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IT Enabled Process Control Management and Competency-Based Training needs Assessment in Opencast Coal Mines

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Abstract

An IT enabled system (AK Safe app) to facilitate Process Control (PC) management and competency-based training needs assessment has been developed, based on integrated approach and system theory. The system has undergone maiden field trial successfully in two opencast coal mines.

Keywords: *SH-Safety & Health, IT-Information Technology, PC-Process Control, SMP-Safety Management Plan, PHMP-Principal Hazard Management Plan, CMC-Closely Monitored Control, HC-Head Control, IC-Intermediate Control, FC-Front Control, KPC-Key Process Control, AIQ-Audit Information Questionnaire, OSH- Occupational Safety & Health*

1. Introduction

Globally, investigations into serious and fatal incidences point to the fact that controls for identified principal hazards were not effectively implemented. This is often as a result of dense and complex safety management systems and hazard management plans or procedures that prove to be difficult to implement or lack clarity as to which controls are most important.

To prevent fatal and catastrophic events from occurring – the critical controls must be clearly defined and understood, with clarity as to who is responsible for implementation. A critical control management approach is an effective way of achieving this, by focusing risk-

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management on those controls that are most critical for health and safety (ICMM, 2015).

Rio Tinto with 50,000+ employees on roll spread over 60+ sites worldwide, has recorded more than one million control verification per year since rolling out its Critical Risk Management (CRM) program, with more than 25,000 verifications completed across Rio Tinto's global operations each week (Rio Tinto, 2018).

In the Indian context, based on integrated approach and system theory, an IT enabled system - *AK Safe app* - for process control (PC)/key process control (KPC) management and competency-based training needs assessment, has been developed and successfully implemented in two opencast coal mines (Sinha, 2016 and 2020).

2. Systems based Integrated Approach

Systems-based approach to safety requires the application of scientific, technical and managerial skills to hazard identification, hazard analysis, and elimination, control, or management of hazards throughout the life-cycle of a system, program, project or an activity or a product.

The primary focus of any system-based safety plan, hazard analysis and assessment of safety issues is to implement a comprehensive process to systematically predict or identify the operational behaviour of any safety-critical failure condition or fault condition or human error that could lead to a hazard and potential mishap.

The integrated approach and processes [Sinha, 2020 and 2021] aligned with Indian regulatory guidelines and expectations of ISO 45001:2018 deal the issues which organisations need to address to manage health and safety risks effectively by formulating and implementing a principal hazard management plan (PHMP) on a digital platform. It also provides guidance to stakeholders on managing health and safety through processes where hazards have been identified and health and safety risks are being controlled across all the organisations activities.

For all priority unwanted events with significant SH consequences relating to processes, products, services and activities, controls and procedures shall be identified and strategies in the form of work plans, protocols and guidelines need to be formulated and implemented.

It is necessary to identify controls that are to be monitored closely—things that can't afford to fail—and isolate those and then manage those controls to make sure they're effective. Closely monitored controls (*CMC*) (Sinha, 2020 and 2021) must be regularly evaluated to ensure they meet established performance requirements. Minimum performance thresholds must also be established to ensure that corrective action is taken when these thresholds are not met. For an effective *CMC* management, the role of *CMC*-custodian, verification officer and that of owner has to be clearly defined (Sinha, 2020 and 2021).

In the safety management plan (SMP), for each *identified principal hazard (PH) categorised as high risk*, there can be single or multiple controls which need close monitoring and verification, and may range from engineering to administrative controls. Prior to commencing a work process, lead operator(s) check that the identified control is in place as per prescribed protocol, by answering a series of yes/no questions, on a task-by-task basis. In a layered process, supervisors routinely verify those control(s) is/are in place, on a shift-by-shift/daily/weekly basis, and manager(s)/work place in-charge(s)/safety officer(s) may review the design and implementation of the control(s).

The results of the above process are fed back into the principal hazard management plan (PHMP) to validate the effectiveness of current controls and also highlighting the need to devise better controls. The results of verification of controls are recorded in a central database. Through appropriate analytics, deviations in control(s) and their trends, etc., are classified, with a roadmap for rectification in a time bound manner. It will also highlight the need for conducting education and training programmes, relating to the specific areas of principal hazard control.

3. Application of system Theory in Mine Hazard Control

In recent years, mining systems are becoming more complex, demands of high productivity leads to introduction of new technology and methods, effecting a distinct change in human roles. It was observed that incidents/accidents often result from interaction among components of mining systems, where a systems theory may be more appropriate to deal with complexity.

System theory, in which the system is treated as a whole, not as the sum of its parts. The concept focuses on emergent properties, that are not in the summation

of the individual parts but "emerge" from relationship among the parts of the system, notably how they interact and fit together. They can only be treated adequately by taking into account all their technical and social aspects (Leveson and Thomas, 2018).

3.1 Mining Process and Hazard Control Framework

A hierarchical mining process and hazard control structure consisting of feedback control loops has been developed, which is detailed below. An effective control structure needs to facilitate enforcement of safety considerations and guidelines on the behaviour of overall mining system.

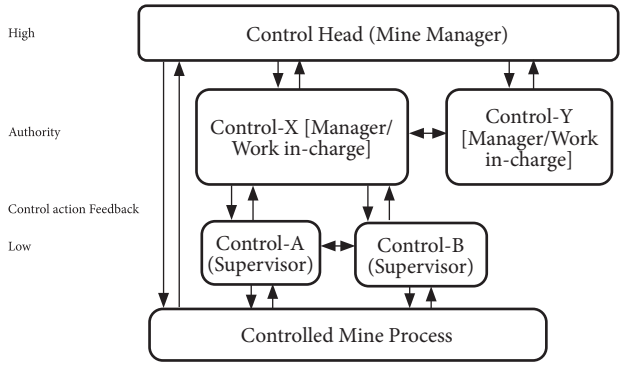

Figure 1. Mining process and hazard control structure (Sinha, 2020 and 2021).

The devised control structure depicts the pathway through which flow of control actions in the form of operational instructions travels from head, control-HC (mine manager) through intermediate control-IC (manager/work in-charge, etc.) to front control-FC (supervisor). There is a provision for lateral interaction at IC & FC level to avoid overlapping of domain functions and facilitate issue of explicit control action(s). Under specific circumstances (e.g., mine emergency, etc.) it also empowers the HC to initiate control action directly to the controlled process with a facility to receive feedback. The system at hand excludes (a) faulty control action due to incomplete/deficient processes and protocols (b) control action directed to wrong entity (c) control action to entities that don't have the necessary feedback to select safe control actions (d) feedback to entities with no ability to do anything about the same, and (e) multiple controllers' issue conflicting commands to the same entity with no ability to detect or resolve the conflict.

4. IT Enabled Process Control Framework (*AK Safe app*)

Drawing inputs from developed principal hazard management plan (PHMP) including work plans and protocols, a process control questionnaire was prepared containing functions of about 35 mine officials, and in sync with the concept of system theory, in respect of opencast coal& metal mines.

An IT enabled process control framework - *AK Safe app* - has been developed, based on PH control protocols and questionnaire with due safety considerations. The app is proactive and facilitates on line safety monitoring with digital data storage and retrieval; It is also equipped with powerful analytics which assists in taking quality safety decision in time.

4.1 Control Analytics

The control analytics developed is capable of (a) determine absence of control(s), (b) assess inadequacy of control(s), (c) identify unsafe control action, and (d) detect flawed implementation of control(s). A system has been placed to examine the background of unsafe behaviour, i.e., command(s) despatched but not received, unsafe command(s) despatched, etc.

Based on the feedback, process control (PC)'s/key process control (KPC)'s with reasonable mitigation status, and PC's/KPC's with varied degree of deviations in mitigation can be mapped, for further management action. The feedback is instrumental in conducting a competency-based training needs analysis in mines. Further, it shall assist in evaluation and necessary revision of principal hazard management plan (PHMP), work protocol(s) and guidelines for value addition and fine tuning of the system.

5. SMP-PHMP Audit by *AK Safe app*

A field trial of the IT enabled process control framework was envisaged, to test its adoptability across a range of operating environments and acceptance by mining personnel. Keeping this in view, audit of SMP-PHMP was taken up, using *AK Safe app* in two opencast coal mines.

The filling up of the audit information questionnaire (AIQ) was done in due consultation with the concerned key mine officials, under the guidance of audit team led

by an eminent OSH expert. The team explained in details about the PH control deviations noted, and also suggested the possible ways and methods of correcting the control deviations. The salient aspects of the concerned mine official's feedback on PH control management were duly noted. The exercise was followed by a field verification visit of the audit team.

6. Concluding Remarks

The user-friendly IT enabled process control system (*AK Safe app*) has been successfully field trialled in two opencast coal mines, and is ready for implementation in other coal and metal mines of Tata Steel Limited. Audit information questionnaire (AIQ) developed on IT platform proved to be a handy tool for continuous monitoring and enabling timely measures to correct deviations in management of PC's/KPC's and engineer mitigation of principal hazards. It has successfully facilitated the audit of SMP-PHMP in both opencast coal mines. It will also assist in framing the mine vocational training schedule, on the basis of competency-based training needs analysis, conducted as a part of PC/KPC management exercise in both coal mines.

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