Abstract

Analytical design procedures to determine optimal noise hazard control strategies for industrial facilities are presented. Two extreme and one mixed procedure for designing a noise hazard prevention program are discussed in this research. The two extreme design procedures (i.e., engineering-based and HPD-based) yield upper and lower bounds of the total noise control cost, respectively; while the mixed design procedure provides an optimal noise hazard prevention program within a given total budget. The upper bound of the workforce size for job rotation is approximated using a heuristic procedure. Six optimization models are developed and utilized by the mixed procedure to eliminate or reduce excessive noise exposures in an industrial workplace. The mixed procedure also follows the OSHA's hierarchy of noise control. Next, two genetic algorithms (GA) are developed to find an optimal (or near-optimal) noise control solution for the engineering control and the administrative control. Both GAs are found to be efficient in solving noise control problems irrespective of the problem size. Besides, a decision support system for designing effective noise hazard prevention (NHP) strategies is developed. The user can choose among single-approach, two-approach, and three-approach solution procedures. Heuristics and genetic algorithms are used to determine appropriate noise controls. From the given noise condition and noise control budget, the NHP recommends a noise hazard prevention strategy that prevents any worker's daily noise exposure from exceeding the permissible level. In case that the budget is insufficient, the NHP is able to search for a feasible noise hazard strategy that requires the minimum noise control budget.

Additionally, a heuristic for designing the auditory warning system is proposed. An analytic procedure is presented to assist safety practitioners in evaluating the audibility of an existing auditory warning system in their workplaces. Next, a heuristic algorithm to determine a minimum number of alarm devices and their locations, so that the warning signals generated by the alarm devices can be clearly heard by workers, is proposed. The heuristic approach is efficient for solving large alarm location problems due to its capability in finding near-optimal solutions within reasonable computation time.