Occupational Health Survey in 'X' Underground Mine – a case study

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Background

Directorate General of Mines Safety (DGMS), under Ministry of Labour, India is particularly concerned for safety ,health and welfare of the persons engaged with mining operations apart from various other activities. " Air borne dust" along with" Noise" is the major cause of health hazard in mines, thus one of the important activities of DGMS is to conduct occupational health survey in mines. " Dust" and " Noise" is also a major environmental issue these days in the mine.

For the purpose of occupational health survey " X " Lead-Zinc underground Mine was selected and as a part of the programme, it was decided to conduct surveys for noise and airborne dust. A team of officers including experts of "Occupational health(OH)" from DGMS reached "X" Lead-Znic Mine sometime back and discussed the matter with the mine management . Thereafter medical and environmental officers of the mine were also associated with the programme. The team finalised the work programme in the mine. Medical records of persons employed in 'X' Underground mine were also evaluated for silicosis and Noise Induced Hearing Loss (NIHL). The results of the above Occupational Health and Hygiene survey revealed that persons employed in the mine were exposed to noise and dust levels higher than permissible limit. The results of the survey shows that;

The dust level at crusher, DTH Drilling and Jack Hammer Drilling operation in underground mine and crushing Plant on surface were higher then the prescribe limit.

The noise levels in almost all underground operations were found to be higher than the recommended limit of 90 DB(A). The noise level, measured as Leq at Simba Drilling, crusher, LHD operations, Loco haulage, DTH Drilling, Jack Hammer drilling varied from 90.6 to 113.2 DB(A).

INTRODUCTION

It is a known fact that extraction of minerals from earth involves working under unnatural conditions. While dark, dusty, hot, humid and often noisy environment in underground mines adversely affect the health of the workers, noise, heat, vibration etc. also pose occupational health problems in opencast mines. Working in dusty environment may cause silicosis, poisoning due to inhalation of metal dust such as manganese, loss of hearing due to noisy environment, miner's nystagmus due to darkness. Occupational health and hygiene survey deals with protection of workers from adverse effects on health through control of work environment.

'X' underground mine is leading in the processing of Znic and Lead ore. During the process the workers are exposed to dust, noise, fumes and gasses of various intensities. The mine was chosen for dust & noise survey, also to determine prevalence of "Silicosis" and "Noise induced hearing loss" among persons employed and the suggest appropriate control and rehabilitation measures.

Statuary provisions relating to occupational health and hygiene

Under the constitution of India, safety, welfare and health of workers employed in mines are the concern of central Govt.. The objective is regulated by Mines Act, 1952 and the rules and regulation framed thereunder. These are administered by the Directorate General of mines Safety (DGMS), under the ministry of Labour. The Mines Act and rules and regulation framed thereunder such as Mines Rules 1955, Coal Mines Regulations, 1957, Metalliferous Mines Regulations 1961, Oil Mines Regulations 1984 etc. lay down the statutory provisions and standards for safety, health and welfare of mine workers. Specific provisions have been made to protect workers from occupational health hazards and prevent occurrence of occupational diseases. Some of the important statutory provisions relating to occupational health and hygiene in mines are as under :

Section 9A, Mines Act 1952 – Occupational Health Surveys

Salient points of section 9A, under Mines Act are as under :

i) Occupational health surveys may be undertaken at any mine by DGMS and mine management is required to provide necessary facilities for the survey.
ii) Any person chosen for medical examination during occupational health survey is required to present himself.
iii) The time spent by the person is to be treated as part of working hours.
iv) Any person found medically unfit to discharge his duties during the survey is entitled for medical treatment at the cost of management with full wages.
v) If after treatment, the person is still found to be medically unfit and his unfitness id directly ascribable to his employment in mines.

    a) he shall be provided with an alternate employment.
    b) If alternate employment is not available, the person shall be given disability allowance.
    c) If the person decides to leave employment, he shall be paid disability compensation.

Section 25, Mines Act 1952 – Notice of diseases

Mine management is required to submit notice of occurrence of notified diseases under this act. Following diseases have been notified as diseases connected with mining operations for the purpose of sub-section (1) of section 25 of the Mines Act, 1952:-

a) Silicosis
b) Pneumoconiosis
c) Managanese poisoning
d) Asbestosis
e) Cancer of lung or the stomach or the pleura and peritoniums

Rule 29B, Mines Rules, 1955 – Initial and Periodic medical Examination

The Rule provides for;

A) Initial medical examination of every person to be employed in the mine.
B) Periodical examination, once every five years of persons employed in the mines
C) In case of the persons engaged in the process of mining or milling of asbestos, periodic medical examination shall be done at least once twelve months and every such examination shall include all the tests except the X-ray examination, which shall be carried out once in every three years.
D) The periodical medical examination or the X-ray examination or both, shall be conducted at more frequent intervals if the examining authority deems it necessary to confirm a suspected case of a dust related disease.
   The routine initial and periodical medical examination should include –
    I) General physical examination
    II) A full size chest radiograph

III) Lung function tests

Regulation 124, Metalliferous Mines Regulation, 1961 – Permissible limits for airborne restorable dust, sampling strategies and control measures

The 8-hrs time weighted average permissible limits for airborne respirable dust as determined by the use of approved dust sampling instruments are as follows –

a) 2 fibres per mililitre of air in case of asbestosis
b) 5 milligram per cubic meter of air in case of manganese ore
c) 3 miligram per cubicmetre of air where free respirable slica content in the respirable dust is less than 5%
d) In other cases where free respirable slica content in the respirable dust is more than 5%, the permissible limit shall be calculated by the formula, 15% of free slica im miligrams per cubic metre of ari.

DIRECTORATE-GENERAL OF MINES SAFETY, THROUGH CIRCULAR NUMBER DG(TECH) 18 OF 1975, HAS RECOMMENDED FOLLOWING STANDARDS FOR NOISE LEVEL:-

Warning Level	85 dB(A) (for 8 hrs daily exposure)
Danger Limit	90 dB(A) (unprotected ears for 8 hrs daily exposure)

Compulsory Wearing of Ear Protection Limit

	115 dB(A) for 8 hrs daily exposure
	130 dB(A) for Impulse noise of short duration
No Work Limit	140 dB(A) or
	140 dB(A) Impulse noise for short duration.

RECOMMENDATIONS OF CONFERENCES ON SAFETY IN MINES

In addition to the statutory provisions on Occupational Heath and Hygiene prescribed under Mines Act, 1952, Mines Rules, 1955, Coal Mines Regulations, 1957, Metalliferous Mines Regulations, 1961, and oil Mines Regulations, 1984 the issues related to Occupational Health and Hygiene in mine have been discussed in Conferences on Safety in Mine. The VIIth , VIIIth and Ixth Conferences on Safety in Mines have made detaied recommendations on creation of occupational health services, occupational health hazards and occupational health surveillance in mining industry. Some of the important recommendations of Conferences on Safety in Mines are.

Occupational Health Services

1. There is need for creation of Occupational Health Services in each mining company working mechanised mines.
2. Occupational Health Services shall have sufficient technical personnel with specialised training and experience in Occupational Health Services shall carry out following functions.

    (i) Identification and assessment of the risk from hearth hazards at work place;
    (ii) Surveillance of the factors in working environment and work practices which may affect worker's health;
    (iii) Surveillance of worker's health relating to work;
    (iv) Advising the management on issues relating to occupational health, industrial hygiene, first aid and ergonomics.

Medical Surveillance

1. There should be at lest one medical officer properly trained in Occupational Health and in use of ILO Classification of Radiographs for Pneumoconiosis.
2. Adequate facilities for X-rays and Lung Function Tests should be provided at each medical examination centre.
3. If the profusion of any type of pneumoconiotic opacities in chest radiograph is as per ILO Classification, the case shall be certified and notified as pneumoconiosis.
4. One of the medical examinations of every person should be arranged within one years of his superannuating.

Dust

1. Every mining company operating mechanised mines should take early steps to ensure that:
   (a) adequate arrangements and wherever necessary infrastructure facilities to carry out dust surveys in mines are established.
   (b) Air borne dust surveys are conducted and necessary control measures, wherever required are taken;

      (i) at all mechanised longwall faces, mechanised bord and pillar workings and road header drivage in coal mines;
      (ii) at all drilling, mechanised loading and crushing operations in non-coal mines;
      (iii) at all ore / coal handling / benefaction plants.

Noise

2. All mining companies should tak steps as regards:

   (i) Standardisation of the information to be furnished by the manufacturers / suppliers; as well as its assessment procedure;
   (ii) Development and supply of proper type of ear protectors including helmet mounted earmuffs.

3. Audiometer should be introduced as a mandatory part of medical examination, for persons seeking employment in mines and for persons engaged in operations / areas where noise level exceeds 90 dB(A).

<u>'X' Underground Mine.</u>

The Mine worked in three shifts and the B shift was the main production shift. The ore in 'X' Underground Mine was composed of galena, sphalerite and pyrite in a gangues of dolomite and quartz. The percentage of free Silica in the ore of 'X' Underground mine was approximately 10%.

Method of Work:

<u>Access</u>

In 'X' Underground mine, Adit No. 4 and underground shaft forms the main entry to the underground workings and second outlet is the production incline. The shaft is 428m deep and is equipped with a double drum conventional winder to all the 8 intermediate levels. The upper most and deepest levels are 378m RL (Audit level) and (-) 40m RL, respectively.

Stoping

The working was by shrinkage stope method. The well established sub-level open stopping with blast hole ring drilling was adopted for mining of ore.

Drilling and Blasting

The drilling in development faces and shrinkage stopes was done by air-leg mounted Jack hammer drills while in sub-level stopes drilling was carried out with BBC 120F drifters (57mm) mounted on Simba Junior Rigs. Down the Hole (115mm) and in the hole (165mm) hammer drills were increasingly being used. The blast holes of 57mm diameter as well as 115mm diameter are drilled by Simba and Down the hole drill machines respectively. ANFO was the main explosive used for blasting in stopes.

Loading and Transport

The ore was carried to the ore passes by Cavo hoper loaders or by diesel LHDs. Diesel powered LHD machines having 1.9 cum capacity were deployed at extraction level for mucking of ore from bottom of the stope. The loaded muck was hauled and dumped into ore pass which then gravitates down to the transport level at 105m RL.

Transportation

The principal transport system comprised of track and trolley wire locomotive system. The vertical transport was through 1500 long series of belt conveyors laid in production incline. Presently, 105m RL was the principal transport level. It extended from eastern to western zone of the mine and had a total length of 2025m. The broken ore from the ore pass was loaded by use of pneumatic chutes into 5 ton capacity Grandby cars and transported to the underground primary crushing station.

Underground Crushing

The broken ore was crushed to 150mm size by a Double Toggle Jaw Crusher having 1200mm x 900mm opening and 250 tonnes per hour crushing capacity. The curshed ore was finally loaded on belt conveyor and hauled upto surface stock yard of 2400 MT live capacity.

Ventilation

The ventilation in the mine was provided through two axial flow fans installed at two extremities of the mine. These were of 60 cum and 40 cum per minute capacity installed at Adit No. 8 and Adit no. 5 in western and eastern end of the mine respectively.

Dust and noise survey

‘X’ underground mine was chosen for dust and noise survey and it would cover both mining operation as well as beneficiation plant while medical program included pre-employment medical assessment, audiometry, follow up medical assessment and a health education program.

‘X’ Underground mine worked in three eight hours shifts- A shift(8 am to 4 pm), B shift(4 pm to 12 pm), and C shift (12 pm to 8 am). The B shift or the afternoon shift was the most significant production shift. A shift was also a production shift while C shift was a maintenance shift. Personnel worked on CBA rotation or ABAB rotation. Due to it being the most significant production shift the bulk of the sampling program for dust and noise survey was done in B shift.

For dust and noise survey of sensitive points, an inspection of underground working environment was carried out. During inspection in the underground it was found that jack hammer drill was working in poor ventilation and there was considerable increase in visible dust level in the surrounding during drilling. Similarly in DTH (down the hole) drilling also significant dust was found to be generated which engulfed the breathing zone of the operators. LHD (loading machine) was found to tram for a distance of approx. 50m, there was moderate level of visible dust particularly while drawing ore from box hole. In the chutes and rail haulage while filling of cars it was found level of visible dust were not significant, however noise level during the operation of pneumatic chutes was significant and may result in excess exposure during a full production shift.

The benefaction plant consisted of a crushing circuit, grinding section, floatation cells and filtering. The crushing plant had a water suppression system using atomizing sprays, also there was extraction ventilation and the dust laden extraction air was cleaned by cyclones. The system was found to be in good condition. Grinding process in benefaction plant was a wet process using ball mills.

Many of the operators observed were utilising respiratory and hearing protection, however some in significant exposure areas were not wearing any personnel protective equipment.

The result of dust survey in sensitive points was as under :

Location	**Dust concentration, mg/cum**
Loco haulage	2
Underground crusher	6.8
Rear side of crusher	39
Conveyor	2.6
LHD operation	0.7
DTH drilling	14.1
SIMBAS drilling	3.7
Jack hammer drilling	15.3
Drive from cage to crusher	1.5
Intake	0.05
Surface	0.05
Surface crusher	7.2
Grinding and floatation	0.5

The percentage of free silica in ‘X’ underground mine was 10%, therefore the respirable dust exposure limit was 1.5mg/cum.

The result of noise survey in the sensitive points was as under :

Location	Average sound pressure level, dB		
	L Aeq;, 8 hrs.	L Peak	L Max
Loco haulage	100	146	120
Crusher	96	146	122
Conveyor	100	145	122
LHD	101	146	120
DTH	100	146	120
SIMBAS	110	146	124
Jack hammer	112	146	123
Benefaction plant crusher	92	145	118
Grinding & floatation	94	144	115

From the survey it was evident that dust and noise level in many of the above sensitive points were higher than the permissible limits.

Employment and Medical Examination

Introduction to Silicosis :

Silicosis is the most ancient and commonest of all occupational diseases and claims large number of lives than any other occupational disease. Even today, it continues to be among the most serious occupational diseases. The crystalline free silica, the agent responsible for the cause of silicosis, is one of the most powerful fibrogenic matter found in nature. It forms about 12% of the earth's crust and is next only to feldspar in abundance. The sand stone industry, cement industry, quarrying, the granite industry, slate quarrying and dressing, grinding of metals, iron and steel foundries, silica milling, flint crushing and the manufacture of abrasive soaps and glass are some of the occupations which may lead to silicosis. In India it is estimated that there are about 1.7 million workers engaged in mining of various minerals, iron and steel industries, cement industry, manufacturing of glass, foundries, quarries etc. who are at the risk of exposure to siliceous dust and subsequent development of silicosis.

Amongst all the atmospheric contaminants encountered in industry, free silica has the dubious distinction of being the only dust which predisposes significantly to the development of tuberculosis. The occurrence of silicosis and tuberculosis together is known as 'silico-tuberculosis'. Susceptibility of silicotic patients to tuberculous infection has been established since the beginning of this century. The prevalence of tuberculosis has direct relationship with the concentration of free silica dust in the work environment.

Clinical Features:

It is important to emphasise that there may be no symptoms even though the radiographic appearances may suggest fairly advanced silicosis. Dyspnoea on exertion is considered to be the most frequent and directly related symptom or silicosis. The severity of Dyspnoea increases with progress of the disease. In the absence of complicating disease (e.g. tuberculosis), it is rarely complained off at rest. Slight unproductive cough is complained at the initial stages, later on the quantity of sputum increases. The symptom complex may resemble chronic bronchitis. Excessive sputum production is due to bronchial mucus brought about by chronic dust exposure and some times it is due to secondary bacterial infection of the devitalized lungs. Chest pain and haemoptysis (blood in sputum) indicate possibility of complication like tuberculosis.

Chest Radiography:

Chest radiography is the most important tool for the diagnosis of silicosis. There appears clear relationship between total dust exposure and severity of radiographic changes. In the initial stage, there is 'reticulation' of lung fields due to thickening of peri-vascular and inter-communicating lymphatics. The radiographic diagnosis of silicosis can be made with some degree of certainty only after the appearance of nodules. The silicotic nodules are 2-5 mm in diameter, homogenous density and usually bilaterally symmetrical. On continuation of dust exposure, the nodules increase in size and number and eventually cover most parts of the lungs. Sometimes the silicotic nodules unite and form 'conglomerate shadows'. These conglomerate shadows are sometimes described as progressive massive fibrosis (PMF), indicating the future course of disease.

Dust Control measures:

There is no silicosis without dust exposure, and the dust levels in work environment correlates well with incidence of severity of the disease. Therefore, elimination or suppression of dust in the work environment is the key in control of silicosis. Each industry has its unique work process and therefore it is not possible to have a single prescription appropriate to all. The general principles of dust control measures include substitution of more hazardous substances with innocuous one, isolation and enclosure of the sources of dust, use of wet methods wherever possible, application of local and general exhaust, humidification of work environment etc. Frequently, the management is found to share the misconception of laymen that the supply of dust mask is sufficient for the prevention of dust control measures have failed. In fact, the dust masks are of little value when the dust concentrations are too high for the dust particles will soon clog the pores in the filter resulting in a choking sensation and discontinuance of the use of masks by workers. Moreover, the masks are not suited for hot and humid climate.

Medical Surveillacne:

As per the recommendation of WHO, the medical screening programme should be integrated and pursued with the environmental surveillance programmes so that the results of both could be related to reviews of measures taken to control the environment. The medical examination is necessary because perfect knowledge does not exist as to the safe level of exposure. Medical surveillance should be continued, not as control method, but to verify the adequacy of dust control measures. The medical measures for the control of silicosis include pre-employment and periodical examinations, incorporating chest x-ray will provide the baseline data for each individual. The periodical medical examinations shall aim at early detection of cases of silicosis and tuberculosis. The success of the prevention programme will largely depend upon the active co-opration of the workers at risk. Therefore, the need for health education of the workers can not be over emphasised.

1. **NOISE**

a. Introduction to Noise.

The Pervasive Nature of Occupational Noise

Noise is one of the most common of all the occupational hazards. These noise levels are potentially hazardous to their hearing and can produce other adverse effects as well.

Hazardous noise levels are easily identified and it is technologically feasible to control excessive noise in the vast majority of cases by applying off-the-shelf technology, by redesigning the equipments or process or by retrofitting noisy machines. But all too often nothing is done. There are several reasons for this. First, although many noise control solutions are remarkable inexpensive, others can be costly, especially when the aim is to reduce the noise hazard to levels of 85 or 80 dBA.

One very important reason for the absence of noise control and hearing conservation programmes is that, unfortunately, noise is often accepted as a “necessary evil”, a part of mining operation. Hazardous noise causes no bloodshed. Breaks no bones, produces no strange-looking tissue, and, if workers can manage to get through the first few days or weeks of exposure, they often feel as though they have “got used” to the noise. But what has most likely happended is that they have started to incur a temporary hearing loss which dulls their hearing sensitivity during the work day and often subsides during he night. Thus, the progress of noise-induced hearing loss is insidious in that it creeps up gradually over the months and years, largely unnoticed until it reaches handicapping proportions.

Another important reason why the hazards of noise are not always recognized is that there is a stigma attached to the resulting hearing impairment. This is an unfortunate situation because noise induced hearing losses become permanent, and, when added to the hearing loss that naturally occurs with aging, can lead to depression and isolation in one's middle and old age. The time to take preventive steps in before the hearing losses begin.

b. Effect of noise on human body.

Loss of hearing is the most well known adverse effect of noise and probably the most serious, but it is not the only one. Other detrimental effect include tinnitus (ringing in the ear), interference with speech communication and with the perception of warning signals, disruption of job performance, annoyance and extra auditory effect. Under most circumstances protecting workers hearing should protect against most other effects.

Tinnitus

Tinnitus is a conditions that frequently accompanies both temporary and permanent hearing loss from noise, as well as other types of sensory neural hearing loss. Often refer to as a ringing in the ears, tinnitus may range from mild in some cases to severe in others. People with tinnitus are likely to notice it the most in quite conditions, such as when they are trying to go to sleep at night, or when they are sitting in a sound proof booth taking at audiometry test. It is a sign that the sensory cells in the inner ear have been irritated. It is often a precursor to noise induced hearing loss and therefore an important warning signal.

Communication interference and safety

The fact that noise can interfere with or mask speech communication and warning signal is only common source. People have learned from experience that in noise level above about 80 dBA they have to speak very loudly and in levels above 85 dBA they have to sought. It is generally known that noise can interfere with safety.

Effect of Job Performance

High level of noise can degrade job performance, specially when the task is complicated or involves doing more than one thing at a time. Intermittent noise tends to be more disruptive than continuous noise, particularly when the periods of noise are unpredictable and un-controllable.

Annoyance

Industrial workers feel annoyed or irritated by the noise at the work place. This annoyance may be related to the interference of speech communication and job performance described above, but it may also be due to the fact that many people have an aversion to noise.

Extra auditory effect

As a biological stressor, noise can influence the entire physiological system. In the long run noise can lead to disorders known as the "stress diseases". Noise has a strongest effects on cardio vascular system causing an increase in blood pressure and change in blood chemistry.

c. Noise Induced hearing Defects.

Noise is a serious hazard to hearing in today's increasingly complex industrial societies. For example, noise exposure accounts for approximately one-third of the 28 million cases of hearing loss in the United States, and NIOSH (the National Institute for Occupational Safety and Health) reports that 14% of American workers are exposed to potentially dangerous sound levels, that is levels exceeding 90 dB. Noise exposure is the most widespread harmful occupational exposure and is the second leading cause, after aggregated effects, of hearing loss.

Acute Noise-induced Damage:

The immediate effects of exposure to high-intensity sound stimuli (for example, explosions) include elevation of the hearing threshold, rupture of the eardrum, and traumatic damage to the middle and inner ears.

Temporary threshold shift:

Noise exposure results in a decrease in the sensitivity of auditory sensory cells which is proportional to the duration and intensity of exposure. In its early stages, this increase in auditory threshold, known as auditory fatigue or temporary threshold shift (TTS), is entirely reversible but persists for some time after the cessation of exposure.

Short-term fatigue dissipates in less than two minutes and results in a maximum threshold shift at the exposure frequency. Long-term fatigue is characterized by recovery in more than two minutes but less than 16 hours. In general, auditory fatigue is a function of stimulus intensity, duration frequency, and continuity.

The severity of the TTS increases by approximately 6 dB for every doubling of stimulus intensity. Above a specific exposure intensity (the critical level), this rate increases, particularly if exposure is to impulse noise. The TTS increases asymptotically with exposure duration; the symptoms itself increases with stimulus intensity. Due to the characteristics of the outer and middle ears transfer function, low frequencies are tolerated the best.

Studies on exposure to pure tones indicate that as the stimulus intensity increases the frequency at which the TTS is the greatest progressively shifts towards frequencies above that of the stimulus. Subjects exposed to a pure tone of 2,000 Hz develop TTS which is maximal at approximately 3,000 Hz (a shift of a semi-octave). The noise's effect on the outer hair cells is believed to be responsible for this phenomenon.

The worker who shows TTS recovers to baseline hearing values within hours after removal from noise. However, repeated noise exposure result in less hearing recovery and resultant permanent hearing loss.

Permanent Threshold Shift

Exposure to high-intensity sound stimuli over several years may lead to permanent threshold shift (PTS). Anatomically, PTS is characterized by degeneration of the hair cells, starting with slight histological modifications but eventually culminating in complete cell destruction. Hearing loss is most likely to involve frequencies that the transmission of acoustic energy from the external environment to the inner ear is optimal. This explains why hearing loss at 4,000 Hz is the first sign of occupationally induced hearing loss. Interaction has been observed between stimulus intensity and duration, and international standards assume the degree of hearing loss to the function of the total acoustic energy received by the ear (does of noise).

The development of noise-induced hearing loss showas individual susceptibility. Various potentially important variables have been examined to explain this susceptibility, such as age, gender, race, cardiovascular disease, smoking etc. The data were inconclusive.

An interesting question is whether the amount of TTS could be used to predict the risk of PTS. As noted above, there is a progressive shift of the TTS to frequencies above that of the stimulation frequency. On the other hand, most of the ciliary damage occurring at high stimulus intensities involves cells that that are sensitive to the stimulus frequency. Should exposure persist, the difference between the frequency at which the PTS is maximal and the stimulation frequency progressively decreases. Ciliary damage of cell loss consequently occur in the cells most sensitive to the stimulus frequencies. It thus appears that TTS and PTS involve different mechanisms, and that it is thus impossible to predict and individual's PTS on the basis of the observed TTS.

Individuals with PTS are usually asymptomatic initially, as the hearing loss progresses, they begin to have difficulty following conversations in noisy settings such as parties or restaurants. The progression, which usually affects the ability to perceive high pitched sounds first, is usually painless and relatively slow.

EXAMINATION OF INDIVIDUALS SUFFERING FROM HEARING LOSS

<u>Calculation of hearing loss</u>

In the United States the most widely accepted formula for calculation functional limitation related to hearing loss is the one proposed in 1979 by the American Academy of Otolaryngology (AAO) and adopted by the American Medical Association. It is based on the average of values obtained at 500, at 1,000 at 2,000 and 3,000 Hz, with the lower limit for functional limitation set.

d. <u>Diagnosis of NIHL</u>

<u>Clinical Examination</u>

In addition to the history of the date when the hearing loss was first detected (if any) and how it has evolved, including any asymmetry of hearing, the medical questionnaire should elicit information on the patient's age, family history, use of ototoxic medications or exposure to other ototoxic chemicals, the presence of tinnitus (I.e,. buzzing, whistling or ringing sounds in one or both ears), dizziness or any problems with balance, and any history of ear infections with pain or discharge from the outer ear canal. Of critical importance is a detailed life-long history of exposures to high sound levels (note that, to the layperson, not all sounds are "noise") on the job in previous jobs and off-the-job. A history of episodes of TTS would confirm prior toxic exposures to noise.

Physical examination should include evaluation of the function of the other cranial nerves, tests of balance, and opthalmoscopy to detect any evidence of increased cranial pressure. Visual examination of the external auditory canal will detect any impacted cerumen and, after it has been cautiously removed (no sharp object), any evidence of scarring or perforation of the tympanic membrane. Hearing loss can be determined very crudely by testing the patient's ability to repeat words and phrases spoken softly or whisper by the examiner when positioned behind and out of the sight of the patient. The Weber test (placing a vibrating tuning fork in the centre of the forehead to determine if this sound is "heard" in either or both ears) and the Rinne pitch-pipe test (placing a vibrating tuning fork on the mastoid process until the patient can no longer hear the sound, then quickly placing the fork near the ear canal; normally the sound can be hared longer through air than through bone) will allow classification of the hearing loss as transmission or neurosensory.

The audiogram is the standard test to detect and evaluate hearing loss (see below). Specialized studies to complement the audiogram may be necessary in some patients. These include: tympanometry, worked discrimination tests, evaluation of the attenuation reflex, electrophysical studies (electrocoochleogram, auditory evoked potentials) and radiological studies (routine skull x-rays complemented by CAT scan, MRI).

Audiometry

This crucial component of the medical evaluation uses a device known as an audiometer to determine the auditory threshold of individuals to pure tones of 250-8,000 Hz and sound levels between – 10dB (the hearing threshold of intact ears) and 110 dB (maximal damage). To eliminate the effects of TTSs, patients should not have been exposed to noise during the previous 16 hours. Air conducting is measured by earphones placed on the ears, while bone conduction is measured by placing a vibrator in contact with the skull behind the ear. Each ear's hearing is measured separately and test results are reported on a graph known as an audiogram. The threshold of intelligibility, i.e. The sound intensity at which speech becomes intelligible, is determined by a complementary test method known as vocal audiometry, based on the ability to understand words composed of two syllables of equal intensity (for instance, shepherd, dinner, stunning).

Comparison of air and bone conduction allow classification of hearing losses as transmission (involving the external auditory canal) or middle ear or neurosensory loss (involving the inner ear or auditory nerve). The audiogram observed in cases of noise-induced hearing loss in characterized by an onset of hearing loss at 4,000 Hz, visible as a dip in the audiogram. As exposure to excessive noise levels continues, neighbouring frequencies are progressively excessive noise levels continues, neighbouring frequencies are progressively affected and the dip broadens, encroaching, at approximately 3,000, at 4,000 and at 6,000 Hz. Asymmetric damage may, however, be present in cases of non-uniform exposure, for example, with marksmen, in whom hearing loss is higher on the side opposite to the trigger finger (the left side, in a right-handed person). In hearing loss unrelated to noise exposure, the audiogram does not exhibit the characteristic 4,000 Hz dip.

There are two types of audiometric examinations; screening and diagnostic. Screening audiometry is used for the rapid examination of groups of individuals in the workplace, in schools or elsewhere in the community to identify those who appear to have some hearing loss. Often, electronic audiometers that permit self-testing are used and, as a rule, screening audiogrames are obtained in a quiet area but not necessarily in a sound-proof, vibration-free chamber. The later is considered to be a prerequisite for diagnostic audiomerty which is intended to measure hearing loss with reproducible precision and accuracy. The diagnostic examination is properly performed by a trained audiologist (in some circumstances, formal certification of the competence of the audiologist is required). The accuracy of both types of audiometry depends on periodic testing and recalibration of the equipment being used.

In many jurisdictions, individuals with job-related, noise-induced hearing loss are eligible for worker's compensation benefits. Accordingly, many employers are including audiometry in their preplacement medical examinations to detect any existing hearing loss that may be the responsibility of a previous employer or represent a non-occupational exposure.

Hearing thresholds progressively increase with age, with higher frequencies being more affected. The characteristic 4,000 Hz dip observed in noise-induced hearing loss is not seen with this type of hearing loss.

Aims and objective of the study

The aims and objectives of the survey are :

1. To determine prevalence of silicosis among person employed in 'X' underground mine.

2. To determine prevalence of Noise induced Hearing Loss (NIHL) among persons employed in ‘X’ underground mine.

3. To suggest appropriate control and rehabilitation measures to reduce the risk of occupational diseases among workers.

Material and method

It was decided that approximately 50 workers would be asked to report for medical examination every day. A list of workers was prepared and the workers were intimated in advance. Medical examination at Central Hospital,. The medical examination included Hemogram, Urine Examination, Chest X-ray, Lung function Tests, Audiometry, General Physical Examination and other investigations if considered necessary.

The chest radiographs of workers were done on 300mA seimens machine. The lung function tests were done on Schillers Spirovit Computerised lung function testing machine. Audiometry was performed in audiometric chamber with Medson’s portable audiometric machine. Medical examinations were evaluated as per standard procedure by comparing with standard set of ILO Classification for Pneumoconiosis.

Results

Silicosis

A total of 292 workers were examined during the survey. Evaluation of chest radiographs and records of previous medical examinations and comparison with ILO classification showed that chest radiographs of 141 workers did not show any abnormality. Chest radiographs of 55 workers showed pneumoconiotic opacities suggestive of suspected Silicosis. Chest radiographs of 75 workers showed Category – 1 Silicosis Chest radiograph of 14 workers showed Category – 2 Workers showed radiological evidence of pulmonary tuberculosis while 1 worker showed silico-tuberculosis. Chest radiograph of 3 workers showed pleural abnormalities mainly unilateral pleural thickening. The results are summarised in Table – 1.

Table – 1, Summary of findings in chest radiographs

Sl. No	Findings	Number of Workers
1.	Normal	142
2.	Suspected Silicosis	55
3.	Category – 1 Silicosis	75
4.	Category – 2 Silicosis	14
5.	Siloco-tuberculosis	1
6.	Pulmonary tuberculosis	2
7.	Pleural abnormalities	3

Noise Induced Hearing Loss

The audiograms of workers were evaluated for Noise Induced Hearing Loss (NIHL). The criteria used for diagnosis of Noise Induced Hearing Loss (NIHL) were adopted from Report of Informal consultation on “Prevention of Noise Induced Hearing Loss” held at World Health Organisation, Geneva in October, 1997.

“The consultation defined Noise Induced Hearing Loss, for survey purposes only, according to (1) Noise exposure history : 100 dB (NI) or 83 dBA L_{aeq} 40 for a 50 year lifetime (equivalent exposure), (2) Audiometric criteria : sensorineural but not unilateral, 0.5 kHz threshold less than 50 dBHL, and at least a 15 dB difference between high and low frequency threshold averages in under 50 year-olds”.

Audiograms of 225 workers showed hearing loss due to excessive exposure to noise. Of 225 workers showing evidence of Noise Induced Hearing Loss (NIHL), 42 showed Mild Hearing Impairment (25-40 dB), 82 workers showed Moderate Hearing Impairment (41-55 dB), 67 workers showed Severe Hearing Impairment (56-70dB) and 28 workers showed Profound Hearing Impairment (71-dB or more). 6 workers showed hearing loss due to non-occupational causes mainly due to Chronic Suppurative Otitis Media. The results are summarised in Table –2

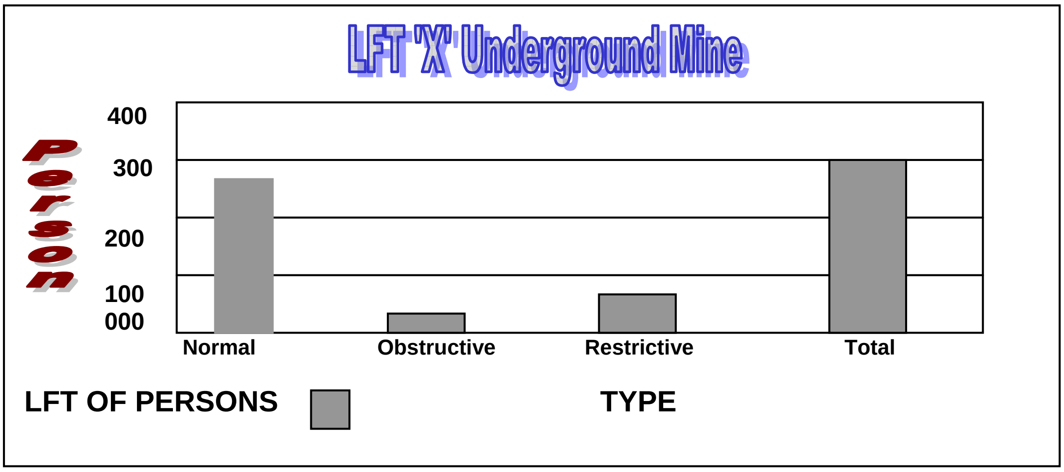
Table – 2, Summary of findings on Audiometry.

Sl. No	Findings	Number of Workers
1.	Normal	40
2.	Mild Hearing Impairment	42
3.	Moderate Hearing Impairment	82
4.	Severe Hearing Impairment	67
5.	Profound hearing Impairment	28
6.	Non Occupational Hearing Impairment	6

Lung function test.

a. Normal – 250 persons
b. Obstructive – 17 persons
c. Restrictive – 22 persons
d. Mixed – 1 person.

It has been observed that out of 290 persons examined for lung function test 86.2% is normal, 5.86% is having obstructive lung diseases, 7.58% is having restrictive lung diseases and 0.34% is having mixed type of lung disease.



Other abnormalities

- Hypertension - 26
- Tuberculosis - 02
- Diabetes Mellitus 02

It has been observed that out of 290 persons examined for general physical examination 8.96% is suffering from Hypertension, 0.68% is suffering from Tuberculosis and 0.68% is suffering from Diabetes Mellitus.

Conclusion

The perliminary analysis of results of occupational health survey of 292 workers in 'X' Underground Mine showed suspected silicosis in 55 (18.8%) workers, Category – 1, Silicosis in 75 (25.7%) workers and Category – 2, Silicosis in 14 (4.8%) workers.

The lung function abnormalities of obstructive, restrictive, or mixed type have been detected in 40 (13.7%) workers.

Noise induced hearing Loss (NIHL) was detected in 219 (75%) of 292 workers of 'X' Underground Mine.

In addition 26 workers showed mild to moderate hypertension.

A detailed analysis of the results of Occupational health Survey will be conducted at the completion of the survey. However, the pattern of abnormalities detected is not likely to substantially different.

Recommendation

From the above study it appears that a substantial number of persons were suffering from silicosis and Noise Induced Hearing Loss (NIHL). So the management was advised to undertake engineering control measure for dust & noise reduction of the machinery along with providing personal protective devices e.g. ear plug, dust musk, etc. to the workmen. Management was also advised to undertake awareness programmes regarding silicosis & NIHL by actively forming groups represented by union leaders and workers.

Regarding medical surveillance occupational health centre was advised for early detection of occupational diseases.

Never before perhaps was more urgent than now to plan the future course of occupational safety and health in our country. There is still need to improve both the legislation designed to protect workers health and it's enforcement. The Government, industry and labour should make an honest effort to work in harmony to accomplish the goal.