Ergonomics Audit for Mining

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Acknowledgments

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Project Objective

To develop and evaluate ergonomics audits for three types of mining operations

- Small and Bulk Bagging Operations
- Haul Truck Operation
- Preparation/Minerals Processing Plant Maintenance and Repair
What is an Ergonomics Audit?

- An ergonomics audit provides a comprehensive measurement at a specific point in time of how well jobs and workplaces have been designed from an ergonomics standpoint (Koli et al., 1998)
- Concepts of checking, acceptable practices/policies, and consistency (Drury and Dempsey, 2012)
- This is not an audit of your ergonomics program
Desired Audit Characteristics

- Modular
- Reasonably self-explanatory
- Based on accepted principles
- User measures when practical
- Encourages *reliable* and *valid* observations
- The audit provides the user recommendations when issues are identified
  - Tiered when possible
  - Some are based on observed solutions
Content Validity

MSHA Data Analysis

MSHA Fatality Reports

Lab/Field Studies

Task Analysis

Mine Information

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Bagging – Field Study

- Small bags
  - Electromyography to estimate spinal compression
  - Oxygen consumption to estimate energy expenditure
  - Process characteristics recorded (layout, shift, bag type, etc.)
Bagging – Lab Study

- Positioning of pallet and worker during palletizing
Bagging – Bulk Closing Study

A - Manual cable or wire tie
B - Cable tie gun
C - Pneumatic cable tie gun
D - Wire tie twist tool
E - Cord or B-lock
F - Drawstring or string
M&R – Postural Analysis
• Data collected:
  – Whole body and upper extremity vibration exposure
  – GPS and tagging of key locations (pit, crusher, etc.)
Haul Truck – Field Study
Audit Development

- Audit items were derived from MSHA data analyses, field observations and experimental studies
- Generally accepted ergonomics methods and MSHA standards were considered
- Items from previously developed and validated audits are included
Audit Development

- Group discussions of audit structure, types of modules to include or exclude, etc.
- Sub-teams focused on areas of expertise and experience
- Review and re-review by everyone
- Review for clarity from outside audit team
- Reliability study
  - 4 Certified Professional Ergonomists
  - Field testing
When to Audit?

- There is no 1 answer to when
- Maintenance and repair is most difficult since the work changes
- Environmental Conditions would ideally reflect warmest and coldest conditions
- Don’t try to beat the audit!
Audit will provide a set of recommendations based on responses

Recommendations have tiered suggestions where applicable

Recommendations are not ranked
Maintenance & Repair Structure

Administrative
- 1: Tools and PPE
- 2: Communication
- 3: Lock Out/Tag Out
- 4: Working at Heights

Facility
- 5: Slip, Trips and Falls
- 6: Environmental
- 7: Machine Guarding

Pre-Maintenance
- 8: Equipment Access
- 9: Prep and Area Inspection
- 10: Housekeeping

All Maintenance Tasks
- 11: Blocking
- 12: Posture
- 13: Gross Posture
- 14: Hand Tool Use

Specific Tasks
- 15: Screen Maintenance
- 16: Greasing
- 17: Conveyor M & R
M&R 2: Communication

• 2.3 How are workers given their work assignments?

• 2.5 Do shifts overlap allowing personnel to communicate with the outgoing shift prior to the start of their shift?

• 2.6 Is information from the outgoing shift transmitted to the incoming shift through written documentation?
• 9.3 When working near stairwells, are guards or gates added to the entrance of the stairwell?
M&R 12: Posture Assessment

Power

Pinch

Wide finger

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Bagging Audit Structure

Facility Level

1: Bagging Operation Characteristics
2: Personal Protective Equipment
3: Work Posture
4: Work Environment
5: Lighting
6: Mobile Equipment
13: Stretch and Shrink Wrapping

Small Bags

7: Filling
8: Weighing
9: Sealing
10: Palletizing

Bulk Bags

11: Hanging, Opening, and Filling
12: Closures
1.1.2 Is the process for checking the weight of small bags after filling (MC):
   a) Automated process (no manual handling during weighing)
   b) Process requiring some manual handling such as lifting a filled bag and moving to a scale

1.3 At any given time, how many workers are typically involved in bagging tasks?

1.4 Do workers rotate between tasks (e.g., driving fork lift, palletizing, bagging)?
Bagging 3: Work Posture

• 3.4 Is the worker able to rest their feet comfortably with a near 90° angle at the hip and knee (e.g., Figure 2) and not like Figure 3?
10.3 What is the highest height of the hands when lifting bags from the conveyor (measured from the surface the worker is standing on to the middle knuckle of the highest hand when lifting the bag)?
Haul Truck Audit Structure

1. Training
2. Policy
3. Haul Road/Mine Pit
4. Pre-shift Inspection
5. Ingress/Egress
6. Driving/Cab Layout
7. Loading
8. Dumping
2.6 Are drivers required to set the parking brake whenever parking the truck?

2.8 Are drivers required to make their first move from a parked position in the forward direction (i.e., first move forward)?

2.10 Is there a policy for cell phone (both personal and company provided) usage for haul truck drivers?
3.17 Are all berm heights at least as high and wide (at the base) as the axle height of the largest piece of equipment that uses the roadway, see Figure 1?

Figure 1: Haul truck next to a berm. The term h is the recommended minimum height and width of the berm and is equivalent to the axle height of the largest piece of equipment that uses the haul road.
8.4 Observe (at least 5 trucks) the geometry of the haul truck, from the side, while moving within the dump site area and when discharging the load. How does the haul truck dumping process compare with the illustrations of dumping practice shown in Figure 3? a.) rear wheel above front wheels, b.) all wheels level, c.) front wheels above rear wheels

Figure 3: Haul truck diagrams displaying dumping practices.
Audit Implementation

- Publication with printable copy
- Google Play Android applications for phones and tablets
- Apple Store iPad and iPhone applications
The findings and conclusions in this presentation are those of the author and do not necessarily represent the views of the National Institute for Occupational Safety and Health.
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Audit App Demonstration