MODULE NUMBER 12
OF
INSTRUCTION GUIDE NUMBER 43

ON-THE-JOB TRAINING MODULES
FOR
SURFACE METAL AND NONMETAL MINES

FIELD MAINTENANCE OF SURFACE MACHINERY

This module describes the basic job steps, potential hazards or accidents, and recommended safe job procedures for field maintenance of surface metal and nonmetal mining machines.

Good preventive maintenance and repairs are essential to the safe, productive, and economical operation of surface machinery. Many maintenance and repair operations can be performed at the job site, without the necessity of removing the machine to a shop.

Field maintenance is performed by such personnel as mechanics, electricians, and their helpers; and by greasers or oilers, and the operators of various machines. Maintenance/repair work may involve:

1. Inspecting, troubleshooting, evaluating condition
2. Towing
3. Deenergizing, securing, releasing pressure
4. Removing and replacing guards or safety devices
5. Lubrication
6. Manual or powered materials handling
7. Use of hand and power tools
8. Welding and cutting
9. Changing component parts
10. Inspecting and testing completed work

Maintenance work is hazardous in comparison to other surface mining jobs. Mechanics and helpers have among the highest, if not the highest, rate of nonfatal injuries at surface mines. Common types of accidents involve material handling, suspended loads, hand and finger injuries, falling material, caught by moving or falling equipment, flying objects, slipping or broken tools, and caught between objects.

The underlying causes of maintenance accidents involve both the nature of the work and the attitudes and circumstances surrounding the work. If machines are inoperative and production must cease until repairs are made, there may be pressure (either conscious or subconscious) to take shortcuts and work hurriedly. Sometimes machine operators or others may attempt repairs they are not qualified to perform. Poor communication with co-workers, and assuming too much about what co-workers will or will not do, cause many maintenance accidents. Maintenance workers should be the first to admit they don't understand something, and should not hesitate to ask machine operators, or others, for help. Experienced maintenance workers must guard against overconfidence. Having gotten away with taking a chance in the past is no indication that good luck will continue.

Hazards inherent in maintenance work include a great deal of material handling, both manual and powered. Maintenance personnel must wear protective equipment and utilize proper lifting and moving procedures to prevent manual handling injuries. They must know

and exercise safe inspection and operational procedures for any powered handling equipment they may be using, such as truck cranes. Improperly used and poorly maintained hand and power tools cause many maintenance injuries. Maintenance people must inspect, maintain, and properly use their tools as well as the larger equipment they work on. Without proper tools, repairs are more difficult and the risk of injury is increased.

Unsafe position is a cause or contributing factor in many maintenance accidents. The safest way in which to position oneself during various steps of the job is not always obvious. Certainly one should not position any part of the body under suspended or raised loads which are not properly blocked or mechanically secured. Each maintenance or repair situation requires thought, however, as to what could slip, shift, break, or otherwise move and in what direction the movement could occur. Then a conscious effort is required to remain out of line of potential movement or pinch points.

Field maintenance operations are so numerous and varied that it is impossible for this module to contain specific procedures for each task. Instead, an attempt is made to include general procedures and precautions which may be applied to most maintenance tasks.

The basic job steps included in this module are:

1. Travel to machine in need of repair or maintenance.
2. Be sure machine is properly parked and secured.
3. Evaluate condition.
4. Tow machine (or have towed) if necessary.
5. Get on and off mobile equipment.
6. Perform repairs.
7. Remove and replace component parts as needed.
8. Perform routine maintenance and lubrication.
9. Replace all guards and shields and restore all safety devices.
10. Inspect and test completed work.

Note: Refer to Module 13, "Welding and Cutting"; Module 14, "Inspecting and Replacing Wire Ropes (Cables)"; Module 16, "Manual Handling of Materials"; and Module 17, "Prevention of Slip and Fall Accidents" as needed during OJT of maintenance personnel.

The following safe job procedures will help minimize incidents which may cause injuries and adversely affect production:

Required and/or recommended personal protective equipment

Hard hat, safety shoes, safety glasses with side shields, gloves, snug fitting clothing appropriate for weather conditions, hearing protection where needed

SEQUENCE OF BASIC JOB STEPS	POTENTIAL ACCIDENTS OR HAZARDS	RECOMMENDED SAFE JOB PROCEDURES
1. Travel to machine in need of repair or maintenance.	1. A) Slipping or tripping, flying objects such as dirt or splashed fluids, caught in pinch points.	1. A) Conduct a pre-shift inspection of the vehicle to include slipping and tripping hazards, tires and wheels, surrounding area for people or obstructions, engine compartment, fluid levels, leaking or broken hoses and lines, fire extinguisher, steps, cab, windows and mirrors, seat belts, instruments and gauges, horn, engine operation, wipers and lights, and brakes and steering.
	B) Collisions, loss of control.	B) Follow traffic rules and adjust speed for conditions.
	C) Being struck or run over by heavy machines, caught in moving machinery.	C) Be sure machine operator is aware of your presence by visual contact, radio, or other means.
	D) Being struck or run over by heavy machines, runaway vehicle.	D) Park well in the clear of operating machines. Set parking brake. If on a grade, block wheels or turn into bank.

SEQUENCE OF BASIC JOB STEPS	POTENTIAL ACCIDENTS OR HAZARDS	RECOMMENDED SAFE JOB PROCEDURES
2. Be sure machine is properly parked and secured.	2. A) Caught by rolling machine, crushed by falling buckets, etc.	2. A) See that buckets, bowls, etc. are lowered. Verify that parking brake is set and controls are in the neutral or shutdown position.
	B) Machine rolling during repair, operations disrupted.	B) Select a safe and easily accessible location (if possible). Mobile equipment that can be moved should be repaired on level ground out of the way of other operations. Advise others of your intentions.
	C) Rock fall or slide.	C) Reposition machine as necessary to avoid working between machine and the pit wall or bank where escape may be hindered.
	D) Caught by rolling machine.	D) Block wheels securely, especially if on a grade or if maintenance operation could possibly cause release of brakes, transmission, etc. Keep yourself to the side when installing and removing wheel blocks.

SEQUENCE OF BASIC JOB STEPS	POTENTIAL ACCIDENTS OR HAZARDS	RECOMMENDED SAFE JOB PROCEDURES
2. (Continued)	E) Struck by falling equipment, falling from raised equipment, inadequate blocking.	E) Lower any raised parts which can be lowered. If necessary to perform work on top of, under, around, or from a raised piece of equipment, block or mechanically secure the equipment to prevent accidental rolling, falling, or lowering. Good blocking materials for most purposes include solid banks, berms, wooden crib blocks, solid concrete blocks, or specially designed locking devices, pins, etc. Cinder blocks are inadequate for many purposes.
	F) Shock, electrocution, caught in moving parts if equipment is started.	F) Power switches must be locked out and tagged before electrical or mechanical work is to be done on electrically powered equipment.
	G) Someone starting machine while repairs are underway.	G) Place warning tags on steering wheel or other prominent location, and remove ignition key.
	H) Slips and falls, rock falls or slides, fires.	H) Visually inspect work area for potential hazards. Remove debris and combustible material from job site.

SEQUENCE OF BASIC JOB STEPS	POTENTIAL ACCIDENTS OR HAZARDS	RECOMMENDED SAFE JOB PROCEDURES
2. (Continued)	I) Struck by moving machine, caught in moving parts.	I) If equipment must be running or moving to evaluate condition, or to complete certain portions of the repair, exercise extreme caution and have good communications with everyone involved.
3. Evaluate condition.	3. A) Being struck by or caught in machinery.	3. A) If watching machine in operation, have good communications with operator and stay in a safe position.
	B) Loss of control, striking others with machine, machine damage.	B) Do not operate machine unless you are properly trained and qualified to do so.
	C) Caught in moving machinery, shock, electrocution.	C) Do not perform repairs or maintenance until the power is off and the machinery is locked out and tagged and blocked against motion, except where machinery motion is necessary for trouble-shooting, or to make adjustments.
	D) Caught in moving machinery, shock, electrocution.	D) Lock out and block against motion before guards or covers are removed from moving parts or electrical circuitry.

SEQUENCE OF BASIC JOB STEPS	POTENTIAL ACCIDENTS OR HAZARDS	RECOMMENDED SAFE JOB PROCEDURES
4. Tow machine (or have towed) if necessary.	4. A) Runaway machine, loss of control.	4. A) Obtain assistance as needed for towing. Be sure the vehicle used is large enough and powerful enough to handle the job.
	B) Loss of control.	B) Do not operate any towing machine you are not trained and qualified to operate.
	C) Loss of control after machine is returned to service.	C) When towing requires disabling any failsafe brake systems or other safety devices, be sure they are restored to operative condition before the machine is returned to service.
	D) Failure of towing attachment, runaway machine.	D) If a machine must be towed, a properly sized tow bar or equivalent must be used. Unless steering and braking are under the control of an operator on the towed machine, a suitable safety chain or wire rope must be used along with primary rigging. Use proper connecting links to attach tow bar. Connections should be of soft (not brittle) steel which will bend or stretch, rather than break, upon impact.
	E) Tow bar failure, equipment damage.	E) Use a smooth, steady pull when towing. Do not snatch and jerk machine.

SEQUENCE OF BASIC JOB STEPS	POTENTIAL ACCIDENTS OR HAZARDS	RECOMMENDED SAFE JOB PROCEDURES
4. (Continued)	F) Loss of control, machine damage.	F) Watch contour of ground carefully when towing. Use of makeshift towing equipment should be avoided.
5. Getting on and off mobile equipment.	5. A) Slips and falls.	5. A) Maintain access areas, ladders, etc. free of excess oil and grease.
	B) Fall from higher level, clothing caught on control levers or other projections.	B) Wear personal protective equipment (proper footwear) and snug fitting clothing. Keep steps and boots free of mud, ice, snow, grease, and oil.
	C) Falling to same level.	C) Do not get on and off moving equipment.
	D) Falls, strains.	D) Use proper techniques for mounting and dismounting.
	E) Falling while climbing ladder.	E) Use belt hooks, pockets, etc. to carry material up ladders and keep both hands free for climbing. Ropes can be used to hoist bulkier items. Face ladder and use three points of contact when climbing (two hands and one foot, or two feet and one hand, in contact with ladder at all times). Use handholds and select firm footing. Avoid haste and projections.
	F) Fall from higher level.	F) Do not use machinery as work platform.

SEQUENCE OF BASIC JOB STEPS	POTENTIAL ACCIDENTS OR HAZARDS	RECOMMENDED SAFE JOB PROCEDURES
5. (Continued)	G) Equipment failure.	G) Report and/or repair damage to access components.
6. Perform repairs.	6. A) See Job Step No. 2.	6. A) Be sure machine is properly parked and secured (see Job Step No. 2).
	B) Personal injury from improper procedure.	B) Machine operators should not attempt repairs or maintenance they do not understand and are not trained to do.
	C) Whipping of pressurized hoses when disconnected, burns from hot hydraulic fluid, mechanical movement caused by release of pressure.	C) Ensure that pressure is relieved from air and hydraulic systems before any attempt to disconnect or repair hoses, cylinders, motors, etc.
	D) Fall to a lower level.	D) Use safety belt or harness and line where there is a danger of falling (when work must be done at an elevated location unprotected by railings).
	E) Injury or equipment damage from use of improper tools.	E) Select, inspect, and use the proper tools for the job. Do not use tools with mushroomed heads, loose or cracked handles, etc.

SEQUENCE OF BASIC JOB STEPS	POTENTIAL ACCIDENTS OR HAZARDS	RECOMMENDED SAFE JOB PROCEDURES
6. (Continued)	F) Persons below being struck by falling objects, trips and falls.	F) Do not leave tools or other objects lying around loose where they could fall on someone. Rope off area, use screens, etc., if necessary, for adequate protection of those working or passing below. Do not leave tools or other objects lying around in walkways.
	G) Strains, sprains, dropping parts.	G) Utilize any substantial work stands or platforms available to minimize reaching and lifting.
	H) Machine damage, personal injury.	H) Follow company and manufacturer's policy, procedures, and safety rules for the specific repair being made.
	I) Premature failure of machinery.	I) Follow manufacturer's recommendations for replacement parts, fluids and lubricants, torque values, etc.
	J) Dirt falling into electrical boxes or mechanical parts.	J) Clean and inspect cover plates before removal.
	K) Crushed fingers or hand.	K) Keep hands, fingers, and other parts of body out of pinch points.
	L) Burns, getting fluids in eyes.	L) Avoid burns from hot bearings, hot hydraulic fluid, etc. Allow to cool if possible. Wear gloves where possible. Wear safety glasses.

SEQUENCE OF BASIC JOB STEPS	POTENTIAL ACCIDENTS OR HAZARDS	RECOMMENDED SAFE JOB PROCEDURES
6. (Continued)	M) Hand injuries, damaging bolt heads or threads.	M) When using a wrench, seat it firmly and use steady controlled force. Avoid jerking the wrench.
	N) Flying objects in eyes.	N) Always wear safety glasses when striking objects with a hammer.
	O) Cuts, scrapes, bruises.	O) Wear gloves to handle metal parts and when using tools.
	P) Injuries or unsuccessful repairs because of lack of communication.	P) Maintain good communication with all co-workers. Tell them what you're about to do if it could cause machine movement or other hazards.
	Q) Struck by moving machinery or ropes.	Q) Assume a safe position out of direct line of potential motion of parts. Do not position yourself in the inside radius or in direct line of wire ropes being used for pulling.
	R) Skin cancer.	R) Avoid excessive skin contact with lubricants, especially penetrating oil. Use of barrier creams, waterless hand cleaner, or soap and water can minimize this hazard.

SEQUENCE OF BASIC JOB STEPS	POTENTIAL ACCIDENTS OR HAZARDS	RECOMMENDED SAFE JOB PROCEDURES
6. (Continued)	S) Electrocution, burns, equipment failure.	S) Be sure all electrical equipment, switches, breakers, controls, panels, guarding, etc., is in proper operating position and in good condition. Never perform any electrical work or enter any energized electrical panels or cabinets unless you are qualified. Be sure to lock out and tag the equipment or circuit.
	T) Shock, equipment damage.	T) Use properly sized and rated material for the job, such as fuses and connectors.
	U) Personal injury, equipment damage.	U) Never bridge or jumper out any safety device.
	V) Electric shock, equipment damage or unexpected movement.	V) Never change wiring from the original prints or schematics.

SEQUENCE OF BASIC JOB STEPS	POTENTIAL ACCIDENTS OR HAZARDS	RECOMMENDED SAFE JOB PROCEDURES
6. (Continued)	W) Struck by exploding lock ring or other parts of rim, crushed under weight of wheel assembly, strains, sprains	W) Use extreme caution when working with tires and multi-piece rims. 1. Completely deflate tires by removal of the valve core: a) before removal from machine, b) before dismounting, c) when the tire has been driven under-inflated at 80% or less of its recommended pressure, and/or d) when there is obvious or suspected damage to the tire or wheel components. 2) Be sure components are properly matched and undamaged. 3) Use inflation cages, long inflation hoses, adequate lifting and handling and dismounting tools. 4) Do not attempt to correct the seating of side and lock rings by hammering, striking or forcing the components while the tire is pressurized. 5) Stay out of the potential path of an exploding wheel assembly as much as possible during your work.

SEQUENCE OF BASIC JOB STEPS	POTENTIAL ACCIDENTS OR HAZARDS	RECOMMENDED SAFE JOB PROCEDURES
7. Remove and replace component parts as needed.	7. A) Strains, sprains, ruptures, overexertion.	7. A) Use proper lifting procedures (see Module 16, "Manual Handling of Materials"). Obtain help when load may be too heavy.
	B) Failure of lifting device.	B) Carry and use lifting devices - jacks and hoists - to the extent possible, to avoid manual lifting. Inspect these devices regularly.
	C) Struck or caught by component falling off unexpectedly.	C) Be sure component being removed is secured or blocked as last bolts or nuts are removed.
	D) Strains, sprains, crushed or lacerated fingers.	D) Before removing a part, be sure it does not weigh more than you can handle. Stand in close to the part and be sure of good footing. Get help in advance if you think it may be needed.
	E) Failure of hoist or rigging.	E) Stay clear of suspended loads.
	F) Caught between hoisted load and stationary object.	F) Use taglines when hoisted objects require steadying or guidance. Stay out of confined areas where you could be caught between a swinging load and a stationary object.
	G) Crushed hand or fingers.	G) Keep hands and fingers clear of pinch points when lowering or placing parts.

SEQUENCE OF BASIC JOB STEPS	POTENTIAL ACCIDENTS OR HAZARDS	RECOMMENDED SAFE JOB PROCEDURES
8. Perform routine maintenance and lubrication.	8. A) Machine damage, unscheduled downtime.	8. A) Perform scheduled preventive maintenance on all machinery in accordance with company policy and/or manufacturer's recommendations.
	B) Various hazards depending on specific job.	B) Some items which are commonly involved in routine maintenance and inspection schedules for mobile equipment include: 1) engine oil 2) tire condition 3) windshield washer level and wipers 4) lights 5) fan belts 6) coolant level 7) battery 8) fire extinguisher 9) emergency flares 10) first aid kit 11) all filters 12) brake adjustments 13) wheel balance and alignment 14) linkages greased 15) backup alarm
	C) Caught in moving machinery.	C) Do not lubricate moving equipment where any hazard exists, unless extended fittings or cups are provided. Otherwise, shut it down, lock it out, and block against motion.

SEQUENCE OF BASIC JOB STEPS	POTENTIAL ACCIDENTS OR HAZARDS	RECOMMENDED SAFE JOB PROCEDURES
9. Replace all guards and shields and restore all safety devices.	9. A) Caught in moving parts, equipment damage.	9. A) Secure all guards, covers, and shields which protect people and equipment.
	B) Fire hazard, slipping hazard.	B) Remove any accumulations of oil and grease.
	C) Losing tools or equipment, trips and falls, struck by falling objects.	C) Be sure tools, old parts, or other objects are returned to proper storage or disposed of. Be especially careful not to leave objects in walkways or at elevated locations. Keep tools clean.
10. Inspect and test completed work.	10. A) Equipment failure, unguarded machinery, tripping hazards, losing tools.	10. A) Inspect completed work to ensure that all bolts are tightened, guards replaced, tools removed, etc.
	B) Machine damage if started with blocking in position.	B) When job is complete, remove blocks, remove locks and tags, and restore power.
	C) Machine reacting in an unexpected manner.	C) Operator should be at the controls of the machine. Other workers or observers should position themselves in a safe area before any operation of the machine. Once the machine reaction has been determined, further testing may continue.

SEQUENCE OF BASIC JOB STEPS	POTENTIAL ACCIDENTS OR HAZARDS	RECOMMENDED SAFE JOB PROCEDURES
10. (Continued)	D) Improper operation, inoperative safety devices.	D) A final test of proper operation should be given to the equipment, including proper grounding system if applicable, before the equipment is put back into service.
	E) Recurrence of preventable damage or repairs.	E) Discuss potential causes of the damage, if applicable, with machine operators or others to prevent recurring repairs.
	F) Disrupting work schedule.	F) Notify other workers and foreman that equipment is repaired and is returning to service.
	G) Machine damage from lack of maintenance, performing unnecessary maintenance due to lack of records.	G) Keep proper maintenance records.

GENERAL INFORMATION

This module is part of an Instruction Guide that was developed to assist the surface metal and nonmetal mining industry in conducting effective on-the-job training (OJT) of new employees, or employees reassigned to different jobs. The use of training materials, such as this module, is an important part of an effective, systematic, OJT program.

This Instruction Guide uses a generic Job Safety Analysis (JSA) of jobs common to the industry. The JSA format facilitates uniform basic training in safe job procedures, while requiring only a minimum of time and effort on the part of the trainer. This material is generic to the industry; therefore, each company using this guide will need to tailor the material somewhat to fit their particular requirements. In some cases, the material must be general in nature, and will not include specific details of procedures or equipment that must be taught by the trainer.

Recommendations for an overall OJT program are contained in the Mine Safety and Health Administration (MSHA) guide: "Structuring Effective On-The-Job Training Programs," June, 1983.

TRAINING RECOMMENDATIONS

On-the-job training is usually best done by the employee's immediate supervisor. If the supervisor relies on another employee to do certain parts of the training, the supervisor should be present to monitor the training. OJT is conducted at the actual job site where the work will be done.

The supervisor/trainer should use the training materials (this module, or other materials) while the training is being done, to help ensure that all job steps are covered, and that no important safety precautions are omitted. Effective OJT should begin with an explanation (lecture and/or discussion) of the safe job procedure. The explanation should be followed by a hands-on demonstration of the proper job procedure. A good demonstration is, perhaps, the most important part of OJT. The demonstration is followed by supervised practice, during which the supervisor/trainer coaches (corrects and encourages) the employee, and evaluates when the employee is ready to do the job without direct supervision.

The first step – explaining the job to the employee – can be done in different ways. The supervisor/trainer and the employee can sit down and go through the training materials together. It may be advantageous to provide the employee with a copy of the training modules that are applicable to his/her job. The fact that most of the training is conducted at the job site does not preclude the use of a classroom or a quiet office for the first part of the training. Any general theory or knowledge training, as well as the initial explanation of the job procedure, may be best done in an office/classroom setting; especially when noise levels, or other conditions at the job site, make communication difficult. A complete series of job steps could be presented through the use of slides developed at the mining operation.