AODIOVISDALS ON AUDITORY EFFECTS, NON-AUDITORY EFFECTS AND LEGISLATORY ASPECTS OF NOISE

REG. NO. M 9423

An Independent project submitted as part of fulfilment for the first year M.Sc. (Speech and Hearing) to the University of Mysore

All India Institute of Speech and Hearing
Mysore-570 006

Dedicated to my beloved

GRAND PARENTS

You are the part of my life
That gives me reason for tomorrow
And thz confildence to find it.

To walk in you.foot steps
Is *the higest form of respect*
I *can give you.*

CERTIFICATE

This is to certify that the independent project entitled **"*AUDIOVISUALS ON AUDITORY* EFFECTS, NON-*AUD1T0RY* EFFECTS *AND* LEGISLATORY ASPECTS OF NOISE"** is *a. bonafide. work done. In part fulfilment for the first year degree of Master of Science (Speech and Hearing) of the student with* Reg. *Ho.* M 9423.

Mysore
1995

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CERTIFICATE

This is to certify that the independent project entitled **"*AUDIOVISUALS ON AUDITORY* EFFECTS, NON-*AUD1T0RY* EFFECTS *AND* LEGISLATORY ASPECTS OF NOISE"** *has been prepared under my supervision and guidance.*

Mysore
1995

Dr. (Miss) S. Nikkam
Guide

DECLARATION

I hereby declare that this Independent project entitled "**AUDIOVISUALS ON AUDITORY EFFECTS, NON-AUD1T0RY EFFECTS AND LEGISLATORY ASPECTS OF NOISE** is the result of my own study under the guidance of Dr. (Miss) S. Nikam, Professor and Head, Department of Audiology, All India Institute of Speech and Hearing, Mysore and has not been submitted earlier at any university for any other diploma or degree.

Mysore
1995

Reg.Mo.M9423

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All that I *am or hope to be,*

1 owe it to my family

Roy, *you mean all the world to me, your love has always given me the courage to face hard times.*

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In you, 0 Lord, **I** ***put my trust ...***

For ***you are my rock and my fortress***

Psalm 31:1,3

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INTRODUCTION

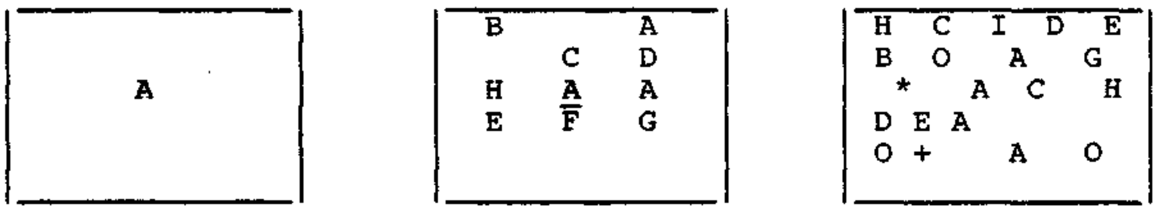
Life is spent in a world of competing signals, some of which are at times extremely important and at other times ignored. A sound one does not want to attend to, can be regarded as a noise and a sound person is interested in as signals. Noise defined as an unwanted sound has been known for a long time. In the name of technological progress, noise has been regarded as undesxrable but a necessary by-product.[i]

It was not until the technological revolution of the past century that unwanted sound crept into significant portions of the life of every resident of civilised world. The proliferation of vehicles, machines, appliances and aircraft has poured noise-producing devices into the environment in ever increasing number. Today's vast technology was triggered by the industrial revolution which has proclaimed the philosophy that the machine should serve to ease human burdens, unfortunately along with it, it gave rise to noise - 'A silent killer'.

How does noise work ?

Noise has been classified as insidious in our environment, because its effects appear slowly. In fact, the effects of noise exposure may not become apparent until long after exposure has begun. That noise is an undesirable element in the environment is readily apparent in the way unwanted signals often impede the hearing of the desired sounds.

Fig. is a schematic representation of signal to noise concept.



(1) (2) (3)

All these boxes carry a signal (A) . The clear box shows the importance and availability of the sound. The other alphabets show noise. Since the noise is not too great in box 2, the signal is still quite easily discerned. The third box indicates an undesirable signal to noise ratio, in that the noise represented by alphabets nearly obliterates the signal. However, extreme quite in the environment also can be alarming, perhaps because man has been so accustomed to a noisy world that an abrupt" interruption of noise is disturbing.

Why is noise exposure an area of such concern ?

Noise affects unaccountable aspects of our life. In Latin, the words 'noise[1] and 'nausea' have the same origin.

Noise reaches into the depth of human being and disrupts the complex processes that strive to maintain physical and chemical balances in the body.

The inner ear which suffers the brunt of destructivity due to intense sound has no pain receptors, hence no sensation akin, to the hurt felt after being cut or burned. Words or any other sounds delivered with sufficient force to the ears can until, cause irreversible damage to portions of the hearing sensory mechanism.

The effects of noise on man can be summarized as follows:

Auditory effects

* Damages the inner ear causing permanent hearing loss.
* Other damages resulting in temporary hearing loss.

Non-auditory effects

* As on adjunct to stressful noise exposure, keen balances maintained on body's physiological operation become disturbed after such disturbances appear at a conscious level as feeling of annoyance, irritability, nervousness or similar sensations. Sounds in the frequency of 2000 Hz are certainly more annoying than sounds in low frequency energy (Peterson and Cross, 1972).

Schiff summarised the non-auditory effects of noise in man.

1. Speech interference
2. Annonyance - a) Disruption of sleep, b) Interference of privacy and rest.
3. Physiological changes - a) Cardiovascular, b) Glandular or endocrine, c) Respiratory, d) Neurological and e) Vertibular.
4. Psychological changes - a) Startle effect,b) Psycho-social effects,c) Information content,d) Personality factors.
5. Efficiency changes.

Noise induced hearing loss continues to be a significant public health problem. In 1987, the National Institute of Occupational Safety and Health (NIOSH) rated NIHL as one of the United States top 10 work related problems involving at least 11 million workers, in Europe the statistics was even, more alarming with 15 million workers being involved. The effects of noise on workers of the entire world is only imaginable. With industrial revolution just picking up in many of the developing countries, the statistics of noise effected population could be shocking than alarming.

With advances in scientific knowledge, better tools and techniques made it possible to answer many of the questions posed by the complex area of noise.

Many legislations came into being in order to control the effects of noise on the world population. As a result of such legal moves, now we have at our disposal levels of noise which are permissible to human being, the various protective measures, and the compensation for damage suffered due to noise in working places.

Compensation for NIHL sometimes amounts to astounding amounts. In 1986, the veterans' administration paid over $ 167 million for compensation claims related to NIHL.

It is always better to prevent the exposure rather than going for a cure. So several signs warn the danger of intense sound to the ear's structures.

Fortunately, the problem of NIHL, has not been ignored by the scientific community and over the past decade considerable progress has been made in understanding many of the important issues.

This project is intended to provide the reader with some of the recent developmetns which have gone into explaining

* the cellular mechanisms of NIHL.
  a) the histological and audiological changes brought about to the hearing sensory mechanism.

* the performance changes of human beings due to noise.
* noise and its effects on the physiological processes of human body and finally the
* the legislatory moves put forth to track down the silent killer of the material world.

CHAPTER 1

AUDITORY EFFECTS OF NOISE

The human ear consists of the external ear, the middle ear and the inner ear.

Slide 1: External ear This consists of the auricle, a structure designed to collect sound waves and transmit them along the external auditory meatus to the tynpanic membrane. The external auditory meatus protects the tympanic membrane and maintains a constant level of temperature and humidity. It acts as a resonator amplifying sound by 5-10 dB around 2 kHz.

Slide 2: Middle ear This is a narrow air filled cavity. It measures 2 to 5 mm in depth and 15 mm in length. The three bony structures of the cavity are the malleus, the incus and the stapes, they transmit vibrations from tympanic membrane to the oval window. This acts as an impedance matching device between the air media and the cochlea fluid.

Slide 3: The inner ear It consists of bony and membranous cochlea. The bony part is cone shaped and measures about 5 mm from base to apex. It consists of a bony tube coiled around a bony pillar, the modiolus. The tube is incompletely divided into the chambers by the lamina, the scala vestibuli and the scala tympani. These chambers contain a fluid the perilymph. The two chambers communicate with each other at a point in the apex called helicotrema. The cavity of the cochlea is culled scala media and this is triangular in shape. This contains a fluid called the endolymph. Its outer wall is formed by striavascularis and the roof by the Reissner's membrane.

Slide 4: **Stria vascularis**

The stria vascularis forms the lateral wall of the cochlear duct. It is held in place by the spiral ligament and in some degree by its connection to radiating arterioles and draining vessels, which are continuous with the capillary network of stria vascularis.

Slide 5: Reissner's membrane

This is a thin, flat, cellular membrane which extends from medial edge of the spiral limbus to the upper edge of the stria vascularis. It is composed of two sheets of cells, one facing the endolymph and the other facing the perilymph.

Slide 6: The organ of corti

Slide 7: Organ of corti (surface view)

The organ contains two types of hair cells. They are outer hair cells and the inner hair cells. Inner and outer hair cells run parallel to each other along the basilar membrane from base to the apex. In addition to hair cells, the organ of corti contains supporting cells and dieter cells. Between outer hair cells and spiral ligament are other supporting cells, cells of Hensen and cells of Boetcher and cells of Claudius.

Slide 8: Auditory pathway

The nerve fibres leading from the hair cells collect at spiral ganglion and then emerge from temporal bone through internal auditory meatus. The neurous from cochlear portion of VIII nerve proceed to the ventral and dorsal cochlear nuclei on ipsilateral side of the upper medulla and pons of the brain stem. Next the neurons proceed to the superior olivary complex of the pons. The neurons then proceed to lateral leminiscus and then to inferior colliculus, then to the medial geniculate body. From here, the auditory radiations spread to cortex specifically to Heschl's gyrus in temporal lobe.

Structural changes in the conductive mechanism

Slide 9: Perforated TM

Among the conductive mechanism, the tympanic membrane is the most susceptible to noise exposure. An explosion causes a blast wave as well as a sound wave. The blast wave in turn produces a wave of compression and this travels down the ear canal. This results in an extreme vibration of the tympanic membrane and the ossicles. Tympanic membrane ruptres by this extreme movement (noise greater than 180 dB SPL), the ossicles may be damaged and the joints dislocated. Singh and Ahluwalia (1968) observed central perforation, reddened and oedematous membrane with bleeding in the external auditory meatus after exposure to noise.

Structural changes in cochlea

Slide 10: Damaged cochlea

Cochlea is most vulnerable to noise exposure. Hawkins and Johnson (1976) found that the sensory neural degeneration due to noise focused on first quadrant of basal turn of cochlea. Continuous noise damages second quadrant, i.e., region between 9 and 13 mm and it is characterised by dip at 4 kHz. Minute droplets of black colour are seen in scala vestibuli and scala tympani indicating presence of lipid and osmiophic substances.

Structural changes in organ of corti

Slide 11: Damage of the organ of corti

The organ of corti is most vulnerable to high intensity bombardment. Damage of the organ of corti also depends on frequency of the stimulus. A high frequency exposure precipitates in a damage to the base of the cochlea while a low frequency exposure results in damage to the apical ends of the cochlea. However, Bohne (1976) found that damage could be more extensive depending on the travelling wave theory. For stimuli of intensity greater than 120 dB SPL, even a very short duration can result in considerable damage.

Damage to Reissner's membrane

Slide 12: Ruptured Reissner's membrane

Rupture of the Reissner's membrane is usualy seen due to exposure to noise. However, the membrane shows signs of repairing itself. The newly formed scar thus closes the gap between its scala vertibuli and the scala media. Lipscomb (1972) reported that together with rupture, there could also be bulging of the membrane into the scala vertibuli or even collapse of the membrane in some parts of the cochlea.

Hair cell damage

Slide 13: Damage to hair cells highlighting on the changes in OHC

The damage to hair cells could range from normal hair cell to complete disappearance. Hair cell damage is usually greater **in** the apical end than in the basal turns. The outer hair cells are more vulnerable than inner hair cells. Lipscomb (1976) reported that damage is most frequently seen in the third row of the outer hair cells, decreasing toward inner hair cells.

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Slide 14: Damage to organ of corti

Earliest signs of damage are: Swelling and pyknosis of hair cells. With increasing exposure to noise proliferation, vasiculation of endoplasmic reticulum of the hair cells are observed. As exposure continues, the outer hair cells have a distorted appearance and begin to show obvious process of degeneration. Healthy cells in between two degenerating cells is possible. This random effect of cell destruction is more common than widespread destruction of single area of cochlea.

Damage of stereo cilia

Slide 15: (a.) **Fusion and absence of stereocilia**

The stereocilia of the hair cells tend to fuse suggesting a change in the electrostatic properties of hair cells due to exposure.

Damage to supporting cells

Slide 15: (b) **Absence of supporting cells**

Engstrom et al. (1966) reported that vasiculation may appear in supporting cells of hair cells including cells of Hensen. Dieter and claudius cells are replaced by collapsed phalangeal process of Dieter cells.

Damage to tectorial membrane

Slide 16: Damages to tectorial membrane

Tectorial membrane is lifted up from organ of corti in its damaged areas. Tectorial membrane may also roll up in some cases of noise exposure (Ward-Duall, 1971). An intense noise exposure, can result in dislodging of the basillar membrane, however it is seldom broken. Cuboidal layer on basilar membrane and swelling of endothelial cells have also been reported.

Vasoconstriction due to noise

Slide 17: Swelling and vasoconstriction of the capillaries

There is marked swelling of the endothelial lining of the blood capillaries supplying the cochlea, such a marked constriction of the lumen often leads to blockage of blood circulation (Bohne, 1976). Joseph E. Hawkins Jr. (1971) found that marked constriction of lumen often blocking the passage of red blood cells. This constriction resulted from swelling of endothelial cells.

Striavascularis - Damage due to noise

Slide 18: Damage to striavascularis

Histopathological findings in wall often of surface cells appeared. There was swelling and shrinking of the intercellular gaps particularly at the apical end, and this is less near the basal turns of the cochlea. The epithelium of stria vascularis gets separated from spiral ligament.

Barbara Bohne (1976) found the following dynamic changes after noise exposure.

Exposure duration less than one hour

Slide 19: Table, showing the mentioned changes

1. Exposure 108 dB SPL octave band noise centered at 4 kHz produces maximal damage in the first turn approximately 4 mm from basal end.

2. Fewer than 10 outer hair cells are missing.

3. Though many outer hair cells are present, their cell bodies are swollen.

4. The cells show dense staining materials accumulated within the cytoplasm, these are turns of cisternae of smooth endoplasmic reticulum.

5. Stereocilia patterns are undisturbed.

6. At such an exposure, the nerve fibres of organ of corti, including fibres of inner spiral bundle have normal appearance.

Exposure duration greater than one hour

Slide 20: Table showing the mentioned changes

1. Outer hair cells show more signs of damage.

2. Stereocilia formed a dot pattern rather than a smooth line.

3. Fusion of several stereocilia forms giant stereocilium.

4. Outer hair cell bodies are more swollen, and the plasma membrane of these cells are thin.

5. Nerve fibres in the inner spiral bundle and within the tunnel space still have normal appearance.

Exposure of two hours

Slide 21: Table showing the mentioned changes

1. No hair cells are seen in a 1 mm long segment of organ of corti in the first lower turn.

2. Small holes are left in reticular lamina since phalangeal process have not yet enlarged to form phalangeal scars.

3. First signs of nerve involvement are seen in the radial tunnel fibres.

4. Clumping of axoplasm which gives an appearance of beads on string are seen.

Exposure beyond two hours

Slide 22: Same as above

1. Supporting cells and inner hair cells show damage.
2. These cells continue to show damage, i.e., necrotic changes occur so that by 14th day after exposure, an average of 1 mm of organ of corti is missing.

Slide 23: Temporary threshold shift

Effects of noise on hearing can be divided generally into - temporary threshold shift (TTS) and permanent threshold shift (PTS). TTS is a short term effect that may follow an exposure to noise. TTS refers to an elevation in the threshold of hearing which recovers gradually after the noise exposure. Because the noise produces a transient shift in the threshold, it has become known as TTS or more specifically as noise-induced temporary threshold shift (NITTS).

Slide 24: Permanent threshold shifts (PTS)

PTS are those hearing changes that persist throughout the life of the affected person. When a threshold shift is permanent, there is no possibility for further recovery with the passage of time after exposure. More frequently, hearing loss produced by the effects of noise is a result of an accumulation of exposures repeated on a daily basis over a period - of years. Thus the portion of hearing loss resulting from chronic exposure and recovery is called noise induced temporary threshold shift (NITTS) and the part that does not recover is called noise-induced permanent threshold shift (NIPTS).

CHAPTER 2

NON-AUDITORY EFFECTS OF NOISE

Under the non-auditory health effects, the following will be considered.

a. Physical illness

b. Psychological effects

c. Sleep

d. Extra-auditory effects on special senses

A. Physical illness

Slide 25: Effects on circulation

Noise has an explicit effect on the blood vessels, especially the smaller ones known as precapillaries. Noise makes the blood vessels narrower thereby reducing blood supply to various aspects of the body-toes, fingers, skin and abdominal areas. Peripheral vasoconstriction is thus the earliest and also the best documented effect of noise on the cardiovascular system. But at high levels of acoustic stimulation there is a reduction in the blood flow to the head along with other parts of the body due to vasoconstruction.

Slide 26: Heart

Heart rate is also effected by noise. Phasic changes in heart rate are usually seen at the onset of an unexpected sound.

Slide 27: Phasic changes in heart rate

A low level stimuli gives a deceleration and high level stimuli gives an acceleration in heart rate. Blood pressure has a close relationship to cardiovascular pathology. Steinman et al. (1955)

reported of an immediate rise in the systolic blood pressure of 5-20 mm Hg during exposure to high frequency metallic sounds. Children are more physiologically affected than adults by noise. Children exposed to high noise level had significantly higher systolic and diastolic BP than the low noise level group children. These differences were greatest during the first two years and became smaller thereafter. There was consistent increase in BP as noise exposure increased with approximately 9-16 mm Hg separating the highest and lowest noise exposure school children.

Slide 28: Blood pressure

Slide 29: Endocrine system

Slide 30: Efffectson endocrine system

Local sounds and other stressful agents increase the secretion of corticotrophic (ACTH) from the pituitary gland. Loud sounds raise plasma concentration of 17-hydroxy corticosterone in man.

Slide 31: Reproductive system

Noise is a known stressor to man and this affects almost every bodily system including the reproductive system.

Research on animals shows that high levels of noise alter ovarian activity, inhibit fertility, interfere with fetal development and produce low-birth weight offspring. Research on pregnant women indicated that noise was associated with reduced human placental lactogen levels which was linked with low birth weight infants.

Other physiological effects of noise

Slide 32: Gastric and salivary glands

Sound exposure causes a reduced gastric mobility and secretion in human beings even at levels as low as 55 dB.

Slide 33: Effects on digestion

Noise of sudden onset can cause reduction in salivary and gastric secretion and a general slowing of digestive function.

Psychological effects of noise

The psychological effects of noise differ from person to person and in one and the same person. It is dependent (1) on the hour, (2) the character of the noise and (3) and the individual variable.

Slide 34: Psychological effects of noise

The psychological changes can be in terms of

—> mental stress
—> maladjustment
—> chronic fatigue
—> neurotic complaints
—> introversion

Noise though not a cause for a psychological breakdown can act as a precipitating factor. Noise definitely does not lead to neurosis but individuals with neurotic tendencies will be affected more, even at low noise levels than the others. Anxiety reaches a peak at • about 75-90 dB exposure. In addition to anxiety, noise also evokes emotions like aggression.

Slide 35: Sleep

Noise may adversely affect sleep in several ways.

-> It may prolong the time initially needed to fall asleep.

-> It may cause awakening once asleep.

-> Interferes with returning to sleep once awakened.

Research data showing that a person in some stages of sleep can discriminate among auditory stimuli in terms of their meaning is consistent with anecdotes that one can listen for certain sounds when asleep and ignore the others. Sleep disturbance especially awakening is influenced by

Slide 36: Awakening from sleep is influenced by

-> Degree of familiarity and significance of the noise to the individual

-> Intensity level of the noise

-> Duration of noise

-> Intrusiveness and abruptness of onset are also related to sleep disturbance.

Increase in stimulus intensity generally results in increased frequencies of behavioural awakening and arousal and reductions in the frequency of EEG change. Psychological and social consequences of sleep disturbing stimuli are greater for middle aged and older persons. Older the individual, more likely is to be awakened or change his sleep stage from exposure to noise. Sleep arousal thresholds are lower in women than in men. In other words, specific distribution of responses to noise during different sleep stages is apparently a function of the age group. From the available data on task performance following noise impacted sleep and on the persistance of physiological responsivity during sleep it can be concluded that noise has the ability to interfere with the restorative function of sleep. Chronic noise disturbed sleep may be capable of producing adverse consequences on health and well-being.

Extra-auditory effects on the special senses

Apart from its effects on the function of the inner ear, noise has been shown to have effects on the function of two of the special senses - vision and balance.

Slide 37: Vestibular system
-EFFECTS OF NOISE.

The vestibular labyrinth has its embryological and evolutionary development from the same source as the inner ear. The vestibular organ are in close proximity to the cochlea of the inner ear. The vestibular organs, the saccule utricle and SCC are connected to the cochlea of the inner ear, they share certain fluids with the cochlea and their innervation are closely connected. These vestibular organs are involved in maintaining body balance and orientation in space. Because of their close proximity and fluid connections, it is not surprising to find that intense sounds affect the cochlea and vestibular organs. Powerful or moderate auditory stimulation can elicit (1) nystagmas, (2) vertigo and disruption of equilibrium.

Slide 37: Effects **on** the **vestibular** system

Sounds of modest intensity elicit lateral eye movements in normal subjects which Hennerbert termed as **Audio kinetic nystagmas** (Weber et *al., 1967).* Bekesy (1935) reported vertigo in normal subjects exposed to intermittent sound of 100 Hz at 120 dB for brief periods. When noise is less intense (less than 130 dB) it may upset one's balance. All these effects are believed to be due to noise directly stimulating the vestibular organ of the inner ear (McCabe and Lawrence, 1958).

Slide 38: Organ of vision

The effects of noise on vision is less direct than those on the vestibular labyrinth, the effects caused are temporary and there is no definite evidence for any long-term damaging effect. The first observation of the effect of noise on vision has been credited to Thomas Bartholinus (1669).

Slide 39: Effects **on vision**

According to Grognot et al_. (1968) noise adversely affects depth perception. There is also narrowing of visual field when workers are exposed to 110-124 dB noise for about 8 hours. Thus noise can sometimes effect a 10% or so change, usually a reduction in CFF from the CFF found in quiet, but the exact effects as a function of various noise and light conditions are highly variable.

Noise has an explicit effect on the well being of man. Cocern about non-auditory effects is increasing since the last decade. This is largely due to heightened public concern regarding environmental pollution 'and workplace health and safety.

CHAPTER 3

LEGISLATORY ASPECTS OF NOISE

The link between the existence of excessive noise in the environment and the production of hearing loss in people working in that environment is beyond question. Unlike many other conditions that produce a hearing loss, a noise related loss can be prevented.

The Medicolegal problem

Slide4D: 1908-Workmen's Compensation Law

1948 - NIHL awarded compensation

Following the lead of several European countries, the United States in 1908 enacted the first Workmen's Compensation" Law under which civilian employees of the federal government were protected against economic loss arising out of accidental injuries incurred on the job. In 1948, a new principle in Workmen's compensation was established through a ruling of the New York Court of Appeals by which compensation for a noise induced hearing loss was awarded. In 1959, the State of Missouri followed the lead of New York and Wisconsin in writing special legislation to cover the problem of occupational hearing loss. The laws hold the last employer liable for all of a Claimant's noise induced hearing impairement, unless that employer can present evidence that the employee had some hearing impairment at the time he commenced employment with him. This provision of the laws points up the importance of employers' instituting hearing testing as part of the physical examination procedure for all new employees. A given employer can then be held responsible for only that amount of hearing impairment an employee incurs after he commences work for that employer.

Slide4l: A.M.A. Method

In medicolegal cases, the amount of compensation for a hearing loss is based on the degree of handicap. The concept of percentage of hearing loss was introduced by E.P. Fowler and P.E. Sabine (1954) to meet this need. For a number of years percentage of hearing loss was computed by the Fowler-Sabine procedure, termed the **A.M.A. Method** because it was published under the aegis of the American Medical Association. In this method, only four frequencies on the audiogram were given consideration 500, 1000, 2000 and 4000 Hz. These frequencies were weighted in their importance to the total speech-hearing function as follows: 500 Hz - 15%, 1kHz = 30%, 2 kHz = 40%, 4 kHz = 15%. Losses in dB at each of these frequencies were assigned percentage values according to a chart which was used in conjunction with the PTA. Losses for each ear were converted to percentages and a formula was applied for computing the binaural percentage loss. However A.M.A. had its own disadvantages in that it told little about the patient's ability to communicate, neither did it shed light on his ability to compensate using a hearing aid.

Slide4X: AAOO method

In 1959, a method for computing percentage hearing impairment was published under the sponsorship of the American Academy of Ophthalmology and Otolaryngology, and hence referred to as the **AAOO method.** This method utilises the average dB loss through the frequencies of 500, 1000 and 2000 Hz. The percentage loss in each ear is determined by subtracting 26 dB from the average dB loss through these three frequencies and then multiplying the remainder by *1½* per cent. Binaural percentage hearing loss is computed by weighting the better ear five times the poorer ear.

Slide43: CHABA

Kryter et al. (1966) published the recommendatXons of a working group of the National Academy of Science-National Research Council Committee on Hearing, Bioacoustics, and Biomechanics usually identified as **CHABA.** The working group adopted as its basic criterion the acceptability of noise exposures that would result in noise induced permanent threshold shifts after 10 years of near-daily exposure of no more than 10 dB at 1000 Hz or lower frequencies, 15 dB at 2000 Hz or 20 dB at 3000 Hz and higher frequencies.

Slide44-: Walsh-Healey Act

In May 1969, The Federal Government expanded the **Walsh-Healey Public Contracts Act.** Under its authority, the Department of Labour (1969) issued a regulation that contained allowable levels and duration of noise exposure. Once these levels were crossed there was a need for active hearing conservation program.

Slide45: Federal register

Consequently, the Walsh-Healey noise standard became an OSHA standard. On March 3, 1983, a revised hearing conservation Amendment was published in the **Federal Register** as the final rule. This amendment is the basis for the hearing conservation component of the OSHA noise regulation and is in effect now.

The activities of federal and state legislative and judicial systems have provided the motivation for development of industrial hearing conservation programs. Government activities continue, resulting in changes in laws and regulation that affect the composition of hearing conservation programs, the workers who are covered by these programs, the criteria for compensable hearing loss, and the amount of compensation to be awarded.

However, inspite of all these.

Has our environmentally really grown QUITER ?

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