

## Problem Statement

Hearing loss can cause safety problems in the workplace as well as diminish the quality of life. The Mine Safety and Health Administration (MSHA) estimates about 37,000 miners will suffer a significant loss of hearing. The National Institute for Occupational Safety and Health (NIOSH) has identified noise-induced hearing loss as one of the leading work-related diseases and injuries in mining. In September of year 2000, MSHA's new health standards to protect mine workers from noise-induced hearing loss took effect. One of the major changes is the requirement to use all feasible engineering and administrative controls to reduce miners' noise exposure to the "permissible exposure limit (PEL) of 90 dBA. There, it was recognized that the loudness and the duration of noise exposure are both factors in causing hearing loss. Furthermore, when these new regulations are enforced for coal mine operations, personal hearing protectors will no longer be permitted. One additional change for coal and metal/nonmetal mine operations is the mandatory enrollment of the miners in a "hearing conservation program (HCP)", if they are exposed to an average sound level of 85 dBA or more over an eight-hour period.

Four specific guidelines are summarized below (Ref):

1. Miners exposed to an average sound level of 85 decibels or more over an eight-hour period must be enrolled in a hearing protection program, which will include special training, hearing tests and hearing protection.
2. If workplace noise level reaches 90 dBA or more over an eight-hour period, mine operators must use feasible engineering and administrative controls to reduce noise levels. Hearing protectors are required to be provided and worn if the permissible exposure level cannot be achieved using feasible engineering and administrative controls.
3. At workplace noise levels of 105 dBA or more over an eight-hour period, mine operators must ensure the use of both earplug and earmuff type hearing protectors.
4. At no time during the work shift noise levels may exceed 115 dBA.

A technically feasible single engineering control or a combination of controls defined by MSHA are expected to achieve at least a 3dBA reduction in a miner's noise exposures. In determining the feasibility of administrative controls, MSHA will consider the same factors, that is, nature and extent of the exposure, demonstrated effectiveness of available technology, and whether resources are out of proportion to expected results. For example, MSHA will not require to hire additional workers in order to "exhaust" all feasible administrative controls.

There are several ways to achieve the required reduction of noise exposure. "Passive noise control" is versatile and least expensive. Some of the well-adapted treatments are resilient screen decks and impact pads, chute liners and loaded-vinyl curtains. However, these preventive treatments are site specific and require detailed measurements on topological and acoustic configurations of a site. On the other hand, "active control" directly deals with vibrating components of machineries and introduce anti-noise to eliminate unwanted noise production. Active control treatments are machine specific as

opposed to site specific, however, directly eliminate the source of unwanted noise. One drawback of this method may be that noise emitted by machine parts is not constant due to wear or loosening of those parts. In this proposal, we introduce additional method called "semi-active noise control". This method includes a feed back system to passive treatments to account for time variable noise so that anti-noise is always fine tuned.