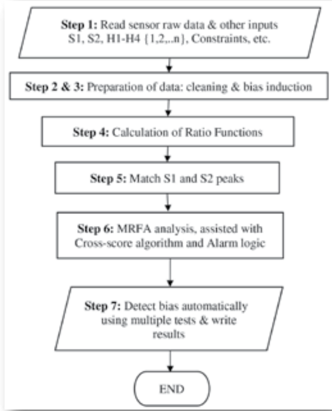

Fig. 3 Flowchart depicting MRFAA algorithm.

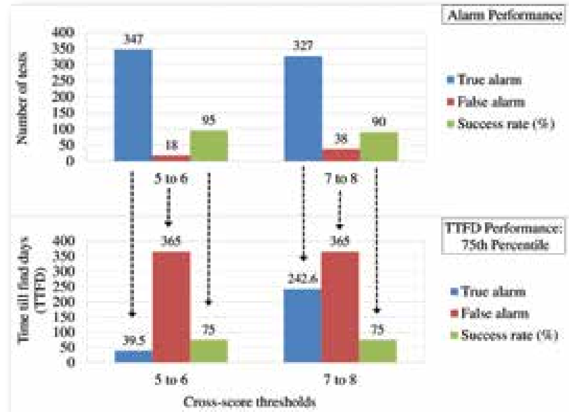

Fig. 4 Combined test: Alarm and TTFD performances..

Detection also triggers alarms, True and False, whereby industry operators depend on True alarms (high rates desired) and TTFD to initiate early recalibration exercises.

Results and discussion

In terms of True alarms, the results from the combined test proved that all the tests together have a high success rate (95 percent) in detecting bias — in about a month (TTFD), or 39.5 strip cycles — at the user-defined cross-score thresholds of 5 or 6 (Fig. 4). Hence, finding these thresholds is the key to the detection exercises in future data sets. Coming to the individual tests, the heat test proved most effective of all. In contrast, the effectiveness of the GLYFL and BARNFL tests is marginal due to their poor response to bias in terms of ratios.

Conclusion

The need for in situ detection of subtle sensor errors (as low as 2 percent) in the mining industry is addressed by the innovative MRFAA algorithm developed for this research. The data-mining concepts used in this context are perhaps the first of their kind. Current detection times of about a month span are promising and can help operators to improve on the industry-average calibration frequency of once a year. To reap the economic benefits — though quantification is beyond the scope of research — operators could use the algorithm alarms to initiate early recalibration exercises. ■

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Analysis of fall-related imminent danger orders in the metal/nonmetal mining sector

Jonathan K. Hrica*, Brianna M. Eiter, Jonisha P. Pollard, Lydia M. Kocher and Mahiyar Nasarwanji

National Institute for Occupational Safety and Health (NIOSH), Pittsburgh, PA, USA

*Corresponding author email: jhrica@cdc.gov

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Keywords: Imminent danger, Hazard recognition, Fall injuries, Fall prevention

To read the full text of this paper (free for SME members), see the beginning of this section for step-by-step instructions.

Special Extended Abstract

Within the metal/nonmetal mining sector, fall-related incidents account for a large proportion of fatal and nonfatal injuries that occur in mining in the United States. However, the events and contributing factors leading up to these incidents have not been fully investigated. To help provide a clearer picture of these factors, an analysis of imminent danger orders issued by the U.S. Mine Safety and Health Administration (MSHA) from 2010 through 2017 at both surface and under-

Table 1 — Primary and secondary factors for fall-related metal/nonmetal imminent danger orders issued by MSHA from 2010 through 2017.

Primary factor – secondary factor	Count of cases				Percent of grand total
	Procedural	Complex	Specialized	Total	
Fall protection	759	124	3	886	83.8
– lack of	666	110	2	778	73.6
– not tied off	39	5		44	4.2
– not provided	24	4		28	2.6
– improper use	17	2		19	1.8
– no tie-off location	10	3		13	1.2
– unsafe for use	3		1	4	0.4
Safe access	51	38		89	8.4
– not provided	43	38		81	7.7
– not used	8			8	0.8
Unsafe act	50	15	1	66	6.2
Inadequate barricades, guarding or signage	9	1	1	11	1.0
Unsafe condition	5			5	0.5
Grand total*	874	178	5	1,057	100.0
Percent of grand total	82.7	16.8	0.5	100.0	

*Total n is equal to 1,007 cases. The grand total of 1,057 shown in this table accounts for cases that were coded into two or more categories.
46 cases were coded with primary factors of both "fall protection" and "safe access."
3 cases were coded with primary factors of both "fall protection" and "inadequate barricades, guarding or signage."
1 case was coded with secondary factors of both "not provided" and "no tie-off location."

ground metal/nonmetal mine sites revealed that most orders are associated with fall risks. Of these cases, 84 percent involved the workers not using fall protection, fall protection not being provided or the improper use of fall protection. Fall risks for workers most frequently occurred when standing on mobile equipment, performing maintenance and repairs on plant equipment or working near highwalls. In most cases, a single, basic, corrective action — such as using fall protection — would have allowed workers to perform the task safely. Overall, these findings suggest that a systematic approach is needed to identify, eliminate and prevent imminent danger situations. Furthermore, to protect mineworkers from falls from height, frequently performed tasks requiring fall protection should be redesigned to eliminate the reliance on personal fall protection.

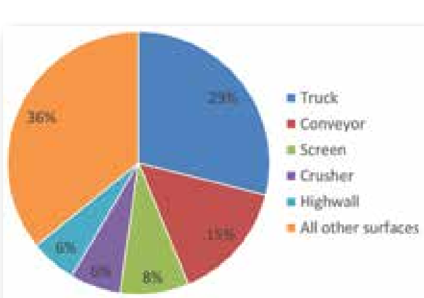

Fig. 1 Top five working surfaces for fall-related metal/nonmetal imminent danger orders issued by MSHA, 2010–2017.

Background

Working at height is common at mine sites, especially metal/nonmetal sites, due to the design of mine equipment and machinery, the presence of highwalls, the size of equipment used, and activities such as machine maintenance and repair. Falls are a significant cause of fatal injuries and are the second leading cause of nonfatal injuries at mine sites [1]. The classification of "slip or fall of person" accounted for 55 (11 percent) of the 479 fatal injuries at U.S. mines from 2006 through 2015 [2]. Nearly 60 percent of all slip or fall fatal injuries could be attributed to falls from height.

Given that fall incidents and injuries continue to be a significant problem for the U.S. mining industry, the purpose of this research is to examine the MSHA imminent danger orders associated with potential falls at metal/nonmetal mine sites. Imminent danger orders provide a unique opportunity to better characterize a potentially serious or fatal fall scenario before a fall occurs and determine what safety measures were not being implemented and why. This paper aims to identify the most common fall-related imminent danger situations, what safety procedures are necessary that are not being followed and where these imminent danger situations are occurring, as well as provide recommendations based on current literature on how to prevent imminent danger situations at mine sites.

Methods

From 2010 through 2017, 1,999 imminent danger orders were issued by MSHA at surface and underground metal/nonmetal mine sites [3]. Researchers from the U.S. National Institute for Occupational Safety and Health (NIOSH) developed a classification system based on MSHA's Classification of Mine Accidents definitions [4] to categorize each order. Following this initial classification, two additional coding schemes were applied to the data to determine: (1) the complexity of the situations using Eiter et al.'s definitions [5] and (2) the primary and secondary reasons (factors) for issuing the imminent danger order, the working surface (location) of the order, the activity being conducted at the time of the order, the exposed fall distance (when available), and the employment type (mineworker, contractor, customer/delivery or mine management) of the person involved (when available).

Results

Phase 1 coding in this study revealed that a large majority of the fall-related imminent danger situations (82.7 percent) were found to be the least complex and had the procedural classification (Table 1). In these cases, one safety procedure that should have been taken while performing the task was omitted. In contrast, a relatively small portion (16.8 percent) of the cases were classified as complex situations, where more than one safety procedure or more than one corrective action were needed to safely perform a work task. Specialized situations that required a worker to have domain-specific knowledge of a problem represented an even smaller (less than 1 percent) portion of the fall-related imminent danger orders.

Phase 2 coding revealed that fall protection was the primary factor for issuing the fall-related imminent danger orders and was usually due to a worker not using fall protection, labeled as "lack of" in Table 1. Workers who were wearing fall protection but were not tied off, along with the other classifications of "not provided," "improper use," "no tie-off location" and "unsafe for use" made up a small proportion, 12 percent, of the total cases.

The top five work surfaces (Fig. 1) attributed to fall-related imminent danger orders were truck, conveyor, screen, crusher and highwall. These work surfaces were grouped based on the type of work and location into three common work situations: working on a truck, working in a plant area, and working near a highwall.

Conclusions

The analysis of imminent danger orders in this study revealed that, in most cases, only one corrective action — such as using fall protection — may have allowed the worker to perform the task safely. These cases occurred on various work surfaces throughout the mine, including trucks, plant equipment and highwalls. In many of these cases, consideration of the workplace design may help to eliminate the need for fall protection or to eliminate the risk. Truck drivers, for example, should not have to put themselves in fall-from-height situations to remove excess materials due to poor loading practices. Moreover, providing tarping or hatching stations may eliminate the need for fall protection when tarping a load or opening and closing hatches.

While these findings indicate that not using fall protection is a significant problem in the mining industry, the results do not explain why mineworkers are choosing not to use fall protection when it is provided. Further analysis of imminent danger situations and mineworkers' perceptions of the risks associated with these situations could reveal why fall protection was not used or deemed not necessary in these cases. ■

Disclaimer

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention.

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Justifying API bentonite rheological behavior through its forming size fractions

R.M. Farag[1], A.M. Salem[2], A.A. El-Midany[1,*] and S.E. El-Mofty[1,3]

[1]Mining, Petroleum and Metallurgical Engineering Dept., Cairo University, Cairo, Egypt
[2]Petroleum Engineering Department, Suez University, Suez, Egypt
[3]Civil Engineering Department, College of Engineering, Bisha University, Bisha, Saudi Arabia
*Corresponding author email: aelmidany@gmail.com

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Keywords: Bentonite, Drilling mud, Size, Size distribution, Rheological properties

To read the full text of this paper (free for SME members), see the beginning of this section for step-by-step instructions.

Special Extended Abstract

Bentonite is one of the main players in the stability of drilling mud. Its particle size and particle size distribution significantly affect drilling mud's rheological properties. Although the Specifications for Drilling Fluids Materials report on Oil Companies Material Association (OCMA)-grade bentonite states that the API recommended powder having 2.5 percent mass fraction as the maximum value of residue of diameter greater than 75 µm, there is no other information on the specific size distribution for API bentonite. It was found that API bentonite has a specific size distribution with specific mixing weights.