

NIOSH Sound Level Meter Application (app) for iOS devices

Hearing Loss Prevention Team (HLPT)

Engineering and Physical Hazards Branch (EPHB)

Division of Applied Research and Technology (DART)



NIOSH Sound Level
Meter



Developed by EA LAB, Inc. under MOU agreement between NIOSH and EA LAB (signed on 02/13/2015)

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Introduction

The NIOSH hearing loss team evaluated 192 sound measurement applications (apps) for the iOS and Android platforms to examine their suitability and accuracy in relation to professional sound measurement instruments. Of the 192 apps, only 4 iOS apps met our selection criteria for functionality, features, and calibration capability [Kardous and Shaw, 2014]. Testing also revealed that most available apps lacked the accuracy and functionality necessary to conduct occupational and general purpose noise measurements. NIOSH hearing loss researchers collaborated with one of the 4 app developers to develop an occupationally-centric sound measurement app that can be distributed freely to the occupational safety and health community as well as the general public similar to the NIOSH ladder safety app. NIOSH signed an MOU agreement with EA LAB in February 2015 to develop the NIOSH Sound Level Meter app. The app was subjected to the same testing requirements that were established in the Kardous and Shaw study. The app met the testing criteria (± 2 dB mean difference from the reference type 1 sound level meter). Further testing with external calibrated microphones performed at the NIOSH Acoustics Laboratory in 2015/2016 showed that the app showed closer agreement (within ± 1 dB) of the reference type 1 sound level meter.

The ubiquity of smartphones and the sophistication of current sound measurement applications present a great opportunity to revolutionize current data collection and surveillance practices for noise. Through the use of crowdsourcing techniques, workers around the world may be able to collect and share workplace (or task-based) noise exposure data using their smartphones. Scientists and occupational safety and health professionals can rely on such shared data to build job exposure databases and promote better hearing health and prevention efforts. In addition, the ability to acquire and display real-time noise exposure data raises workers' awareness about their work (and off-work) environment and allows them to make informed decisions about potential hazards to their hearing. A NIOSH-developed and branded occupational sound measurement smartphone app will help advance the NIOSH mission by translating knowledge of occupational sound measurement into a practical and informational product that will be available to the more than 2 billion smartphone users today.

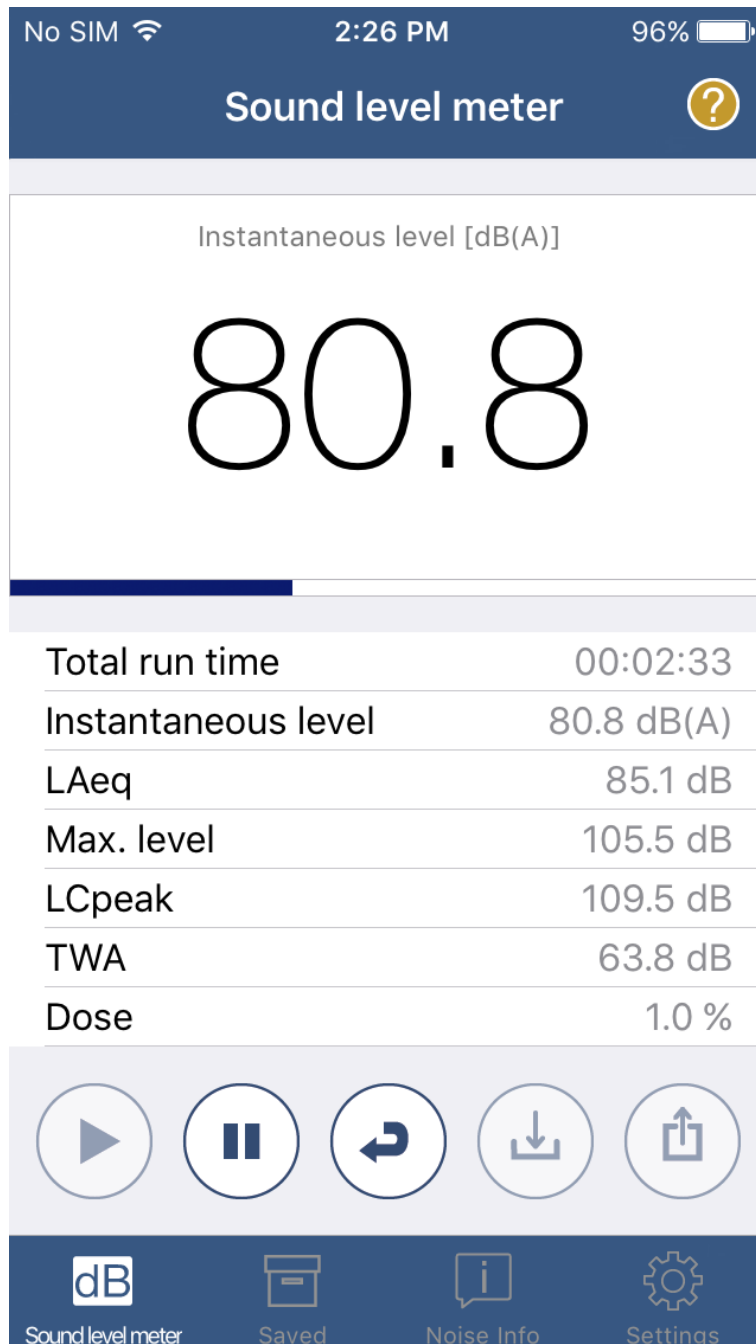
Professional sound level meters (SLMs) must comply with national and international standards such as American National Standards Institute (ANSI) S1.4-1983 (R2007), Specifications for Sound Level Meters (ANSI, 1983 (R2007)) and International Electrotechnical Commission (IEC) 61672-1, Sound Level Meters – Part 1: Specifications (IEC, 2013). Both standards specify a host of acoustical and electrical tests with indicated tolerance limits and measurement uncertainties that are specified in decibels over a wide frequency range (typically from 10 Hz – 20 kHz). Such tests must account for level linearity, directionality, time and frequency-weighting responses, tonebursts, radio frequency interference, and atmospheric and environmental conditions. The standards also specify that these tests shall be made on the complete instrument, including the microphone and pre-amplifier. As of today, no smartphone or smartphone-based app has met the requirements of IEC or ANSI standards. We recognize that this app meets only one of the requirements specified in sound level meters standards and we want to emphasize that smartphones and smartphone sound apps were not designed to meet such rigorous standards and that this app does not meet type 2/Class 2 standards and should not be used for compliance purposes. We included a statement to this effect in the disclaimer of the app, and also in the initial pop-up screen.



Figure 1. The main screen of the app as shown on an iPhone 5S

Main Screen (Sound Level Meter)

Once the user launches the app, they will be presented with a main screen (dB icon highlighted on the bottom left corner). The top half of the screen shows a readout of the sound level using the built-in microphone (or external microphone if used) and reports the instantaneous sound level in A, C, or Z-weighted decibels. The weighting is user-selectable and can be accessed in the Settings screen.



The app also reports the main metrics that are of importance to occupational noise measurements, mainly the run time (total time), the A-weighted Equivalent Sound Level (LAeq), the Maximum Level measured during the current run time, the C-weighted Peak Sound Pressure Level (LCpeak), the Time-Weighted Average (TWA) and Dose.

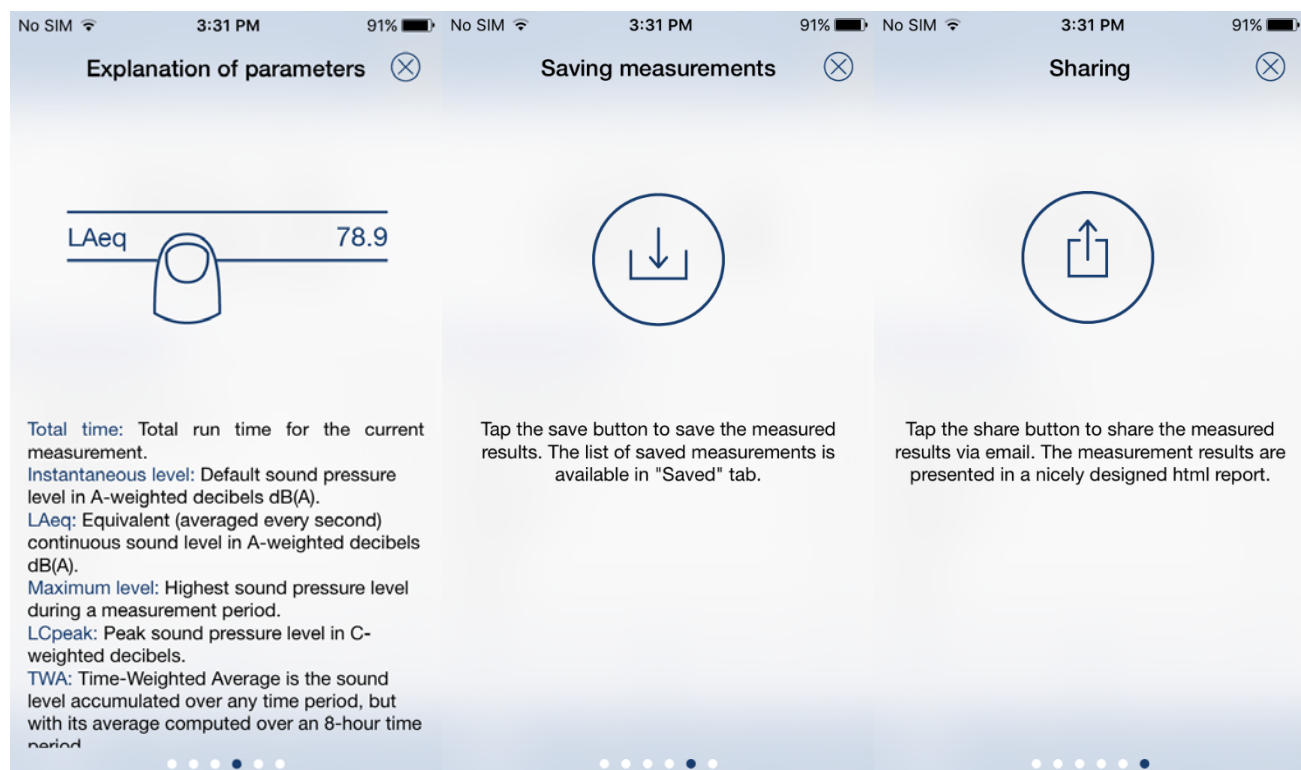
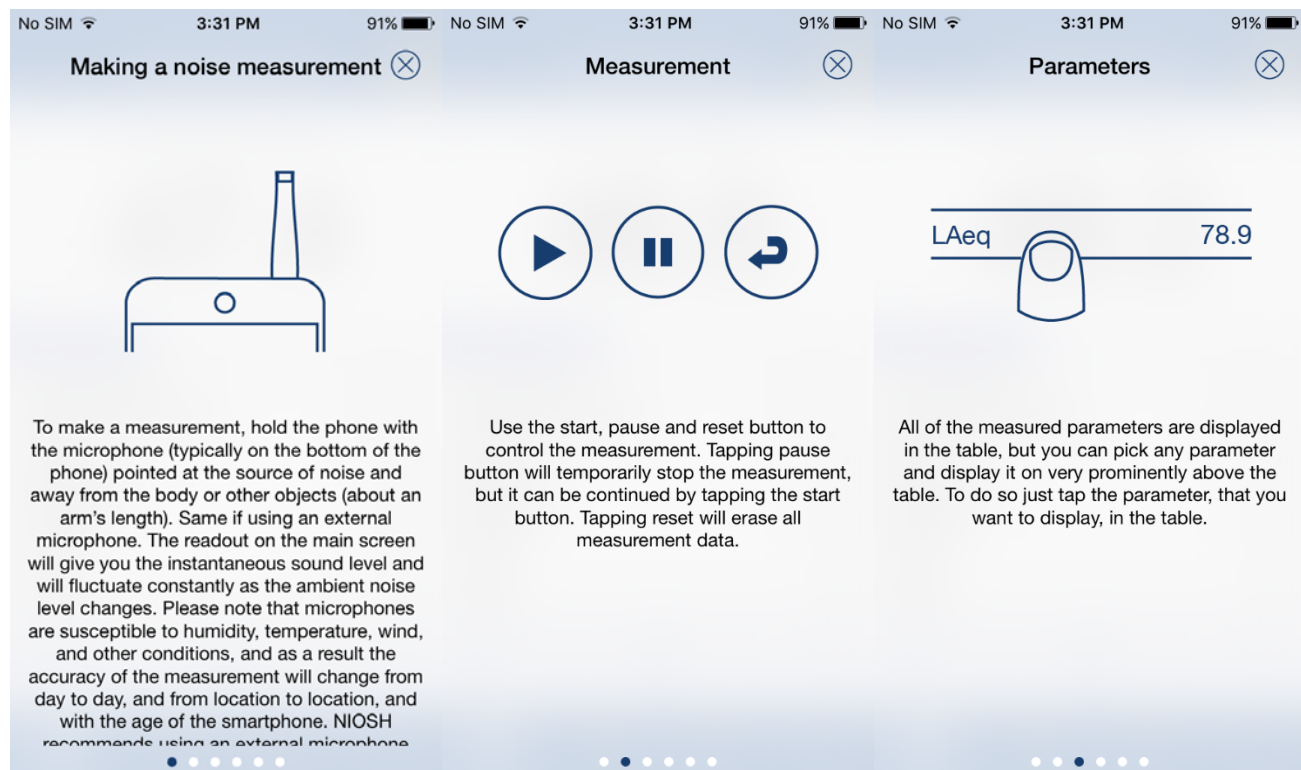
- **Total run time:** Total run time for the current measurement
- **Instantaneous level:** Default sound pressure level in A, C, or Z-weighted decibels [dB(A), dB(C), dB].
- **LAeq:** Equivalent (averaged every second) continuous sound level in A-weighted decibels [dB(A)].
- **Max Level:** Highest sound pressure level during a measurement period.
- **LCpeak:** Peak sound pressure level in C-weighted decibels [dB(C)].
- **TWA:** Time-Weighted Average is the sound level accumulated over any time period, but with its average computed over an 8-hour time period.
- **Dose:** A percentage of the maximum allowable daily noise dose. Exposures at 100% or above are considered hazardous.

On the bottom of the screen, there are five major buttons: Start, Pause, Reset (will give the user a warning before reset, Save, and Upload (through email)).

There is a help “?” button that the user can select to get more information about the specific screen or its content.

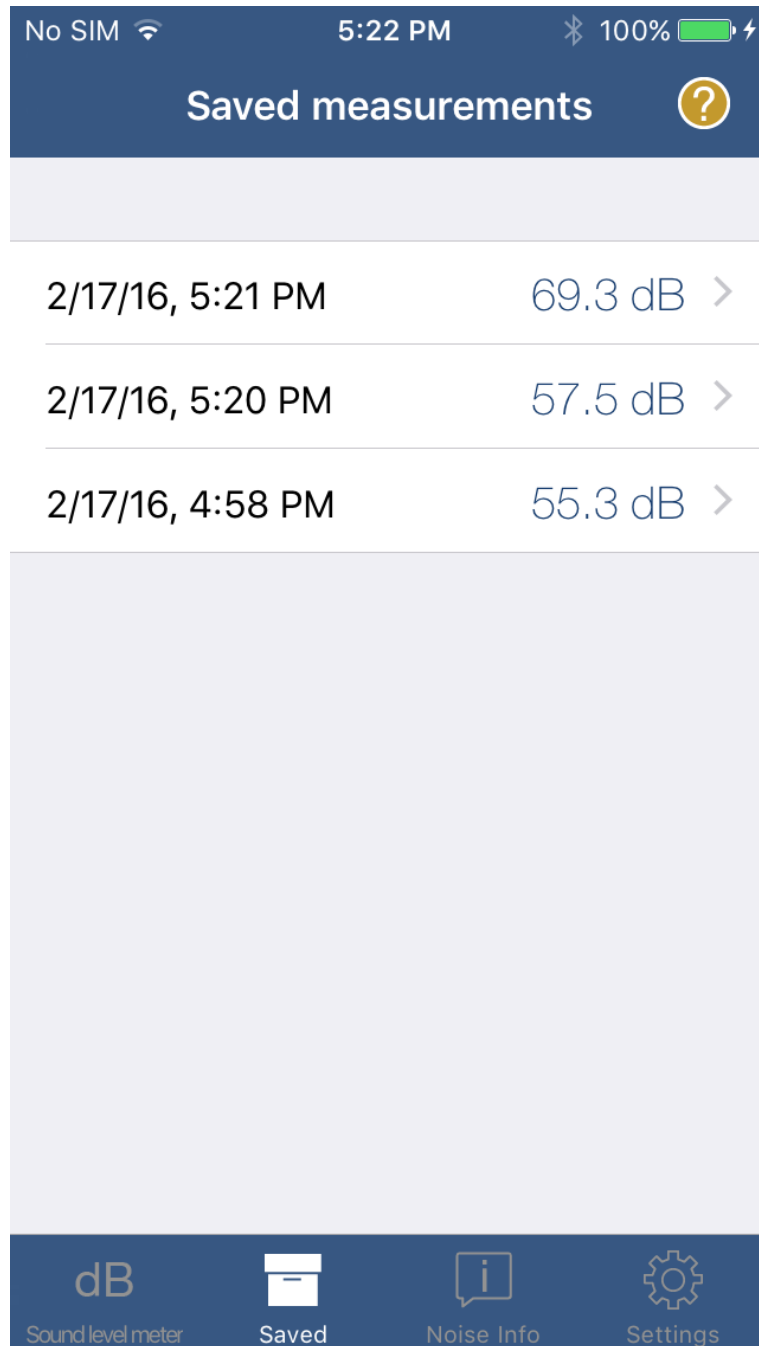
There is a permanent bar at the bottom of the screen that allows the user to switch between the main 4 screens of the app – Soundlevelmeter, Saved, Noise info, and Settings. The user can toggle back and forth between these screens and can also use the ← button at the top left of the screen to go back to the previous screen.

There are several “help” screens designated by “?” in the upper top right corner of each screen that should assist the user in conducting a noise measurement accurately, and help explain the various metrics:











Saved measurements screen

The second screen will give the user a list of “Saved measurements” with date and time stamp and the TWA for that specific measurement. Each saved measurement is stored separately.

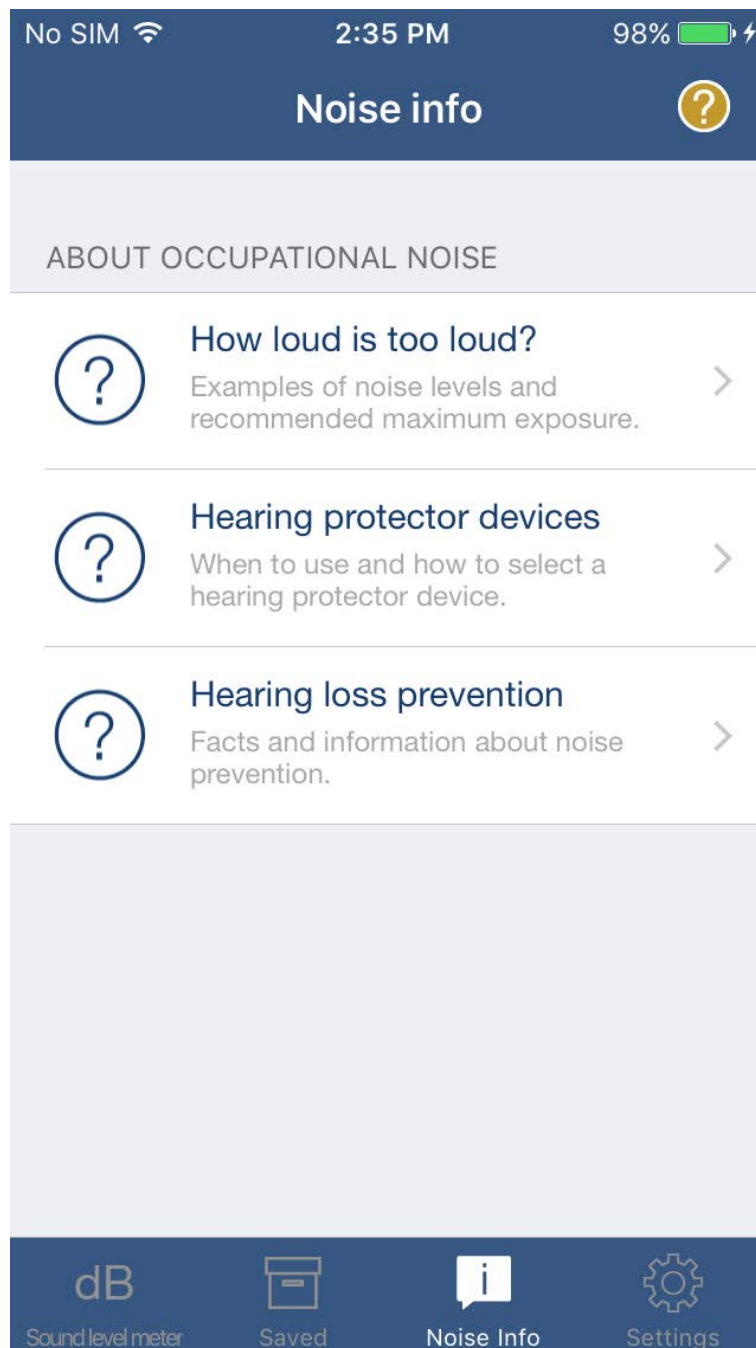


A detailed look at what the saved measurement will contain, the report information (date, measurement time, operator, location) as well as the measured values from the mains screen.

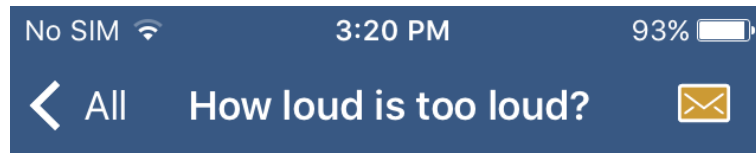
No SIM  5:07 PM 89% 	
 All	Measurement 
Date	3/7/16, 4:45 PM
Measurement time	00:01:04
Operator	Bob
Location	Cincy
MEASURED VALUES	
LAeq	70.1 dB
Max. level	94.4 dB
LCpeak	115.3 dB
TWA	51.0 dB
Dose	0.0 %
<div><div> Sound level meter</div><div> Saved</div><div> Noise Info</div><div> Settings</div></div>	

Noise info screen

The third screen contains some basic information from the NIOSH Noise and Hearing Loss Prevention Website: About Occupational Noise (How loud is too loud? Hearing protector devices, and Hearing loss prevention). The 3 screens are informational only with text from the NIOSH hearing loss prevention topic page.



a. How loud is too loud?



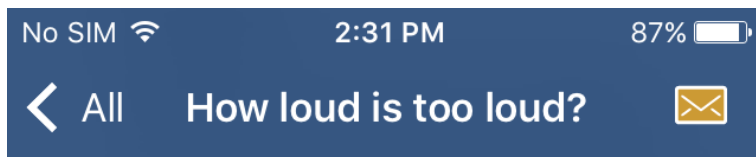
Know which noises can cause damage. Wear hearing protection when you are involved in a loud activity.

- **85 dB(A)**
Regular and prolonged exposures to noise at or above 85 dB(A) (averaged over 8 hours per day) are considered hazardous.
- **100 dB(A)**
Regular and prolonged unprotected exposure of more than 15 minute per day risks permanent hearing loss.
- **110 dB(A)**
Regular and prolonged unprotected exposure of more than 1.5 minutes per day risks permanent hearing loss.

Examples of noise levels

- **194 dB** Loudest possible tone
- **180 dB** Rocket launch
- **165 dB** 12-gauge shotgun
- **140 dB** Jet engine at takeoff
- **120 dB** Ambulance siren
- **110 dB** Pneumatic percussion drill





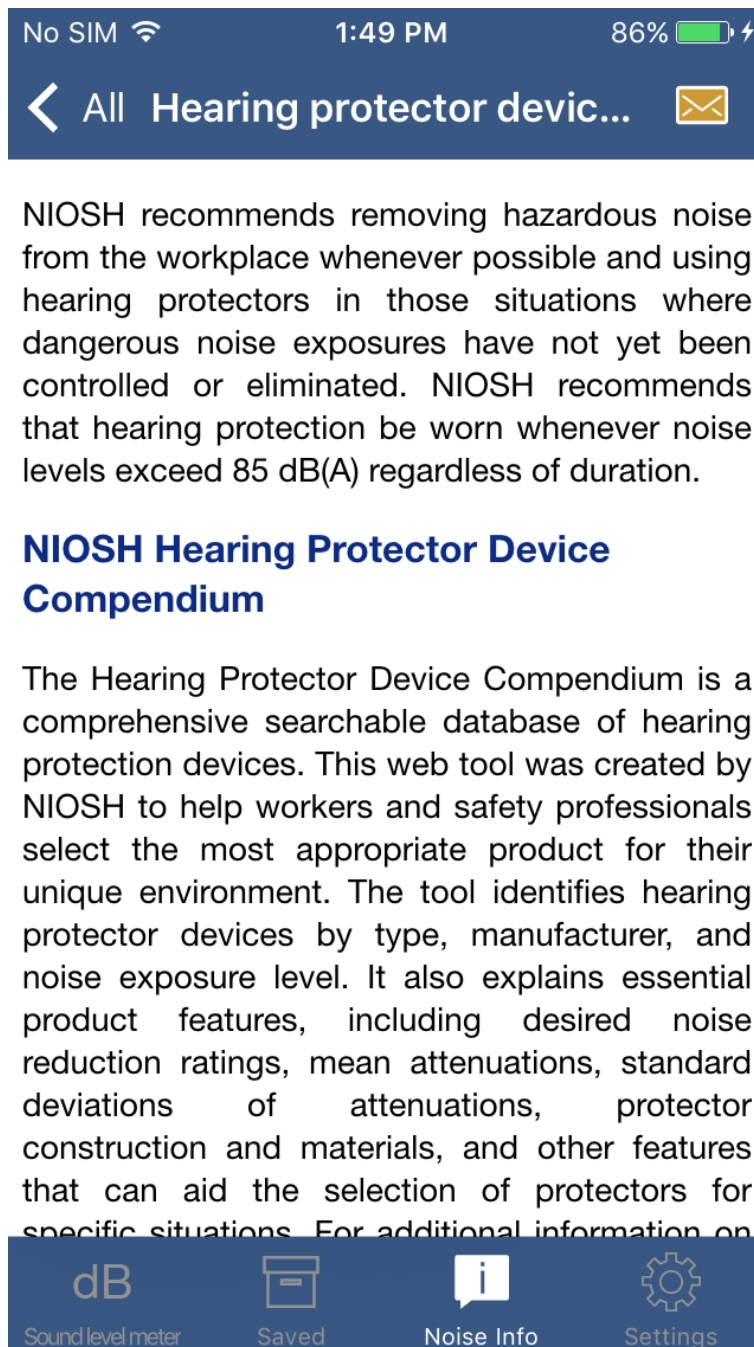
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Examples of noise levels

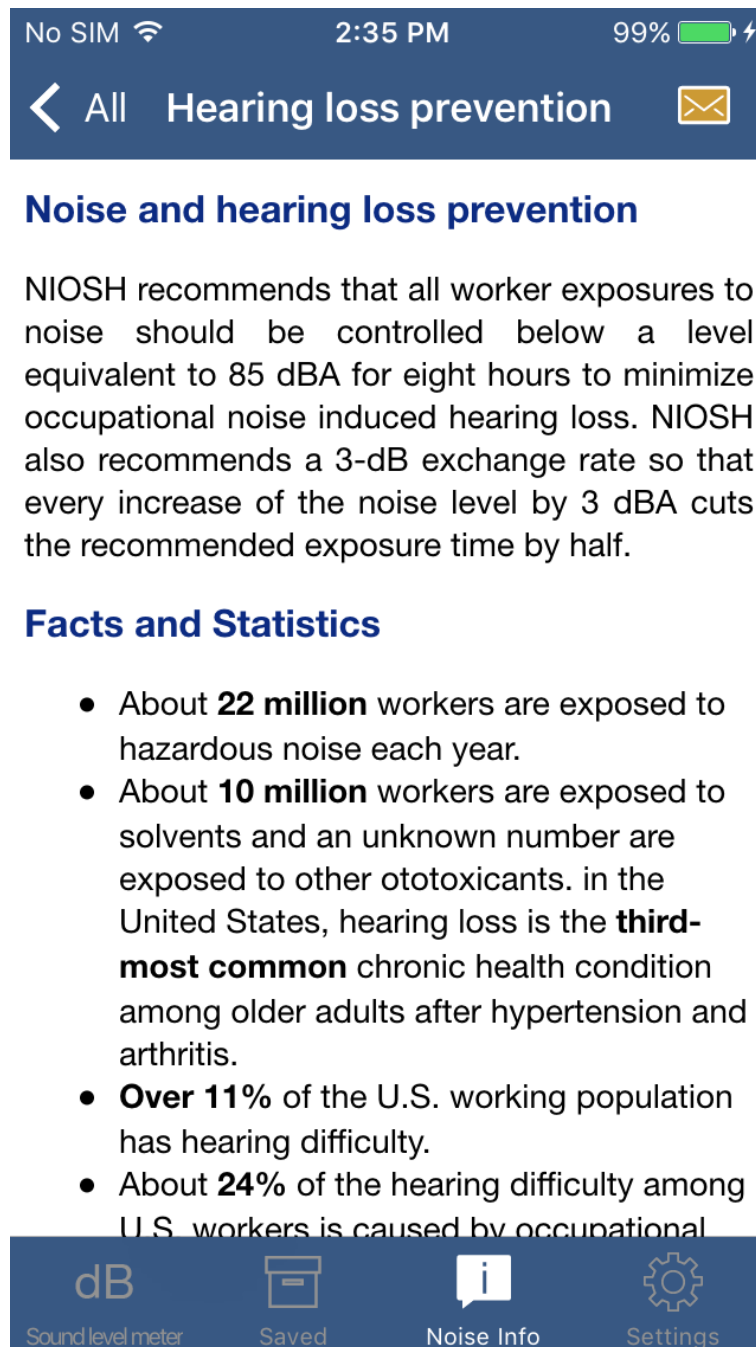
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- **120 dB** Ambulance siren
- **119 dB** Pneumatic percussion drill
- **114 dB** Hammer drill
- **108 dB** Chain saw
- **108 dB** Continuous miner
- **105 dB** Bulldozer, spray painter
- **103 dB** Impact wrench
- **98 dB** Hand drill
- **96 dB** Tractor
- **93 dB** Belt sander
- **90 dB** Hair dryer/power lawn mower
- **80 dB** Ringing telephone
- **60 dB** Normal conversation
- **30 dB** Whisper
- **0 dB** Weakest sound heard by the average ear



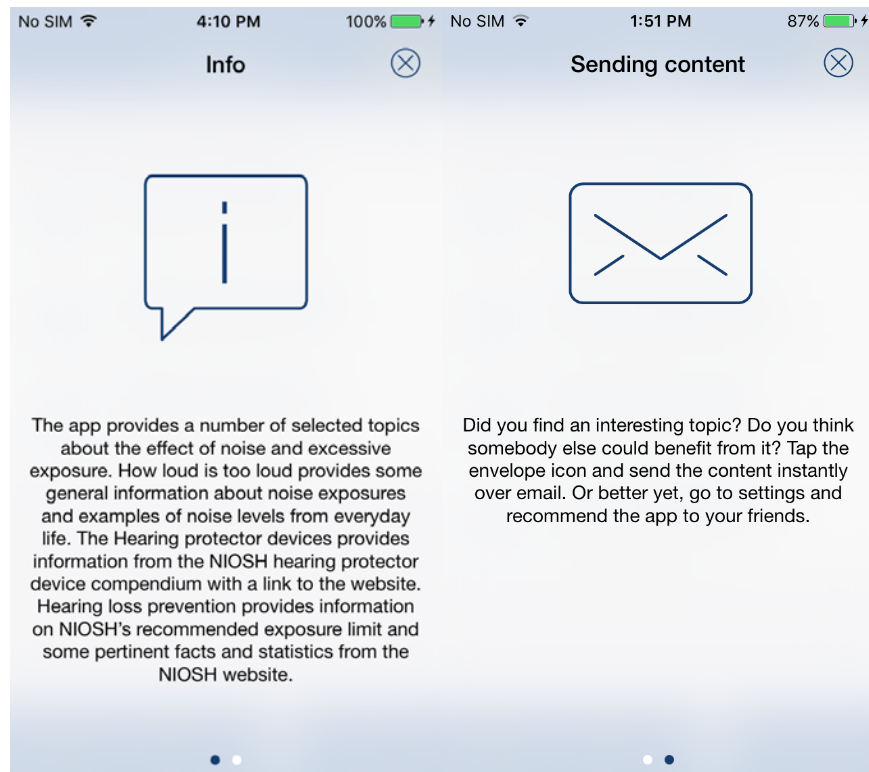
Hearing protector devices



b. Hearing loss prevention

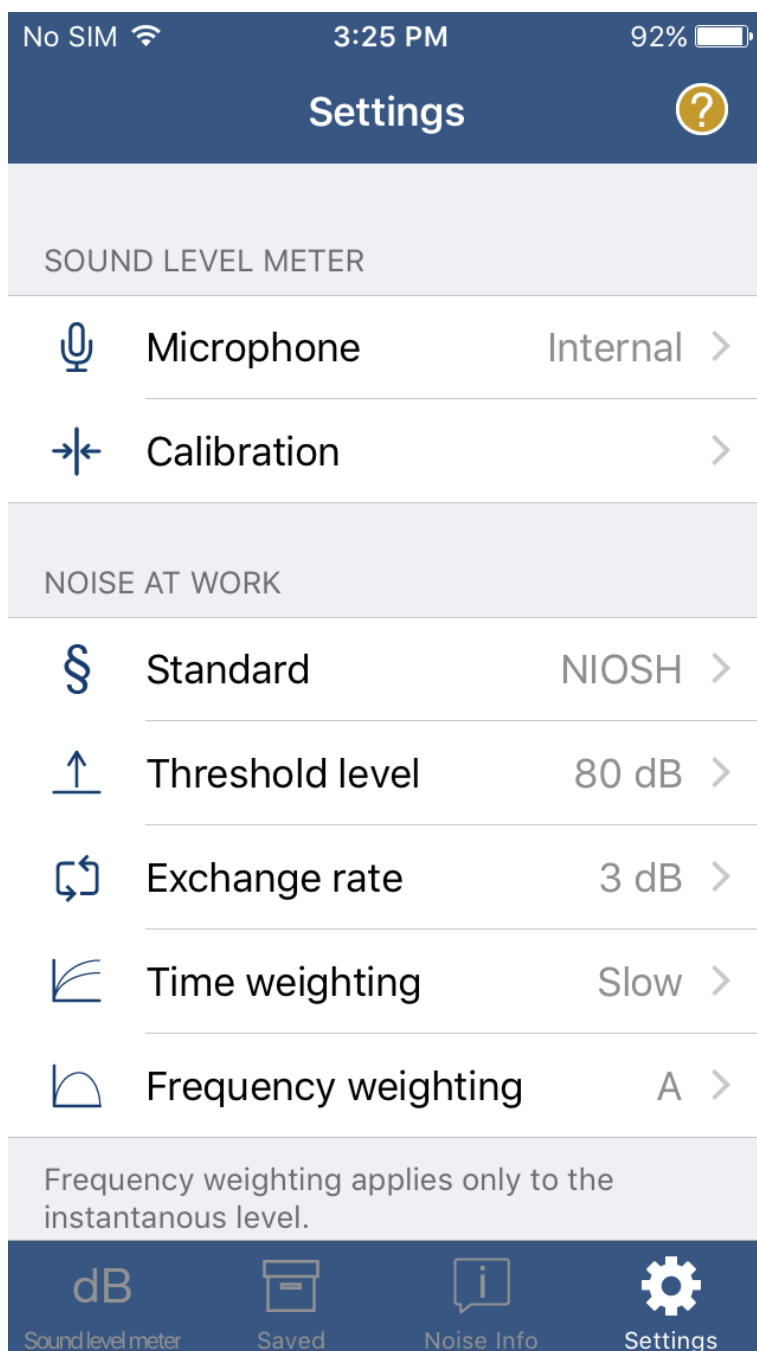


There are two “help” screens for such as for Info, and Sending content from the Noise info screens.

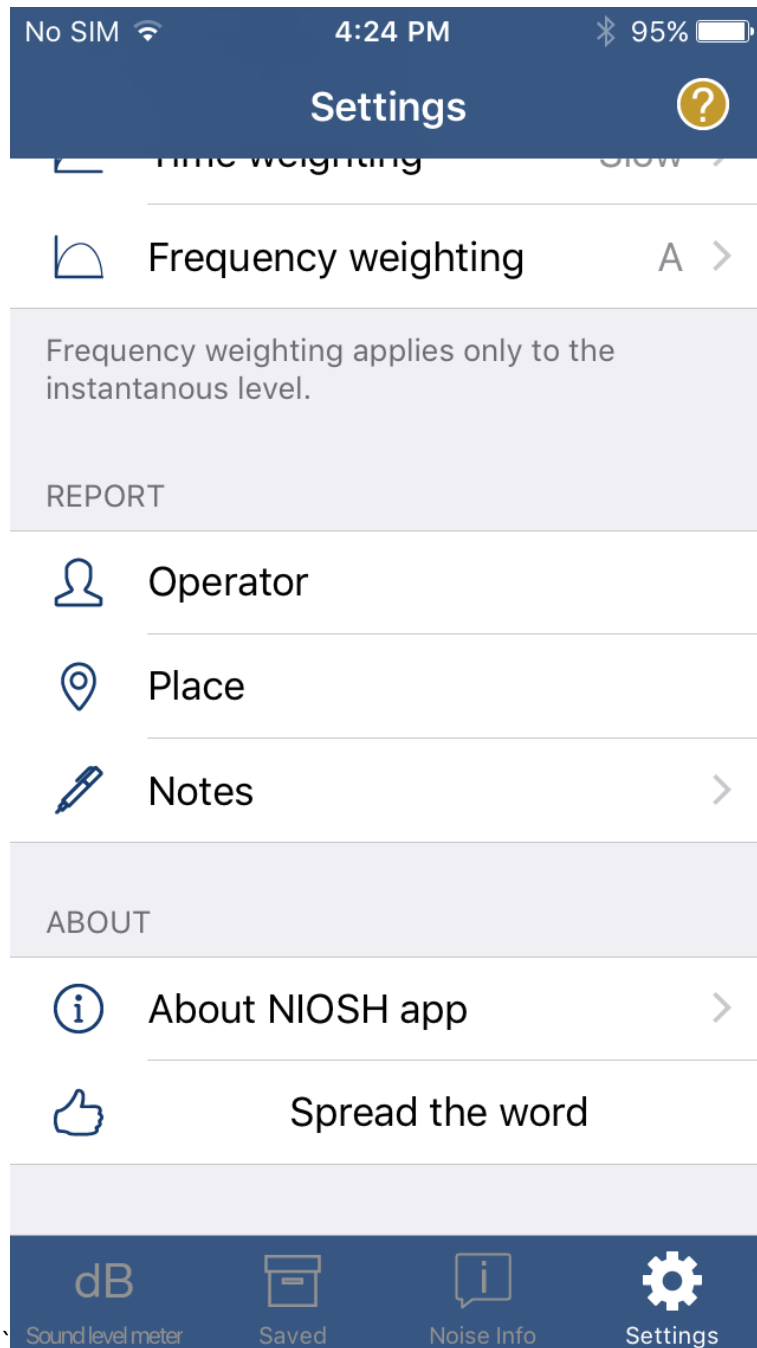


Settings Screen

The settings screen provides the user with the proper controls and settings to make accurate measurements.

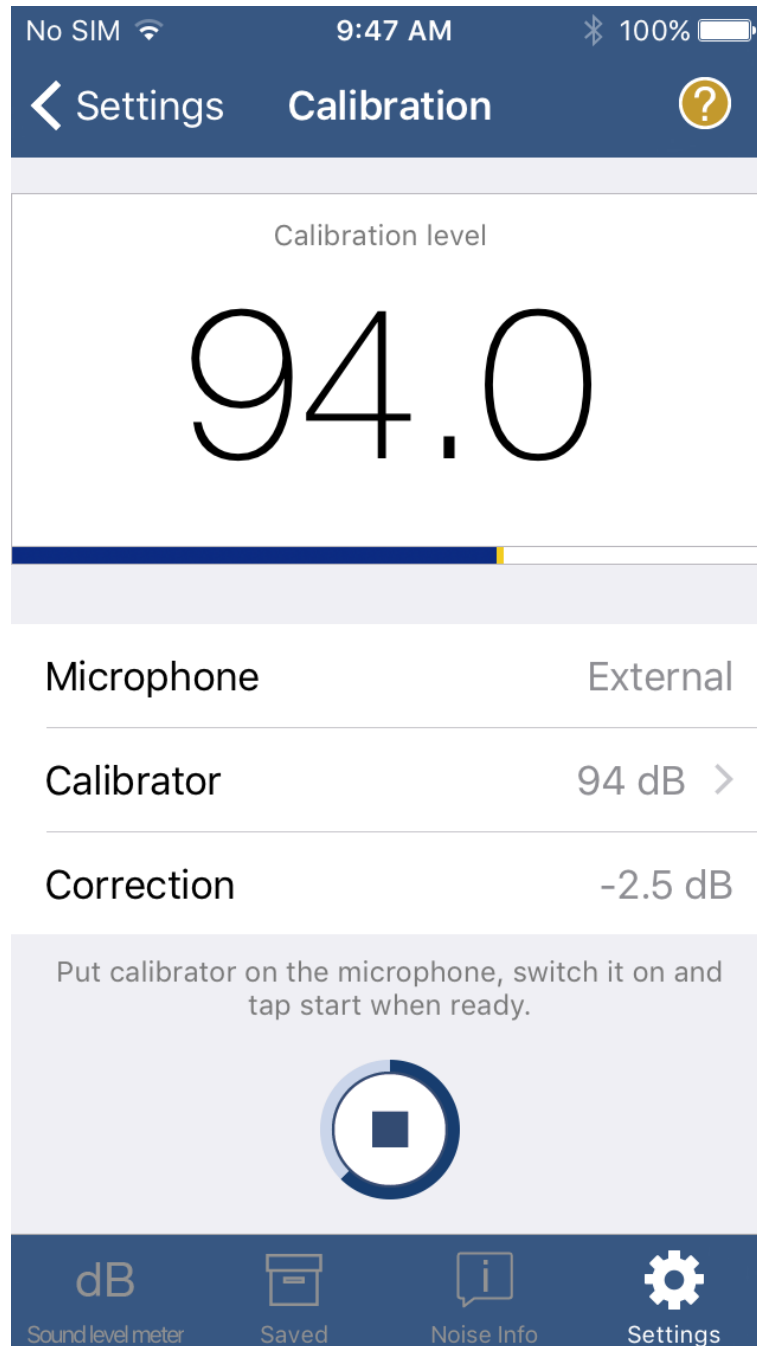


Remainder of the screen

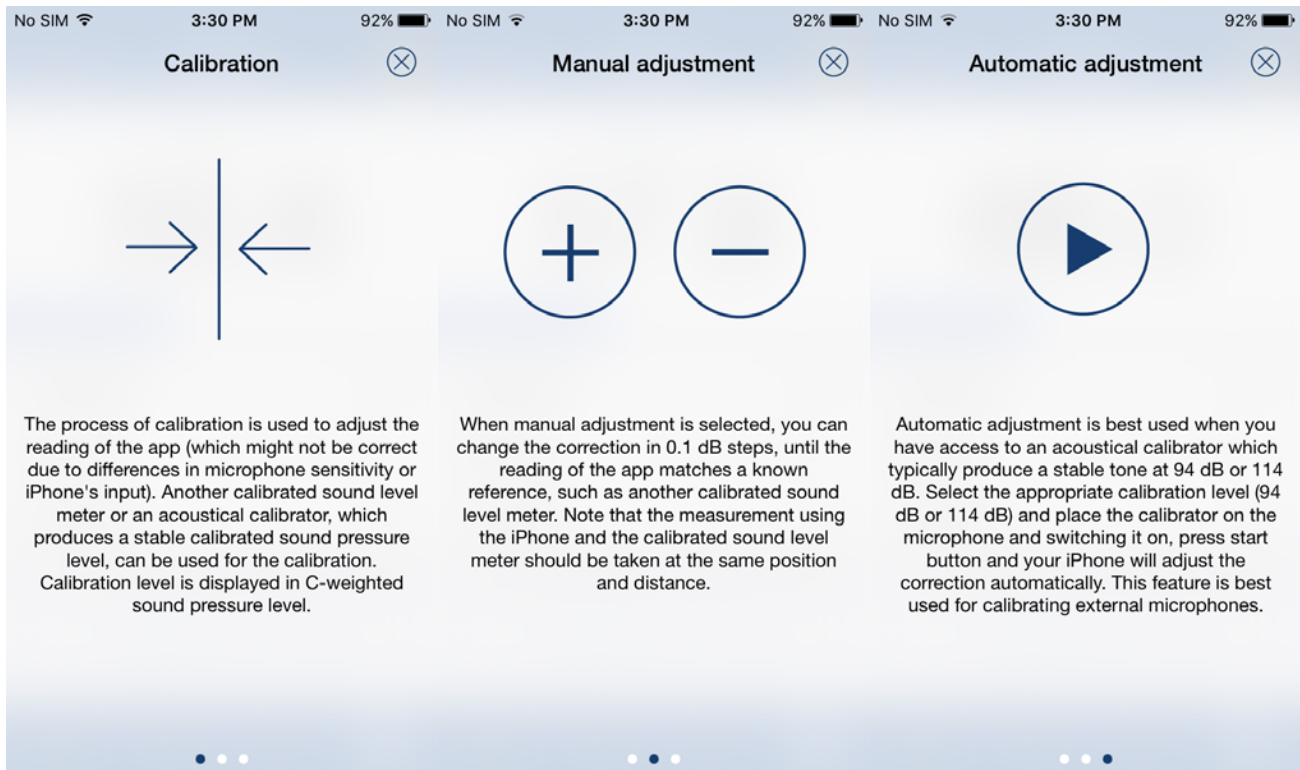


Under Sound Level Meter, there are two control settings:

1. Microphone: Allows the user to select between built-in internal or external microphone connected through the headset jack.
2. Calibration: Allows the user to calibrate the app based on a known sound source, such as an acoustic calibrator.

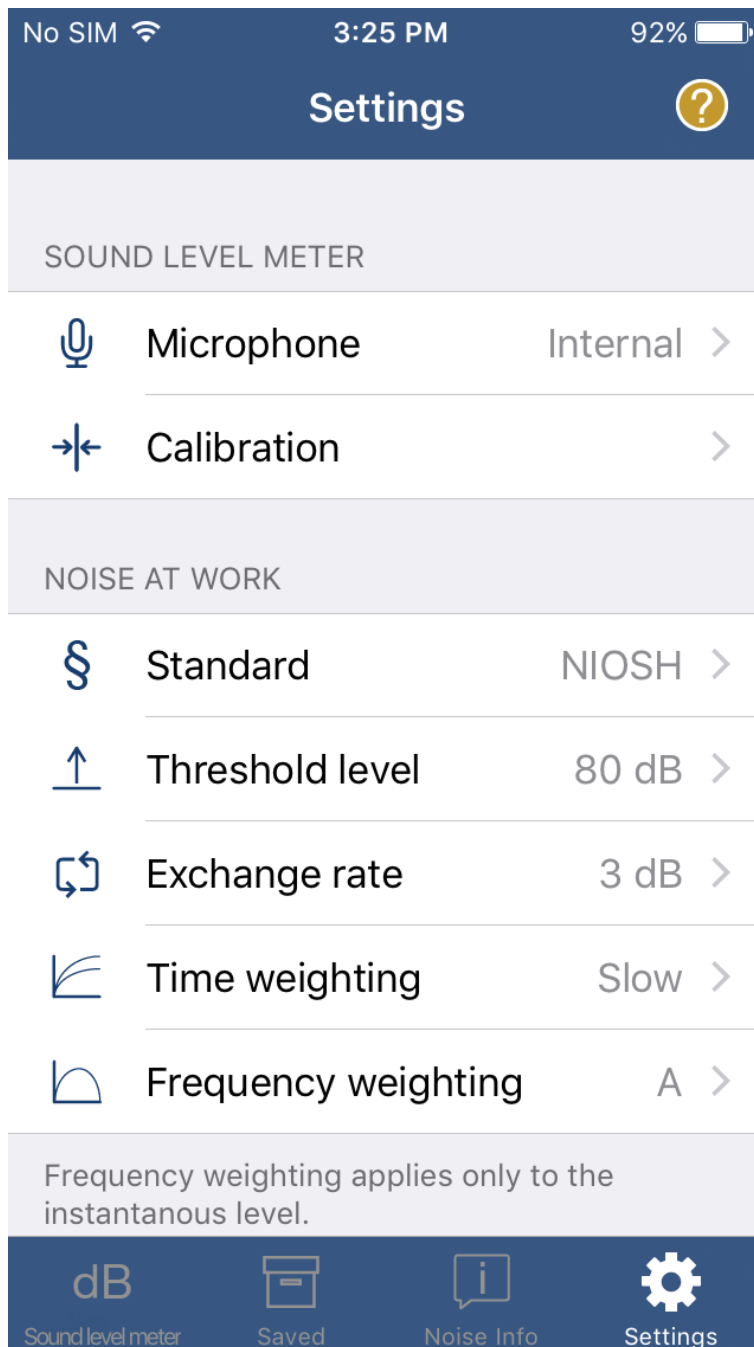


There are three “help” screens that can guide the user in conducting an accurate calibration, whether using the smartphone built-in microphone which would require a manual adjustment based on a known reference, or automatically which is best used with acoustical calibrators.



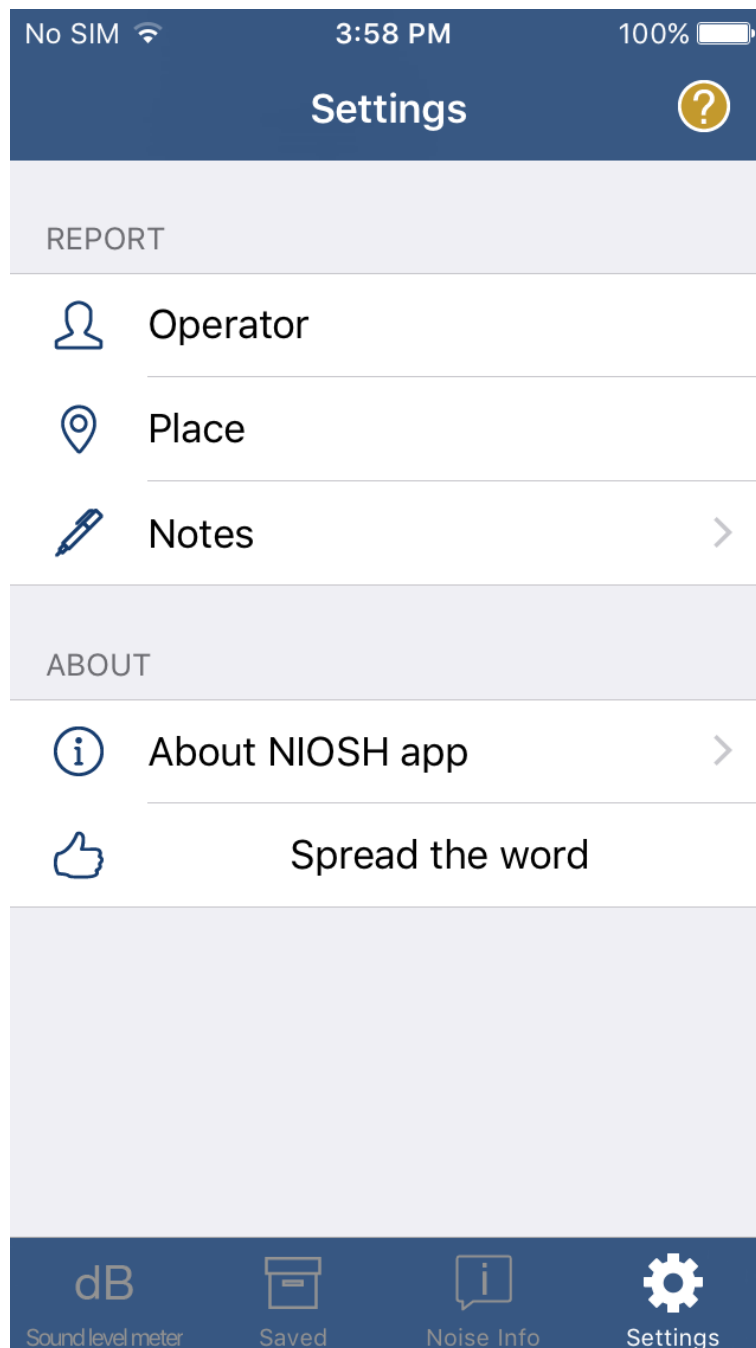
Under Noise at Work, there are four settings:

1. Standard: Allows the user to select between NIOSH (REL), OSHA Permissible Exposure Limit (PEL).
2. Threshold level: Threshold levels are automatically set to 80 for NIOSH, or 90 dB for OSHA.
3. Exchange rate: Exchange rates are automatically set to 3-dB for NIOSH or 5-dB for OSHA.
4. Time weighting: Allows the user to select the time constant (Slow or Fast)
5. Frequency weighting: Allows the user to select the appropriate frequency weighting response (A/C/Z).



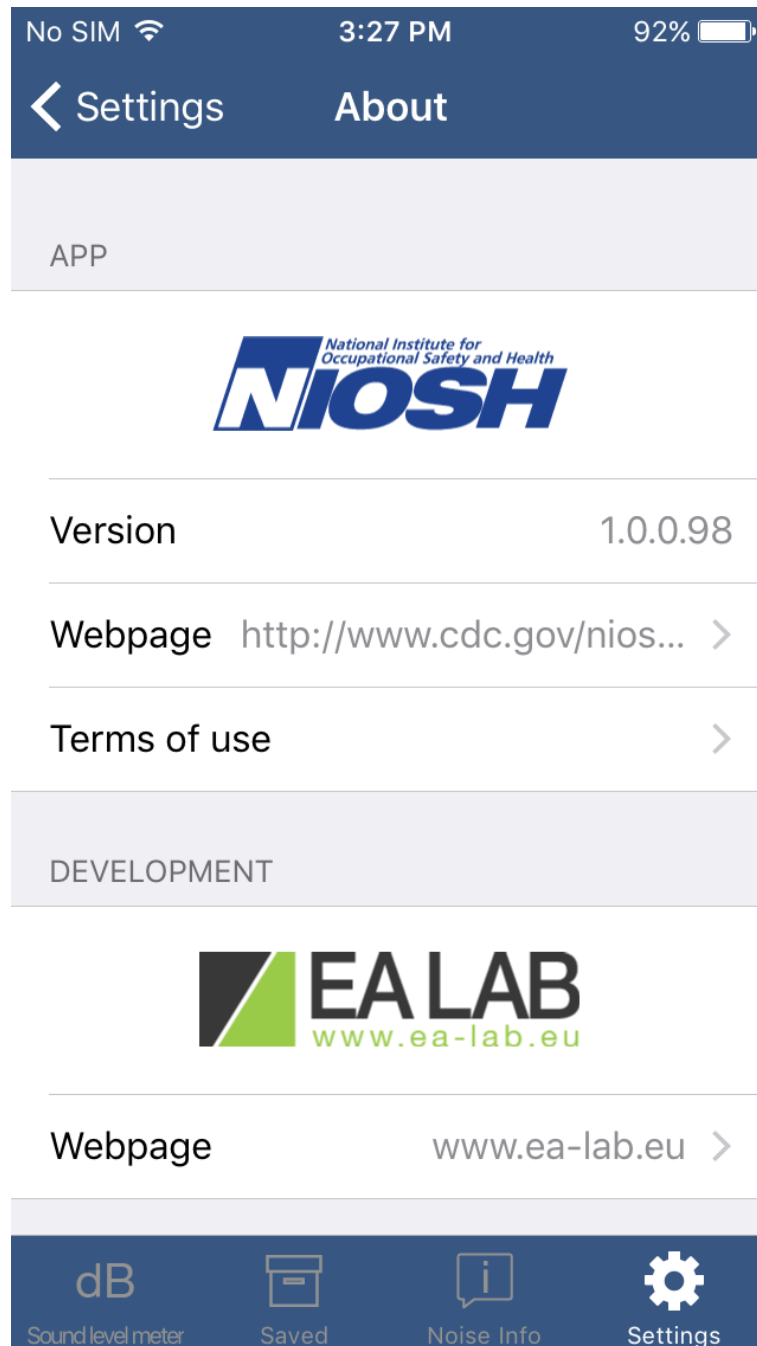
Under Report, there are three settings:

1. Operator: Allows the user to input the name or number related to the operator of the app.
2. Place: Allows the user to input the location of the measurement, which can either be typed in manually or automatically generated by selecting the GIS location icon to use the phone's location service.
3. Notes: Allows the user to enter additional notes up to 500 characters.



Under About, there are two settings:

1. About NIOSH app (contains information about NIOSH, version, terms of use; and EA LAB - the developer of the app).
2. Spread the word: Allows the user to share the app via email or other social media messaging platforms.



NIOSH Disclaimer under “Terms of Use”, basically used the same language from the NIOSH Ladder App:

