CERTIFICATE

By Authority Of
THE UNITED STATES OF AMERICA
Legally Binding Document

By the Authority Vested By Part 5 of the United States Code § 552(a) and Part 1 of the Code of Regulations § 51 the attached document has been duly INCORPORATED BY REFERENCE and shall be considered legally binding upon all citizens and residents of the United States of America. *HEED THIS NOTICE*: Criminal penalties may apply for noncompliance.

Document Name: SAE J334: Protective Frame Test Procedures and Performance Requirements

CFR Section(s): 30 CFR 77.403-1(d)(1)(vi)

Standards Body: Society for Automotive Engineering

APPROVED

Official Incorporator:

THE EXECUTIVE DIRECTOR
OFFICE OF THE FEDERAL REGISTER
WASHINGTON, D.C.

PROTECTIVE FRAME TEST PROCEDURES AND PERFORMANCE REQUIREMENTS — SAE J334a

SAE Standard

Report of Tractor Technical Committee approved April 1968 and last revised July 1970. Conforms to ASAE S306.

1. Purpose—The purpose of this standard is to establish requirements of a frame for the protection of operators on wheel type agricultural and industrial tractors to minimize the possibility of operator injury resulting from accidental upsets during normal operation. General requirements for the protection of operators are specified in SAE J333.

2. Scope

2.1 This standard establishes the test procedures and performance requirements necessary to fulfill the intended purpose.

2.2 Fulfillment of the intended purpose requires two separate test procedures as follows:

2.2.1 A laboratory test, either static or dynamic, under repeatable and controlled loading, to permit analysis of the protective frame to insure compliance with the purpose of the standard.

2.2.2 A field upset under reasonably controlled conditions, both rearward and sideways, to verify the effectiveness of the protective frame under actual dynamic conditions.

2.3 The test procedures and performance requirements outlined in this standard are based on current available engineering data.

3. Definitions

3.1 An agricultural tractor is defined in paragraph 3.1 of SAE J333.

3.2 An industrial tractor is defined in paragraph 3.2 of SAE J333.

3.3 Weight of tractor includes the protective frame, all fuels, and other components required for normal use of the tractor. Ballast must be added if necessary to achieve a minimum total weight of 130 lb (59 kg) per maximum PTO horsepower at rated engine speed. Front end weight must be at least 33 lb (15 kg) per maximum PTO horsepower. (In case PTO horsepower is not available, use 95% of net engine flywheel horsepower.)

4. Description

4.1 Protective Frame—The protective frame to which this standard applies is a structure generally comprising one or more uprights mounted to the tractor, extending above the operator's seat and conforming generally to Fig. 1.

4.2 Overhead Weather Shield—If an overhead weather shield is available for attachment to the protective frame, it may be in place during tests, providing it does not contribute to the strength of the protective frame. If used, it must comply with paragraph 6.1.1.

5. Test Procedures

5.1 General

5.1.1 The procedures are as specified in paragraphs 5.2, 5.3, and 5.4.

5.1.2 The tractor used shall be the tractor with the greatest weight on which the protective frame is to be used.

5.1.3 A new protective frame and mounting connections of the same design shall be used for each test procedure (paragraphs 5.2, 5.3, 5.4).

5.1.4 Instantaneous and permanent frame deformation shall be measured and recorded for each segment of the test. Minimum dimensions during test are specified for each test.

5.1.5 Dimensions relative to the seat are determined with the seat unloaded and adjusted to its highest and most rearward latched position provided for a seated operator.

5.1.6 In case of offset seat, the frame loading shall be on side with

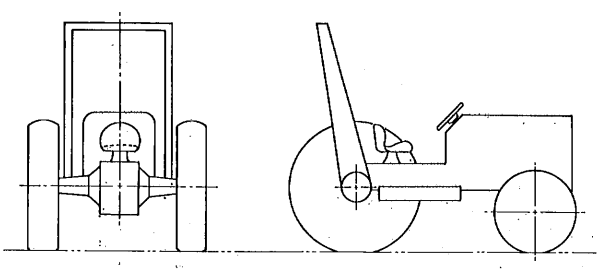

FIG. 1—TYPICAL FRAME CONFIGURATION

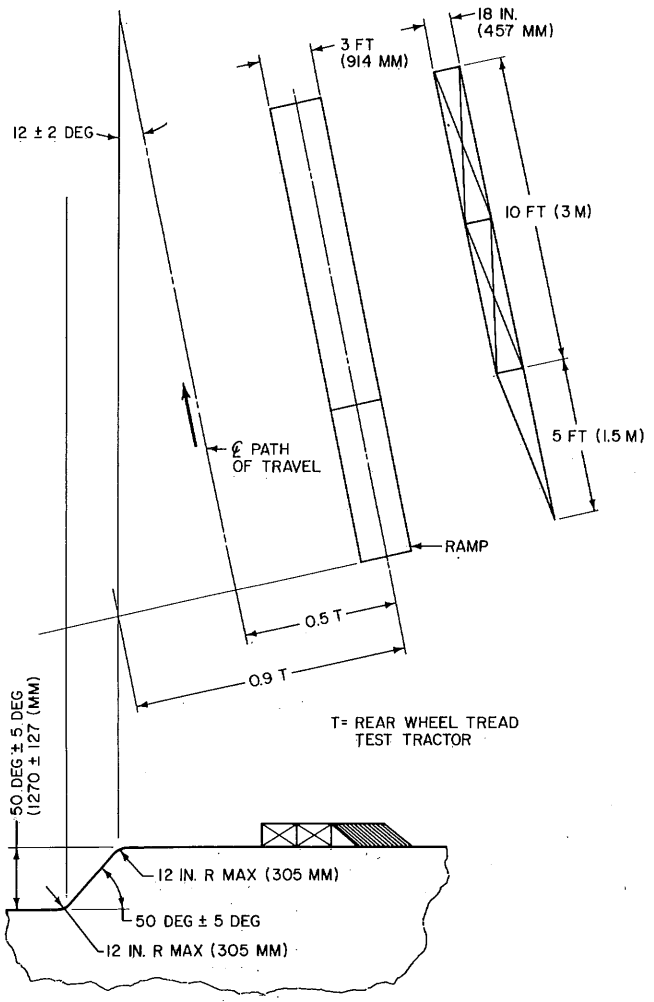

FIG. 2

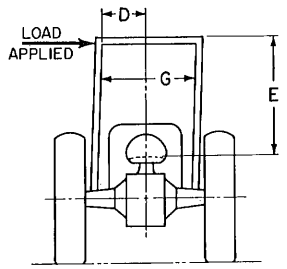

FIG. 3—SIDE LOAD APPLICATION

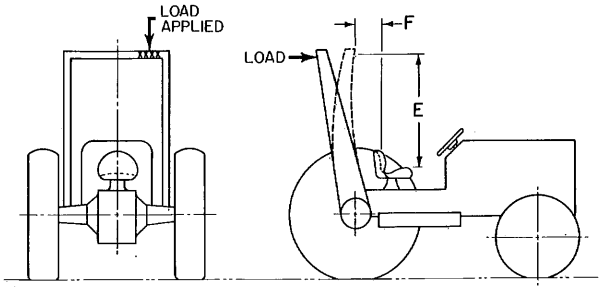

FIG. 4—REAR LOAD APPLICATION

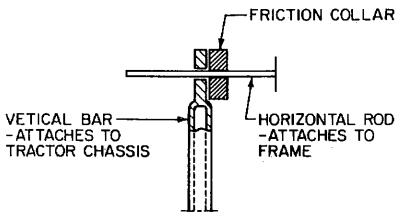

FIG. 5—METHOD OF MEASURING INSTANTANEOUS DEFLECTION

least space between centerline of seat and upright.

5.1.7 Verify the low temperature impact strength of the material used in the protective structure by suitable material tests or material certification.

5.2 Vehicle Overturn Test Procedure

5.2.1 Test Conditions

5.2.1.1 Agricultural tractor as defined in paragraph 3.1 shall be tested at the weight established in paragraph 3.3.

5.2.1.2 Industrial tractor as defined in paragraph 3.2 shall be tested with items of integral or mounted equipment and ballast that are sold as standard equipment or approved by the vehicle manufacturer for use with the vehicle where the protective frame is expected to provide protection for the operator with such equipment installed. The total vehicle weight and front end weight as tested shall not be less than the weights established in paragraph 3.3.

5.2.1.3 The test shall be conducted on a dry, firm soil bank as shown in Fig. 2. The soil in the impact area shall have an average cone index in the 0-6 in. (153 mm) layer not less than 150 per ASAE R313, Soil Cone Penetrometer. The path of travel of vehicle shall be 12 ±2 deg to the top edge of the bank.

5.2.1.4 The upper edge of the bank shall be equipped with an 18 in. (457 mm) high ramp as described and located in Fig. 2 to assist in tipping the vehicle.

5.2.1.5 The front and rear wheel tread settings, where adjustable, shall be at the position nearest to halfway between the minimum and maximum settings obtainable on the vehicle. Where only two settings are obtainable, the minimum setting shall be used.

5.2.2 Vehicle Overturn Tests—Sideways and Rearward

5.2.2.1 The tractor shall be driven under its own power along the specified path of travel at a minimum speed of 10 mph (16 km/hr) or maximum vehicle speed if under 10 mph (16 km/hr) up the ramp as described in paragraph 5.2.1.4 to induce sideways overturn.

5.2.2.2 Rear upset shall be induced by engine power with tractor operating in a gear to obtain 3-5 mph (4.8-8 km/hr) at maximum governed engine rpm preferably by driving forward directly up a minimum slope of two vertical to one horizontal. The engine clutch may be used to aid in inducing the upset.

5.3 Static Test Procedure (optional to paragraph 5.4)

5.3.1 Test Conditions

5.3.1.1 The laboratory mounting base shall include that part of tractor chassis to which the protective frame is attached including the mounting parts.

5.3.1.2 The protective frame shall be instrumented with the necessary equipment to obtain the required load deflection data at location and direction specified in Figs. 3-5.

5.3.1.3 The protective frame and mounting connections shall be instrumented with the necessary recording equipment to obtain the required load-deflection data to be used in paragraph 5.3.3.6.

NOTE: The gages shall be placed on mounting connections before installation load is applied.

5.3.2 Definition of Terms

E_{1s}	= Energy input to be absorbed during side loading. E_{1s} = 723 + 0.4 W ft-lb (E'_{1s} = 100 + 0.12 W' m-kg)
E_{1r}	= Energy input to be absorbed during rear loading. E_{1r} = 0.47 W ft-lb (E'_{1r} = 0.14 W' m-kg)
W	= Tractor weight as defined in paragraphs 3.3 and 5.2.1.2, lb (W', kg).
L	= Static load, lb (kg)
D	= Deflection under L, in. (mm)
L-D	= Static load-deflection diagram.
L_m-D_m	= Modified static load-deflection diagram (Fig. 6). To account for increase in strength due to increase in strain rate, raise L in plastic range to L × K.

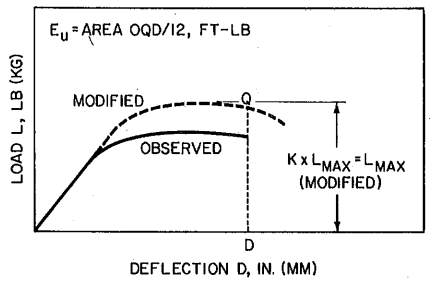

FIG. 6—TYPICAL MODIFIED L_m-D_m DIAGRAM

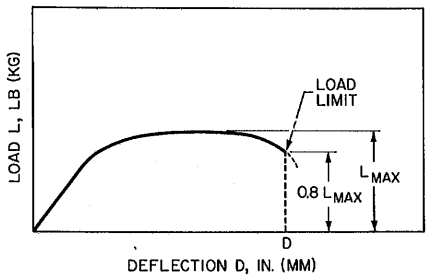

FIG. 7—TYPICAL L-D DIAGRAM

K = Increase in yield strength induced by higher rate of loading (1.3 for hot rolled low carbon steel 1010-1030). Low carbon is preferable; however, if higher carbon or other material is used, K must be determined in the laboratory.[1]

L_{max} = Maximum observed static load

Load Limit = Point on L-D curve where observed static load is 0.8 L_{max} (refer to Fig. 7).

E_u = Strain energy absorbed by the frame, ft-lb (m-kg) area under L_m-D_m curve

FER = Factor of energy ratio, FER = E_u/E_{1s}; also = E_u/E_{1r}

P_b = Maximum observed force in mounting connection under static load, L, lb (kg)

P_u = Ultimate force capacity of mounting connection, lb (kg)

FSB = Design margin for mounting connection FSB = $(P_u/P_b) - 1$

5.3.3 TEST PROCEDURE

5.3.3.1 Side load application shall be at the upper extremity of the frame upright at a 90 deg angle to the centerline of the vehicle. Apply side load L per Fig. 3 and record L and D simultaneously. Stop test when (1) the strain energy absorbed by the frame is equal to the required input energy E_{1s}, or (2) deflection of the frame exceeds the allowable deflection, or (3) frame load limit occurs before the allowable deflection is reached in side load.

5.3.3.2 Using data obtained in paragraph 5.3.3.1 construct the L-D diagram as shown typically in Fig. 7.

5.3.3.3 Construct the modified L_m-D_m diagram as per paragraph 5.3.2 and as shown in Fig. 6. Determine E_u.

5.3.3.4 Calculate E_{1s}.

5.3.3.5 Calculate FER.

5.3.3.6 Calculate FSB.

5.3.3.7 Repeat test procedure on the same frame utilizing L (rear input; see Fig. 4) and E_{1r}. Rear load application shall be uniformly distributed along maximum projected dimension of 27 in. (686 mm) and a maximum area of 160 sq in. (1032 sq cm) normal to the direction of load application. The load shall be applied to the upper extremity of the frame at the point which is midway between the centerline of the seat and the inside of the frame upright.

5.4 Dynamic Procedure (Optional to paragraph 5.3)

5.4.1 TEST CONDITIONS

5.4.1.1 The protective frame and tractor shall comply with paragraph 5.2.1.1 or 5.2.1.2 as appropriate.

[1]Refer to Charles H. Norris, Robert J. Hansen, Myle J. Holley, Jr., John M. Biggs, Saul Namyet, and John K. Minami, *Structural Design for Dynamic Loads*. New York: McGraw-Hill Book Company, Inc., 1959, Chapt. 1, page 3.

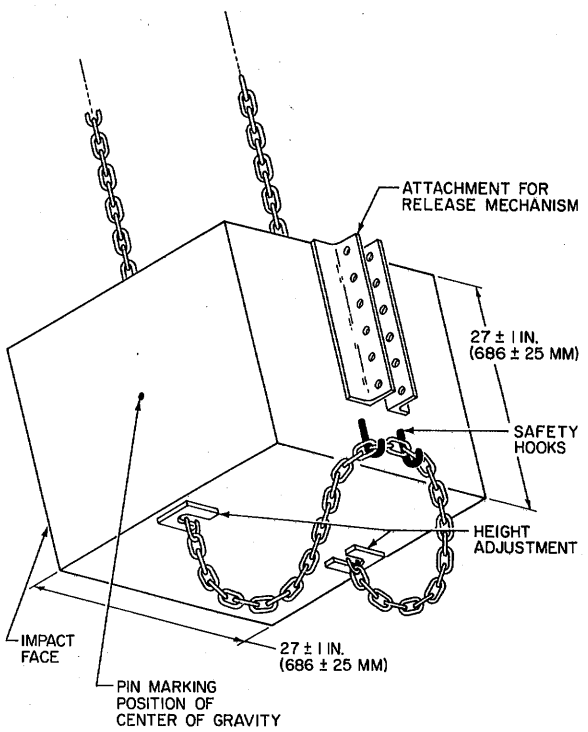

FIG. 8—PENDULUM

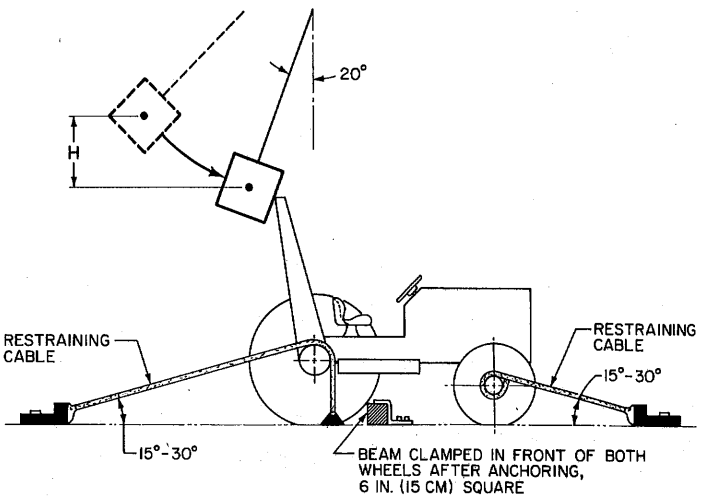

FIG. 9—METHOD OF IMPACT FROM REAR

5.4.1.2 The dynamic loading shall be produced by use of a 4410 lb (2000 kg) weight acting as a pendulum. The impact face of the weight shall be 27 ±1 in. by 27 ±1 in. (686 ±25 mm) and shall be constructed so that its center of gravity is within 1 in. (25.4 mm) of its geometric center. The weight shall be suspended from a pivot point 18-22 ft (5.5-6.7 m) above the point of impact on the frame and shall be conveniently and safely adjustable for height. (See Fig. 8.)

5.4.1.3 For each phase of testing, the tractor shall be restrained from moving when the dynamic load is applied. The restraining members shall be of 0.5-0.63 in. (12.5-16 mm) steel cable and points of attaching restraining members shall be located an appropriate distance behind the rear axle and in front of the front axle to provide a 15-30 deg angle between a restraining cable and the horizontal. The restraining member shall either be in the plane in which the center gravity of the pendulum will swing or more than one restraining cable shall give a resultant force in this plane. (See Fig. 9.)

5.4.1.4 The wheel tread setting shall comply with paragraph 5.2.1.5. The tires shall have no liquid ballast and shall be inflated to the maxi-