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# MSHA Handbook Series

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## **DUMP-POINT INSPECTION HANDBOOK**

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# **DUMP-POINT INSPECTION HANDBOOK**

## **PREFACE**

This handbook provides guidance to assist inspectors in performing safety inspections of the conditions and practices at points where material is dumped from trucks. This includes stockpiles, waste piles, spoil piles, and hoppers. Some of the dump-point practices recommended in this handbook are not covered by the standards but the information is included so that it can be shared with miners and mine operators to improve the safety of dumping operations. The handbook is intended to serve as an aid to personnel in both Metal and Nonmetal Mine Safety and Health and Coal Mine Safety and Health.

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## CHAPTER 1 - INTRODUCTION

### A. Purpose

Dumping material from trucks is a common practice in the mining industry. No matter what type of dump point is involved, a waste pile, an overburden dump, a stockpile, or a hopper, accidents can occur if certain precautions are not taken. The intent of this handbook is to provide MSHA inspection staff with the information needed to understand the hazards at dump points, and to better recognize potentially unsafe dump-point conditions and practices. In addition, the handbook can assist inspectors in sharing information on dump-point safety with miners and mine operators.

#### **Regulations:**

The standards related to dump points, in both Coal and Metal/Nonmetal, are summarized in each chapter. For easier reference, this information is always placed in a box like this one. **Parts 56, 57 and 77 of the Code of Federal Regulations should be consulted for the complete standards.**

Appendix D of this handbook contains a listing of “Dump-Point Safety: Best Practices.” This information may be useful for inspectors to quickly review the main safety points covered in this handbook, or as the basis for a brief safety talk on dump-point safety.

### B. Authority

The Federal Mine Safety and Health Act of 1977 requires that authorized representatives of the Secretary of Labor make mine inspections and investigations for the purpose of determining whether there is compliance with the mandatory safety standards and for disseminating information related to safety conditions.

### C. Responsibility

The Administrators for Coal Mine Safety and Health and Metal and Nonmetal Mine Safety and Health have primary responsibility for enforcing the Mine Act and Title 30 of the Code of Federal Regulations (30 CFR). This responsibility ultimately rests with the authorized representatives (ARs) - mine inspectors, specialists, and their supervisors. The ARs are responsible for conducting mine inspections which include evaluating the safety of the conditions and practices at dump points.

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## CHAPTER 2 - DUMP POINTS

### A. Potential hazards at dump points

Accidents can occur for various reasons at dump points. The most common fatal dump-point accidents involve trucks going over the edge of piles. Accidents may occur because of unsafe dump-point conditions, unsafe dumping practices, or from some combination of the two.

Some unsafe-dump-point conditions include:

**-no berm or restraint, or an inadequate berm or restraint.** Makes the edge location difficult to judge; offers inadequate restraint to keep a vehicle from going over the edge.

**-a berm that's too narrow** at the base. Allows the heavy loading of the truck to get so close to the edge of the pile that the edge material may not be strong enough to support the weight.

**-an edge of a pile that has been weakened** because the pile has been loaded-out at the toe and over-steepened. Edge material may not be able to support the truck weight, in addition to its own weight. A portion of the berm may have sloughed off reducing the berm's capability to provide restraint.

**-an edge of a pile that has been undercut.** Overhanging conditions can be created especially when the pile material is frozen, or has sat for an extended period of time.

**-cracks, settlement, or a slide near the edge** of the pile. Means the edge may be unstable and may not support the additional truck weight.

**-a soft area near the edge** of the pile. May cause tires to sink in and the truck to tip over as it attempts to dump.

**-a pile that runs downgrade to the berm.** Gives drivers less control while backing, and can soften the dump area from poor drainage.

**-a pile that's placed on a soft or weak foundation.** As the pile gets larger, the slope may become unstable due to the foundation giving away underneath the pile.

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**-inadequate illumination** for nighttime operations, or **poor visibility** during inclement weather. Makes driver judgements, and detection of unsafe conditions, more difficult.

**-inadequate clearance** between equipment and overhead power lines. Two particular concerns are that truck beds are raised at dump points, and as piles get larger the clearance may be gradually reduced.

Some unsafe equipment practices at dump points include:

**-attempting to dump over the edge of the pile even though there's no berm**, or the berm is inadequate.

**-attempting to dump over the edge even though the area below the dump point has been loaded-out** and made steeper than the material's angle of repose.

**-attempting to dump over the edge in an area where there are cracks.**

**-backing up at an angle to the edge.** The driver may not realize that the rear tires opposite the driver's-side are closer to the edge than intended, or have gone through the berm.

**-hitting into the berm** when positioning to dump. Using the berm to help stop the truck creates the risk that the vehicle may go through the berm or cause the berm to give way.

**-running the rear tires up onto the berm** so that material can be dumped over the berm. Can cause the berm to give way, or cause the truck to go through the berm.

**-jamming on the brakes** while backing near the edge of a pile. Puts additional forces pushing down and out on the top of the pile which can cause the edge to give way.

**-raising the bed too high when the material sticks in the bed.** As the bed is raised, the truck can become unstable and tip over.

**-operating equipment while not wearing the seat belt.**

**-using a truck with defective brakes.**

**B. Procedures for examining dump points**

It is critically important that dump locations be examined for unsafe conditions. Dump-point conditions can change due to such factors as new material being dumped, the operation of equipment near the dump point, weather conditions, or even just the settling-in of material with the passage of time. In stockpiles, a big factor affecting dump-point conditions is the loading-out of material from the toe of the pile.

**Metal and Nonmetal:**

Section 56/57.9304 (a) requires that dumping locations be visually inspected prior to work commencing and as ground conditions warrant.

Section 56/57.3401 requires that persons experienced in examining and testing for loose ground be designated by the mine operator. Appropriate supervisors, or other designated persons, are to examine, and where applicable, test ground conditions in areas where work is to be performed prior to work starting, after blasting, and as ground conditions warrant during the work shift. Highwalls and banks adjoining travelways are to be examined weekly or more often if changing ground conditions warrant.

Section 56/57.18002 requires, in part, that: (a) a competent person examine each working place at least once each shift for conditions which may adversely affect safety and that the mine operator promptly initiate appropriate action to correct such conditions; (b) a record of the examination be kept for one year; and (c) conditions that may present an imminent danger be brought to the attention of the mine operator, and that all persons be withdrawn from the affected area.

**Coal:**

Section 77.1713 requires, in part, that: (a) at least once during each working shift, and more often if necessary for safety, each active work area be examined by a certified person for hazardous conditions, and any hazardous conditions be reported to the operator and corrected; (b) the operator withdraw persons from any area where a hazardous condition creates an imminent danger; (c) a written report be made of the conditions found; and (d) a report be made of the action taken to abate any hazardous conditions.



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**Coal:**

Section 77.1004 requires, in part, that (a) highwalls, banks, benches and terrain sloping into the working areas be examined after every rain, freeze, or thaw before men work in such areas; and (b) overhanging banks be taken down and other unsafe ground conditions be corrected promptly, or the area be posted.

During your inspection, observe how the dump point is examined, and discuss with the supervisor and dump-point workers what steps they take to check for and correct unsafe conditions. Be especially mindful of the following:

- < Before dumping begins, and throughout the shift, equipment operators and their supervisors should routinely check the dump area for unsafe conditions, such as cracks, inadequate berms, unstable material on the slope below the dump point, or a loaded-out slope below the dump point. Such conditions should be promptly reported and corrected.
- < Check with supervisors to see if they routinely observe dumping operations to make sure that unsafe practices are not being used. The dump supervisor has the key responsibility to ensure that safe work practices are maintained. Even an experienced equipment operator can lapse into using poor work practices. Emphasize that the margin for error at dump points can be small, so dump-point operations need to be looked after regularly to ensure that safe operations are maintained.
- < Once a truck is backing to a dump point, it is difficult for the driver to detect unsafe conditions. So encourage mine operators to route trucks to the dump area in a way that provides the drivers with the best opportunity to routinely observe and examine the dump area before they begin to back toward the dump point.
- < With the large blind spot to the right side of haulage trucks, the dump area can be most readily examined if it is to the driver's left side as the driver makes the turn before backing to dump. This is why some mines "drive left" on their dump sites.
- < On many dumps a dozer operator has responsibility for maintaining the dump area and the berm. This operator should know to be alert to unsafe dump-point conditions, report them to the dump supervisor, and take action to either correct them or barricade the hazardous area.
- < On stockpiles, the front-end loader operator who loads material out from the toe

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of the pile is often in a good position to observe when unsafe conditions develop and inform the dump supervisor.

### **C. Training received by mine personnel on dump-point hazards**

During your inspection, determine whether adequate and appropriate training on dump-point hazards has been provided to dump point workers.

#### **Metal and Nonmetal:**

Section 56/57.18006 requires that new employees be indoctrinated in safety rules and safe work procedures.

#### **Coal:**

Section 77.1708 requires, in part, that each mine operator establish and maintain a program of instruction on, and post and distribute to each employee, the safety regulations and procedures to be followed at the mine.

Section 77.1709 requires that new employees be indoctrinated in safety rules and safe work procedures, and that inexperienced employees not be assigned to work duties until they have been trained thoroughly in safe work procedures related to the assigned duties.

With regard to dump-point training, keep the following in mind:

Equipment operators and their supervisors need to know what unsafe conditions and practices to look for when they examine dump points and dumping operations. For dump-point workers, this information needs to be covered in the portions of the Part 48 miner training dealing with hazard awareness, ground control, and safe-operating procedures. Training is required for new miners (Section 48.25), for certain experienced miners (Section 48.26), and for miners assigned to a task in which they have had no previous experience (Section 48.27). Requirements for annual refresher training are contained in Section 48.28.

Part 46 Mines Only (Surface mines only - sand & gravel, stone, clay, limestone, marble, sandstone, slate, shale, traprock, kaolin, cement, feldspar, lime, shell dredging, and colloidal phosphate). Equipment operators and their supervisors need to know what unsafe conditions and practices to look for when they examine dump points and dumping operations. For dump-point workers, this information needs to be covered in the portions of Part 46 miner training dealing with hazard awareness, ground control, and safe

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operating procedures. Training is required for new miners (Section 46.5), for newly hired experienced miners (Section 46.6) and for miners assigned to a task where he or she has no previous work experience (Section 46.7). Requirement for annual refresher training are contained in Section 46.8. Additionally, this training may be required for site-specific hazard awareness training (Section 46.11).

- < Specifics on the potentially unsafe conditions that dump-point workers should be aware of are discussed in this handbook and a listing of dump-point “Best Practices” is provided in the Appendix.
- < Because conditions can change quickly, it’s important that mine personnel know to look for unsafe conditions both before any work begins, and throughout the shift. And they should know that any problems need to be reported to the dump supervisor and corrected before dumping operations begin, or are resumed.
- < **The single most important point that dump-point workers should know is that if there is any question or uncertainty about the safety of the dump point, then material should be dumped one-truck length back from the edge, or back from any cracks, and then pushed over.** Dumping short of the edge or moving to another location when potentially unsafe conditions exist would prevent the vast majority of serious dump-point accidents.
- < Where trucks dump into hoppers, it is important that truck drivers and other workers are aware of the danger of walking on the material in the hopper. They could be drawn into the material either as it feeds or as bridged material collapses.

Share with mine operators the list of dump-point related training materials available from MSHA. A listing is included in the Appendix of this handbook.

### **D. Dump-point berms or restraints**

The size and weight of haulage trucks, combined with the limited visibility from the cab, makes the job of backing a truck to a dump point potentially hazardous. Yet this is a common activity, done thousands of times a day in the mining industry. To prevent a mishap, it is important that adequate berms or other restraints be provided at dump points.

#### **Metal and Nonmetal:**

Section 56/57.9000 defines “berm” as a pile or mound of material along an elevated roadway capable of moderating or limiting the force of a vehicle in order to impede the

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vehicle's passage over the bank of the roadway.

### **Metal and Nonmetal:**

Section 56/57.9301 requires that berms, bumper blocks, safety hooks, or similar impeding devices be provided at dumping locations where there is a hazard of overtravel or overturning.

### **Coal:**

Section 77.1605 (l) requires that berms, bumper blocks, safety hooks, or similar means be provided to prevent overtravel and overturning at dumping locations.

Section 77.2 defines "berm" as a pile of material capable of restraining a vehicle.

Earthen berms are normally used to provide restraint for dumping near the edge of a pile, while bumper blocks are typically used at hoppers. To prevent overtravel of the dump point, the restraint needs to:

1. Provide a good visual indicator of the location of the dump point, or edge of the pile;
2. Provide the driver with a "contact" point so that if necessary he/she can "feel" that the berm or restraint has been reached; and
3. Be substantial enough to provide restraint or to impede equipment from going over the edge in the event of a misjudgement, operational error, or mechanical problem.

During your inspection, check that the earthen berms appear to be adequate to serve these functions. To do so, they need to be **at least** mid-axle height of the largest piece of equipment that will use the dump area. While the adequacy of a berm is normally judged based on the mid-axle-height criterion, it should be recognized that it only sets a *minimum* value for berm height. It is good practice to provide as large a berm as is practical, and operators should realize that the effectiveness of a berm depends not just on its height but also on its thickness and firmness.

To offer adequate restraint, earthen berms should be firm enough that they are not easily penetrated by tires, and they should have a steep inside slope. Berms constructed of broken rock will normally offer adequate restraint due to the interlocking and frictional resistance of the rock pieces. A berm that is constructed of loose, fine-grained material will normally offer less restraint. If berms are constructed using only fine-grained material, then to compensate either the berm material should be compacted, or larger berms should be constructed.

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The inside slope of a berm should be steep to prevent the tires from too easily climbing up and going over the berm. If the inside slope of a berm is cut to steepen it, operators should ensure that a sufficient amount of berm material is initially placed so that after the berm is cut, it will still have an adequate base-width. The base-width should be at least the width that an axle-height berm would have, if both its outside and inside slopes were at the material's angle of repose.

You should check that there are procedures in place to keep adequate berms constructed at dump points. Also check whether truck drivers know what to do if a dump point doesn't have an adequate berm. They should know to dump back from the edge, or to dump in another area where an adequate berm has been provided. Check that the dozer operator who is responsible for maintaining the dump area knows the requirements for a safe dump point and knows what action to take if there is cracking, settling, or a soft area, near the edge.

When a truck dumps into a hopper, the concern is that an adequate bumper-block be in place. The block should be sturdy and of sufficient height to offer definite restraint. Observe the dumping operations, and if there is any tendency for a truck's tires to ride up over the bumper block, its height should be raised. Check that the bumper block appears adequate for the piece of equipment with the largest tires that will use the dump point. A concern to watch for at a bumper block is that spillage may accumulate in front of it, and effectively reduce the height of the block. Mine personnel should check for this condition during workplace examinations, and remove accumulated material as necessary to maintain adequate bumper-block height.

### **E. Stability of the edge of a pile**

Anytime that heavy equipment is operated near the edge of a slope, there is concern for whether the edge material will be able to support the equipment. This is especially a concern on dumps and stockpiles where the material is normally in a relatively loose condition and the side-slope is steep. This section is intended to assist you in understanding and evaluating dump-point edge-stability conditions that you observe during your inspection.

#### **Metal and Nonmetal:**

Section 56/57.3130 requires that mining methods be used that will maintain wall, bank, and slope stability in places where persons work or travel in performing their assigned tasks. When benching is necessary, the width and height are to be based on the type of equipment used for cleaning of the benches or for scaling of the walls, banks, and slopes.

Section 56.3131 requires that, in places where persons work or travel in performing their assigned tasks, loose or unconsolidated material be sloped to the angle of repose or

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stripped back for at least 10 feet from the top of the pit or quarry wall.

**Metal and Nonmetal:**

Section 56/57.3200 requires that ground conditions that create a hazard to persons be taken down or supported before other work or travel is permitted in the affected area. Until corrective work is completed, the area is to be posted with a warning against entry and, when left unattended, a barrier is to be installed to impede unauthorized entry.

**Coal:**

Section 77.1000 requires that each operator establish and follow a ground control plan for the safe control of all highwalls, pits and spoil banks, which is consistent with prudent engineering design and will ensure safe working conditions. The mining methods employed by the operator is to be selected to insure highwall and spoil bank stability.

In a pile created by end-dumping with trucks, the pile material is typically at its “angle of repose.” The angle of repose is the angle at which the material rests when simply dumped in a pile. This angle will vary somewhat depending on the size and shape of the particles, the conditions under which the material is dumped (e.g. how far it is dropped) and the amount of moisture in the material when it is dumped.

For a pile of material at its angle of repose, the edge of the pile is marginally stable. In other words, when dumped or pushed over the edge, the material tends to slide until it comes to rest at an angle where it can just barely support its own weight. This is why it is dangerous to bring the heavy weight of a haul truck too close to the edge of an angle-of-repose slope. When this occurs, the slope material must support not only its own weight, but also the additional weight of the loaded truck. If the additional weight of the truck causes the material’s shear strength to be exceeded, the edge of the pile will give way under the weight of the truck.

The edge of a pile can also become unstable if the foundation material cannot support the weight of the pile and begins to give way. Or, especially in a pile of overburden, the edge may become unstable because of the presence of a zone of weaker material in the pile. Finer-grained material, for example, will tend to have lower strength than coarser material. Sliding may occur on a layer of the weaker material.

Water can effect the stability of the edge of a pile. As material at the angle of repose absorbs rain, it may become heavier than it was when it was dumped. In the heavier condition it will have more of a tendency to slide. This would mainly effect the material near the surface on the slope. A second effect of water occurs if there is sufficient water, either from heavy rainfall, or

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from other sources, to saturate a portion of the pile. If this occurs then the water in the saturated portion of the pile has a buoyant effect and reduces the strength of the material, making the pile more prone to sliding. For this reason, measures should be taken so that water drains away from dumped piles.

At stockpiles, the removal of material from the toe of the pile can have a significant effect on the stability of the edge of the pile. In the case of loose, free-flowing material, loading-out at the toe may have little impact because the material tends to slide back to its angle of repose. But more typically, once material in a pile has become more tightly packed, such as from traffic on the pile, or even just from sitting for a period of time and settling in, then the area where material is loaded-out will stand at a steeper angle. Material standing at about 35 degrees when dumped over the edge can typically stand at 45 degrees once loaded-out. In some cases, such as when material has sat for a long time, or when part of the pile is frozen, the material may stand even steeper, or may even stand in an overhanging condition. With these steepened conditions, there is less slope material to support equipment loadings on the pile, and a sudden failure of the pile could occur.

### **F. Evidence that the dump point may fail to support the equipment**

The dump point must be capable of supporting the weight of the equipment, normally a truck, and withstand the other forces imposed in stopping and dumping near the edge. To avoid accidents, the conditions at the dump point must provide the equipment operator with a reasonable margin for error in carrying out the dumping operation. The weight imposed by the rear tires of a loaded haul truck can be substantial, as indicated by the typical values given in Appendix A.

#### **Metal and Nonmetal:**

Section 56/57.9304 (b) requires that, where there is evidence that the ground at a dumping location may fail to support the mobile equipment, loads be dumped a safe distance back from the edge of the unstable area of the bank.

Section 56/57.9303 requires, in part, that ramps and dumping facilities be designed and constructed of material capable of supporting the loads to which they will be subjected.

#### **Coal:**

Section 77.1608(b) requires that, where the ground at a dumping place may fail to support the weight of a loaded dump truck, trucks be dumped a safe distance back from the edge of the bank.

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The main evidence that you should look for that indicates that a dump point may fail to support equipment is the following:

### **1. Tension cracks or settlement in the area where equipment operates near the edge of the pile.**

A tension crack or settled area near the edge of a pile is a warning sign of an unstable, or marginally stable, slope. The crack is an indicator that some movement has already taken place. If movement has occurred, then the slope material is having trouble holding up its own weight, and it must not be relied on to hold additional weight, such as a truck.

If there is a tension crack in the dump area, the haulage equipment should not travel over or near the crack. The additional weight of the equipment may trigger the slope to fail. Loads should be dumped back from the crack (back one truck-length from the crack is a good safety rule) or in another safe area.

Cracked areas at a dump point should either be clearly marked so that the area is not used, or the condition should be corrected by flattening that area of the pile. This can be done by some combination of dumping material at the base of the pile, and carefully pushing material down from the top of the pile, preferably using a track dozer.

Tension cracks will tend to run parallel to the edge of the slope. In some materials, other types of surface cracking may occur as a result of the material drying out. Drying cracks tend to be randomly oriented.

### **2. A dump-point berm that is inadequate.**

It may seem odd to indicate that an inadequate berm should be considered evidence that a dump point may not support equipment. Berms are normally thought of mainly in terms of providing restraint. However, a critical function of a berm at a dump point is to keep the heavy load on the rear tires of the truck from getting too close to the edge of the pile. In this respect the height of the berm is important because the higher the berm, the wider the base of the berm. It is this wide base that is critical in keeping the load back from the edge.

This is another reason why it is important that equipment not back forcibly into the berm. As the tires sink into the berm, the heavy loading on the rear tires gets closer to the edge of the pile. If you notice tire marks penetrating well into the berm material, the potential danger of this practice should be discussed with the operator and appropriate action

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taken.

You should note that, in some operations, the inside of the berm is cut to provide a steep inner berm surface for the trucks to backup to, and to allow the trucks to dump on top of, or over, the existing berm. If the inside slope of a berm is cut to steepen the berm, then the mine operator should make sure that enough material is initially placed so that once the berm is cut, the berm's base width will still be adequate. The base width should be at least the width that an axle-height berm would have, if both its outside and inside slopes were at the material's angle of repose. It is important that a full base width be maintained to serve the function of keeping the truck loading back from the edge of the pile.

**3. Dumping at the edge in an area where the pile has been loaded-out and made steeper than the material's angle of repose.**

This condition has been a common factor in many of the accidents where a truck has gone over a stockpile. When material is loaded out from the toe of a slope, it makes the slope less stable and more prone to sliding. In this weakened condition, the material at the edge of the slope may not be able to support both its own weight and the additional weight of a haulage truck. An over-steepened slope is especially dangerous at a dump point because the additional weight of the truck, if positioned too close to the edge, can cause the edge to suddenly give way. Because of this danger, even without cracks, or other signs of instability, you should consider dumping above a point where the pile has been loaded-out, and made steeper than the material's normal angle of repose, to be evidence that the ground may fail to support the mobile equipment. ***Dumping at or near the edge of a pile, where the pile has been loaded-out and over-steepened, should be strictly prohibited.*** Possible remedies for this situation are to dump back from the edge, (a good rule-of-thumb is to stay one truck length back from the edge); to dump at the base of the pile; or to dump in another area where the pile has not been loaded-out.

The best safety practice on stockpiles is to routinely dump back from the edge and push the material over with a track-dozer. Alternatively, an excellent safety procedure used at some operations, is for the loader operator to block the access ramp to the top of the pile whenever material is going to be loaded out from the toe of the pile. That is, before loading material from the pile, the loader operator uses the first bucket or two of material to block the ramp to the top of the pile. With the ramp blocked, no truck can access the top of the pile and be exposed to a potentially hazardous area, while material is being loaded out. Once the loading-out is completed, the loader operator ensures that the dump area is safe by carefully pushing material down from the top and constructing an adequate berm before trucks again have access to the top of the pile. Whatever method is

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used the procedure should ensure that a truck never attempts to dump above an area where the pile has been loaded-out and over-steepened.

You should check with the mine operator to ensure that the stockpiling procedures used at the mine consider the hazard of dumping above an area where a pile has been loaded-out. Stockpiling procedures should routinely incorporate methods such as the practices indicated above to prevent this dangerous practice from occurring.

### **4. Movement of the slope material below the dump point.**

If the material on the slope below the dump point is unstable, this would be evidence that the dump point may not support a truck. A crack or a scarp (a steepened area where the material has slid) on the slope would be an indication of instability. Bulging of the slope material is not always as apparent as cracks, but it is another sign that the slope material is moving. Bulging can be detected by looking along the slope of the pile, especially the area near the toe, and paying particular attention to any material that is not at the normal angle of repose of the material. Bulging of the ground next to the pile would be an indication that the foundation material underneath the pile is too weak to support the weight of the pile. A failure through the foundation material could cause a portion of the pile to slide.

Another condition to be aware of is the presence of soft areas at the dump site. This may be indicated by ruts and accumulations of water. The danger in this situation is that as a truck starts to dump, the tires may sink into the soft area. In the worst case, this could result in the truck tipping over, especially if combined with material hanging up in the bed.

Mine operators should instruct their truck drivers to avoid soft areas. Drivers should stop dumping and move to a firmer area if they feel the tires sinking into the dump. Point out to the operator that soft areas should be eliminated by regrading and by sloping the area to promote better drainage.

On overburden dumps problems can occur because of the variability of the material being dumped. In general, finer-grained soils will have less strength and be less free draining than gravel-size or rockfill-type materials. As a result, portions of the dump where finer material has been dumped may be less stable, or less capable of supporting equipment weight. Mine operators should make use of their experience and knowledge of the way their dump materials behave. Equipment operators should be cautioned to take special care where weaker material has been dumped. In dealing with weaker materials near the edge the recommended practice is to dump back from the edge and push material over with a track dozer.

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**G. Safe dumping practices near the edge of a pile**

The way that equipment is operated at a dump point has a direct effect on the safety of dumping operations. During the course of your inspection encourage mine operators and dump-point workers to use the following good practices.

**-The top of the dump should be kept sloped** a small amount, perhaps 2 to 3 percent, so that in backing up to dump, the trucks will be going up a slight grade. This gives the driver better control. It also provides a better opportunity to get the truck out if any shifting of the ground occurs and keeps the dump point better drained. (Note that a 2% slope means that the top of the dump would rise a vertical distance of 2 feet over a horizontal distance of 100 feet.)

**Coal:** Section 77.1608 (a) requires, in part, that dumping locations be kept reasonably free of water.

**-The top of the dump should be kept level** - from side to side - so that trucks do not tend to tip on their side whenever the bed is raised.

**-Drivers should stay back from the edge of the pile on their approach** and in making their turn at the dump point. Staying back a truck length from the edge is a good rule-of-thumb. Approaching with the dump point to the left side of the truck gives the driver the best opportunity to check the condition of the dump area just prior to dumping.

**-Drivers should back-up perpendicular to the edge**, or with the driver's-side tires leading just slightly. In many dump-point accidents, the tire tracks have revealed that the truck was backing at an angle, with the rear tires opposite the driver leading. In these cases the driver-side mirror would have indicated that the driver still had a distance to back up, while the opposite side rear tires were already contacting the berm or going over the edge.

**-The berm should be used as a visual guide only.** The berm should not be used to help stop the truck but only as a visual guide to judge where to stop.

**-Trucks should back slowly and come to a gradual stop** at the dump point. As a truck backs up and the brakes are applied, dynamic forces are produced which push down and out on the pile. The more abruptly a vehicle stops, the higher these forces are. These forces are applied at the contact between the tires and the top of the pile and can make a marginally stable edge give way.

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**-Rearward looking cameras**, or other sensing devices, mounted on trucks can help truck drivers at dump points by providing better information on their position and alignment relative to the berm.

**-Adequate illumination** needs to be provided for nighttime operations. This is especially critical where trucks back right up to the berm. The area must be illuminated well enough to allow signs of dump-point instability, such as cracks, to be detected. If the dump area is not adequately lit or if visibility is poor due to bad weather conditions, trucks need to be dumped back from the edge.

### **Metal and Nonmetal:**

Section 56/57.17001 requires, in part, that illumination, sufficient to provide safe working conditions, be provided on all loading and dumping sites, and work areas.

### **Coal:**

Section 77.207 requires, in part, that illumination, sufficient to provide safe working conditions, be provided on all loading and dumping sites, and working areas.

**-Drivers need to be alert to material sticking in the bed** of the truck. Such material can make the truck tip over or can cause a more critical loading condition on the edge of the pile, as the bed is raised. A rule-of-thumb is that if the bed gets about two-thirds of the way up and material is still sticking, the driver should lower the bed and find another means of getting the material out, such as by using a backhoe. When material sticks in the bed, drivers should never try to jar it loose by jamming on the brakes as they back up. The truck could tip over or if this is done near the edge of a pile, the added force could cause the edge to collapse.

**-Drivers should space the trucks out** when more than one truck is dumping at the same time. This leaves room in case a truck tips over to the side while attempting to dump. It also better distributes the truck loadings along the edge of the pile.

**-Drivers should wear their seatbelts.** Accident experience has shown that staying in the cab with the seatbelt fastened offers the best opportunity to avoid a serious injury or death when a truck goes out of control.

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### **Metal and Nonmetal:**

Section 56/57.14131 requires, in part, that (a) seatbelts be provided and worn in haulage trucks, and (b) the seatbelts be maintained in functional condition, and replaced when necessary to assure proper performance.

Section 56/57.14130 requires, in part, that equipment such as crawler tractors and wheel loaders, manufactured after July 1, 1969, be provided with seat belts and that the belts be worn by the equipment operator.

### **Coal:**

Section 77.1710 (i) requires that each employee wear seatbelts in a vehicle where there is danger of overturning and where roll protection is provided.

### **Coal:**

Section 77.403a(g) indicates that the seat belts required by 77.1710 (i) are to be worn by the operator of mobile equipment required to be equipped with rollover protective structures (ROPS) by 77.403a.

Special precautions should be taken on **stockpiles** because of the added danger posed by the removal of material from the toe of the pile. Check whether the following procedures are being used:

-The operations of dumping material on the pile and loading material out from the toe should be coordinated so the trucks are not exposed to the hazard of dumping above an area where the pile has been, or is being loaded-out. It is important that the stockpiling procedures used at the mine prevent this from occurring.

-Drivers should understand that berms that appear to be in good condition from their viewpoint on the top of the pile, may actually have been undercut and may not be a full berm at all. Backing-up to such a berm would be dangerous. This situation can be avoided if truck drivers can examine the dump area from the bottom side as their vehicle approaches the stockpile, or if the front-end loader operator notifies drivers of this condition and takes action to block access to the dangerous area, or if drivers routinely dump back from the edge.

-There should be communication between the front-end loader operators and the truck drivers since the loader operator is in a good position to know when unsafe dumping conditions exist.

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-Front-end loader operators should be trained to recognize unsafe dump conditions and either take prompt action to correct the situation or barricade the unsafe area.

### **Metal and Nonmetal:**

Section 56/57.20011 requires that areas where safety or health hazards exist, that are not immediately obvious to employees, shall be barricaded, or warning signs shall be posted at all approaches. Warning signs are required to be readily visible, legible, and display the nature of the hazard and any protective action required.

*It is worth repeating that to avoid the hazards associated with dumping near the edge of a pile, the best safety practice is to routinely dump back from the edge, and push the material over, preferably with a track-dozer.* This practice should be encouraged. A good rule of thumb is to dump one truck-length back from the edge. Benefits of using this method are that the truck drivers are not exposed to the potential hazards at the edge of the pile, and they can complete the haul quicker since they don't need to be as precise in backing and positioning the truck when they are dumping.

The bed-height and bed-overhang on some of the larger trucks now in use allows these trucks to dump material over the top of an axle-height berm even when the truck is not backed up all the way to the berm. The heavy weight of these larger trucks makes it prudent to keep the rear tires back from the berm as much as is practical in these situations.

### **H. Dump-point hazards from overhead power lines**

A potential hazard that should be evaluated at dump points is the presence of overhead power lines. In locating power lines and dump areas, mine operators must take into account the danger of equipment contacting, or coming too close to, an energized conductor. It is especially important to check for power line clearance at dump areas for two reasons. First, there is the obvious concern that the trucks will be raising their beds to dump. Accidents can occur if adequate clearance isn't provided for the raised bed. Contact with power lines may also occur if a driver fails to lower the truck bed as he/she leaves the dump. Secondly, as a pile increases in size, equipment may gradually begin working closer and closer to power lines that were too far away to be a concern when the dump was started.

### **Metal and Nonmetal:**

Section 56/57.12045 requires that overhead high-potential power lines be installed as specified by the National Electrical Code.

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Section 56/57.12071 requires that when the clearance between equipment and energized high-voltage power lines would be less than 10 feet, the lines be de-energized, or other precautionary measures taken.

**Coal:**

Section 77.807-1 requires, in part, that high-voltage power lines located above haulageways be installed to provide the minimum clearance specified in the National Electrical Safety Code, provided that no high-voltage power line is installed less than 15 feet above ground.

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### **Coal:**

Section 77.807-2 requires that the booms and masts of equipment not be operated within 10 feet of an energized overhead power line. Where the voltage is 69,000 volts or more, the minimum distance from the boom or mast is required to be as follows:

Nominal power line voltage (in 1000 volts)	Minimum clearance distance, in ft.
69 to 114	12
115 to 229	15
230 to 344	20
345 to 499	25
500 or more	35

Section 77.807-3 requires that when the clearances specified in 77.807-2 would not be met for any part of any equipment, the power lines are to be de-energized or other precautions taken.

The clearance values specified in Section 77.807-2 of the Coal regulations are based on the National Electrical Safety Code (NESC). The Metal/Nonmetal regulation refers to the National Electrical Code, but this code refers back to the NESC. So the clearance values specified in Section 77.807-2 should be used to determine adequate clearance from overhead power lines at any kind of mine. Mine operators should be reminded of the required clearance. Any deviation from these values must be corrected immediately.

Where haulage trucks pass under power lines, a good practice is to suspend the power lines high enough that the minimum clearances are provided above the raised-bed height of the haulage trucks used at the mine. Another good measure is to mark the location of the lines with a large, highly visible object, such as a brightly colored plastic sphere.

### **I. Hazard of entrapment at hoppers**

There is the potential for an accident if anyone attempts to walk on the material that has been dumped into a hopper. Truck drivers and other workers have been killed in situations in which they have attempted to free hung-up material, or for some other reason have gone out on the hopper material. The dangers are that they may be drawn into the feeding material, or, if the material is hung up, they may be drawn in when the material breaks free. The material in the hopper may look solid, but there may be a hidden void where it has bridged over the feeder. Anyone walking on the material is in danger of being engulfed if the bridged-over material collapsed. Check that appropriate safety precautions are taken if it becomes necessary to free

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hung-up or bridged material.

### **Metal and Nonmetal:**

Section 56/57.9312 requires that, unless platforms or safety lines are used, persons not position themselves over drawholes if there is danger that broken rock or material may be withdrawn or bridged.

Section 56/57.16002 requires, in part, that (a) bins, hoppers, silos, tanks and surge piles, where loose, unconsolidated material are stored, be equipped with mechanical devices or other effective means of handling materials so that during normal operations persons are not required to enter or work where they are exposed to entrapment by the caving or sliding of materials; (b) suitable walkways or passageways be provided where persons are required to move around or over any facility where loose, unconsolidated material is stored; and (c) where persons are required to enter any such facility for maintenance or inspection purposes, platforms or staging is to be provided. No person is to enter the facility until the supply and discharge of materials has ceased and the supply and discharge equipment is locked out. Persons entering the facility are to wear a safety belt and harness equipped with a lifeline suitably fastened. A second person, similarly equipped, is to be stationed near where the lifeline is fastened and is to constantly adjust it, or keep it tight as needed, with minimum slack.

Section 56/57.15005 requires that safety belts and lines be worn when persons work where there is danger of falling; a second person is to tend the lifeline when bins, tanks, or other dangerous areas are entered.

### **Coal:**

Section 77.209 requires that no person be permitted to walk or stand immediately above a reclaiming area or in any other area at or near a surge pile or storage pile where the reclaiming operation may expose him to a hazard.

Section 77.1710 (g) requires that safety belts and lines be worn where there is a danger of falling; a second person is to tend the lifeline when bins, tanks, or other dangerous areas are entered.

## **J. Other mandatory standards related to dumping points**

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Inspectors should be aware of these other standards that are applicable to dump points.

### - Use of truck spotters.

#### **Metal and Nonmetal:**

Section 56/57.9305 requires that (a) if truck spotters are used, they be in the clear while trucks are backing into dumping position or dumping; (b) spotters use signal lights to direct trucks where visibility is limited; and (c) a truck be stopped when the truck driver cannot clearly recognize the spotter's signal.

#### **Coal:**

Section 77.1608 (e) requires that if truck spotters are used, they be well in the clear while trucks are backing into dumping position and dumping; lights are to be used to direct trucks at night.

In situations where a dozer is used to continuously maintain the dumping area and push material over, the dozer operator is often used to position the trucks. This is often the case on large valley fills and is especially useful at night.

### - General dump construction.

#### **Metal and Nonmetal:**

Section 56/57.9303 requires that ramps and dumping facilities be designed and constructed of material capable of supporting the loads to which they will be subjected. The ramps and dumping facilities are to provide width, clearance, and headroom to safely accommodate the mobile equipment using the facilities.

#### **Coal:**

Section 77.1605 (i) requires that ramps and dumps be of solid construction, of ample width, have ample clearance and headroom, and be kept reasonably free of spillage.

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### **- Hazardous clearances to the side or overhead of loading or dumping locations.**

#### **Metal and Nonmetal:**

Section 56/57.9306 requires that where restricted clearance creates a hazard to persons on mobile equipment, warning devices be installed in advance of the restricted area and the restricted area shall be conspicuously marked.

#### **Coal:**

Section 77.1600 (c) requires that where side or overhead clearances at any loading or dumping location or on any haulage road are hazardous to mine workers, such areas are to be conspicuously marked and warning devices shall be installed when necessary to ensure the safety of the workers.

Remember that as the area and height of dumps increases, clearances will change. A situation which is not a problem now, can become a problem with time. As indicated above, of particular concern is the presence of power lines in the vicinity of a dump point, especially since trucks will be raising their beds in this area.

### **- Dumping locations free of water, debris and spillage.**

#### **Coal:**

Section 77.1608 (a) requires that dumping locations and haulage roads be kept reasonably free of water, debris, and spillage.

### **- Control of Dust**

#### **Metal and Nonmetal:**

Section 56/57.9315 requires, in part, that dust be controlled at material transfer points where hazards to persons would be created as a result of impaired visibility.

#### **Coal:**

Section 77.1607 (i) requires that dust control measures be taken where dust significantly reduces visibility of equipment operators.

### **- Protection from falling material.**

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**Coal:**

Section 77.1608 (c) requires that adequate protection be provided at dumping locations where persons may be endangered by falling material.

**- Anchorage of sizing devices.****Coal:**

Section 77.1608 (d) requires that grizzlies, grates and other sizing devices at dumps and transfer points be anchored securely in place.

**- Spillage into shafts.****Metal and Nonmetal:**

Section 56/57.19103 requires that dumping facilities and loading pockets be constructed so as to minimize spillage into the shaft.

**APPENDICES**

**Appendix A. Typical Truck Weights**

The trucks typically used in dumping operations are single-rear-axle dump trucks which may vary in capacity from 25 tons to 270 tons. For this type of truck, two-thirds of the loaded truck weight is on the rear axle. As a truck backs toward the edge of a pile, this is a significant weight that the edge must be strong enough to support. Table No. 1 shows some typical values for the loaded weight of various capacity haul trucks and the weight carried by the rear axle.

<b>Table No. 1 Some typical truck weights</b>		
<b>Truck Capacity, tons</b>	<b>Total Truck Weight, Loaded, tons</b>	<b>Weight on Rear Axle, Loaded, tons</b>
40 - 45	75 - 80	49 - 54
58 - 65	102 - 112	67 - 74
95	162	107
150	275	181
200	350	231
240	415	274
320	550	366

**Appendix B. MSHA training materials related to dump-point safety.**

The following training materials are available from the National Mine Health and Safety Academy (304-256-3257).

1. Dump-point Safety: Stockpiles and Wastepiles; VC-858, 1997 (safety video).
2. Stockpiling Operations; VC-831, 1994 (safety video).
3. Stockpiling Safety; Safety Manual No. 30, 58 pages, 1992 (pamphlet).
4. Hazards Due to Stockpile Instability; AV 23, 1987 (sound-on-slide).
5. Front-End Loader Safety; VC 862, 1994, (safety video)
6. Material Instability Hazards in Mine-Processing Operations; IR 1212, 1994.
7. Good Berms Save Lives; VC-928, 1998 (safety video).

**Appendix C. Engineering analyses of dump-point stability**

You should be aware that there are engineering methods that can be used to estimate how close to the edge of a pile a truck can come before the edge becomes unstable. This can be done using a three-dimensional slope stability analysis. One available method is a computer program called "INSLOPE3." This type of analysis is complex because the impact of the weight of the truck as well as the effect of the forces created by the truck's braking action must be taken into account. Another difficulty is that you need to know the strength of the pile material.

Because of the variability of dumping conditions, the best use of this type of analysis is probably to show the impact of changes in the dump-point operations. For example, if a company was going to start using larger trucks, analyses could be performed to show the impact of the change on the stability of the dump point and provide guidance on how far back from the edge the larger trucks would need to stay.

"INSLOPE3" was developed by the U.S. Bureau of Mines. Information on the program is contained in IC 9291, "User's Guide for INSLOPE3: A Computer Code to Analyze the Effect of Haulage Truck Operation on Dump Point Stability," by James May, 1991. For additional information on the use of "INSLOPE3," or to obtain a copy of the program and user's manual, you can contact Technical Support's Mine Waste and Geotechnical Engineering Division.

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### **Appendix D. Dump-Point Safety: Best Practices**

The attached list entitled “Dump-Point Safety: Best Practices” may be useful for inspectors or mine personnel in giving a brief safety talk on dump-point safety or to quickly review the main safety points covered in this handbook.

### **DUMP-POINT SAFETY: BEST PRACTICES**

#### **I. MINE OPERATORS:**

Best Practices for *mine operators* at dump points are to:

- < Provide training to dump-point workers on recognizing dump-point hazards, taking appropriate corrective measures and using safe dumping procedures.
- < Supervise dumping operations regularly to ensure that unsafe conditions are being corrected and safe practices are being followed.
- < Instruct dozer operators to maintain adequate berms, keep the dump properly graded, and correct or barricade unsafe dump areas.
- < Avoid the hazards associated with dumping near the edge of a pile by routinely dumping back from the edge and pushing the material over, preferably with a track-dozer.
- < Dump directly over the edge of a pile ONLY when all proper safety precautions are taken. These include ensuring that close supervision is provided; a berm with sufficient height and base-width is maintained; and truck drivers are well-trained on the potential dangers.
- < Instruct truck drivers to always dump a truck-length back from the edge in areas where the berm is inadequate or where the dump area is cracked, settled, or too soft.
- < Instruct truck drivers to always dump a truck-length back from the edge if the pile below the dump point has been loaded-out and over-steepened.
- < Establish procedures for stockpiles that prevent the possibility of trucks attempting to dump above a point where the pile has been loaded-out and over-steepened. Methods to do this are to dump a truck length back from the edge or to block the pile’s access ramp during loading operations.

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- < Route truck traffic so that drivers have the best opportunity to routinely observe the condition of the dump area, both above and below the dump point, on their approach.
- < Consider the practice of “driving left” on the dump to allow drivers a better opportunity to observe the dump area on the approach.
- < Instruct dump-point workers to examine both the top of the pile and the area below the dump point for signs of instability.
- < Provide for communication between dump-point workers.
- < Provide adequate illumination of the dump-point area for night operations.
- < Ensure that the location of overhead power lines does not present a hazard for the trucks. Be especially alert to this problem as the size of stockpiles increases.
- < Provide training to truck operators on safe driving procedures, specifically the proper use of the transmission and brakes while backing and dumping the truck.
- < Ensure that equipment is properly maintained and that safety features are operational.
- < Require customer truck drivers to stay in their cab while being loaded at a stockpile.
- < Make use of new technologies such as the use of vehicle-mounted cameras that can improve both dump-point safety and efficiency. A rearward-looking camera, for example, can assist a truck driver in backing up square to the berm and in knowing how close to the berm the vehicle is positioned.



## DUMP-POINT SAFETY: BEST PRACTICES

### II. TRUCK DRIVERS

Best Practices for *truck drivers* at dump points are:

- < Check the dump area for unsafe conditions on their approach, staying a truck length back from the edge.
- < Dump back from the edge if:
  - , the berm is inadequate (for example, the berm is not at least mid-axle height, the berm has been partially undercut, etc.).
  - , the area below the dump point has been loaded-out and over-steepened.
  - , there are cracks near the edge of a pile.
  - , the edge area is soft and the tires sink in.
  - , there are signs that the slope below the dump point is unstable.
  - , visibility is poor.
- < Dump a truck-length back from the edge anytime there is uncertainty about the safety of the dump area.
- < Back up perpendicular to the edge or with the driver's-side rear tires leading just slightly.
- < Back up slowly and come to a gradual stop at the dumping point.
- < Use the berm as a visual guide only. Do not use it routinely to help stop the truck.
- < Avoid running the rear tires up on the berm.
- < Maintain spacing from other trucks while dumping.
- < Do not attempt to dump the material if it sticks in the bed, especially if it sticks after the bed is raised about two-thirds of the way.

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- < Communicate dump-point conditions to the dump supervisor, the dozer and front-end-loader operators, as well as other drivers.
- < Be aware of the proximity of overhead power lines.
- < Be sure to lower the bed after dumping.
- < Wear your seatbelt.
- < Get proper training on safe dumping procedures.

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### III. DOZER OPERATORS

Best Practices for *dozer operators* at dump points are to:

- < Maintain adequate berms at the dump points.
- < Grade the top of the pile so that trucks are going up a slight grade as they back up to dump and the dump area is kept well-drained.
- < Keep the dump area graded so that trucks are not tilting to one side as they back up to dump.
- < Keep alert throughout the shift for the development of potentially unsafe conditions such as cracks, settling, or soft areas.
- < Correct or barricade potentially unstable areas.
- < Remedy steep or overhanging pile slopes by carefully pushing material down from the top of the pile.
- < Re-grade soft spots with better material and smooth out rough areas on the dump.
- < Act as a spotter for the trucks and keep them back from the edge when conditions warrant.
- < Communicate dump conditions to the dump supervisor and the truck drivers.
- < Wear your seatbelt.

## DUMP-POINT SAFETY: BEST PRACTICES

### IV. FRONT-END LOADER OPERATORS

Best Practices for *front-end loader operators* working at stockpiles are to:

- < Recognize that loading-out material at the toe of a pile affects the safety of the dump point above the load-out area.
- < Communicate to company truck drivers and the dump supervisor any questionable dump-point conditions.
- < Block off the pile access ramp or barricade the area when trucks would be exposed to dangerous or questionable conditions on the top of the pile.
- < Limit the height of the loaded-out and over-steepened portion of the pile to about the reach of their equipment.
- < Remedy steep slopes or overhangs before such conditions get high enough to pose a hazard. If necessary, correct such conditions by carefully pushing or dumping material from the top of the pile - preferably using a track-mounted piece of equipment.
- < Wear seatbelts.
- < Be alert to the dangers of blind spots around their equipment.
- < Remind customer truck drivers that they need to stay in their cab while parked near, or being loaded at, a stockpile.