OPERATIONAL START-OF-SHIFT INSPECTION PROCEDURES FOR MOBILE, SELF-PROPELLED SURFACE MINE EQUIPMENT

Prepared for

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

By

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Final Report

on

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Study to Develop Inspection Procedures

for Surface Mine Equipment

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NOTICE

The views and conclusions contained in this document are those of the author and should not be interpreted as necessarily representing the official policies or recommendations of the Interior Department's Bureau of Mines or of the U.S. Government.

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16. ABSTRACT | The objectives of this effort were to: 1) Develop and validate start-of-shift operational inspection procedures to be used by operators of mobile, self-propelled equipment used in surface mining operations; 2) Evaluate user acceptance of the developed procedures; and 3) Recommend methods and media for presentation of the developed procedures to the user population.

Mobile, self-propelled surface mine equipment requiring start-of-shift inspection was identified. Subsystems amenable to operational inspection were identified. The procedures addressing all safety critical subsystems on each equipment type were then developed and validated. The inspection procedures developed were those that could be performed largely from the operator's station.

User acceptance was evaluated during on-site data collection visits to surface mines. Representatives of the user population reviewed the procedures and were then interviewed. Recommendations for the methods and media of presentation to the user population were developed from information obtained in: 1) Review and analysis of instructional technology literature applicable to this area; 2) On-site data collection; and 3) Analysis of the working environment and characteristics of the user population.

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FOREWORD

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This report is a summary of work completed during the period 25 May 1976 to 21 December 1976. This final report was submitted by the author on 21 January 1977.

This technical report has been reviewed and approved.

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DEPARTMENT OF THE INTERIOR
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WASHINGTON, D.C.

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SUBJECT INVENTIONS

This report does not include a listing of subject inventions. No subject inventions were developed during execution of this contract.

TABLE OF CONTENTS

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INTRODUCTION AND SUMMARY

The operation of surface mine equipment can be hazardous--both to the operator and to fellow workers in the immediate area. Recent research indicates that at least some surface mine equipment operational hazards could be eliminated through the use of proper start-of-shift equipment operational inspections.

A recent study for the U.S. Bureau of Mines (Theodore Barry and Associates, 1974) concluded that "...a significant number of hazards could be associated with the failure of the equipment operator to adequately inspect his machine before operation." Pynnonen and Look (1974) arrived at much the same conclusion following their analysis of several front-end loader accidents. They recommended: "Loaders should be inspected daily; equipment known to be defective should be removed from service."

It presently is common for experienced operators to perform certain start-of-shift equipment inspections in which, for example, they inspect tires, tracks, and system fluid levels. However, in many mining operations, new hires and operators who are being checked out on a piece of equipment that is new to them are only informally instructed on necessary equipment inspections. In particular, many operators must find out for themselves what types of operational checks are needed to determine if their equipment is safe to operate.

The postulated percentage of accidents which could be affected by proper start-of-shift operator inspection is relatively small ($\leq$ 15%) for all equipment categories (Theodore Barry & Associates, 1974). It is, however, a finite percentage of accidents (and fatalities) that could be reduced at relatively small cost. Procedure development costs are a one-time expense; procedure implementation costs to management are minimal; and there are no design costs or other implications for equipment manufacturers. Summarily, the development of start-of-shift equipment inspection procedures for use by surface mine equipment operators appears to be a cost-effective investment and one which should show immediate returns in the area of mine safety.

The present study was conceived in response to these conditions. Specific objectives of the study were:

> Develop and validate start-of-shift operational inspection procedures to be used by operators of mobile, self-propelled equipment used in surface mining operations.
>
> Evaluate user acceptance of the developed procedures.

Recommend methods and media for presentation of the developed procedures to the user population.

A primary thrust was to develop and validate meaningful, operational, start-of-shift inspection (checkout) procedures to check safety-critical equipment subsystems of mobile, self-propelled surface mine equipment. The following definitions were used:

> Operational procedures center largely on critical operation of the machine in a safe environment to determine whether certain of its subsystems are operating in a manner that will allow for safe use of the machine in the mine working environment.
>
> Start-of-shift procedures are those performed before the machine is used for normal production operations.
>
> Safety critical subsystems are those whose failure alone could cause an injury accident under normal working conditions.
>
> Meaningful operator inspections are those not requiring special test equipment or maintenance knowledge. Primarily, meaningful inspections center upon system responses to operator control inputs along with recognition of acceptable and unacceptable equipment responses.
>
> Mobile, self-propelled surface mining equipment consists of machines where movement is an integral part of the machine's function; movement is achieved solely by means of self-contained propulsion mechanisms; and an operator is required in or on the machine to operate it.

Emphasis was placed on developing procedures that were acceptable to surface mine equipment operators and thus would have a higher likelihood of actually being used.

Table 1 summarizes the surface mine equipment and safety-critical subsystems for each equipment type for which operational, start-of-shift inspection procedures were developed. Appendix A presents the procedures.

A second thrust was to evaluate alternative methods and media for communicating the inspection procedures to the broadest possible segment of the equipment operator population. Relevant instructional technology literature was reviewed to derive methods and media for presenting the procedures to

people sharing common equipment operator population characteristics, and with consideration to the operational environment. Resulting recommendations for pocket checklists and abbreviated dashboard plackards are discussed fully in the results section. The need for pictorial back-up to written procedures is discussed. It also was concluded that formalized instruction using a tape and slide presentation would be required to effectively communicate inspection procedures content and related, necessary system knowledge. Further research was recommended to ensure the effectiveness of the needed instructional packages.

TABLE 1. MINE EQUIPMENT AND SAFETY-CRITICAL SUBSYSTEMS

MINE EQUIPMENT	SAFETY CRITICAL SUBSYSTEMS															
	Engine (General)	Hydraulic System (General)	Pneumatic System (General)	Auxiliary Brakes	Battery Charge	Cables	Dynamic Brakes	Emergency/Park Brakes	Emergency Steering	Retarder (Hydraulic)	Service/Steering Brakes	Steering	Steering Clutches	Throttle Controls	Trailer Brakes	Transmission Neutral/Clutch	Tires
Compactors	X	X	X	X				X			X	X		X		X	
Crawler Dozers	X	X						X			X	X	X	X		X	
Crawler Loaders	X	X						X			X	X	X	X		X	
Crawler Tractors	X	X						X			X	X	X	X		X	
Dual Crawler-Tractors	X	X						X			X	X	X	X		X	
Motor Graders	X	X	X	X				X			X	X		X		X	X
Off Road Rear Dump Haulers, Diesel	X	X	X	X				X	X	X	X	X		X		X	X
Off Road Bottom Dump Haulers, Diesel	X	X	X	X				X	X	X	X	X		X	X	X	X
Off Road Rear Dump Haulers, Diesel-Electric	X	X	X		X		X	X	X		X	X		X			X
Off Road Bottom Dump Haulers, Diesel-Elec.	X	X	X		X		X	X	X		X	X		X	X		X
On/Off Road Rear Dump Haulers	X	X	X	X				X	X	X	X	X		X		X	X
Pipelayers	X	X				X		X			X	X	X	X		X	
Single Engine Scrapers	X	X	X	X				X	X	X	X	X		X	X	X	X
Support/Utility Trucks	X	X	X	X				X	X	X	X	X		X		X	X
Twin-Engine Scrapers	X	X	X	X				X	X	X	X	X		X	X	X	X
Water Haulers (No Trailer)	X	X	X	X				X	X	X	X	X		X		X	X
Water & Utility Haulers (Trailer)	X	X	X	X				X	X	X	X	X		X	X	X	X
Wheeled Dozers, Diesel	X	X	X	X				X			X	X		X		X	X
Wheeled Loaders, Diesel	X	X	X	X				X			X	X		X		X	X
Wheeled Dozers, Diesel-Electric	X	X	X		X		X	X			X	X		X			X
Wheeled Loaders, Diesel-Electric	X	X	X		X		X	X			X	X		X			X
Wheeled Service Tractors	X	X	X	X				X	X		X	X		X		X	X

METHOD

Introduction

This section describes the methodology that was used to develop and validate the inspection procedures, and to assess user acceptance of the procedures. Selection of optimum methods and media for presentation of the procedures is addressed in the results section.

Procedure Development

An initial step was to obtain and integrate information that would provide for a thorough understanding of the problem and its background. In pursuit of this, literature searches were carried out in the following areas:

- Heavy equipment inspection
- Mining accidents involving mobile equipment
- Inspection/checklist development
- Mining equipment manufacturers
- Safety program promotional methods and media
- User acceptance of safety programs, devices and procedures.

In addition to the literature, other information sources were used to fill in gaps and provide first-hand experience. This included interviews with:

- Heavy equipment dealers
- Heavy equipment manufacturers (many supplied operator and maintenance manuals)
- Heavy equipment operator training school personnel
- Los Angeles County Fire Department, Heavy Equipment Branch personnel
- Mine management personnel
- Mine operator training personnel
- Mine safety personnel
- Mine equipment mechanics
- Mine equipment operators
- Used equipment appraisers
- Woodward and Associates (a Bureau of Mines contractor in the area of mine safety).

Additionally, the services of Wolf Demolition and Dismantling were obtained on a consulting basis. Members of this organization have expertise in the operation and inspection of certain heavy equipment types. Additionally, they provided valuable introductions to various heavy equipment manufacturers and dealers.

Information from these sources was reviewed, condensed and integrated to form three information taxonomies:

Standard mobile self-propelled equipment used in surface mining.

Safety-critical subsystems for each equipment type.

Subsystems amenable to operational inspection for each equipment type.

The taxonomy of standard, mobile, self-propelled equipment used in surface mining (see Table 1) included all the equipment types normally found in surface mining operations. It did not, however, include:

Custom equipment designed and/or built by mine personnel.

Prototype equipment in field testing stages, supplied by manufacturers.

Continuous miners and augers.

Shovels and drag lines.

The taxonomy of safety-critical subsystems listed the subsystems of each equipment type which are safety critical. The determination of "safety-critical" was made on the following basis: "Could a failure of this subsystem alone cause an injury accident under normal working conditions?" A "yes" answer defined the subsystem in question as "safety-critical." A "no" answer did not, however, automatically exclude the subsystem from possible inspection. The taxonomy of subsystems amenable to operational inspection (see Table 1) was a listing of subsystems for each equipment type which can be checked-out largely from the operator's station.

Additional areas of analysis during this phase included:

Inspection procedures currently available and/or in use.

Environmental limitations and constraints.

User population characteristics.

Some of the relevant findings from these activities were:

Few, if any, operators use the inspection procedures recommended in equipment operators' manuals.

Currently available inspection procedures were developed with a heavy emphasis on preventive maintenance and little or no apparent emphasis on operator safety.

Operations in which equipment inspection is routine are those in which an accompanying system of enforcement is in effect.

The mining environment is frequently extreme and uncomfortable to an unprotected human.

The typical operator is experienced and technically sophisticated in the operation of his machine type.

The typical operator is technically unsophisticated in the mechanics of his machine type.

A significant proportion of the operators cannot effectively read or write material which is unfamiliar to them.

Operators are concerned with their own safety, a subject they frequently feel "the company" treats too lightly.

With the knowledge gained from the above analyses, emphasis was shifted from the development of procedures per se to the development of procedures with the maximal likelihood of user acceptance. The results of prior analyses set several constraints on the development of procedures. Key constraints were:

The procedures had to be perceived by operators as being operator-safety oriented.

Each procedural step should be easily relatable to operator safety.

The procedures should require a minimum of time outside environmentally controlled operator stations.

Symbology should be used in procedure presentation and training to facilitate recall by operators.

The procedures should not be perceived as "something else just to benefit the company."

In addition to constraints, the results of initial interviews indicated a considerable level of operator sophistication in the operating characteristics of their machines. This knowledge baseline proved highly useful in creating brevity within the procedure sets.

The above constraints were integrated with the technical information provided by equipment manufacturers to produce draft inspection procedures for each equipment type. Each set of procedures was thoroughly reviewed to assure that they were general enough to accommodate inspection of machines manufactured by different companies.

Every effort was made to develop procedures that could be executed primarily from the operator's station. Among the reasons for this emphasis were:

> Safety, e.g., the way in which a machine responds to control inputs can be more easily related to operator safety than the presence or absence of a grease puddle under the machine.
>
> Operator convenience, i.e., the less demanding the procedures are to execute, the greater the likelihood of their execution.
>
> Environmental constraints, i.e., the less time the procedures require the operator to stay in an uncomfortable environment (e.g., snow, excessive heat), the greater the anticipated acceptance of the procedures.

Crawler mounted drills, backhoes, shovels and draglines were omitted from consideration at this state because operational inspection procedures of the type being addressed were not appropriate for them. Interviews with operators, mechanics, managerial and safety personnel yielded the conclusion that procedures of this nature do not practically apply to the operation of these machinery categories. The principal factors leading to this conclusion were:

> Machines in these categories are not subject to hazards associated with speed. These machines typically move at less than 2 miles per hour.
>
> Machines in these categories are not subject to the hazards associated with a rough, non-level environment. The machines typically work in areas that have been previously prepared for them.
>
> The machines are not normally subject to rolling over. Their working environment is fairly level and most of the machines have low centers of gravity and wide, stable bases.

Operator stations are relatively safe from intrusion by equipment components or other machinery. Shovel and dragline operator stations are normally above the level of other equipment. Drills typically work in areas free from other machines. None but an obscure and highly improbable chain of component failures would cause the operator harm.

Movement is not an integral part of normal operation of these machines; when occurring, movement is usually for short distances. Longer distance moves are major projects and exceptions rather than the rule.

A different type of procedure was contemplated for these machine categories. The alternative appraoch involved the machine operator performing one production cycle while observing the reactions and responses of his machine. This was not practical because operators, particularly experienced operators, tend to make the same observations routinely during normal production. The desirability of attempting to formalize such routine activities was questioned at length. The final determination was that such an attempt would dilute the credibility and resultant acceptability of the other procedure sets.

Examination of the candidate procedure sets revealed that, in several instances, procedures were virtually identical for two or more machine types. Where this occurred, one procedure set was developed to cover all appropriate machine types. Resulting machinery type groupings were:

On/off road end-dump haulers (usually $\leq$30 ton) and support/utility trucks (e.g., lube trucks).

Diesel-electric powered rubber-tired dozers and rubber-tired loaders.

Diesel powered rubber-tired dozers and rubber-tired loaders.

Crawler tractors, crawler dozers and crawler loaders.

Bottom dump haulers, single engine scrapers, water trucks (with trailer type tank), and miscellaneous off-road tractor-trailer haulers.

Tractor-mounted rotary blasthole drills and rubber-tired utility tractors.

Procedure sets for wheeled loaders/dozers and motor graders were determined to be applicable to both articulated and rigid frame configurations. Procedure sets covering scrapers accommodated both standard and elevating configurations. The final result of the initial development process was thirteen different procedure sets covering a wide variety of equipment types.

Procedure Validation

The validation effort consisted of four tasks:

Verify that the procedures adequately check all safety critical subsystems.

Verify clear and concise statement of the procedures.

Determine levels of user acceptance of the procedures.

Modify the procedures, integrating information obtained from the preceding tasks.

Validation activities centered around interviews with representatives of the user population. Each equipment operator was asked to review the procedure set (one of 13) which covered the machine he was operating. The operator was then interviewed by an experienced interviewer from the project staff. The primary thrust of the interview was to review and modify as necessary the particular procedure set which was seen by the operator. Additionally, the interviewer attempted to obtain information relevant to operator attitudes, management climate and any other factor which might affect the use (by operators) of such procedure sets. Specific areas addressed included:

Completeness of coverage of the procedure set

Generalizability of each procedure set to equipment from different manufacturers

Clarity of wording

Usefulness to operators

Usefulness of inspection in general

Accident prevention potential

Operator willingness to use

Improvement of procedure set

Ways of presenting resulting procedures to operators

To interview equipment operators in surface mines, two on-site trips were made covering nine different mines operated by six different companies. The mines ranged in size from approximately 30 employees to over 500 employees. The mines were located in four western states and operated more than a dozen different major makes of equipment. About 100 operators were interviewed. Collectively, they represented experience with 16 different types of equipment which the procedure sets addressed.

An additional effort was made to assure the technical comprehensiveness of the procedure sets. Daniel W. Thaxton, Inc., was retained on a consulting basis to review the procedure sets in their final form. That organization has extensive qualifications in the following areas: Heavy equipment (used) appraisals, maintenance, operation, and new/used equipment purchasing and sales.

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RESULTS

Introduction

Inspection procedure development results are presented first. Procedure validation and user acceptance findings are then presented. The third section discusses methods and media for presenting the procedures to equipment operators. The fourth discusses training requirements.

Procedure Development

A primary product of this effort was the thirteen sets of equipment start-of-shift operational inspection procedures. The procedure sets are contained in Appendix A.

Of necessity, the procedure sets incorporate the assumption that the user population consists of experienced surface mine equipment operators. Thus, it is assumed that the operators know appropriate and inappropriate system responses to specified control inputs, whether this knowledge was gained through on-the-job experience or through formal training.

To use the procedures, inexperienced operators will require training to maximize the effectiveness of the procedures. This follows since effective use of the procedures requires knowledge of how equipment and safety-critical subsystems should and should not react, depending upon operating conditions.

The knowledgeable operator assumption was necessary for several reasons. First, inexperienced operators comprise a minority of all operators. The procedures were designed to maximize likelihood of use by the majority.

Second, to provide a complete, detailed listing of all possibly relevant system failures (e.g., hydraulic pressure gauge showing no reading at all) would require substantially more verbiage. As a result, more than one page would be required for each procedure set. Two probable consequences of lengthy, "overly-detailed" procedures are: Experienced operators (the majority) would quickly become bored with the procedures, and possibly be insulted by them. As a result, they would be much less apt to use them. Also, a presentation format requiring more than one page brings the associated problem of keeping multiple pages together. Increased perceived length of the procedures also could contribute to their not being used.

Cost and logistic factors also had to be reckoned with. Increased length would mean increased production costs, possibly increased procedure execution times, and more complex presentation formats. Replacement costs also would be higher. Taken together, these factors could translate into reduced probabilities of management support for an adequate start-of-shift inspection program.

Titles and applications of each resulting procedure set are given in the following paragraphs.

Bottom Dump Haulers, Single-engine Scrapers. This procedure set was designed to be used on the wide variety of equipment which employs a scraper-type tractor (2 or 4 wheel) pulling a trailer. The more common equipment types within this grouping are: Bottom dump haulers, single engine scrapers, water trucks (tank type trailer), and off-road equipment haulers.

Twin Engine Scrapers. Twin engine scrapers require different procedures than single engine only because they have a rear engine-transmission unit and associated controls to monitor. This difference required different wording than that found in the procedure set for single engine scrapers and similar equipment. The actual procedures are, however, highly similar.

Crawler Tractors/Dozers/Loaders. These procedures are designed for crawler-mounted dozers, loaders and utility tractors. With the exception of pipelayers, any single crawler-mounted tractor in which the operator rides can be checked using this procedure set. Special procedures are required for pipelayers and dual crawler tractors.

Pipelayers. Pipelayers could have been covered in the previously discussed set but for one unique hazard. The cables in most pipelayers run across the operator's lap and can be extremely dangerous if they were to break under load. This procedure set, as a result, differs from the previous set only in that it has one additional step addressing cables.

Dual Crawler Tractors. This procedure set covers the side by side dual tractor dozers used largely for reclamation work and the front to back configuration used primarily for scraper loading. These procedures are different from those for single crawlers only as required to reflect the duality of monitoring required here.

Motor Graders. This procedure set covers both articulated and ridig frame configurations. A separate procedure set was required because the procedures and terminologies for motor graders are unique.

On/Off Road Rear Dump Haulers, Support/Utility Trucks. These procedures are designed for trucks which are based on highway-legal models, although vehicles in this group do not necessarily have to be highway-legal themselves. Haulers of this type are usually rated at less than 30 tons. Other common vehicles in this group are lube trucks and tractor-trailer rigs used for transporting equipment over public roads.

Off-Road Rear Dump Haulers, Diesel. This set, as opposed to the one mentioned above, is designed for heavier duty diesel-powered haulage trucks. These trucks are usually designed specifically for off-road use and could not be highway-legal in any configuration. They are usually rated at over 30 tons and are seldom used in any application other than haulage. This set does not apply to haulers using a diesel-electric propulsion system.

Off-Road Haulers, Diesel-Electric. Haulers in this group are different from those discussed previously in that they use diesel-electric propulsion systems. A diesel engine drives an alternator or generator, which in turn provides power to motors at each drive wheel. Haulers with this type of propulsion system also use different types of braking systems, and typically are larger than mechanically driven counterparts. Accordingly, procedures and selected terminology had to be tailored to this hauler type. Both rear dump and bottom dump haulers with diesel-electric propulsion systems can be inspected using this procedure set.

Rubber Tired Service Tractors. This procedure was designed as a catchall category and is, as a result, the most general set developed. The original intent of this set was to account for some of the plethora of one-of-a-kind equipment found in mining operations. Some of the equipment types covered by this procedure set are: Coal drills mounted on rubber tired tractors, forklifts, specialty tractors (usually scraper tractor based), tugs (towing tractors), tractor-mounted backhoes, and "cherry pickers".

It must be noted, however, that this procedure set is not designed to cover small, non-diesel forklifts and tugs which are more typically found in warehouse operations.

Wheeled Loaders/Dozers, Diesel. This set is applicable to machines referred to as front-end loaders and rubber tired dozers. It also can be used to inspect any skidders used in mines in the more wooded areas of the country. The procedure set is applicable to both articulated and rigid frame designs, but not to diesel-electric propelled units.

Wheeled Loaders/Dozers, Diesel-Electric. This equipment group is similar in function, design and appearance to the group described immediately above. The primary difference is the propulsion system, which in turn creates differences in descriptive terminology and braking systems. These units are typically larger in both size and capacities.

Compactors. Since compactors are essentially diesel powered, wheeled dozers without tires, this procedure set is essentially that of diesel powered wheeled dozers without a check for tires. This procedure set covers no other equipment type.

Procedure Validation and User Acceptance

The validation of the procedure sets yielded overwhelmingly positive responses from the user population. They recognized the need for the procedures and seemed more than willing to use the procedures if they were provided. The operators who were interviewed during the validation visits appeared to be representative of the user population.

Forty-nine percent (49%) felt the procedures covered every start-of-shift check necessary to assure operator safety; 51% felt additional checks should be added. The majority of the latter group suggested a preventive maintenance-type check or checks. Some suggestions were, however, safety-centered, such as: mirrors, windows, back-up alarms, lights, walking surfaces, seat belts, horn, fire extinguisher, structural stress points and flammable dust on engines or generators.

These recommendations were reviewed using the "meaningful" and the safety-critical determinations discussed earlier, and several were subsequently added to the procedure sets.

Ninety percent (90%) of the operators felt the procedures were applicable to all makes and models of their particular machine type. Of the remaining respondents, 7% identified no specific makes or models that the procedures could not be used on. The remaining 3% responded with specific makes of machines. Upon investigation of their statements, it was found that they misunderstood the nature of particular systems on makes of machinery they did not operate.

Eighty-four percent (84%) felt that the procedures were stated clearly enough. The remaining 16% suggested four basic points:

> Translate the procedures to Navajo. Written Navajo is essentially phonetic English spelling of Navajo words. Consequently, written translation would be meaningless in that one must be literate in English to read written Navajo. (This is the case with most Indian languages.) Additionally, the extent of this problem is limited, and the cost-effectiveness of such an effort must be questioned.
>
> The word "tram" was not understood. It was replaced by other wording in all procedure sets.
>
> The phrase "operator station" was not understood. It was changed to "cab" in all procedure sets.

The phrase "full power" was used inappropriately in some of the initial procedures. It was changed to "half speed" with no loss in procedure comprehensiveness or effectiveness.

Ninety-two (92%) of the interviewees felt the procedures they reviewed would be useful to most operators using their type of equipment. Most of these operators felt safety was the major purpose for using them. The other 8% gave various reasons for the procedures not being useful. The most frequent reason was that broken components would not be repaired. The highly positive response to this question was particularly heartening in light of the fact that it very closely approximates the 95% of operators who felt equipment inspection in general was useful to operators. A conclusion that can be drawn from these results is that the operators have a positive attitude toward equipment inspection in general (95%) and equally (92%) perceived the developed procedures to be useful.

Ninety-seven percent (97%) of those interviewed felt that using the developed procedures at the beginning of a shift could help to prevent an accident later on. This aspect of the operator's feelings toward the procedures should make the job of convincing operators to use the procedures a great deal easier. Additionally, 91% indicated that they felt equipment operators would be willing to use the procedures. Of the 9% who did not, the most frequent reason given was time required for execution. A proper management climate could go far toward overcoming this objection.

When the interviewees were asked to make any other recommendations for improving the procedures, they responded with several recurring suggestions. Some of the comments, verbatim, were:

On training:	"Operator training program . . ."
	"Make operators aware"
	"Operator awareness"
	"Education - teach the operators about their machinery: how, why and when"
	"Have a designated place, time and instruction . . ."
On enforcement:	"Signed and mandatory"
	"Make sure everybody does it"
	"Enforcement"
	"Something turned in"
On format:	"Shorten them"
	"Checklist format"
	"Make into checklist"
	"Check card"

As mentioned earlier, the procedures were also reviewed by expert consultants. The consultants reviewed the procedure sets for technical completeness and accuracy. Their review yielded no major changes in any of the procedure sets. They did, however, make a recommendation on presentation format. It was:

> "... that each set of guidelines be reduced to one page, which should be placed in each machine in an all-weather wall mounting frame. This will enable the operator to read each safety precaution with the least amount of effort."

Presentation Methods and Media

Preceding sections have discussed the need for and anticipated acceptance of start-of-shift surface mine equipment operational inspection procedures. The development of such procedures is one thing. Making them readily usable by equipment operators is an additional consideration.

Information obtained during the course of this effort indicated that there is a distinct problem to be solved in communicating inspection procedures information to equipment operators, and getting them to use it. There are three facets to the problem. One is the presentation of the inspection information. The second is providing for operator training necessary for effective use of the procedural information. Associated with the second facet is the need to convince at least some mine management personnel of the need and viability of such inspections.

This section deals with presentation methods and media. The following section discusses training requirements. Changing mine management climates is not discussed as this is a topic requiring additional investigation.

The same basic elements that occur in any communication situation must be considered in the design of a communication strategy to be used in presenting procedural information to surface mine equipment operators.

As shown in Figure 1, all communication or information transmission situations can be considered as basic closed loop systems. In the present situation, the sender (or source of information) is the entity that develops and distributes the inspection procedures. The message (information) consists of the procedure sets. The operational environment is the day to day working environment in which the messages must be used. This factor poses constraints because, in a worst case, the environment can be wet, dirty, noisy, cold and windy. This factor alone eliminates many communication methods and media. The receiver, in the model, consists of two populations. One is the equipment operator. The other is management, including

mine safety personnel. As in any closed loop model, feedback is the measure of performance or effectiveness. In this application, feedback would be accident, incident and attitudinal information reflecting the effectiveness and acceptance of using start-of-shift operational inspection procedures.

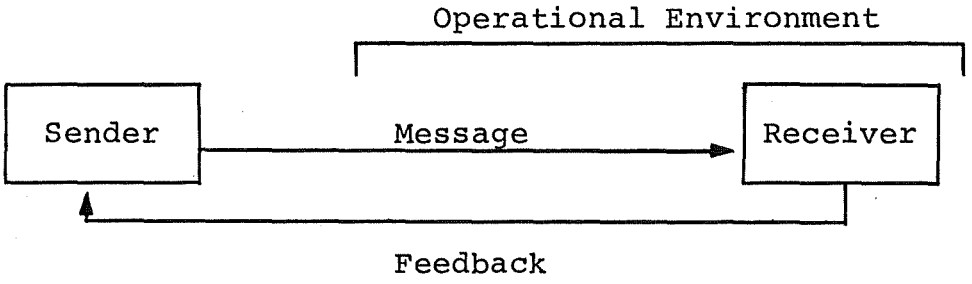

Figure 1. Generalized Communication Model.

Specifically, what is required is the selection of a communication strategy and method that will present inspection procedures to equipment operators and mine management in a way that is effective (causes positive changes in performance and attitudes), efficient (causes changes in ways that management and operators can accept and with minimum cost), and is practical in the operational environment.

To accomplish this, it is necessary that the following major variables be considered (Zimbardo, 1970):

The nature of the message.

The composition and characteristics of the audience (surface mining equipment operators and mine management).

The kinds of performance that are to be changed (what is it that the operators are doing/not doing that should be changed).

The type of feedback that is needed to objectively show that the procedures have, in fact, had an impact on operator performance.

Heinrich (1959) indicates that methods of most value in preventing accidents are very similar to the methods required for the control of quality, cost and quantity of production. Four basic methods are available for preventing or decreasing accidents: Engineering changes, personnel changes, discipline, and persuasion and appeal.

In light of available information, it is felt that the most efficient and effective way to improve mine accident rates is through the latter of these methods: persuasion and appeal. Proper design of the procedural information presentation will go a long way toward accomplishing effective communication through persuasion and appeal. This approach, being the most viable, also has implications for associated management and operator training, as discussed subsequently.

With the method selected, it is now necessary to determine the optimum communication medium for this task.

The information to be communicated consists of series of relatively short verbal instructions which identify specific procedural tasks that the operator should perform and the system responses he should look for. The procedures may have to be performed in an adverse climatological and operational environment, as discussed previously. Further, the nature of the user population must be considered.

An analysis of characteristics of the equipment operator population suggests that the population reflects the following characteristics:

> The distribution of intelligence and education seems to be about the national average.
>
> Reading ability on the average tends to be slightly lower than the national average.
>
> A small but significant proportion cannot rely upon written technical material alone as a meaningful means of communication.
>
> They possess an excellent understanding of equipment operational characteristics but little understanding of critical system and subsystem interrelationships.

Numerous media exist for delivering procedural messages to populations sharing these characteristics. They include: audio visual training courses, self-instructional pamphlets and workbooks, company notification systems, public relations/advertising messages, incentive programs, text, and point-of-use displays (Bretz, 1971). The latter two, although traditional and mundane, are recommended for direct operator usage in the surface mine environment.

Based on the relevant literature, experience, and consultant and operator recommendations, the procedures text should consist of pocket sized, plastic laminated cards that present both pictorial and verbal procedures information. The point of use displays should consist of placards that can be

mounted in equipment cabs. The placards should contain "abbreviated checklists" that can cue the operator to major inspection tasks to be performed. As discussed previously, checklist and placard media both assume operator training, whether such training occurs on the job or is formal.

The need for pictorial and/or symbolic translation of procedural information is felt to be particularly important as this technique can enable functionally illiterate or non-English speaking operators to comprehend the procedures. Even for the functionally literate, pictorial or symbolic cues can save having to read specific procedural steps. This is particularly effective when operators know the details of the procedures, and need only be reminded of the general category of checks to be made. Military equipment checklists are similarly designed in that operationally used checklists are abbreviated and designed largely to provide verbal or pictorial cues that will cause detailed procedures to be performed. Training, however, is assumed.

Operator Training Requirements

Checklists and placards serve the function of cueing the user to perform desired behaviors and, depending upon how they are designed, observe related system responses. They are not, however, a substitute for instruction.

As discussed previously, the philosophy used in designing the checklists required assuming at least a minimal level of operator knowledge and sophistication regarding his machine and its internal functions.

Results of developmental and validation interviews strongly suggest that, in particular, operators who are new to a machine are left to their own means to discover the interrelationships among machine subsystems, which malfunctioning subsystems can mean trouble for them, and how to check for potential trouble.

This section discusses the need for operator training in equipment subsystem operational understanding, evaluation and limited troubleshooting.

The need exists. It is only met in a very limited number of mining operations -- mostly large corporate operations. The majority of the mining community continues to go "in want".

Central to this issue is the fact that having operational, start-of-shift inspection procedures available is only a partial solution to the need to reduce equipment-related accidents and fatalities. To have any significant effect, the procedures must be ingrained into the equipment operators in a way that will have a positive, measurable effect on equipment-related problems. This necessitates educating operators and mine management with respect to why and how the procedures should be

used, and with respect to the payoff (feedback in terms of the model) to both groups.

The purpose of the following discussion is to consider the nature of the communication/information presentation problem in terms of presenting the necessary information in an acceptable, efficient, effective way to mine equipment operators and mine management. In short, this means training geared toward the bottom line production resource -- equipment operators.

In the context of surface mining operations an accepted principle of instructional development/behavior modification requires that the nature (reason for) and results of the procedures must be made clear to each operator. Even more important, operators must accept the procedures as being of value to them personally.

Accomplishing this with something as apparently mundane as the procedures for starting and checking operations of a dozer or scraper is a difficult task. Operators perceive of themselves as skilled and proficient in their jobs, and the thought of an "outsider" trying to tell them how to do their job could create antagonism.

Overcoming this type of opposition requires skill in the development of the procedures themselves and skill in the initial introduction of the procedures to surface mine equipment operators and mine management. The skills involved are associated with the design of the format and graphics to be used in presenting the procedures, and the skill of the people who approach the mine managers and the operators about the adoption of these procedures.

Any change in operator behavior will be more persistent over time if the operator actively participates in the communication process, rather than passively receiving the message (Zimbardo, 1970). This principle of communication means that the basic approach to the delivery of the procedures must involve methods and media which require the operator to do something, rather than just passively watching or listening to someone telling or showing him what he should do. There also is a reasonable amount of evidence which indicates that individuals of lesser mental ability may learn more from active participation and response during the presentation of information (Allen, 1975).

In order to be successful in changing operator attitudes and equipment operation behavior, the message itself must recur frequently and reliably to let the operator know what is expected of him (Hammer & Hammer, 1976). In terms of surface mine equipment checkout procedures, this means that the selected method and media must be such that the repetition is feasible, cost effective, and will fit within the context of existing mine operations.

Redundancy of information, either through repeated exposure to the same message or exposure to several different messages with the same intent, has been shown to increase the learning of that information by individuals at all mental ability levels (Allen, 1975). Operationally, this requires that the methods and media selected must be of a nature that permits repetition at a reasonable cost, and in a manner which does not interfere with or add materially to the cost of mine operations.

Consideration was given to the use of an advertising style campaign (e.g., public service advertising) to acquaint the equipment operators with both the requirement for adhering to the checkout procedures and the content of the procedures. Review of the relevant research, however, led to the following conclusions regarding this approach:

> Advertising campaigns are, by definition, passive learning experiences. The message is presented to the target audience who may or may not be exposed to it and who may or may not "attend" to what the message is.
>
> The cost of producing ads, especially for the broadcast media (television and radio), dictates that they be run repeatedly to both put the message before the entire target population, and to maximize their impact on those who have already seen or heard them. To reach some people for the first time, those responsible for the campaign pay the price of boring and even antagonizing other people who are seeing the same message for the twentieth time. Repeated exposure to a message is, as we have already cited (Hammer & Hammer, 1976), necessary for behavior change to occur; however, repeated exposure may cause what has been termed "perceptual defense" and irritation, or even outright rejection of the message.
>
> The requirement for saturation and wide distribution almost always implies a higher cost per response or measurable behavior change than a more active approach.
>
> The logistics associated with the implementation of an advertising type of campaign are complex and costly, e.g., developing the materials, obtaining air time, etc.
>
> The results of safety-oriented public service advertising programs in the past have been disappointing. Fhaner and Hane (1973), reporting on research regarding the effects of mass media advertising campaigns on the use of seat belts, for example, found the following: U.S. and

European data indicate only a 25% to 30% belt usage rate despite extensive public service advertising and a generally favorable public attitude toward safety and safety devices such as seat belts.

However, mass media advertising could be effectively used to make equipment operators and mine management aware that start-of-shift operational inspection procedures are available, very likely will reduce accident rates and thus be of meaningful value to operators and management alike.

Solely printed materials, such as self instructional pamphlets, also were considered. This approach enables the learner to participate in the learning process, but discriminates against functionally illiterate individuals. Additionally, repetition of the materials to be learned cannot be guaranteed since the amount of repetition (i.e., studying) is at the discretion of the learner. Further, reason has shown that, as a rule of thumb, printed instructions and associated text will be understood by the reader only about two-thirds of the time, and this is within minutes of having read the material (Allen, 1975). Couple this with other evidence (Maude, 1974) indicating that approximately 80% of all written material is forgotten within three days, and it is surprising that any information transfer or training actually takes place using solely printed materials.

A highly feasible approach, which is the one recommended as being the cost-effective, is the use of audio-visual training aids. Because of the nature of the information to be presented and other considerations, a tape and slide presentation is recommended. The reasons are:

At least some mines already have obtained tape and slide equipment for use in other training contexts. Thus, such equipment is at least somewhat available. Further, capital costs are relatively low.

Being quite cost-effective, the recommended instructional approach should fit easily into satisfying newly legislated requirements for mine equipment operator training.

The medium is well suited to the functionally illiterate, particularly if the recommended symbolic (e.g., pictorial or schematic) coding of procedural information is adopted.

The medium is well suited to teaching equipment system knowledge that is highly desirable to make the procedures meaningful.

Repetition of information can be controlled. "Over training", which can be desirable, also can be controlled. Interest can be retained through the use of humor and cartooning.

Learner participation can be encouraged by incorporating a workbook for those able to read. Here, too, careful design can minimize the literacy level needed to use the workbook, and humor and cartooning can be used to maintain interest.

Learning feedback can be obtained through simple, but carefully designed tests. Review of test results can then be used to focus additional training or at least alert the learner to areas where he should be particularly attentive in the future.

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CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The first conclusion of this effort is that there is a definite need for operational, start-of-shift, safety-critical, surface mining equipment operational inspection procedures. This conclusion is drawn both from the literature and from interviews with equipment operators, plus manufacturers, dealers and many management and training personnel. Based on interview content, this conclusion is not limited to coal mining operations.

Second, it can be concluded that operator acceptance of the procedures will be high, based on both enthusiasm and the need.

It also can be concluded that the procedures should be presented to equipment operators in two forms. One form is as a pocket sized, plastic laminated checklist that presents the procedures that are unique to the operator's machine type. Also, a permanently mounted, weather-protected abbreviated checklist should appear on the "dashboard" (instrument panel) of each item of equipment. The abbreviated checklists would serve to cue operators to inspection sequence clusters and would facilitate performance of the inspections if the pocket-sized checklist was not readily available.

Finally, it was concluded that the checklists should display required procedural information both verbally and pictorially (symbolically). The latter conclusion stems from the observation that at least some surface mine equipment operators are functionally illiterate, yet, they must not be excluded from benefits the procedures are anticipated to provide.

Recommendations

It is highly recommended that field-usable versions of the inspection procedures be developed. Field-usable means that they should be as concise as possible and presented in pocket-sized, weatherproofed form.

Experimental tape and slide training materials also should be developed to evaluate the effectiveness of alternative ways of sensitizing operators and mine management to the need for equipment inspection, provide operators with needed system knowledge, and present the inspection procedures. Such materials should be developed for various equipment types.

Third, it is recommended that the instructional packages and associated checklists be empirically evaluated to determine their effectiveness and to provide feedback for improving them.

Finally, it is recommended that generalizable guidelines be developed for preparing similar instructional and/or procedural information for other mining applications.

BIBLIOGRAPHY

Allen, W. H. "Intellectual Abilities and Instructional Media Design," AV Communication Review, Vol. 23, No. 2, Summer 1975, Pages 139-170.

Bretz, R., The Selection of Appropriate Communication Media for Instruction: A Guide for Designers of Air Force Technical Training Programs, Rand Corporation, Santa Monica, CA, 1971.

Fhaner, G. and Hane, M. "Seat Belts: Factors Influencing Their Use. A Literature Survey" Accident Analysis and Prevention, Vol. 5, 1973, Pages 27-43.

Folley, J. D., Joyce, R. P. and Mallory, W. J. Fully Proceduralized Job Performance Aids. AFHRL-TR-71-53, Air Force Human Resources Laboratory, Wright-Patterson AFB, Ohio, December 1971.

Hammer, W. C. and Hammer, E. P. "Behavior Modification on the Bottom Line," Organizational Dynamics, Spring 1976, Pages 3-21.

Heinrich, H. W. Industrial Accident Prevention, McGraw-Hill, New York, 1959.

Kamman, R. "The Comprehensibility of Printed Instructions and the Flow Chart Alternative," Human Factors, Vol. 17, No. 2, April 1975, Pages 183-191.

Maude, B. Practical Communications for Managers, Longmans Group, London, 1974.

McLellan, R. R. and Speirer, R. A., Analysis of Fatalities Related to Scoops and Tractors in Underground Bituminous Coal Mines, 1971-1973, U. S. Bureau of Mines, Pittsburgh, PA., 1974.

Miller, W. K., Analysis of Truck Related Fatalities and Disabling Injuries at Metal and Non-Metal Surface Mines, U. S. Bureau of Mines, Pittsburgh, PA., 1974.

Oitto, R. H. and McLellan, R. R., Analysis of Fatal Accidents Involving Front-End Loaders at Metal and Non-Metal Mines, 1972-1974, U. S. Bureau of Mines, Pittsburgh, PA., 1975.

Pynnonen, R. O. and Look, A. D., An Analysis of 44 Recent Fatal Accidents with Front-End Loaders, U. S. Bureau of Mines, Pittsburgh, PA., 1967.

Theodore Barry and Associates, Industrial Engineering Study of Hazards Associated with Surface Coal Mines, U. S. Bureau of Mines, Pittsburgh, PA., 1974.

Van Denput, M.A.E., "Unsafe Habits and Social Pressures," Psychologique Belgique, 1970, Volume 10, No. 1, Pages 99-107.

Zimbardo, P. and Ebbesen, E. B., Influencing Attitudes and Changing Behavior, Addison-Wesley Publishing Company, Reading, Mass., 1970.

APPENDIX A

OPERATIONAL START-OF-SHIFT INSPECTION PROCEDURES

Do this, if the result is this notify your foreman & do not move machine.

PROCEDURE	LOOK FOR
1. Inspect all tires.	- Loose lugnuts. - Serious cuts. - Low tire pressure. - Other persons on/around/under your machine.
2. Remove dirt and trash from cab floor and around controls.	
3. Master switch on. Check all gauges and warning lights.	- Wrong readings.
4. Emergency steering switch on (if so equipped). Turn steering wheel completely to the right then completely to the left, then back to the straight ahead position.	- Jerky or incomplete steering response. - Unusual whining or grinding noises. - Too much play in steering wheel.
5. Emergency steering switch off.	
6. Put transmission in neutral. Start engine. Check all gauges and warning lights.	- Wrong readings.
7. Warm-up engine at least 5 minutes. Throttle to low idle. Check engine operation.	- Rough or uneven running. - Unusual smoke or noises.
8. Turn steering wheel completely to the right then completely to the left, then back to the straight ahead position.	- Jerky or incomplete steering response. - Unusual whining or grinding noises. - Hydraulic oil pressure below operating range. - Too much play in steering wheel.
9. Throttle to half-speed. Check engine operation until air pressure stops building.	- Rough or uneven running.
10. Throttle to low idle. Apply and hold service brakes.	- Lack of "pedal".
11. Observe air pressure gauge (if so equipped).	- Continuous pressure drop after initial rapid drop.
12. Release then reapply and hold brakes.	- Lack of "pedal". - Air pressure below operating range.

Do this, if the result is this notify your foreman & do not move machine.

PROCEDURE	LOOK FOR
13. Put transmission in low forward gear.	- Engine doesn't slow down.
14. Throttle to ¼ power. Release all brake systems except service brakes.	- Machine moving.
15. Set parking/emergency brakes then release service brakes.	- Machine moving.
16. Raise all attachments to position for moving.	
17. Release all brakes. Accelerate machine to approximately 5 mph. Firmly apply service brakes.	- Machine doesn't stop quickly enough. - Machine pulls to one side or the other.
18. Accelerate machine to approximately 5 mph. Apply retarder (if so equipped).	- Machine doesn't slow down.

*NOTE: Make sure the surrounding area is clear of personnel, equipment, and other obstructions.

HAULERS, DIESEL-ELECTRIC

Do this, if the result is this notify your foreman & do not move machine.

PROCEDURE	LOOK FOR
1. Inspect all tires.	- Loose lugnuts. - Serious cuts. - Low tire pressure. - Other persons on/around/ under your machine
2. Remove dirt and trash from cab floor and around controls.	
3. Master switch on. Check all gauges and warning lights.	- Wrong readings. - Voltmeter (if equipped) showing battery charge.
4. Emergency steering switch on (if so equipped). Turn steering wheel completely to the right then completely to the left, then back to the straight ahead position.	- Jerky or incomplete steering response. - Unusual whining or grinding noises. - Too much play in steering wheel.
5. Emergency steering switch off.	
6. Put direction selector in neutral. Start engine. Check all gauges and warning lights.	- Wrong readings.
7. Warm-up engine at least 5 minutes. Throttle to low idle. Check engine operation.	- Rough or uneven running. - Unusual smoke or noises.
8. Turn steering wheel completely to the right then completely to the left, then back to the straight ahead position.	- Jerky or incomplete steering response. - Unusual whining or grinding noises. - Hydraulic oil pressure below operating range. - Too much play in steering wheel.
9. Throttle to high idle. Check engine operation until air pressure stops building.	- Rough or uneven running. - Unusual smoke or noises.
10. Throttle to low idle. Apply and hold service brakes.	- Lack of "pedal".
11. Observe air pressure gauge (if so equipped).	- Continuous pressure drop after initial rapid drop.

Do this, if the result is this notify your foreman & do not move machine.

PROCEDURE	LOOK FOR
12. Release then reapply and hold service brakes.	- Lack of "pedal". - Air pressure below operating range.

*NOTE: Make sure the surrounding area is clear of personnel, equipment, and other obstructions.

13. Release all brake systems except service (mechanical) brakes. Place direction selector in forward.	- Machine moving.
14. Apply parking/emergency brake, then release service brakes (if applicable, repeat this step using trailer brakes).	- Machine moving.
15. Release parking brake, throttle to high idle. Accelerate machine to 3 mph, firmly apply service (mechanical) brakes.	- Machine doesn't stop quickly enough. - Machine pulls to one side or the other.
16. Accelerate machine to about 7 mph, apply dynamic brakes (retarder).	- Machine doesn't slow down.

BOTTOM DUMP HAULERS, SINGLE ENGINE SCRAPERS, ETC.

Do this, if the result is this notify your foreman & do not move machine.

PROCEDURE	LOOK FOR
1. Inspect all tires.	- Loose lugnuts. - Serious cuts. - Low tire pressure. - Other persons on/around/ under your machine.
2. Remove dirt and trash from cab floor and around controls.	
3. Master switch on. Check all gauges and warning lights.	- Wrong readings.
4. Emergency steering switch on (if so equipped). Turn steering wheel completely to the right then completely to the left, then back to the straight ahead position.	- Jerky or incomplete steering response. - Unusual whining or grinding noises. - Too much play in steering wheel.
5. Emergency steering switch off.	
6. Put transmission in neutral. Start engine. Check all gauges and warning lights.	- Wrong readings.
7. Warm-up engine at least 5 minutes. Throttle to low idle. Check engine operation.	- Rough or uneven running. - Unusual smoke or noises.
8. Turn steering wheel completely to the right then completely to the left, then back to the straight ahead position.	- Jerkey or incomplete steering response. - Unusual whining or grinding noises. - Hydraulic oil pressure below operating range. - Too much play in steering wheel.
9. Throttle to half-speed. Check engine operation until air pressure stops building.	- Rough or uneven running. - Unusual smoke or noises.
10. Throttle to low idle. Apply and hold service brakes.	- Lack of "pedal".
11. Observe air pressure gauge (if so equipped).	- Continuous pressure drop after initial rapid drop.
12. Release then reapply and hold service brakes.	- Lack of "pedal". - Air pressure below operating range.

BOTTOM DUMP HAULERS, SINGLE ENGINE SCRAPERS, ETC.

Do this, if the result is this notify your foreman & do not move machine.

PROCEDURE → LOOK FOR

*NOTE: Make sure the surrounding area is clear of personnel, equipment, and other obstructions.

13.	Pur transmission in low forward gear.	- Engine doesn't slow down.
14.	Throttle to ¼ power. Release all brake systems except service brakes.	- Machine moving.
15.	Set parking/emergency brakes then release service brakes.	- Machine moving.
16.	Set trailer brakes (if so equipped), then release parking/emergency brakes. (Repeat this step for each auxiliary brake system).	- Machine moving.
17.	Raise bowl and/or attachments to position for moving.	
18.	Release all brakes. Accelerate machine to approximately 5 mph. Firmly apply service brakes.	- Machine doesn't stop quickly enough. - Machine pulls to one side or the other.
19.	Accelerate machine to approximately 5 mph. Apply retarder (if so equipped).	- Machine doesn't slow down.

Do this, if the result is this notify your foreman & do not move machine.

PROCEDURE	LOOK FOR
1. Inspect all tires.	- Loose lugnuts. - Serious cuts. - Low tire pressure. - Other persons on/around/under your machine.
2. Remove dirt and trash from cab floor and around controls.	
3. Master switch on. Check all gauges and warning lights.	- Wrong readings.
4. Emergency steering switch on (if so equipped). Turn steering wheel completely to the right then completely to the left, then back to the straight ahead position.	- Jerky or incomplete steering response. - Unusual whining or grinding noises. - Too much play in steering wheel.
5. Emergency steering switch off.	
6. Put transmission in neutral. Start engine. Check all gauges and warning lights.	- Wrong readings.
7. Warm-up engine at least 5 minutes. Throttle to low idle. Check engine operation.	- Rough or uneven running. - Unusual smoke or noises.
8. Turn steering wheel completely to the right then completely to the left, then back to the straight ahead position.	- Jerky or incomplete steering response. - Unusual whining or grinding noises. - Hydraulic oil pressure below operating range. - Too much play in steering wheel.
9. Throttle to half-speed. Check engine operation until air pressure stops building.	- Rough or uneven running. - Unusual smoke or noises.
10. Throttle to low idle. Apply and hold service brakes.	- Lack of "pedal".
11. Observe air pressure gauge (if so equipped).	- Continuous pressure drop after initial rapid drop.
12. Release then reapply and hold service brakes.	- Lack of "pedal". - Air pressure below operating range.

Do this, if the result is this notify your foreman & do not move machine.

PROCEDURE	LOOK FOR
*NOTE: Make sure the surrounding area is clear of personnel, equipment, and other obstructions.	
13. Put transmission in low forward gear.	- Engine doesn't slow down.
14. Throttle to ¼ power. Release all brake systems except service brakes.	- Machine moving.
15. Set parking/emergency brakes then release service brakes.	- Machine moving.
16. Set auxiliary brakes (if so equipped), then release parking/emergency brakes. (Repeat this step for each auxiliary brake system).	- Machine moving.
17. Release all brakes. Accelerate machine to approximately 5 mph. Firmly apply service brakes.	- Machine doesn't stop quickly enough. - Machine pulls to one side or the other.
18. Accelerate machine to approximately 5 mph. Apply retarder (if so equipped).	- Machine doesn't slow down.

WHEELED LOADERS/DOZERS, DIESEL

Do this, if the result is this notify your foreman & do not move machine.

	PROCEDURE	LOOK FOR
1.	Inspect all tires.	- Loose lug nuts. - Serious cuts. - Low tire pressure. - Other persons on/around/under your machine.
2.	Inspect engine.	- Deposits of coal dust or other flamable dusts or fluids.
3.	Remove dirt and trash from cab floor and around controls.	
4.	Master switch on. Check all gauges and warning lights.	- Wrong readings.
5.	Put transmission in neutral. Start engine. Check all gauges and warning lights.	- Wrong readings.
6.	Warm-up engine at least 5 minutes. Throttle to low idle. Check engine operation.	- Rough or uneven running. - Unusual smoke or noises.
7.	Turn steering wheel completely to the right then completely to the left, then back to the straight ahead position.	- Jerky or incomplete steering response. - Unusual whining or grinding noises. - Hydraulic oil pressure below operating range. - Too much play in steering wheel.
8.	Throttle to half-speed. Check engine operation until air pressure stops building.	- Rough or uneven running. - Unusual smoke or noises.
9.	Throttle to low idle. Apply and hold service brakes.	- Lack of "pedal".
10.	Observe air pressure gauge (if so equipped).	- Continuous pressure drop after initial rapid drop.
11.	Release then reapply and hold service brakes.	- Lack of "pedal". - Air pressure below operating range.

WHEELED LOADERS/DOZERS, DIESEL

Do this, if the result is this notify your foreman & do not move machine.

PROCEDURE	LOOK FOR
*NOTE: Make sure the surrounding area is clear of personnel, equipment, and other obstructions.	
12. Put transmission in low forward gear.	- Engine doesn't slow down.
13. Throttle to ¼ power. Release all brake systems except service brakes.	- Machine moving.
14. Set parking/emergency brakes then release servive brakes.	- Machine moving.
15. Set auxiliary brakes (if so equipped), then release parking/emergency brakes. (Repeat this step for each auxiliary brake system).	- Machine moving.
16. Raise bucket/blade and/or attachments to position for moving.	
17. Release all brakes. Accelerate machine to approximately 5 mph. Firmly apply service brakes.	- Machine doesn't stop quickly enough. - Machine pulls to one side or the other.

WHEELED LOADERS/DOZERS, DIESEL-ELECTRIC

Do this, if the result is this notify your foreman & do not move machine.

PROCEDURE	LOOK FOR
1. Inspect all tires.	- Loose lug nuts. - Serious cuts. - Low tire pressure. - Other persons on/around/under your machine.
2. Inspect engine and generator/ alternator.	- Deposits of coal dust or other flamable dusts or fluids.
3. Remove dirt and trash from cab floor and around controls.	
4. Master switch on. Check all gauges and warning lights.	- Wrong readings. - Voltmeter (if equipped) showing low battery charge.
5. Put direction selector in neutral. Start engine. Check all gauges and warning lights.	- Wrong readings.
6. Warm-up engine at least 5 minutes. Throttle to low idle. Check engine operation.	- Rough or uneven running. - Unusual smoke or noises.
7. Turn steering wheel completely to the right then completely to the left, then back to the straight ahead position.	- Jerky or incomplete steering response. - Unusual whining or grinding noises. - Hydraulic oil pressure below operating range. - Too much play in steering wheel.
8. Throttle to high idle. Check engine operation until air pressure stops building.	- Rough or uneven running. - Unusual smoke or noises.
9. Throttle to low idle. Apply and hold service (mechanical) brakes.	- Lack of "pedal".
10. Observe air pressure gauge (if so equipped).	- Continuous pressure drop after initial rapid drop.
11. Release then reapply and hold service (mechanical) brakes.	- Lack of "pedal". - Air pressure below operating range.

WHEELED LOADERS/DOZERS, DIESEL-ELECTRIC

Do this, if the result is this notify your foreman & do not move machine.

PROCEDURE	LOOK FOR
*NOTE: Make sure the surrounding area is clear of personnel, equipment, and other obstructions.	
12. Put direction selector in forward range.	
13. Release all brake systems except service (mechanical) brakes.	- Machine moving.
14. Set parking/emergency brakes then release service (mechanical) brakes.	- Machine moving.
15. Raise bucket/blade and/or attachments to position for moving.	
16. Release all brakes. Throttle to high idle. Accelerate machine to approximately 3 mph. Firmly apply service (mechanical) brakes.	- Machine doesn't stop quickly enough. - Machine pulls to one side or the other.
17. Accelerate machine to about 7 mph. Apply dynamic (electric) brakes.	- Machine doesn't stop quickly enough.

COMPACTORS

Do this, if the result is this notify your foreman & do not move machine.

PROCEDURE	LOOK FOR
1. Inspect all wheels.	- Loose lug nuts. - Other persons on/around/under your machine.
2. Inspect engine.	- Deposits of coal dust or other flamable dusts or fluids.
3. Remove dirt and trash from cab floor and around controls.	
4. Master switch on. Check all gauges and warning lights.	- Wrong readings.
5. Put transmission in neutral. Start engine. Check all gauges and warning lights.	- Wrong readings.
6. Warm-up engine at least 5 minutes. Throttle to low idle. Check engine operation.	- Rough or uneven running. - Unusual smoke or noises.
7. Turn steering wheel completely to the right then completely to the left, then back to the straight ahead position.	- Jerky or incomplete steering response. - Unusual whining or grinding noises. - Hydraulic oil pressure below operating range. - Too much play in steering wheel.
8. Throttle to half-speed. Check engine operation until air pressure stops building.	- Rough or uneven running. - Unusual smoke or noises.
9. Throttle to low idle. Apply and hold service brakes.	- Lack of "pedal".
10. Observe air pressure gauge (if so equipped).	- Continuous pressure drop after initial rapid drop.
11. Release then reapply and hold service brakes.	- Lack of "pedal". - Air pressure below operating range.

COMPACTORS

Do this, if the result is this notify your foreman & do not move machine.

PROCEDURE	LOOK FOR

*NOTE: Make sure the surrounding area is clear of personnel, equipment, and other obstructions.

12.	Put transmission in low forward gear.	- Engine doesn't slow down.
13.	Throttle to ¼ power. Release all brake systems except service brakes.	- Machine moving.
14.	Set parking/emergency brakes then release service brakes.	- Machine moving.
15.	Set auxiliary brakes (if so equipped), then release parking/emergency brakes. (Repeat this step for each auxiliary brake system).	- Machine moving.
16.	Raise bucket/blade and/or attachments to position for moving.	
17.	Release all brakes. Accelerate machine to approximately 5 mph. Firmly apply brakes.	- Machine doesn't stop quickly enough. - Machine pulls to one side or the other.

Do this, if the result is this notify your foreman & do not move machine.

PROCEDURE	LOOK FOR
1. Inspect all tires.	- Loose lugnuts. - Serious cuts. - Low tire pressure. - Other persons on/around/ under your machine.
2. Remove dirt and trash from cab floor and around controls.	
3. Master switch on. Check all gauges and warning lights.	- Wrong readings.
4. Emergency steering switch on (if so equipped). Turn steering wheel completely to the right then completely to the left, then back to the straight ahead position.	- Jerky or incomplete steering response. - Unusual whining or grinding noises. - Too much play in steering wheel.
5. Emergency steering switch off.	
6. Put transmissions in neutral. Start engines. Check all gauges and warning lights.	- Wrong readings.
7. Warm-up engines at least 5 minutes. Throttle to low idle. Check operation of each engine.	- Rough or uneven running. - Unusual smoke or noises.
8. Turn steering wheel completely to the right then completely to the left, then back to the straight ahead position.	- Jerky or incomplete steering response. - Unusual whining or grinding noises. - Hydraulic oil pressure below operating range. - Too much play in steering wheel.
9. Throttle both engines to half-speed. Check operation of each engine until pressure stops building.	- Rough or uneven running. - Unusual smoke or noises.
10. Throttle to low idle. Apply and hold service brakes.	- Lack of "pedal".
11. Observe air pressure gauge (if so equipped).	- Continuous pressure drop after initial rapid drop.
12. Release then reapply and hold service brakes.	- Lack of "pedal". - Air pressure below operating range.

Do this, if the result is this notify your foreman & do not move machine.

PROCEDURE	LOOK FOR
13. Put transmissions in low forward gear.	- Engine doesn't slow down.
14. Throttle to ¼ power. Release all brake systems except service brakes.	- Machine moving.
15. Set parking/emergency brakes then release service brakes.	- Machine moving.
16. Set trailer brakes (if so equipped), then release parking/emergency brakes. (Repeat this step for each auxiliary brake system).	- Machine moving.
17. Raise bowl and/or attachments to position for moving.	
18. Release all brakes. Accelerate machine to approximately 5 mph. Firmly apply service brakes.	- Machine doesn't stop quickly enough. - Machine pulls to one side or other.
19. Accelerate machine to approximately 5 mph. Apply retarder (if so equipped).	- Machine doesn't slow down.

*NOTE: Make sure the surrounding area is clear of personnel, equipment, and other obstructions.

Do this, if the result is this notify your foreman & do not move machine.

PROCEDURE	LOOK FOR
1. Look around machine and inspect engines.	- Other persons on/around/ under your machine. - Deposits of coal dust or other flamable dusts or fluids.
2. Remove dirt and trash from cab floor and around controls.	
3. Master switch on. Check all gauges and warning lights.	- Wrong readings.
4. Put transmissions in neutral. Start engines. Check all gauges and warning lights.	- Wrong readings.
5. Warm-up engines at least 5 minutes. Throttle to low idle. Check engine operation.	- Rough or uneven running. - Unusual smoke or noises.
6. Hand throttle to high idle. Check engine operation.	- Rough or uneven running. - Unusual smoke or noises.
7. Engage the decelerator (if so equipped).	- Engine doesn't slow down.
8. Release decelerator and return hand throttle to low idle position.	- Engine doesn't slow down.
9. Apply and hold parking/emergency brake only (if so equipped).	

*NOTE: Make sure the surrounding area is clear of personnel, equipment, and other obstructions.

10. Test braking power against engine power for:	
Automatic Transmissions	
1. Place transmission in low forward gear.	- Engine doesn't slow down when transmission in gear. - Machine moving.
2. Place transmission in neutral.	- Engine doesn't speed-up.
Manual Transmissions	
1. Disengage engine clutch and place transmission in low forward gear.	

Do this, if the result is this notify your foreman & do not move machine.

PROCEDURE	LOOK FOR
2. Engage engine clutch slowly until there is a drop in engine speed.	- Unusual vibrations or noises as clutch engages. - Machine moving.
3. Disengage clutch and place transmission in neutral.	
11. Apply and hold service/steering brakes, then release parking brakes (if so equipped).	
12. Set throttle at ¼ power.	
13. Test braking power against engine power for:	
Automatic Transmission	
1. Place transmission in low forward gear.	- Machine moving.
2. Place transmission in neutral.	
Manual Transmission	
1. Disengage engine clutch and place transmission in low forward gear.	
2. Engage engine clutch slowly until there is a drop in engine speed.	- Machine moving.
3. Disengage clutch and place transmission in neutral.	
14. Raise blade/bucket and other attachments to position for moving.	
15. Place transmission in low, forward gear, release all brakes and place tractor in motion.	
16. Turn gradually to the right then gradually to the left.	- Jerky or incomplete steering response. - Unusual whining or grinding noises. - Too much play in steering controls. - Hydraulic oil pressure below operating range.

Do this, if the result is this notify your foreman & do not move machine.

PROCEDURE	LOOK FOR
1. Look around machine and inspect engines.	- Other persons on/around/ under your machine. - Deposits of coal dust or other flamable dusts or fluids.
2. Remove dirt and trash from cab floor and around control.	
3. Master switch on. Check all gauges and warning lights.	- Wrong readings.
4. Put transmissions in neutral. Start engines. Check all gauges and warning lights.	- Wrong readings.
5. Warm-up engines at least 5 minutes. Throttle to low idle. Check engine operation.	- Rough or uneven running. - Unusual smoke or noises.
6. Hand throttle to high idle. Check engine operation.	- Rough or uneven running. - Unusual smoke or noises.
7. Engage the decelerator (if so equipped).	- Engine doesn't slow down.
8. Release decelerator and return hand throttle to low idle position.	- Engine doesn't slow down.
9. Apply and hold parking/emergency brake only (if so equipped).	

*NOTE: Make sure the surrounding area is clear of personnel, equipment, and other obstructions.

10. Test braking power against engine power for:	
Automatic Transmissions	
1. Place transmission in low forward gear.	- Engine doesn't slow down when transmission in gear. - Machine moving.
2. Place transmission in neutral.	- Engine doesn't speed-up.
Manual Transmissions	
1. Disengage engine clutch and place transmission in low forward gear.	
2. Engage engine clutch slowly until there is a drop in engine speed.	- Unusual vibrations or noises as clutch engages. - Machine moving.

Do this, if the result is this notify your foreman & do not move machine.

PROCEDURE	LOOK FOR
3. Disengage clutch and place transmission in neutral.	
11. Apply and hold service/steering brakes, then release parking brakes (if so equipped).	
12. Set throttle at ¼ power.	
13. Test braking power against engine power for:	
Automatic Transmission	
1. Place transmission in low forward gear.	- Machine moving.
2. Place transmission in neutral.	
Manual Transmission	
1. Disengage engine clutch and place transmission in low forward gear.	
2. Engage engine clutch slowly until there is a drop in engine speed.	- Machine moving.
3. Engage clutch and place transmission in neutral.	
14. Raise blade/bucket and other attachments to position for moving.	
15. Place transmission in low, forward gear, release all brakes and place tractor in motion.	
16. Turn gradually to the right then gradually to the left.	- Jerky or incomplete steering response. - Unusual whining or grinding noises. - Too much play in steering controls. - Hydraulic oil pressure below operating range.
17. Lower boom to full down position. Inspect cables.	- Kinks, fraying or flatspots on cable.

DUAL CRAWLER TRACTORS

Do this, if the result is this notify your foreman & do not move machine.

PROCEDURE	LOOK FOR
1. Look around machine and inspect engines.	- Other persons on/around/ under your machine. - Deposits of coal dust or other flamable dusts or fluids.
2. Remove dirt and trash from cab floor and around controls.	
3. Master switch on. Check all gauges and warning lights.	- Wrong readings.
4. Put transmissions in neutral. Start engines. Check all gauges and warning lights.	- Wrong readings.
5. Warm-up engines at least 5 minutes. Throttle to low idle. Check operation of engines.	- Rough or uneven running. - Unusual smoke or noises.
6. Hand throttle to high idle. Check operation of engines.	- Rough or uneven running. - Unusual smoke or noises.
7. Engage the decelerator (if so equipped).	- Engines don't slow down.
8. Release decelerator and return hand throttle to low idle position.	- Engines don't slow down.
9. Apply and hold parking/emergency brake only (if so equipped).	

*NOTE: Make sure the surrounding area is clear of personnel, equipment, and other obstructions.

10. Place transmissions in low forward gear.	- Engines don't slow down when transmissions in gear. - Machine moving.
11. Place transmissions in neutral.	- Engines don't speed-up.
12. Set throttle at ¼ power.	
13. Apply and hold service/steering brakes, then release parking brakes (if so equipped).	
14. Place transmissions in low forward gear.	- Machine moving.
15. Raise blade/bucket and other attachments to position for moving.	

Do this, if the result is this notify your foreman & do not move machine.

PROCEDURE	LOOK FOR
16. Release all brakes and place tractors in motion.	
17. Turn gradually to the right then gradually to the left.	- Jerky or incomplete steering response. - Unusual whining or grinding noises. - Too much play in steering controls. - Hydraulic oil pressure below operating range.

Do this if the result is this notify your foreman & do not move machine.

PROCEDURE	LOOK FOR
1. Inspect all tires.	- Loose lugnuts. - Serious cuts. - Low tire pressure. - Ohter persons on/around/ under your machine.
2. Remove dirt and trash from cab floor and around controls.	
3. Master switch on. Check all gauges and warning lights.	- Wrong readings.
4. Put transmission in neutral. Start engine. Check all gauges and warning lights.	- Wrong readings.
5. Warm-up engine at least 5 minutes. Throttle to low idle. Check engine operation.	- Rough or uneven running. - Unusual smoke or noises.
6. Turn steering wheel completely to the right then completely to the left, then back to the straight ahead position.	- Jerky or incomplete steering response. - Unusual whining or grinding noises. - Hydraulic oil pressure below operating range. - Too much play in steering wheel.
7. Throttle to high idle. Check engine operation until air pressure stops building.	- Rough or uneven running. - Unusual smoke or noises.
8. Engage the decelerator (if so equipped).	- Engine doesn't slow down.
9. Release decelerator and return hand throttle to low idle position.	- Engine doesn't slow down.
10. Apply and hold service brakes.	- Lack of "pedal".
11. Observe air pressure ga-ge (if so equipped).	- Continuous pressure drop after initial rapid drop.
12. Release then reapply and hold service brakes.	- Lack of "pedal". - Air pressure below operating range.

Do this, if the result is this notify your foreman & do not move machine.

PROCEDURE	LOOK FOR

*NOTE: Make sure the surrounding area is clear of personnel, equipment, and other obstructions.

13.	Put transmissions in low forward gear.	- Engine doesn't slow down.
14.	Throttle to ¼ power. Release all brake systems except service brakes.	- Machine moving.
15.	Set parking/emergency brakes then release service brakes.	- Machine moving.
16.	Set auxiliary brakes (if so equipped), then release parking/emergency brakes. (Repeat this step for each auxiliary brake system).	- Machine moving.
17.	Raise moldboard and/or attachments to position for moving.	
18.	Release all brakes. Accelerate machine to approximately 5 mph. Firmly apply service brakes.	- Machine doesn't stop quickly enough. - Machine pulls to one side or the other.

ON/OFF ROAD REAR DUMP HAULERS, SUPPORT/UTILITY TRUCKS

(Automatic Transmission)

Do this, if the result is this notify your foreman & do not move machine.

PROCEDURE	LOOK FOR
1. Inspect all tires.	- Loose lugnuts. - Serious cuts. - Low tire pressure. - Other persons on/around/ under your machine.
2. Remove dirt and trash from cab floor and around controls.	
3. Master switch on. Check all gauges and warning lights.	- Wrong readings.
4. Emergency steering switch on (if so equipped). Turn steering wheel completely to the right then completely to the left, then back to the straight ahead position.	- Jerky or incomplete steering response. - Unusual whining or grinding noises. - Too much play in steering wheel.
5. Emergency steering switch off.	
6. Put transmission in neutral. Start engine. Check all gauges and warning lights.	- Wrong readings.
7. Warm-up engine at least 5 minutes. Throttle to low idle. Check engine operation.	- Rough or uneven running. - Unusual smoke or noises.
8. Turn steering wheel completely to the right then completely to the left, then back to the straight ahead position.	- Jerky or incomplete steering response. - Unusual whining or grinding noises. - Hydraulic oil pressure below operating range. - Too much play in steering wheel.
9. Throttle to half-speed. Check engine operation until air pressure stops building.	- Rough or uneven running. - Unusual smoke or noises.
10. Throttle to low idle. Apply and hold service brakes.	- Lack of "pedal".
11. Observe air pressure gauge (if so equipped).	- Continuous pressure drop after initial rapid drop.

ON/OFF ROAD REAR DUMP HAULERS, SUPPORT/UTILITY TRUCKS

(Automatic Transmission)

Do this, if the result is this notify your foreman & do not move machine.

PROCEDURE	LOOK FOR
12. Release then reapply and hold service brakes.	- Lack of "pedal". - Air pressure below operating range.
*NOTE: Make sure the surrounding area is clear of personnel, equipment, and other obstructions.	
13. Throttle to ¼ power. Release all brake systems except service brakes.	
14. Place transmission in low forward gear.	- Engine doesn't slow down when transmission in gear. - Machine moving. - Engine doesn't speed-up.
15. Place transmission in neutral.	
16. Set parking/emergency brakes then release service brakes.	
17. Place transmission in low forward gear.	- Machine moving.
18. Place transmission in neutral.	
19. Set auxiliary brakes (if so equipped), then release parking/emergency brakes. (Repeat this and next step for each auxiliary brake system).	
20. Place transmission in low forward gear.	- Machine moving.
21. Release all brakes. Accelerate machine to approximately 5 mph. Firmly apply service brakes.	- Machine doesn't stop quickly enough. - Machine pulls to one side or the other.
22. Accelerate machine to approximately 5 mph. Apply retarder (if so equipped).	- Machine doesn't slow down.

ON/OFF ROAD REAR DUMP HAULERS, SUPPORT/UTILITY TRUCKS

(Manual Transmission)

Do this, if the result is this notify your foreman & do not move machine.

PROCEDURE	LOOK FOR
1. Inspect all tires.	- Loose lugnuts. - Serious cuts. - Low tire pressure. - Other persons on/around/ under your machine.
2. Remove dirt and trash from cab floor and around controls.	
3. Master switch on. Check all gauges and warning lights.	- Wrong readings.
4. Emergency steering switch on (if so equipped). Turn steering wheel completely to the right then completely to the left, then back to the straight ahead position.	- Jerky or incomplete steering response. - Unusual whining or grinding noises. - Too much play in steering wheel.
5. Emergency steering switch off.	
6. Put transmission in neutral. Start engine. Check all gauges and warning lights.	- Wrong readings.
7. Warm-up engine at least 5 minutes. Throttle to low idle. Check engine operation.	- Rough or uneven running. - Unusual smoke or noises.
8. Turn steering wheel completely to the right then completely to the left, then back to the straight ahead position.	- Jerky or incomplete steering response. - Unusual whining or grinding noises. - Hydraulic oil pressure below operating range. - Too much play in steering wheel.
9. Throttle to half-speed. Check engine operation until air pressure stops building.	- Rough or uneven running. - Unusual smoke or noises.
10. Throttle to low idle. Apply and hold service brakes.	- Lack of "pedal".
11. Observe air pressure gauge (if so equipped).	- Continuous pressure drop after initial rapid drop.
12. Release then reapply and hold service brakes.	- Lack of "pedal". - Air pressure below operating range.

ON/OFF ROAD REAR DUMP HAULERS, SUPPORT/UTILITY TRUCKS

(Manual Transmission)

Do this, if the result is this notify your foreman & do not move machine.

PROCEDURE	LOOK FOR
*NOTE: Make sure the surrounding area is clear of personnel, equipment, and other obstructions.	
13. Throttle to ¼ power. Release all brake systems except service brakes.	
14. Disengage engine clutch and place transmission in low forward gear.	
15. Engage engine clutch slowly until there is a drop in engine speed.	- Unusual vibrations or noises as clutch engages. - Machine moving.
16. Disengage clutch and place transmission in neutral.	
17. Set parking/emergency brakes then release service brakes.	
18. Disengage engine clutch and place transmission in low forward gear.	
19. Engage engine clutch slowly until there is a drop in engine speed.	- Machine moving.
20. Disengage clutch and place transmission in neutral.	
21. Set auxiliary brakes (if so equipped), then release parking/emergency brakes. (Repeat this and next step for each auxiliary brake system).	
22. Disengage engine clutch and place transmission in low forward gear.	
23. Engage engine clutch slowly until there is a drop in engine speed.	- Machine moving.
24. Disengage clutch and place transmission in neutral.	
25. Release all brakes. Accelerate machine to approximately 5 mph. Firmly apply service brakes.	- Machine doesn't stop quickly enough. - Machine pulls to one side or the other.
26. Accelerate machine to approximately 5 mph. Apply retarder (if so equipped).	- Machine doesn't slow down.