SAE International™ SURFACE VEHICLE STANDARD

SAE J1091 REAF. MAR2003

Issued 1996-11
Reaffirmed 2003-03

Superseding J1092 NOV1996

Submitted for recognition as an American National Standard

Earthmoving Machinery—Operator's Field of View

Foreword—The purpose of this document is to establish a test method to determine the maskings that are caused by various parts of the machine on a visibility test circle around the machine from a point which simulates the eye position of the 50th percentile earthmoving machinery operator. The document also includes a means of evaluating the field of view.

This document differs from ISO 5006 Parts 1 and 2 in the following significant points:

a. 4.1 allows 15-degree forward rotation of the light source
b. 6.1.1 allows expanding the test circle in all sectors to eliminate horizontal blockages for machines larger than 24 tons
c. 6.2.1 same as 6.1.1
d. 6.2.2 allows the light bar to be rotated forward 15 degrees
e. 6.2.3 allows the light bar to be rotated forward 15 degrees
f. 9.2.1.5 defines maskings on increased test circle sizes

This document does not include criteria as is found in ISO 5006 Part 3. The ISO criteria is shown in Appendix B.

1. Scope—This SAE Standard specifies a stationary test method for determining the masking effect caused by parts of the base machine with equipment as specified by the manufacturer on a visibility test circle around the machine from the eye position point of a seated operator. It specifies a method for evaluating the maskings that may be present.

It applies to earthmoving machines which have a specific operator's station. It does not consider evaluation of maskings which may be present with operational movement of working tools.

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2. References

2.1 Applicable Publications—The following publications contain provisions which, through reference in this text, constitute provisions of this document. At the time of publication, the editions indicated were valid.

All documents are subject to revision and the user of this document is encouraged to investigate the possibility of applying the most recent editions of the publications indicated as follows:

2.1.1 SAE PUBLICATION—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1163 JUN91—Determining Seat Index Point

2.1.2 ISO PUBLICATIONS—Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002.

ISO 5006-1:91—Earth-moving machinery—Operator's field of view—Part 1: Test method
ISO 5006-2:93—Earth-moving machinery—Operator's field of view—Part 2: Evaluation method
ISO 5006-3:93—Earth-moving machinery—Operator's field of view—Part 3: Criteria

2.2 Related Publications—The following publications are for reference purposes only and are not a required part of this document.

2.2.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1116 JUN86—Categories of Off-Road Self-Propelled Work Machines
SAE J/ISO 3411 FEB2003—Earth-moving machinery – Human physical dimensions of operators and minimum operator space envelope

2.2.2 ISO PUBLICATIONS—Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002.

ISO 3411:82—Earth-moving machinery—Human physical dimensions of operators and minimum operator space envelope
ISO 5353:95—Earth-moving machinery and tractors and machinery for agricultural and forestry—Seat index point
ISO 6165:87—Earth-moving machinery—Basic types—Vocabulary

3. Definitions

3.1 Filament Position Center-Point—Point located 660 mm above and 20 mm in front of the seat index point as defined by SAE J1163. This represents the eye position point of the 50th percentile world-wide male operator. Available seat adjustment range accounts for the 5th to 95th percentile operator. (See Figure 1.)

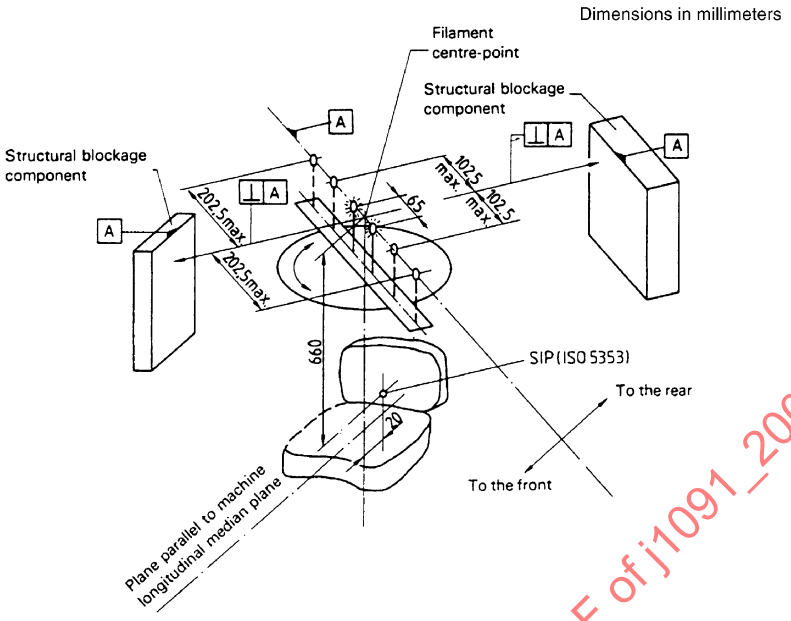


FIGURE 1—ARRANGEMENT OF TEST EQUIPMENT (SEE SECTION 4)

3.2 Visibility Test Circle—Circle with a 12 m radius on a horizontal surface with its center at the filament position center. The test circle can be increased in size to extend beyond horizontal blockages created by hoods, buckets, blades, etc.

3.3 Sector of Vision (Front)—Segment of the visibility test circle to the front of the machine established by a 9.5 m cord which is perpendicular to the longitudinal plane passing through the filament position center point with the cord length bisected by the longitudinal plane. (See Figure 2.)

3.4 Field of Vision (Front Side)—Segments of the visibility test circle to the front of the machine outside the sector of vision and bounded by the transverse plane through the filament center-point. (See Figure 2.)

3.5 Visual Field (Rear)—Segment of the visibility test circle to the rear defined by an angle of 45 degrees to both the right and left sides of the longitudinal plane passing through the filament center-point. (See Figure 2.)

3.6 Field of View (Rear Side)—Segments of the visibility test circle to the rear between the visual field and the fields of vision. (See Figure 2.)

3.7 Masking Effect—Segments of the visibility test circle on which a shadow is created because a part(s) of the base machine and/or its equipment block(s) the light rays from both of the filaments. For example, masking could be caused by ROPS, window and door frames, exhaust pipes, the hood and equipment components such as bucket, boom, etc.

3.8 Horizontal Blockage—Light source is above the blockage and the light can be seen on the ground.

3.9 Vertical Blockage—A block that extends above the light source.

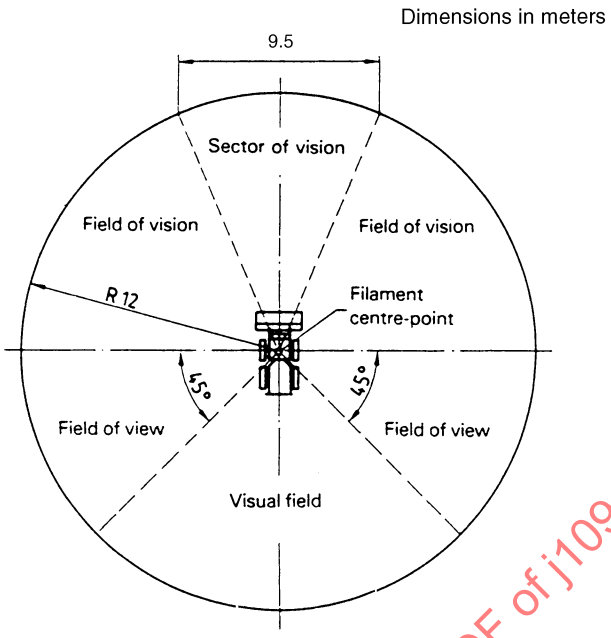


FIGURE 2—DEFINITION OF VISIBILITY TEST AREAS (SEE SECTION 3)

4. Test Apparatus

4.1 Light Source—Consisting of two halogen bulbs (or equivalent) mounted with the filaments vertical. The fixture shall be such that the mid-point of the filaments is at the height of the filament position center-point defined in 3.1. Each filament should be horizontally movable from 32.5 mm up to 202.5 mm on each side of the filament position center-point and rotatable (see Figure 1). The fixture may be capable of 15-degree forward rotation (parallel to the centerline of the machine) from the SIP perpendicular to the light bar.

4.2 Test Surface—An area of compacted earth or paved surface which has no more than a 3% gradient in any direction.

5. Machine Test Configuration

5.1 The machine shall be equipped according to the manufacturer's specification.

5.2 All machine openings such as doors and windows shall be closed.

5.3 The machine shall be set up according to the specific information given in Appendix A for each type of machine.

6. Measurement Procedure

6.1 Machine and Filament Placement

6.1.1 Place the machine on the test surface and mark the 12 m radius visibility test circle on the test surface. In addition for machines greater than 24 tons, mark a larger radius, if required, to eliminate horizontal blockages from hoods, buckets, blades, etc., as needed if the maskings exceed the 12 m radius in a sector when tested in accordance with 6.2.4. The larger radius shall not exceed 30 m.

The filament position center-point defined in 3.1 shall be vertically above the visibility circle center-point.

6.1.2 Mount the filaments so that they are equally spaced around the filament position center-point defined in 3.1.

6.1.3 To take measurements, rotate the light bar so that the line between the filaments is perpendicular to the line between the filament position center-point defined in 3.1 and the center of the visibility blockage components.

6.2 Determination of Masking

6.2.1 Place the light-bulbs so that they are 32.5 mm either side of the filament center-point defined in 3.1. Rotate the light bar for one revolution and record the masking effect of each visibility blockage created on the visibility test circle. Measure the maskings in millimeters as a chord-length.

NOTE— The test can be carried out in a dark environment where the masking effects can be directly noted on the visibility test circle or a mirror located on the test surface can be used to develop a line of sight to the filament to determine the point on the visibility test circle where masking occurs.

6.2.2 If maskings are recorded in the sectors of vision and field of vision, conduct a second test with the filament spacing up to 202.5 mm to either side of the filament center-point. The light bar may also be rotated forward up to 15 degrees. Record the remaining masking effect, if any, on the visibility test circle.

6.2.3 If maskings are recorded in the field of view, carry out a second test with the filament spacing up to 102.5 to either side of the filament center-point. The light bar may also be rotated forward up to 15 degrees.

6.2.4 If maskings recorded are caused by a horizontal blockage, carry out a second test with a radius of visibility test circle increased to exceed the horizontal blockage. Using the appropriate filament spacing for the segment being measured, record the maskings on the larger visibility test circle, if any.

Record the remaining masking effect, if any, on the visibility test circle.

7. Calculation Procedure for Determination of Maskings—The calculation procedure provides an alternative to the test method. (See Figure 3.)

For binocular vision with an eye spacing of s, the masking, expressed in millimeters, is given by Equation 1:

$$x = \left(\frac{b - s}{a}\right) r + s \qquad \text{(Eq. 1)}$$

where:

- r is the radius from the filament center-point on the test surface to the visibility test circle on the test surface, in millimeters
- b is the width of the component causing the maskings measured horizontally, and perpendicular to the radius from the filament position center-point and the center of the component, in millimeters
- s is the distance between the filaments, used to represent binocular vision with this eye spacing, in millimeters
- x is the width of the masking calculation of the masking and becomes less accurate as the length of the masking increases

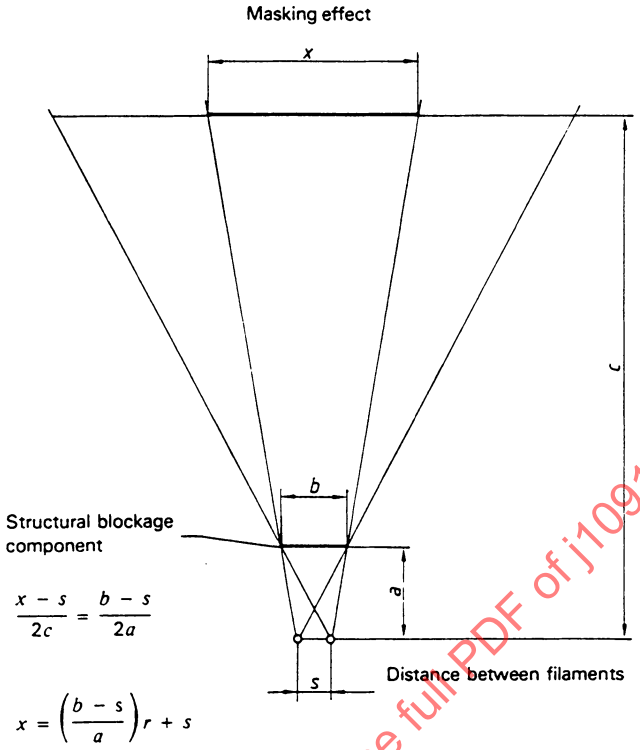


FIGURE 3—MATHEMATICAL DETERMINATION OF MASKING EFFECTS (SEE SECTION 7)

8. ***Test Report*****—**The test report shall include the information indicated in 8.1 and 8.2.

8.1 Machine Details

a. Manufacturer
b. Model
c. Machine mass or rated pay-load
d. Serial number
e. Operator enclosure and/or ROPS description or identification
f. Equipment installed on the machine
g. Any other information which affects the masking measurements

8.2 Drawing—The drawing shall show the maskings (dimensions in millimeters) on the visibility test circle by the designated visibility test area with the specific filament spacing. The distance between maskings and also the distance from the end of the specific visibility test area shall be provided (see Figure 4 for an example). In lieu of a drawing, a tabulation can also be provided if it gives the required information.

Machine type

Manufacturer: .....

Machine type and model: Wheel loader /704.....

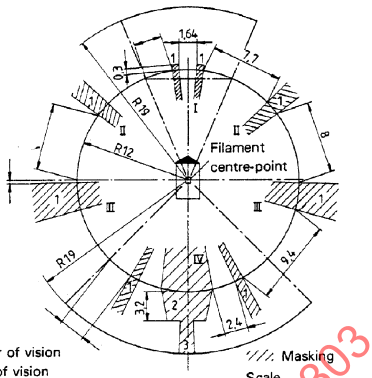
Mass: .....22.600.....kg

Serial No.: ...377.510301.....

Type of cab (indicate)

- ROPS and cab ☒
- ROPS and canopy ☐
- Cab without ROPS ☐
- Without cab ☐

Equipment fitted on machine: ..Standard...bucket....



I Sector of vision
II Field of vision
III Field of view
IV Visual field

Masking

Scale 0 2 4 6 8

I Sector of vision

Radius		12 m		19 m	
Filament position, i.e, cumulative distance of filaments from filament centre-point		mm		mm	
		65	405	65	405
Masking (indicate cause and width in millimetres)	Cause	Width		Width	
	No. 1 Tilt cover	600			
	No. 2				
	No. 3				
	No. 4				

II Field of vision

Radius		12 m	
Filament position, i.e. cumulative distance of filaments from filament centre-point		mm	
		65	405
Masking (indicate cause and width in millimetres)	Cause	Width[1]	
	No. 1 Cab post	1600	0 (230)
	No. 2		
	No. 3		
	No. 4		
	No. 5		
	No. 6		

1) Measurement in parentheses is bulb distance.

III Field of view

Radius		12 m	
Filament position, i.e, cumulative distance of filaments from filament centre-point		mm	
		65	205
Masking (indicate cause and width in millimetres)	Cause	Width	
	No. 1 Cab/ROPS post	3200	880
	No. 2		
	No. 3		
	No. 4		
	No. 5		
	No. 6		

IV Visual field

Radius		12 m	19 m
Filament position, i.e. cumulative distance of filaments from filament centre-point		mm	
		65	
Masking (indicate cause and width in millimetres)	Cause	Width	
	No. 1 Window frame	700	
	No. 2 Engine bonnet	5600	
	No. 3 Exhaust pipe and pre-cleaner		1600
	No. 4		

FIGURE 4—EXAMPLE OF COMPLETED TEST REPORT

9. Evaluation Method

9.1 General

9.1.1 When maskings overlap adjacent visibility areas, the masking shall be evaluated in the visibility test area in which the greatest part of the masking lies.

9.1.2 Adjacent narrow maskings may be combined with the space between them and treated as one larger masking to reduce the count of maskings.

9.1.3 The space between any two adjacent maskings in the visibility test area being evaluated and the space with adjacent maskings in the adjoining visibility test area shall be equal to or greater than 1 300 mm. If this is not the case, the two maskings and the space shall be combined to result in one reported masking. See Figures 5 to 7.

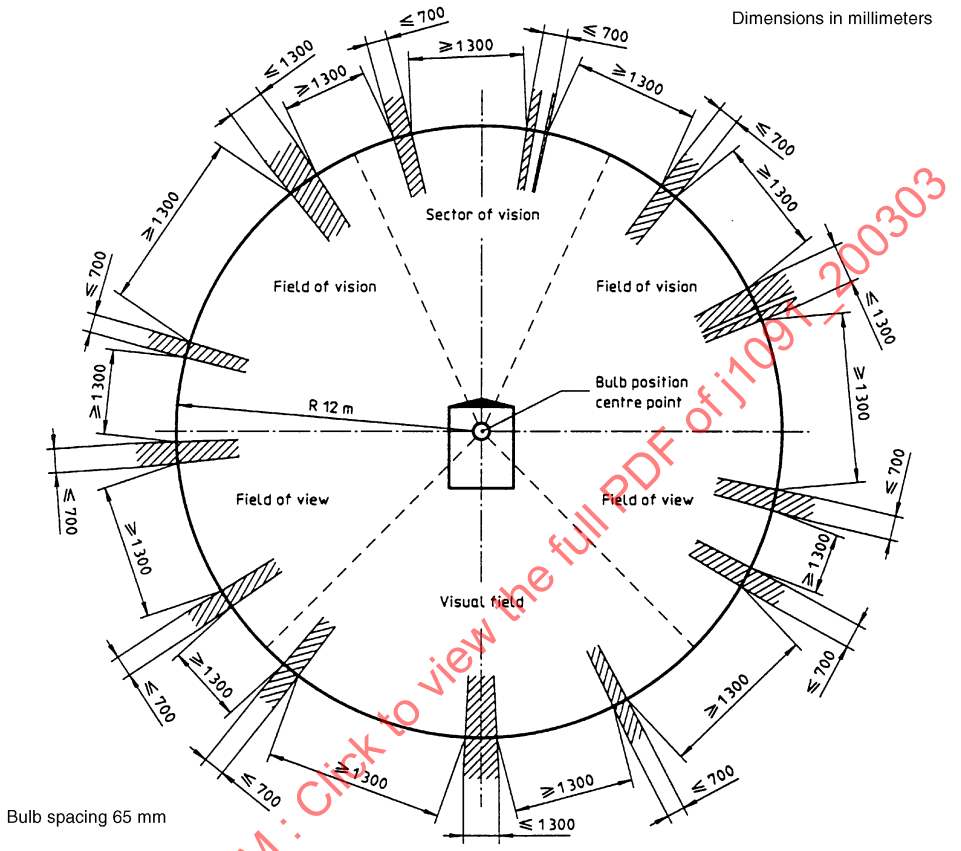


FIGURE 5—CATEGORY I EVALUATION

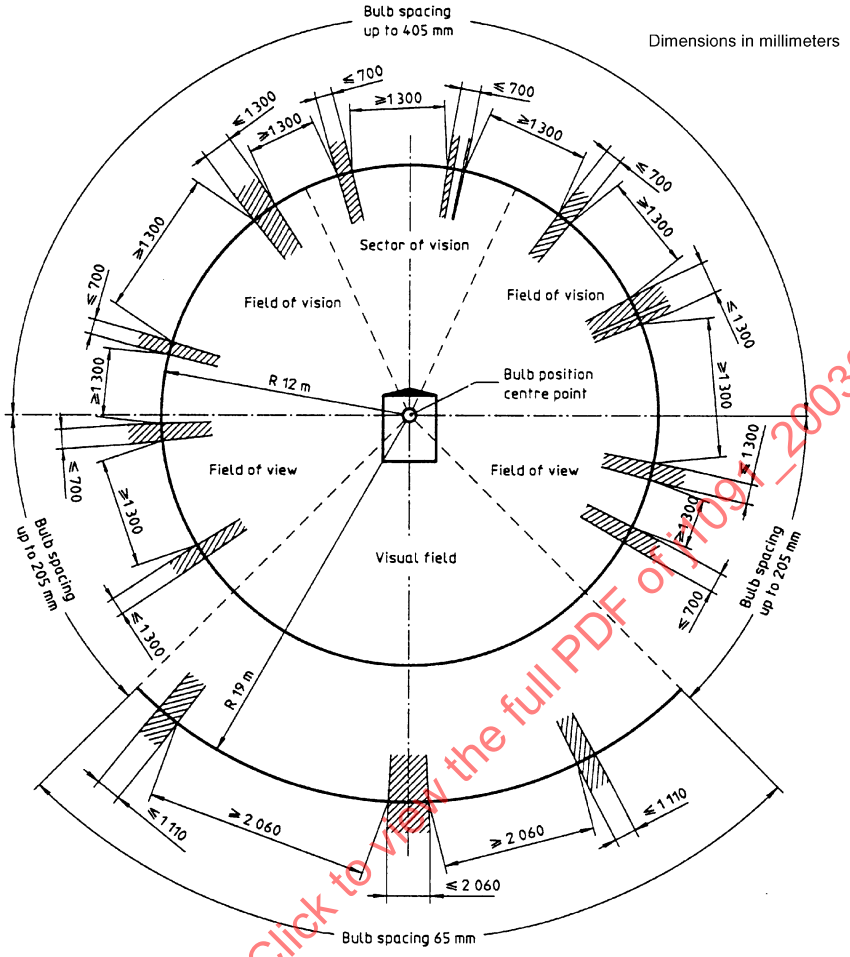


FIGURE 6—CATEGORY II EVALUATION

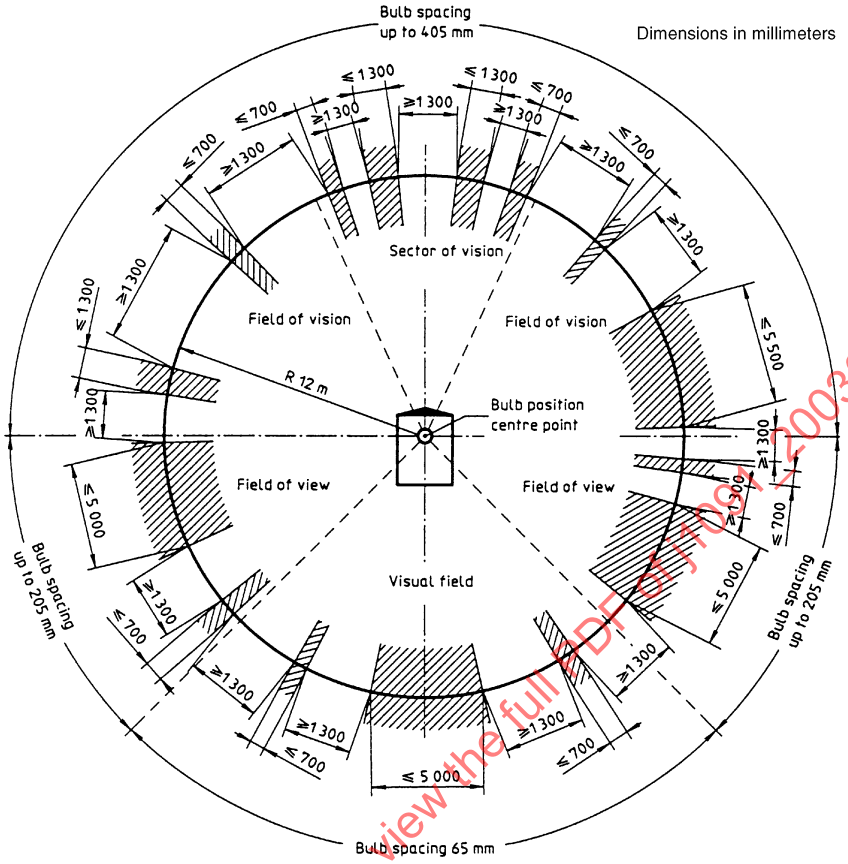


FIGURE 7—CATEGORY III EVALUATION

9.1.4 A masking under 100 mm may be neglected when it is not covered by the requirements in 9.1.3.

9.1.5 When a radius greater than 12 m is used, the allowable maskings are increased by the ratio of the new radius to the 12 m radius. For example, with a radius of 19 m, the blockage width would increase X1.58.

9.2 Maskings at Sector of Vision

9.2.1 VISIBILITY CATEGORY I—The visibility is evaluated as Category I, if, where measured in accordance with 6.2.1, there are no more than two maskings each with a masking chord length of 700 mm or less. (See Figure 5.)

9.2.2 VISIBILITY CATEGORY II—The visibility is evaluated as Category II, if, when measured in accordance with 6.2.2, the masking conditions in 9.2.1 are met. (See Figure 6.)

9.2.3 VISIBILITY CATEGORY III—The visibility is evaluated as Category III, if, when measured in accordance with 6.2.2, there are no more than two maskings with a masking chord length of 700 mm or less and two maskings with a masking chord length of 1 300 mm or less. (See Figure 7.)

9.3 Field of Vision

9.3.1 VISIBILITY CATEGORY I—The visibility is evaluated as Category I, if, when measured in accordance with 6.2.1, there are no more than one masking with a masking chord length of 700 mm or less and no more than one masking with a masking chord length of 1 300 mm or less in each of the left and right areas of the field of vision. (See Figure 5.)

9.3.2 VISIBILITY CATEGORY II—The visibility is evaluated as Category II, if, when measured in accordance with 6.2.2, the masking conditions in 9.3.1 are met.

9.3.3 VISIBILITY CATEGORY III—The visibility is evaluated as Category III, if, when measured in accordance with 6.2.2, there are more than one of the maskings of 9.3.2 with a chord length of 5 500 mm or less. (See Figure 7.)

9.4 Field of View

9.4.1 VISIBILITY CATEGORY I—The visibility is evaluated as Category I, if, when measured in accordance with 6.2.1, there are no more than two maskings with a masking chord length of 700 mm or less in either the left or the right field of view. (See Figure 5.)

9.4.2 VISIBILITY CATEGORY II—The visibility is evaluated as Category II, if, when measured in accordance with ISO 5006-1:1991, 6.2.3, there are no more than one masking with a masking chord length of 700 mm or less and one masking with a masking chord length of 1 300 mm or less in either the left or right field of view. (See Figure 6.)

9.4.3 VISIBILITY CATEGORY III—The visibility is evaluated as Category III, if, when measured in accordance with 6.2.3, there are no more than one masking with a masking chord length of 700 mm or less and one masking with a masking chord length of 5 000 mm or less in either the left or right field of view. (See Figure 7.)

9.5 Visual Field

9.5.1 VISIBILITY CATEGORY I—The visibility is evaluated as Category I, if, when measured in accordance with 6.2.1, there are no more than two maskings with a masking chord length of 700 mm or less and one masking with a masking chord length of 1300 mm or less in the rear visual field. (See Figure 5.)

9.5.2 VISIBILITY CATEGORY II—The visibility is evaluated as Category II, if, when measured in accordance with 6.2.4, there are no more than two maskings with a masking chord length of 1 110 mm or less and one masking with a masking chord length of 2 060 mm or less. (See Figure 6.)

9.5.3 VISIBILITY CATEGORY III—The visibility is evaluated as Category III, if, when measured in accordance with 6.2.4, there are not more than two maskings with a masking chord length of 700 mm or less and one masking with a masking chord length of 5 000 mm or less. (See Figure 7.)

PREPARED BY THE SAE HUMAN FACTORS TECHNICAL COMMITTEE SC1—
MACHINE CONTROLS—OPERATOR

APPENDIX A

(NORMATIVE)
MACHINE SET-UP

Preface—As specified in 5.1, the machine shall be equipped according to the manufacturer's specification.

The machine shall be placed on the test surface described in 4.2 as shown in Sections A.1 to A.9 for each type of earthmoving machine.

A.1 Loader—Bucket in carry position. See Figure A1.

a. HH = 300 mm ± 50 mm for machines ≤ 24 000 kg
b. 400 mm ± 50 mm for machines > 24 000 kg

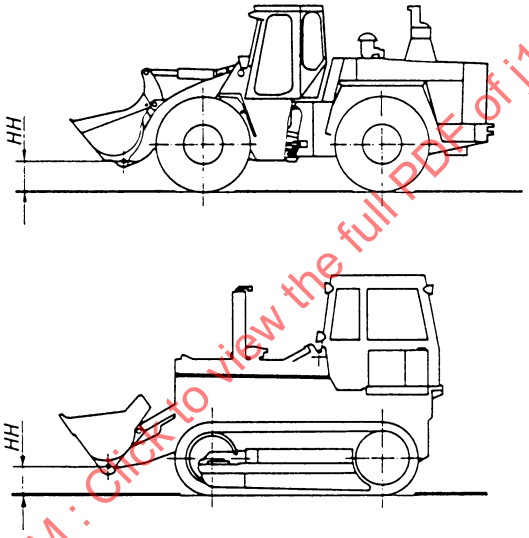


FIGURE A1—LOADER

A.2 Backhoe-Loader—See Figure A2.

a. HH = 300 mm ± 50 mm

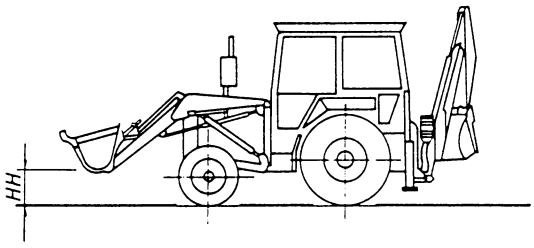


FIGURE A2—BACKHOE-LOADER

A.3 ***Tractor—***ROPS and Cab Fitted. See Figure A3.

a. HH = 150 mm ± 50 mm

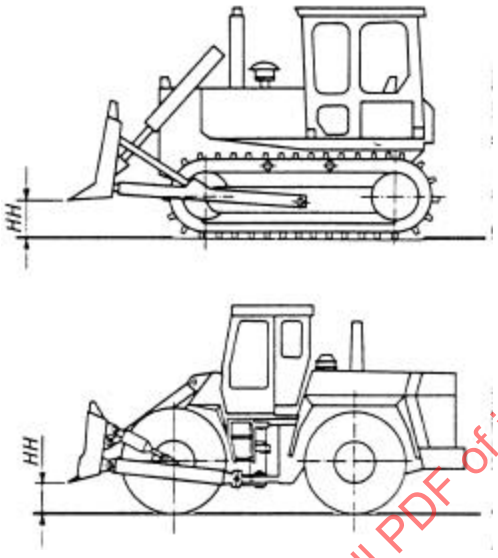


FIGURE A3—TRACTOR

A.4 ***Excavator—***Standard Cab Fitted. See Figures A4a, A4b, and A4c.

a. Dimensions HH and RR shall be recorded and reported in the scaled drawing as required in 8.2.

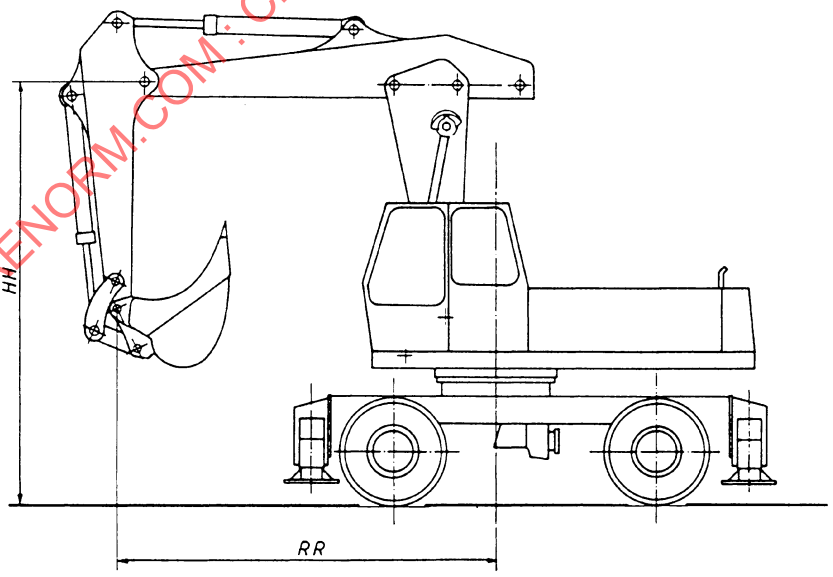


FIGURE A4A—EXCAVATOR

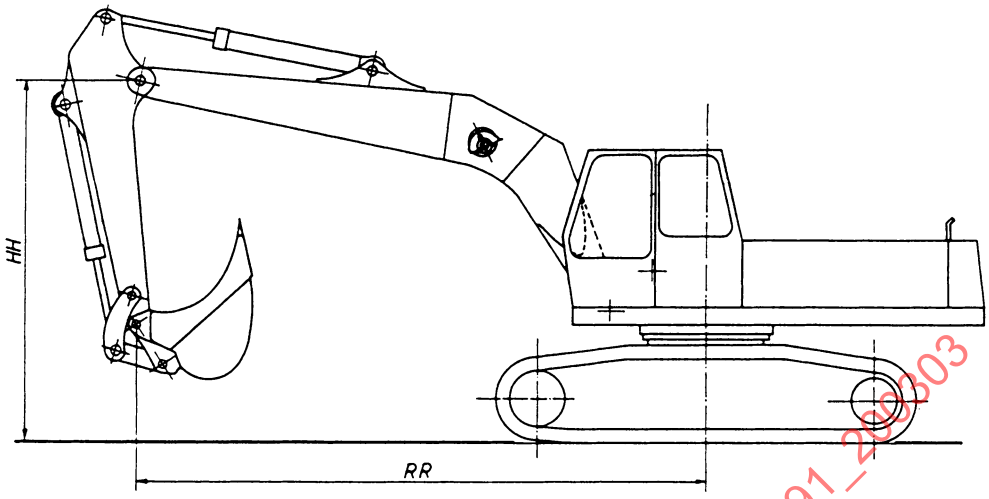


FIGURE A4B—EXCAVATOR

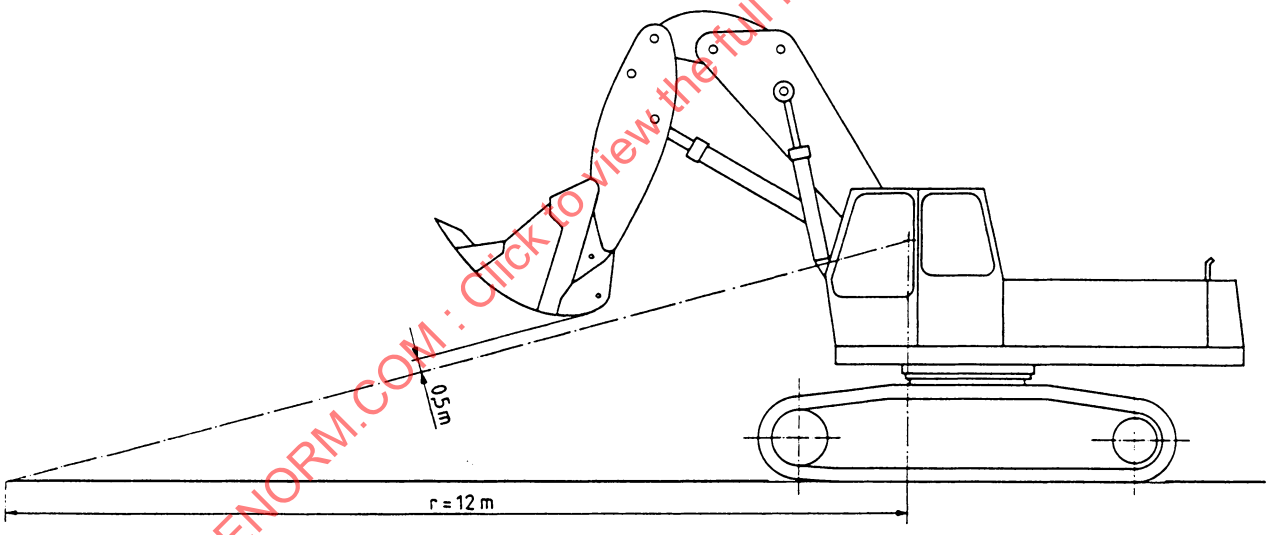


FIGURE A4C—EXCAVATOR

A.5 Tractor-Scraper—Cutting edge of the bowl 150 mm ± 50 mm above ground level. See Figure A5.

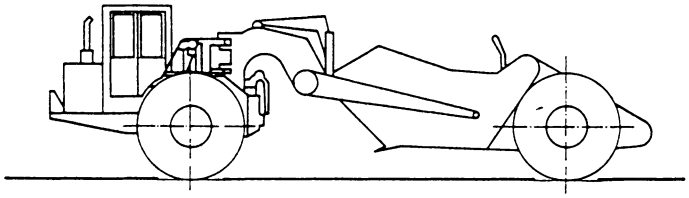


FIGURE A5—TRACTOR-SCRAPER

A.6 Grader—All blades 150 mm ± 50 mm above ground level. See Figure A6.

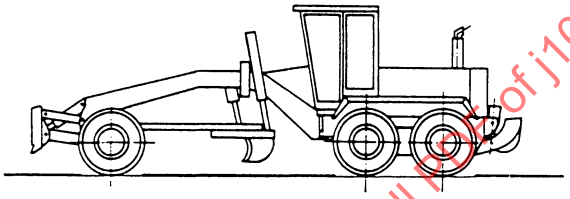


FIGURE A6—GRADER

A.7 Dumper

A.7.1 Rear Dump—See Figure A7.

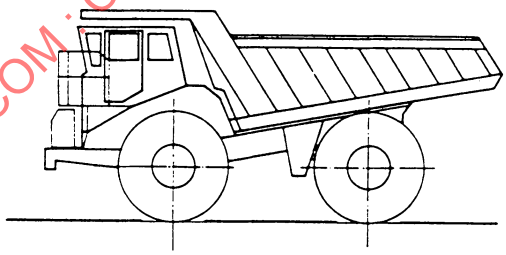


FIGURE A7—REAR DUMP

A.7.2 Bottom Dump—See Figure A8.

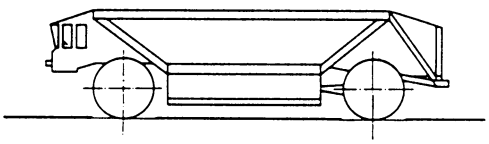


FIGURE A8—BOTTOM DUMP

A.7.3 Side Dump—See Figure A9.

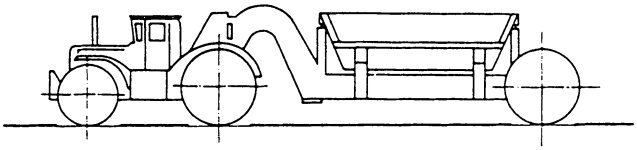


FIGURE A9—SIDE DUMP

A.7.4 Articulated Steer—See Figure A10.

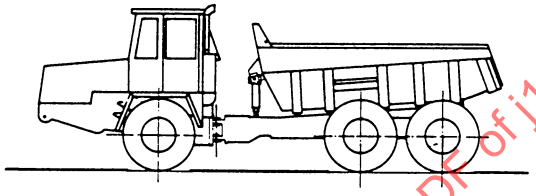


FIGURE A10—ARTICULATED STEER

A.8 Pipelayer—See Figure A11.

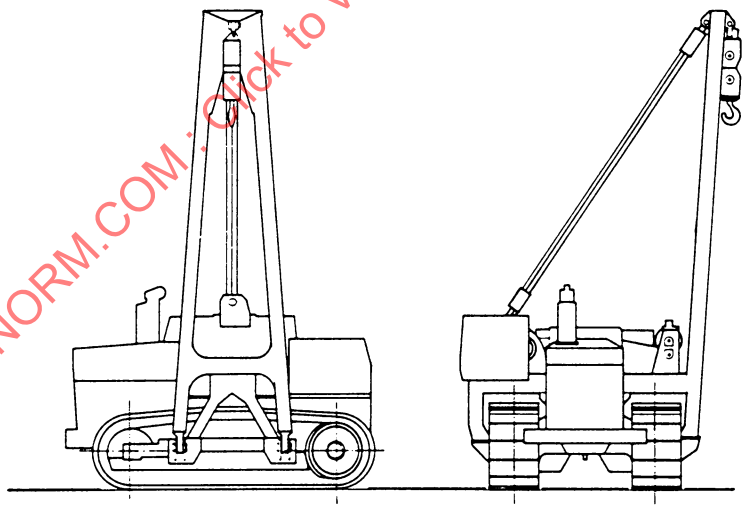


FIGURE A11—PIPELAYER