

SURFACE VEHICLE RECOMMENDED PRACTICE

Submitted for recognition as an American National Standard

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MINIMUM PERFORMANCE CRITERIA FOR EMERGENCY STEERING OF WHEELD EARTHMOVING CONSTRUCTION MACHINES

1. **Objective**—This SAE Recommended Practice provides minimum performance and test criteria for the emergency steering of specified machines in the event of an engine or steering power source failure. This criteria shall enable machine manufacturers to uniformly evaluate emergency steering capability.
2. **Scope**—This recommended practice is specifically limited to tractor scrapers, wheel loads, wheel tractors, graders, and dumpers (as defined in SAE J1116 (January, 1977) and J1057a (June, 1975)) which are designed to operate at a maximum rated speed in excess of 20.0 km/h (12.4 mph) and which employ power source(s) in addition to the operator control effort to effect machine steering.
3. **Definitions**
 - 3.1 **Steering System**—The means by which the machine is controlled about the vertical axis.
 - 3.2 **Steering Power Source**—The means for generating power to produce steering (e.g., pump, generator, etc.).
 - 3.3 **Steering Control Effort**—The force exerted by the operator when steering the machine. For the steering wheel, this force is considered to be exerted at the rim.
 - 3.4 **Maximum Axle Spacing (MAS)**—The centerline distance from the forward-most axle to the rear-most axle.
 - 3.5 **Tire Track Circle (TTC)**—The outside diameter of the tire track when the machine is steered to its limit and run in a continuous path.
 - 3.6 **Failure**—Sudden and complete loss of the engine or steering power source output.
4. **Performance Criteria**
 - 4.1 In the event of failure of an engine or a steering power source, a means shall be provided to continue maintaining steering control of the machine. As a minimum, the machine must be capable of negotiating the appropriate test course shown in Figure 1.
 - 4.2 The normal means provided the operator for steering control, (e.g., wheel, switch, level, pedal, etc.) of the machine will continue to be used in the event of an engine or a steering power source failure. Emergency steering capability after failure shall be provided without requiring a supplementary operator control function (e.g., turning a switch, pulling a knob, etc.)

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4.3 Required steering wheel effort while negotiating the test courses must be within the acceptable range as specified by Figure 3. All other means of control (switch, lever, pedal, etc.) must not exceed the force levels shown in the Controls Section of Military Equipment and Facilities, MIL-STD-1472.

4.4 A warning device indicating an engine or steering power source failure is required for machines which will not negotiate the Figure 1 test course when using only operator muscular power within the limits of paragraph 4.3 and with no power assist devices. This warning device shall be audible and/or visual and shall actuate after failure. After actuating, the steering capability shall be at least the minimum amount required for one trip through the Figure 1 test course.

A warning device is not required for machines which will negotiate the Figure 1 test course when using only operator muscular power within the limits of paragraph 4.3 and with no power assist devices.

4.5 Emergency steering response, including any time delay introduced by an engine or a steering power source failure, must permit the machine to stay within the boundaries of the Figure 2 test course.

4.6 Machines that have maximum rated speeds in excess of 20.0 km/h (12.4 mph) in reverse must have similar emergency steering capability (force, rate, and duration), in either forward or reverse direction and should be tested in the forward direction. Tests can be conducted in the reverse direction in addition to the forward direction if normal machine use dictates.

4.7 Machines having different steering performance in right and left hand turns must comply with the appropriate Test Courses shown on Figures 1 and 2 and with a mirror image of Figures 1 and 2.

5. Test Course

5.1 The test courses are to be constructed in accordance with Figures 1 and 2 on a compacted or paved surface. A mirror image of either course may be used, provided the steering performance in right and left hand turns is equal.

5.2 The test courses shall not exceed 1½% grade in any direction.

6. Test Procedures

6.1 Test Machine Specifications

6.1.1 All component parameters related to emergency steering capability shall be within the manufacturer's specifications. Machines with optional tire sizes should be tested with the arrangement which requires the greatest amount of steering. This is normally represented by the smallest tire track circle.

6.1.2 Tractor scrapers and dumpers are to be loaded to the manufacturer's gross machine weight ratings and distribution, including the weight of the heaviest combination of attachments approved by the manufacturer.

6.1.3 Wheel loaders, wheel tractors, and graders are to be at manufacturer's empty machine weight ratings and distribution, including the weight of the heaviest combination of attachments approved by the manufacturer.

6.2 The tire track circle (used in calculating the test course dimensions) is to be determined as follows:

6.2.1 Use only the steering capability provided by the primary steering control means (e.g., steering wheel).

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6.2.2 The tire track circle is to be determined on the same ground surface conditions (grade, rolling resistance, tractive coefficient, etc.) on which the test courses are to be constructed.

6.2.3 The machine is to be steered to its limit and driven in a continuous circular path between 2.0 and 4.0 km/h inclusive in order to describe the tire track paths on the ground surface. The tire track circle is the maximum diameter of the described paths. Suitable marking devices may be used in lieu of the actual tire print to establish the tire track path.

For the following machines as classified in SAE J1057a (June, 1975) and similar configurations; 4.1.1.4, 4.2.1.1, 4.3.1.2, 4.3.1.3, 4.3.1.4, 5.1.3, 5.1.4, 5.1.5, 5.2.3, and 5.2.4 the tire track circle should be determined for only the leading unit (prime mover) which excludes possible steering top interference between the prime mover and the trailing units.

6.2.4 For machines with different right and left hand steering capabilities, use the smaller tire track circle in calculating the test course dimensions.

6.3 The machine is to be driven through the Figure 1 test course with a steering power source inactive (to simulate a power source failure). Other machine functions, which might be automatically triggered by the simulated steering power source failure and thus affect driving through the test course, may be rendered inoperative providing such action does not increase the emergency steering capability above the level normally available.

6.3.1 At 8.0 km/h (5.0 mph) \pm 15% to verify the emergency steering force and duration. Tire tracks must stay within the test course boundaries except for the tire tracks of the trailing unit(s) for the following machines as classified in SAE J1057a (June, 1975) and similar configurations; 4.1.1.4, 4.2.1.1, 4.3.1.2, 4.3.1.3, 4.3.1.4, 5.1.3, 5.1.4, 5.1.5, 5.2.3, and 5.2.4.

6.3.2 At 16.0 km/h (10.0 mph) \pm 15% to verify the emergency steering force and rate. Tire tracks must stay within the test course boundaries except for the tire tracks of the trailing unit(s) for the following machines as classified in SAE J1057a (June, 1975) and similar configurations; 4.1.1.4, 4.2.1.1, 4.3.1.2, 4.3.1.3, 4.3.1.4, 5.1.3, 5.1.4, 5.1.5, 5.2.3, and 5.2.4.

6.4 Verify that the steering wheel or steering control effort required to steer through the Figure 1 test course does not exceed levels described in paragraph 4.3.

6.5 Verify the warning function as described in paragraph 4.4.

6.6 Verify the emergency steering response as described in paragraph 4.5 by driving the machine through the test course shown in Figure 2 at 16.0 km/h (10.0 mph) \pm 15%. Enter the test course with full steering system capability. Initiate a turn at Line a. Start of steering control actuation should trigger a ground marker located under the front axle, and simultaneously simulate a steering power source failure. The machine must complete a 90 degree turn with the tire track paths remaining within the boundaries specified.

This verification is not required for steering systems which experience no time delay introduced by an engine or steering power source failure.

PREPARED BY THE SAE OFF-ROAD MACHINERY TECHNICAL COMMITTEE

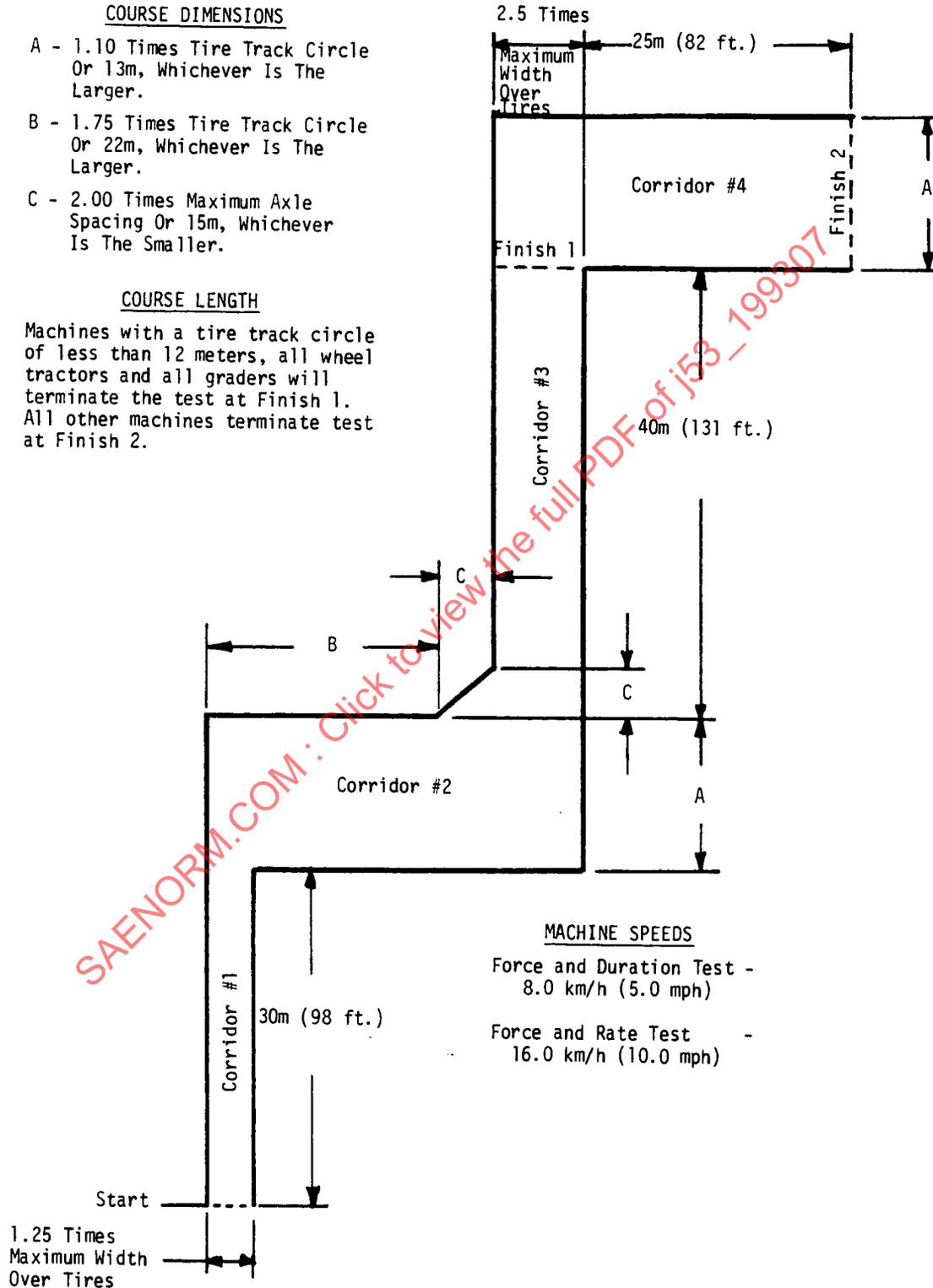
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COURSE DIMENSIONS

- A - 1.10 Times Tire Track Circle Or 13m, Whichever Is The Larger.
- B - 1.75 Times Tire Track Circle Or 22m, Whichever Is The Larger.
- C - 2.00 Times Maximum Axle Spacing Or 15m, Whichever Is The Smaller.

COURSE LENGTH

Machines with a tire track circle of less than 12 meters, all wheel tractors and all graders will terminate the test at Finish 1. All other machines terminate test at Finish 2.



MACHINE SPEEDS

- Force and Duration Test - 8.0 km/h (5.0 mph)
- Force and Rate Test - 16.0 km/h (10.0 mph)

FIGURE 1—EMERGENCY STEERING FORCE, RATE, AND DURATION TEST COURSE

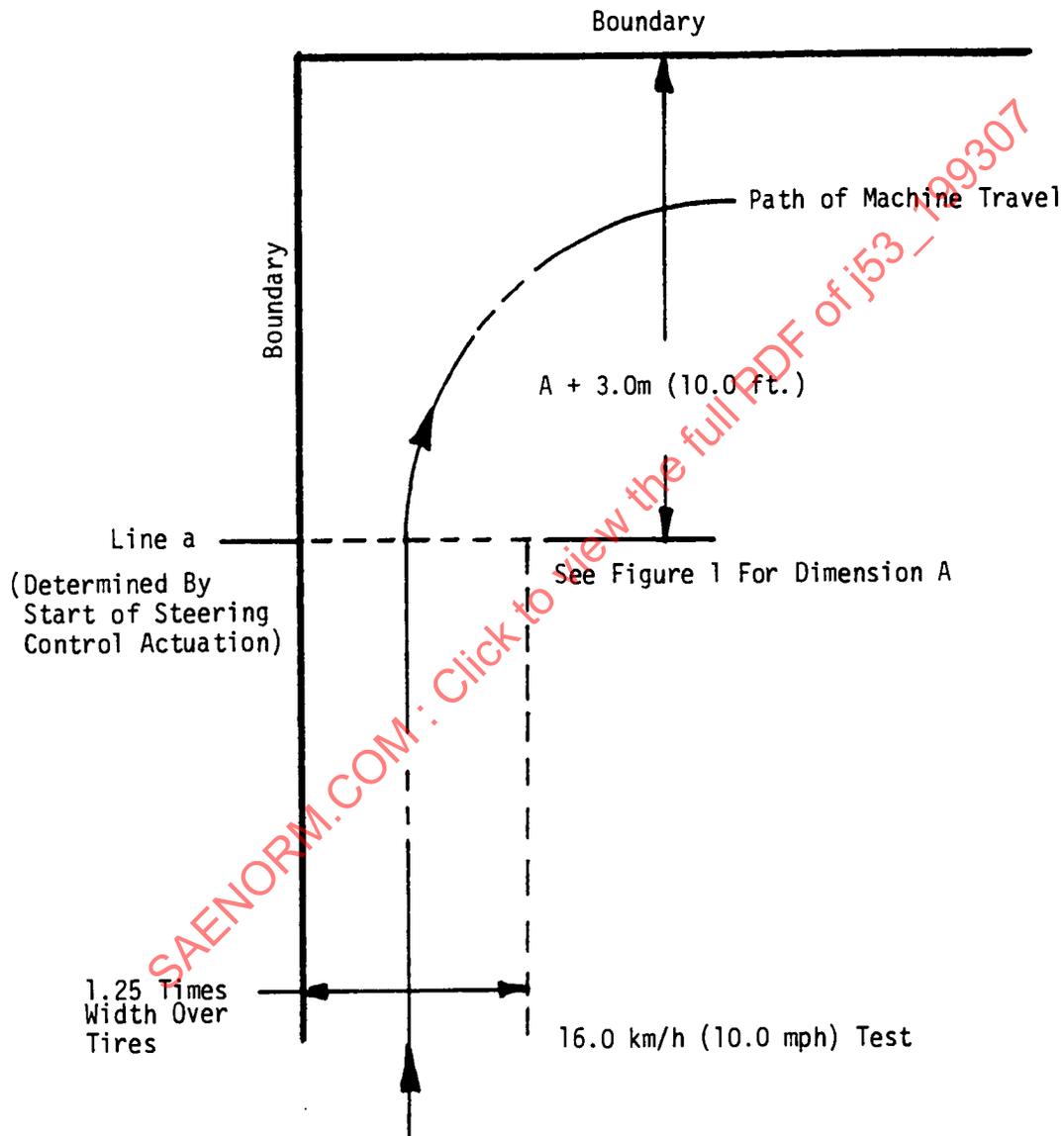


FIGURE 2—EMERGENCY STEERING RESPONSE TEST COURSE