BS ISO 789-3:2015

BSI Standards Publication

Agricultural tractors — Test procedures

Part 3: Turning and clearance diameters

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National foreword

This British Standard is the UK implementation of ISO 789-3:2015. It supersedes BS 6347-3:1983 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee AGE/6, Agricultural tractors and forestry machinery.

A list of organizations represented on this committee can be obtained on request to its secretary.

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INTERNATIONAL STANDARD

ISO 789-3

Third edition
2015-09-01

Agricultural tractors — Test procedures —

Part 3: Turning and clearance diameters

Tracteurs agricoles — Méthodes d'essai —

Partie 3: Diamètres de braquage et de dégagement

Reference number
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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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The committee responsible for this document is ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee 2, *Common tests*.

This third edition cancels and replaces the second edition (ISO 789-3:1993), which has been technically revised.

ISO 789 consists of the following parts, under the general title *Agricultural tractors — Test procedures*:

— *Part 1: Power tests for power take-off*

— *Part 2: Rear three-point linkage lifting capacity*

— *Part 3: Turning and clearance diameters*

— *Part 4: Measurement of exhaust smoke*

— *Part 5: Partial power PT0 – Non-mechanically transmitted power*

— *Part 6: Centre of gravity*

— *Part 7: Axle power determination*

— *Part 8: Engine air cleaner*

— *Part 9: Power tests for drawbar*

— *Part 11: Steering capability of wheeled tractors*

— *Part 12: Low temperature starting*

ISO/OECD 789 consists of the following parts, under the general title *Agricultural tractors – Test procedures*:

— *Part 10: Hydraulic power at tractor/implement interface*

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INTERNATIONAL STANDARD ISO 789-3:2015(E)

Agricultural tractors — Test procedures —

Part 3: Turning and clearance diameters

1 Scope

This part of ISO 789 specifies a method of determining the turning and clearance diameters of wheeled agricultural tractors.

It applies to wheeled agricultural tractors having at least two axles fitted with pneumatic tyres.

2 Terms and definitions

For the purpose of this document, the following terms and definitions apply.

2.1
agricultural tractor
self-propelled agricultural vehicle having at least two axles and wheels, or endless tracks, particularly designed to pull agricultural trailers and to pull, push, carry and operate implements used for agricultural work (including forestry work), which may be provided with detachable loading platform

Note 1 to entry: The agricultural vehicle has a maximum design speed of not less than 6 km/h and may be equipped with one or more seats.

[SOURCE: ISO 12934:2013, 3.1]

2.2
track
tread
<wheeled tractor> distance at ground level between two vertical planes passing through the centreline of ground contact of the tires parallel to the median plane of the tractor with the wheels in the straight ahead position

Note 1 to entry: In the case of dual wheels, it is the distance at ground level between two planes passing through the centreline of the dual wheels.

Note 2 to entry: See Figure 1.

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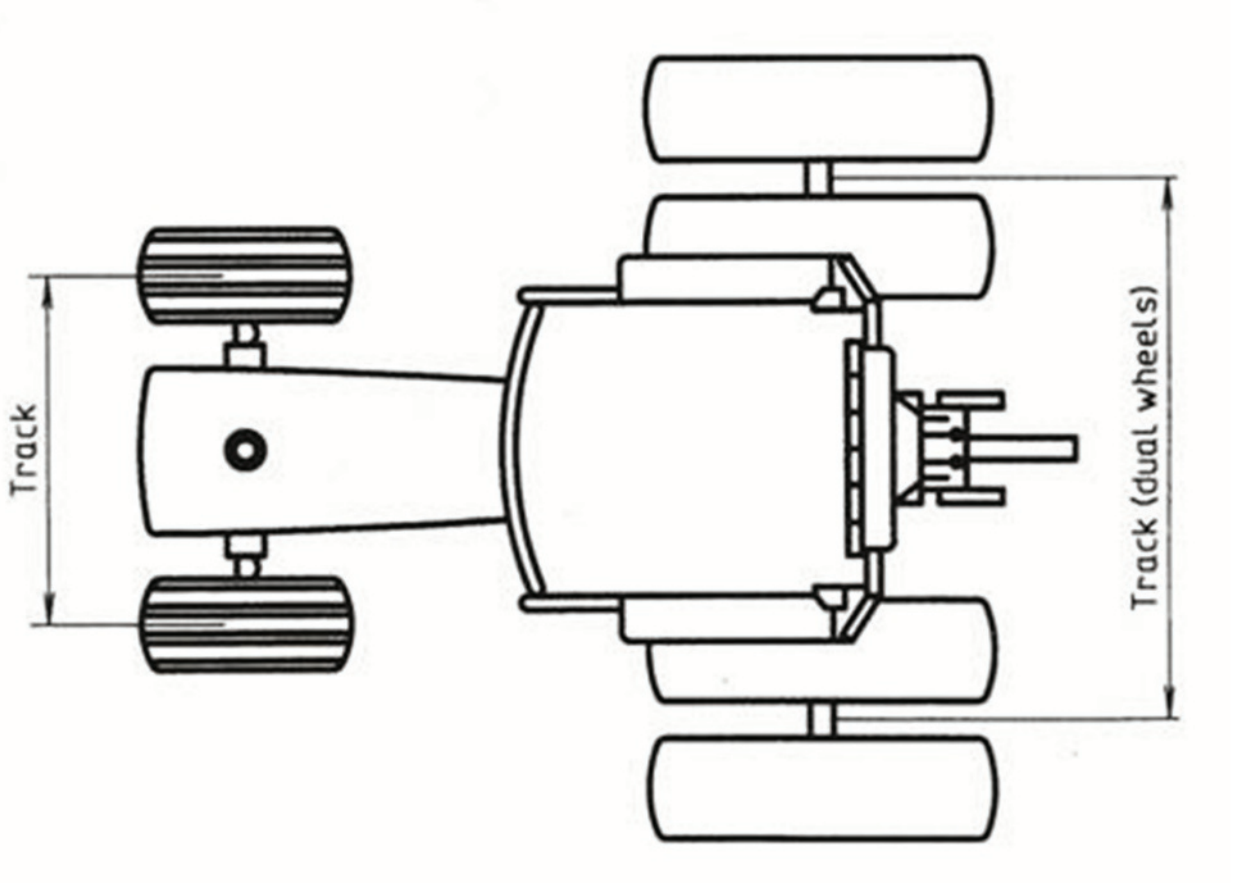

Figure 1 — Track (tread) of the wheeled tractor

2.3
wheelbase
horizontal distance between the two vertical planes passing through the rotational centrelines of the wheels, where one plane is for the front wheels and the other for the rear wheels

Note 1 to entry: In the case of a tractor equipped with a rear tandem, it is the distance between two vertical planes passing through the centres of the front wheel and the vertical plane midway between the wheel centres of the two axles of the tandem.

Note 2 to entry: See Figure 2.

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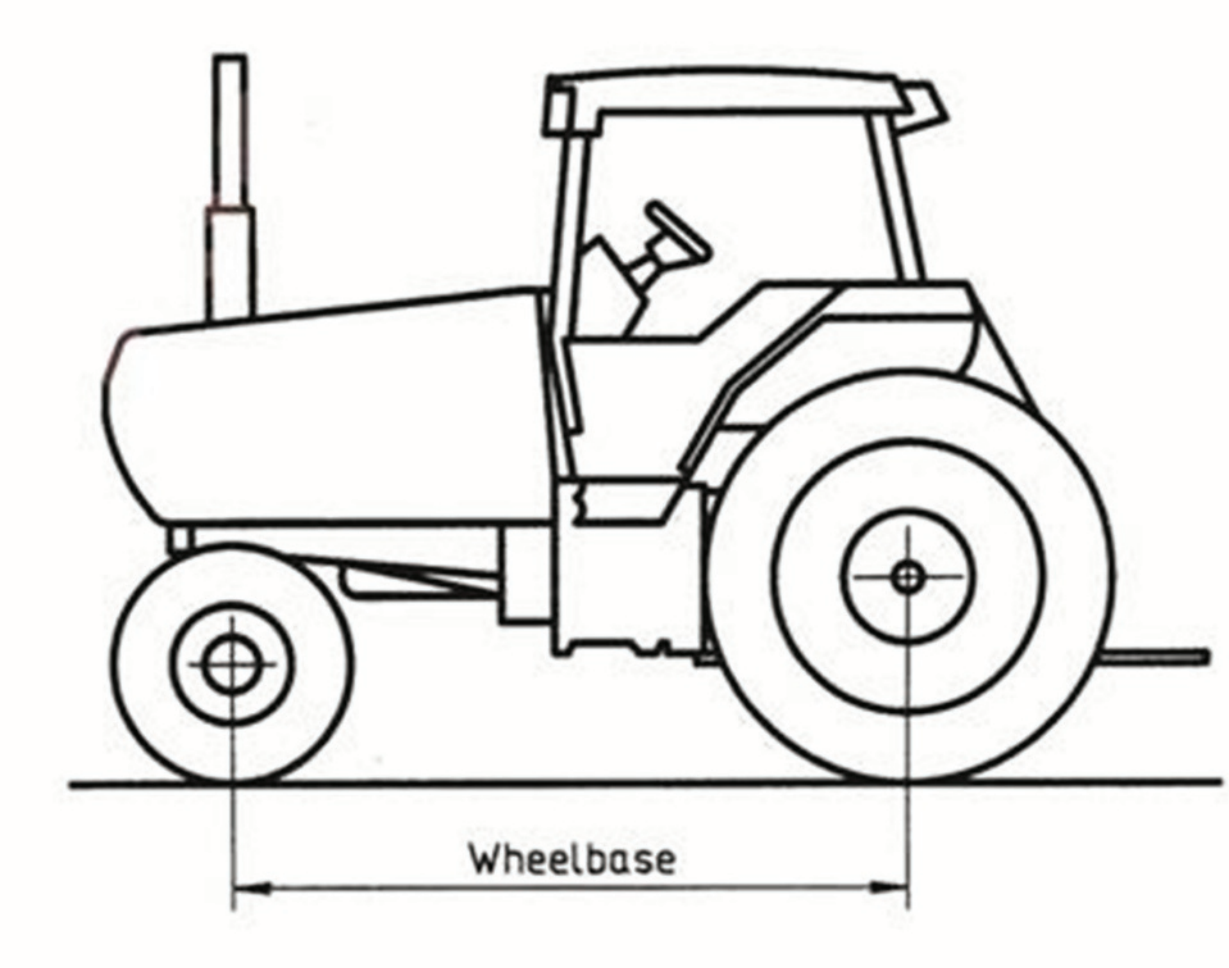

Figure 2 — Wheelbase of the wheeled tractor

2.4
turning diameter
diameter of the circular path described by the centre of tire contact with the surface of the test site of the wheel describing the largest circle when the tractor is executing its sharpest practicable turn under the test conditions described in Clause 5

Note 1 to entry: See Figure 3.

2.5
clearance diameter
diameter of the smallest circle which will enclose the outermost points of projection of the tractor and its equipment while executing its sharpest practicable turn

Note 1 to entry: See Figure 3.

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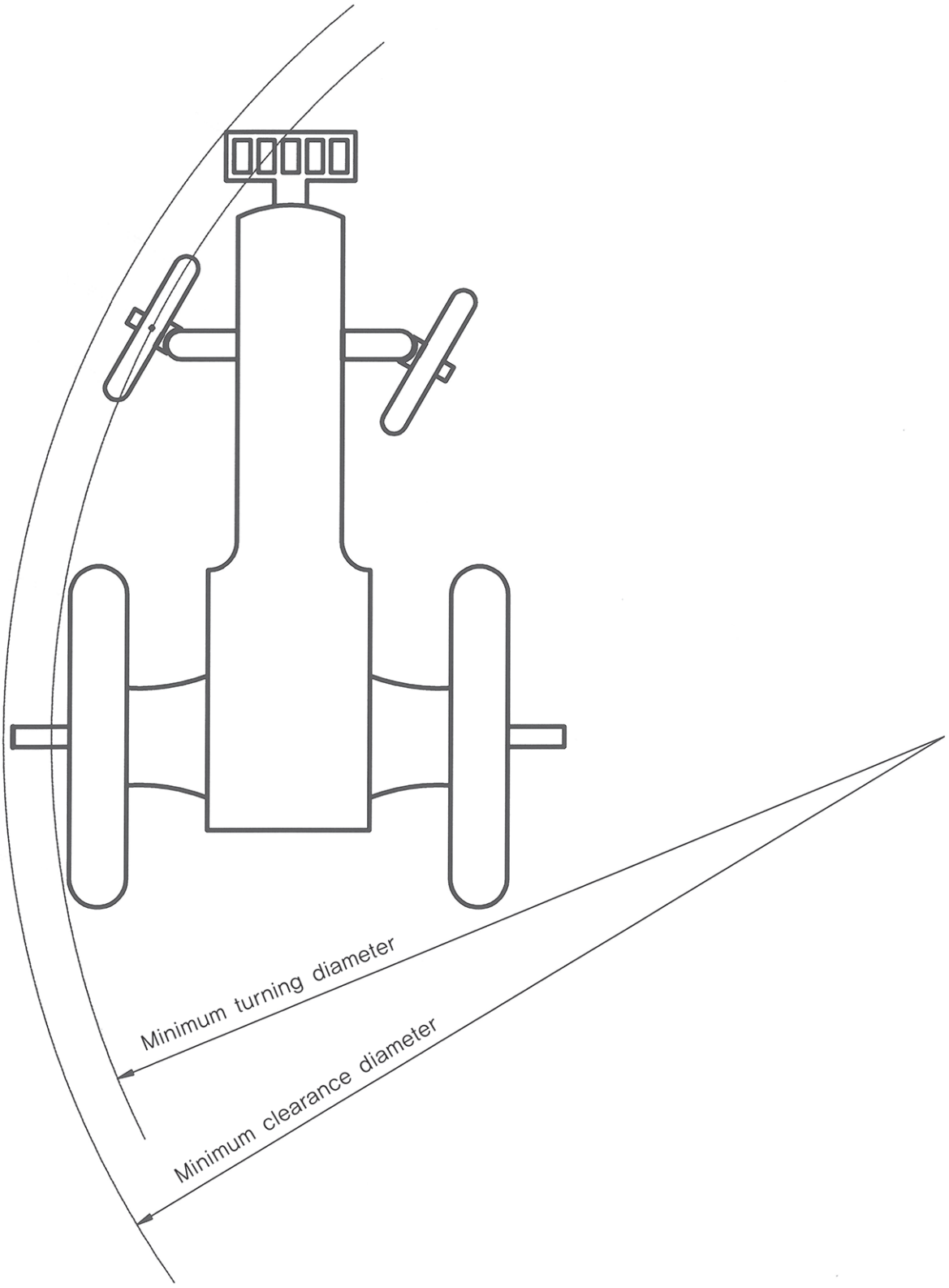

Figure 3 — Tractor turning configurations

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3 Apparatus

3.1 Tape measure, of length greater than the turning and clearance diameters to be measured, having a tolerance within ± 0,5 %.

3.2 Plumb-line, if required, for measuring clearance diameters.

3.3 GPS equipment for alternate test, corrected GPS having a measurement accuracy sufficient to produce a linear measurement tolerance of ± 0,5 %.

4 General requirements

4.1 Test area

The test area shall be a compacted or paved dry surface affording good tire adhesion, capable of displaying legible markings, and resistant to defacement by turning machines. The test surface shall be visually flat, with no more than 3 % grade in any direction.

In selecting the test area used for GPS measurement, take into consideration the effects of obstructions (e.g. tall buildings, trees, etc.) on GPS accuracy.

4.2 Tractor test requirements

4.2.1 Tire and wheel equipment

The tractor to be tested shall be in its operating state, and the attachments with which it is equipped and their positions shall be noted.

The tire, wheel and fender equipment shall be that commonly used in the country for which the tractor is intended, i.e. as specified by the manufacturer, and shall be stated in the test report. Generally, dual wheeled tractors or tractors with added ballast should not be tested unless it is the only specification presented by the manufacturer. Tire pressures, tractor ballast and use of duals on front or rear shall be recorded in the test report. If steering and/or axle oscillation stops and fenders are part of standard equipment, then these shall be positioned according to the manufacturer's instructions.

4.2.2 Track (tread) setting

A track (tread) setting of 1 500 mm ± 25 mm shall be used. If this is not possible, the nearest setting specified by the manufacturer shall be used. Additional measurement may be made at other track settings specified by the manufacturer. Front and rear track settings shall be as nearly as possible the same and shall be recorded.

4.2.3 Other settings

4.2.3.1 Tractors which have all wheels steerable, or which incorporate devices for disconnecting either or both axles, shall be tested in each operating condition in which the tractor is intended to be used.

Results shall be recorded for each operating condition.

4.2.3.2 Tractors which have more than one powered axle, and which have devices for disconnecting the power to any of the axles, shall be tested in each operating condition in which the tractor is intended to be used.

Results shall be recorded for each operating condition.

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5 Procedure

5.1 Right-hand turn, without brakes

5.1.1 Direct measurement

5.1.1.1 Drive the tractor slowly forward while making its sharpest possible right-hand turn, that is, with the steering kept on full right-hand lock, at a speed not exceeding 2 km/h for at least one complete turn, until it is established that the minimum turning circle is being described.

5.1.1.2 Continue to drive the tractor slowly forward on the same lock for a further complete turn, at a speed not exceeding 2 km/h. At short regular intervals around the turn, mark on the ground those points coinciding with the centre of the tire-to-ground contact area of the outermost wheel. Make the marks immediately behind this contact area and determine the position of each mark by visually projecting vertically downwards from the centre of the tire tread width at points on the tire circumference situated as close as possible to the ground.

The marking may be done with or without stopping the tractor. The broken circle formed by the marks on the ground is the turning circle.

5.1.1.3 During the turn described in 5.1.1.2, stop the tractor and drop a plumb-line (3.2) to the ground from the outermost point of the tractor (that is from the point of the tractor describing the largest circle). Clearly mark the point on the ground beneath the plumb-line: this point lies on the tractor clearance circle.

5.1.1.4 Measure (3.1) the diameter of the turning circle (see 5.1.1.2) at a minimum of three places spaced approximately equally around the circle as shown in Figure 4. Calculate the average value of the diameter measured and report it as the “minimum turning diameter, right-hand, without brakes”.

5.1.1.5 Measure and record the radial distance between the point on the tractor clearance circle (see 5.1.1.3) and the circumference of the tractor turning circle (see 5.1.1.2). Add twice this dimension to the minimum turning diameter and report the result as the “minimum clearance diameter, right-hand, without brakes”.

5.1.2 Alternate GPS method

5.1.2.1 Drive the tractor slowly forward while making its sharpest possible right-hand turn, that is, with the steering kept on full right-hand lock, at a speed not exceeding 2 km/h for at least one complete turn, until it is established that the minimum turning circle is being described.

5.1.2.2 The diameter of the turning circle shall be calculated as shown in Figure 5 and report it as the “minimum turning diameter, right-hand, without brakes”.

5.1.2.3 Measure and record the lateral and longitudinal position from the GPS receiver (3.3) to the points on the vehicle most likely to produce the largest clearance circle. Calculate as shown in Figure 5 and record the largest clearance circle diameter.

5.2 Left-hand turn, without brakes

Repeat the procedures described in 5.1 with the tractor driven forward while making its sharpest possible left-hand turn, that is, with the steering kept on full left-hand lock. Report the results as the “minimum turning diameter, left-hand, without brakes”.

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5.3 Right-hand turn, with brakes

Where applicable, repeat the procedure described in 5.1 with the inside non-steered wheel brake applied with a pedal effort sufficient to lock the wheel, subject to a maximum of 60 daN.

Report the results as the “minimum turning/clearance diameter, right-hand, with brakes”.

5.4 Left-hand turn, with brakes

Where applicable, repeat the procedure described in 5.3 with the tractor making its sharpest possible left-hand turn, that is, with the steering kept on full left-hand lock.

Report the results as the “minimum turning/clearance diameter, left-hand, with brakes”.

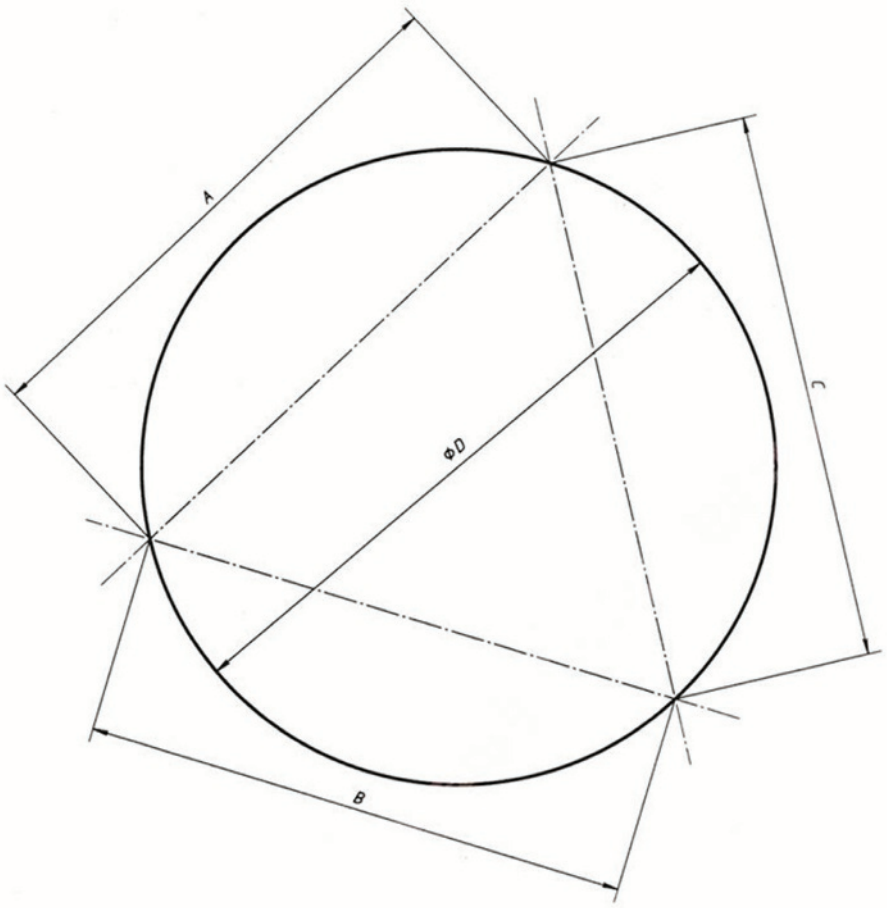

Figure 4 — Calculation of the diameters from measurements between three approximately equally spaced circumference points

$$D = \frac{2ABC}{\sqrt{2\left(A^2B^2 + A^2C^2 + B^2C^2\right) - \left(A^4 + B^4 + C^4\right)}}$$

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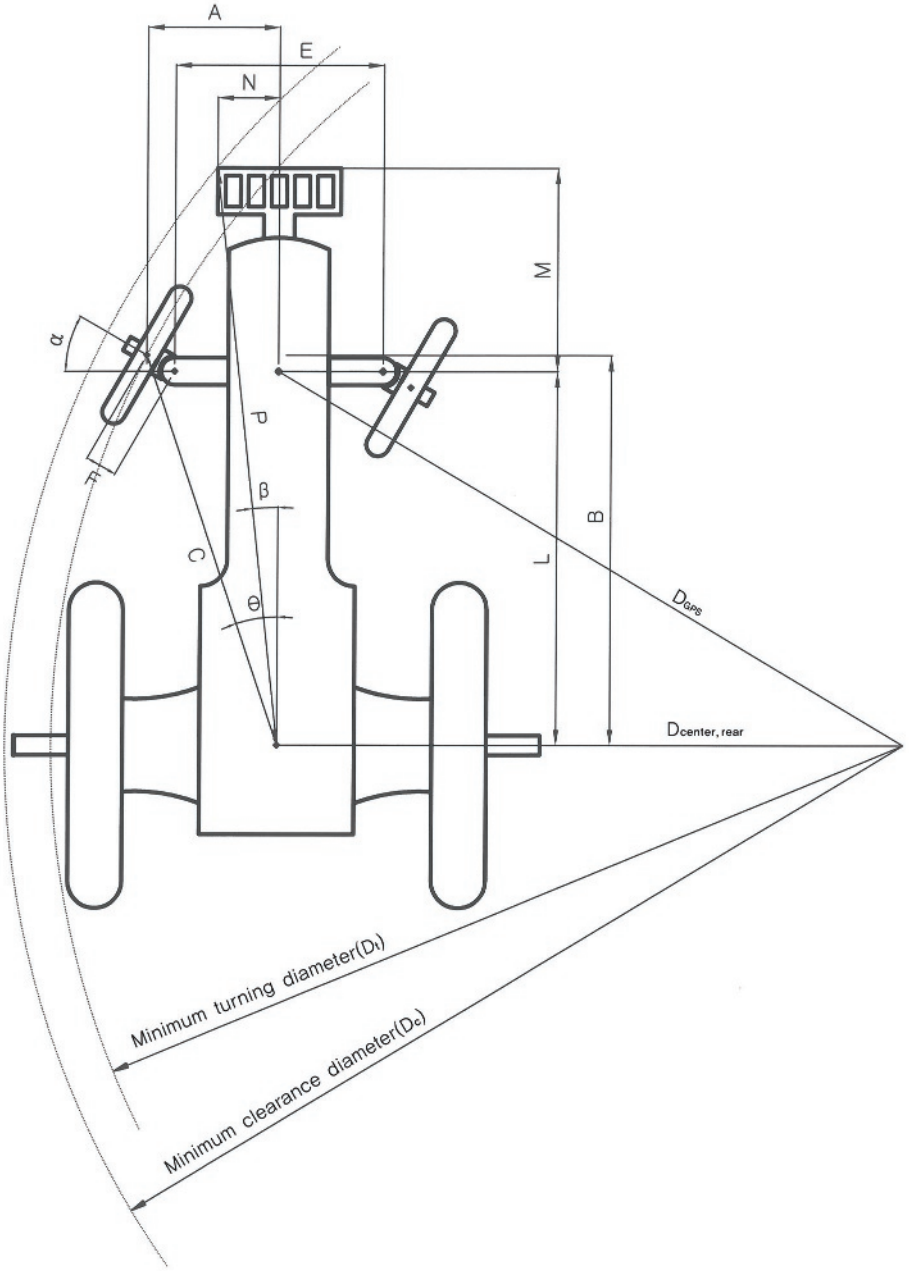

Figure 5 — Geometric for calculation of the turning diameter

$$C = \sqrt{(\frac{E}{2} + F \cdot \cos\alpha)^2 + (L + F \cdot \sin\alpha)^2}$$

$$\theta = \tan^{-1} \frac{(\frac{E}{2} + F \cdot \cos\alpha)}{(L + F \cdot \sin\alpha)}$$

$$D_t = 2 \times \sqrt{((\frac{D_{GPS}}{2})^2 - L^2) + C^2 - 2\sqrt{(\frac{D_{GPS}}{2})^2 - L^2} \times C \times \cos(\frac{\pi}{2} + \theta)}$$

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$$D_c = 2 \times \sqrt{\left(\left(\frac{D_{GPS}}{2}\right)^2 - L^2\right) + (L+M)^2 + N^2 - 2\sqrt{\left(\frac{D_{GPS}}{2}\right)^2 - L^2} \times \sqrt{(L+M)^2 + N^2} \times \cos\left(\frac{\pi}{2} + \tan^{-1}\frac{N}{(L+M)}\right)}$$

Symbol	Explanation
D_t	minimum turning diameter
D_c	minimum clearance diameter
D_{GPS}	turning diameter in the GPS antenna position
$D_{centre,rear}$	turning diameter in the rear axle centre
A	horizontal distance between the tractor longitudinal centreline and the ground point coinciding with the centre of the tire-to-ground contact area of the outermost wheel when the steering kept on full right-hand(or left-hand) lock
B	horizontal shortest distance between the rear axle and the centre of the tire-to-ground contact area of the outermost wheel when the steering kept on full right-hand (or left-hand) lock
C	horizontal distance from rear axle centre to the ground point coinciding with the centre of the tire-to-ground contact area outermost wheel when the steering kept on full right-hand (or left-hand) lock
E	horizontal distance between the right-hand and left-hand kingpin centres
F	horizontal distance from kingpin centre to the ground point coinciding with the centre of the tire-to-ground contact area of the outermost wheel
L	wheelbase
M	horizontal shortest distance between the front axle and the most outer point on the turning circle
N	horizontal distance between the tractor longitudinal centreline and the most outer point on the turning circle
P	horizontal distance from rear axle centre to the most outer point on the turning circle
α	steering angle of outer front wheel
β	angle between the tractor longitudinal centreline and extension line from the rear axle centre point to the most outer point on the turning circle
θ	angle between longitudinal centre line and extension line from rear axle centre to the centre of the tire-to-ground contact area outermost wheel when the steering kept on full right-hand(or left-hand) lock

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6 Test report

A suitable test report form is shown in Annex A. The test report shall include the following information:

a) the name and address of the manufacturer;

b) the type and model of tractor;

c) tractor ballast and front fender installation;

d) the tire sizes and pressures, in kilopascals;

e) the wheelbase, in millimetres;

f) the front and rear track (tread) widths of the tractor, in millimetres;

g) the minimum turning diameters and the minimum clearance diameters, in meters, to two decimal places, as follows:

   1) right-hand turn without brakes,

   2) left-hand turn without brakes, and, if applicable,

   3) right-hand turn with brakes,

   4) left-hand turn with brakes,

   5) additional test conditions, if appropriate (see 4.2.3);

h) the point of the tractor which determines the minimum clearance diameter.

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Annex A
(informative)

Specimen test report

A.1 Tractor

Manufacturer's name and address:

Tractor make: Model: Date of test:

Mass of tractor submitted for test: kg

Description of ballast

A.2 Track (tread) setting

Nominal	Actual front	Actual rear	Wheelbase
mm	mm	mm	mm
mm	mm	mm	mm

A.3 Drive wheels

Two wheel (rear):

Four wheel (equal front and rear): (unequal front and rear):

Fenders (front): yes/no

Oscillation stop position:

A.4 Tires and wheels

	Front	Rear
Tire size		
Singles or duals		
Tire pressure	kPa	kPa
Wheel type		

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A.5 Turning and clearance diameters

Track (tread)	**Minimum turning diameter**				**Minimum clearance diameter**			
	With brakes		**Without brakes**		**With brakes**		**Without brakes**	
nom	left	right	left	right	left	right	left	right

Comments:

Measurement method:

Measured by:

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