Session No. 533

What Are the 85-3 Coalition and the Dangerous Decibel® Program

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The 85-3 Coalition

In 1979 I took a job, my first job in the safety profession, as a Training Officer for the Accident Prevention Division (APD) of the Workers' Compensation Department in Salem, Oregon. Oregon had a State Plan with Federal OSHA, and one of my first assignments was training Safety Compliance Officers in the topic of Occupational Noise. The APD later became Oregon OSHA, but at that time noise was not well understood. The training program I put together took a day to complete, and was a comprehensive review of the state of the art at that time. I discussed the OSHA Permissible Exposure Limit, and then described in easy language how to interpret results from sound level meters and apply them to the regulations under APD, which were the same as OSHA's federal regulations.

Skipping ahead to 2009, I was in an MSPH program through Tulane University's Center for Applied Environmental Public Health, in Industrial Hygiene and needed to complete my Capstone Project for the degree. So I started looking at different possible topics, and two that I thought would be interesting were the NIOSH Lifting Equation, and Occupational Noise. I decided to pursue the Capstone Project on Occupational Noise because this topic had been neglected for many years. My research showed that the same PEL that I taught in 1979 to Oregon's Safety Compliance Officers was still in effect in 2009, thirty years later. But the state of the science for occupational noise exposure had changed.

These changes came about because we gained a lot of knowledge of hearing loss, how it occurs and the driving forces for it. I joined the American Industrial Hygiene Association's Noise Committee, and then was asked if I could become the Secretary. I agreed, not realizing that this was a progressive step, and the next year I would become the Vice Chairman, and the third year I would become the Chairman of the Noise Committee. So I was able to discuss this problem of noise-induced hearing loss with the people in the field who were the experts, some of whom had written the AIHA book, *The Noise Manual*. At the same time, as a member of the ASSE Industrial Hygiene Section, my Capstone Project was published in ASSE's *The Monitor* as a three-part series. As a part of this process, I got to know people like Alice Suter and Scott Schneider, who were among those who started the 85-3 Coalition.

Before getting into this though, let's step back a bit and understand what the OSHA PEL actually involves, and why there is an 85-3 Coalition. There is a lot of research behind all this, and of course politics too.

The OSHA Permissible Exposure Limit was established in the late 1960s, using a compromise formula which allowed exposures to start at 90 decibels on the A-scale (which is what our ears hear, rather than a C-scale, which represents the sound pressure levels). To actually understand noise, you need to understand what this thing called a "decibel" actually is. The decibel in a unit of measurement of sound pressure level, using a logarithmic formula based upon the number "10" and a decibel[1] is 1/10th of a Bell (a little-used unit currently, named in honor of Alexander Graham Bell). Figure 2.1[2] better visualizes the difference between the sound power in watts and the sound power level in decibels.

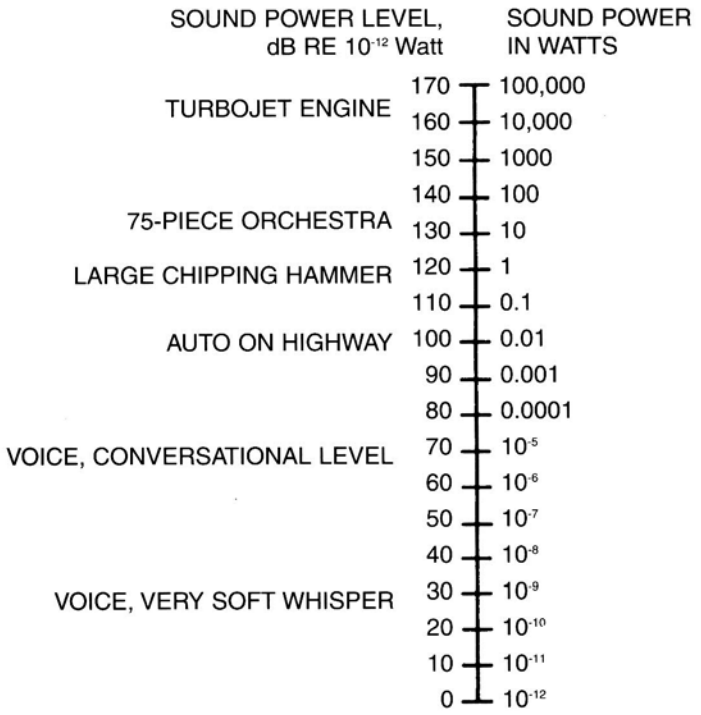

Figure 2.1 — Relationship between sound power level (L_w) and sound power (W).

See that the sound power goes from 10^{-12} watts to 100,000 watts, which represents over 15 orders of magnitude difference in power.

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[1]The formula is shown as: $L = 10 \log(A/B)dB$, where the Level (L) is equal to 10 times the logarithm of A divided by B, in decibels. "A" and "B" are quantities related to power. The reference is 10^{-12} watts, which is "B" above. The sound power in watts is in the numerator. So a 100 watt sound power level, divided by 10^{-12} watts, and put into this formula equals 140 decibels (dB).

[2] Ostergaard, Paul B., "Chapter 2, Physics of Sound and Vibration," *The Noise Manual, Fifth Revised Edition*, American Industrial Hygiene Association, 2003, page 23.

In order to translate this into a Permissible Exposure Limit (PEL), we also need to know the time that we can be exposed to these levels without undue harm. This is what is expressed in the "Table G-16 - Permissible Noise Exposures" table in the OSHA regulations.

Table G-16 – Permissible Noise Exposures [1]

Duration per day, hours	Sound level dBA slow response
8	90
6	92
4	95
3	97
2	100
1 1/2	102
1	105
1/2	110
1/4 or less	115

1 When the daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect should be considered, rather than the individual effect of each. If the sum of the following fractions: $C_1/T_1+C_2/T_2 C_n/T_n$ exceeds unity, then, the mixed exposure should be considered to exceed the limit value. C_n indicates the total time of exposure at a specified noise level, and T_n indicates the total time of exposure permitted at that level.

Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.

Note how the exposure starts at 90 decibels on the A-scale for 8 hours, and then as the duration of exposure is halved, the allowed sound level is doubled, so that at 95 decibels a person under the OSHA PEL is allowed to be exposed for 4 hours, and at 100 decibels, 2 hours, etc. This is now known as the 5 decibel, or 5 dBA exchange rate.

But does this level actually protect the worker? That was the assumption years ago, but it was a political compromise. Even then, it was known that not all workers would be protected by this PEL. Now, we know that the PEL is not very protective. NIOSH in 1998 published their ***Table 3-4, Comparisons of excess risk estimates by organization***[3]. This table shows that the daily exposure to 90 dBA for 8 hours results in a between 3 and 29 percent excess risk of significant hearing loss over a 40-year working lifetime. It also shows two other average daily levels, at 85 dB and 80 dB. At 85 dB there is much less likelihood of a hearing handicap during a working lifetime. At 80 dB for an 8-hour exposure, few workers would lose hearing over the working lifetime.

[3] Centers for Disease Control and Prevention, National Institute of Occupational Safety and Health, ***Criteria for a Recommended Standard—Occupational Noise Exposure, Revised Criteria 1998***, June 1998, page 24.

Table 3–4. Comparison of models for estimating the excess risk of material hearing impairment at age 60 after a 40-year working lifetime exposure to occupational noise, by definition of material hearing impairment

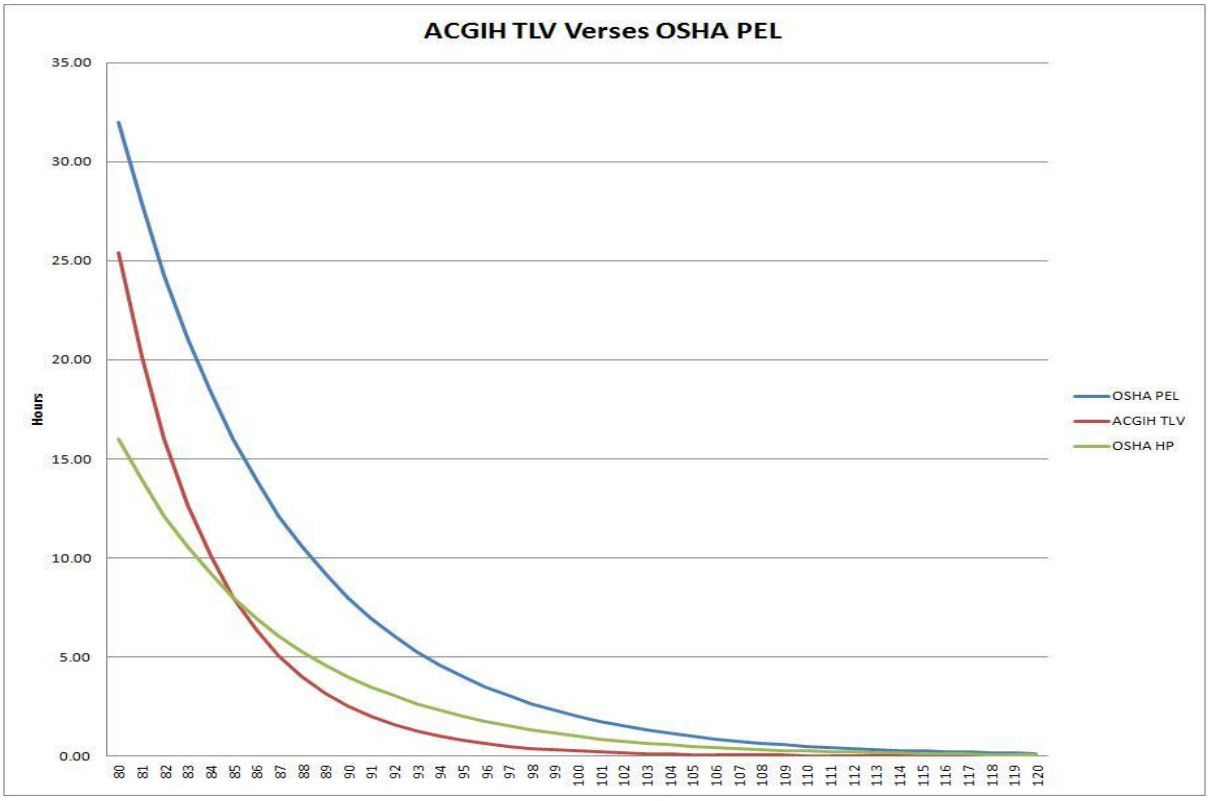
Average exposure level (dBA)	0.5–1–2-kHz definition					1–2–3-kHz definition			1–2–3–4-kHz definition	
	1971-ISO	1972-NIOSH	1973-EPA	1990-ISO	1997-NIOSH	1972-NIOSH	1990-ISO	1997-NIOSH	1990-ISO	1997-NIOSH
90	21	29	22	3	23	29	14	32	17	25
85	10	15	12	1	10	16	4	14	6	8
80	0	3	5	0	4	3	0	5	1	1

The numbers in this table under each standard represent the percent of individual who will obtain hearing loss under each definition. My Capstone Project through Tulane University was titled ***The OSHA Noise Regulations and More Protective Noise Strategies***.[4] In it, I looked at both the OSHA PEL and OSHA Hearing Protection levels, and compared them with the ACGIH Threshold Limit Value and my own criterion based upon the 80 dBA level for 8 hours. This information is available in ***The Monitor*** articles we published through ASSE. While the 80 dBA level is a great goal, and I know of at least two companies who have adopted it, the main emphasis now is to have companies adopt the 85-3 concept.

What is 85-3? It is a time-weighted average noise level of 85 dBA for eight hours, using a 3 dB exchange rate rather than the 5 dB exchange rate that OSHA uses. How does this affect the actual dose? Well, that is the crux of the reasons 85-3 is important. This allows an exposure of 85 dBA for 8 hours, then decreases that exposure by half for each 3 dB increase. So the at 88 dBA, the ACGIH TLV is 4 hours, and at 91 dBA, 2 hours, 94 dBA for 1 hour, etc.

Take a look at his chart, which shows dramatically the difference between the 85-3 concept and both the OSHA PEL and Hearing Protection levels.

[4] Ratliff, John C., "OSHA Noise Regulations: More Protective Alternative Noise Strategies," The Monitor, Vol. 10, No. 2, 2010, page 1; Vol. 10. No. 2. page 1; Vol. 11, No. 1., 2011, page 1.



Note that the ACGIH TLV (red in the chart above), which is the 85-3 concept, is more protective than either the OSHA PEL or the OSHA Hearing Protection levels (blue and green, respectively) at levels above 85 dBA.

Given this information, there is a group named the 85-3 Coalition which is trying to get companies who have adopted voluntarily this concept to sign their company's name to their website. The National Hearing Conservation Association began the campaign, and many other organizations have endorsed it, including ASSE and AIHA. This is their mission statement and information from their home page:

85 3
THE SOUND CHOICE

> **WHAT?:** Our mission is to recognize organizations and employers that have adopted 85 dBA for an 8-hour noise exposure limit measured with a 3-dB exchange rate for their hearing loss prevention programs, and to encourage others to adopt this same hearing protective strategy.

WHY? Occupational hearing loss has become a “silent epidemic” in the United States. It is a major problem that deserves far more attention. We believe that by publicly acknowledging the large number of companies who make extra efforts to truly protect worker hearing we can encourage others to follow their lead.

A number of governments and consensus organizations have long advocated the 85-dBA average exposure limit for an 8-hour day measured with a 3-dB exchange rate, which means that whenever the exposure time is halved, the permissible limit may be raised 3 dB. For example, an exposure of 88 dBA for 4 hours would be equivalent to the same 8-hour exposure at 85 dBA. Most countries around the world require these evidence-based exposure limits, as well as certain U.S. companies committed to employing best practices to protect the hearing of their workers beyond simple regulatory compliance. You will be expected to publish a link on your website and communicate information via e-news informing members or users about the new campaign and its progress; encourage employers, companies, or agencies to become listed as 85-3 practitioners (or “Pioneers”), and recruit others to become 85-3 Coalition Members.

WHO? The 85-3 Coalition Members are concerned professionals and organizations who aim to recognize real-world efforts towards making workplaces quieter, healthier, and more productive (see logos below). The 85 3 Pioneers are progressive companies, agencies, and nations that have adopted the 85-3 criterion for the noise exposure assessment of employees.

HOW? In this campaign we are highlighting progressive companies, agencies, and nations that have adopted the 85-3 criterion for the noise exposure assessment of employees.

To become an 85-3 Coalition Member; please email a letter on your institution letterhead signed by an authorized representative agreeing to list your agency on this web site along with a high definition file of your logo to 85noise@gmail.com.

To become an 85-3 Pioneer: please email us a letter on company letterhead signed by an authorized representative agreeing to list your company on the 85-3 network's Web site and the relevant excerpt from your noise policy demonstrating the use of 85-3 noise exposure criteria to 85noise@gmail.com. There is no financial commitment required. It would be greatly appreciated if you would like to further publicize your participation in this effort and highlight that this approach is already a standard of practice in your workplace, agency or organization.

WHEN? A coordinated effort is being undertaken to enlist as many companies and organizations as possible to sign-on. The campaign was launched in conjunction

with the National Hearing Conservation Association 37th Annual Conference held on February 24, 2012 (http://www.hearingconservation.org). To be part of the ongoing campaign, please contact 85noise@gmail.com. If you have any questions, please send us an email.

What this campaign will do is to document that many, many companies are already using the 85-3 concept as an occupational exposure limit (OEL) and that its use is becoming more prevalent. If and when it comes time for OSHA to change its PEL there will already be precedent for such a change. If your company is using the 85-3 OEL, consider becoming an 85-3 Pioneer. If you haven't started using 85-3 as your OEL for noise, there is now very good research that says it is a much better OEL than the OSHA PEL, allowing your workers will keep their hearing throughout their working lifetime.

Society Update, February 2013:

ASSE Joins 85-3 Coalition

85-3

THE SOUND CHOICE

ASSE has joined the 85-3 Campaign, which recognizes organizations and employers that have adopted the 85 dBA noise protection level as part of their efforts to protect workers' hearing.

"ASSE is pleased to join the 85-3 Coalition and looks forward to working with the coalition's members to support the adoption of the 85-dBA average exposure limit for an 8-hour day measured with a 3-dB exchange rate," says ASSE President Richard A. Pollock, CSP. "The appropriateness of the 85-3 level is widely accepted in practice by our members and many of the employers with whom they work throughout the world."

Earlier this year, ASSE urged OSHA to focus its efforts to improve hearing protection on lowering OSHA's permissible exposure limit for noise from the current 90 dBA to 85 dBA. 85-3 is also required in ANSI/ASSE A10.46.

http://societyupdate.asse.org/2012/12/asse-joins-85-3-coalition/

The Dangerous Decibel® Program

The American Society of Safety Engineers is a group of people dedicated to the safety and health of all Americans. We concentrate on worker safety and health, but know that we also need to pay attention to the safety of our children. Years ago, I was asked to work with a school district to determine why a swing set had broken, and a little girl had fallen from mid-swing onto the pavement. I examined the swing, and found that the chains had never, since the swing had been set up, been changed--40+ years of wear. And the links were razor thin, and one had given way. I went from that school, and began looking at other schools in the county, including the one my sons were attending. I found a few more...something no one thought about, until we had a severe accident.

That is also happening in the USA and around the world with our kids concerning a vital sense that they were born with--hearing. We don't think about it until it is too late. In order to try to change that, Dr. William Hal "Billy" Martin at the Oregon Health & Science University's Prevention Research Center, Center for Healthy Communities and other leading researchers decided a new initiative was necessary, and so they developed the concept of Dangerous Decibels®. They have set up a website at: http://www.dangerousdecibels.org/

When we look at noise in the workplace, we are thinking about noise over a working lifetime, and that is usually assumed to be about 40 years. But we are finding that children's hearing is already, in their early years, showing problems from noise exposure. Here are the statements from the Dangerous Decibel® website:

- **North American children "may receive more noise at school than workers from an 8-hour work day at a factory" (***Report of a World Health Organization-Prevention of Deafness/Hearing Impairment Informal Consultation III, WHO, Geneva, 1997)*
- **Approximately 10 million persons in the U.S. have permanent hearing loss from noise or trauma. (***NIDCD. Fact Sheet on Noise-Induced Hearing Loss. Washington, DC:HHS, 1999)*

- **112.5% of 6-19 year olds in the U.S. (5.2 million) have documented evidence of elevated hearing thresholds directly attributed to noise exposure. (***Niskar, A.S.et al. NHANES III, 1988-1994, United States, Pediatrics, 108, 2001)*
- **50 million Americans have tinnitus, one-quarter of them to a severity that they seek medical help. (***Seidman, M.D. and Jacobson, G.P., Otolaryngol Clinics N Amer,1996)*

The Dangerous Decibel® program recently received the 2013 Safe in Sound Excellence in Hearing Loss Prevention Award. Here is their write-up:

> **The 2013 Award recipient for the Innovation in Hearing Loss Prevention was:**
>
> Dangerous Decibels® is a multi-faceted, evidence-based intervention program dedicated to the prevention of noise-induced hearing loss and tinnitus. The Dangerous Decibels program has been built upon collaborative partnerships between the Oregon Health & Science University, the Portland State University, the University of Northern Colorado and the Oregon Museum of Science and Industry with widespread funding and dissemination support by numerous organizations. Dangerous Decibels was recognized for their development, widespread dissemination and cultural adaptation of innovative training strategies shown to positively change knowledge, attitudes and behaviors in youth and adults. The program is unique in terms of the solid scientific and theoretical basis which incorporates health communication theory into all program aspects including science museum exhibits, virtual exhibits, K-12 classroom programs, educator training workshops, "Jolene – How Loud is Your Music" public outreach tools, and research. Dangerous Decibels® emphasizes the need to protect hearing for a "lifetime" and bridges the occupational and non-occupational noise risks. Dangerous Decibels® is changing the culture of hearing loss prevention across all ages and investing in the hearing health of current and future workers.

Dangerous Decibels® Presentation (Adobe Flash Required)

http://www.safeinsound.us/swf/DD/index.html

This award is the result of years of hard work by Dr. Martin, his partners and his staff. Because of my long-standing interest in noise matters, and wanting to know more about the program, I recently sat down with Linda Howarth, Program Manager for the Dangerous Decibels® Program at Oregon Health & Science University. Linda explained that this program was developed over a number of years using the Health Communication Theory. Research was done on the program to ensure that it actually worked. The article titled "Effectiveness of Dangerous Decibels®, a School-based Hearing Loss Prevention Program,"[5] found that "...Fourth-grade students who participated in the Dangerous Decibels presentation exhibited significant improvements in knowledge and attitudes related to hearing and hearing loss prevention. These improvements were maintained 3 months after the presentation. Seventh-grade students also experienced long-term improvements in their knowledge base. However,

[5] Griest, Susan E., Robert L. Folmer and William Hal Martin, "Effectiveness of Dangerous Decibels, a School-based Hearing Loss Prevention Program," American Journal of Audiology, Vol. 16, S165-S181, December 2007.

attitudes and intended behaviors in 7th graders returned to baseline levels 3 months post presentation."

Because of the success of the program with students, this program is now being taught to adults too, both in the USA and overseas.

Recently, the New Zealand government brought the Dangerous Decibel® Program in for two-weeks. The Dangerous Decibel® team trained 90 people to present the program plus did special training of a group of hearing scientists so that they could produce their own workshops. As a result the government is putting the Dangerous Decibel® Program into all schools in the country, and requiring all military recruits, the police, railroad personnel, dairy workers to receive the program. The Nestle Corporation is also active in this enterprise. The New Zealand government agency, Accident Compensation Corporation (ACC), pays for hearing loss care throughout the country. They spend a lot of money on noise-related claims and feel that they will save money by bringing Dangerous Decibels to New Zealand. The University of Auckland scientists have presented more than 10 workshops since November 2011 when they were trained. ACC pays for all the workshops. And they are teaching at least 30 people per workshop.

In the USA, there is one Air Force representative registered to attend the next workshop in Anaheim in early April. The Army hearing program is in conversation with the program team as noise in the military is a very high concern. They hope to send representative to the training this year (pending funding approval). Research has been conducted on impact noise, such as from IEDs, and its effects on the ear.

The Dangerous Decibel® Program has a number of components, which are outlined on their website. These include the Information Center, Classroom Program, Educator Training Workshops, Jolene, and Classroom Materials and Resources. Of these, the highlights are the means of protecting yourself from noise, and Jolene.

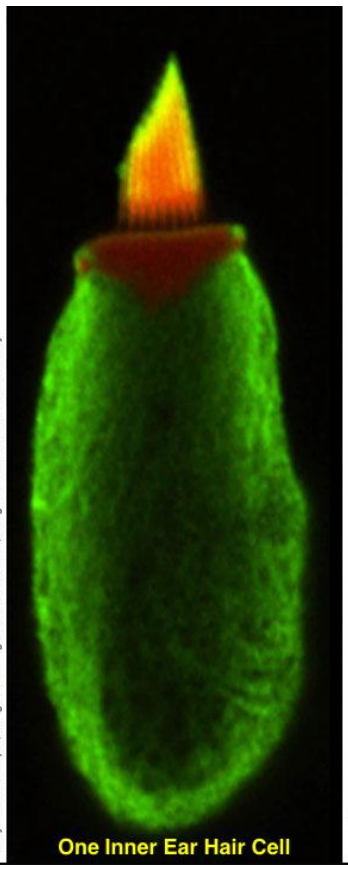
Protecting Yourself from Sound[6]

The first method is a very simple one: Walk away from the loud sound source. Get distance between you and the source of noise. By doubling the distance between the person and the noise source, the sound pressure is decreased by 6 dB. I have used this to stay away from noise on many occasions, from bicycling to work on-the-job.

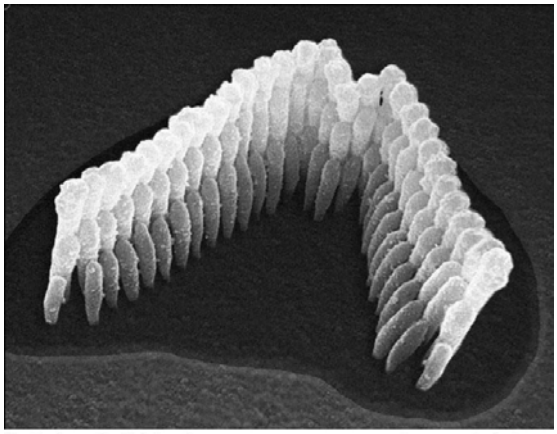
[6] Normally, we in the safety profession say to "Protect yourself from noise." But Dr. Martin stated in reviewing this paper, "We like to stay away from the word 'noise' because of its negative connotations We like to say loud sounds instead – because not all loud sounds are unpleasant but they can still be dangerous."

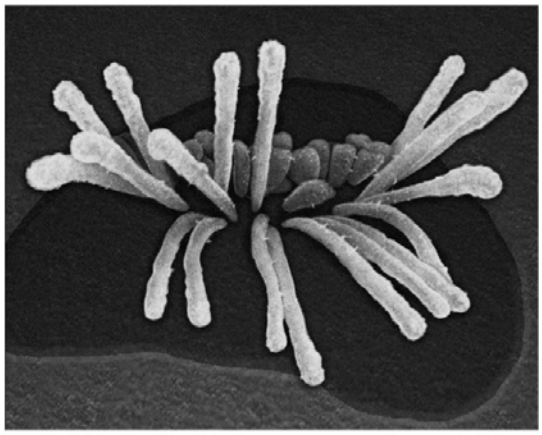
We control the amount of sound many times. We can turn sound up, or down. By turning the sound source (such as a stereo system, a music player, or a headset) down, we can save our hearing from excessive sound. According to the Dangerous Decibel® program, the rule of thumb relating to person music systems (iPod, MP3 players) is, if you cannot understand someone speaking to you an arm's length away, or have to shout to be understood at that distance, it is too loud.

This is the traditional way for occupational exposures, to protect your ears using hearing protection devices such as ear muffs and ear plugs. But for these to be effective, training must occur. There is a very good training video on the Dangerous Decibel website on how to use hearing protection devices.



To understand why the noise is dangerous, we must look at the inner ear itself. The inner ear is made up of the cochlea, which is a spiral organ which has a membrane which contacts what are known as inner ear hair cells. The individual hair cell looks like this a tall ear of corn with the "hair" on the top that are referred to as hair bundle. These hair bundles will bend as sound vibrations move through the cochlea. When they bend they stimulate the rest of the hair cell which in turn sends an electrical signal to the brain to be recognized as a sound. If the hair bundles are bent too much and/or too often, they can break,

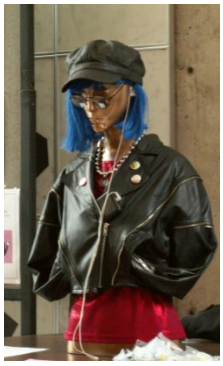




thus killing the hair cell. We are born with about 18,000 of these hair cells in each ear. They must last a lifetime because once a hair cell dies, it does NOT grow back. The loss is permanent. OHSU scientists have taken electron micrographs of damaged hair cell to compare with the healthy hair cell bundles seen above[7]. This is what the damaged hair cell bundles look like.

Hair cells are arranged within the cochlea so that they pick up different frequencies of sound. If we lose enough hair cells we can lose whole frequencies, such as high frequencies. This is the most common and usually the frequency to be lost. It prevent us from understanding certain aspects of speech, especially speech by women as they often have voices that are mostly in the higher frequencies – it is not selective hearing, it is hearing loss.

Jolene and Maya



(Source: Photo by OHSU)

Because of the need to determine the loudness of music coming through portable music players (PMP), which adolescents could understand, the concept of "Jolene" was developed. School-age children and youths use music players, and are damaging their hearing at times with them. To understand how loud they are listening to their PMPs, there needed to be a simple way of demonstrating this loudness to them. They also needed to enjoy the experience. A mannequin named Jolene was designed to have an ear with a microphone in it, attached to a sound level meter. Because of Jolene's popularity, a number of replicas have been produced by the Dangerous Decibel® program and by others around the world. When I interviewed Linda Howarth, Program Manager for the Dangerous Decibels Program, she said that Jolene has done so much travel in the past few years that she is in need of repairs so she introduced me to Jolene's sister, Maya.

(Source: Photos by John C. Ratliff)

Maya and Jolene come in a suitcase, and therefore can be transported easily to training sites.

[7] Oregon Health and Science University, Dangerous Decibel Program. Used with permission.

> Jolene is a system for measuring the sound levels of personal stereo systems. She is part of the Dangerous Decibels education and research projects. Jolene was constructed using a used fashion mannequin and a sound level meter wired to a silicon ear. Jolene makes appearances at schools and universities, scientific meetings, health fairs, and many other public events. She always attracts a crowd and is helpful for promoting noise-induced hearing loss and tinnitus prevention. Jolene has also been used as a research tool to study the beliefs and listening practices regarding personal stereo systems.

Maya is one of the Jolene family of mannequins.

The National Hearing Conservation Association (NHCA) liked the idea, and realized the benefit of Jolene so much that they commissioned Genna Martin (Jolene's inventor) to produce a how-to manual on building your own Jolene. Thus the "Jolene Cookbook" was developed. The cookbook is freely available on the Dangerous Decibel® website, and so far people from all 50 states and 4 territories plus 35 countries have downloaded the Cookbook. You can see photos of just a few of the Jolene "Siblings" in the Jolene Family Album on the website. Here are a few more photos of Maya:

(Source: Photos by John C. Ratliff)

Summary

I have only touched the surface of the Dangerous Decibel® Program. What I hope to do with this paper, and the presentation at the ASSE 2013 Professional Development Conference, is to show that new and innovative approaches to teaching about hearing conservation are available. These have been tested with university research, and found effective in changing knowledge, attitudes, and behaviors in children. But to understand this approach takes more than a short presentation can give. People interested in this approach need to contact the Dangerous Decibel® Program. This year there will be many opportunities to find out more about Dangerous Decibel®, hearing loss prevention in general, and to meet more Jolenes. Below is a list of the various events scheduled this year.

I would like to thank Alice Suter, Scott Schneider, Linda Howarth and Dr. William Hal "Billy" Martin for their review and considerable input on this paper.