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Abstracts

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A Study of Heat Strain Among Mine Rescue Workers

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Broad Importance: Mine Rescue workers are the front line for emergency response when catastrophic events strike underground mines. Mine rescue teams can face dynamic and extreme environments as they work to rescue trapped miners and restore mine workings to operational status. Rescue operations can require teams to work under self-contained breathing apparatus (SCBA) for up to two hours in dangerous environments. No specific guidance regarding safe operational durations in hot environments has been provided to mine rescue workers in the United States. In October 2002, two mine rescue team members suffered fatal exposures to hot environments in an underground gold mine.

Purpose of Study: This study attempts to quantify the heat strain exposures of mine rescue workers engaged in underground operations in hot environments. The relative contributions of the mine environment, metabolic activity, breathing apparatus, and body mass of the individual will be assessed to identify administrative and engineering controls to reduce the risk associated with mine rescue operations in hot environments.

Methodology: Mine rescue workers were monitored during training exercises in hot underground mines in Idaho and Nevada. Environmental parameters of air velocity, dry bulb temperature, passive wet bulb temperature, globe temperature and rock temperature were measured. Physiological parameters of core body temperature and heart rate were collected in one-minute increments throughout the exercise utilizing thermometry pills. Observations of activities performed were made to assess relative metabolic rates between individuals.

Findings: Ten percent of the participants reached the NIOSH limit of 39 C during the observations. Over 40% of the participants experienced core temperatures in excess of 38.5 C, the ACGIH action level. Over 70% of the participants exceeded 38.0 C, a level associated with diminished judgment and reaction times. Excess heat retention was associated with high peak heart rates and slow recovery rates.

The rate of heat gain observed was predictable. Work time duration limits can be proposed based on ambient conditions, availability of rest periods and initial condition of the mine rescuer. Engineering controls to reduce heat have been identified for further study

Applications of the Findings: A model for prescribing limitations for durations of exposures for mine rescue work is being developed. Validation of the model will require additional monitoring of teams in a variety of exposures.

Administrative tools utilizing ambulatory heart rate monitors can allow teams to regulate their rest periods based on peak and recovery heart rates. An engineering control to provide the ability to hydrate during wearing of the closed circuit SCBA is being evaluated. The impact on acceptable durations of exposure is being assessed.

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