indicates conformance to an ANSI standard, then the manufacturer has the detailed test results to backup this assertion. *This may not always be the case.*

Dosimeter Standards

- ANSI S1.4-1971 American National Standard Specification for Sound Level Meters
- ANSI S1.25-1978 American National Standard Specification for Personal Noise Dosimeters
- ANSI S1.25 – 1991 American National Standard Specification for Personal Noise Dosimeters
- ANSI S1.25 is currently undergoing revision in conjunction with the ANSI Sound Level Meter Standard.

Testing and Certification of Personal Noise Dosimeters

■ NIOSH

- April 16, 1975, published a proposed requirement for the certification of sound level meter sets which became final.
- December 30, 1977, published a “Proposed Rules for Certification of Personal Noise Dosimeter Sets”
- NIOSH developed test procedures and evaluation criteria for personal dosimeters (Fortner, et. al.)
- Meetings between industry, NIOSH and NIST regarding testing and evaluation of sound level meters and personal noise dosimeters.
- With a change in administrations and reallocation of resources, NIOSH did not complete the regulation on the noise dosimeter certification program and ultimately withdrew the certification program for sound level meters.

Testing and Certification of Personal Noise Dosimeters

- MSHA
 - MSHA Acceptability Criteria for Personal Noise Dosimeter (IR-1072)
 - The certification program was in effect from 1978 until 2000. It ended with the new MSHA noise standard for occupational noise exposure.
 - List of Acceptable Noise Dosimeters which could be used to monitor miners' noise exposure.
- Requirements for maximum readout capability, crest factor, exchange rate linearity, A-weighting response, pink noise response, and availability of a field calibration technique
- 2 of 3 instruments tested must pass all criteria
- Voluntary participation

Testing and Certification of Personal Noise Dosimeters - Today

- There are no regulatory requirements for testing and evaluation in the United States.
- There is no US certifying body.
- Instruments used for regulatory measurements are required to conform to ANSI Standards, but there is no mandatory testing and evaluation program.
- There are “Pattern Evaluation” testing requirements in IEC rules conducted by manufacturer.
- A 5-dB exchange rate unit is not covered in IEC standards.
- Let the buyer beware!

Summary

- There is a long history of direct reading instruments for noise exposure assessment.
- Performance evaluations have been conducted, but none recently.
- ANSI standards are in place and are being updated in line with IEC noise dosimeter standards.
- There is no testing and certification program in the United States for noise dosimeters.

■ Thank You!