

Development of Underground transportation Hazard management System (UTHMS) for Indian underground hard rock mines

Dr. Falguni Sarkar
Assistant Professor,
Department of Mining Engineering
National Institute of Technology-
Rourkela, India
E-mail: sarkarf@nitrrkl.ac.in,
falguniind31@gmail.com

Sabyasachi Nayak
Mining Engineer
Founder and Director
Minemagma Pvt. Ltd. Bangalore, India
E-mail: sabyasachi@minemagma.com

Abstract

In present day Indian Mining scenario, the deployment of Heavy Earth Moving Machineries (HEMM) like LHD (Load haul Dump), LPDT (Low Profile Dump Truck), Drill Jumbo, Scissor lifts and passenger carriers etc. in trackless underground mines is very much indispensable requirement for carrying out production, transportation of men and material, manage environmental sustainability and handling emergency situations efficiently. As the HEMM's are exhaustively used to load and haul the mined out materials and also to carry a number of mine workers at a time, occurrence of any accident can give rise to the disastrous consequence. The proactive Safety Management System (SMP) devised and implemented in accordance with Directorate General of Mine safety (DGMS), India, guidelines and Hazard and Operability Analysis (HAZOP) procedure is found inadequate to explore component interaction failure and events involved with operational safety protocol breach in such complex transportation machineries. Therefore, a field experience based hazard management framework namely **Underground transportation Hazard management System (UTHMS)** is proposed in this research for mitigating hazards arises due to contravention of complex human-machine interaction protocols and contemporary health- safety management procedures. The proposed UTHMS will be structured on the basis of **System Theoretic Process Analysis (STPA)**, which will help the mine operators to presume the factors involved in accidents pertaining to transportation system, and formulate effective control structures and OCPs (Operational control Procedure) with clear guidance to control the events leading to the adversity. A digitized platform for monitoring various aspects of UTHMS will be framed and the efficacy of the UTHMS will be tested in selected underground hard mines in India. The brief methodology for establishing UTHMS are explained below:

1. Study on the safety features of various types of HEMMs and construction of a database.
2. Detailed study on the accident/incident scenario pertaining to HEMM, development of Mine Accident Data Analysis (MADA) structure.
3. Evaluation of present safety management system implemented by the mine management to reduce the number of accidents.
4. Establishment of a hazard and failure Analysis Framework for HEMM System Based on STPA.
5. Design of hazard mitigation procedure as per STPA that includes operational control structures, standard

operating procedures (SOP), codes of practice (COP) and their monitoring measures.

6. Development of digitized platform to monitor all control procedures, feedback management and record keeping.
7. Implementation of the designed system and analysis of outcomes.

The judicial implementation of the **UTHMS** is expected to reduce maintenance errors and cost of compensations for accidents significantly. Thus, it will help the mining industry to maintain safe and productive work environment.

Keywords: Heavy Earth Moving Machineries (HEMM), Directorate General of Mine safety (DGMS), Hazard and Operability Analysis procedure (HAZOP), System Theoretic Process Analysis (STPA), Underground transportation Hazard management System (UTHMS)