What's That Sound? Hearing Aid Mysteries Explained

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What Goes Bump in the Night…Or Day

- Baffled by a patient complaint?
- Strange sounds emitted from the hearing aid…only in certain circumstances?
- Problems replicating these sounds in the clinic?
- Ever wondered what is causing these "unexplained mysteries"?

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Agenda

- Hearing Aid Mysteries Case Files
- Unsolved Mysteries
- Hearing Aid Myth Busters

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Hearing Aid Mysteries…Solved

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Case of the Disappearing Sound Quality

Concern about exposing patients to high output levels

MYSTERY FOREST BY HENDRIC BÜNCK

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Case of the Disappearing Sound Quality

You're concerned about exposing patients to high output levels. You made some changes, but now the patient is complaining of sound quality issues.

You want to be sure that amplified sound is not above the patient's tolerance.

You should:

A. Decrease the MPO to match UCL
B. Decrease gain levels in output view to ensure they are below UCL
C. If possible, include UCL measurements in the audiogram
D. Order an earmold with a large vent allowing more sound to escape

Let's follow the more probable leads in the case!

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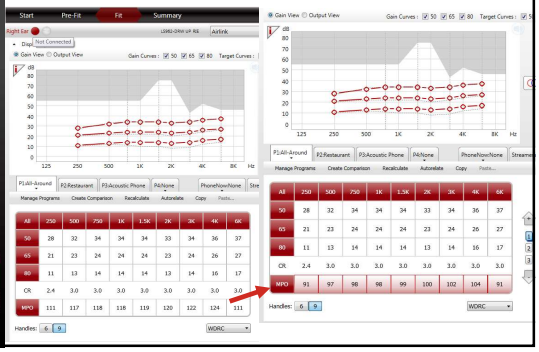
Investigating Option A: MPO Change



Investigating Option A: MPO Change

Uh Oh!

The patient has returned with complaints of sound quality issues such as

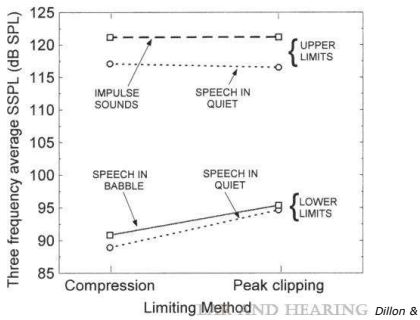
- Sound uneven
- Sound suddenly seem to cut out
- Sound is choppy at times

Investigating Option A: MPO Change

What happened?

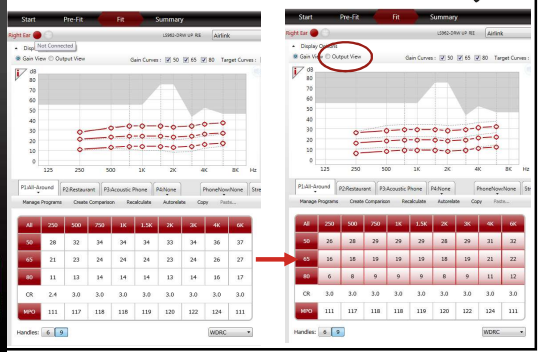
- The compression ratio is now too high because the output range has been significantly reduced
- The hearing instrument is now going into saturation
- Patient is frequently exposed to distortion and sound artifacts

Investigating Option A: MPO Change



SECOND HEARING *Dillon & Storey, 1998*

Investigating Options B: Gain Change



Sample of Possible Distortion

Lowering MPO

Lowering Gain

Case of the D CASE CLOSED ound Quality

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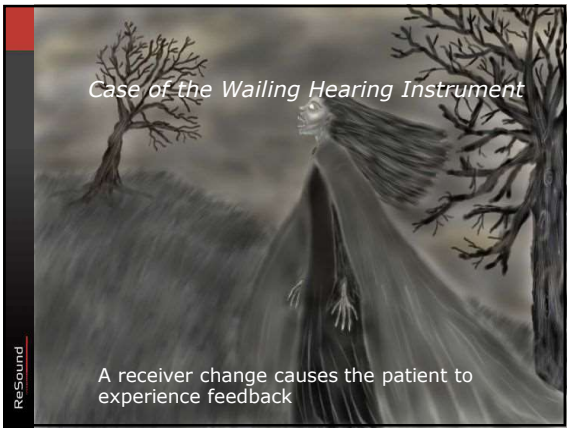

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Case of the Wailing Hearing Instrument

Patient was originally fit with a medium power receiver.

Later, the patient was upgraded to a high power receiver, and is now experiencing feedback.

What could be the cause?

A. The receiver was not properly placed in the sound bore of the custom earmold
B. The Safe Fitting Mode of the feedback manager was turned off
C. When the receiver was changed on the hearing aid, it was not reconfigured in the fitting software for the correct receiver
D. There is a Tic Tac in the ear

Let's follow the more probable leads in the case!

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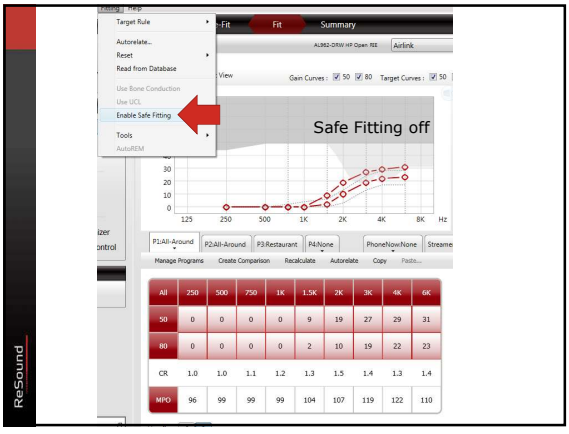
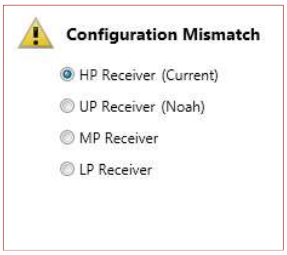
Investigating Option A: Misaligned Sound Bore

OSPL90 and 60 dB gain curves with gross misalignment

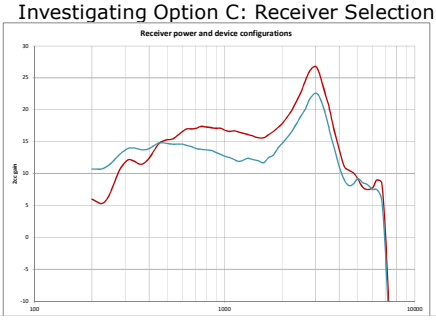
Investigating Option B: Safe Fitting Mode



Investigating Option C: Receiver Selected in Fitting Software vs. Receiver Actually On the Hearing Instrument



Investigating Option C: Receiver Selection



HP receiver with MP fitting software configuration
HP receiver with HP fitting software configuration

Investigating Option C: Receiver Selection

Case of th CASE CLOSED ring Instrument

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Case of the Hearing Aid Killer

Patient reports that the hearing aid goes dead after a loud sound, and sometimes needs a reboot to start working again.

What could it be?

A. The loud sound caused a drop in the battery voltage, resulting in the device crashing
B. The hearing aid selected wasn't the appropriate power level
C. The processing chip was not properly installed in the hearing instrument
D. The hearing aid just got tired and went into "snooze" mode – hey, it's a lot of work being a hearing aid!

Let's follow the more probable leads in the case!

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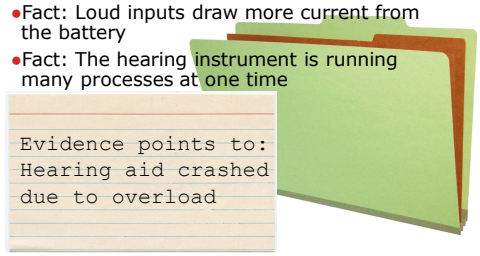
Investigating Option A: Battery Voltage Drop

- Fact: A certain battery voltage is required for the signal processing to work properly
- Fact: Loud inputs draw more current from the battery
- Fact: The hearing instrument is running many processes at one time



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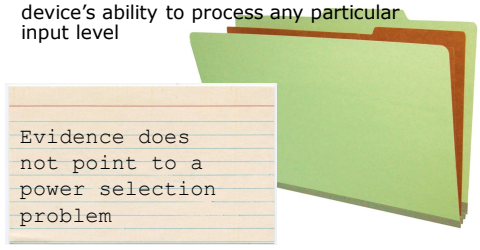
Investigating Option B: Power Level Selection

- Fact: Power levels vary in the capabilities of the receiver to produce output
- Fact: Power level does not determine the device's ability to process any particular input level



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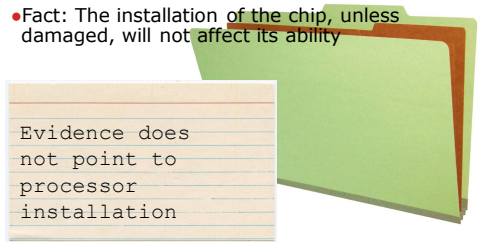
Investigating Option C: Processing Chip Installation

- Fact: The processing capabilities of the chip can have an effect on its ability to handle complicated environments
- Fact: The installation of the chip, unless damaged, will not affect its ability



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Case of the Haunted Automobile

Patient noted strange sounds and/or the hearing aids shutting down when entering the car.

What could it be?

A. The seatbelt alarm
B. The hearing instrument is in "car mode," which changes the feature settings to reduce road noise
C. The ultrasonic airbag sensor in the car
D. The tire pressure sensor

Let's follow the more probable leads in the case!

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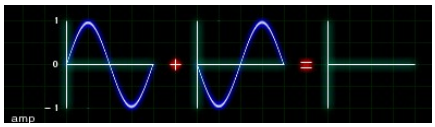
Investigating Option A: Seat Belt Alarm

- Feedback systems use phase cancellation



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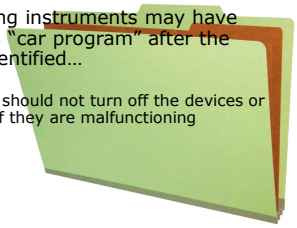
Investigating Option B: "Car Mode" or Car Program

- Fact: Currently there is no "car detection" in hearing instruments
- Fact: Some hearing instruments may have auto steering to a "car program" after the environment is identified…
  - But in any case, it should not turn off the devices or make it sound as if they are malfunctioning



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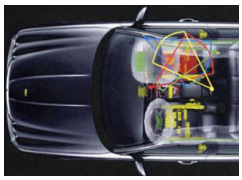
Investigating Option C: Airbag Sensor

Did you know?

Ultrasonic detectors are commonly used for turning lights off and on automatically, as well as for some cars to detect a passenger in the seat and decide whether to activate the airbag for that seat.



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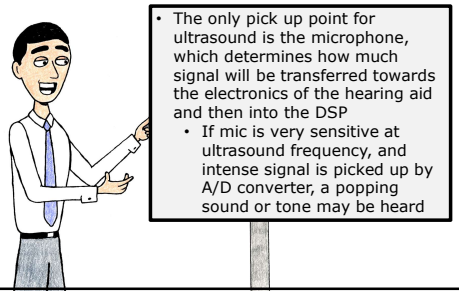
Investigating Option C: Airbag Sensor

- Expert Interview: Electroacoustic Engineer



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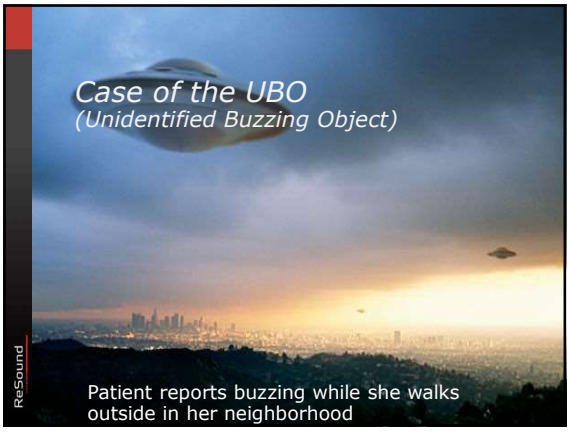

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Case of the UBO

Patient notices buzzing in her hearing instruments, but only while walking outside in her neighborhood.

What could be causing this?

Could be anyone's guess!!!!

Let's do some PI work!

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Investigation: UBO

Report details:

- This is a more recent event, hasn't been a problem in the past
- It has been so frequent the practice will no longer order the wireless hearing instruments
- Replacing the devices is not helping
- One patient's spouse, an engineer, believes it is coming from the streetlights!

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Investigation: UBO

Review of similar closed case flies:

- Multiple cases of the buzzing near store security posts
- Findings:
  - The security posts at stores are looking for the RFID tags on items that haven't been deactivated.
  - They can cause temporary buzzing in the hearing aids due to electromagnetic interference.
  - This is not really a defect, but typical transient interference.

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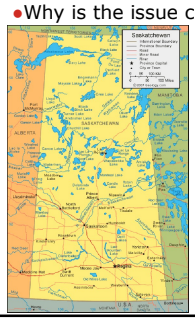
Investigation: UBO

- Why is the issue centralized in this location?



- Google search on the town revealed that had recently undergone streetlight replacement with LED streetlights
- Some LED lights have been known to cause electromagnetic interference

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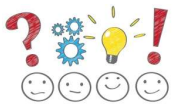
Case

CASE CLOSED

Patient notices buzzing in her hearing aids, but only while walking outside in her neighborhood.

What could be causing this?

New LED streetlights



But what about all of the other towns with LED lights?

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Electromagnetic Interference (EMI) Minimization

- All electronic equipment should be properly grounded against EMI.
- Although the hearing aid's wireless components are shielded, there are practical limitations due to size constraints.
- Cities should ensure that streetlights are meeting certain immunity criteria.
- Other cities use LED lights but this is not a widespread problem.
- *This community may have installed streetlights that did not meet EMI immunity criteria.*

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Case of the Telekinetic Hearing Instruments

Patients report hearing aids are beeping/changing programs on their own

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Case of the Telekinetic Hearing Instruments

Patients reporting hearing instruments changing programs/beeping on their own

What could it be?

A. The patient's glasses
B. A malfunctioning remote control
C. The TV remote is controlling the hearing aids
D. The patient's psychic cat

Let's follow the more probable leads in the case!

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Investigating Option A: Glasses

Report details:

- Upon questioning, patients identified these changes in conjunction with audible tones from the hearing instruments
- These tones were identified as the beeps indicating when the Autophone program activates and deactivates
- All patients reporting this issue wear glasses at least on a part time basis

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Investigating Option A: Glasses

- Fact: In all of these cases, the glasses frames were made of metal
- Fact: Metal can become magnetized by touching other metal objects
- Fact: The Autophone program uses the magnet in the phone to activate and deactivate

Evidence points to: Magnetization of glasses frame

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Investigating Option B: Rogue HA Remote Control

- Not all patients had a remote control in this case
- But sometimes, it IS the remote control's fault! (sort of)
  - Patient doesn't realize that the remote control is not locked in a purse or pocket, and buttons are getting pressed accidentally

Evidence does not point to the remote control

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Investigating Option C: Rogue TV Remote

- Fact: Standard TV remotes use infrared transmission
  - Infrared runs at 300 GHz – 430 THz
- Fact: Hearing device uses proprietary 2.4 GHz

Evidence does not point to TV remote

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Case of th Hearing Instrumer

Patients have reported hearing instruments changing programs/beeping on their own

What could it be?

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B. A malfunctioning remote control
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D. The patient's psychic cat

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Unexplained Occurrence #1

- Report: My patient is picking up random cell phone conversations with her wireless hearing aids, although she does not have any wireless accessories.
- Possible causes:
  - Interference with voice carrying transmission
    - Radio frequency
    - Cell phones

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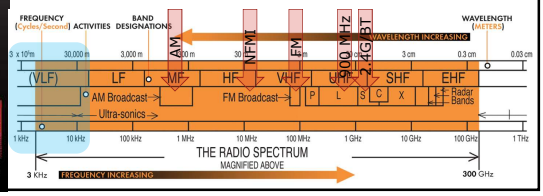
Unexplained Occurrence #1

UNSOLVED MYSTERIES

- Could theoretically happen when the patient is near a radio tower with strong AM (amplitude modulation) radio frequency transmission – but unlikely in everyday circumstances.
- FM radio transmission is more complex, because the information is "stored" in the frequency modulation and must be extracted



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Unexplained Occurrence #1

UNSOLVED MYSTERIES

- Engineers conducted an experiment:
  - Hearing aid exposed to an AM signal in a controlled environment.
  - While it was actually possible to generate an audible signal in the hearing aid, this only happened at extremely high field strengths that would not occur in real-life environments.

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Unexplained Occurrence #1

UNSOLVED MYSTERIES

Cell phone transmissions explained:

- Cell phone signals are transmitted in a different frequency band than our 2.4 GHz wireless system
- Phone signals are encrypted
- However, close proximity to cell phones can cause interference, heard as a pulsing or buzzing noise in the hearing aid

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Unexplained Occurrence #1

Analogy:

- Even though the physical systems might be the same (radio transmissions in the 2.4 GHz band), the rules for communication are not.
- It is like two humans (same physical species) who are speaking different languages.
- They may be able to talk over each other and block each other's signals, but they can't just take over each other's communications.

Unexplained Occurrence #2

- Report: Hearing aid volume decreases when the neighbor uses his garage door opener

Unexplained Occurrence #2

- Garage openers explained:
  - Transmission strategies based on the age of the garage door opener:
    - Early garage door openers transmitted on a designated frequency; the receiver would pick up the designated radio signal
    - Later, a digital code was preset by switching eight to twelve DIP switches on the receiver and transmitter
    - Many current garage door openers use a frequency spectrum range between 300-400 MHz, and most of the transmitter/receivers rely on hopping- or rolling-code technology
  - None of these scenarios are compatible with or could be confused by a 2.4GHz hearing instrument

Unexplained Occurrence #2

UNSOLVED MYSTERIES

- Garage openers explained:
  - Even a garage door opener operating at 2.4 GHz would not be capable of changing any settings in the hearing aid.
- *COULD IT BE NOISE REDUCTION???*

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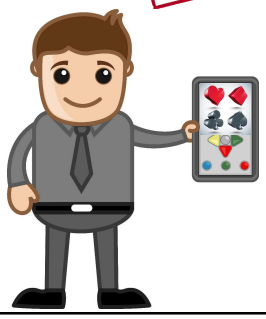
Unexplained Occurrence #3

UNSOLVED MYSTERIES

- Report: My patient says her wireless hearing aids are causing her handheld poker game to turn on.



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Unexplained Occurrence #3

UNSOLVED MYSTERIES

- Explanation**:**
  - Similar to the cell phone question, the hearing aids cannot communicate with devices that are not using the same proprietary wireless protocol.
  - Apart from that, the game had a mechanical switch that powers it off and on.
  - The wireless transmissions from the hearing aids cannot activate a mechanical switch.
  - Maybe a faulty switch on the poker game?

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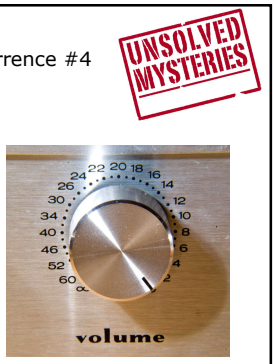
Semi-Unexplained Occurrence #4



- Report: My patient hears random beeps, followed occasionally by random drops in the volume.
- Proof of volume drop: decrease in % volume level in iOS native app

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Semi-Unexplained Occurrence #4

- Possible Explanation:
  - Momentary weak radio connection causes a problem with the cycles redundant check (CRC)
  - Result: Incorrect instructions being sent to the hearing aids to change volume or programs

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Common Thread among Many of These Unsolved Mysteries

- Several were experienced by new users
- Normal tendency to attribute new occurrences to recent changes or other "new" occurrences

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Mythbuster #1: Can you have better ear to ear wireless connectivity if you wear glasses?

- **Yes**
- **No**

- The wire frames can act as a conductor
- Patients have reported this occurrence

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Mythbuster #2: Is there EVER a situation where you can run your hearing aid over with a car and not "total" your hearing aid?

- **Yes**
- **No**

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The Case:

- A woman slowly reversed her Toyota Scion XD in her driveway.
- She didn't notice the small hearing aid case behind one of her back wheels which held her RIE
- Her husband brought the hearing aid along with the case

Exhibit A

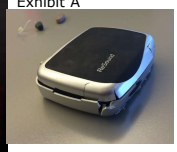

Exhibit B

Exhibit C

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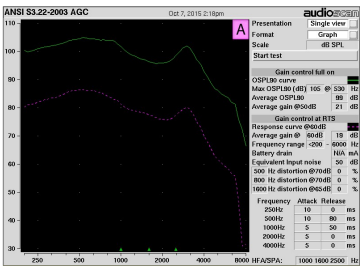
The device WORKED after the receiver was replaced (the receiver did not survive)



ANSI Test Results with New Receiver

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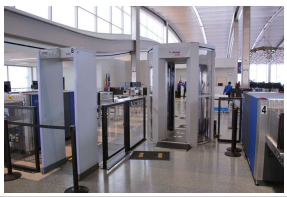
Mythbuster #3: Do you have to remove my hearing aids when going through an airport scanner?

- **Yes**
- **No**



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Thank You!