

# Ergo2.0Mine

## Maintenance & Repair Audit



Centers for Disease Control  
and Prevention  
National Institute for Occupational  
Safety and Health

# Maintenance and Repair Audit



This audit assesses the administrative issues, facility characteristics, and pre-maintenance and maintenance activities for maintenance and repair carried out at coal preparation and minerals processing facilities. Three of the modules in this audit specifically address screen maintenance, greasing, and conveyor maintenance and repair tasks.

## Maintenance and Repair Audit Instructions

This audit package contains four documents that are necessary to conduct a maintenance and repair audit. A description and intended use of each document is provided below.

- 1) **Maintenance and Repair Audit Information Page** – This page allows the audit user to record pertinent information to be filed with the audit results and recommendations. A separate Maintenance and Repair Audit Information Page should be used for each location and time when conducting an audit of multiple location or at multiple times.
- 2) **Maintenance and Repair Audit Answer Sheet** – This document can be used to record responses to audit questions, thereby allowing the user to reuse the Audit Questions Document multiple times without the need for additional copies of the questions.
- 3) **Maintenance and Repair Audit Questions** – This document contains the full set of audit questions and is arranged in a modular format. This should be used to conduct the ergonomics audit. Please note, completion of some modules will require tools. You will need a tape measure to complete modules 5, 14, and 17. You will need a means to determine incline to complete module 5. You will need a thermometer to complete module 6. You will need a scale to complete modules 7, 15, and 17.
- 4) **Maintenance and Repair Audit Recommendations** – This document contains all the recommendations for the audit questions. It includes a checkbox beside each recommendation allowing the user to check the recommendation which corresponds to each of the answers recorded on the answer sheet.

# Maintenance and Repair Audit Table of Contents

Maintenance and Repair Audit Information Page..... Page 1

Maintenance and Repair Audit Answer Sheet ..... Page 2

Maintenance and Repair Audit Questions Document ..... Page 7

Maintenance and Repair Audit Recommendations Document ..... Page 42



# Maintenance and Repair Audit Information Page

Name of Auditor: \_\_\_\_\_

Location of Audit: \_\_\_\_\_

Date of Audit: \_\_\_\_\_

Comments:

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# Maintenance and Repair Audit Answer Sheet

## Administrative Elements

### Module 1 – Tools and Safety devices/PPE

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### Module 2 – Communication

2.1 \_\_\_\_\_

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2.6.1 \_\_\_\_\_

2.7 \_\_\_\_\_

2.8 \_\_\_\_\_

### Module 3 – Lock Out/Tag Out

3.1 \_\_\_\_\_

3.2 \_\_\_\_\_

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3.4.1 \_\_\_\_\_

3.5 \_\_\_\_\_

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3.7 \_\_\_\_\_

3.8 \_\_\_\_\_

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3.9.1 \_\_\_\_\_

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3.9.3 \_\_\_\_\_

3.9.4 \_\_\_\_\_

3.9.5 \_\_\_\_\_

3.9.6 \_\_\_\_\_

3.9.7 \_\_\_\_\_

3.9.8 \_\_\_\_\_

3.9.9 \_\_\_\_\_

3.10 \_\_\_\_\_

3.11 \_\_\_\_\_

3.12 \_\_\_\_\_

3.12.1 \_\_\_\_\_

3.13 \_\_\_\_\_

**Module 4 – Working at Heights**

- 4.1 \_\_\_\_\_
- 4.2 \_\_\_\_\_
- 4.3 \_\_\_\_\_
- 4.4 \_\_\_\_\_

**Facility Characteristics**

**Module 5 – Slips, Trips and Falls**

- 5.1 \_\_\_\_\_
- 5.2 \_\_\_\_\_
- 5.3 \_\_\_\_\_
  - 5.3.1 \_\_\_\_\_
  - 5.3.2 \_\_\_\_\_
- 5.4 \_\_\_\_\_
- 5.5 \_\_\_\_\_
- 5.6 \_\_\_\_\_
- 5.7 \_\_\_\_\_
- 5.8 \_\_\_\_\_
- 5.9 \_\_\_\_\_
- 5.10 \_\_\_\_\_
- 5.11 \_\_\_\_\_
- 5.12 \_\_\_\_\_
- 5.13 \_\_\_\_\_
- 5.14 \_\_\_\_\_
- 5.15 \_\_\_\_\_
- 5.16 \_\_\_\_\_

**Module 6 – Environmental Factors**

- 6.1 \_\_\_\_\_
- 6.2 \_\_\_\_\_
- 6.2.1 \_\_\_\_\_
- 6.3 Air Temp: \_\_\_\_\_
- 6.3 Humidity: \_\_\_\_\_
- 6.3 Thermal Radiation: \_\_\_\_\_
- 6.3 Air Movement: \_\_\_\_\_
- 6.3 Workload: \_\_\_\_\_
- 6.3 Clothing: \_\_\_\_\_
- 6.3 Opinion: \_\_\_\_\_
- 6.4 \_\_\_\_\_
- 6.5 \_\_\_\_\_
- 6.6 \_\_\_\_\_
- 6.7 \_\_\_\_\_
- 6.8 \_\_\_\_\_
- 6.9 \_\_\_\_\_
- 6.10 \_\_\_\_\_
- 6.11 \_\_\_\_\_
- 6.12 \_\_\_\_\_
- 6.13 \_\_\_\_\_
- 6.14 \_\_\_\_\_
- 6.15 \_\_\_\_\_

# Facility Characteristics, continued

## Module 7 – Machine Guarding

- 7.1 \_\_\_\_\_
- 7.2 \_\_\_\_\_
- 7.3 \_\_\_\_\_
- 7.4 \_\_\_\_\_
- 7.5 \_\_\_\_\_
- 7.6 \_\_\_\_\_
- 7.7 \_\_\_\_\_
- 7.8 \_\_\_\_\_
- 7.9 \_\_\_\_\_
- 7.10 \_\_\_\_\_
- 7.11 \_\_\_\_\_
- 7.12 \_\_\_\_\_

## Pre-Maintenance

### Module 8 – Equipment Access

- 8.1 \_\_\_\_\_
- 8.1.1 \_\_\_\_\_
- 8.1.2 \_\_\_\_\_
- 8.1.3 \_\_\_\_\_
- 8.1.4 \_\_\_\_\_
- 8.2 \_\_\_\_\_
- 8.3 \_\_\_\_\_
- 8.4 \_\_\_\_\_
- 8.5 \_\_\_\_\_
- 8.6 \_\_\_\_\_
- 8.7 \_\_\_\_\_
- 8.8 \_\_\_\_\_

### Module 9 – Maintenance Preparations and Area Inspections

- 9.1 \_\_\_\_\_
- 9.2 \_\_\_\_\_
- 9.3 \_\_\_\_\_
- 9.4 \_\_\_\_\_
- 9.5 \_\_\_\_\_
- 9.6 \_\_\_\_\_
- 9.7 \_\_\_\_\_
- 9.8 \_\_\_\_\_
- 9.9 \_\_\_\_\_
- 9.10 \_\_\_\_\_

**Module 10 – Housekeeping**

- 10.1 \_\_\_\_\_
- 10.2 \_\_\_\_\_
- 10.2.1 \_\_\_\_\_
- 10.3 \_\_\_\_\_
- 10.4 \_\_\_\_\_
- 10.5 \_\_\_\_\_
- 10.6 \_\_\_\_\_
- 10.7 \_\_\_\_\_

**All Maintenance Tasks**

**Module 11 – Blocking**

- 11.1 \_\_\_\_\_
- 11.2 \_\_\_\_\_
- 11.3 \_\_\_\_\_
- 11.4 \_\_\_\_\_

**Module 12 – Posture Assessment**

- 12.1 \_\_\_\_\_
- 12.2 \_\_\_\_\_
- 12.3 \_\_\_\_\_
- 12.4 \_\_\_\_\_
- 12.5 \_\_\_\_\_
- 12.6 \_\_\_\_\_

**Module 13 – Gross Posture Assessment**

- 13.1 \_\_\_\_\_
- 13.2 \_\_\_\_\_
- 13.3 \_\_\_\_\_
- 13.4 \_\_\_\_\_
- 13.5 \_\_\_\_\_
- 13.6 \_\_\_\_\_

**Module 14 – Hand Tool Use**

- 14.1 \_\_\_\_\_
- 14.2 \_\_\_\_\_
- 14.3 \_\_\_\_\_
- 14.4 \_\_\_\_\_
- 14.5 \_\_\_\_\_
- 14.6 \_\_\_\_\_
- 14.7 \_\_\_\_\_
- 14.8 \_\_\_\_\_
- 14.9 \_\_\_\_\_
- 14.10 \_\_\_\_\_
- 14.11 \_\_\_\_\_
- 14.12 \_\_\_\_\_
- 14.13 \_\_\_\_\_
- 14.14 \_\_\_\_\_
- 14.15 \_\_\_\_\_
- 14.16 \_\_\_\_\_
- 14.17 \_\_\_\_\_
- 14.18 \_\_\_\_\_
- 14.19 \_\_\_\_\_
- 14.20 \_\_\_\_\_

# Specific Maintenance Tasks

## Module 15 – Screen Maintenance Checklist

- 15.1 \_\_\_\_\_
- 15.2 \_\_\_\_\_
- 15.3 \_\_\_\_\_
- 15.4 \_\_\_\_\_
- 15.5 \_\_\_\_\_
- 15.6 \_\_\_\_\_
- 15.7 \_\_\_\_\_
- 15.8 \_\_\_\_\_
- 15.9 \_\_\_\_\_
- 15.10 \_\_\_\_\_
- 15.11 \_\_\_\_\_
- 15.12 \_\_\_\_\_
- 15.13 \_\_\_\_\_
- 15.14 \_\_\_\_\_
- 15.15 \_\_\_\_\_
- 15.16 \_\_\_\_\_
- 15.17 \_\_\_\_\_
- 15.18 \_\_\_\_\_

## Module 16 – Greasing

- 16.1 \_\_\_\_\_
- 16.2 \_\_\_\_\_
- 16.3 \_\_\_\_\_
- 16.4 \_\_\_\_\_
- 16.5 \_\_\_\_\_
- 16.6 \_\_\_\_\_
- 16.7 \_\_\_\_\_
- 16.8 \_\_\_\_\_

## Module 17 – Conveyor Maintenance and Repair

- 17.1 \_\_\_\_\_
- 17.2 \_\_\_\_\_
- 17.3 \_\_\_\_\_
- 17.3.1 \_\_\_\_\_
- 17.3.2 \_\_\_\_\_
- 17.4 \_\_\_\_\_
- 17.5 \_\_\_\_\_
- 17.6 \_\_\_\_\_
- 17.7 \_\_\_\_\_
- 17.8 \_\_\_\_\_
- 17.9 \_\_\_\_\_
- 17.10 \_\_\_\_\_
- 17.11 \_\_\_\_\_
- 17.12 \_\_\_\_\_
- 17.13 \_\_\_\_\_
- 17.14 \_\_\_\_\_
- 17.15 \_\_\_\_\_
- 17.16 \_\_\_\_\_
- 17.17 \_\_\_\_\_
- 17.18 \_\_\_\_\_
- 17.19 \_\_\_\_\_

# Maintenance and Repair Audit Questions

I.	Administrative Elements .....	8
	Module 1 – Tools and Safety Devices/PPE .....	8
	Module 2 – Communication .....	10
	Module 3 – Lock Out / Tag Out .....	11
	Module 4 – Working at Heights.....	14
II.	Facility Characteristics .....	15
	Module 5 – Slips, Trips, and Falls .....	15
	Module 6 – Environmental Factors .....	17
	Module 7 – Machine Guarding.....	20
III.	Pre-Maintenance .....	21
	Module 8 – Equipment Access .....	21
	Module 9 – Maintenance Preparation and Area Inspection .....	23
	Module 10 – Housekeeping.....	24
IV.	All Maintenance Tasks.....	25
	Module 11 – Blocking .....	25
	Module 12 – Posture Assessment .....	26
	Module 13 – Gross Posture Assessment .....	29
	Module 14 – Hand Toll Use .....	35
V.	Specific Maintenance and Repair Tasks .....	37
	Module 15 – Screen Maintenance Checklist .....	37
	Module 16 – Greasing .....	39
	Module 17 – Conveyor Maintenance and Repair.....	40

# I. Administrative Elements

*The following series of modules pertain to policy issues. These modules should be answered by someone familiar with mine policies as well as personnel practices.*

## 1. Module 1 – Tools and Safety Devices/PPE

*This module pertains to the usage and availability of common tools, safety devices, and personal protective equipment.*

- 1.1. Are employees provided their own PPE? **Yes / No**
- 1.2. Are safety goggles and nonwelding face shields available for employee use? **Yes / No**
- 1.3. Are employees required to wear gloves for any tasks? **Yes / No**
  - If yes, proceed to question 1.3.1
  - If no, proceed to question 1.4
- 1.3.1. Are workers ever required to wear metacarpal gloves? These are gloves with added protection on the top to help prevent finger or hand fractures. **Yes / No**
- 1.4. Are fall-arrest harnesses provided to individuals or available as needed? **Individual / As needed**
- 1.5. Are tool lanyards (cords attached to tools and used to tie-off tools to a person or to a piece of equipment) provided? **Yes / No**
- 1.6. Are incentives (allowances or discounts) provided for boot replacements? **Yes / No**
- 1.7. If exposed to outdoor winter conditions, are over-shoe traction aides such as cleats or spikes provided? **Yes / No / NA (not applicable)**
- 1.8. Are areas requiring hearing protection clearly marked at all entrances? **Yes / No / NA**
- 1.9. If needed, are earplugs provided in working areas? **Yes / No / NA**
- 1.10. Is provided hearing protection derated? **Yes / No / Don't know what derating is**
- 1.11. Are workers wearing hearing protection in areas where it is required? **Yes / No / NA**
- 1.12. Do workers carry tool bags/buckets/tool boxes with their own tools? **Yes / No**
- 1.13. Are tools stored in one general storage area? **Yes / No**
- 1.14. Are chisels used? **Yes / No**
- 1.15. Are box cutters and utility knives used? **Yes / No**

- 1.16. Are there established (written or verbal) procedures for inspecting tools (powered and nonpowered) before and after each use and discarding broken tools? **Yes / No**
- 1.17. Are workers wearing appropriate PPE when using tools? **Yes / No**
- 1.18. Are practices in place to ensure employees are informed of necessary PPE when performing specific jobs/tasks or using specific tools (e.g. labeling tools and equipment with recommended PPE)? **Yes / No**

## 2. Module 2 – Communication

*This module pertains to communication between shifts, how work tasks are given to employees, and the availability of portable communication devices.*

- 2.1. When are workers given their tasks? **beginning of shift / throughout shift / other**
- 2.2. Do workers usually come prepared with tools, equipment and PPE for the job? **Yes / No**
- 2.3. How are workers given their work assignments? Choose all that apply. **Verbal communication / handwritten document / typed document**
- 2.4. What is the minimum number of workers assigned to a high-risk task such as a task with fall, entrapment, confined spaces, drowning, heavy lifting, etc. hazards? **One / two or more**
- 2.5. Do shifts overlap allowing personnel to communicate with the leaving shift prior to the start of their shift? **Yes / No**
- 2.6. Is information from the outgoing shift transmitted to the oncoming shift through written documentation? **Yes / No**
  - If yes, proceed to Question 2.6.1
  - If no, proceed to Question 2.7
- 2.6.1. Are the written documents communicating shift change legible? **Yes / No**
- 2.7. Is the lead maintenance worker or shift supervisor available at any time for questions by the laborers? **Yes / No**
- 2.8. Are personal communication devices such as walkie-talkies provided to all employees for use at all times? **Yes / No**

### 3. Module 3 – Lock Out / Tag Out

*This module pertains to the Lock Out and Tag Out process of energized equipment. It includes questions regarding mine policies as well as personnel practices.*

- 3.1. Who is responsible for locking out equipment prior to maintenance or repair? Removal following maintenance completion? **Supervisor(s) / Workers (Employees or contractors) / Both**
- 3.2. Are all workers (employees or contractors) required to carry locks and tags at all times? **Yes / No**
- 3.3. Are all workers (employees or contractors) involved in a maintenance or repair activity required to put their lock and tag on equipment? **Yes / No**
- 3.4. Are multilock hasps (fasteners which can be locked using several locks at once) provided at all lock out locations? **Yes / No**
  - If yes, proceed to Question 3.4.1
  - If no, proceed to Question 3.5
- 3.4.1. Can the provided hasps accommodate the locks of all employed workers (employees or contractors) on each shift? **Yes / No**
- 3.5. Do locks and/or multilock hasps fit all valves, lever, and switches which are used to control hazardous energy? **Yes / No**
- 3.6. Are all circuits lockable? **Yes / No**
- 3.7. Are devices (e.g. additional valves, blocks or anti-motion pins) available to provide protection from unintentional motion due to stored mechanical, hydraulic, pneumatic, chemical, or thermal energy? **Yes / No**
- 3.8. When locking out a piece of equipment that is fed by another source, are the feeding equipment power sources identified on the lock out boxes of? **All equipment / some equipment / no equipment**
- 3.9. Do you currently have written lock out/tag out procedures? **Yes / No**
  - If yes, proceed to Question 3.9.1
  - If no, proceed to Question 3.10

**Table 1. Lock out/Tag out procedure checklist.**

Are the following included in your written lock out/tag out procedures for electrical equipment?	Yes	No
3.9.1. Notify employees working in the area that equipment is going to be locked out/tagged out and the reason why.		
3.9.2. Identify, de-energize, and disconnect all energy sources.		
3.9.3. Relieve all stored energy.		
3.9.4. Lock and tag out all energy sources.		
3.9.5. Prove that energy isolation is effective by attempting to operate equipment to determine that it is inoperable.		
3.9.6. Prove that energy isolation is effective by testing equipment with voltmeter.		
3.9.7. Test voltmeters before and after each use.		
3.9.8. Install a temporary protective grounding equipment device to eliminate induced voltage or stored energy, if needed.		
3.9.9. Ensure that all tools and unused materials are removed from the work area before energizing equipment.		

- 3.10. Are all employees who perform lock out/tag out trained to be able to locate all sources of electrical energy and the type and location of all stored energy (e.g. heat, water pressure, falling debris, hydraulic)? **Yes / No**
- 3.11. Is management notified by employees and contractors whenever electrical equipment is repaired? **Yes / No**
- 3.12. Is equipment flagged (adding high-visibility triangular safety flag or high-visibility cones to the top of equipment, adding an audible alarm to the equipment, placing blinking or flashing light sources on equipment) when locked out? **Yes / No**
- If yes, proceed to Question 3.12.1
  - If no, proceed to Question 3.13
- 3.12.1. If site is operational at night, are equipment flags visible during the day and night (reflective or light emitting)? **Yes / No / NA**

3.13. Are up-to-date drawings / diagrams available for workers to review to identify all possible sources of energy before performing any maintenance or repair? **Yes / No**

## 4. Module 4 – Working at Heights

*This module pertains to mine policies and personnel practices related to working at heights.*

- 4.1. Are all tie-off locations (attachment points for fall protection) available and clearly marked? **Yes / No**
- 4.2. Are supporting structures for hoisting equipment (e.g. structural beams, hoist beams) labeled with maximum supported weights? **Yes / No**
- 4.3. Are barricades, additional guards, or warning signs used when working in areas that may have open hatches, weak surfaces, or other falling hazards? **Yes / No**
- 4.4. Are processes in place to eliminate working at heights outdoors during adverse weather conditions (e.g. high winds or icy conditions)? **Yes / No**

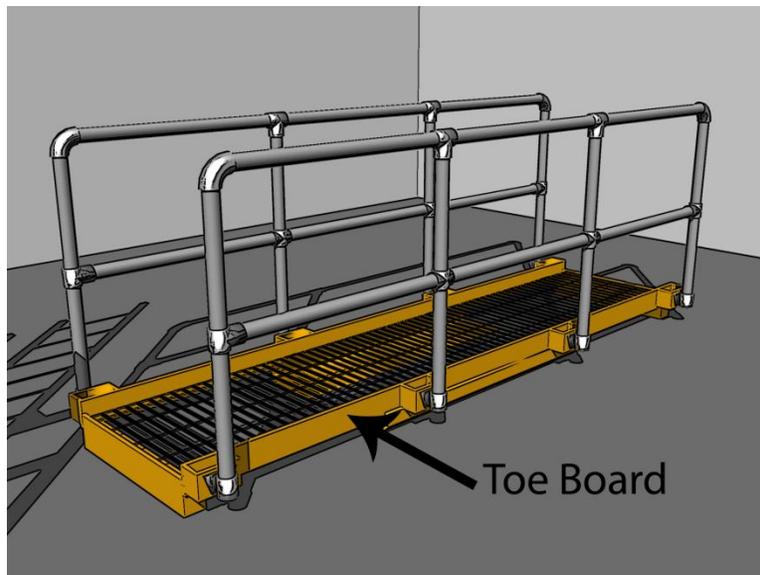
## II. Facility Characteristics

*The following series of modules examine specific characteristics of the mine site. These modules should be answered by someone familiar with the differing areas of the mine site including shops and plants.*

### 5. Module 5 – Slips, Trips, and Falls

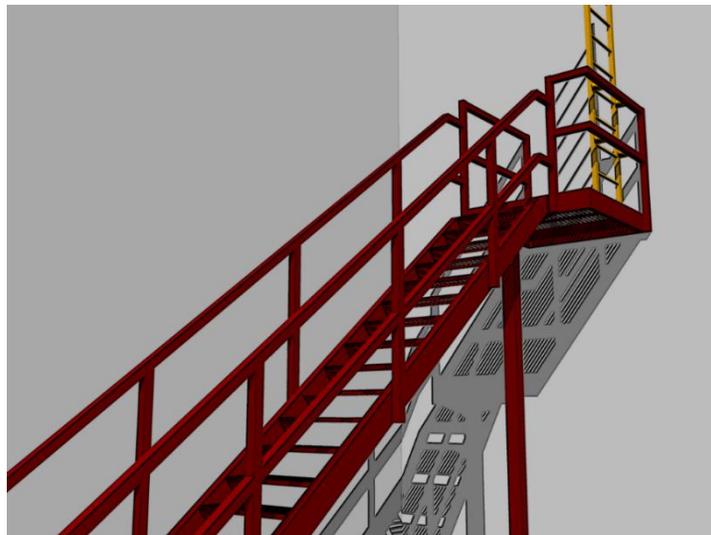
*This module pertains to workplace characteristics and mine policies related to the prevention of slips, trips, and falls. This module requires a tape measure and a means to determine walkway incline*

- 5.1. Are all stairs of uniform color? **Yes / No**
- 5.2. In addition to overhead lighting, are light sources mounted near ground level to improve illumination of walking areas? **Yes / No**
- 5.3. Do all stairways and walkways, including equipment access systems, have handrails? **Yes / No**
  - If yes, proceed to Question 5.3.1
  - If no, proceed to Question 5.4
- 5.3.1. Are all handrails on stairs between 34 in and 38 in from stair tread? **Yes / No**
- 5.3.2. Are all handrails for level or inclined walkways between 34 in and 38 in from the walking surface? **Yes / No**
- 5.4. Do all walkways have toe boards (see Figure 1)? **Yes / No**



**Figure 1. Example of walkway with toe board.**

- 5.5. Are all metal and wood surfaces that workers walk on / perform work on regularly inspected for deterioration? **Yes / No**
- 5.6. What is the steepest walkway angle of incline (grade) present? **<10° (< 18% grade) / 10°–15° (18%–27% grade) / > 15° (>27% grade)**
- 5.7. Do any walkways or stairs have vertical clearance heights less than 7 ft? **Yes / No**
- 5.8. Are water, grease, or other contaminants present on any walkways, walking surfaces, stairs, or ladders? **Yes / No**
- 5.9. Does water or other liquid run off or spray from equipment or processes contaminating walkways, walking surfaces, or stairs? **Yes / No**
- 5.10. Are permanent hose covers (e.g., dropovers, rubber duct, cord protectors) in place on walking surfaces? **Yes / No**
- 5.11. Are outdoor walking areas clearly designated? **Yes / No**
- 5.12. Is there ever glare on outdoor walking surfaces? **Yes / No**
- 5.13. Do outdoor temperatures drop below 32° during the year? **Yes / No**
- 5.14. Do walking paths cross water run-off? **Yes / No**
- 5.15. Are any walkways located along conveyor belts? **Yes / No**
- 5.16. Do any permanent ladders share landings with stairways (see Figure 2)? **Yes / No**



**Figure 2. Stairway and permanent ladder that share a landing.**

## 6. Module 6 – Environmental Factors

*This module pertains to the environmental factors associated with your mine site at differing times of the year and covers temperature and lighting. This module requires a thermometer.*

6.1. During the summer months, is work performed outdoors? **Yes / No**

6.2. During winter months, is work performed outdoors? **Yes / No**

- If yes, proceed to Question 6.2.1
- If no, proceed to Question 6.3

6.2.1. Are workers provided portable heating sources? **Yes / No**

6.3. Using the ISO 15265<sup>1</sup> Thermal Working Conditions shown in Table 2, ask employees who routinely work in the area being audited to score their current thermal environment.

**Table 2. Thermal working conditions scores<sup>1</sup>.**

Score	Condition
	Air Temperature
-3	Generally freezing
-2	Generally between 32°F and 50°F
-1	Generally between 50°F and 64°F
0	Generally between 64°F and 75°F
1	Generally between 75°F and 90°F
2	Generally between 90°F and 104°F
3	Generally greater than 104 °F
	Humidity
-1	Dry throat/eyes after 2 – 3 hours
0	Normal
1	Moist skin
2	Skin completely wet
	Thermal Radiation
-1	Cold on the face after 2 – 3 minutes
0	No radiation discernible
1	Warm on face after 2 – 3 minutes
2	Unbearable on the face after more than 2 minutes
3	Immediate burning sensation

<sup>1</sup> ISO [2004]. ISO 15265 Risk assessment strategy for the prevention of stress or discomfort in thermal working conditions. Geneva, Switzerland: International Organization for Standardization, pp. 4–5.

Score	Condition
	Air Movements
-2	Cold strong air movements
-1	Cold light air movements
0	No air movements
1	Warm light air movements
2	Warm strong air movements
	Physical Work Load
0	Office work: easy, low muscular constraints, occasional movements at normal speed
1	Moderate work with arms or legs: use of heavy machines, steadily walking
2	Intense work with arms and trunk: handling heavy objects, shoveling, woodcutting, walking rapidly or while carrying a heavy load
3	Very intense work at high speed: stairs, ladders
	Clothing
0	Light, flexible, not interfering with the work
1	Long, heavier, interfering slightly with the work
2	Clumsy, heavy, special for radiation, humidity or cold temperatures
3	Special overalls with gloves, hoods, shoes
	Opinions of the workers
-3	Shivering, strong discomfort for the whole body
-2	Strong local discomfort; overall sensation of coolness
-1	Slight local cool discomfort
0	No discomfort
1	Slight sweating and discomfort; thirst
2	Heavy sweating, strong thirst, work pace modified
3	Excessive sweating, very tiring work, special clothing

6.4. Are all light sources working? **Yes / No**

6.5. Are LED lights used for overhead lighting everywhere? **Yes / No**

- If yes, proceed to Question 6.7
- If no, proceed to Question 6.6

6.6. If fluorescent bulbs are used, does flicker exist? **Yes / No / NA**

*Please answer the next series of questions by interviewing all employees who routinely work in the area which is currently being audited.*

- 6.7. Are lighting fixtures free/clean from dirt/paint? **Yes / No**
- 6.8. Are light sources provided with shades or glare shields? **Yes / No**
- 6.9. Is additional lighting (in the form of spotlights or area lighting) provided in areas with high spillage and near equipment? **Yes / No**
- 6.10. Is additional lighting (in the form of spotlights or area lighting) provided in passageways and entrances/exits? **Yes / No**
- 6.11. By asking workers, how should current lighting be changed? **Increase amount of light (brighter) / Decrease amount of light (less bright) / No change**
- 6.12. By asking workers, do current sources of light create shadows or glare that interfere with task performance or safety? **Yes / No**
- 6.13. What type of light source is used for portable lighting? **hand-held lamp (e.g. flashlight, lantern) / standing lamp / head lamp / none**
- If Hand-held Lamp, proceed to question 6.14
  - If Standing Lamp, proceed to question 6.15
  - If Head Lamp, proceed to Module 7
  - If None, proceed to Module 7
- 6.14. By asking workers, do hand-held lighting sources need to be held when walking up/down stairs, walking on inclined walkways, climbing or descending ladders or while holding other objects? **Yes / No**
- 6.15. Do workers experience any difficulties handling light sources due to the size or weight of the lighting equipment? **Yes / No**

## 7. Module 7 – Machine Guarding

*This module pertains to the guarding of machines and equipment. Please answer the next series of questions by interviewing all employees who routinely remove and replace guards in the area which is currently being audited. Conduct this assessment for one guard at a time. Be sure to audit guards which are heavy and in hard-to-reach areas. This module requires a scale.*

**Table 3. Machine Guarding Checklist**

Machine Guarding Checklist		Yes	No
7.1.	Please provide a brief description of the guard being audited.		
7.2.	Are mechanical assist devices used to remove the guard?		
7.3.	Does removing or replacing the guard require more than one person?		
7.4.	Does the guard exceed 50 lb?		
7.5.	Is the guard difficult to bring close to the body because of its size, bulk, or shape?		
7.6.	Does the guard lack handles or cutouts for handles, or does it have slippery surfaces or sharp edges?		
7.7.	Does removing or replacing the guard require fast movements to avoid being pinned or struck by the guard?		
7.8.	Does removing or replacing the guard require stressful body postures, such as bending to the floor, twisting, reaching overhead, or bending to the side?		
7.9.	Is the guard handled by only one hand, arm, or shoulder?		
7.10.	Are hinges used to attach the guard?		
7.11.	Is the guard painted such that it is easily noticeable from equipment and conveyors?		
7.12.	Is the guard removed to perform routine maintenance tasks?		

### III. Pre-Maintenance

*The following series of modules examine those activities performed prior to the start of maintenance or repair tasks. These modules should be answered by someone responsible for performing maintenance activities.*

#### 8. Module 8 – Equipment Access

*This module pertains to equipment access and working inside of equipment.*

- 8.1. Is there equipment that workers climb inside to perform work (e.g. crusher, screen deck, centrifugal dryer, hopper, bin)? **Yes / No**
- If yes, proceed to Question 8.1.1
  - If no, proceed to Question 8.2
- 8.1.1. Does climbing in or on the equipment require taking steps with a vertical distance greater than 8 in? **Yes / No**
- 8.1.2. Is all equipment that workers climb inside to perform work equipped with stairs or steps? **Yes / No**
- If yes, proceed to Question 8.1.3
  - If no, proceed to Question 8.2
- 8.1.3. When working inside of equipment, is fall protection used? **Yes / No**
- If yes, proceed to Question 8.1.4
  - If no, proceed to Question 8.2
- 8.1.4. When working inside of equipment, is the equipment always off, locked/tagged out and de-energized? **Yes / No**
- 8.2. Are platforms provided for areas requiring frequent usage of scaffolding? **Yes / No / NA**
- If yes, proceed to Question 8.3
  - If no, proceed to Question 8.3
  - If NA, proceed to Question 8.4
- 8.3. If buildings have multiple floors, are scaffolds available on each floor? **Yes / No / NA**
- 8.4. Are ladders available on each floor where they are commonly used for maintenance and repair work? **Yes / No**
- 8.5. Are foldout or stepladders provided? **Yes / No**
- 8.6. Are two or more surfaces used together to reach a work area (e.g. using a ladder on a scaffolding, using two ladders and a board to create platform)? **Yes / No**

- 8.7. Are nonremovable handrails blocking access to equipment? **Yes / No**
- 8.8. Are all inspection areas visible without requiring workers to dismantle equipment or remove large guards? **Yes / No**

## 9. Module 9 – Maintenance Preparation and Area Inspection

*This module pertains to preparing the area before maintenance or repair work begins.*

- 9.1. When working above working/walking areas, are areas below taped off or provided signage to indicate the presence of overhead work? **Yes / No**
- 9.2. Are beacons/flashing lights used to identify nighttime maintenance is being performed in areas without overhead lighting? **Yes / No / NA**
- 9.3. When working near stairwells, are guards or gates always added to the entrance of the stairwell? **Yes / No**
- 9.4. Are tie-off locations added and identified near areas requiring fall protection and inside of hoppers, bins, and other places where maintenance tasks are performed above ground? **Yes / No / NA**
- 9.5. Is additional signage or signaling method (e.g. caution tape, safety cone) used to identify potential hazards in the work area due to maintenance or other non-routine activities? **Yes / No**
- 9.6. Are areas always cleaned prior to and after maintenance/repair to reduce slip and fall hazards? **Yes / No**
- 9.7. Are tool supports (e.g. stands to support weight of tool, means to suspend tool from above) provided if using heavy tools (tools weighing more than 25 lb)? **Yes / No**
- 9.8. Are the manufacturer's maintenance manuals available for reference before making repairs? **Yes / No**
- 9.9. Is there is a likelihood that the machine, equipment, or structure on which maintenance is being performed could shift, move, or shake during maintenance activities? **Yes / No**
- 9.10. Will any handrails, guardrails, or floor opening covers (hatch covers) be removed or opened as part of maintenance activities? **Yes / No**

## 10. Module 10 – Housekeeping

*This module examines overall housekeeping policies and practices and includes spillage.*

10.1. Are hoses or cords present on walking surfaces? **Yes / No**

10.2. Are rocks, mud, or other types of buildup present on stairs or walkways? **Yes / No**

- If yes, proceed to Question 10.2.1
- If no, proceed to Question 10.3

10.2.1. Can the source (e.g., conveyor) of contaminants be identified? **Yes / No**

10.3. Are tools, boxes, supplies, trash, debris, or other tripping hazards present on walking surfaces? **Yes / No**

10.4. Are handle holders provided for storage of shovels, brooms, etc.? **Yes / No**

10.5. Does spillage occur around conveyor belts? **Yes / No**

10.6. Are shovels used to remove spillage? **Yes / No**

10.7. Are physical barriers in place to reduce accumulation of debris in walkways or paths of foot travel?  
**Yes / No**

## IV. All Maintenance Tasks

*The following series of modules relate to the performance of any maintenance task. Each module should be answered by an employee responsible for performing maintenance and repair tasks.*

### 11. Module 11 – Blocking

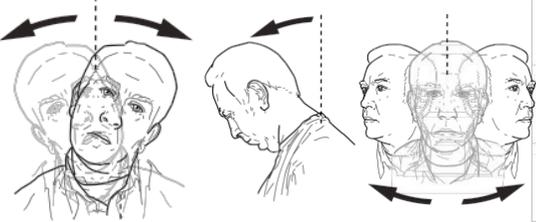
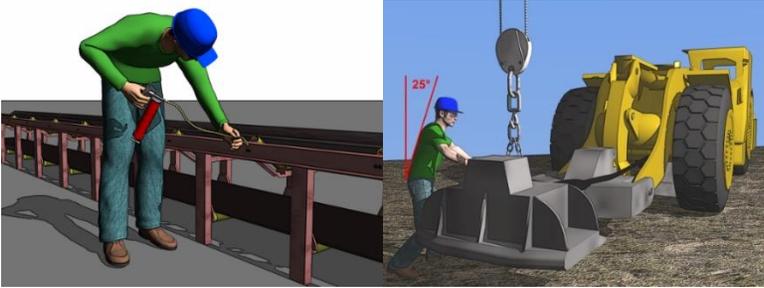
*This module examines equipment blocking and steps taken to prevent unexpected motion of de-energized equipment.*

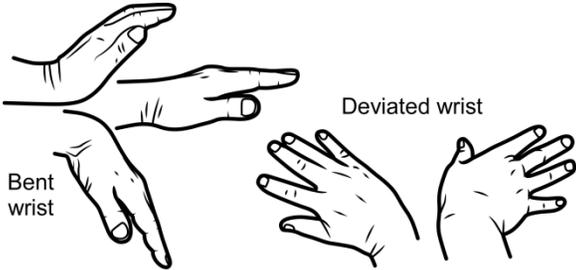
- 11.1. Is equipment blocked in all directions of possible movement before repairs are made? **Yes / No**
- 11.2. Are metal blocks used with metal equipment? **Yes / No**
- 11.3. When blocking raised equipment, is the ground always level, even, and stable? **Yes / No**
- 11.4. Are jacks used? **Yes / No**

## 12. Module 12 – Posture Assessment

*This module examines worker posture during maintenance activities. For each task being audited, observe employees, then evaluate their posture using the questions presented below. Rate all postures as low, moderate, or high exposure.*

**Table 4. Posture Assessment**

Awkward Postures	Low	Moderate	High
<p>12.1. The head/neck is considered bent or twisted if an obvious angle between the neck and back can be observed as a result of performing the task. See Figure 3.</p>  <p><b>Figure 3. Images of head/neck bending and twisting</b></p>	<p>Bent or twisted rarely</p>	<p>Bent or twisted sometimes</p>	<p>Bent or twisted frequently</p>
<p>12.2. The back posture is considered awkward if more than 20° of twisting or bending (to the side or front) is observed. See Figure 4.</p>  <p><b>Figure 4. Workers bend to perform manual greasing (left) and equipment repair (right).</b></p>	<p>Bent forward, sideways or twisted rarely</p>	<p>Bent forward, sideways or twisted sometimes</p>	<p>Bent forward, sideways or twisted frequently</p>

Awkward Postures	Low	Moderate	High
<p>12.3. The arm is considered to adopt an awkward posture if the arm is away from the body (the elbow is raised to around chest height; the arm is unsupported; reaching to the side, front, or back is present). See Figure 5.</p>  <p><b>Figure 5. Workers reach to perform various tasks.</b></p>	<p>Arms away from the body rarely</p>	<p>Arms away from the body sometimes</p>	<p>Arms away from the body frequently</p>
<p>12.4. The wrist is considered to be bent or deviated if an obvious wrist angle can be observed. See Figure 6.</p>  <p><b>Figure 6. Examples of bent and deviated wrists.</b></p>	<p>Bent or deviated wrists rarely</p>	<p>Bent or deviated wrists sometimes</p>	<p>Bent or deviated wrists frequently</p>

Awkward Postures	Low	Moderate	High
<p>12.5. The type of grips (See Figure 7) used by the hands or fingers to hold an object or tool is a:</p> <p style="text-align: center;"><b>Figure 7. Types of grips.</b></p>	<p>Power grip or rarely use wide or pinch grip</p>	<p>Pinch or wide finger grip sometimes</p>	<p>Pinch or wide finger grip frequently</p>
<p>12.6. Are hand tools used?</p>	<p>No hand tools used</p>	<p>Yes</p>	<p>Yes</p>

### 13. Module 13 – Gross Posture Assessment

*The module examines the overall working posture required to perform a maintenance activity. For each task being audited, observe employees and then evaluate their posture using the questions presented below. Rate all postures as low, moderate, or high exposure.*

**Table 5. Gross Posture Assessment**

Gross Posture	N/A	Low	Moderate	High
13.1. Which postures are used for the task?		Standing or seated postures with the ability to move freely and frequently throughout the task.	Prolonged standing, prolonged sitting, infrequent kneeling/squatting.	Frequent kneeling/squatting or severely restricted posture.
13.2. Is the worker able to move freely in the work environment (free of obstructions, constraints, or barriers)?		Free of obstructions, constraints, or barriers to posture.	Some constraints present but minimally affect working posture.	Clearance restrictions, obstructions, and barriers present through much of the task.
13.3. What type of floor surface is in the working area of the task?		Cushioned or antifatigue surface.	Ground.	Hard surface such as grated metal, wood, concrete.
13.4. If seated, is the worker able to sit with the knees and hips in a comfortable position?		Knees near 90°, hips comfortable.	Knees comfortable but somewhat restricted.	Uncomfortable in hips and/or knees.
13.5. If seated, is the worker able to rest their feet comfortably?		Feet rest comfortably on floor; feet are supported.	Feet are supported but sitting is sometimes uncomfortable.	Feet dangle and no supports are available.
13.6. By asking the operator, what is the condition of the seat?		Good (No rips in seat cover, padding intact, provides proper support, and sliding/swivel function still working properly).	Fair/Poor (seat cover ripped, padding lost or no longer comfortable, pieces broken off, sliding/swivel function is not working properly).	(This cell intentionally blank)

## 14. Module 14 – Hand Tool Use

*This module examines characteristic of the hand tools being used. Answer these questions only when hand-held tools are used as part of a maintenance task. This module requires a tape measure.*

**Table 6. Hand Tool Checklist**

Hand Tool Checklist				
14.1.	Is the elbow raised away from the body during tool use?			
14.2.	Does using the tool require twisting the wrists from side to side?			
14.3.	Does using the tool require the wrist to remain bent up or down?			
14.4.	Is a heavy grip needed to avoid the tool from sliding out of the hands or does the tool handle not have a nonslip surface?			
14.5.	<p>The grip (See Figure 8) used on the tool is (select one)</p> <ul style="list-style-type: none"> <li>a. <b>pinch grip</b></li> <li>b. <b>wide finger grip</b></li> <li>c. <b>power grip</b></li> </ul> <p><b>Figure 8. Types of grips</b></p>			
14.6.	<p>If triggered, is the trigger (select one):</p> <ul style="list-style-type: none"> <li>a. <b>Single finger</b></li> <li>b. <b>Multiple finger</b></li> <li>c. <b>Thumb</b></li> <li>d. <b>N/A</b></li> </ul>			
14.7.	If thumb triggered, does the thumb have to be fully extended?			
14.8.	If single handled and used for power tasks (hammer, wrench, large screwdriver), is the handle diameter between 1¼ and 2 in?			

Hand Tool Checklist	Yes	No	N/A
14.9. If single handled and used for precision tasks (small screw driver), is the handle diameter between ¼ and ½ in?			
14.10. If doubled handled and used for power tasks (such as pliers), is the grip span (see Figure 9) at least 2 in when closed and no more than 3 ½ in when open? <div data-bbox="430 569 867 884" data-label="Image"> </div> <p data-bbox="516 926 748 957" style="text-align: center;"><b>Figure 9. Grip span</b></p>			
14.11. If doubled handled and used for precision tasks (such as tweezers), is the grip span (shown in Figure 9 above) no less than 1 inch when closed and no more than 3 in when open?			
14.12. If double handled is the handle spring-loaded?			
14.13. Is the tool handle without sharp edges or finger grooves?			
14.14. Is the tool handle coated with soft material?			
14.15. Can the tool be used with either hand?			
14.16. Is the handle longer than the widest part of the worker's hands (usually 4 to 6 in)?			
14.17. If powered, does the handle provide electrical insulation?			
14.18. If heavy, is the tool counterbalanced?			
14.19. Does the tool vibrate?			
14.20. Is the tool free from defect?			

## V. Specific Maintenance and Repair Tasks

The following series of modules pertain to the performance of specific maintenance tasks. The questions in each module should be answered by an employee responsible for performing the specific task in the module. It is possible that these modules will be answered by different employees.

### 15. Module 15 – Screen Maintenance Checklist

This module examines the process of repairing, replacing and maintaining screens and screen decks. This module requires a scale.

**Table 7. Screen Maintenance Checklist**

Screen Maintenance	Yes	No
15.1. Please provide a brief description of the screen being audited.		
15.2. Does removing or replacing the screen require more than one person?		
15.3. Does the screen exceed 50 lb?		
15.4. Is the screen difficult to bring close to the body because of its size, bulk, or shape?		
15.5. Are come-a-longs or chain pulls used to support the screen?		
15.6. Is a fully mechanical hoist used to hoist the screen?		
15.7. Does the screen have a slippery surface or sharp edges?		
15.8. Do employees have to stand inside the screen deck to remove or replace the screen?		
15.9. Is the footing unsafe? For example, are the floors slippery, inclined, or uneven?		
15.10. Does removing or replacing the screen require fast movements to avoid being pinned or struck by the screen?		
15.11. Does removing or replacing the screen require stressful body postures, such as bending to the floor, twisting, reaching overhead, or bending to the side?		
15.12. Is the employee in a kneeling or squatting posture to remove the screen?		
15.13. Does the employee lie down to remove or replace the screen?		
15.14. Is the screen handled by only one hand, arm, or shoulder?		
15.15. Are pry bars or prying tools used to remove or replace screens?		

Screen Maintenance	Yes	No
15.16. Are tools (excluding pry bars and hammers) used to remove or replace screens?		
15.17. Should employees wear gloves when removing or replacing screens to protect from sharp edges?		
15.18. Do all employees wear gloves when removing or replacing screens?		

## 16. Module 16 – Greasing

*This module examines the process of greasing. It should be completed for all types of greasing performed including hand greasing, auto-greasing, and powered greasing.*

- 16.1. Please select all the types of greasing performed on equipment. **Manual using nonpowered grease gun / manual using powered grease gun / automatic with auto-greaser / none (e.g. sealed bearings).**
- If Manual using nonpowered grease gun, proceed to Question 16.2
  - If Manual using powered grease gun, proceed to Question 16.2
  - If Automatic with auto-greaser, proceed to Question 16.5
  - If None (e.g. sealed bearings), proceed to Module 17
- 16.2. How is the grease gun transported while greasing multiple locations? Choose all that apply: **carried in hand / transported in tool belt / transported in backpack / carried in hand-held object (e.g. tool bucket)**
- 16.3. How is the grease gun refilled? Choose all that apply: **replacement cartridges carried by the employee / replacement cartridges stored in warehouse / gun refilled from larger container**
- If Cartridges carried, proceed to question 16.4
  - If Cartridges stored, proceed to question 16.5
  - If Larger Container, proceed to question 16.6
- 16.4. How are additional grease cartridges transported while greasing multiple locations? Choose all that apply: **carried in hand / transported in tool belt / transported in backpack / carried in hand-held object (e.g. tool bucket)**
- 16.5. Does removal of the empty cartridge require awkward posture, forceful pushing or pulling, or the use of the body for leverage (e.g. stepping on grease gun and pulling)? **Yes / No**
- 16.6. Is removal of guards required for routine greasing of equipment? **Yes / No**
- 16.7. Do workers have to kneel, squat, bend down, reach up, reach over, or lean to access grease fittings? **Yes / No**
- 16.8. Does the worker have to traverse inclined walkways, climb ladders, or walk up/down stairs to access grease fittings? **Yes / No**

## 17. Module 17 – Conveyor Maintenance and Repair

*The module examines conveyor belt maintenance and repair including belt and roller maintenance. This module requires a tape measure and scale.*

- 17.1. During daily inspection of conveyors, are the audio and/or visual startup alarms tested to ensure that they work properly? **Yes / No**
- 17.2. When performing maintenance (not including greasing or cleaning) on and around conveyor belts, is the conveyor off and locked out/tagged out? **Yes / No**
- 17.3. When cleaning around conveyors, is the conveyor ever operating? **Yes / No**
- If yes, proceed to question 17.3.1
  - If no, proceed to question 17.4
- 17.3.1. When cleaning around conveyors, is guarding always in place? **Yes / No**
- 17.3.2. When cleaning around conveyors, do workers keep clear of pulleys? **Yes / No**
- 17.4. Do workers ever stand or travel underneath conveyors? **Yes / No**

**Table 8. Roller Maintenance Checklist**

Roller Maintenance		Yes	No	N/A
17.5.	Does removing, replacing, or transporting the roller require more than one person?			
17.6.	Does the roller exceed 50 lb?			
17.7.	Is the roller difficult to bring close to the body because of its size, bulk, or shape?			
17.8.	Do employees have to stand on or walk across the conveyor belt to remove or replace the roller?			
17.9.	To remove the roller, must employees stand on an area more than 4 ft above ground level?			
17.10.	Is the footing unsafe? For example, are the floors slippery, inclined, or uneven?			
17.11.	Does removing or replacing the roller require fast movements to avoid being pinned or struck by the roller?			

Roller Maintenance	Yes	No	N/A
17.12. Does removing or replacing the roller require stressful body postures, such as bending to the floor, twisting, reaching overhead, or bending to the side?			
17.13. Is the employee in a kneeling or squatting posture to remove or replace the roller?			
17.14. Does the employee lie down to remove or replace the roller?			
17.15. Are pry bars used to remove or replace the roller?			
17.16. Is a cutting via torch required to remove or replace the roller?			
17.17. Are tools (excluding pry bars and hammers) used to remove or replace rollers?			
17.18. Do employees wear gloves when removing or replacing rollers?			
17.19. Should employees wear gloves when removing or replacing rollers?			

# Maintenance and Repair Audit Recommendations

I.	Administrative Elements .....	43
	Module 1 – Tool and Safety Devices/PPE.....	43
	Module 2 – Communication .....	49
	Module 3 – Lock out/Tag out .....	51
	Module 4 – Working at Heights.....	55
II.	Facility Characteristics .....	56
	Module 5 – Slips, Trips, and Falls. ....	56
	Module 6 – Environmental Factors .....	60
	Module 7 – Machine Guarding.....	65
III.	Pre-Maintenance .....	67
	Module 8 – Equipment Access .....	67
	Module 9 – Maintenance Preparation and Area Inspection .....	69
	Module 10 – Housekeeping.....	71
IV.	All Maintenance Tasks.....	73
	Module 11 – Blocking .....	73
	Module 12 – Posture Assessment .....	75
	Module 13 – Gross Posture Assessment .....	78
	Module 14 – Hand Tool Use .....	80
V.	Specific Maintenance and Repair Tasks .....	84
	Module 15 – Screen Maintenance Checklist .....	84
	Module 16 – Greasing .....	86
	Module 17 – Conveyor Maintenance and Repair.....	87

# I. Administrative Elements

## Module 1 – Tool and Safety Devices/PPE

- **(M&R Q 1.1 Yes)** You indicated that workers are provided their own PPE. When possible, also provide a cache of additional PPE required for usage with specific tools in tool storage locations. This will ensure that workers always have access to necessary safety equipment.
- **(M&R Q 1.1 No)** You indicated that workers are not provided their own PPE. Providing workers the required PPE may improve their likelihood of having the necessary protection from work. Ensure methods are in place to care and store these items properly and that provided PPE are available in a variety of sizes to accommodate your working population. When possible, also provide a cache of additional PPE required for use with specific tools in tool storage locations. This will ensure that workers always have access to necessary safety equipment.
- **(M&R Q 1.2 Yes)** You indicated that safety goggles and nonwelding face shields are provided. To reduce fogging, treat goggles and face shields with antifog coatings when cleaned and prior to use.
- **(M&R Q 1.2 No)** You indicated that safety goggles and nonwelding face shields are not provided. Safety goggles provide better seals around the eyes and may offer better protection from flying and loose debris than safety glasses. To minimize fogging, consider treating goggles with antifog coatings when cleaned and prior to use. Nonwelding face shields may be necessary in some areas to ensure workers wear them at all times with minimal visual obstruction due to fogging.
- **(M&R Q 1.3.1 Yes)** You indicated that workers are required to wear metacarpal gloves at times. Meta-carpal gloves may protect workers from finger fractures and crushing injuries when handling materials or working near pinch points. However, they reduce dexterity and tactile sensitivity which may contribute to additional injuries. Care should be taken to eliminate working near pinch points and reduce the weight of materials through equipment redesign and the use of mechanical assist devices before mandating the usage of meta-carpal gloves. For any and all types of gloves, proper fit is essential to maximize their performance. Ensure provided gloves are available in a range of sizes. Educate workers to select a glove that fits their hand snugly and allows the full range of motion.
- **(M&R Q 1.3.1 No)** You indicated that workers are never required to wear meta-carpal gloves. Ensure that any provided gloves are available in a range of sizes. Educate workers to select the glove that fits their hand snugly and allows the full range of motion.
- **(M&R Q 1.4 Individual)** You indicated that workers are provided their own fall-arrest harness. In addition to individual harnesses, it is recommended that spare harnesses be provided in areas where fall protection is needed to encourage their use. Lanyards should also be provided in these areas. It is preferable to use self-retracting lanyards as they reduce the fall distance, provide some stretch, and decelerate the fall. Rip-stitch and stretch type lanyards also provide some stretch and decelerate the fall. Falls with a fixed length lanyard can lead to an abrupt stop and should be avoided if possible.

- **(M&R Q 1.4 As needed)** You indicated that fall-arrest harnesses are provided as needed. If possible, ensure harnesses are stored in areas close to where they will be needed. Provide a cache of various sizes near tie-off locations. Lanyards should also be provided in these areas. It is preferable to use self-retracting lanyards as they reduce the fall distance, provide some stretch, and decelerate the fall. Rip-stitch and stretch type lanyards also provide some stretch and decelerate the fall. Falls with a fixed length lanyard can lead to an abrupt stop and should be avoided if possible.
- **(M&R Q 1.5 No)** You indicated that no tool lanyards are provided. Using tool lanyards will reduce the risk for injury to workers below when working at heights (> 6 ft above). Tool lanyards can attach to workers' belts or wrists. Tool lanyards should be stored on fall-arrest harnesses to ensure workers have ready access to them when needed. Some tools may need to be modified to add lanyard attachment points. When modifying tools, ensure that the attachment points do not compromise the integrity of the tool. Tools modified for tool lanyard attachments should also be stored with the fall-arrest harnesses. When tool bags are necessary, the tool bag should be secured to the worker. Tools should then be tied off to the tool bag, using the tool lanyards.
- **(M&R Q 1.6 Yes)** You indicated that there is an incentive program such as a discount or allowance for workers to purchase new boots. Providing incentives may help to ensure that workers have adequate boots to reduce slip and fall injury risks. Implementation of this program should allow employees to receive boots as they are needed, mindful that some employees may wear their boots more quickly than others due to their walking styles or exposure. Boots should be evaluated at least quarterly to determine when replacement is necessary and incentives should be provided at that time. To enhance worker safety against slip accidents, a boot inspection process should be implemented whereby workers are educated on when work boots should be replaced and signs of wear. Tread depths should be a minimum of 2 mm in all places on the boot sole. It is recommended that once worn beyond the 2-mm recommendation, an incentive is provided for the purchase of new boots. Some workers may wear their boots out quicker than others, and therefore should be entitled to the incentives more frequently.
- **(M&R Q 1.6 No)** You indicated that there isn't an incentive program for workers to purchase new boots. Providing incentives may help to ensure workers have adequate boots to reduce slip and fall injury risks. Boots should be evaluated at least quarterly to determine when replacement is necessary and adequate boots should be provided or workers should be able to purchase adequate footwear through vouchers with reputable companies or through a discount program. To enhance worker safety against slip accidents, a boot inspection process should be implemented whereby workers are educated on when work boots should be replaced and signs of wear. Tread depths should be a minimum of 2 mm in all places of the boot sole. It is recommended that once worn beyond the 2-mm recommendation, an incentive is provided for the purchase of new boots. Some workers may wear their boots out quicker than others, and therefore should be entitled to the incentives more frequently.
- **(M&R Q 1.7 No)** You indicated that workers are not provided traction aids in winter months. In winter months where snow and ice may be present, providing traction aids which are applied to the workers current footwear can provide additional protection when it's necessary to walk through these conditions. An example of an over-shoe traction aid is shown in Figure 10.



**Figure 10. Over shoe traction aide**

- (M&R Q 1.8 No)** You indicated that areas requiring hearing protection are not clearly marked at all entrances. Add signage to areas where hearing protection is required to clearly indicate these areas. Specify areas where single and double hearing protection is required.
- (M&R Q 1.9 Yes)** You indicated that hearing protection is provided in all working areas. Ensure that storage locations of hearing protection are clearly visible and located near the signage designating the area as needing hearing protection.
- (M&R Q 1.9 No)** You indicated that hearing protection is not provided in all working areas. To encourage use, provide earplugs in working areas. Ensure that storage locations of hearing protection are clearly visible and located near the signage designating the area as needing hearing protection. This will also facilitate workers wearing clean, disposable earplugs.
- (M&R Q 1.10 No)** You indicated that hearing protection was not derated. Actual noise reduction provided by hearing protection may only be half of the manufacturer's rated value. Ensure hearing protection provides adequate decibel reduction to protect the hearing of the workforce. Also inspect nondisposable hearing protection, such as custom molded earplugs and earmuffs, often to ensure that it is properly functioning. NIOSH recommends derating the Noise Reduction Rating (NRR) by a multiplicative factor of 75% for earmuffs, 50% for slow-recovery foam earplugs and custom earplugs, and 30% for all other earplugs. This variable derating scheme considers the real world performance of most different types of hearing protectors. This means that an earmuff rated for 70 dB NRR of noise may only provide workers with 75% of 70 dB, which is 52.5 dB. For more information see: Criteria for a Recommended Standard - Occupational Noise Exposure, Revised Criteria. National Institute for Occupational Safety and Health, Cincinnati, OH. DHHS (NIOSH) Publication No. 98-126 (<https://www.cdc.gov/niosh/docs/98-126/default.html>).
- (M&R Q 1.10 Don't Know)** You indicated that you do not know what derating means. Derating is a process of reducing the noise reduction rating of hearing protection to be more consistent with real-world reductions. Actual noise reduction provided by hearing protection may only be half of the manufacturer's rated value. Ensure hearing protection provides adequate decibel reduction to protect the hearing of the workforce. Also inspect nondisposable hearing protection, such as custom molded earplugs and earmuffs, often to ensure that it is properly functioning. NIOSH recommends derating the Noise Reduction Rating

(NRR) by a multiplicative factor of 75% for earmuffs, 50% for slow-recovery foam earplugs and custom earplugs, and 30% for all other earplugs. This variable derating scheme considers the real world performance of most different types of hearing protectors. This means that an earmuff rated for 70 dB NRR of noise may only provide workers with 75% of 70 dB, which is 52.5 dB. For more information see: Criteria for a Recommended Standard - Occupational Noise Exposure, Revised Criteria. National Institute for Occupational Safety and Health, Cincinnati, OH. DHHS (NIOSH) Publication No. 98-126 (<https://www.cdc.gov/niosh/docs/98-126/default.html>).

- **(M&R Q 1.11 No)** You indicated that workers may not be wearing hearing protection in all areas where it is required. Remind workers that wearing hearing protection in these areas is mandatory by adding signage in areas of high noise. Discussing the importance of hearing conservation during safety talks and trainings may also be helpful. The NIOSH hearing loss simulator can help workers get a feel for what it's like to lose your hearing and how important it can be to protect it. The tool can be downloaded for free at <https://www.cdc.gov/niosh/mining/works/coversheet1820.html>.
- **(M&R Q 1.12 Yes)** You indicated that workers carry tool bags/buckets/boxes with their own tools. Reduce the need for carrying tool bags, which may be large and heavy, by providing caches of tools near work areas. Encourage the usage of tool shadow boards as shown in Figure 11 to ensure necessary tools are always readily available. For workers who frequently climb stairs, ladders, or inclined walkways, a tool vest or backpack should be provided to allow free hands at all times (compared to tool bags which often need to be held in place by workers while walking).



**Figure 11. Tool shadow board.**

- **(M&R Q 1.13 Yes)** You indicated that tools are stored in one general storage area. Provide tool storage in an area close to where they will be used which may require several tool storage locations. Ideally, tools could be stored on equipment. Also provide necessary PPE at this location. A tool shadow board as shown in Figure 11 could be implemented to ensure necessary tools are available when needed and to easily show which tools need to be replaced.
- **(M&R Q 1.14 Yes)** You indicated that chisels are provided. Ensure provided chisels have perpendicular handles (safety chisels) to protect the hand of the worker during use.

- **(M&R Q 1.15 Yes)** You indicated that box cutters or utility knives are used. To reduce potentially serious cuts and lacerations, consider purchasing safety cutting tools (self-retracting cutting blades), especially for cutting belts.
- **(M&R Q 1.16 No)** You indicated that there is no established tool inspection program. Establish a tool inspection checklist whereby one worker is responsible for inspecting all tools located in the tool storage area on a regular basis (e.g., daily or weekly). Additionally, this worker should ensure all necessary PPE is available and in good condition. Broken tools and PPE should be removed and replaced. Tools should also be cleaned before inspection. Inspect tools to ensure:
  - Handles are not cracked or splintered
  - Head is securely attached
  - Blades are sharp with no visible defects
  - Tips of screwdrivers are not chipped
  - Bits are not worn or degraded
  - Guards are in place and working correctly
  - Power cables are intact
- **(M&R Q 1.17 No)** You indicated that workers may not be wearing appropriate PPE when using tools. Educate workers on necessary PPE and provide PPE tool storage locations. See Recommended PPE (Table C8).
- **(M&R Q 1.18 No)** You indicated that there are no practices in place to ensure that workers are informed of necessary PPE for performing specific tasks or when using specific tools. Establish policies for the usage, storage, cleaning, and inspection of PPE. A good policy will designate workers responsible for inspecting and cleaning the PPE at predetermined time intervals and proper storage of PPE. To ensure workers are adequately protected from the hazards created while performing work, equipment and tools should be labeled with recommended PPE. Tool storage areas can also be used to illustrate which PPE may be necessary when using specific tools. See Table 2 below.

**Table 9. Recommended PPE When Using Tools**

<b>Tool</b>	<b>Auditory PPE</b>	<b>Visual PPE</b>	<b>Physical PPE</b>
<b>Grinders/Sanders</b>	Earmuffs	Safety goggles or face shield	Where possible, handles should include shock-absorbing sleeves.*
<b>Impact Wrenches</b>	Earmuffs	Safety goggles or face shield	Where possible, handles should include shock-absorbing sleeves.*
<b>Welding/Cutting</b>	Hearing protection may be needed	Welding helmet	Flame resistant clothing Heat-resistant gloves
<b>Knives, nonpowered cutting tools</b>	No additional PPE needed	Safety glasses	Tear-resistance gloves
<b>Electric drills</b>	Earmuffs	Safety goggles or face shield	Where possible, handles should include shock-absorbing sleeves.*

<b>Circular/band saws</b>	Earmuffs	Safety goggles or face shield	Where possible, handles should include shock-absorbing sleeves.*
<b>Reciprocating saw</b>	Hearing protection may be needed	Safety glasses	Where possible, handles should include shock-absorbing sleeves.*
<b>Nonpowered Hammers</b>	Earplugs	Safety goggles or face shield	Impact resistant gloves may be needed
<b>Jack hammers</b>	Earmuffs	Safety goggles or face shield	Where possible, handles should include shock-absorbing sleeves.*
<b>Chipper</b>	Earmuffs	Safety goggles or face shield	Where possible, handles should include shock-absorbing sleeves.*

\*Shock-absorbing gloves have been found to increase grip force and therefore should only be used when equipment cannot be fitted with shock-absorbing sleeves on the handles.

## Module 2 – Communication

- **(M&R Q 2.1 Throughout or other)** You indicated that workers are not assigned their work tasks at the beginning of their shift. When possible, assigning tasks at the beginning of the shift is preferred because it allows workers who may work in multiple locations to ensure that they have all necessary tools, PPE, and parts.
- **(M&R Q 2.2 No)** You indicated that workers may not come prepared with the necessary tools, equipment, and PPE for a job. Provide a cache of required items near equipment. Label equipment with necessary tools for repair. Create a database with tools necessary for jobs and provide information to workers when assigning daily work activities. Ideally, when workers are given their work tasks they should also be given a list of necessary tools and safety equipment or PPE needed to perform the assignment.
- **(M&R Q 2.3 Verbal)** You indicated that workers are often given their work assignments through verbal communication. Written documents are better because they allow management to communicate more information to the worker. For all communication methods, ensure that workers are clear on the nature of their work assignment and are aware of hazards. A good work assignment will include the task, associated personnel assigned to the task, tools and safety equipment or PPE needed for the task, any hazards associated with the task or new hazards in the work environment (i.e., heat, cold, overhead work, lock out/tag out requirements).
- **(M&R Q 2.3 Hand written or typed)** You indicated that workers are often given their work assignments through written documentation. For all communication methods, ensure that workers are clear on the nature of their work assignment and are aware of hazards. A good work assignment will include the task, associated personnel assigned to the task, tools and safety equipment or PPE needed for the task, any hazards associated with the task or new hazards in the work environment (i.e., heat, cold, overhead work, lock out/tag out requirements).
- **(M&R Q 2.4 One)** You indicated a minimum of one worker is assigned to high-risk tasks. Always use the “buddy system” for high-risk tasks to ensure the safety of all workers. A minimum of two workers should be assigned to a task when there is risk of falling, entrapment, drowning, or the task involves heavy lifting. Also, communication devices should be provided to workers performing these tasks.
- **(M&R Q 2.5 No)** You indicated shifts do not overlap. Ideally, outgoing shift workers should be provided time to brief oncoming shift workers on the status of maintenance and repair work. This briefing may occur at the supervisor level but would be ideal at the worker level.
- **(M&R Q 2.6.1 No)** You indicated that written documents communicating shift change are often illegible. If legibility is the primary issue, consider typing messages or using a phone system to record messages to update oncoming shift with necessary information. Using a phone system will also allow the message to be heard by multiple workers and ensure everyone receives the same message.
- **(M&R Q 2.7 No)** You indicated that maintenance or shift supervisors may not always be available for questions by the laborers. Laborers and all workers performing maintenance should be able to reach the maintenance supervisor and lead worker at all times.

- **(M&R Q 2.8 No)** You indicated that personal communication devices are not provided to all workers for use at all times. Efficient and timely communication is essential to working safely in maintenance and repair operations. All tasks should be designed such that assistance is readily available and emergency contact can be obtained rapidly. If every worker does not receive their own communication device, a cache should be provided, and each team of workers assigned to the same work task should receive one communication device. Workers performing work alone should always be provided communication devices to facilitate receiving help when needed.

## Module 3 – Lock out/Tag out

- **(M&R Q 3.1 Supervisor)** You indicated that the supervisor is responsible for locking out equipment. MSHA recommends each worker should place his/her own lock and tag on the disconnecting device when working on equipment.
- **(M&R Q 3.1 Both)** You indicated that both supervisors and employees are responsible for locking out equipment. MSHA recommends each worker should place his/her own lock and tag on the disconnecting device when working on equipment.
- **(M&R Q 3.2 No)** You indicated that workers are not required to carry locks and tags at all times. Requiring workers to carry locks and tags will ensure that workers have necessary equipment to lock out/tag out at all times.
- **(M&R Q 3.3 No)** You indicated that all workers involved in a specific maintenance or repair activity may not be required to place their locks and tags on the equipment. Requiring all workers to place their locks and tags on equipment will ensure workers are not still in the area when equipment is re-energized. If work is carried out on multiple shifts, management should oversee the process of removing and adding locks/tags during shift change.
- **(M&R Q 3.4 No)** You indicated that multilock hasps are not provided at all lock out locations. Using multilock hasps allows all workers to add their own locks and tags. Redundancy aids in safety. Figure 12 shows multilock hasps and how they can be used.



**Figure 12. Multilock hasps (left) and multilock hasp used on a piece of equipment with multiple workers' locks and tags (right)**

- **(M&R Q 3.4.1 No)** You indicated that hasps cannot accommodate the locks of all workers working on the shift. Ensure provided hasps can accommodate all workers' locks and tags. Redundancy aids in safety. Large repair jobs may require more workers than usual tasks.
- **(M&R Q 3.5 No)** You indicated that locks or hasps do not fit all lock outs including valves and sources of non-electrical energy. Ensure that all provided locks and hasp(s) fit all necessary lock out locations. Remember all sources of energy can be potentially dangerous. This includes steam, falling debris, and water pressure.

- **(M&R Q 3.6 No)** You indicated that all circuits may not be lockable. Ensure that all circuits are capable of being locked using provided locks and hasps.
- **(M&R Q 3.7 No)** You indicated that devices may not be available to provide protection from unintentional motion. Stored energy can be in many forms including hydraulic, pneumatic, chemical, and thermal. Stored energy in equipment needs to be released prior to any maintenance activity. All types of energy, not just electricity, can be harmful and potentially fatal when not blocked or released.
- **(M&R Q 3.8 Some Equipment)** You indicated that when locking out a piece of equipment which is fed by another source, the feeding equipment power source may not be identified on the lock out box. Ideally, workers will be provided information on the lock out box allowing them to know when feeding equipment needs to be locked out with other equipment. For example, if working in a crusher and the feeding conveyor isn't locked out/tagged out, fatal injuries may result. To ensure workers do not have to rely on memory, feeding equipment should be identified on all lock out boxes.
- **(M&R Q 3.8 No Equipment)** You indicated that when locking out a piece of equipment which is fed by another source, the feeding equipment power source is not identified on the lock out box. Ideally, workers will be provided information on the lock out box allowing them to know when feeding equipment needs to be locked out with other equipment. If working in a crusher and the feeding conveyor isn't locked out/tagged out, fatal injuries may result. To ensure workers do not have to rely on memory, feeding equipment should be identified on all lock out boxes.
- **(M&R Q 3.9 No)** You indicated that you don't currently have written lock out/tag out procedures. Ideally the lock out/tag out procedure should be written and available to workers for all energized equipment. The procedure should include at least the following steps (see more detail in the National Fire Protection Association's NFPA 70E – Standard for Electrical Safety in the Workplace (particularly Article 120 – Establishing an Electrically Safe Work Condition and Annex G – Sample Lock out/Tag out Procedures, which are subsections of NFPA 70E) or the OSHA General Industry Regulations, 29 CFR 1910.147, The Control of Hazardous Energy):
  1. Step 1: Notify workers that equipment is going to be locked out/tagged out and the reason why.
  2. Step 2: Identify energy sources.
  3. Step 3: De-energize and disconnect electrical supply.
  4. Step 4: Relieve all stored energy.
  5. Step 5: Lock out and tag out the electrical energy source.
  6. Step 6: Prove that energy isolation is effective (attempt to operate equipment to determine that it is inoperable).
  7. Step 7: Ensure equipment is de-energized by testing with voltmeter.
  8. Step 8: Install temporary protective grounds on the phase conductors or circuits to eliminate induced voltage or stored energy, if needed.
  9. Step 9: Ensure that all tools and unused materials are removed from the work area before energizing equipment.
- **(M&R Q 3.9.1 No)** You indicated that notifying other employees when and why equipment is going to be locked out/tagged out is not part of your written lock out/tag out procedures. Informing workers in the area

of upcoming lock out/tag out is necessary to prevent others from accidentally energizing equipment while maintenance is being performed, which has been the cause of many fatalities.

- **(M&R Q 3.9.2 No)** You indicated that identifying all sources of energy is not part of your written lock out/tag out procedures. Many fatalities have occurred when not all energy sources were identified and properly de-energized and disconnected before maintenance. This includes electrical as well as nonelectrical sources such as hydraulics, pneumatics, and pressure.
- **(M&R Q 3.9.3 No)** You indicated that relieving all stored energy is not part of your written lock out/tag out procedures. Many fatalities have occurred when unexpected energy was present in equipment that was not relieved prior to beginning maintenance work. The NFPA 70E (<https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=70E>) states that all capacitors should be discharged and high-capacitance elements should be short-circuited and grounded before the associated equipment is touched. Springs shall be released or physical restraint should be applied when necessary to immobilize mechanical equipment and pneumatic and hydraulic pressure reservoirs.
- **(M&R Q 3.9.4 No)** You indicated that locking and tagging out all sources of energy is not part of your written lock out/tag out procedures. Properly locking and tagging out all energy sources can prevent accidental activation of equipment, which has led to many fatalities.
- **(M&R Q 3.9.5 No)** You indicated that verifying energy isolation by attempting to operate equipment is not part of your written lock out/tag out procedures. Many fatalities have occurred when a worker de-energized and locked/tagged out equipment but failed to verify the absence of energy in the equipment. For example, wiring issues in circuit breakers have caused a circuit to appear de-energized when it was actually still energized. All equipment should, therefore, be tested to prove that energy isolation was effective, both by attempting to operate the equipment (from a safe place) and by testing with a voltmeter.
- **(M&R Q 3.9.6 No)** You indicated that verifying energy isolation by testing with a voltmeter is not part of your written lock out/tag out procedures. Many fatalities have occurred when a worker de-energized and locked/tagged out equipment but failed to verify the absence of energy in the equipment. For example, wiring issues in circuit breakers have caused a circuit to appear de-energized, but actually still be energized. All equipment should therefore be tested to prove that energy isolation was effective, both by attempting to operate the equipment (from a safe place) and by testing with a voltmeter.
- **(M&R Q 3.9.7 No)** You indicated that voltmeters are not always tested before and after each use. Ensuring proper working order of voltmeters is essential to verify that equipment has been isolated properly. Many injuries and deaths have occurred due to defective testing equipment which led a worker to think equipment was de-energized when it wasn't.
- **(M&R Q 3.9.8 No)** You indicated that eliminating induced voltage or stored energy through temporary protective grounding equipment is not part of your written lock out/tag out procedures. Powered equipment should be grounded during maintenance. Temporary protective grounding equipment should meet the requirements of ASTM F 855, Standard Specification for Temporary Protective Grounds to be Used on De-energized Electric Power Lines and Equipment. Personal protective grounds are used whenever workers perform tasks on electrical systems that may become re-energized for some reason, either by the reclosing of switches or circuit breakers, static voltages, induced voltages, or capacitive discharges.

Protective grounds are even needed when working on low-voltage systems, especially when there may be capacitors connected into the circuit or when the circuit may be subject to one of the previously mentioned issues. The use of personal protective grounding is covered by OSHA 1910.269(n), "Grounding for the Protection of Employees," and similarly in the NFPA 70E Section 120.3, "Temporary Protective Grounding."

- **(M&R Q 3.9.9 No)** You indicated that removing all tools and unused materials from the work area prior to re-energizing equipment is not part of your written lock out/tag out procedures. Leaving tools and materials near equipment as it is re-energized has led to unexpected movement of the objects, which has caused fatalities. Completely removing all objects from the work area can prevent these incidents.
- **(M&R Q 3.10 No)** You indicated that not all workers who perform lock out/tag out are able to locate all sources of electrical energy and the type and sources of all other stored energy such as heat, water pressure, falling debris, and hydraulic energy. Ensure that all workers who perform lock out/tag out understand the location of all sources of electrical energy and all stored energy. Many injuries and deaths have occurred because not all sources of energy were identified and relieved prior to performing maintenance on equipment. The types and sources of all energy should be documented for all energized equipment as part of the lock out/tag out procedures.
- **(M&R Q 3.11 No)** You indicated that management may not be notified when energized equipment is repaired. Coordinating electrical maintenance and repair with management can make workers accountable for following established lock out/tag out procedures.
- **(M&R Q 3.12 No)** You indicated that equipment is not flagged via triangular safety flags, cones, audible alarms or light sources when locked out. Flagging locked-out equipment can help to ensure all workers are aware that the equipment is intentionally not in service. Equipment can be flagged by adding a flag, cone, beacon, or other visible signaling device.
- **(M&R Q 3.12.1 No)** When flagging, ensure flags are visible for all hours where they will be used. It is possible that flags may need to include flashing lights at night and physical flags during the day.
- **(M&R Q 3.13 No)** You indicated that up-to-date drawings/diagrams may not be readily available for workers to identify all sources of energy before performing maintenance or repair. Current drawings/diagrams should be consulted to locate all disconnecting means that need to be locked/tagged out to ensure that all sources of energy (electrical and nonelectrical) are locked/tagged out, relieved, and isolated correctly. See NFPA 70E Informative Annex G Section 3 for more information (<https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=70E>).

## Module 4 – Working at Heights

- **(M&R Q 4.1 No)** You indicated that all tie-off locations may not be available or clearly marked. To ensure workers tie-off in approved locations, it is recommended that tie-off locations be clearly marked and identify the maximum rated load for the tie-off. Additionally, tie-off locations should be available for all areas where fall protection may be needed.
- **(M&R Q 4.2 No)** You indicated that supporting structures may not all be labeled with maximum supported weights. To ensure safety, all supporting structures should be labeled with their maximum loads. Fatalities have occurred when the maximum weight capacities of support structures were exceeded. These accidents are preventable by clearly labeling maximum allowed loads and knowing the actual weight of the load to be lifted or supported.
- **(M&R Q 4.3 No)** You indicated that barricades, additional guarding and warning signs may not be added when working at heights with open hatches, weak surfaces, or falling hazards. Injuries and deaths have occurred due to working at heights and encountering unforeseen hazards. It's essential to add additional guarding when working at heights and to identify and label areas of known hazards to ensure worker safety.
- **(M&R Q 4.4 No)** You indicated that processes may not be in place to eliminate working at heights outdoors during adverse weather conditions. Adverse weather conditions can drastically increase the dangers of working at heights even when working on scaffolding or when using fall protection. When possible, work should not be performed at heights in bad weather, especially during high wind conditions.

## II. Facility Characteristics

### Module 5 – Slips, Trips, and Falls.

- **(M&R Q 5.1 Yes)** You indicated that all stairs are of uniform color. Improving tread visibility may help prevent a falling or stumbling on stairs. Paint the nosing of the steps (front 2 inches) a high visibility color or use retro-reflective tape, such as reflective safety yellow, to make the steps more visible and increase contrast. When metal stairways are used, nosings of different materials, patterns, or colors (Figure 13) can be helpful. When a landing is present on a stairwell, it's important to add demarcation zones. Add contrasting colors to the treads at the steps before and after the landing areas. Wherever possible, it is important to maximize the luminance contrast of objects and surfaces in areas critical to worker safety. The luminance contrast is the relationship between the luminances (the light seen by the eyes) of an object or surface and its immediate background.



**Figure 13. Painting of stair nosings before and after landings.**

- **(M&R Q 5.2 No)** You indicated that additional light sources are not mounted near ground level in walking areas. To improve hazard identification and detection, increase the light levels near walking areas especially those where there are high chances of debris and contaminants accumulating. A minimum of 20 lux is recommended. Light meters can be purchased to measure lux levels. Care should also be taken to place, aim, and deflect a light source away from the workers direct line of sight to minimize glare.
- **(M&R Q 5.3 No)** You indicated that all stairways and walkways, including those used to access equipment, may not have handrails. Handrails should be provided to allow adequate handholds for employees to grasp

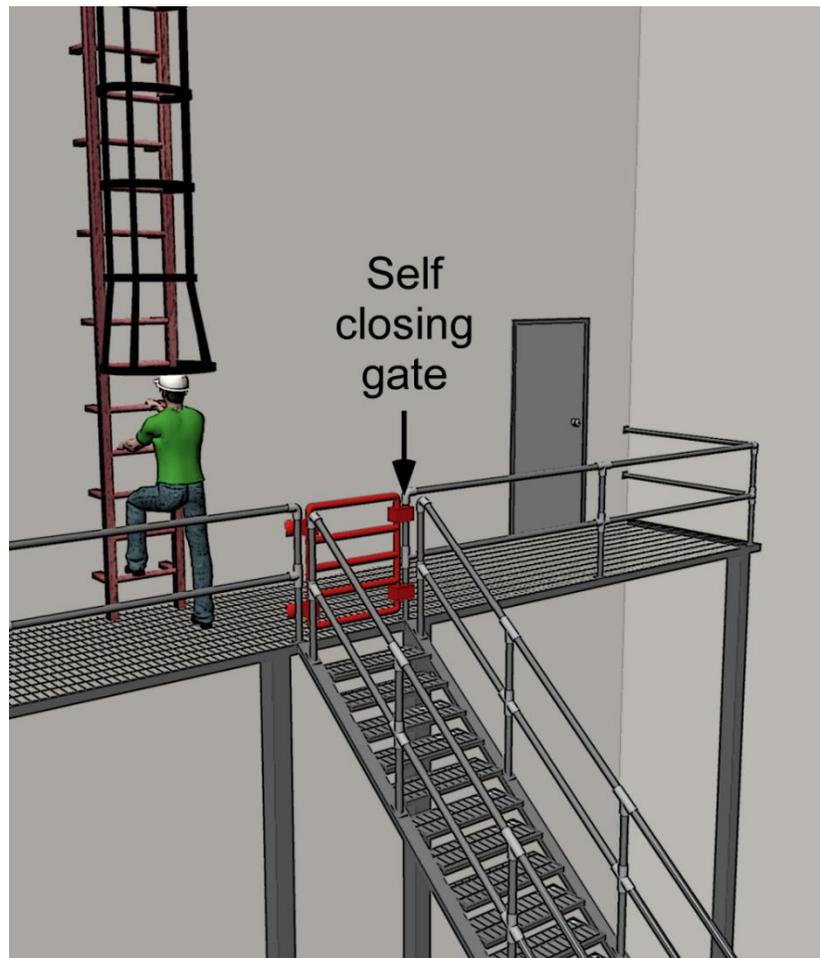
to prevent falls. Provided handrails should be between 34 in and 38 in from walking surface for level or inclined walking areas. Handrails on stairs should be between 34 in and 38 in from the stair tread (29 CFR §1910.29(f)(1)(i)).

- **(M&R Q 5.3.1 No)** You indicated that provided handrails on stairs may not be 34-38" from the stair tread. Stair rails are used as handrails to provide adequate handholds for employees to grasp to prevent falls. Per OSHA, handrails on stairs should be between 34" and 38" from the stair tread.
- **(M&R Q 5.3.2 No)** You indicated that provided handrails on inclined walkways may not be 34-38" from the walking surface. Handrails should be provided to allow adequate handholds for employees to grasp to prevent falls. Provided handrails should be between 34" and 38" from walking surface for level or inclined walking areas.
- **(M&R Q 5.4 No)** You indicated that not all walkways have toe-boards. Toe-boards should be provided for all inclined walkways and for level walkways located above working areas. These serve as guards to protect areas and workers below from falling objects.
- **(M&R Q 5.5 No)** You indicated that not all surfaces where workers walk are regularly inspected for deterioration. Walking areas should be monitored to ensure that they are properly functioning. Normal wear and tear can reduce the friction provided by surfaces, therefore reducing their effectiveness at preventing slips. Inclined walkways are especially important as the frictional requirements for safe walking increases when walking up or down an incline compared to level surfaces.
- **(M&R Q 5.6 10°-15° or 18%-27% grade)** You indicated walkway angles between 10° and 15°. Walking on surfaces at these angles increase the frictional requirements needed for safe walking. When walking and holding items, more traction is needed for safe walking. Walkways of this incline should be constructed of grated metal, such as diamond weave, to provide optimal traction for workers. Care should also be taken to reduce accumulation of debris and contaminants which could increase risks of slip and fall events.
- **(M&R Q 5.6 >15° or >27% grade)** You indicated walkways angles greater than 15°. Walking at these angles increases the frictional requirements for safe walking, particularly when carrying items. Walkways should not be of this high an incline. When possible, replace these inclines with combination of stairs and level walkways. If replacement is not possible, ensure walkways are constructed of grated metal such as a diamond weave pattern. Ensure that workers are able to maintain 3 points of contact (this means that at any time there should be two feet and one hand supported or both hands and one foot supported) while walking by providing handrails on both sides and eliminate their need to carry items in their hands by providing tool backpacks and materials handling systems. Care should also be taken to reduce accumulation of debris and contaminants which could also increase risks of slip and fall events.
- **(M&R Q 5.7 Yes)** You indicated that walkways or stairs are present where vertical clearances are less than 7 ft from the walkway surface. To reduce hazards associated with vertical clearance obstacles, all areas should have vertical clearance heights of at least 7 ft. Remove/reroute any obstructions (such as cables, hoses, pipes, tools, or equipment) that result in less than 7 feet of vertical clearance. Areas with vertical clearances below 7 ft should be painted in a high-visibility color and provided signage to indicate low clearance. Routinely inspect and maintain stairways and warning signs.

- **(M&R Q 5.8 Yes)** You indicated that contaminants are visible on walking surfaces. Improved housekeeping may be necessary to maintain clean walkways. Sources of spillage should be identified and eliminated. Provide alternate routes and restrict access to the area using barricades and signs if the entire walkway has spillage, debris, or other contaminants on it. Only employees aware of the risks and authorized to access the area for cleaning and maintenance should be allowed access. Promptly remove the barricades and signs once the hazard is eliminated.
- **(M&R Q 5.9 Yes)** You indicated that liquid sprays or runs off from your wet process and contaminates walking surfaces. Control the source of liquid. If the source cannot be controlled, add physical barriers such as splash guards or toe guarding to prevent liquid from entering walking areas. Additionally, add grated metal walkways in these areas to reduce the formation of puddles and maintain adequate friction.
- **(M&R Q 5.10 Yes)** You indicated that permanent hose covers are in place. Consider mounting these hoses above the walking area to eliminate the tripping hazard.
- **(M&R Q 5.11 No)** You indicated that outdoor walking areas are not clearly designated. It is beneficial to establish designated walkways as it 1) encourages mine workers to use the walkway, 2) highlights which areas should be the first priority for clearing contaminants, debris, and snow or ice, and 3) offers an indication to mobile equipment operators of where to expect foot traffic. Install bright yellow or high-visibility markings to indicate designated walkways. Routinely inspect and maintain markings to ensure they are visible and easily identifiable. MSHA recommends reducing slipping/falling accidents by using designated walkways and keeping them clean, and clear of stumbling hazards. For more information, see Sand, Gravel, and Crushed Stone On-the-Job Training Modules at <https://arlweb.msha.gov/TRAINING/part46/ig40/ig40.pdf>.
- **(M&R Q 5.12 Yes)** You indicated the presence of glare on the outdoor walking surfaces. Where possible introduce means to provide shade in walking areas where potential for glare is high. When the light hitting the walking surface cannot be reduced, provide workers with suitable eye protection such as shaded safety glasses to reduce the effects of glare. Glare cannot only be uncomfortable but it can also reduce vision which is of serious concern.
- **(M&R Q 5.13 Yes)** You indicated that outdoor temperatures drop below 32° during the year. When working in cold environments, several hazards exist. Workers lose dexterity and sensation due to the cold. Parts of outdoor equipment become frozen together and may require more physical effort to perform repairs. Materials freeze together inside of chutes and along conveyor belts, requiring more frequent maintenance. Additionally, ice and snow can accumulate on walking and working surfaces and sometimes may be undetected, increasing potential for a slip and fall accident. Workers should be provided means to carry tools and parts such as backpacks and hoisting systems during these conditions. This allows their hands to remain free so that 3 points of contact (which means that at any time there should be two feet and one hand supported or both hands and one foot supported) can be maintained while walking along inclined walkways and up/down stairs and ladders. Ensure all walkways have adequate handrails. Keep walkways free from ice by regularly inspecting and cleaning or treating these areas.
- **(M&R Q 5.14 Yes)** You indicated that walking paths cross water run-off. Walkway paths should not cross areas of known run-off. MSHA recommends preventing falls by walking around, rather than through, visibly

slippery areas and water holes. If possible, create a walk over such that workers do not walk through muddy, puddled areas.

- **(M&R Q 5.15 Yes)** You indicated that some walkways are located along conveyor belts. MSHA requires that these walkways include outboard railings. Ideally, a top rail, mid rail and toe board will be provided. The width of these walkways should allow workers to transport tools and equipment without risk of making contact with the conveyor.
- **(M&R Q 5.16 Yes)** You indicated that permanent ladders are located near stairways. These configurations can be hazardous especially if a worker missteps on the last rung of the ladder. To improve safety, ensure stairways are equipped with self-closing gates to reduce the potential for a serious fall accident. See Figure 14.



**Figure 14. Ladder landing near stairways.**

## Module 6 – Environmental Factors

- **(M&R Q 6.1 Yes)** You indicated that work is performed outdoors during the summer months. During summer months, the risk of heat stress and heat exhaustion can be high. Heat stress and heat exhaustion can be hard to detect and often detected too late. Prevention is essential to ensure workers remain healthy while working in high heat. MSHA provides the following seven key recommendations for preventing heat stress in workers:
  1. Arrange for miners who are to be exposed to heat stress to have a medical examination by a physician prior to assignment. Be sure that the physician is informed of the heat exposure so as to make the proper evaluation.
  2. Allow new workers in heat exposure a period of 5 to 6 workdays to become acclimatized by gradually increasing workload and exposure time during this period. Start by allowing new workers to work only 50 percent of regular work time in the heat. Check at the end of the six-workday period to see how they are doing.
  3. Schedule rest periods during the work shift as necessary to avoid severe strain among acclimatized workers. Schedule the heaviest work, particularly manual labor, for the cooler parts of the shift if possible.
  4. Ensure that workers wear lightweight, loose-fitting clothing for protection against the sun and to allow for air circulation, and a hard hat with sun protection (e.g., consider a hard hat with a longer brim to offer more sun protection).
  5. Consider using air conditioning inside the cabs of heavy equipment and ventilating and circulating fans, where appropriate. Provide shelters for protection against the sun during rest periods.
  6. Supply adequate quantities of drinking water, cooled if possible, and salt tablets to workers for their use as desired. Providing salt can help ensure workers maintain an appropriate balance of electrolytes.
  7. Plan in advance to ensure that first-aid treatment for heat ailments is available, as well as transportation for medical treatment, if necessary. Workers should be allowed frequent rest breaks to remove them from the heat and to rehydrate. Air-conditioned recovery areas are recommended. However when this isn't feasible a shaded area with airflow may be used. Hydration and rest is needed more frequently when working in high heat.
  
- **(M&R Q 6.2.1 No)** You indicated that workers are not provided portable heating sources. Provide heating sources for employees. Adding additional layers of clothing may help to retain body heat but is likely to reduce flexibility and range of motion; therefore, providing heat sources is the most appropriate solution.
  
- **(M&R Q 6.3 Air temperature < -1)** You indicated an air temperature below the acceptable range. Provide heating sources for employees. Adding additional layers of clothing may help to retain body heat but is likely to reduce flexibility and range of motion; therefore, providing heat sources is the most appropriate solution.
  
- **(M&R Q 6.3 Air temperature > 1)** You indicated an air temperature above the acceptable range. Heat stress and heat exhaustion can be hard to detect and are often detected too late. Prevention is essential to ensure that workers remain healthy while working in high heat. MSHA provides seven key recommendations for preventing heat stress in workers.

1. Arrange for miners who are to be exposed to heat stress to have a medical examination by a physician prior to assignment. Be sure that the physician is informed of the heat exposure so as to make the proper evaluation.
  2. Allow new workers in heat exposure a period of 5 to 6 workdays to become acclimatized by gradually increasing workload and exposure time during this period. Start by allowing new workers to work only 50 percent of regular work time in the heat. Check at the end of the 6 workday period to see how they are doing.
  3. Schedule rest periods during the work shift as necessary to avoid severe strain among acclimatized workers. Schedule the heaviest work, particularly manual labor, for the cooler parts of the shift if possible.
  4. Ensure that workers wear lightweight loose fitting clothing for protection against the sun and to allow for air circulation, and a hard hat with sun protection (e.g., consider a hard hat with a longer brim to offer more sun protection).
  5. Consider using air conditioning inside the cabs of heavy equipment and ventilating and circulating fans, where appropriate. Provide shelters for protection against the sun during rest periods.
  6. Supply adequate quantities of drinking water, cooled if possible, and salt tablets to workers for their use as desired. Providing salt can help ensure workers maintain appropriate balance of electrolytes.
  7. Plan in advance to ensure that first-aid treatment for heat ailments is available, as well as transportation for medical treatment, if necessary. Workers should be allowed frequent rest breaks to remove them from the heat and re-hydrate. Air conditioned recovery areas are recommended. However when this isn't feasible a shaded area with airflow may be used. Hydration and rest is needed more frequently when working in high heat.
- (M&R Q 6.3 Humidity = -1)** You indicated humidity levels below the acceptable range. Low humidity allows the body to cool through sweating but may have drying effects on the skin and eyes which can cause discomfort. Air mists can be provided to add some moisture to the air making it more comfortable for workers in hot, dry areas. Not only will the air mists increase the humidity in the air, but they will also provide a cooling effect by cooling the air in the working area.
  - (M&R Q 6.3 Humidity > 1)** You indicated humidity above the acceptable range. In addition to high air temperatures, outdoor workers are exposed to radiant heat from the sun, and sometimes high humidity as well. High humidity reduces heat loss from the body by evaporation of perspiration (sweat), the main avenue of heat loss in hot environments. In general, increased air velocity or movement increases the cooling effects of sweating. When reducing the humidity isn't possible, increasing the air velocity through fans may improve cooling of the body when air temperatures are less than 93° F.
  - (M&R Q 6.3 Thermal radiation > 1)** You indicated thermal radiation above the acceptable range. Provide a means to deflect radiation heat, such as sunlight or artificial light sources, away from workers through reflective shades or screens. Whenever possible, move work to a shaded area. Work scheduling may also need to be adjusted to ensure workers are not working in areas with high sun exposures during peak times (e.g., midday). This work should be scheduled earlier in the morning or later in the evening.
  - (M&R Q 6.3 Air movements < -1)** You indicated cold air movement above the acceptable range. Provide a means to reduce these cold air currents through deflection. Add tarps over working areas when needed and

provide a means to heat the area. Wind chill can affect the health and safety of workers even at temperatures above freezing and should be mitigated through heat sources and wind protection. MSHA provides the following chart (see Table 10) with recommendations regarding cold weather working conditions.

**Table 10: Wind Chill Factor Chart**

<b>Wind Chill Factor Chart</b>												
		<b>Actual Temperature Reading (°F)</b>										
		<b>50 °F</b>	<b>40 °F</b>	<b>30 °F</b>	<b>20 °F</b>	<b>10 °F</b>	<b>0 °F</b>	<b>-10 °F</b>	<b>-20 °F</b>	<b>-30 °F</b>	<b>-40 °F</b>	
<b>Wind Speed (mph)</b>	<b>Calm</b>	50	40	30	20	10	0	-10	-20	-30	-40	
	<b>5</b>	48	37	27	16	6	-5	-15	-26	-36	-47	
	<b>10</b>	40	28	16	4	-9	-21	-33	-46	-58	-70	
	<b>15</b>	36	22	9	-5	-18	-36	-45	-58	-72	-85	
	<b>20</b>	32	18	4	-10	-25	-39	-53	-67	-82	-96	
	<b>25</b>	30	16	0	-15	-29	-44	-59	-74	-88	-104	
	<b>30</b>	28	13	-2	-18	-33	-48	-63	-79	-94	-109	
	<b>35</b>	27	11	-4	-20	-35	-49	-67	-82	-98	-113	
	<b>40</b>	26	10	-6	-21	-37	-53	-67	-85	-100	-116	
			<b>NO WORKER RESTRICTIONS</b> Little Potential Danger (for properly clothed person)				<b>RESTRICTED WORK</b> Increased Potential Danger (Danger from freezing of exposed flesh)			<b>RESTRICTED WORK</b> Great Potential Danger		
<b>NOTE: Wind speed above 40 mph has little effect</b>												

- **(M&R Q 6.3 Air movements > 1)** You indicated hot air movement above the acceptable range. Provide a means to reduce these hot air current through deflection. Add tarps over working areas when needed and provide a means to cool the area.
- **(M&R Q 6.3 Physical work load > 1)** You indicated physical work load above the acceptable range for employee’s thermal comfort. In these working conditions fatigue may occur quickly. Environmental factors should be modified to be within a comfortable range to ensure worker health and safety at this level of physical exertion. Thermal Working Conditions scores should be between -1 and +1 for air temperature, humidity, thermal radiation, air movements, clothing, and opinions of workers.
- **(M&R Q 6.3 Clothing > 1)** You indicated a clothing score above the acceptable range. Many jobs require specialized clothing to protect workers from their hazards. However, specialized clothing can also become hazardous when it doesn’t allow for natural cooling through the evaporation of sweat, is bulky limiting flexibility, or has an overall ill fit. Selection of suitable, moisture wicking, and properly sized clothing is essential to ensure proper functionality of specialized clothing and to reduce the risks of the clothing becoming its own hazard.

- **(M&R Q 6.3 Worker opinion < -1)** You indicated that workers feel the environment is too cold. Care should be taken to ensure that workers are provided necessary heating sources, protection from wind chill, and suitable cold weather clothing. Thermal Working Conditions scores should be between -1 and +1 for air temperature, humidity, thermal radiation, and air movements.
- **(M&R Q 6.3 Worker opinion > 1)** You indicated that workers feel the environment is too hot. Care should be taken to ensure that workers are provided necessary cooling sources, hydration, reduction in sun exposure, and rests breaks. Also, clothing should be suitable for working in hot environments. Thermal Working Conditions scores should be between -1 and +1 for air temperature, humidity, thermal radiation, and air movements.
- **(M&R Q 6.4 No)** You indicated that not all light sources are working. Properly illuminating work and travel areas is important to ensure worker safety. Replace all nonworking light sources as soon as possible.
- **(M&R Q 6.5 No)** You indicated that LEDs were not used for overhead lighting everywhere. Using cool-white LEDs can reduce glare for older workers in low-light conditions. Additionally, due to their long-life and associated decrease in maintenance requirements, using LEDs can reduce the potential for maintenance-related accidents that result from replacing spent bulbs/lamps in lighting systems.
- **(M&R Q 6.6 Yes)** You indicated that flicker exists in fluorescent bulbs. Exposure to flicker can contribute to worker discomfort, headaches, and impaired visual performance. To ensure that lighting does not impair worker safety or health, replace the flickering bulbs or repair the light fixture to eliminate the flicker.
- **(M&R Q 6.7 No)** You indicated that light fixtures are not clean. Bulbs and shades should be cleaned regularly so that they output the full amount of light and should be inspected regularly to ensure that they are staying clean.
- **(M&R Q 6.8 No)** You indicated light sources are not provided with shades or glare shields. Glare can impair vision and cause discomfort for workers, which can reduce task performance and safety. All light sources should have shades or glare shields to protect workers.
- **(M&R Q 6.9 No)** You indicated that additional lighting is not provided in areas with high spillage or near equipment. To improve hazard identification and detection, increase the light levels near walking areas, especially where there is a high chance of debris and contaminants accumulating. A minimum of 20 lux is recommended. Light meters can be purchased to measure lux levels. When adding lighting, ensure that it does not create glare for workers (e.g., do not aim light directly in workers' line of sight; use a glare shield).
- **(M&R Q 6.10 No)** You indicated that additional lighting is not provided around entrances/exits. It is important to consider the transition of light levels, especially in entrances to enclosed spaces from outside. A slow transition in lighting levels should be provided, allowing eyes to adapt to the changing light levels and reducing negative impacts on vision (e.g., sunlight from outdoors is likely much brighter than indoor light levels; providing extra lighting in the entrances/exits can reduce transition effects from going from brighter into darker areas). When adding lighting, ensure that it does not create glare for workers (e.g., do not aim light directly in workers' line of sight; use a glare shield).
- **(M&R Q 6.11 Increase light)** You indicated that the provided light is insufficient and workers would choose to increase the amount of lighting. Evaluate the work environment and consult with workers to determine

specific areas that are in need of additional lighting. When adding lighting, ensure that it does not create glare for workers (e.g., do not aim light directly in workers' line of sight, use a glare shield). If portable lighting is added, ensure that it does not interfere with task performance or safety (e.g., if the worker needs both hands for the task, provide portable lighting that does not need to be held).

- **(M&R Q 6.11 Decrease light)** You indicated that the provided light is more than sufficient and workers would choose to decrease the amount of lighting. Evaluate the work environment and consult workers to determine specific areas that need decreased lighting. When removing lighting, ensure that the remaining light sources evenly illuminate the work environment (e.g., ensure that shadows are not created). Ensure that the placement of the light sources is not the cause of the lighting problem. Lighting should not be mounted at eye level or in the workers direct line of sight.
- **(M&R Q 6.12 Yes)** You indicated that workers report that shadows or glare is present and interferes with task performance or safety. Evaluate the work environment and consult with workers to determine specific areas that have shadows or glare. Where shadows are present, consider re-directing current light sources to more evenly illuminate the area, or consider adding additional light sources to cover areas that are shadowed. Where glare is present, consider redirecting the light sources to eliminate the glare (e.g., ensure that light sources are not in the line of sight of workers) and ensure that all lights have shades or glare shields.
- **(M&R Q 6.14 Yes)** You indicated that hand-held lighting sources need to be held while walking or while holding other objects. Holding a light source while walking or holding other objects can decrease safety by increasing the risk of falling (e.g., worker might not be able to maintain 3 points of contact on stairs) or dropping objects. Wherever possible, provide sufficient ambient lighting so that portable lighting is not needed. If it is not possible to increase the ambient lighting, consider using head lamps or floor lamps instead of hand-held lighting. Ensure that additional light sources do not create shadows or glare (e.g., do not aim light directly in workers' line of sight; use a glare shield). Provide straps, hooks, or magnets on hand-held light sources such that they may be mounted or suspended from the body.
- **(M&R Q 6.15 Yes)** You indicated that workers experience difficulties handling portable light sources due to the size or weight of lighting equipment. Wherever possible, provide sufficient ambient lighting so that portable lighting is not needed. If it is not possible to increase ambient lighting and the worker primarily works in one area, consider providing floor lamps or the means to suspend light sources (e.g., hook or strap suspended from ceiling or attached to wall; magnetic attachments to attach lights to equipment). If the worker travels between areas frequently, consider providing lightweight headlamps. This will decrease the amount of manual handling needed to use light sources. Ensure that additional light sources do not create shadows or glare (e.g., Do not aim light directly in workers' line of sight; use a glare shield).

## Module 7 – Machine Guarding

- **(M&R 7.3 & 7.4 & 7.5 Yes and 7.2 No)** You indicated that removing or replacing a machine guard requires more than one person because the guard exceeds 50 pounds and is difficult to bring close to the body. Using smaller, modular guards may reduce the strain associated with handling machine guards and will allow the guards to be removed in pieces and handled by one worker. Further, modular guards can enable smaller areas to be accessed without requiring removal of the entire guard. Areas requiring routine access could also be easily accessed through hinged guards or smaller removable pieces. Using guards which are modular and easily handled by one worker will reduce the probably of back and shoulder strains associated with manually handling machine guards. Lighter-weight materials may also be used to reduce the weight of machine guards.
- **(M&R Q 7.3 Yes)** You indicated that removing or replacing a machine guard requires more than one person. Re-fabricate the guard such that it is composed of lighter, smaller sections that may be handled by one person.
- **(M&R Q 7.4 Yes)** You indicated that the weight of the guard exceeds 50 lb. Re-fabricate the guard such that it is composed of lighter, smaller sections that may be safely handled by one person.
- **(M&R Q 7.5 Yes)** You indicated that the guard is difficult to bring close to the body because of its size, bulk or shape. Re-fabricate the guard such that it is composed of lighter, smaller sections that may be safely handled by one person and can be brought close to the body to reduce awkward postures and forceful lifting.
- **(M&R Q 7.6 Yes)** You indicated that the guard lacks handles or cutout handles or has a slippery surface or sharp edges. Adding handles to machine guards may reduce the risk for hand and finger injuries due to the hands being caught in/under/between guards or other injuries due to being struck by a guard. Handles will also improve coupling and reduce the strain associated with handling guards. The handles should be located shoulder width apart so that lifting the guard does not require awkward shoulder postures.
- **(M&R Q 7.7 Yes)** You indicated that removing or replacing the guard requires fast movements to avoid being pinned or struck by the guard. Ensure that the guard is properly supported and does not create a hazard during removal. If necessary, provide means to support the weight of the guard, through bungee cords or support cables, until it can be full unattached from the equipment. If weight is the cause of concern, reduce the weight of the guard by refabricating it in multiple smaller, lighter weight pieces.
- **(M&R Q 7.8 Yes)** You indicated that removing or replacing the guard requires stressful body postures such as bending to the floor, twisting, reaching overhead, or bending to the side. Provide or modify access systems to reduce awkward postures necessary to remove the guard. Reduce the size and weight of the guard by using multiple smaller, lighter-weight pieces to protect the area.
- **(M&R Q 7.9 Yes)** You indicated that the guard is handled by only one hand, arm or shoulder. Provide handles that allow the guard to be handled by both hands. The handles should be located a shoulder width apart so that lifting the guard does not require awkward shoulder postures.

- **(M&R Q 7.10 No)** You indicated that hinges are not used to attach the guard. Consider adding hinges to modular guarding systems to areas requiring frequent access without exposing hazardous areas or requiring removal of the entire guard.
- **(M&R Q 7.11 No)** You indicated that the guard is not painted such that it is easily discernible from equipment and conveyors. Painting all workplace guards one standardized color will improve detection of improperly placed or removed guards. Guards should be all painted one standard color such as safety yellow.
- **(M&R Q 7.12 Yes)** You indicated that the guard is removed to perform routine maintenance. Consider adding hinges to this guard or adding an access door within the guard so that the full guard will not need to be completely removed for maintenance activities and to ensure that the worker is still protected from hazards while performing routine maintenance. When the guard must be removed, ensure equipment is off and locked/tagged out before performing any maintenance.

## III. Pre-Maintenance

### Module 8 – Equipment Access

- **(M&R Q 8.1 Yes)** You indicated that there is equipment that workers climb inside to perform work. It is recommended that this equipment is locked out, tagged, de-energized and blocked from any hazardous motion before entering. Additionally, if working inside the equipment can be a fall or crushing hazard (as in crusher maintenance), add a platform that will restrain the equipment from unintended motion as well as provide a safe working surface.
- **(M&R Q 8.1.1 Yes)** You indicated that there is equipment that workers climb inside to perform work and climbing in or out of this equipment requires an employee to take steps with vertical distances greater than 8 in. Steps with heights greater than 8 in require increased muscular effort and may increase risks of missteps. Provide steps, platforms, or another alternative ingress/egress system to reduce the step height.
- **(M&R Q 8.1.2 No)** You indicated that there is equipment that workers climb inside to perform work and this equipment does not have stairs or steps. Provide stairs or steps on equipment so that workers may easily climb in and out. Steps and stairs should be designed such that:
  - Handrails and toe boards are provided.
  - Stairs are at least 22" wide.
  - Stairs are made of anti-slip material.
  - Stairs are installed at angles to the horizontal of between 30° and 50°. See Figure 16 for angle description.

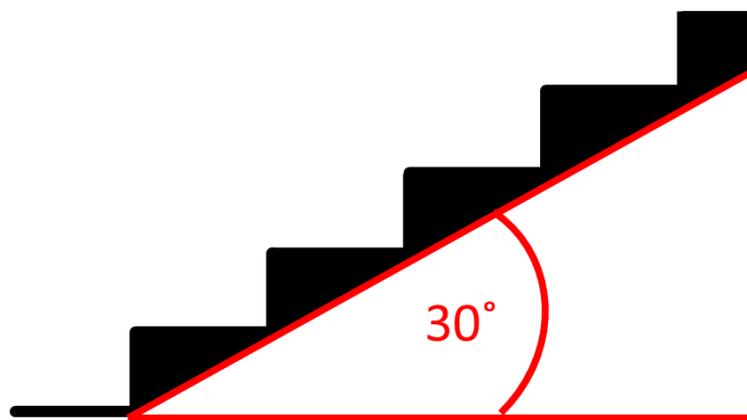


Figure 16. Stairs built to 30° incline.

- **(M&R Q 8.1.3 No)** You indicated that fall protection is not used while working in bins, hoppers and crushers. Many injuries and fatalities have occurred when workers fall into these types of equipment, which could be prevented with proper use of fall protection. Install and mark tie-off locations such that workers are aware of their location. Provide fall protection harnesses near these areas to promote use.

- **(M&R Q 8.1.4 No)** You indicated that bins, hoppers, or crushers are not always de-energized and locked/tagged out when work is being performed on them. Many injuries and fatalities have occurred when workers come into contact with these types of equipment while they are operating. This equipment should always be de-energized and locked/tagged out before any maintenance work begins.
- **(M&R Q 8.2 No)** You indicated that platforms are not provided in areas requiring frequent usage of scaffolding. Opposed to scaffolding, adding access platforms can improve equipment access and worker safety when working in inaccessible areas frequently.
- **(M&R Q 8.3 No)** You indicated that multi-floor buildings do not have scaffolding present on each floor. Providing scaffolding on each floor may encourage workers to use scaffolding over ladders which improves safety by reducing the risk of falling or dropping objects. For areas requiring frequent access, permanent platforms should be built.
- **(M&R Q 8.4 No)** You indicated that ladders are not available on each floor where they are commonly used for maintenance and repair work. Ideally, permanent platforms or scaffolding should be provided in areas where work is performed at heights. When this isn't possible, providing ladders on each floor may encourage their usage over other make-shift access equipment. Permanent ladders should be installed in areas which commonly require access.
- **(M&R Q 8.5 Yes)** You indicated that foldout or stepladders are provided. Ensure ladders have a metal spreader or locking device to hold the front and back sections in an open position and discourage workers from using the top of the ladder as a step.
- **(M&R Q 8.6 Yes)** You indicated that two or more surfaces are used together to reach a work area. This condition is unsafe and scaffolding should be used.
- **(M&R Q 8.7 Yes)** You indicated that some handrails may block access to equipment. Handrails should be left in place but redesigned such that they may be readily removed. Providing removable handrails will aide in equipment access while maintaining a barrier from falls when in place. When working at heights, ensure workers wear fall protection when removing the handrails.
- **(M&R Q 8.8 No)** You indicated that inspection areas are not visible without dismantling equipment or removing large guards. Adding access panels can improve workers' ability to inspect areas inside equipment. For chutes and other areas prone to blockage, a camera system may be helpful in preventing process disruption due to unexpected blockages.

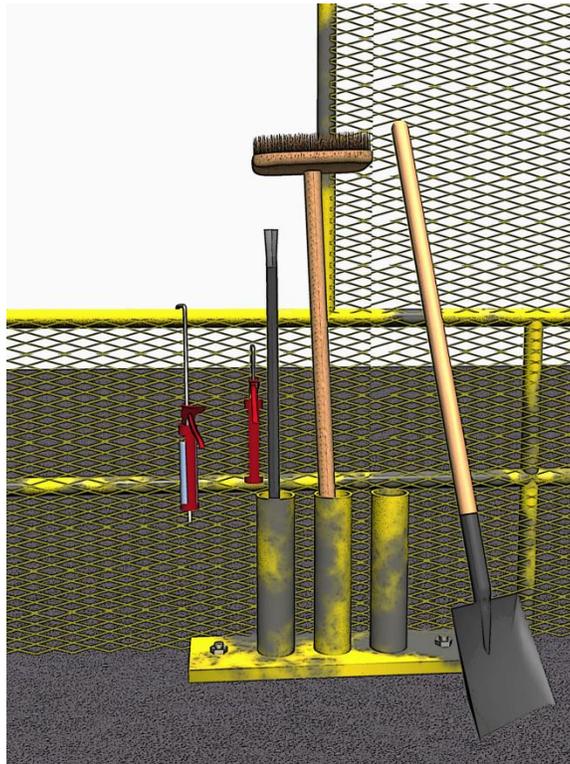
## Module 9 – Maintenance Preparation and Area Inspection

- **(M&R Q 9.1 No)** You indicated that areas below current overhead work are not marked indicating the presence of overhead work. Several injuries occur each year due to objects falling from overhead work areas and injuring workers below. To reduce risk of injury due to falling tools/parts, workers are encouraged to use warning/caution tape in areas below overhead work. Additionally, using tool lanyards will help prevent falling tools from causing injuries to workers below.
- **(M&R Q 9.2 No)** You indicated that beacons are not used to indicate nighttime maintenance in areas without overhead lighting. Using beacons to flag equipment in areas without overhead lighting can improve visibility and make other workers aware of locations currently under repair.
- **(M&R Q 9.3 No)** You indicated that guards or gates may not be added to the entrances of stairways when working near them. Adding gates to stairwells can prevent potential injuries due to workers falling. Stairwells near working areas should always be guarded such that workers do not inadvertently fall down the stairs.
- **(M&R Q 9.4 No)** You indicated that tie-off locations are not always added or identified in all areas requiring fall protection. These areas include the insides of hoppers and bins and other maintenance locations where there are dangers of falling. Providing and identifying tie-off locations may encourage workers to use fall protection when needed for safety. When adding tie-off locations, ensure that anchor points are of substantial quality and capable of bearing worker weight.
- **(M&R Q 9.5 No)** You indicated that additional signage or signaling methods are not used to identify potential hazards in the work area due to maintenance or other nonroutine activities. Provide additional signage as needed in work areas to identify potentially hazardous areas. Workers may not be accustomed to working in these areas and may need reminders of safety concerns. Suggested signage includes: low clearance, falling debris, poor visibility, high temperature, low temperature, welding in progress.
- **(M&R Q 9.6 No)** You indicated that areas are not cleaned prior to and after maintenance or repair. Prior to any maintenance and repair work, the work area should be cleaned to eliminate any potential safety hazards. Unexpected safety hazards, such as chemical exposure, may be present in some work areas. Workers may not be accustomed to working in these areas and may need reminders of specific hazards. Additionally, after work is performed the area should be cleaned to ensure all tools are removed and the area no longer poses a safety hazard to workers.
- **(M&R Q 9.7 No)** You indicated that tool supports are not provided for workers using heavy tools. Heavy tools may be supported by tool supports such as those which connect to lifelines or other hoisting equipment. Supporting heavy tools reduces the effort of the worker and may reduce potential injuries or damaged equipment due to dropping a tool.
- **(M&R Q 9.8 No)** You indicated that manufacturers' maintenance manuals may not be available for reference before making repairs to equipment. It is important to provide manufacturers' maintenance manuals for all equipment to ensure that workers understand the proper procedures for performing work. Many fatalities have occurred when workers did not have access to the manufacturer's maintenance manual and followed incorrect procedures for repairing the equipment.

- **(M&R Q 9.9 Yes)** You indicated that there is a likelihood that the machine, equipment, or structure on which maintenance is being performed could shift, move, or shake during maintenance activities. Unexpected movement of machines, equipment, or structures have led to fall related fatalities in mining. Fall protection should be worn for these activities to prevent getting thrown from the machine, equipment, or structures when movement occurs.
  
- **(M&R Q 9.10 Yes)** You indicated that handrails, guardrails, or floor opening covers (hatch covers) may be removed or opened as part of maintenance activities. Handrails, guardrails, or hatch covers should only be removed when needed and promptly replaced to reduce the risk of falling from heights or through floor openings. If removal of handrails and guardrails create a fall from height risk, fall protection should be provided including a tie-off point, harness, and suitable lanyard. Temporary barriers should be placed to restrict access to the area and signs should be posted indicating the hazard.

## Module 10 – Housekeeping

- **(M&R Q 10.1 Yes)** You indicated that hoses or cords are visible on walking surfaces. Hoses and cords which are frequently used should be mounted on hose reels allowing workers to retract the hose or cord when not in use. Additionally, these reels could be mounted overhead to eliminate the cord or hose becoming a tripping hazard below.
- **(M&R Q 10.2.1 Yes)** You indicated the source of the contaminants present on the walking surface can be identified. When the source of the contamination can be identified, the hazard can be controlled. Prompt action should be taken to eliminate the source of the contamination. Proper maintenance of equipment is essential to reducing hazards in walking areas due to spillage or process contamination.
- **(M&R Q 10.3 Yes)** You indicated that tools, boxes, trash or other debris are visible on walking surfaces. Prompt action should be taken to eliminate any slipping or tripping hazards in walking areas. If current maintenance work is being performed, provide necessary signage and hazard identification to reduce the potential for accidents.
- **(M&R Q 10.4 No)** You indicated that handle holders are not provided for shovels, brooms, etc. Creating locations for commonly used tools and equipment can reduce the risk for tripping or stumbling hazards associated with workers leaning them along walls and them falling over. Welding or bolting pipes to walls and equipment make for easy broom and shovel holders as shown in Figure 17.



**Figure 17. Handle holder designed for storage of tools with long handles**

- **(M&R Q 10.5 Yes)** You indicated that spillage occurs around conveyor belts. Inspect belts for proper tracking before each shift. Consider using belt trackers to help align belts thereby reducing spillage and minimizing belt edge damage. If needed, redesign transfer points and add belt skirting to reduce spillage. In areas of high spillage due to transfers or belt-cleaner tailings, an additional “scavenger” conveyor may be added to return spillage to the transfer chute. A scavenger conveyor is an additional belt added under a conveyor to catch and carry spillage to another location. This not only prevents spillage from contaminating walkways, but also reduces product loss by reintroducing spillage into materials processing.
- **(M&R Q 10.6 Yes)** You indicated that shovels are used to remove spillage. Minimize shoveling as high forces are created when shoveling. If shoveling is necessary, purchase smaller capacity shovels to reduce the weight of spillage handled with each load. Consider using scrapers to move spillage to one location then removing all spillage using mobile equipment or vacuum systems.
- **(M&R Q 10.7 No)** You indicated that physical barriers are not in place to reduce accumulation of debris in travel ways. Consider adding physical barriers such as netting, toe guards, or other means to prevent debris from accumulating in travel ways along conveyors or other spillage sources.

## IV. All Maintenance Tasks

### Module 11 – Blocking

- **(M&R Q 11.1 No)** You indicated that equipment may not be blocked in all directions of motion prior to repair. Equipment manuals should be consulted to determine in which directions motion may occur and to block these directions. Equipment must be blocked in all possible directions of movement, even if movement in all directions is not expected. Ensure blocks are sufficient to prevent movement as loads often shift during repairs. Injuries and fatalities have occurred because unexpected movement of equipment can cause blocks to become dislodged and no longer support the equipment.
- **(M&R Q 11.2 Yes)** You indicated that metal blocks are used for blocking metal equipment. This is a serious concern. A fatality occurred as a result of using a blocking device made of metal on another metal surface. The metal block slid against the inside of the equipment and resulted in the death of a mine worker. When choosing blocking materials, you must consider how this material will interact with the location where it is placed. Metal against metal may have decreased friction and result in the movement of the block away from its intended location, wood should be used in this situation.
- **(M&R Q 11.3 No)** You indicated that blocking may not always be performed on stable, level ground. Blocks should never be used on sloped, uneven, or unstable ground. If blocks are not level with full, even contact with the ground, it is more likely that they will shift position and fail to properly support the load.
- **(M&R Q 11.4 Yes)** You indicated that jacks are used. Many injuries happen as a result of improper jacking and blocking. OSHA provides an informational booklet on the safe usage of Hand and Power tools, <http://www.osha.gov/Publications/osha3080.html>. The following information is provided on the safe use and application of jacks.

All jacks, including lever and ratchet jacks, screw jacks, and hydraulic jacks, must have a stop indicator, and the stop limit must not be exceeded. Also, the manufacturer's load limit must be permanently marked in a prominent place on the jack, and the load limit must not be exceeded. A jack should never be used to support a lifted load. Blocks must be used with jacks. Once the load has been lifted, it must immediately be blocked up. Put a block under the base of the jack when the foundation is not firm and place a block between the jack cap and load if the cap might slip.

To set up a jack, make certain of the following:

- The base of the jack rests on a firm, level surface;
- The jack is correctly centered;
- The jack head bears against a level surface; and
- The lift force is applied evenly.
- Proper maintenance of jacks is essential for safety. All jacks must be lubricated regularly. In addition, each jack must be inspected according to the following schedule: (1) for jacks used continuously or intermittently at one site -- inspected at least once every 6 months, (2) for jacks

sent out of the shop for special work -- inspected when sent out and inspected when returned, and (3) for jacks subjected to abnormal loads or shock -- inspected before use and immediately thereafter.

## Module 12 – Posture Assessment

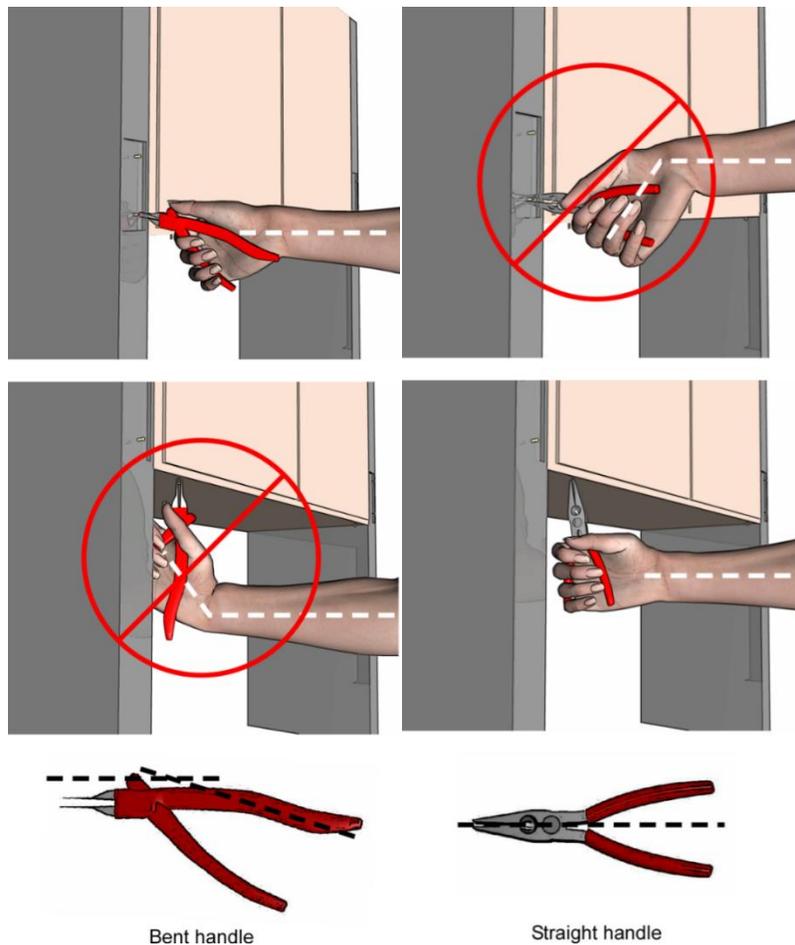
- **(M&R Q 12.1 Moderate or High)** You indicated that the neck is bent or twisted sometimes or frequently during the task which will likely lead to muscular soreness and discomfort. The neck contains spinal discs which may be damaged when exposed to prolonged pinching which reduces the circulation of vital nutrition through the discs. When possible, position the work to reduce the necessity to bend or twist the neck. If standing and having to look down, provide a chair or stool so the work can be performed at eye level. If forced to look up, use scaffolding to raise the worker such that work can be performing without bending or twisting the neck. Educate workers to understand and recognize awkward postures to reduce the risk for musculoskeletal disorders. Ergonomics and Risk Factor Awareness Training for Miners is available for download from NIOSH at: <http://www.cdc.gov/niosh/mining/works/coversheet582.html>
- **(M&R Q 12.2 Moderate or High)** You indicated that the back is bent forward, bent sideways or twisted sometimes or frequently during the task which may lead to back injury or the development of low back pain. Whether sitting or standing, it is important to maintain a natural S-curve in the spine. During maintenance tasks, manual materials handling is common. Handling materials in awkward postures, such as bending over, can drastically change the loads experienced by the spine. When considering the stress placed on the low back during lifting, the weight of the load is not the only factor determining the amount of stress. The load and the lever arm both play major roles in back injury and the development of low back pain. The lever arm is the horizontal distance between the load and the point of force generation. When lifting a box, the lever arm is the horizontal distance between the center of the box and the spine. As the lever arm increases, so does the loading on the spine. This means that a 20-lb roller, which is small and easy to bring close to the body, may cause less spinal loading than a 10-lb roller, which is awkwardly shaped and has to be held further away from the body. Back flexion adds to this increase in loading. When the back is bent over 30 degrees it can cause spinal forces over three times those which would be experienced handling the same load at the same lever arm in an upright position.

To prevent back injuries, consider these important safeguards:

- Keep it close. Reduce the level arm by keeping the load close to the body and removing any barrier to lifting.
  - Keep the S-curve. Reduce spinal compression by maintaining an upright posture, allowing the spine to be in its natural S-curve.
  - Keep it light. Reduce load weight through the redesign of jobs, use of mechanical assists devices and team lifting.
  - Keep it infrequent. Reduce the frequency of lifting to enable the body to repair from manual lifting.
  - Keep it straight. Reduce the amount of twisting necessary to perform a job by changing work placement.
- **(M&R Q 12.3 Moderate or HIGH)** You indicated that the arms are away from the body sometimes or frequently during the task which may lead to shoulder injury or discomfort. The shoulder is the most dynamic joint in the body capable of many types of motion. As such, it is also prone to instability and joint deterioration. Shoulder injuries, such as rotator cuff injuries, are associated with frequent and prolonged shoulder flexion (stretching the arm in front of the body) and shoulder abduction (raising the arm away from

the body). The risk for injury is increased when these postures are used while maintaining a load such as during overhead work. When possible, reduce the amount of time spent in these postures through proper work placement and breaks. If the worker must raise their arms to perform work, lower the work to waist level. If the location of the work cannot be modified, use scaffolding to raise the worker such that work doesn't require the arms to be raised away from the body. Educate workers to understand and recognize awkward postures to reduce the risk for musculoskeletal disorders. Ergonomics and Risk Factor Awareness Training for Miners is available for download from NIOSH at <http://www.cdc.gov/niosh/mining/works/coversheet582.html>

- **(M&R Q 12.4 Moderate or High)** You indicated that the wrists are bent or deviated sometimes or frequently during the task which may lead to a wrist injury or discomfort. Jobs that require a combination of wrist bending and forceful work increase risks for tendon injuries of the hand and wrist. Tendonitis is characterized by inflammation or irritation of the tendon and can be painful making motion and work difficult. Prevent awkward wrist postures by selecting light-weight powered tools instead of manual tools and using hand tools with proper handle diameters and curvatures. Tools with bent handles are better than those with straight handles when the force is applied in the same direction of your straight forearm. Tools with straight handles are better than those with bent handles when the force is applied vertically (above or below forearm). See Figure 18.



**Figure 18. Use of bent handle (left) and straight handle (right) hand tools.**

- **(M&R Q 12.5 Moderate or High)** You indicated that pinch or wide finger grips are used sometimes during the task which may lead to a hand injury or discomfort. Pinch grips are used to maintain grasps of small items requiring precise motion and control. Pinch grips require the use of small hand muscles which are not well suited for high force production. As such, prolonged usage of a pinch grip can lead to muscle fatigue and soreness. Wide finger grips are similar to power grips, except the object is too wide to allow the user's thumb and fingers to touch, making the grip less efficient. Ideally tools should be used that require a power grip. The power grip allows the greatest force production and may be comfortably maintained longer than a pinch or wide finger grip which could reduce the potential for hand discomfort.
  
- **(M&R Q 12.6 High)** You indicated that the task requires using a hand tool. Please complete the Tool Use Module, Module 14.

## Module 13 – Gross Posture Assessment

- **(M&R Q 13.1 Moderate)** You indicated the task requires prolonged standing or sitting and infrequent kneeling or squatting. Prolonged standing requires more energy and muscular effort and can lead to back and knee pain. Seated workstations constrain posture and do not allow for much movement, which contributes to injury risk. Further, seated workstations can require awkward arm and back postures to handle objects. To reduce these awkward postures, objects should be handled to the side or in front of the worker. When possible, provide stools so that workers may sit or stand for prolonged work.
- **(M&R Q 13.1 High)** You indicated the task requires frequent kneeling or squatting and severely restricted postures. When possible, provide workers with stools to sit instead of kneel or crawling. In terms of kneeling, upright kneeling is better than squatting or kneeling and sitting on one's heels. Provide protection in the form of kneepads or kneeling cushions to reduce surface pressures on the surface of the knees. Reduce exposure to these awkward postures by allowing frequent breaks and job rotation.
- **(M&R Q 13.2 High)** You indicated there are clearance restrictions, obstructions or barriers present through much of the task. Ensure obstructions are clearly marked and do not pose additional hazards. When feasible, provide sitting stools that allow workers to sit instead of squat or stoop. Increase lighting to improve detection of hazards. Lifting capacity is reduced when in restricted postures. Reduce manual materials handling while in these postures by providing mechanical assist devices. Reduce exposure to awkward postures by allowing frequent breaks and job rotation.
- **(M&R Q 13.3 High)** You indicated the worker stands on hard surfaces for the duration of the task. If the worker is standing on a hard surface, an anti-fatigue mat can be helpful in reducing stress on the body and increasing blood flow to the leg muscles, which can reduce fatigue. Be sure that mats are secured to the floor and do not create a tripping hazard. Also anti-fatigue insoles may provide additional comfort for workers and should be considered especially if the floor surface or working surface does not easily allow for securing a mat to the floor.
- **(M&R Q 13.4 High)** You indicated that in the seated position, the worker sits in a position where the knees or hips are uncomfortable. Adjust the seat or provide an adjustable seat allowing for an approximately 90° angle at the hips and back of knees and ensure the feet are supported comfortably by adding foot rests. An example of good seated posture through seat adjustments and foot rests is shown in Figure 19.

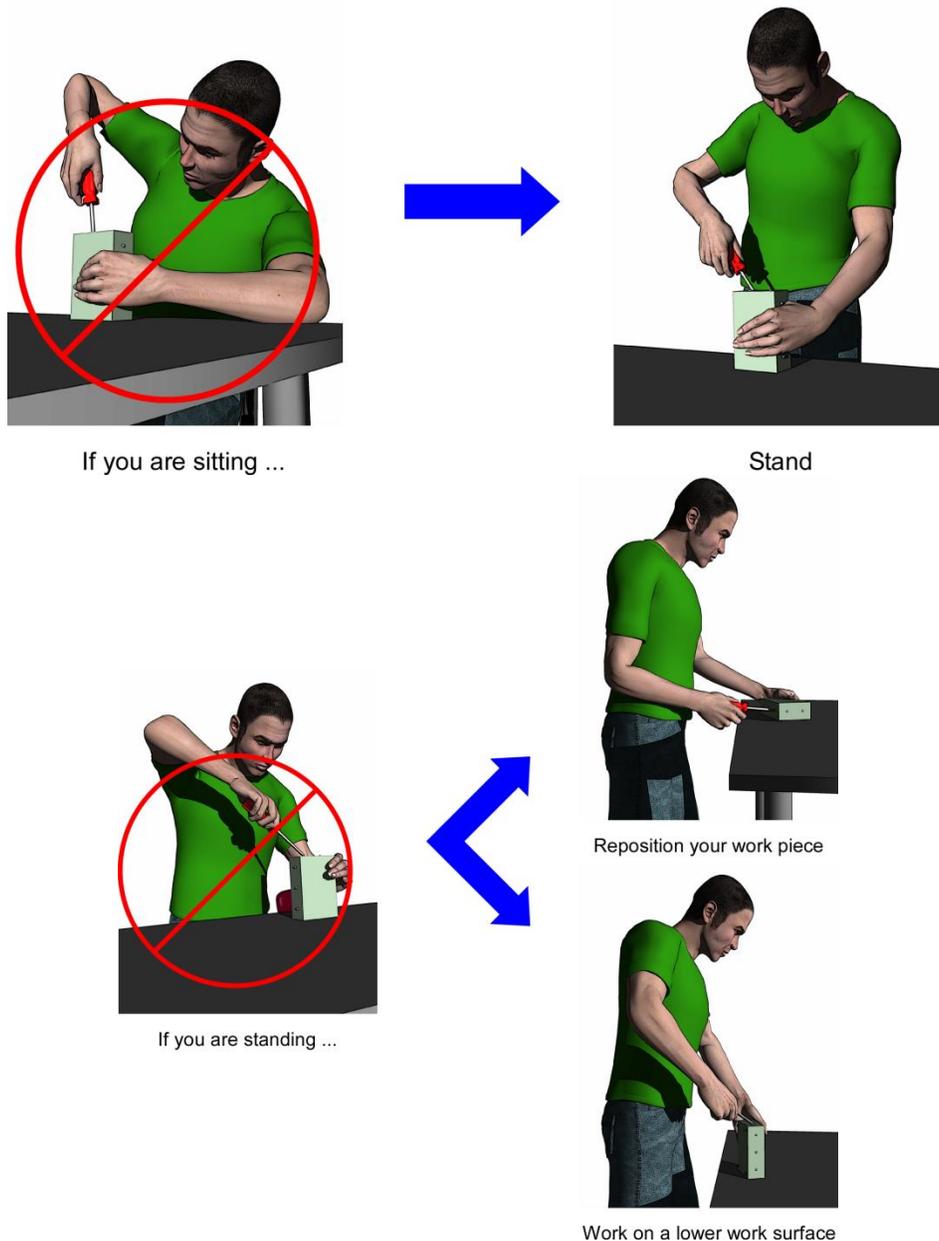


**Figure 19. Worker is sitting with hip and knee at the same level. Both the hips and knees are at approximately 90 degrees angles and the feet are supported.**

- **(M&R Q 13.5 High)** You indicated that in the seated position, the worker's feet dangle from the chair and are unsupported. Ensure that workers' chairs are at a height that allows for an approximately 90° angle at the hip and back of knee and that feet are supported comfortably. Seats should have height adjustability allowing workers to assume the better posture while sitting. If feet do not comfortably reach the floor, blood circulation and nerve sensations may be reduced resulting in numbness or pain. If necessary, provide a foot support (bar, platform, or footstool). Further, if the workers' seat is too close to the floor, excessive strain can be placed on the knees and hips.
- **(M&R Q 13.6 Moderate)** You indicated that the worker feels the seat is in poor condition. Consider replacing or repairing the seat or seat cover. A seat in poor condition may no longer provide proper body support and can lead to discomfort.

## Module 14 – Hand Tool Use

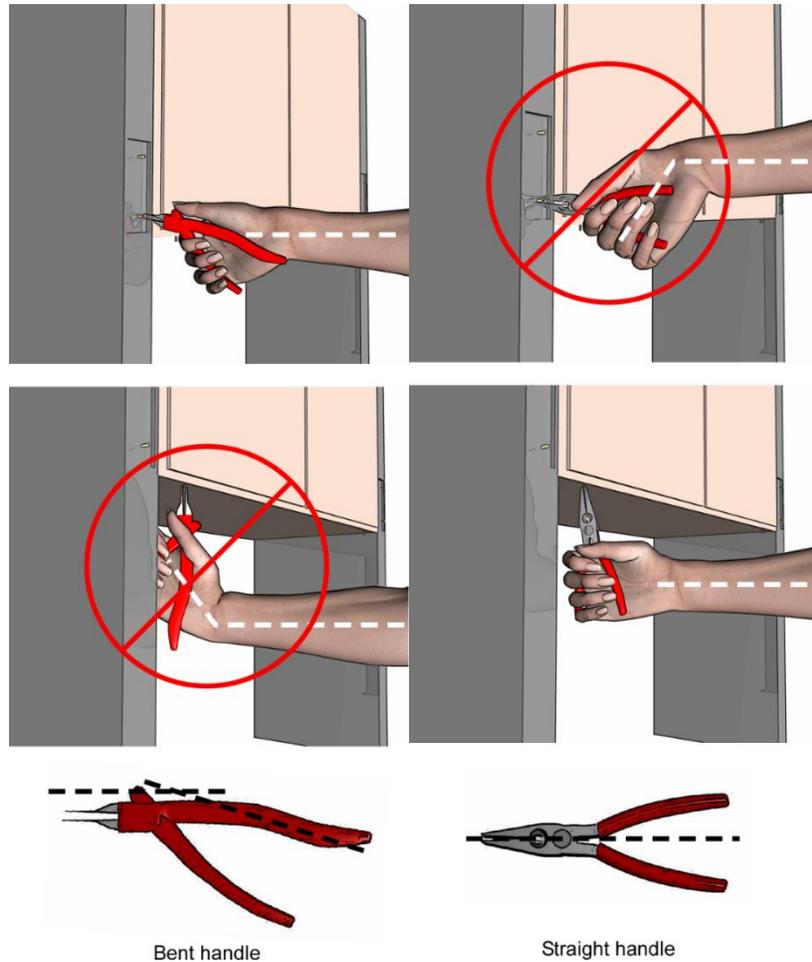
- **(M&R Q 14.1 Yes)** You indicated that the elbow is raised during tool use. Reposition the work or the worker to reduce the need to raise the elbow during tool use. If the elbow is used to gain more leverage, consider using a power tool to reduce the forceful exertions. See Figure 20.



**Figure 20. How to reposition work to reduce the need to raise elbow for sitting and standing workstations**

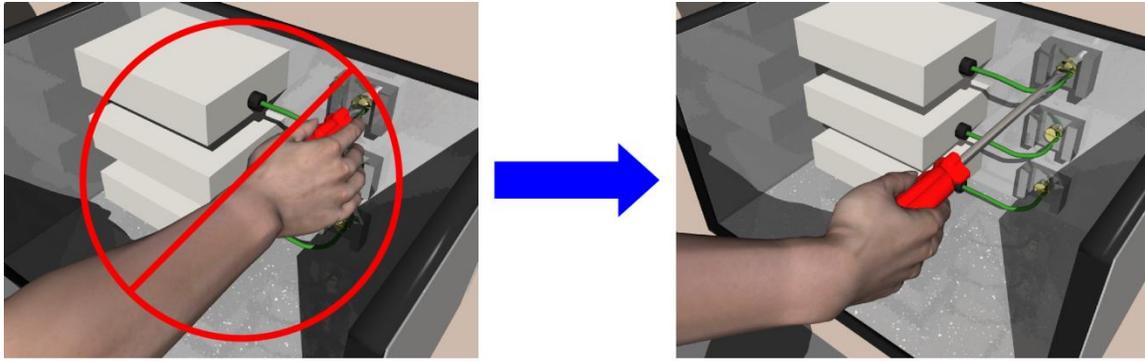
- **(M&R Q 14.2 Yes)** You indicated that using the tool requires twisting of the wrists. If frequent and prolonged twisting of the wrist is needed to use a tool, use a powered tool instead.
- **(M&R Q 14.3 Yes)** You indicated that using the tool requires a bent wrist. If frequent and prolonged bending of the wrists is needed to use a tool, consider the angle of the tool handle. Tools with bent handles are

better than those with straight handles when the force is applied in the same direction of your straight forearm. Tools with straight handles are better than those with bent handles when the force is applied vertically (above or below forearm). See Figure 21.



**Figure 21. Usage of bent handle (left) and straight handle (right) hand tools.**

- **(M&R Q 14.4 Yes)** You indicated that using the tool requires a heavy grip to keep the tool from sliding out of the users hands. Select a tool with a nonslip surface for a better grip. Adding a nonslip sleeve to the tool can improve the surface texture of the handle. To prevent tool slippage within the sleeve, make sure that the sleeve fits snugly on the tool handle.
- **(M&R Q 14.5 Pinch)** You indicated that using the tool requires a pinch grip. Pinch grip is less powerful than a power grip and leads to higher tendon forces. Exerting forces with a tool that requires a pinch grip will cause you to work harder to accomplish the same task than when using a tool with a power grip. A power grip is the preferred grip for hand tool use. Select tools that allow a power grip to be used. See Figure 22.



Pinch grip

Power grip

**Figure 22. Pinch and power grips when working in tight workspaces**

- **(M&R Q 14.5 Wide)** You indicated that using the tool requires a wide grip. Avoid using a tool that requires a wide grip. For double handled tools used for precision tasks, select tools with open grip spans no more than 3 ½ in. A power grip is the preferred grip for hand tool use. Select tools that allow a power grip to be used.
- **(M&R Q 14.6 Single)** You indicated that the tool is triggered by a single finger. Poorly designed tools where the last segment of the index finger is used to depress the trigger can contribute to injury. Select powered hand tools equipped with trigger-levers which are triggers designed to be large enough for activation by two or three fingers.
- **(M&R Q 14.7 Yes)** You indicated that the tool requires the thumb to be fully extended and the trigger is frequently used. Avoid frequent usage of thumb triggered tools that require the thumb to remain fully extended. Discomfort may result quickly due to this type of tool. Instead, use tools with trigger-levers which allow several fingers to be used to depress the trigger in a more comfortable position.
- **(M&R Q 14.8 No)** You indicated that the handle diameter of the tool used for power tasks is not between 1 ¼ in and 2 in. Over time, exposure to awkward postures or harmful contact pressures can contribute to an injury. For single-handle tools used for power tasks, select a tool that feels comfortable in the hand and has a handle diameter in the range of 1 ¼ in to 2 in. You can increase the diameter of a tool handle by adding a nonslip sleeve to the handle. The addition of a sleeve may also help with gripping the tool.
- **(M&R Q 14.9 No)** You indicated that the handle diameter of the tool used for precision tasks is not between ¼ in and ½ in. Over time, exposure to awkward postures or harmful contact pressures can contribute to an injury. For single-handle tools used for precision tasks, select a tool with a handle diameter of ¼ in to ½ in.
- **(M&R Q 14.10 No)** You indicated that the grip span is less than 2 in or more than 3 ½ in for a double handled tool used for power tasks (like pliers). Over time, exposure to awkward postures or harmful contact pressures can contribute to an injury. For double-handle tools used for power tasks, select a tool with a grip span that is at least 2 in when fully closed and no more than 3 ½ in when fully open. When continuous force is required, consider using a clamp, a grip, or locking pliers.

- **(M&R Q 14.11 No)** You indicated that the grip span is less than 1 in or more than 3 in for a double handled tool used for precision tasks (like tweezers). Over time, exposure to awkward postures or harmful contact pressures can contribute to an injury. For double-handle tools used for precision tasks, select a tool with a grip span that is at least 1 in when fully closed and no more than 3 in when fully open.
- **(M&R Q 14.12 No)** You indicated that this double handled tool is not spring loaded. For double handled pinching, gripping, or cutting tools, select a tool with handles that are spring-loaded enabling the tool to easily return the handles to the open position.
- **(M&R Q 14.13 No)** You indicated that handle of the tool has sharp edges or finger grooves. Over time, exposure to harmful contact pressures can contribute to an injury. Select a tool without sharp edges or finger grooves on the handle.
- **(M&R Q 14.14 No)** You indicated that the tool is not coated with soft material. Adding a soft nonslip sleeve to the tool handle pads the surface and improves grip but also increases the diameter or the grip span of the handle. When adding sleeves, ensure the handle diameter is between ¼ in to ½ in for tools used for precision tasks and 1 ¼ in to 2 in for tools used in power tasks.
- **(M&R Q 14.15 No)** You indicated that the tool cannot be used by either hand. Select tools that can be used by the dominant hand or either hand.
- **(M&R Q 14.16 No)** You indicated that the tool handle is shorter than the widest part of the worker's hand. If the handle of the tool is too short, the end will press against the palm of the hand and may cause injury. Select tools with a handle length longer than the widest part of the hand (usually 4–6 in).
- **(M&R Q 14.17 No)** You indicated that the handle of this powered tool does not provide electrical insulation. To improve safety when using powered tools, select tools with electrically insulated handles.
- **(M&R Q 14.18 No)** You indicated that this heavy tool is not counterbalanced. When using heavy tools, forceful exertions and awkward postures are of concern. A tool that weighs 10 to 15 pounds cannot be held in a horizontal position for more than a few minutes without discomfort, fatigue and reduce productivity. When possible, provide means to support the weights of these tools. Tools can be suspended from overhead or provided with counterbalances, under-tool supports or “kickstands” to reduce the effort required for their usage. Add torque bars on tools to minimize the exertion required to control the tool.
- **(M&R Q 14.19 Yes)** You indicated that the tool vibrates. When possible purchase tools with vibration dampening handles such that harmful vibrations are not transmitted to the hands. Avoid using anti-vibration gloves as they may not provide adequate vibration isolation and have been found to increase grip strength. The addition of vibration dampening sleeves to the handle of vibrating hand tools may reduce the vibration transmitted to the worker.
- **(M&R Q 14.20 No)** You indicated that the tool has a defect. This tool should be immediately removed from service. Serious injuries can result from using a tool with even minor damage. For example, if the wooden handle of a tool is splintered or cracked the head of the tool may fly off and strike the user or other workers.

## V. Specific Maintenance and Repair Tasks

### Module 15 – Screen Maintenance Checklist

- **(M&R Q 15.2 Yes & 15.3 Yes & 15.4 Yes & 15.5 No & 15.6 No)** You indicated that removing or replacing the screen requires more than one person because the screen weighs over 50 lb and is difficult to bring close to the body. You also indicated that come-a-longs and hoists were not used. Team lifts are recommended when dealing with objects which may be heavy and awkwardly shaped. Come-a-longs also aide in manual materials handling to lift, lower and support the weight of equipment and parts. However, come-a-longs require repetitive shoulder pulling and can lead to injury. Ideally, a powered hoist not come-a-longs should be used to assist with the maintenance of screens which cannot be easily handled by one worker.
- **(M&R Q 15.5 Yes)** You indicated that workers use come-a-longs or chain pulls to support the screen. Come-a-longs aide in manual materials handling to lift, lower and support the weight of equipment and parts. However, come-a-longs require repetitive shoulder pulling and can lead to injury. Ideally, a fully mechanized hoist should be used to assist with the maintenance of screens which cannot be easily handled by one worker.
- **(M&R Q 15.7 Yes & 15.8 Yes)** You indicated that workers stand inside the screen deck and the screen has a slippery surface or sharp edges. In these conditions a slip and fall accident may likely occur. As many maintenance procedures require workers to stand inside equipment, mats should be provided which improve traction and reduce the need to walk on the slippery surface. Nonskid rubber matting, with holes to facilitate drainage, may be placed inside the screen deck prior to maintenance to provide a safer surface for workers to stand. If on an oily surface, ensure there is sufficient traction between the mat and the screen surface such that the mat will not move or create a tripping hazard.
- **(M&R Q 15.9 Yes)** You indicated that footing is unsafe due to slippery, inclined or uneven flooring. If possible, construct a platform allowing workers to perform screen maintenance without having to work on unsafe flooring.
- **(M&R Q 15.10 Yes)** You indicated that screen maintenance requires fast movements to avoid being pinned or struck by the screen. Many finger fractures and crushing injuries occur from getting the hands caught in or struck by machine parts and tools during maintenance. When possible, provide a means to support the weight of the screen during maintenance so workers will not need to dodge a potentially heavy object when performing maintenance.
- **(M&R Q 15.11 Yes & 15.12 Yes )** You indicated that screen maintenance requires stressful body postures and kneeling or squatting. Kneeling and squatting can increase the loading on the knee and may lead to discomfort and potential knee injuries. Although allowing more mobility than kneeling, squatting can be damaging to the knee structures and should be minimized. Encourage workers to kneel upright and provide kneepads or kneeling cushions to improve their comfort when kneeling on hard surfaces. If the job requires kneeling for a prolonged period, consider providing stools which allow workers to sit, reducing the stress on their knees. Additionally, kneeling and squatting reduces lifting capacity making manual materials handling more difficult and more stressful for the body. In areas where posture is restricted, provide hoists or other powered materials handling systems to reduce the lifting requirements.

Handling materials in awkward postures, such as bending over, can drastically change the loads experienced by the spine. Back flexion adds to this increase in loading. When the back is bent over 30 degrees it can cause spinal forces over three times those which would be experienced handling the same load in an upright position. To prevent back injuries, consider these important safeguards:

- Keep it close. Reduce the level arm by keeping the load close to the body and removing any barrier to lifting.
- Keep the S-curve. Reduce spinal compression by maintaining an upright posture, allowing the spine to be in its natural S-curve.
- Keep it light. Reduce load weight through the redesign of jobs, use of mechanical assists devices and team lifting.
- Keep it infrequent. Reduce the frequency of lifting to enable the body to repair from manual lifting.
- Keep it straight. Reduce the amount of twisting necessary to perform a job by changing work placement.

- (M&R Q 15.13 Yes)** You indicated that screen maintenance requires stressful body postures and the worker must lie down. Lying down significantly reduces lifting capacity making manual materials handling severely stressful for the body. High stresses may be placed on the back as well as the shoulders and discomfort or injury will likely to occur. Manual materials handling should not occur while lying down. In areas where access is so restricted to necessitate lying down, provide hoists or other powered materials handling systems to eliminate the lifting requirements.
- (M&R Q 15.14 Yes)** You indicated that the screen is handled by only one hand or arm. Encourage workers to handle screens with both hands reducing asymmetric loading of the back and reducing loading at the shoulder.
- (M&R Q 15.15 Yes)** You indicated that pry bars are used to remove or replace screens. Pry bars are associated with several injuries each year especially when used with hammers. Ensure workers are using actual pry bars equipped with handles rather than screwdrivers or metal pieces. Inspect pry bars and hammers prior to use to ensure they are free from defect. Any tool with signs of damage should be removed from service immediately.
- (M&R Q 15.16 Yes)** You indicated that tools other than pry bars and sledge hammers are used to remove or replace screens. Complete the Tool Use Module, Module 14.
- (M&R Q 15.17 Yes & 15.18 No)** You indicated that workers should wear gloves but don't when removing or replacing screens. Proper fitting of gloves is essential to ensure adequate protection and functionality. Gloves should fit the hands snugly as to not create hazards. While some companies recommend the use of metacarpal gloves to reduce hand and finger injuries, it's important to be aware of their limitations. Any time the hand is protected by a glove, tactical sensitivity is reduced. As the thickness of the glove increases, dexterity decreases and grip force increases making it harder and requiring more effort to use hand tools. When possible, reduce the need for metacarpal gloves by reducing worker exposure to pinch points through the use of tools, addition of handles away from pinch points, and the use of materials handling systems to support the weight of equipment or parts such as screens during screen maintenance.

## Module 16 – Greasing

- **(M&R Q 16.2 Carried in hand)** You indicated that the grease gun is carried in the hand or in a hand-held object. Many greasing locations require workers to ascend and descend stairs, climb up and down ladders or walk along inclined walkways. In these conditions, it's essential to allow 3 points of contact for safety. This means that at any time there should be two feet and one hand supported or both hands and one foot. Three points of contact are not possible when holding an object in the hand. Provide a holster or carrier for grease guns allowing workers to maintain 3 points of contact while being able to readily access the grease gun.
- **(M&R Q 16.4 Carried in hand)** You indicated that replacement grease cartridges are carried in the hand or in a hand-held object. Many greasing locations require workers to ascend and descend stairs, climb up and down ladders or walk along inclined walkways. In these conditions, it's essential to allow 3 points of contact for safety. This means that at any time there should be two feet and one hand or both hands and one foot supported. Three points of contact are not possible when holding an object in the hand. Provide a backpack for workers to wear to transport replacement grease cartridges while performing greasing maintenance.
- **(M&R Q 16.5 Yes)** You indicated that replacement of an empty grease cartridge requires awkward postures, forceful exertions or using the body for leverage. Switch to a powered grease gun with larger storage that does not require replacement of individual cartridges. If needed, store grease filling containers near greasing locations so workers are able to refill grease guns near where they will be used.
- **(M&R Q 16.6 Yes)** You indicated that removal of a guard is required for routine greasing of equipment. Add access lines outside of the equipment, external to the guards. This allows greasing to be performed safely without removal of guards or the worker coming into contact with the hazard. This will allow the equipment to remain operational while greasing and reduce the potential for workers to go around guards while greasing.
- **(M&R Q 16.7 Yes)** You indicated that workers assume awkward postures to access grease fittings. Add or extend access lines allowing greasing to occur between knee and elbow height and without the worker needing to bend forward or reach with the arms. Additionally multiple access lines can be routed to a more central location to ensure all necessary parts are properly greased.
- **(M&R Q 16.8 Yes)** You indicated that workers have to traverse inclined walkways, climb ladders or walk up/down stairs to access grease fittings. In these conditions, it's essential to allow 3 points of contact for safety. This means that at any time there should be two feet and one hand supported or both hands and one foot. Three points of contact are not possible when holding an object in the hand. Provide a holster or carrier for grease guns allowing workers to maintain 3 points of contact while being able to readily access the grease gun.

## Module 17 – Conveyor Maintenance and Repair

- **(M&R Q 17.1 No)** You indicated that audio and/or visual startup alarms are not tested during daily inspection of conveyors. It is critical that alarms are tested to ensure that they are in proper working order and can be heard and seen clearly. Many injuries and fatalities have occurred when a conveyor started unexpectedly because either the alarm was not working properly or could not be heard in the work environment.
- **(M&R Q 17.2 No)** You indicated that the conveyor belt is not always off and locked/tagged out during maintenance. Many fatalities have occurred because the conveyor belt was still energized and operating during maintenance, or because the conveyor was not locked/tagged out properly before maintenance began. The conveyor should always be properly de-energized and locked/tagged out before maintenance.
- **(M&R Q 17.3 Yes)** You indicated that the conveyor is sometimes operating while cleaning is being performed. While sometimes it might be safe to clean near a conveyor while it is operational, it is important to recognize hazards associated with cleaning near conveyors and to safeguard workers against these hazards. A source of worker fatalities is entanglement in the conveyor (e.g., worker pulled under belt or into pulley). Ensure that workers and their tools maintain a safe distance from the conveyor in order to stay clear of the belt and pulleys, and that they never contact any moving components of the conveyor. If any cleaning is needed within reach of the conveyor or the area directly below the conveyor, ensure that the conveyor is de-energized and locked/tagged out.
- **(M&R Q 17.3.1 No)** You indicated that guarding is not always in place during cleaning around conveyors. Fatalities have occurred due to missing guards on conveyors, and cleaning should never be performed near running conveyors unless all guards are properly in place.
- **(M&R Q 17.3.2 No)** You indicated that workers do not stay clear of pulleys during cleaning around conveyors. Fatalities have occurred when workers became entangled in pulleys. If cleaning is needed near pulleys, ensure that the conveyor is de-energized and locked/tagged out.
- **(M&R Q 17.4 Yes)** You indicated that workers stand or travel underneath conveyors. Fatalities have occurred when workers are working in close proximity to conveyors, such as performing work while underneath a conveyor. If it is necessary for a worker to stand or travel underneath a conveyor, ensure that the conveyor is de-energized and locked/tagged out.
- **(M&R Q 17.5 Yes & 17.6 Yes & 17.7 Yes)** You indicated that removing or replacing rollers requires more than one person because the roller weighs over 50 lb and is difficult to bring close to the body. Team lifts are recommended when dealing with objects which may be heavy and/or awkwardly shaped. Come-a-longs also aid in manual materials handling to lift, lower and support the weight of equipment and parts. However, come-a-longs require repetitive shoulder pulling and can lead to injury. Ideally, a fully mechanized hoist should be used to assist with the maintenance of rollers which cannot be easily handled by one worker.
- **(M&R Q 17.8 Yes)** You indicated that workers stand or walk across the conveyor belt to perform roller maintenance. Discourage workers from walking across conveyor belts while performing maintenance as this often requires taking large steps which can increase the loading at the back and knees and contribute to falls. If necessary, ensure workers are wearing appropriate fall protection if there is a danger of falling. A

good rule of the thumb is to provide fall protection when working on a surface 4 ft or more in height.

- **(M&R Q 17.9)** You indicated that the workers must stand on an area more than 4 ft above the ground to access the roller. At this working height, dangers associated with fall risks are high. Ensure workers are provided fall protection, have marked tie-off locations, and have ready access to harnesses.
- **(M&R Q 17.10 Yes)** You indicated that the footing is unsafe when performing roller maintenance. Try to provide a level working surface for roller repair. Ensure the work area is clear from debris or other tripping hazards prior to starting work. When tools are used with long cables, consider suspending the cables from above to reduce their becoming a tripping hazard.
- **(M&R Q 17.11 Yes)** You indicated that removing or replacing rollers require fast movements to avoid being pinned or struck by rollers. When possible, provide a means to support the weight of the roller during maintenance so workers will not need to dodge a potentially heavy object when performing maintenance. Many finger fractures and crushing injuries occur from getting the hands caught in or struck by machine parts and tools during maintenance. If necessary, use blocking to support the weight of the roller while it is being removed or replaced. Jacks can be used to raise the roller so long as proper blocking is also used. Equipment must be blocked in all possible directions of movement, even if movement in all directions is not expected. Loads often shift during repairs, and many fatalities have occurred because unexpected movement of equipment can cause blocks to become dislodged and no longer support the equipment. When choosing blocking materials, you must consider how this material will interact with the location it is placed. Metal against metal may have decreased friction and result in the movement of the block away from its intended location; wood would be an appropriate blocking material.
- **(M&R Q 17.12 Yes & 17.13 Yes)** You indicated that removing or replacing rollers require stressful body postures and kneeling or squatting. Kneeling and squatting can increase the loading on the knee and may lead to discomfort or injury. Although allowing more mobility than kneeling, squatting can be damaging to the knee structures and should be minimized. Encourage workers to kneel upright and provide kneepads or kneeling cushions to improve their comfort when kneeling on hard surfaces. If the job requires kneeling for a prolonged period, provide stools which allow workers to sit, reducing the stress on their knees. Additionally, kneeling and squatting reduces lifting capacity making manual materials handling more difficult and more stressful for the body. In areas where posture is restricted, provide hoists or other powered materials handling systems to reduce the lifting requirements.

Handling materials in awkward postures, such as bending over, can drastically change the loads experienced by the spine. Back flexion adds to this increase in loading. When the back is bent over 30 degrees it can cause spinal forces over three times those which would be experienced handling the same load in an upright position. To prevent back injuries, consider these important safeguards:

- Keep it close. Reduce the level arm by keeping the load close to the body and removing any barrier to lifting.
- Keep the S-curve. Reduce spinal compression by maintaining an upright posture, allowing the spine to be in its natural S-curve.
- Keep it light. Reduce load weight through the redesign of jobs, use of mechanical assists devices and team lifting.

- Keep it infrequent. Reduce the frequency of lifting to enable the body to repair from manual lifting.
  - Keep it straight. Reduce the amount of twisting necessary to perform a job by changing work placement.
- **(M&R Q 17.14 Yes)** You indicated that roller maintenance requires stressful body postures and the worker must lie down. Manual materials handling should not occur while lying down. Lying down significantly reduces lifting capacity making manual materials handling more stressful for the body. High stresses may be placed on the back as well as the shoulders and discomfort or injury risk will increase. In areas where access is so restricted to necessitate lying down, provide hoists or other powered materials handling systems to eliminate the lifting requirements.
- **(M&R Q 17.15 Yes)** You indicated that pry bars are used to remove or replace rollers. Pry bars are associated with several injuries every year especially when used with hammers. Ensure workers are using actual pry bars equipped with handles rather than screwdrivers or metal pieces. Inspect pry bars and hammers prior to use to ensure they are free from defect. Any tool with signs of damage should be removed from service immediately.
- **(M&R Q 17.16 Yes)** You indicated that torches are used to remove or replace rollers. Torches are commonly used when roller frame rust onto the conveyer structure, making removal through powered tools or hand tools impossible. To reduce this occurrence and improve maintainability of rollers, consider using corrosion-resistant (e.g., stainless steel) bolts, washers, and nuts and an appropriate thread lubricant which will resist corrosion.
- **(M&R Q 17.17 Yes)** You indicated that tools other than pry bars and sledge hammers are used to remove or replace rollers. Complete the Tool Use Module, Module 14.
- **(M&R Q 17.18 Yes & 17.19 No)** You indicated that workers should wear gloves but don't when removing or replacing rollers. Proper fitting of gloves is essential to ensure adequate protection and functionality. Gloves should fit the hands snugly as to not create hazards. While many companies are recommending the use of metacarpal gloves to reduce hand and finger injuries, it's important to be aware of their limitations. Any time the hand is protected by a glove, tactile sensitivity is reduced. As the thickness of the glove increases, dexterity decreases and grip force increases making it harder and requiring more effort to use a hand tool. When possible, reduce the need for metacarpal gloves by reducing worker exposure to pinch points through the use of tools, addition of handles away from pinch points, and the use of materials handling systems to support the weight of equipment or parts such as rollers during roller maintenance.



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