

of this section and manufactured or placed in service (owned or operated by the employer) prior to September 1, 1972, shall be fitted with rollover protective structures no later than the dates listed below:

- (i) Machines manufactured on or after January 1, 1972, shall be fitted no later than April 1, 1973.
- (ii) Machines manufactured between July 1, 1971, and December 31, 1971, shall be fitted no later than July 1, 1973.
- (iii) Machines manufactured between July 1, 1970, and June 30, 1971, shall be fitted no later than January 1, 1974.
- (iv) Machines manufactured between July 1, 1969, and June 30, 1970, shall be fitted no later than July 1, 1974.
- (v) Machines manufactured before July 1, 1969: Reserved pending further study, development, and review.

(2) Rollover protective structures and supporting attachment shall meet the minimum performance criteria detailed in §§ 1926.1001 and 1926.1002, as applicable or shall be designed, fabricated, and installed in a manner which will support, based on the ultimate strength of the metal, at least two times the weight of the prime mover applied at the point of impact.

(i) The design objective shall be to minimize the likelihood of a complete overturn and thereby minimize the possibility of the operator being crushed as a result of a rollover or upset.

(ii) The design shall provide a vertical clearance of at least 52 inches from the work deck to the ROPS at the point of ingress or egress.

(d) *Remounting.* ROPS removed for any reason, shall be remounted with equal quality, or better, bolts or welding as required for the original mounting.

(e) *Labeling.* Each ROPS shall have the following information permanently affixed to the structure:

- (1) Manufacturer or fabricator's name and address;
- (2) ROPS model number, if any;
- (3) Machine make, model, or series number that the structure is designed to fit.

(f) *Machines meeting certain existing governmental requirements.* Any machine in use, equipped with rollover protec-

tive structures, shall be deemed in compliance with this section if it meets the rollover protective structure requirements of the State of California, the U.S. Army Corps of Engineers, or the Bureau of Reclamation of the U.S. Department of the Interior in effect on April 5, 1972. The requirements in effect are:

- (1) State of California: Construction Safety Orders, issued by the Department of Industrial Relations pursuant to Division 5, Labor Code, § 6312, State of California.
- (2) U.S. Army Corps of Engineers: General Safety Requirements, EM-385-1-1 (March 1967).
- (3) Bureau of Reclamation, U.S. Department of the Interior: Safety and Health Regulations for Construction, Part II (September 1971).

§ 1926.1001 Minimum performance criteria for rollover protective structures for designated scrapers, loaders, dozers, graders, and crawler tractors.

(a) *General.* This section prescribes minimum performance criteria for rollover protective structures (ROPS) for rubber-tired self-propelled scrapers; rubber-tired front-end loaders and rubber-tired dozers; crawler tractors, and crawler-type loaders, and motor graders. The vehicle and ROPS as a system shall have the structural characteristics prescribed in paragraph (f) of this section for each type of machine described in this paragraph.

(b) The static laboratory test prescribed herein will determine the adequacy of the structures used to protect the operator under the following conditions:

- (1) For rubber-tired self-propelled scrapers, rubber-tired front-end loaders, and rubber-tired dozers: Operating between 0 and 10 miles per hour over hard clay where rollover would be limited to a maximum roll angle of 360° down a slope of 30° maximum.
- (2) For motor graders: Operating between 0 and 10 miles per hour over hard clay where rollover would be limited to 360° down a slope of 30° maximum.
- (3) For crawler tractors and crawler-type loaders: Operating between 0 and 10 miles per hour over hard clay where

rollover would be limited to a maximum roll angle of 360° down a slope of 45°.

(c) *Facilities and apparatus.* (1) The following material is necessary:

(i) Material, equipment, and tiedown means adequate to insure that the ROPS and its vehicle frame absorb the applied energy.

(ii) Equipment necessary to measure and apply loads to the ROPS. Adequate means to measure deflections and lengths should also be provided.

(iii) Recommended, but not mandatory, types of test setups are illustrated in Figure W-1 for all types of equipment to which this section applies; and in Figure W-2 for rubber-tired self-propelled scrapers; Figure W-3 for rubber-tired front-end loaders, rubber-tired dozers, and motor graders; and Figure W-4 for crawler tractors and crawler-type loaders.

(2) Table W-1 contains a listing of the required apparatus for all types of equipment described in paragraph (a) of this section.

TABLE W-1

Means to measure	Accuracy
Deflection of ROPS, inches	±5% of deflection measured.
Vehicle weight, pounds	±5% of the weight measured.
Force applied to frame, pounds ...	±5% of force measured.
Dimensions of critical zone, inches.	±0.5 in.

(d) *Vehicle condition.* The ROPS to be tested must be attached to the vehicle

structure in the same manner as it will be attached during vehicle use. A totally assembled vehicle is not required. However, the vehicle structure and frame which support the ROPS must represent the actual vehicle installation. All normally detachable windows, panels, or nonstructural fittings shall be removed so that they do not contribute to the strength of the ROPS.

(e) *Test procedure.* The test procedure shall include the following, in the sequence indicated:

(1) Energy absorbing capabilities of ROPS shall be verified when loaded laterally by incrementally applying a distributed load to the longitudinal outside top member of the ROPS, as shown in Figure W-1, W-2, or W-3, as applicable. The distributed load must be applied so as to result in approximately uniform deflection of the ROPS. The load increments should correspond with approximately 0.5 in. ROPS deflection increment in the direction of the load application, measured at the ROPS top edge. Should the operator's seat be offcenter, the load shall be applied on the offcenter side. For each applied load increment, the total load (lb.) versus corresponding deflection (in.) shall be plotted, and the area under the load-deflection curve shall be calculated. This area is equal to the energy (in.-lb.) absorbed by the ROPS. For a typical load-deflection curve and calculation method, see Figure W-5.

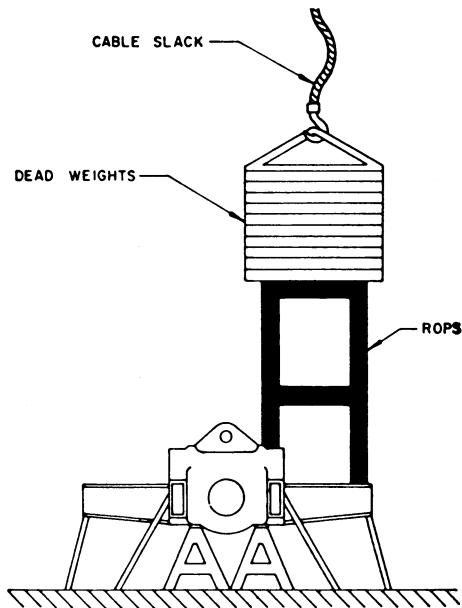


FIGURE W-1—Vertical loading setup for all types of equipment described in § 1518.1001(a).

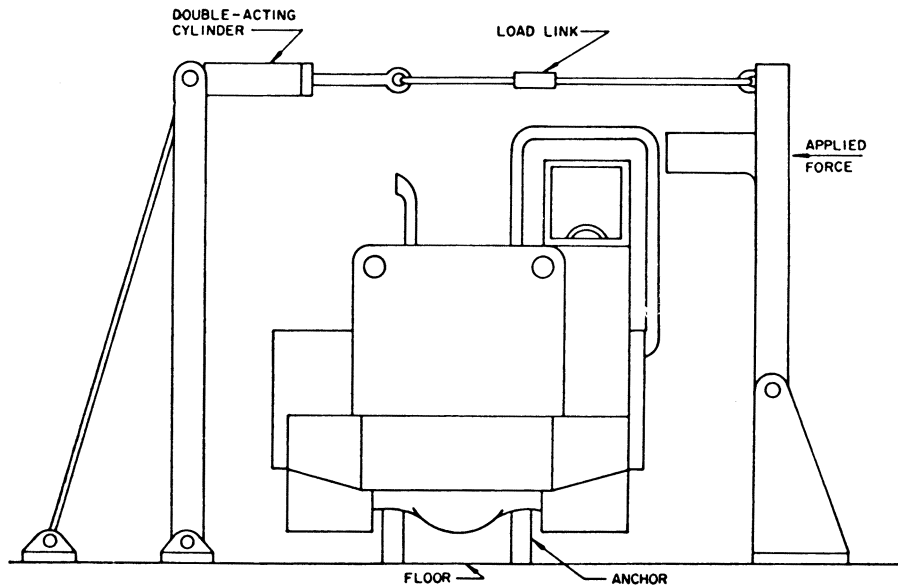


FIGURE W-2—Test setup for rubber-tired self-propelled scrapers.

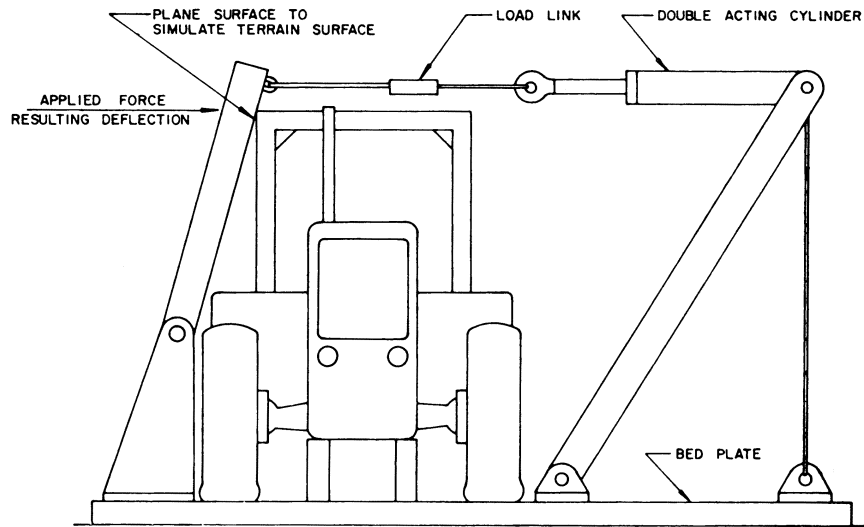


FIGURE W-3—Test setup for rubber-tired front-end loaders, rubber-tired dozers, and motor graders.

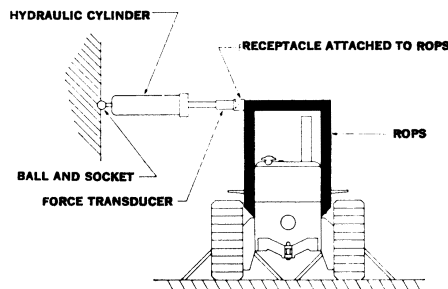


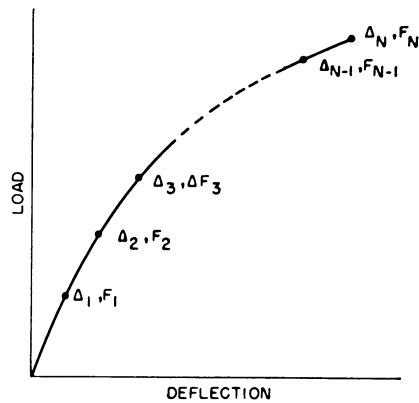
FIGURE W-4—Side-loading setup for crawler tractors and crawler loaders.

Incremental loading shall be continued until the ROPS has absorbed the amount of energy and the minimum applied load specified under paragraph (f) of this section has been reached or surpassed.

(2) To cover the possibility of the vehicle coming to rest on its top, the support capability shall be verified by applying a distributed vertical load to the top of the ROPS so as to result in approximately uniform deflection (see Figure W-1). The load magnitude is specified in paragraph (f)(2)(iii) of this section.

(3) The low temperature impact strength of the material used in the

ROPS shall be verified by suitable material tests or material certification (see paragraph (f)(2)(iv) of this section).



Δ - TOTAL DEFLECTION
F - FORCE APPLIED

$$\text{AREA} = \frac{\Delta_1 F_1}{2} + (\Delta_2 - \Delta_1) \frac{F_1 + F_2}{2} + (\Delta_3 - \Delta_2) \frac{F_2 + F_3}{2} + \dots + (\Delta_N - \Delta_{N-1}) \frac{F_{N-1} + F_N}{2}$$

FIGURE W-5—Determination of energy area under force deflection curve for all types of ROPS equipment defined in § 1926.1001.

(f) *Performance requirements*—(1) *General performance requirements.* (i) No repairs or straightening of any member shall be carried out between each prescribed test.

(ii) During each test, no part of the ROPS shall enter the critical zone as detailed in SAE J397 (1969). Deformation of the ROPS shall not allow the plane of the ground to enter this zone.

(2) *Specific performance requirements.*

(i) The energy requirement for purposes of meeting the requirements of paragraph (e)(1) of this section is to be determined by referring to the plot of the energy versus weight of vehicle (see Figure W-6 for rubber-tired self-propelled scrapers; Figure W-7 for rubber-tired front-end loaders and rubber-tired dozers; Figure W-8 for crawler tractors and crawler-type loaders; and Figure W-9 for motor graders). For purposes of this section, force and weight are measured as pounds (lb.); energy (U) is measured as inch-pounds.

(iii) The load magnitude for purposes of compliance with paragraph (e)(2) of this section is equal to the vehicle weight. The test of load magnitude shall only be made after the requirements of paragraph (f)(2)(i) of this section are met.

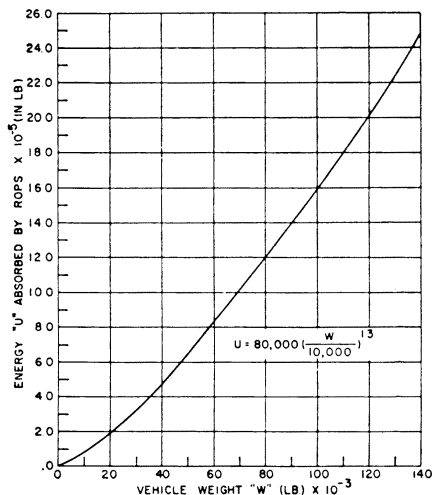


FIGURE W-6—Energy absorbed versus vehicle weight.

(ii) The applied load must attain at least a value which is determined by multiplying the vehicle weight by the corresponding factor shown in Figure W-10 for rubber-tired self-propelled scrapers; in Figure W-11 for rubber-tired front-end loaders and rubber-tired dozers; in Figure W-12 for crawler tractors and crawler-type loaders; and in Figure W-13 for motor graders.

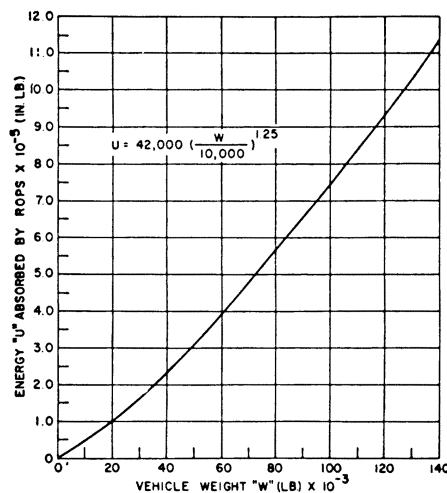


FIGURE W-7—Energy absorbed versus vehicle weight.

(iv) Material used in the ROPS must have the capability of performing at zero degrees Fahrenheit, or exhibit Charpy V notch impact strength of 8 foot-pounds at minus 20 °Fahrenheit.

This is a standard Charpy specimen as described in American Society of Testing and Materials A 370, Methods and Definitions for Mechanical Testing of Steel Products (available at each Regional Office of the Occupational Safety and Health Administration). The purpose of this requirement is to reduce the tendency of brittle fracture associated with dynamic loading, low temperature operation, and stress raisers which cannot be entirely avoided on welded structures.

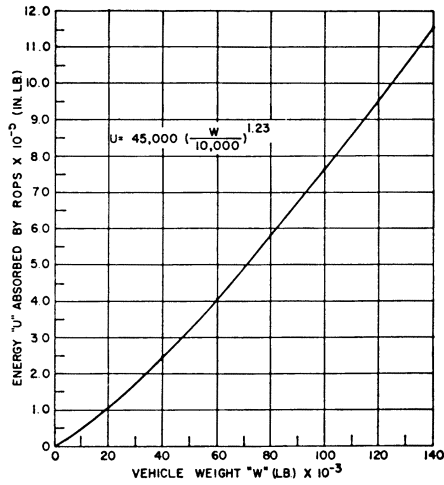


FIGURE W-8—Energy absorbed versus vehicle weight.

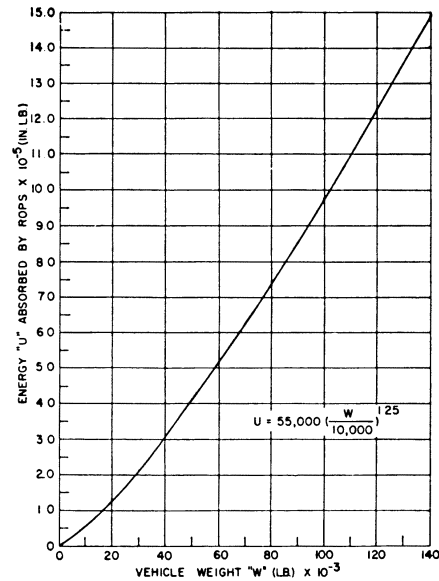


FIGURE W-9—Energy absorbed Versus Vehicle Weight.

(g) *Definitions.* For purposes of this section, “vehicle weight” means the manufacturer’s maximum weight of the prime mover for rubber-tired self-propelled scrapers. For other types of equipment to which this section applies, “vehicle weight” means the manufacturer’s maximum recommended

weight of the vehicle plus the heaviest attachment.

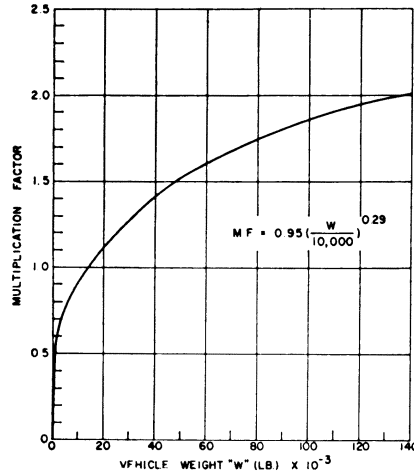


FIGURE W-10—Minimum horizontal load factor for self-propelled scrapers.

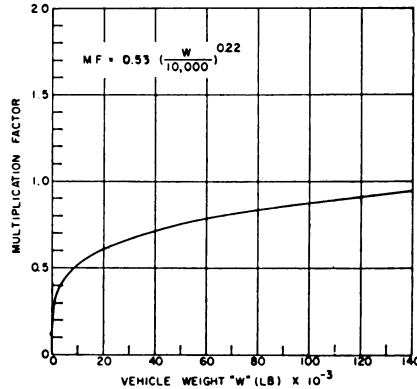


FIGURE W-11—Minimum horizontal load factor for rubber-tired loaders and dozers.

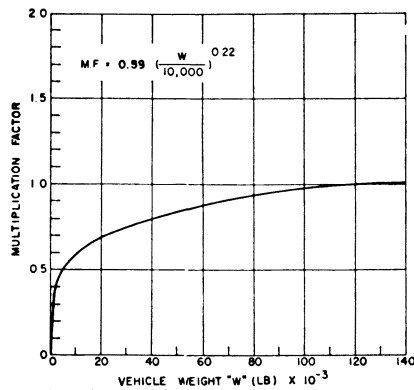


FIGURE W-12—Minimum horizontal load factor for crawler tractors and crawler-type loaders.

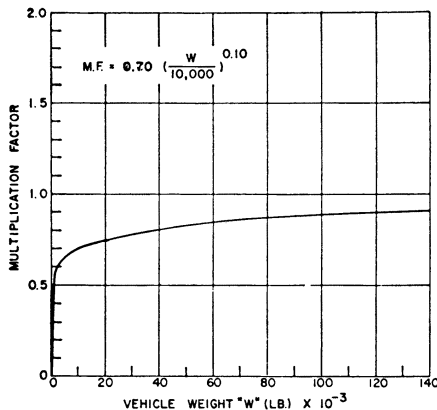


FIGURE W-13—Minimum horizontal load factor for motor graders.

(h) *Source of standard.* This standard is derived from, and restates, the following Society of Automotive Engineers Recommended Practices: SAE J320a, Minimum Performance Criteria for Roll-Over Protective Structure for Rubber-Tired, Self-Propelled Scrapers; SAE J394, Minimum Performance Criteria for Roll-Over Protective Structure for Rubber-Tired Front End Loaders and Rubber-Tired Dozers; SAE J395, Minimum Performance Criteria for Roll-Over Protective Structure for Crawler Tractors and Crawler-Type Loaders; and SAE J396, Minimum Performance Criteria for Roll-Over Protective Structure for Motor Graders. These recommended practices shall be resorted to in the event that questions

of interpretation arise. The recommended practices appear in the 1971 SAE Handbook, which may be examined in each of the Regional Offices of the Occupational Safety and Health Administration.

§ 1926.1002 Protective frames (roll-over protective structures, known as ROPS) for wheel-type agricultural and industrial tractors used in construction.

(a) *General.* (1) The purpose of this section is to set forth requirements for frames used to protect operators of wheel-type agricultural and industrial tractors that will minimize the possibility of operator injury resulting from accidental upsets during normal operation. With respect to agricultural and industrial tractors, the provisions of 29 CFR 1926.1001 and 1926.1003 for rubber-tired dozers and rubber-tired loaders may be used instead of the requirements of this section.

(2) The protective frame that is the subject of this standard is a structure mounted to the tractor that extends above the operator's seat and conforms generally to Figure W-14.

(3) When an overhead weather shield is attached to the protective frame, it may be in place during testing, provided that it does not contribute to the strength of the protective frame. When such an overhead weather shield is attached, it must meet the requirements of paragraph (i) of this section.

(4) For overhead protection requirements, see 29 CFR 1926.1003.

(5) The following provisions address requirements for protective enclosures.

(i) When protective enclosures are used on wheel-type agricultural and industrial tractors, they shall meet the requirements of Society of Automotive Engineers ("SAE") standard J168-1970 ("Protective enclosures—test procedures and performance requirements"), which is incorporated by reference. The incorporation by reference was approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51.

(ii) SAE standard J168-1970 appears in the 1971 SAE Handbook, or it may be examined at: any OSHA Regional Office; the OSHA Docket Office, U.S. Department of Labor, 200 Constitution