IC 9009

Bureau of Mines Information Circular/1985

Rollover Protective Structures (ROPS) Inspection and Maintenance Guide

By Stephen A. Swan, Dennis C. Jones, and Kazimir Niziol

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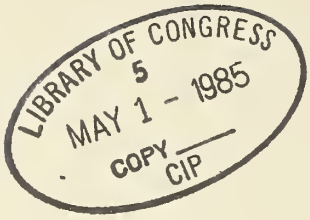

Library of Congress Cataloging in Publication Data:

Swan, Stephen A

Rollover protective structures (ROPS) inspection and maintenance guide.

(Information circular ; 9009)

Supt. of Docs. no.: I 28.27:9009.

I. Mining machinery—Safety measures. I. Jones, Dennis C. II. Niziol, Kazimir. III. Title. IV. Title: Rollover protective structures (ROPS) inspection and maintenance guide. V. Series: Information circular (United States. Bureau of Mines) ; 9009.

~~TN295.U4~~ [TN345] 622s [622'.8] 84-600304

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ILLUSTRATIONS

ROLLOVER PROTECTIVE STRUCTURES (ROPS) INSPECTION AND MAINTENANCE GUIDE

By Stephen A. Swan,[1] Dennis C. Jones,[2] and Kazimir Niziol[3]

ABSTRACT

Bureau of Mines researchers have collected and evaluated rollover protective structures (ROPS) for more than 10 yr. ROPS and falling object protective structures (FOPS) are required on specified mining machines under regulations of the Mine Health and Safety Administration (MSHA). Both ROPS and FOPS are required on mining machines used in surface coal mines and surface areas of underground coal mines (30 CFR 77.403 and 77.413a), and ROPS are required on mining machines used in metal and nonmetal mining operations (30 CFR 55, 56, and 57.9-88).

This illustrated manual provides mine safety personnel, MSHA inspectors, and original-equipment manufacturers with guidelines and a checklist for inspecting ROPS being used in the field. The manual discusses specific requirements of the MSHA regulations and minimum inspection and maintenance checks for ensuring compliance with those regulations. An easily reproducible checklist is provided as an aid to the inspection of ROPS.

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INTRODUCTION

A ROPS is a structure designed to lessen the possibility of a properly belted-in operator being injured in the event of a rollover. ROPS may also offer some protection to the operator if the machine is involved in a collision. A FOPS is a structure designed to protect a machine operator from a falling object or other falling material. ROPS and FOPS are often found in combination, as when a ROPS has a steel plate or a heavy wire mesh as part of its roof (fig. 1). ROPS are designed specifically for each machine model and normally have two, four, or six supporting structural members. A ROPS may be made to fit over the cab (fig. 2), or may be made an integral part of the cab (figs. 3-4). It is not always apparent by looking at the outside of a cab whether or not it is also a ROPS. An inspection must be made *inside the cab* to determine if there are structural members.

In most cases, the machine operator or mine owner is not aware that the protection capability of a ROPS may have been reduced because of a failure to properly correct a deficiency. This manual was prepared to help remedy this situation. It provides a systematic means for identifying deficiencies in ROPS so they can be corrected.

FIGURE 1. - Combination ROPS and FOPS.

FIGURE 2. - ROPS over cab.

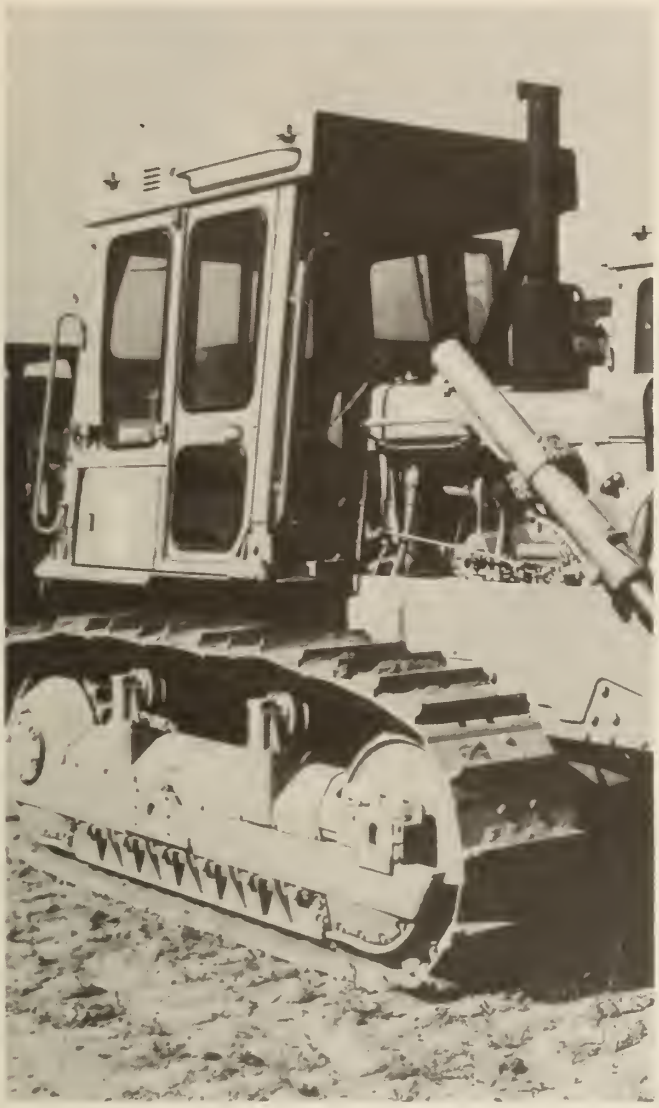

FIGURE 3. - Integral ROPS exterior.

FIGURE 4. - Integral ROPS interior.

TYPES OF MACHINES REQUIRED TO HAVE ROPS AND SEAT BELTS

MSHA regulations require that all rubber-tired or crawler-mounted self-propelled scrapers, loaders, dozers, graders, tractors, and powered industrial trucks must be provided with ROPS and seat belts when used at surface coal mines; surface areas of underground coal mines; metal and nonmetal open pit mines; sand, gravel, and crushed-stone operations; and metal and nonmetal underground mines.

ROPS INSPECTION ITEMS

IDENTIFICATION OR CERTIFICATION LABEL

A ROPS should have an identification or certification label attached to it or a certificate on file at the mine from the ROPS manufacturer or a registered professional engineer with knowledge and experience on ROPS design stating that ROPS meets the performance standards and is appropriate for the machine upon which is is installed. The identification label or certificate, should be examined to ensure that the ROPS meets the applicable MSHA requirements.

MOUNTING PARTS

Bolts and Nuts

Many different grades of bolts and nuts may be used to mount ROPS. However, SAE grades 5 and 8 are the most common. If there is any question concerning the grade of bolts and nuts that should be on the ROPS, the ROPS manufacturer must be consulted. The most common methods of marking grades 5 and 8 bolts and nuts are shown in figures 5 and 6, respectively. As shown in figure 5, bolts may be designated by equivalent International Standards Organization (ISO) grades.

In addition to ensuring that bolts and nuts of the correct SAE grade are used, the following should be checked:

- Are bolts and nuts missing?
- Are bolts and nuts loose?
- Are bolt heads and nuts properly seated in complete contact with ROPS assembly?
- Are nuts fully threaded onto bolts?
- Are bolts and nuts rusted?
- Are bolts and nuts damaged?

Rubber Pads and Bushings

Most ROPS mounts include rubber pads or bushings to reduce vibration of the ROPS (figs. 7-8). The rubber parts should be checked for deterioration, which may be caused by various environmental factors. The most practical way of determining the condition of the rubber pads or bushings is to observe the ROPS mounts for noise or vibration while the machine is in operation.

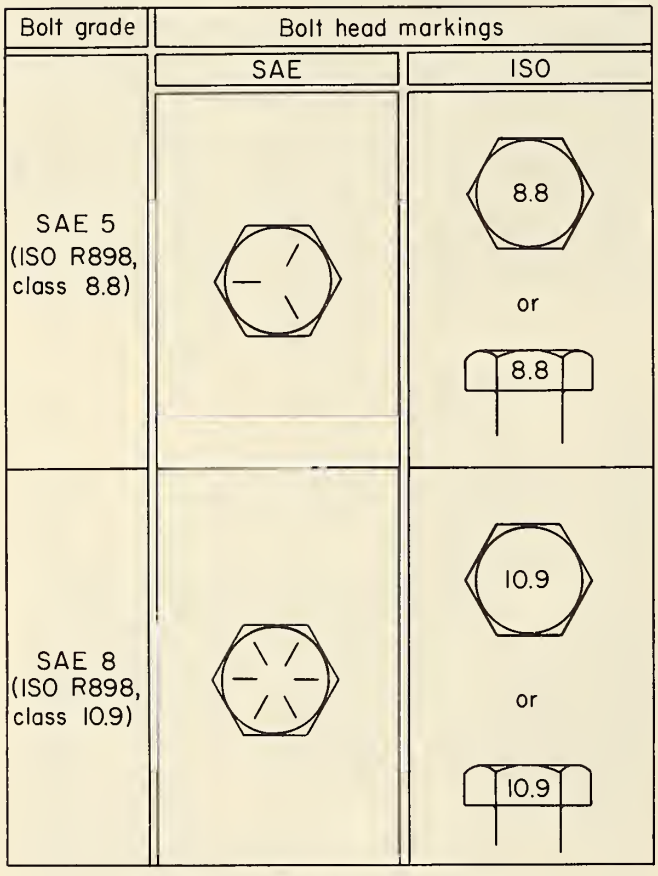

FIGURE 5. - Bolt head markings.

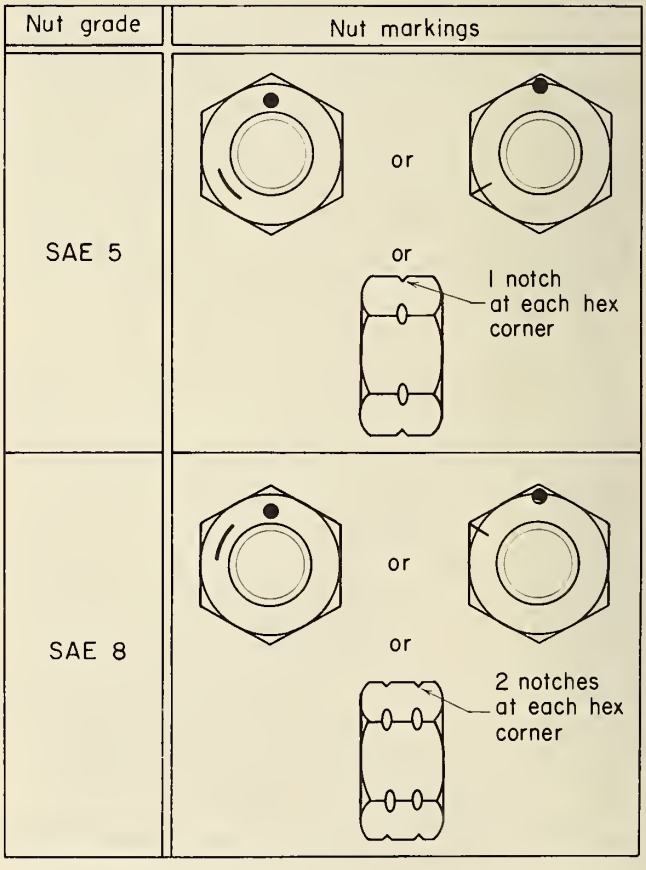

FIGURE 6. - Nut markings.

FIGURE 7. - Rubber pad.

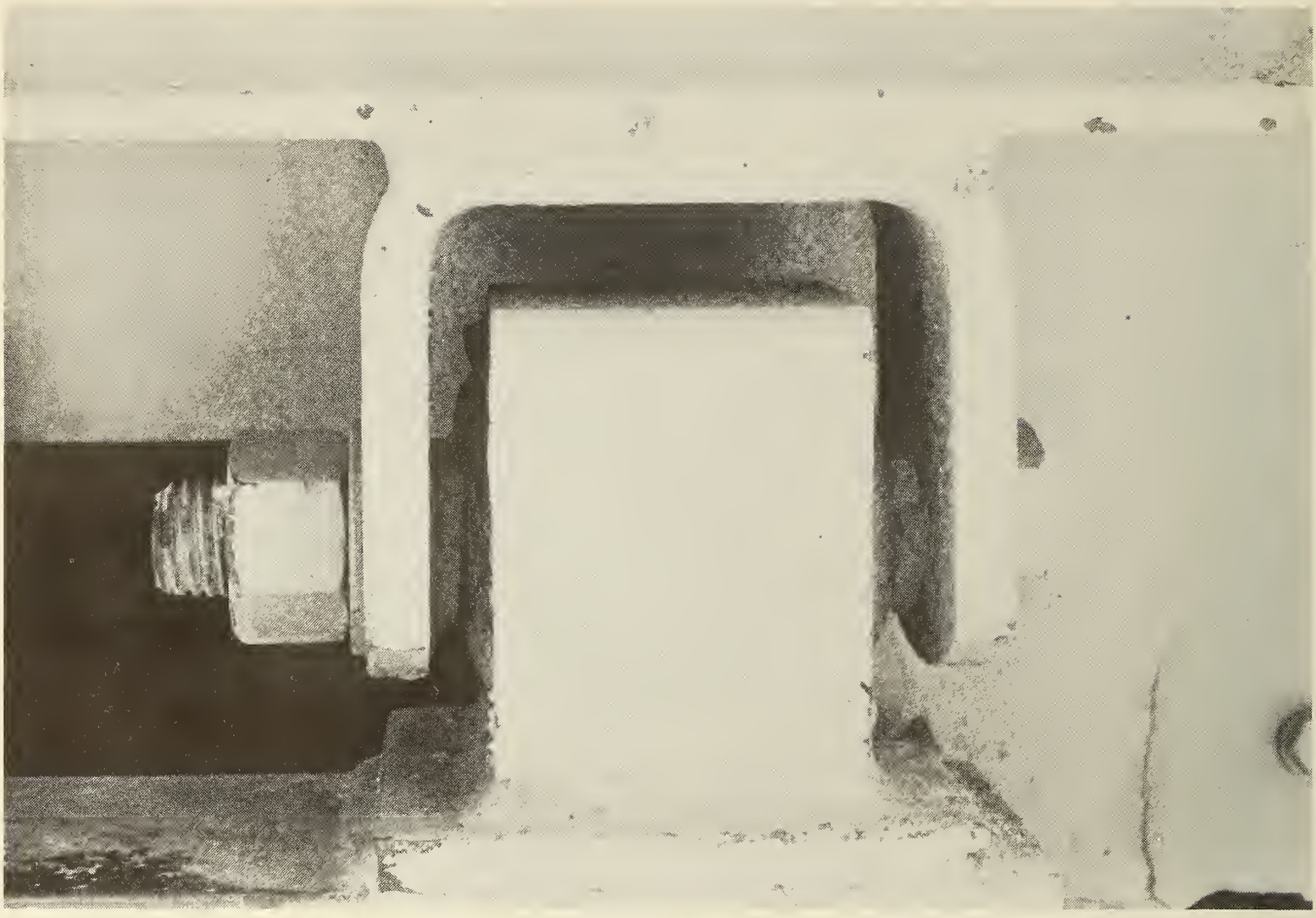

FIGURE 8. - Rubber bushing.

OVERALL CHECK FOR VISIBLE DAMAGE

An overall inspection of the ROPS is necessary in order to locate possible damage that could reduce the integrity of the structure. Examples of such damage are rust, corrosion, overall shape damage, bent members, and cracks in the ROPS structure.

The overall inspection should include the following:

- Inspect the ROPS for any overall shape distortion:

  Door may not close to fit properly.

  Entire ROPS may lean to one side.

  Gaps may be present around windows.

- Inspect individual ROPS structural members to see if they are bent.

- Inspect structural members for visible cracks, bulges, kinks, or dents.

- Inspect ROPS for visible cracks, corrosion, and rust.

As noted above, the overall inspection includes inspection of the entire ROPS structure for visible cracks. Cracks are usually indicated by the presence of corrosion or a rust track on the paint. The most critical areas are around the ROPS mounts and welded areas of the ROPS

structure. Cracks can be caused by accident, vibration (fatigue), by water freezing inside the ROPS tubes, etc. (figs. 9-11). Since freezing water inside the ROPS tubing can cause the tubes to crack, some ROPS are manufactured with drain holes at the bottom of the vertical members.

Visible damage to the ROPS may result when a machine is involved in an accident--rollover, exposure to intense heat, highwall caving, collision, etc. In the event of an accident resulting in visible damage to the ROPS, the ROPS manufacturer should be consulted to determine if the ROPS can be put back into service. Most manufacturers require replacement of the ROPS if it has been damaged.

SEAT BELTS

Mine regulations for coal and for metal and nonmetal mines require a seat belt in addition to ROPS on the specified machines. Therefore, the following should be checked:

- The belt must not be frayed, and it should not be so dirty that its use is discouraged (fig. 12).
- The belt must be attached to the anchors, and the anchors must be in good condition (fig. 13).
- The buckle device must work easily, and the belt length must be quickly and easily adjustable for comfort and safety (fig. 14).

FIGURE 9. - Weld separation (crack).

FIGURE 10. - Crack in ROPS mount.

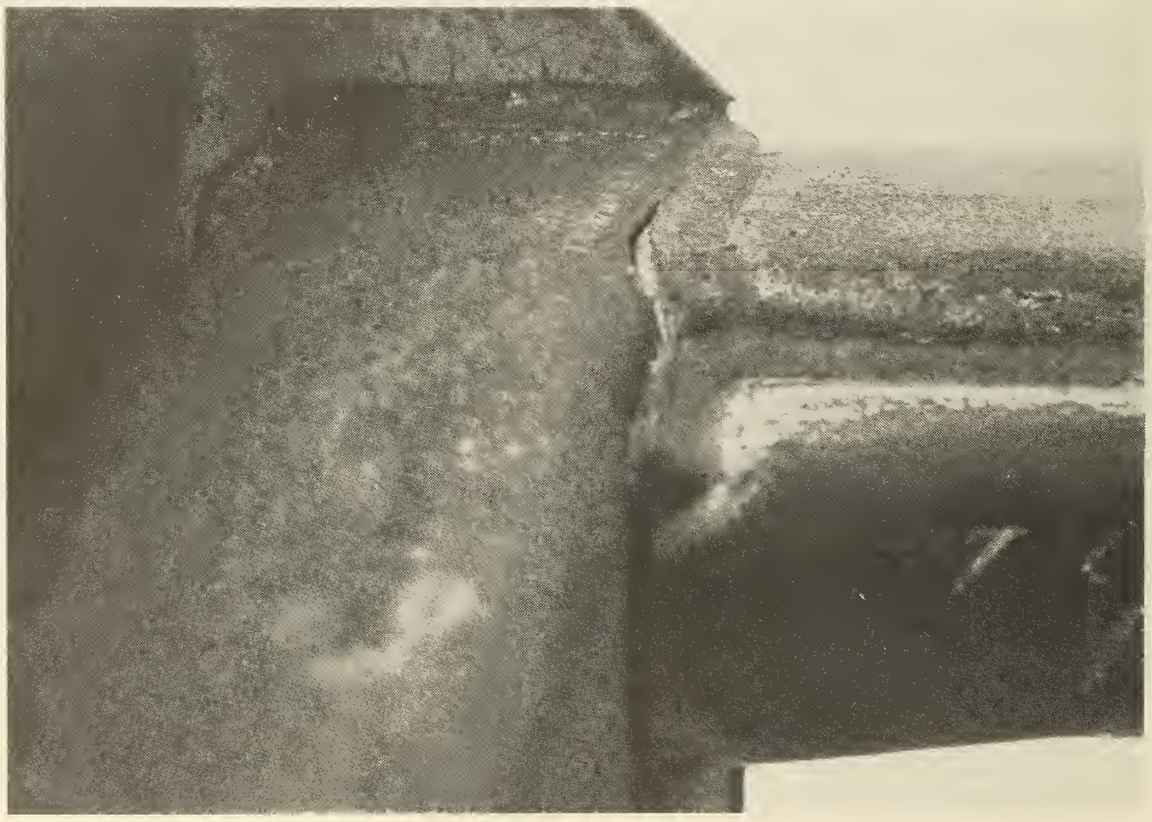

FIGURE 11. - Crack in weldment.

FIGURE 12. - Frayed and dirty seat belt.

FIGURE 13. - Seat belt anchors.

FIGURE 14. - Seat belt buckle.

CHECK FOR IMPROPER REPAIRS AND/OR MODIFICATIONS

All ROPS manufacturers void the certification if the ROPS has been altered, modified, or repaired without their written consent. If the certification is voided by the manufacturer, the ROPS no longer meets the MSHA requirements.

The regulations for coal mines state that all field welding must be performed by welders who are certified by the coal mine operator or equipment distributor in accordance with the American Welding Society Structural Welding Code.

The metal and nonmetal mine regulations state that any alteration, repair, or welding on the ROPS or on the ROPS-to-vehicle frame mounts shall be performed only with prior approval and with instructions from the ROPS manufacturer or a registered professional engineer with knowledge and experience in ROPS design. In addition, the manufacturer or engineer is required to decide what qualifications the welders performing such alterations or repairs must have.

Welds

Welds are one of the most critical areas in determining the overall structural integrity of ROPS. Poor weld appearance is the most obvious indication of a potential weld defect. The most frequent cause of weld defects are carelessness on the part of the welder and poor welding techniques such as using the incorrect welding rod, welding with the improper amount of current, applying an inconsistent amount of weld material to the damaged area, and improper preparation of the damaged area prior to applying the weld.

Welding is a commercial method for joining two metals together and preserving their individual strength characteristics, provided the weld is properly applied. However, if improperly applied, the welding process may cause metallurgical changes in the internal structure of the weld and/or surrounding metals, thereby weakening the respective ROPS members. Environmental conditions are other critical factors to be considered in the welding process.

Unauthorized Field Modifications

Some ROPS are equipped with light fixtures, mirrors, handrails, and fire extinguisher brackets by the manufacturer. Examples of unauthorized field modifications made after a ROPS is placed in service include--

- Welding or bolting accessories to the ROPS.
- Drilling holes in the ROPS.
- Additional welding to change ROPS structure.

Unauthorized field modifications are illustrated in figures 15 through 18.

FIGURE 15. - Unauthorized spot weld.

FIGURE 16. - Unauthorized mount.

FIGURE 17. - Unauthorized alteration of tube. (Note weld.)

INSTRUCTIONS FOR USING ROPS INSPECTION AND MAINTENANCE CHECKLIST

A rule of thumb is to conduct a ROPS inspection every 1,000 h of equipment operation, or sooner if the structure has been subjected to any unusual loads which could cause damage (i.e., rollover, highwall caving, collision, etc.).

An easily reproducible copy of the ROPS inspection and maintenance checklist, which is based on Bureau research findings, follows the "Summary" section of this manual. Using the checklist as a guide, the ROPS should be inspected item by item. Each inspection item should be checked either *yes* or *no*. If a check does not appear in any of the boxes on the checklist, this indicates an unacceptable condition on the ROPS which must be corrected.

Refer to this manual if any questions arise in completing the checklist. Additional information pertaining to a specific ROPS (or FOPS machine) make or model can be obtained from the manufacturer.

SUMMARY

It is not uncommon to find the following deficiencies in ROPS, all of which affect the service life of a ROPS:

- Missing, loose, or inadequate mounting bolts and nuts.
- Deterioration of rubber vibration insulators (pads and bushings).
- Cracks in major structural areas and other structural damage.
- Improper repairs and modifications.

The checklist on pages 14 and 15 details deficiencies in the above-listed categories. This checklist, when used as instructed in this manual, provides a means for the systematic inspection of ROPS to ensure maximum protective capability and conformance with applicable Federal regulations.

FIGURE 18. - Unauthorized mount and tube. (Note welds on tube.)

ROPS INSPECTION AND MAINTENANCE CHECKLIST

Date inspected: _____

Inspected by: _____

Machine type and model number: _____

Serial number: _____

Mine machine identification number: _____

Company and mine name: _____

Mine identification number: _____

NOTE.--The ROPS may have an identification or certification label, but a satisfactory substitute is a certificate from the ROPS manufacturer or a registered professional engineer stating that the ROPS meets the performance standards and is appropriate for the machine upon which it is installed. The following organizations may be referenced on the label or on the professional engineer's certificate:

SAE - Society of Automotive Engineers
MSHA - Mine Safety and Health Administration
OSHA - Occupational Safety and Health Administration
COE - U.S. Army Corps of Engineers
BOR - Bureau of Reclamation
ISO - International Standards Organization
State of California

Inspection item	Yes	No
1. Identification of ROPS		
a. Does the machine have a ROPS?	☐	
b. Is there an identification label on the ROPS or a certificate on file at the mine?	☐	
2. Visible damage		
a. Is the frame twisted, bent, or cracked in the area of the ROPS mount?		☐
b. Is the frame and/or ROPS rusted?		☐
c. Is there any overall shape damage to the Rops?		☐
d. Are there any localized bulges, kinks, dents, or bent parts in the ROPS?		☐
e. Are there any hairline or open cracks anywhere on the ROPS structure?		☐
f. Are there any signs of corrosion?		☐
3. Rubber pads and bushings, if any		
a. Is the rubber damaged or missing?		☐
b. Does the ROPS rattle when the machine is operated?		☐

ROPS INSPECTION AND MAINTENANCE CHECKLIST--Continued

	Yes	No
4. Bolts and nuts		
a. Are there any missing bolts or nuts?		☐
b. Are bolts the proper grade?	☐	
c. Are nuts the proper grade?	☐	
d. Are the bolts and nuts loose?		☐
e. Are the bolt heads and nuts property seated and in complete contact with ROPS assembly?	☐	
f. Are nuts fully threaded onto bolts?	☐	
g. Are the bolt threads stripped?		☐
h. Are the bolts or nuts rusted?		☐
i. Are the bolts or nuts bent or deformed?		☐
5. Seat belt		
a. Is the seat belt missing?		☐
b. Is the belt too dirty to use?		☐
c. Is the belt frayed?		☐
d. Is the belt hard to adjust?		☐
e. Is the buckle hard to work?		☐
f. Are the anchors loose or damaged?		☐
6. Modifications and repairs		
a. Are there accessories welded or bolted to the ROPS that were not provided by the manufacturer?		☐
b. Are there additional holes drilled in the ROPS?		☐
c. Have any additional welds changed the ROPS structure?		☐

☆U.S. GPO: 1985-505-019/20,019

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