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Earth-moving machinery and rough-terrain trucks — Lighting, signalling and marking lights, and reflex reflectors

Engins de terrassement et chariots tout-terrain — Feux d'éclairage, de signalisation, de position et d'encombrement, et catadioptres

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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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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 127, *Earth-moving machinery*, Subcommittee SC 3, *Machine characteristics, electrical and electronic systems, operation and maintenance*.

This third edition cancels and replaces the second edition (ISO 12509:2004), which has been technically revised.

The main changes are as follows:

— in the Scope, it was clarified that rough-terrain trucks are included;

— the term "earth-moving machines" was replaced with "machines" throughout this document;

— the normative references were updated;

— in Clause 3, several definitions were revised and several were removed as they no longer appear in this document;

— in Clause 4, technical changes were made including a re-write of 4.1.6 and the addition of 4.1.10, with Table 4-1 and addition of clauses moved from the former C.0;

— in Annex A, Table A-1 was revised, including the removal of the footnotes;

— in Annex B, the annex title was clarified and Figure B-1 was revised;

— Annex C from the previous edition was removed;

— Annex D from the previous edition was removed;

— in Annex E (now Annex C), there were technical changes to most of the clauses, including modifications to the text, the figures and the tables. Configurations text was removed in most clauses as this information is now covered in 4.1.10 and Table 4-1. The exception for steel-tracked or steel-pad-foot was moved to Table A-1. The content of Clause C.0 has been moved to other sections in this document and only the index remains;

— in Annex F (now Annex D), the figures and keys were revised;

— in Annex G from the previous edition was removed.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Earth-moving machines and rough-terrain trucks are designed to function in a wide variety of operations and worksites. Their size, mass, speed, combinations and equipment also greatly vary. Therefore, the combination of lighting, signalling and marking lights, and reflex reflectors will differ.

This document provides information needed for the selection of lighting, signalling and marking lights and reflex reflectors based on machine application and speed.

Earth-moving machinery and rough-terrain trucks — Lighting, signalling and marking lights, and reflex reflectors

1 Scope

This document specifies requirements for installation and performance of lighting, signalling and marking lights, and reflex reflectors. It is applicable to ride-on self-propelled wheeled or crawler earth-moving machines as defined in ISO 6165, and rough-terrain variable-reach trucks as defined in ISO 10896-1 and ISO 10896-2, hereafter known as "machines". These machines are used off-road and can occasionally be driven on the road.

NOTE 1 Meeting the requirements of this document does not ensure conformance to national or regional on-road regulations.

NOTE 2 Rough-terrain trucks with mast as defined in ISO 3691-1 and rough-terrain lorry-mounted trucks as defined in ISO 20297-1 are not specifically covered by this document, but this document can be used for guidance.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6165, *Earth-moving machinery — Basic types — Identification and vocabulary*

ISO 10896-1, *Rough-terrain trucks — Safety requirements and verification — Part 1: Variable-reach trucks*

ISO 10896-2, *Rough-terrain trucks — Safety requirements and verification — Part 2: Slewing trucks*

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6165, ISO 10896-1, ISO 10896-2 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1.1
zero Y plane
vertical plane which passes through the longitudinal centreline of the machine

[SOURCE: ISO 6746-1:2003, 3.1.1]

3.1.2
ground reference plane
GRP
plane on which the machine is placed for measurements: in the case of the base machine, a hard, level surface; in the case of equipment and attachments, either a hard, level surface or compacted earth

[SOURCE: ISO 6746-1:2003, 3.2, modified — Note 1 to entry not included.]

3.1.3
extreme outer edge
plane parallel to the *zero Y plane* (3.1.1) of the machine and touching its lateral outer edge on either side of the machine, disregarding the projection of tyres near the point of contact with the *ground reference plane* (3.1.2) and connections for tyre-pressure gauges, the projection of any anti-skid device mounted on the wheels, of rear-view mirrors, and of side direction-indicator *lamps* (3.1.5), front and rear position lamps and stopping lamps

3.1.4
overall width
distance on Y coordinate between two Y planes passing through the *extreme outer edge* (3.1.3) of the machine on both sides of the *zero Y plane* (3.1.1)

3.1.5
lamp
device designated to illuminate the *road* (3.1.16) or ground (lighting) or to emit a light signal (light signalling)

Note 1 to entry: Marking light is similarly regarded as a lamp.

3.1.5.1
grouped
lamps (3.1.5) which have separate *illuminating surfaces* (3.1.7, 3.1.8) and separate light sources, but a common lamp body

Note 1 to entry: See Table 4-1.

3.1.5.2
combined
lamps (3.1.5) which have separate *illuminating surfaces* (3.1.7, 3.1.8), but a common light source and a common lamp body

Note 1 to entry: See Table 4-1.

3.1.5.3
reciprocally incorporated
lamps (3.1.5) which have separate light sources (or a single light source operating under different conditions), totally or partially common *illuminating surfaces* (3.1.7, 3.1.8) and a common lamp body

Note 1 to entry: See Table 4-1.

3.1.6
reflex reflector
device which, by the reflection of light emanating from a light source not connected to the machine, is used to indicate the presence of a machine or to identify a specific part of a machine to an observer near the source

3.1.7
illuminating surface
<lighting device> orthogonal projection of the full aperture of a reflector in a transverse plane

Note 1 to entry: If the lighting device has no reflector, the definition of the illuminating surface of a signalling device applies. If the lamp lens(es) extend(s) over part only of the full aperture of the reflector, then the projection of that part only is taken into account.

Note 2 to entry: In the case of a dipped-beam headlamp, having a screened light source giving a defined cut-off, the illuminating surface is limited by the apparent trace of the cut-off on to the lens. If the reflector and glass are adjustable relative to one another, the mean adjustment is preferred.

3.1.8
illuminating surface
<signalling device> orthogonal projection of the *lamp* (3.1.5) in a plane perpendicular to its *reference axis* (3.1.10) and in contact with the exterior *light-emitting surface* (3.1.12) of a lamp

Note 1 to entry: This projection is bounded by the edges of screens situated in this plane which allows only 98 % of the total luminous intensity of the light to persist in the reference axis direction.

3.1.9
reflective surface
reflex reflector surface in a plane perpendicular to the *reference axis* (3.1.10) and bounded by planes on the outer edges of the light projection and parallel to this axis

3.1.10
reference axis
characteristic axis of the light signal for use as the reference direction (α = 0°, β = 0°) for photometric measurements and when fitting the *lamp* (3.1.5) on the machine

3.1.11
reference centre
intersection of the *reference axis* (3.1.10) with the *light-emitting surface* (3.1.12)

3.1.12
light-emitting surface
all or part of the exterior surface of the transparent lens that encloses the lighting and light signalling devices and conforms to certain defined photometric and colourimetric conditions

3.1.13
tell-tale
optical signal that when illuminated indicates actuation or deactivation of a machine function, a correct or defective functioning or condition, or a failure to function

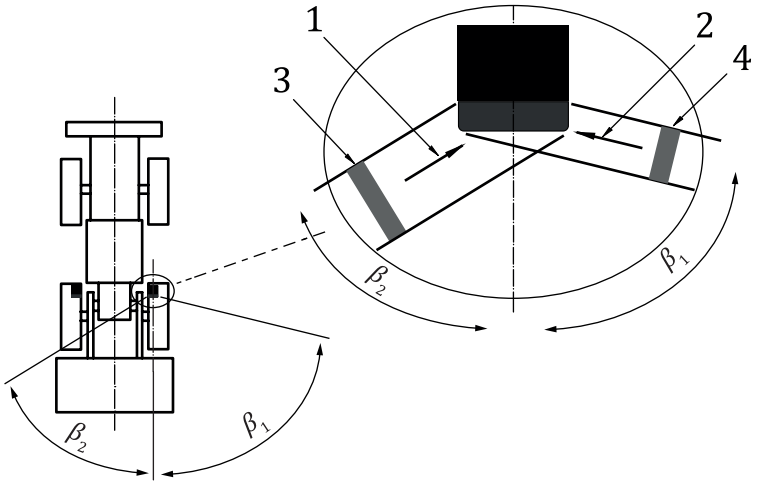
3.1.13.1
operational tell-tale
tell-tale (3.1.13) which informs the operator whether a lighting or light signalling device or system that has been actuated is operating correctly or not

3.1.13.2
circuit-closed tell-tale
tell-tale (3.1.13) which informs the operator whether a lighting or light signalling device or system has been switched on but not whether a lighting is operating correctly or not

3.1.14
geometric visibility
specified angles which define the solid angle in which the *apparent surface* (3.1.15) of a *lamp* (3.1.5) or *reflex reflector* (3.1.6) is visible

Note 1 to entry: See Figure 3-1.

Note 2 to entry: The solid angle is determined by the segments of a sphere in which the centre coincides with the *reference centre* (3.1.11) of the *lamp* (3.1.5) and the equator is parallel to the *ground reference plane* (3.1.2). These segments are determined in relation to the *reference axis* (3.1.10). The horizontal angles correspond to the longitude and the vertical angle to the latitude. The horizontal angles are β_1 corresponding to longitude outboard, and β_2 corresponding to the longitude inboard, and the vertical angles are α_1 corresponding to the up latitude and α_2 corresponding to the down latitude (see data sheet diagram in Annex C).



Key

1 direction of observation longitude inboard
2 direction of observation longitude outboard
3 apparent surface longitude inboard
4 apparent surface longitude outboard

Figure 3-1 — Example of geometric visibility showing directions of observation and apparent surfaces

3.1.15
apparent surface
orthogonal projection of the *light-emitting surface* (3.1.12) in a plane perpendicular to a specified direction of observation

Note 1 to entry: See Figure 3-1.

3.1.16
road
public traffic area for use by automotive vehicles for travel or transportation

Note 1 to entry: *Public traffic area* does not include the sites of temporary road works (for example, for repairs, maintenance, alterations, improvements, installations, or any other works to, above or under a road, including works to road equipment lighting, barriers, walls, etc.) or roads not open to the public (for example, on new housing and industrial developments), or on which public traffic is not permitted.

[SOURCE: ISO 17253:2014, 3.2]

3.1.17
travel on the road
travelling on the road
use of machines on the *road* (3.1.16) (for example, travelling between work sites, to and from the site of normal storage, travelling for refuelling of the machine) for purposes other than intended operation

Note 1 to entry: The crossing of a *road* (3.1.16) in order to carry out job site work can be considered travelling on the road.

[SOURCE: ISO 17253:2014, 3.3, modified — The term was originally "driving on the road" and Note 1 to entry has been added.]

3.1.18
wheel tread/track gauge
distance on Y coordinate between two Y planes passing through the mid-width of the sprocket teeth or tyre centreline as appropriate

3.1.19
emergency braking signal
signal to indicate to other road users and exposed persons to the rear of the machine that a high retardation force has been applied to the machine relative to the prevailing road conditions

3.2 Symbols

B	distance between the outer edges of the light-emitting surface
E	distance between extreme outer edge of machine and outer illuminating surface of lighting device
D	minimum distance between two lamps
H_1	maximum height above ground reference plane to upper edge of illuminating surface or reflective surface
H_2	minimum height above ground reference plane to lower edge of illuminating surface or reflective surface
K	distance from front of machine or behind machine to edge of illuminating surface
L	maximum length of base machine, including front and rear equipment
M	distance between edges of illuminating surface
N	distance between the edges of the illumination surface of the lamps
α_1	vertical angles corresponding to up latitude
α_2	vertical angles corresponding to down latitude
β_1	horizontal angles corresponding to longitude outboard
β_2	horizontal angles corresponding to longitude inboard

4 General requirements

4.1 Installation of lighting, signalling and marking lights, and reflex reflectors

4.1.1 The lighting, signalling and marking lights, and reflex reflectors shall be so fitted that, under normal operating conditions specified by the manufacturer, they retain the characteristics specified in Annex C. It shall not be possible for the lamps to be inadvertently disturbed, for example, due to excessive vibration. General locations for lighting, signalling and marking lights, and reflex reflectors are shown in Annex D.

4.1.2 The position (for example, height and orientation) of the lamps shall be verified with the unladen machine on the ground reference plane. All measurements in this document require the machine to be in the straight, unarticulated roading position. When the machine has a bucket, the bucket shall be in the carry position as specified by the manufacturer.

4.1.3 Lamps constituting a pair shall:

a) be fitted to the machine symmetrically in relation to the zero Y plane and at the same height above the ground reference plane, except on machines with unsymmetrical shape;

b) satisfy the same colourimetric characteristics (see CIE S004 for guidance);

c) have substantially identical photometric characteristics (see CIE S004 for guidance).

4.1.4 The maximum height (H_1) shall be measured from the ground reference plane to the highest point of the illuminating surface. The minimum height (H_2) shall be measured from the ground reference plane to the lowest point of the illuminating surface. When the height requirements are substantially met, it is sufficient to refer to actual lamp edges.

4.1.5 The width dimension (E) shall be determined from the edge of the illuminating surface which is furthest from the zero Y plane of the machine. The width dimension (D) shall be determined from the inner edges of the illuminating surfaces which are closest to the zero Y plane of the machine. When the width requirements are substantially met, it is sufficient to refer to the actual lamp edges.

4.1.6 With the machine located on a horizontal plane and, in the case of articulated frame steering, in a straight position the machine shall be tested to verify that there is:

a) no direct visibility of red light from a lamp or red reflex reflector as given in Annex C if viewed by an observer (at a height above the ground reference plane between 1 m and 2,2 m) anywhere within Zone 1;

Zone 1 is in a transverse plane located 25 m from the front of the wheel/track. The width of Zone 1 is determined by 15° planes originating from the outermost front wheel tread/track gauge on the left side and right side of the machine [see Figure B-1 a)]. For machines with a single wheel/track at the front of the machine (for example, roller with drum), the 15° planes originate from the outside of the wheel/track, for example a drum.

b) no direct visibility of white light from a lamp or white reflex reflector as given in Annex C if viewed by an observer (at a height above the ground reference plane between 1 m and 2,2 m) anywhere within Zone 2 with the following exceptions:

   — white light from the reversing lamp(s);

   — white light from the working lamp(s).

Zone 2 is in a transverse plane located 25 m from the rear of the wheel/track. The width of Zone 2 is determined by 15° planes originating from the outermost rear wheel tread/track gauge on left and right side of the machine. [see Figure B-1 b)]. For machines with a single wheel/track at the rear of the machine (for example, roller with drum), the 15° planes originate from the outside of the wheel/track, for example, a drum.

4.1.7 The electrical connections shall be such that the front position lamps, rear position lamps, and rear registration plate lamp(s) (if any), can only be switched on and off simultaneously.

4.1.8 The electrical connections shall be such that the upper beam headlamps, dipped beam headlamps, and rear fog lamp(s) (if any) cannot be switched on unless the front and rear position lamps, and rear registration plate lamp(s) (if any) are also switched on. This requirement shall not apply when upper beam or dipped beam headlamps are used to give short momentary luminous signals.

4.1.9 Lamps shall be fitted to the machine according to the data sheets in Annex C. Lighting combinations given in Annex C are defined in Annex A, which shall be followed.

4.1.10 Lamps may be grouped, combined, or reciprocally incorporated with one another provided that all requirements regarding colour, position, orientation, geometric visibility, electrical connections, and other requirements, if any, for each lamp are fulfilled. (See Table 4-1.)

Table 4-1 — Comparison of lamp types

Lamp types	Illuminating surface	Light source	Lamp body
grouped	separate	separate	common
[a] Can be a single light source operating under different conditions.			

Table 4-1 *(continued)*

Lamp types	Illuminating surface	Light source	Lamp body
combined	separate	common	common
reciprocally incorporated	common or partially common	separate[a]	common

[a] Can be a single light source operating under different conditions.

4.1.11 The dimensions and geometric visibility specifications given in the data sheets in Annex C are based on the travel or the carry position of the machine as specified by the manufacturer.

4.1.12 Lamps may be activated and deactivated automatically for the purpose of the operator aid as long as the general requirements of this document are followed (for example, autonomous emergency braking).

4.1.13 Figures in Annex C are only representations; actual mounting may vary.

NOTE Where national or regional requirements differ from the requirements of this document, the national or regional requirements can take precedence.

4.2 Reference documents pertaining to lighting and marking devices

Lighting and marking devices can be subject to regional standards and regulations. Annex E provides example reference documents pertaining to lighting and marking devices.

Annex A
(normative)

Lighting combinations

Table A-1 defines lighting combinations based on machine application and the rated maximum travelling speed.

NOTE 1 Following Table A-1 does not ensure conformance to specific national roading standards or regulations. It is possible that all lighting, signalling and marking lights, and reflex reflectors used on machines in lighting group II need to be type approved according to the national regulations.

NOTE 2 The crossing of a road can be considered travelling on the road.

Table A-1 — Lighting combinations

Machines application	**Lighting groups**	**Rated maximum travelling speed** v (km/h)		
		A v ≤ 10	**B** 10 < v ≤ 40	**C** v > 40
Machines that are not configured for travel on the road.	I	Lighting groups I or II can apply to a given machine type. Manufacturer defines lighting group I or II, based on lighting configuration provided.		
Machines that are configured for travel on the road.	II			
Machines not allowed to travel on the road due to physical characteristics exceeding road limits due to regulations.	III	EXAMPLE Machines that exceed permissible axle load limits, machine width exceeds permissible dimensions, machines with steel tracks, sheepfoot drums or padfoot drums.		

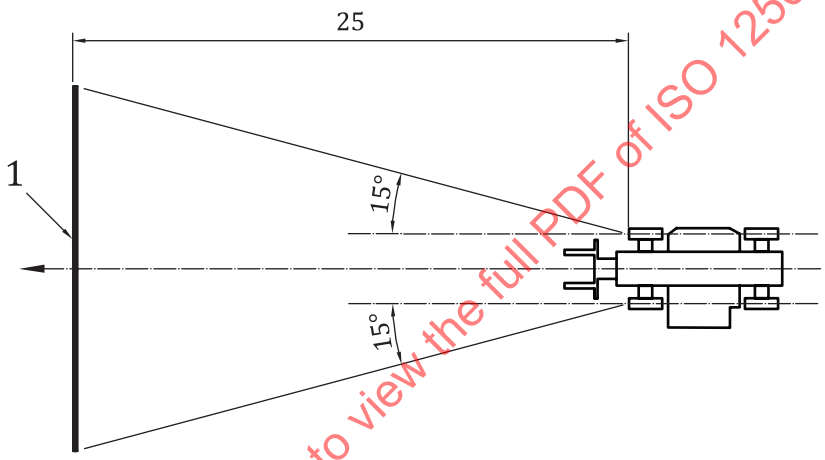
Annex B
(informative)

Forward visibility of red light and rearward visibility of white light

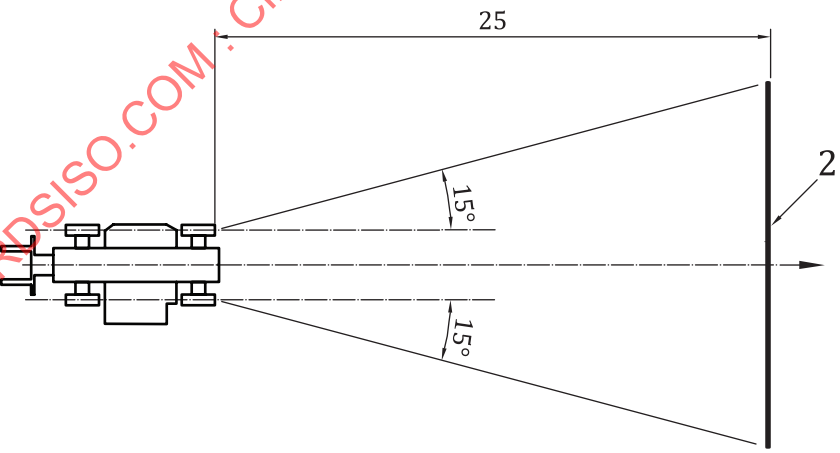
The zone for which no red light from a lamp or red reflex reflector is to be visible to the front of the machine is shown in Figure B-1 a).

The zone for which no white light from a lamp or white reflex reflector is to be visible to the rear of the machine is shown in Figure B-1 b).

Dimensions in metres



a) Forward visibility zone of no red light from a lamp or red reflex reflector [see 4.1.6 a)]



b) Rearward visibility zone of no white light from a lamp or white reflex reflector [see 4.1.6 b)]

Key

1 zone 1

2 zone 2

Figure B-1 — Forward visibility of red light and rearward visibility of white light

Annex C
(normative)

Lighting, signalling and marking lights, and reflex reflectors — Data sheets

Index to data sheets

In the tables of this annex:

— S specifies minimum requirements regarding lighting, signalling, and marking lights and reflex reflectors for on-road or off-road use;

— O specifies optional lighting, signalling and marking lights and reflex reflectors for on-road or off-road use which may be installed on machines. When these lighting, signalling and marking lights, and reflex-reflector devices are used, they should be in accordance with this document.

— N/A is not applicable.

C.1 Dipped beam headlamp

C.1.1 Dipped beam headlamp: lamp used to illuminate the road or the ground reference plane ahead of the machine without causing undue dazzle or discomfort to oncoming drivers and other road users or workers. See Figure C.1-1 and Table C.1-1.

NOTE Dipped beam headlamps are also referred to as driving lamps, low beam headlamps, passing headlamps.

C.1.1.1 Colour of light: white.

C.1.1.2 Alignment: towards the front.

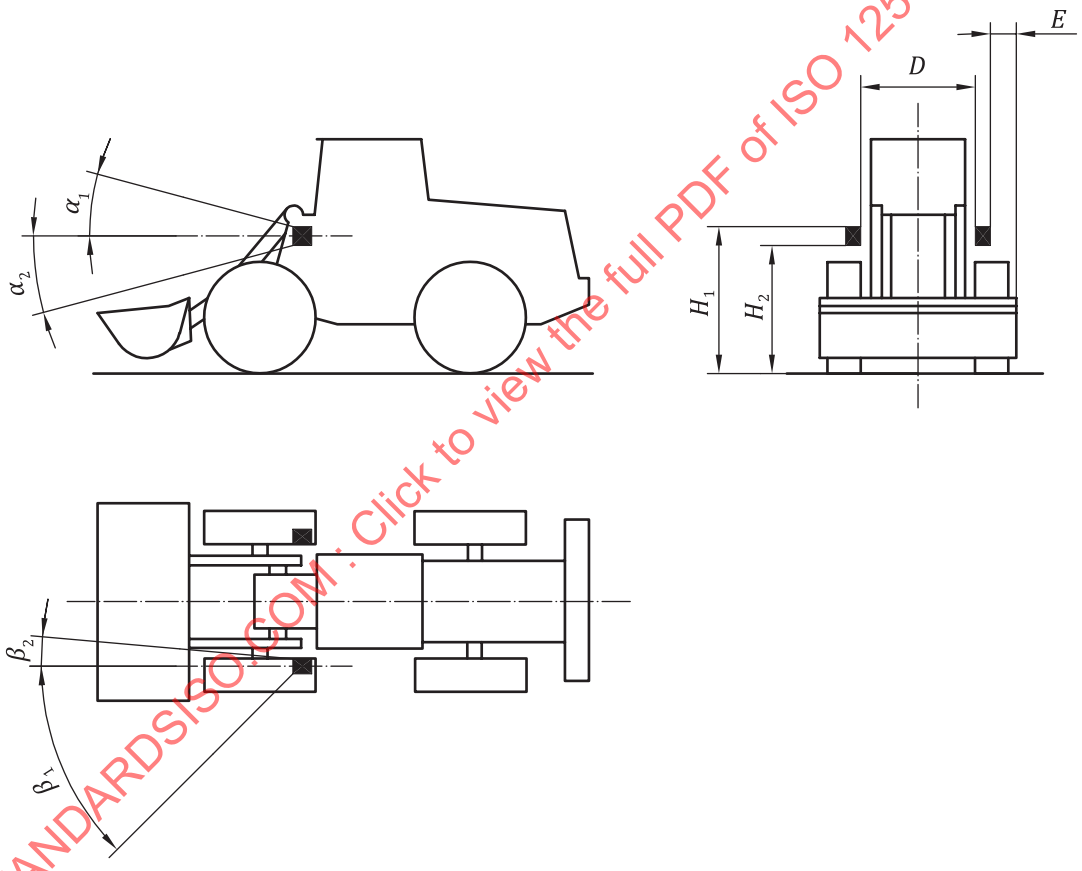


Figure C.1-1 — Dipped beam headlamp

Table C.1-1 — Requirements for dipped beam headlamp

Lighting combinations (see Annex A)	I			II			III		
	A	B	C	A	B	C	A	B	C
Application to machines	O	O	O	S	S	S	N/A	O	O
Number	Two[a]						N/A	Two[a]	
Dimensions, mm									
H_1	≤ 1 500[b]						N/A	≤ 2 100[c]	
H_2	> 500						N/A	> 500	
E	≤ 400[d]						N/A	≤ 400[d]	
D	N/A								
Geometric visibility, minimum angles									
α_1	10°						N/A	10°	
α_2	10°[e]						N/A	10°[e]	
β_1	45°						N/A	45°	
β_2	5°[f]						N/A	5°[f]	
Electrical connections	The dipped beam light may remain switched on at the same time as the upper beam light. When the control switch for dipped beam light is activated, all upper beam lights shall be switched off.								
Tell-tale	N/A								
Other requirements	Symmetrically in relation to the zero Y plane[g]								

a In front of the machine as far ahead as possible. The light shall not cause discomfort to the operator either directly or indirectly through the rear-view mirror or other reflecting surfaces. Two additional dipped beam headlights are optional.

b May be > 1 500 mm if the design of the machine makes it impractical to keep within 1 500 mm.

c May be > 2 100 mm if the design of the machine makes it impractical to keep within 2 100 mm.

d Owing to the design, may be > 400 mm from the extreme outer edge of the machine.

e May be reduced to 5° if the design of the machine makes it necessary.

f May be reduced to 0° if the structure of the machine makes it impractical (for example, loaders and other machines with front end attachments).

g Initial adjustment of the cut-off line. The distance between the screen and the headlamp reference centre shall be at 10 m. When the highest point of the illuminating surface of the headlamp is

— ≤ 1 200 mm, the dipped beam headlamp inclination shall be between 1 % and 3 %, and

— > 1 200 mm, the adjustment of the dipped beam headlamps mounted higher than 1 200 mm shall be such that the horizontal part of the cut-off line at a distance of 15 m in front of the machine is half the height of the centre of the dipped beam headlamp.

C.2 Upper beam headlamp

C.2.1 Upper beam headlamp: lamp used to illuminate the road or the ground reference plane over a long distance ahead of the machine. See Figure C.2-1 and Table C.2-1.

NOTE Upper beam headlamps are also referred to as main beam lamps, high beam headlamps.

C.2.1.1 Colour of light: white.

C.2.1.2 Alignment: towards the front.

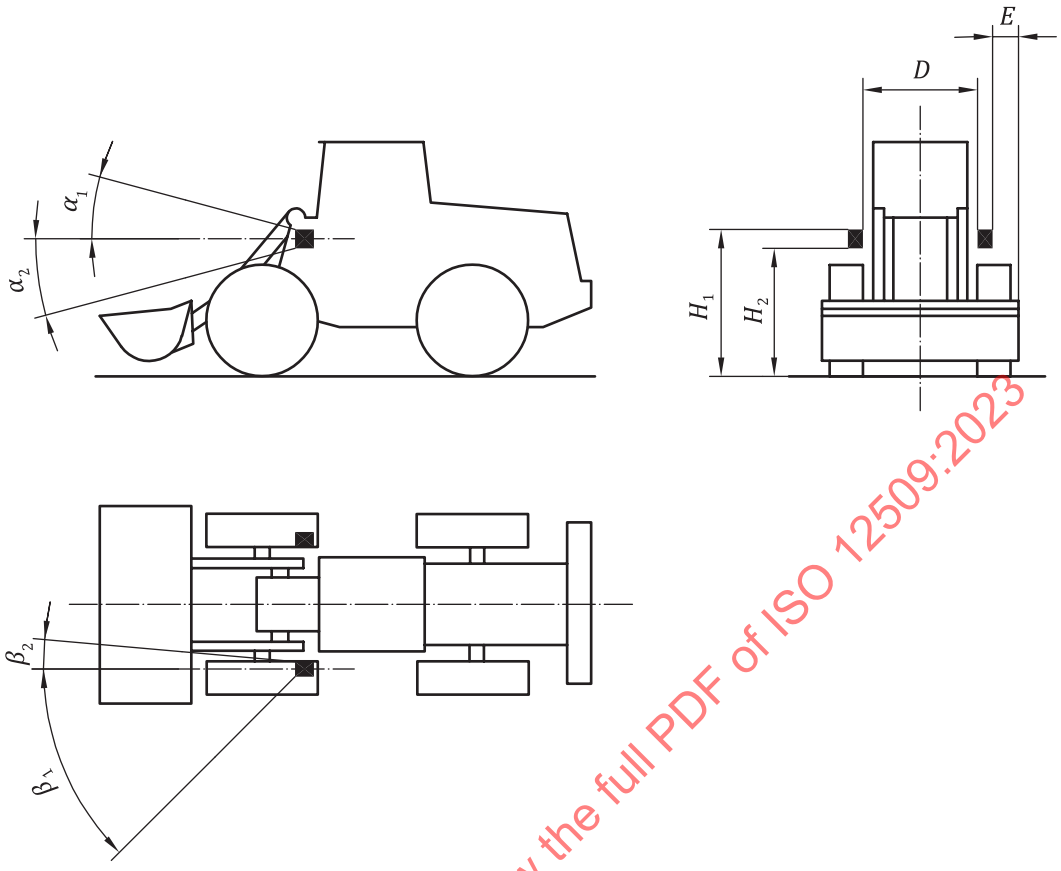


Figure C.2-1 — Upper beam headlight

Table C.2-1 — Requirements for upper beam headlamp

Lighting combinations (see Annex A)	**I**			**II**			**III**		
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Application to machines	N/A			O	O	O	N/A	O	O
Number	N/A			Two or four[a]			N/A	Two or four[a]	
Dimensions, mm									
H_1	N/A								
H_2	N/A								
E	N/A			[b]			N/A	[b]	
D	N/A								
Geometric visibility, minimum angles									
α_1	N/A								

a In front of the machine as far ahead as possible. The light shall not cause discomfort to the operator either directly or indirectly through the rear-view mirror or other reflecting surfaces.

b The outer edges of the illuminating surfaces shall in no case be closer to the extreme outer edge of the machine than the outer edges of the illuminating surfaces of the dipped beam headlamp.

c Shall be switched on either simultaneously or in pairs. For changing over from the dipped beam headlamps to the upper beam headlamps, at least one pair of upper beam headlamps shall be switched on. For changing over from upper beam headlamps to dipped beam headlamps, all upper beam headlamps shall be switched off simultaneously.

d The tell-tale shall be a blue light visible in the operator's field of view, when the upper beam headlamps are switched on.

e Symmetrical in relation to the zero Y plane of the machine. The total maximum intensity of the upper beam headlamps which can be switched on simultaneously shall not exceed 225 000 candelas.

Table C.2-1 *(continued)*

Lighting combinations (see Annex A)	I			II			III		
	A	B	C	A	B	C	A	B	C
α_2	N/A								
β_1	N/A								
β_2	N/A								
Electrical connections	N/A			c			N/A	c	
Tell-tale	N/A			d			N/A	d	
Other requirements	N/A			e			N/A	e	

a In front of the machine as far ahead as possible. The light shall not cause discomfort to the operator either directly or indirectly through the rear-view mirror or other reflecting surfaces.

b The outer edges of the illuminating surfaces shall in no case be closer to the extreme outer edge of the machine than the outer edges of the illuminating surfaces of the dipped beam headlamp.

c Shall be switched on either simultaneously or in pairs. For changing over from the dipped beam headlamps to the upper beam headlamps, at least one pair of upper beam headlamps shall be switched on. For changing over from upper beam headlamps to dipped beam headlamps, all upper beam headlamps shall be switched off simultaneously.

d The tell-tale shall be a blue light visible in the operator's field of view, when the upper beam headlamps are switched on.

e Symmetrical in relation to the zero Y plane of the machine. The total maximum intensity of the upper beam headlamps which can be switched on simultaneously shall not exceed 225 000 candelas.

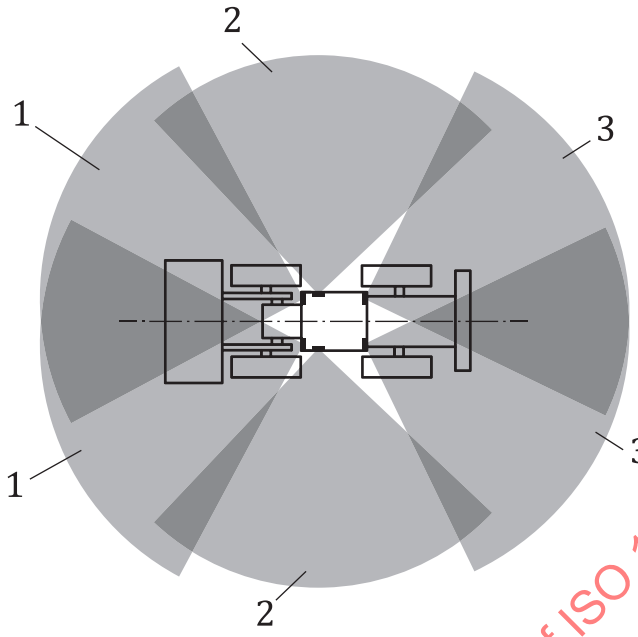
C.3 Work lamp

C.3.1 Work lamp: lamp used for illuminating the working area to the front, rear or side of the machine. See Figure C.3-1 and Table C.3-1.

NOTE Work lamps are also referred to as working lights.

C.3.1.1 Colour of light: white.

C.3.1.2 Alignment: any direction, or all around where necessary.



Key

1 example working zone illuminated by work lamp directed to the front of the machine
2 example working zone illuminated by work lamp directed to the side of the machine
3 example working zone illuminated by work lamp directed to the rear of the machine

Figure C.3-1 — Work lamp

Table C.3-1 — Requirements for work lamp

Lighting combinations (see Annex A)	**I**			**II**			**III**		
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Application to machines	O	O	O	O	O	O	O	O	O
Number	One or more[a]								
Dimensions, mm									
H_1	N/A								
H_2	N/A								
E	N/A								
D	N/A								
Geometric visibility, minimum angles									
α_1	N/A								
α_2	N/A								
β_1	N/A								
β_2	N/A								
Electrical connections	Shall have a separate switch or control.[b]								
Tell-tale	N/A								
Other requirements	N/A								
Where national requirements differ from those given here, the national requirements may be applied.									

a A number that makes it possible to observe the actual working area of the machine and if necessary, also the attachment.

b If equipped, the front and rear position lamps may be illuminated when the work lamps are switched on.

C.4 Reversing lamp

C.4.1 Reversing lamp: lamp actuated when the operator has moved the control to select the reverse direction, provided to illuminate the area to the rear of the machine. See Figure C.4-1 and Table C.4-1.

C.4.1.1 Colour of light: white.

C.4.1.2 Alignment: rearwards.

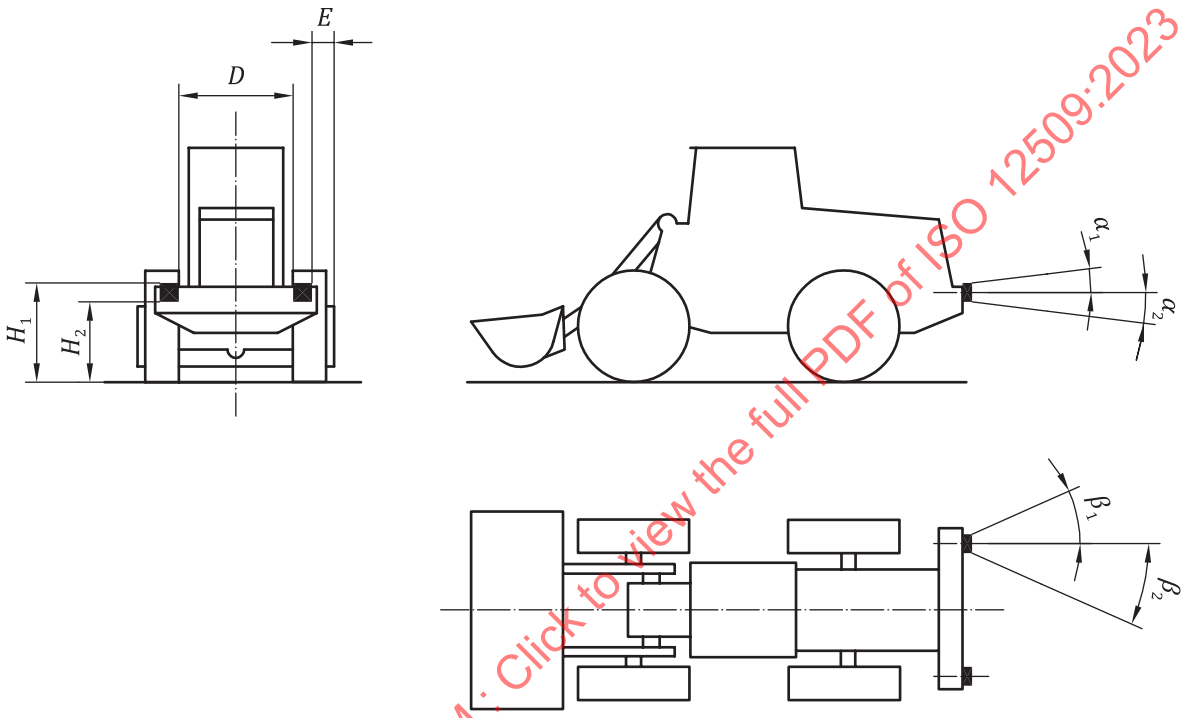


Figure C.4-1 — Reversing lamp

Table C.4-1 — Requirements for reversing lamp

Lighting combinations (see Annex A)	**I**			**II**			**III**		
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Application to machines	N/A	O	O	O	O	O	N/A	O	O
Number	One or more								
Dimensions, mm									
H_1	≤ 1 500[a]								
H_2	> 400								
E	N/A								
D	N/A								

a In a longitudinal direction at the rear portion of the machine. May be fitted higher if the design of the machine makes it impractical to keep within 1 500 mm.

b May be reduced to 10° if the design of the machine makes it necessary.

c The reversing lamp shall be illuminated when the operator has actuated the control for the reverse direction and if the device which controls the starting or stopping of the engine is in a position such that operation of the engine is possible. The reversing lamp shall not be illuminated if either of the above conditions is not satisfied. The reversing lamp shall not be illuminated when the direction control is in the neutral or forward direction positions.

Table C.4-1 *(continued)*

Lighting combinations (see Annex A)	I			II			III		
	A	B	C	A	B	C	A	B	C
Geometric visibility, minimum angles									
α_1	15°								
α_2	5°								
β_1	45°								
β_2	45°[b]								
Electrical connections	[c]								
Tell-tale	Optional								
Other requirements	N/A								

a In a longitudinal direction at the rear portion of the machine. May be fitted higher if the design of the machine makes it impractical to keep within 1 500 mm.

b May be reduced to 10° if the design of the machine makes it necessary.

c The reversing lamp shall be illuminated when the operator has actuated the control for the reverse direction and if the device which controls the starting or stopping of the engine is in a position such that operation of the engine is possible. The reversing lamp shall not be illuminated if either of the above conditions is not satisfied. The reversing lamp shall not be illuminated when the direction control is in the neutral or forward direction positions.

C.5 Direction indicator lamps

C.5.1 Direction-indicator lamp

C.5.1.1 Direction-indicator lamp: lamp used to indicate to other road users and other participants on the work site that the operator of the machine intends to change direction to the right or to the left. See Figure C.5-1 and Table C.5-1.

NOTE Direction-indicator lamps are also referred to as turn signal lights.

C.5.1.2 Colour of light: amber.

C.5.1.3 Alignment: the installation direction laid down by the lamp manufacturer shall be observed.

C.5.1.4 Flashing frequency: 1,5 Hz ± 0,5 Hz (90 ± 30 times/min).

C.5.1.5 Types of direction-indicator lamps:

Categories 1, 1a, 1b: front direction-indicator lamps

Categories 2a or 2b: rear direction-indicator lamps

Category 3: combined front direction-indicator and rear direction-indicator lamp mounted to the sides of a machine

Category 4: combined front direction-indicator and side direction-indicator lamp (to be used in conjunction with a Category 2a or 2b lamp)

Category 5: supplementary side direction-indicator lamp (to be used in conjunctions with 1, 1a, or 1b and 2a or 2b lamps)

C.5.1.6 General requirements/explanations: these are as follows.

a) Direction-indicator lamps shall illuminate independently of other lamps. All direction-indicator lamps on one side of the machine shall be switched on and off by means of one control and shall flash in phase.

b) Circuit-closed tell-tale is mandatory for front and rear direction-indicator lamps. The tell-tale shall be green, flashing, and an audible signal may be provided. For lighting group II machines, an operational tell-tale could be required for front and rear lamps.

c) Operation of the light-signal control shall be followed ≤ 1 s by the appearance of the light and ≤ 1,5 s by its first extinction. The illuminating surface of front direction-indicator lamps, Category 1, shall be ≥ 40 mm, Category 1a < 40 but > 20 mm, and Category 1b ≤20 mm from the illuminating surface of the dipped beam headlamp.

d) Category 2a: rear direction-indicator lamps with steady luminous intensity (marker light). Category 2b: rear direction-indicator lamps with variable luminous intensity (turn-signal light).

e) When the hazard warning signal control is actuated, the direction-indicator lamps need not function in the direction-indicator mode.

f) On lighting group II machines, where the distance between the outer edges of the illuminating surfaces of the front and rear direction-indicator lamps is more than 6 m, supplementary direction-indicator lamps, Category 5, shall be fitted on both sides, preferably to the first third of the total length of the machine [see Figure C.5-1 c)].

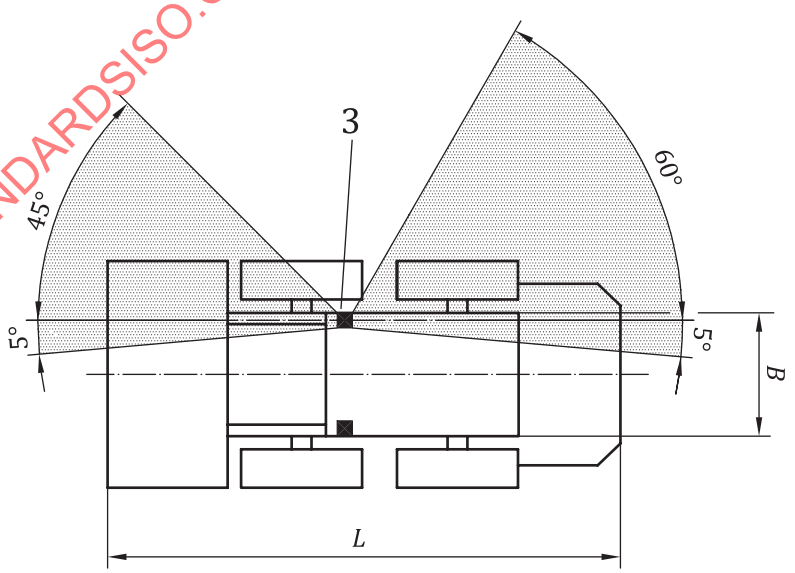
g) If sufficient visibility of the direction-indicator lamps is not available due to machine structure, Category 5 lighting is required.

C.5.1.7 Minimum angle of visibility for direction-indicators.

C.5.1.7.1 Arrangements A and B: geometrical visibility horizontal (Data Sheets C.5.2 to C.5.6). See Figure C.5-1, a) and b).

C.5.1.7.2 Arrangements C and D: see Figure C.5-1, c) and d).

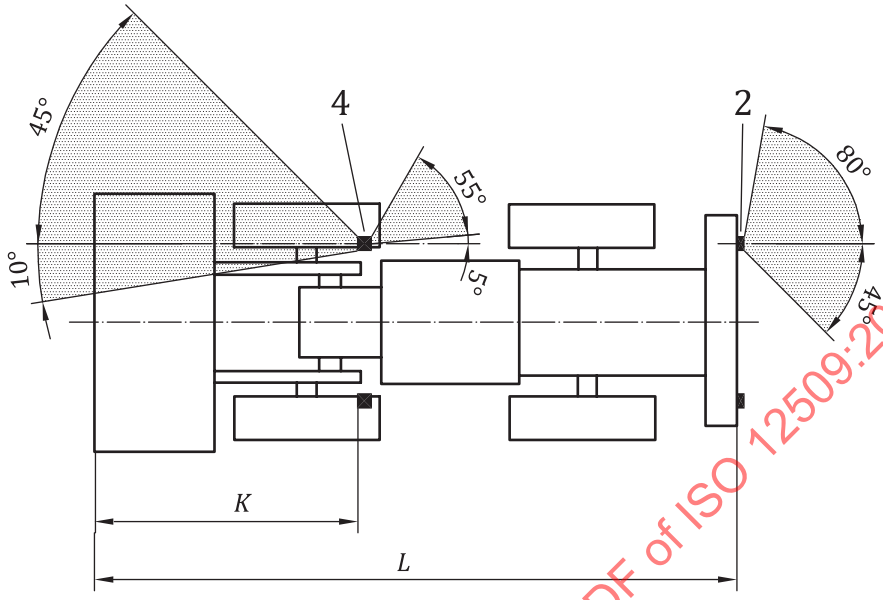
Dimensions are in metres



$L \leq 4{,}6$

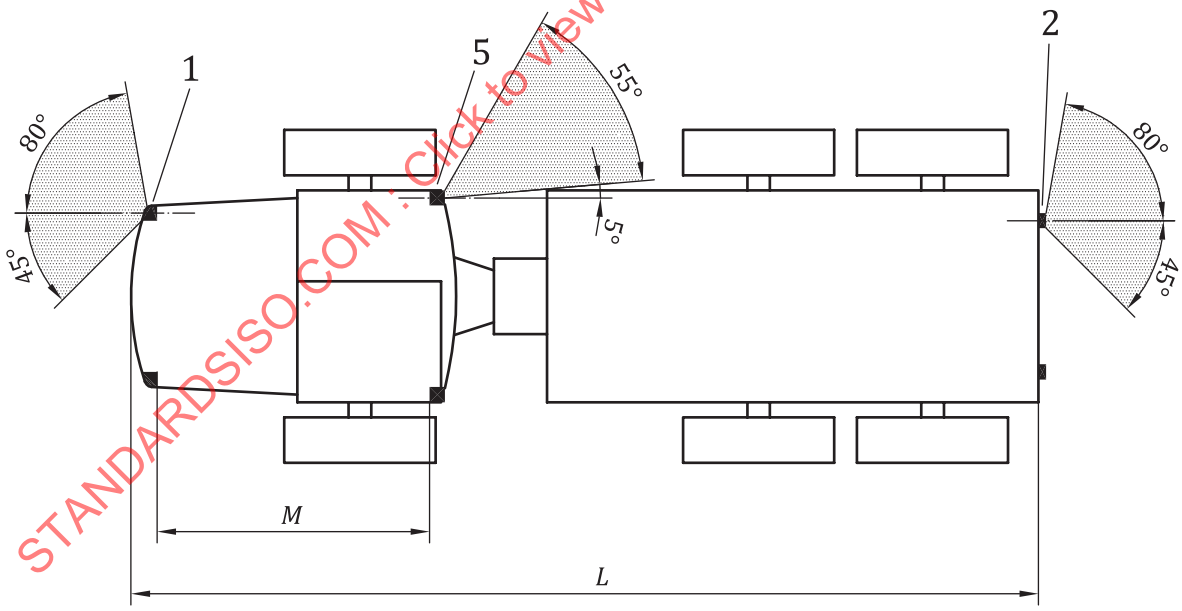
$B \leq 1{,}6$

a) Arrangement A



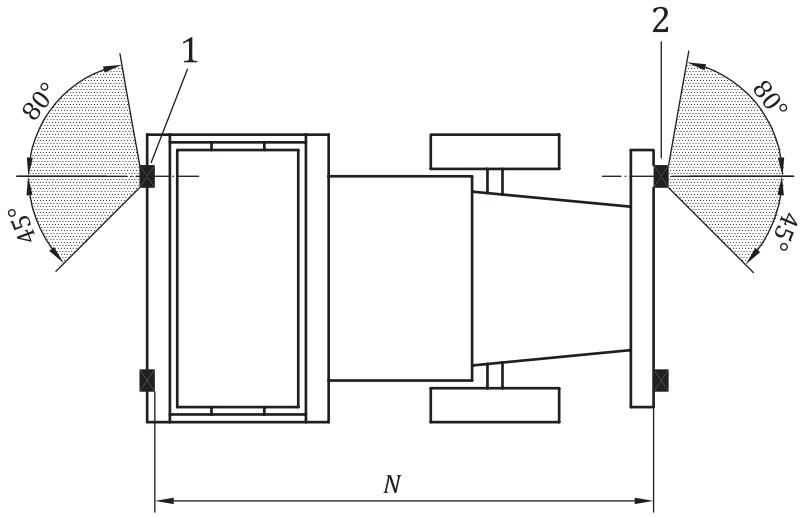
$K \leq L/2$a

b) Arrangement B



$M \leq L/3$b

c) Arrangement C



$N \leq 6$

d) Arrangement D

Key

1 category 1d
2 category 2d
3 category 3d
4 category 4d
5 category 5d
L overall length of base machine, including front and rear equipment c
N distance between the edges of the illumination surface of the lamps
K distance from the front of the machine to the edge of the illuminating surface
M distance between the edges of the illuminating surface
B distance between the outer edges of the light-emitting surface
a The direction-indicator lamp shall be installed as close as possible towards the front.
b If $M \leq 1/3L$ is impractical, the direction-indicator lamp shall be installed as close as possible towards the front.
c See, for example, ISO 7131, ISO 7133.
d See C.5.1.5.

Figure C.5-1 — Direction-indicator lamp

Table C.5-1 — Direction-indicator lamp application

Application	Arrangement[a]	Installation outline	Category
Machine with a maximum base machine length of 4,60 m and a maximum lateral distance between the outer edges of the illuminating surfaces of 1,50 m.	A [Figure C.5-1 a)]	Two front-and rear - indicator lamps	3
Machine with a front-mounted structure, linkage, etc. which prevents the use of arrangements A, C and D.	B [Figure C.5-1 b)]	Two front and side combined direction-indicator lamps	4
		Two rear direction-indicator lamps	2a or 2b
a Accepted combinations are presented in Figure C.5-1 a) to d).			

Table C.5-1 *(continued)*

Application	Arrangement[a]	Installation outline	Category
Any machine	C [Figure C.5-1 c)]	Two front direction-indicator lamps	1 or 1a or 1b
		Two rear direction-indicator lamps	2a or 2b
		Two side direction-indicator lamps	5
Any machine	D [Figure C.5-1 d)]	Two front direction-indicator lamps	1 or 1a or 1b
		Two rear direction-indicator lamps	2a or 2b

a Accepted combinations are presented in Figure C.5-1 a) to d).

C.5.2 Front direction-indicator lamp

C.5.2.1 Front direction-indicator lamp: (see Figure C.5-2 and Table C.5-2). Categories 1, 1a and 1b.

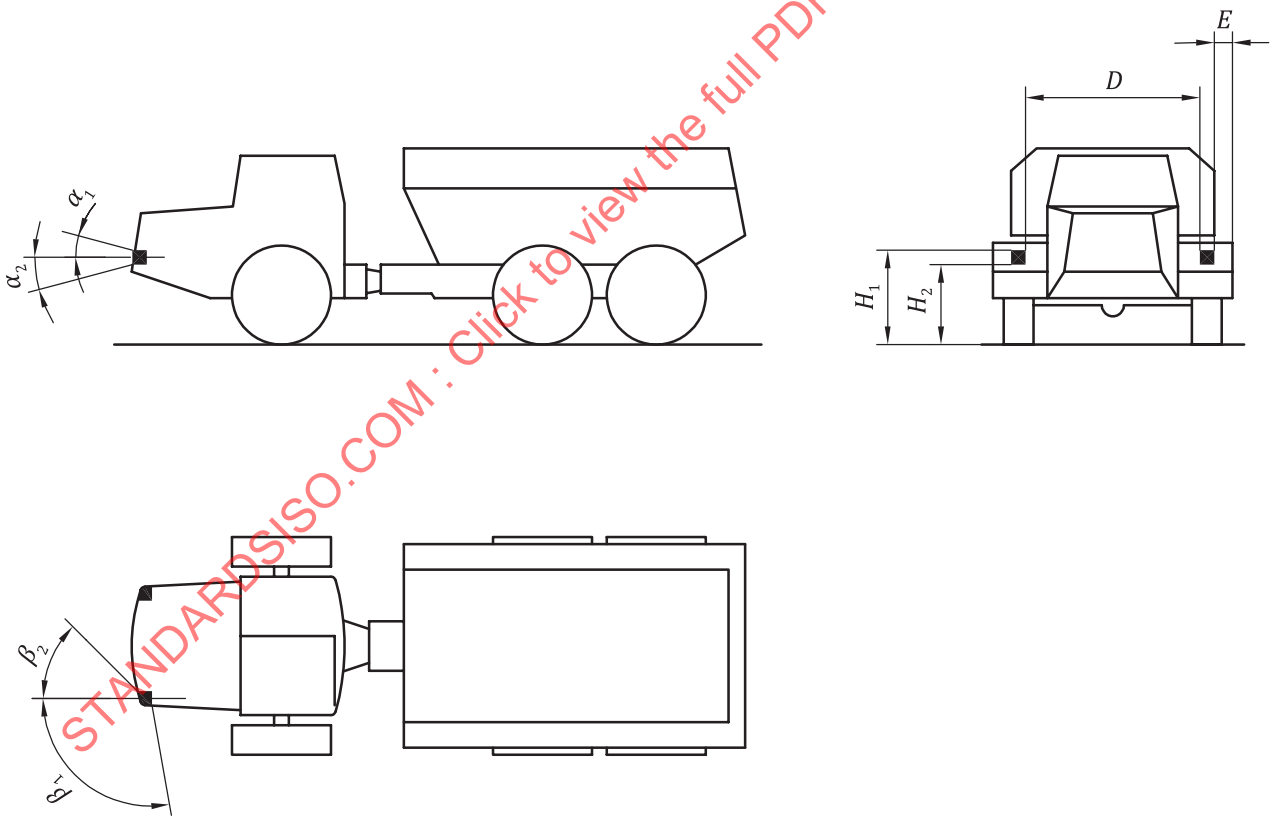


Figure C.5-2 — Front direction-indicator lamp

C.5.2.2 Configuration: in Arrangement C, together with direction-indicator lamps Categories 2 and 5; and in Arrangement D, together with direction-indicator lamp Category 2 (see C.5.1.7.2).

Table C.5-2 — Requirements for front direction-indicator lamp: Categories 1, 1a and 1b (see C.5.1.6)

Lighting combinations (see Annex A)	**I**			**II**			**III**		
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Application to machines	N/A	O	S	S	S	S	N/A	O	S
Number	N/A	Two or four[a]					N/A	Two or four[a]	
Dimensions, in mm									
H_1	N/A	≤ 1 500[b]		≤ 1 500[c]			N/A	≤ 1 500[b]	
H_2	N/A	> 400					N/A	> 600	
E	N/A	≤ 400[d]		≤ 400			N/A	≤ 400[d]	
D	N/A	> 500[e]					N/A	> 500[e]	
Geometric visibility, minimum angles									
α_1	N/A	15° latitude					N/A	15° latitude	
α_2	N/A	15° latitude[f]					N/A	15° latitude	
β_1	N/A	80°[g]					N/A	80°[g h]	
β_2	N/A	45°[g]					N/A	45°[g h]	
Electrical connections	N/A	See C.5.1.6					N/A	See C.5.1.6	
Tell-tale	N/A	See C.5.1.6					N/A	See C.5.1.6	
Other requirements	N/A	See C.5.1.6					N/A	See C.5.1.6	

a Four allowed if two do not comply with angles β_1 (outward) and β_2 (inward). If four, one pair shall meet the requirement of angle β_1 and the other, β_2.

b May be fitted higher if the design of the machine makes it impractical to meet the requirement of ≤ 1 500 mm.

c May be fitted higher if the design of the machine makes it impractical to meet the requirement of ≤ 1 500 mm; maximum height shall be 2 100 mm.

d May be > 400 mm if the design of the machine makes it impractical to meet the requirement of ≤ 400 mm.

e May be < 500 mm if the design of the machine makes it impractical to meet the requirement of > 500 mm.

f May be reduced to 5° machine makes it necessary.

g If two pairs, the angle of one pair shall be 80° and that of the other, 45°.

h May be reduced if the design of the machine makes 80° or 45° impractical.

C.5.3 Rear direction-indicator lamp

C.5.3.1 Rear direction-indicator lamp: (see Figure C.5-3 and Table C.5-3). Categories 2a and 2b.

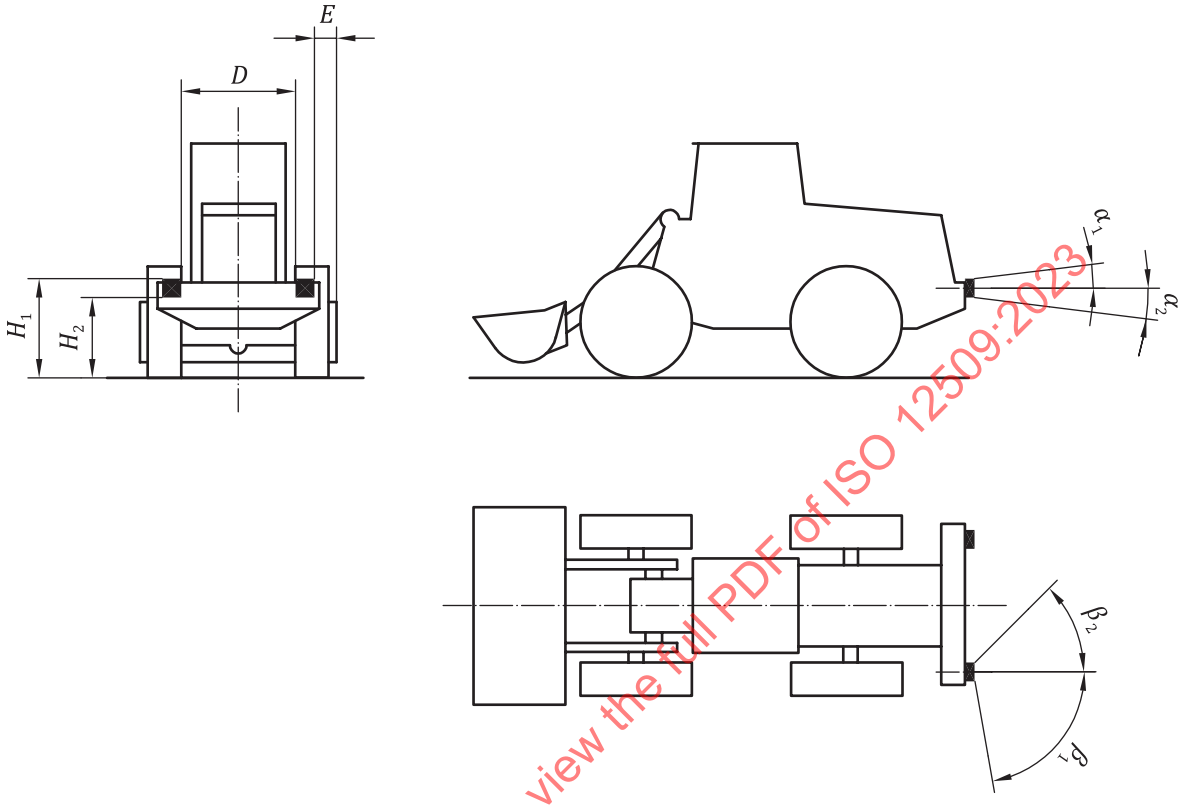


Figure C.5-3 – Rear direction-indicator lamp

C.5.3.2 Configuration:

— in Arrangement B, together with direction-indicator lamp Category 4 (see C.5.1.7.1);

— in Arrangement C, together with direction-indicator lamps Categories 1 and 5;

— in Arrangement D, together with direction-indicator lamp Category 1 (see C.5.1.7.2).

Table C.5-3 — Requirements for rear direction-indicator lamp: Categories 2a and 2b (see C.5.1.6)

Lighting combinations (see Annex A)	**I**			**II**			**III**		
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Application to machines	N/A	O	S	S	S	S	N/A	O	S
Number	N/A	Two or four[a]					N/A	Two or four[a]	
Dimensions, in mm									
H_1	N/A	≤ 1 500[b]		≤ 1 500[c]			N/A	≤1 500[b]	
H_2	N/A	> 400					N/A	> 600	
E	N/A	≤ 400[d]		≤ 400			N/A	≤ 400[d]	
D	N/A	> 500[e]					N/A	> 500[e]	
Geometric visibility, minimum angles									
α_1	N/A	15° latitude[f]					N/A	15° latitude[f]	
α_2	N/A	15° latitude[g]					N/A	15° latitude[g]	
β_1	N/	80°[h]					N/A	80°[h, i]	
β_2	N/A	45°[h]					N/A	45°[h, i]	
Electrical connections	N/A	See C.5.1.6					N/A	See C.5.1.6	
Tell-tale	N/A	See C.5.1.6					N/A	See C.5.1.6	
Other requirements	N/A	See C.5.1.6					N/A	See C.5.1.6	

a Four allowed if two do not comply with angles β_1 (outward) and β_2 (inward). If four, one pair shall meet the requirement of angle β_1 and the other, β_2.

b May be fitted higher if the design of the machine makes it impractical to meet the requirement of ≤ 1 500 mm.

c May be fitted higher if the design of the machine makes it impractical to meet the requirement of ≤ 1 500 mm: maximum height shall be 2 100 mm.

d May be > 400 mm if the design of the machine makes it impractical to meet the requirement of ≤ 400 mm.

e May be reduced if the design of the machine makes it impractical to meet the requirement of > 500 mm, for example, on rear-dump dumper.

f May be reduced to 10° if the design of the machine makes it necessary.

g May be reduced to 5° if the design of the machine makes it necessary.

h If two pairs, the angle of one pair shall be 80° and that of the other 45°.

i May be reduced if the design of the machine makes it impractical to achieve 80° or 45°, for example, on a machine with rear-mounted working equipment or rear-dump dumper.

C.5.4 Combined front direction-indicator and rear direction-indicator lamp

C.5.4.1 Combined front direction-indicator and rear direction-indicator lamp: (see Figure C.5-4 and Table C.5-4) Category 3.

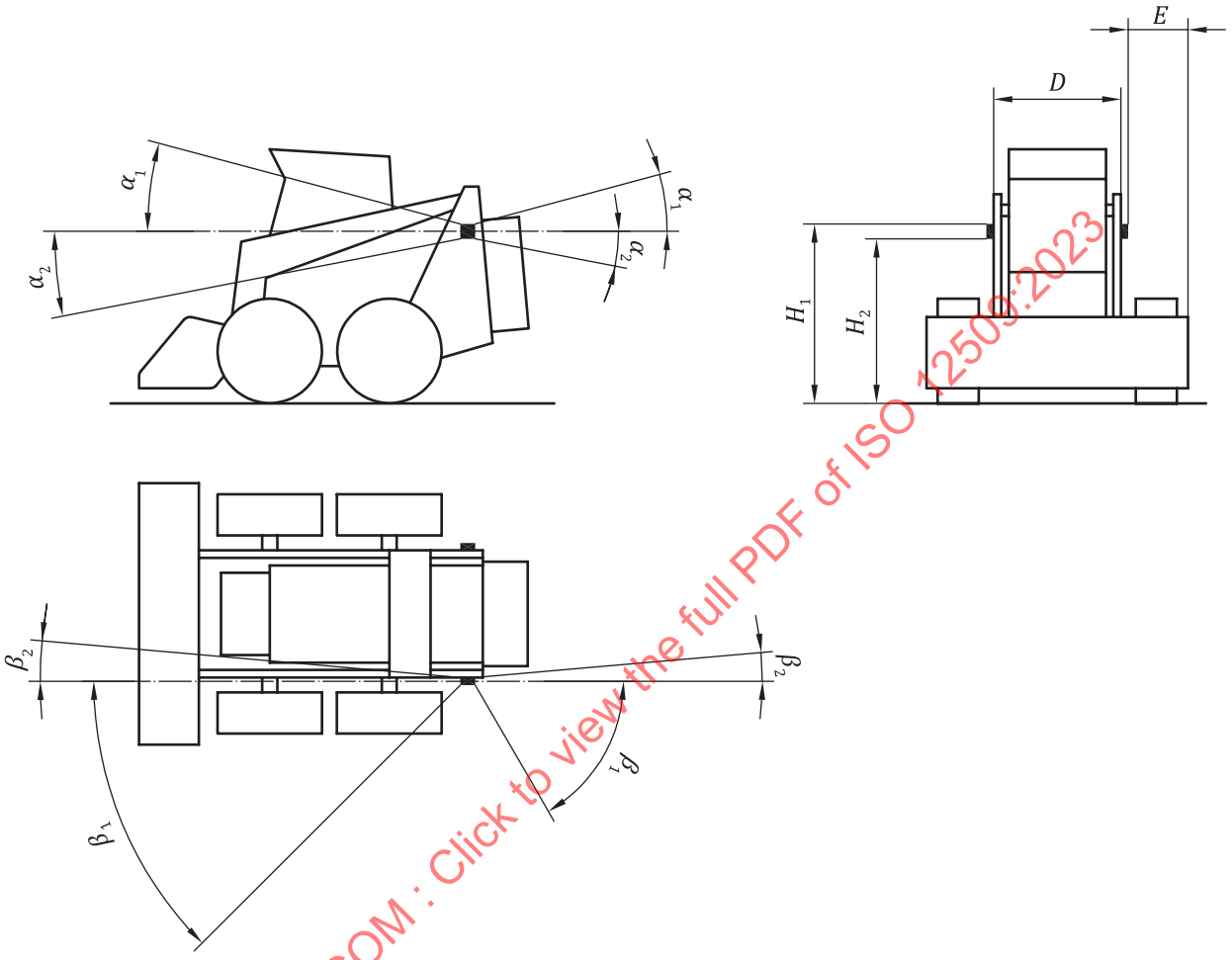


Figure C.5-4 — Combined front direction-indicator and rear direction-indicator lamp

C.5.4.2 Configuration: in Arrangement A (see C.5.1.7.1).

Table C.5-4 — Requirements for combined front direction-indicator lamp and rear direction-indicator lamp: Category 3 (see C.5.1.6)

Lighting combinations (see Annex A)	**I**			**II**			**III**		
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Application to machines	O	O	O	S	S	S	N/A	S	S
Number	Two[a]						N/A	Two[a]	
Dimensions, in mm									
H_1	≤ 1 500[b]			≤ 1 500[c]			N/A	≤ 1 500[b]	
H_2	> 400						N/A	> 600	
E	N/A								
D	N/A								
Geometric visibility, minimum angles									
α_1	15° latitude						N/A	15° latitude	
α_2	10° latitude						N/A	10° latitude	
β_1	45° front						N/A	45° front	
	60° rear						N/A	60° rear	
β_2	5° front						N/A	5° front[d]	
	5° rear						N/A	5° rear[d]	
Electrical connections	See C.5.1.6						N/A	See C.5.1.6	
Tell-tale	See C.5.1.6						N/A	See C.5.1.6	
Other requirements	See C.5.1.6						N/A	See C.5.1.6[e]	

a Direction-indicator lamps of Category 3 may not be combined with any other direction-indicator lamp (see C.5.1.7.1, Arrangement A). If the Category 3 lamp does not fulfil the geometric visibility (owing to equipment or attachment), Arrangement D (see C.5.1.7.2) shall be used.

b May be fitted higher if the design of the machine makes it impractical to meet the requirement of ≤ 1 500 mm.

c May be fitted higher if the design of the machine makes it impractical to meet the requirement of ≤ 1 500 mm: maximum height shall be 2 100 mm.

d May be reduced to 2° if the design of the machine makes it necessary.

e Direction-indicator lamps of Category 3 may only be used on machines whose maximum length does not exceed 4,60 m and where the distance between the outlines of the illuminating surfaces of the front and the rear indicators is ≤ 1,50 m. See C.5.1.7.1, Arrangement A.

C.5.5 Combined front direction-indicator and side direction-indicator lamp

C.5.5.1 Combined front direction-indicator and side direction-indicator lamp: (see Figure C.5-5 and Table C.5-5) Category 4.

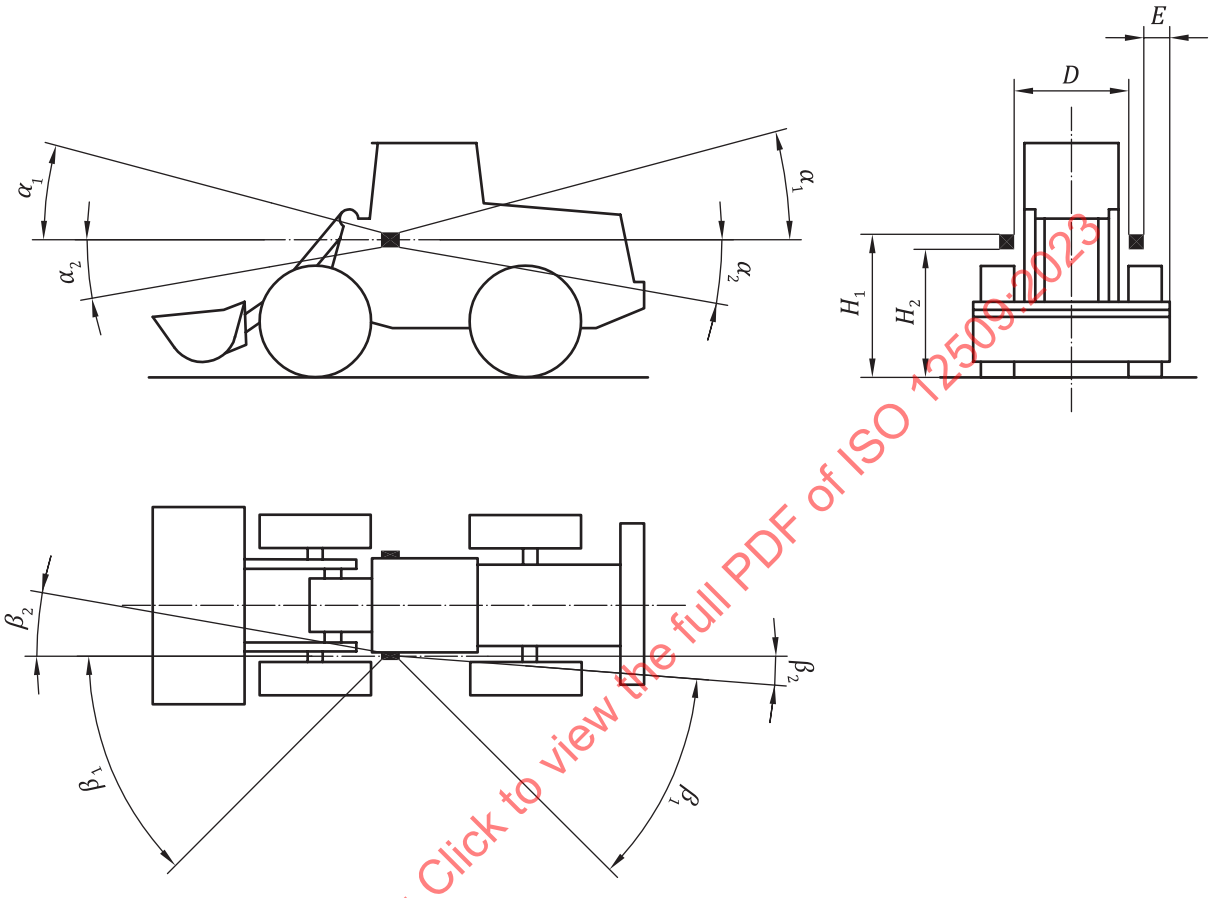


Figure C.5-5 — Combined front direction-indicator and side direction-indicator lamp

C.5.5.2 Configuration: in Arrangement B, it shall be used in conjunction with rear direction-indicator lamp, Category 2a or 2b (see C.5.1.7.1).

Table C.5-5 — Requirements for combined front direction-indicator and side direction-indicator lamp: Category 4 (see C.5.1.6)

Lighting combinations (see Annex A)	**I**			**II**			**III**		
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Application to machines	N/A	O	S	S	S	S	N/A	O	S
Number	N/A	Two[a]					N/A	Two[a]	
Dimensions, in mm									
H_1	N/A	≤ 1 500[b]		≤ 1 500[c]			N/A	≤ 1 500[b]	

a Side direction-indicator lamps of Category 4 may only be used in combination with rear direction-indicator lamps of Category 2. See C.5.1.7.1, Arrangement B.

b May be fitted higher if the design of the machine makes it impractical to meet the requirement of ≤ 1 500 mm.

c May be fitted higher if the design of the machine makes it impractical to meet the requirement of ≤ 1 500 mm: maximum height shall be 2 100 mm.

d May be > 400 mm if the design of the machine makes it impractical to meet the requirement of ≤ 400 mm.

e See C.5.1.7.1.

Table C.5-5 *(continued)*

Lighting combinations (see Annex A)	**I**			**II**			**III**		
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
H_2	N/A	> 400					N/A	> 600	
E	N/A	≤ 400[d]		≤ 400			N/A	≤ 400[d]	
D	N/A	> 500					N/A	> 500	
K	N/A	[e]					N/A	[e]	
Geometric visibility, minimum angles									
α_1	N/A	15° latitude					N/A	15° latitude	
α_2	N/A	10° latitude					N/A	10° latitude	
β_1	N/A	45° front					N/A	45° front	
	N/A	55° rear					N/A	55°rear	
β_2	N/A	10° front					N/A	10° front	
	N/A	-5° rear					N/A	-5° rear	
Electrical connections	N/A	See C.5.1.6					N/A	See C.5.1.6	
Tell-tale	N/A	See C.5.1.6					N/A	See C.5.1.6	
Other requirements	N/A	See C.5.1.6					N/A	See C.5.1.6	

a Side direction-indicator lamps of Category 4 may only be used in combination with rear direction-indicator lamps of Category 2. See C.5.1.7.1, Arrangement B.

b May be fitted higher if the design of the machine makes it impractical to meet the requirement of ≤ 1 500 mm.

c May be fitted higher if the design of the machine makes it impractical to meet the requirement of ≤ 1 500 mm: maximum height shall be 2 100 mm.

d May be > 400 mm if the design of the machine makes it impractical to meet the requirement of ≤ 400 mm.

e See C.5.1.7.1.

C.5.6 Supplementary side direction-indicator lamp

C.5.6.1 Supplementary side direction-indicator lamp: (see Figure C.5-6 and Table C.5-6) Category 5.

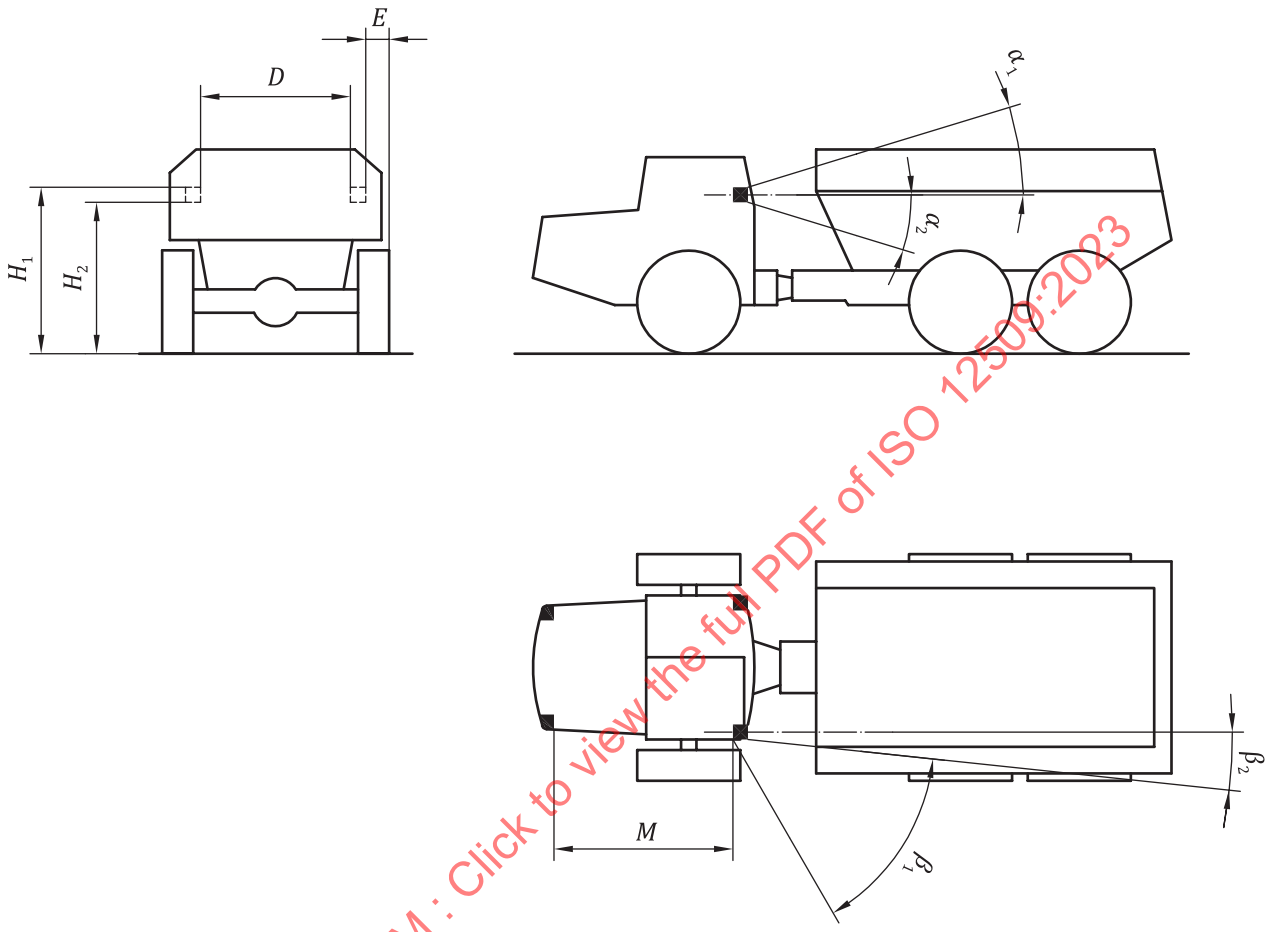


Figure C.5-6 — Supplementary side direction-indicator lamp

C.5.6.2 Configuration: in Arrangement C, it shall be combined with direction-indicator lamps, Categories 1 and 2 (see C.5.1.7.2).

Table C.5-6 — Requirements for supplementary side direction-indicator lamp: Category 5 (see C.5.1.6)

Lighting combinations (see Annex A)	**I**			**II**			**III**		
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Application to machines	N/A	O	O	S	S	S	N/A	O	O
Number	N/A	Two					N/A	Two	
Dimensions, in mm									
a May be fitted higher if the design of the machine makes it impractical to meet the requirement of ≤ 1 500 mm.									
b May be fitted higher if the design of the machine makes it impractical to meet the requirement of ≤ 1 500 mm: maximum height shall be 2 100 mm.									
c See C.5.1.7.2 Arrangement C.									
d May be reduced to 5° if the design of the machine makes it necessary.									
e Supplementary side direction-indicator lamps of Category 5 may only be used in combination with direction-indicator lamps of Categories 1 and 2. See Figure C.5-1, c) and C.5.1.6, f) and g).									

Table C.5-6 *(continued)*

Lighting combinations (see Annex A)	I			II			III		
	A	B	C	A	B	C	A	B	C
H_1	N/A	≤ 1 500[a]		≤ 1 500[b]			N/A	≤ 1 500[a]	
H_2	N/A	> 500					N/A	> 800	
E	N/A								
D	N/A								
M	N/A	[c]					N/A	[c]	
Geometric visibility, minimum angles									
α_1	N/A	15° latitude					N/A	15° latitude	
α_2	N/A	15° latitude[d]					N/A	15° latitude[d]	
β_1	N/A	55° rear					N/A	55° rear	
β_2	N/A	−5° rear					N/A	−5° rear	
Electrical connections	N/A	See C.5.1.6					N/A	See C.5.1.6	
Tell-tale	N/A	See C.5.1.6					N/A	See C.5.1.6	
Other requirements	N/A	See C.5.1.6[e]					N/A	See C.5.1.6[e]	

a May be fitted higher if the design of the machine makes it impractical to meet the requirement of ≤ 1 500 mm.

b May be fitted higher if the design of the machine makes it impractical to meet the requirement of ≤ 1 500 mm: maximum height shall be 2 100 mm.

c See C.5.1.7.2 Arrangement C.

d May be reduced to 5° if the design of the machine makes it necessary.

e Supplementary side direction-indicator lamps of Category 5 may only be used in combination with direction-indicator lamps of Categories 1 and 2. See Figure C.5-1, c) and C.5.1.6, f) and g).

C.6 Hazard warning signal

C.6.1 Hazard warning signal: simultaneous operation of all direction-indicator lamps of the machine to indicate the presence of the machine which is unable to continue its operation, or is operating at a reduced speed, and thus presents a hazard to other on-road and off-road users. See Figure C.6-1 and Table C.6-1.

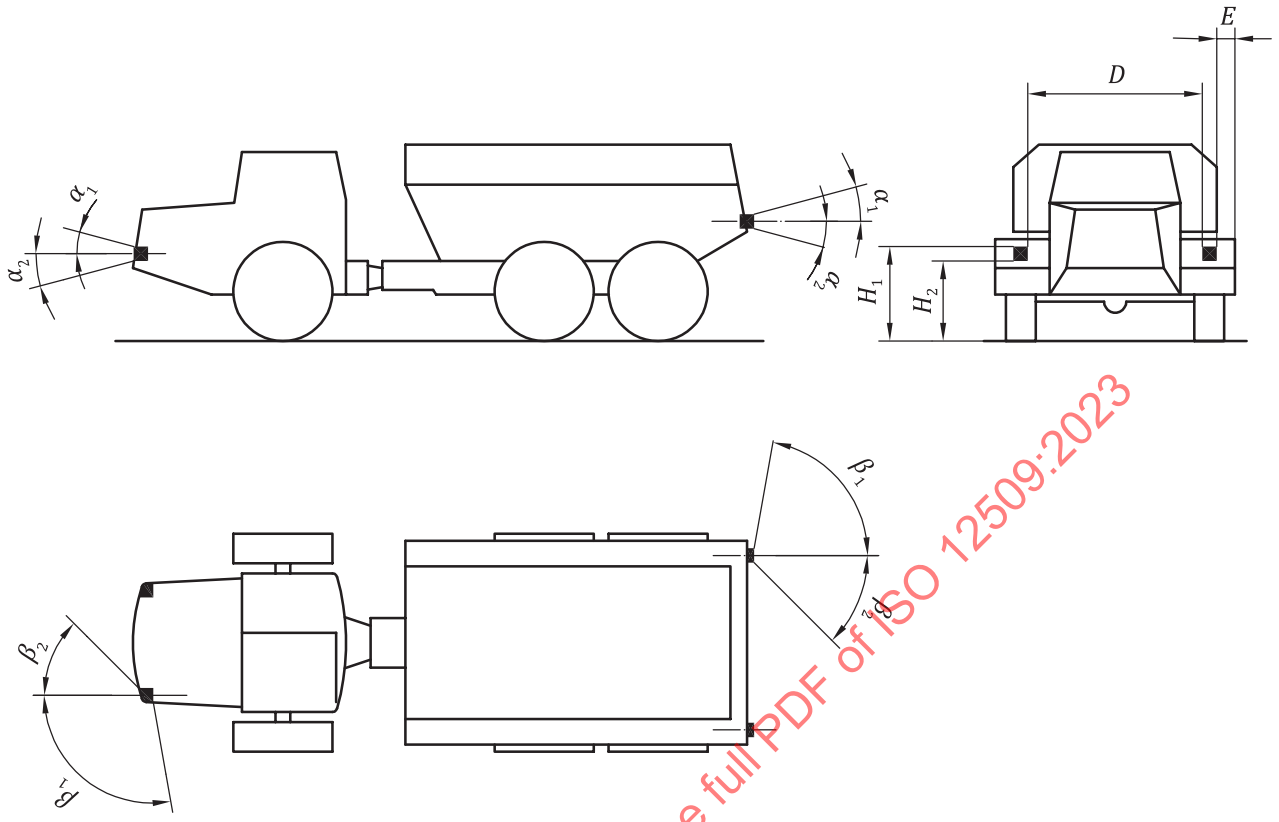


Figure C.6-1 — Hazard warning signal

C.6.2 Configuration: Arrangement — see C.5.

Table C.6-1 — Requirements for hazard warning signal

Lighting combinations (see Annex A)	**I**			**II**			**III**		
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Application to machines	N/A	O	S	S	S	S	N/A	O	S
Number	N/A	a					N/A	a	
Dimensions, mm	N/A	a					N/A	a	
Geometric visibility, minimum angle	N/A	a					N/A	a	
Electrical connections	N/A	b					N/A	b	
Tell-tale	N/A	c					N/A	c	
Other requirements	N/A	d, e					N/A	d, e	

a Equivalent to direction-indicator lamps (see C.5.2 to C.5.6).

b Shall be operated by separate control. All direction-indicator lamps shall function simultaneously.

c Circuit-closed tell-tale is required. Tell-tale light shall be flashing and may be the simultaneous operation of the tell-tale of the direction-indicator lamps (see C.5.1.6).

d The hazard warning signal lamps shall not be connected with the switch-off key for the engine.

e The function to automatically activate hazard warning signal may be adopted to prevent accidents. (for example, collision from the rear side).

C.7 Stop lamp

C.7.1 **Stop lamp:** lamp used to indicate to road users and other exposed persons to the rear of the machine, that the service brake control has been actuated. See Figure C.7-1 and Table C.7-1.

NOTE Stop lamps are also referred to as brake lights.

An emergency braking signal that simultaneously flashes the stop lamps may be provided on machines with a maximum ground speed greater than 50 km/h. An emergency braking signal is optional. See Annex F for requirements for an emergency braking signal, if provided.

C.7.1.1 Colour of light: red.

C.7.1.2 Alignment: towards the rear.

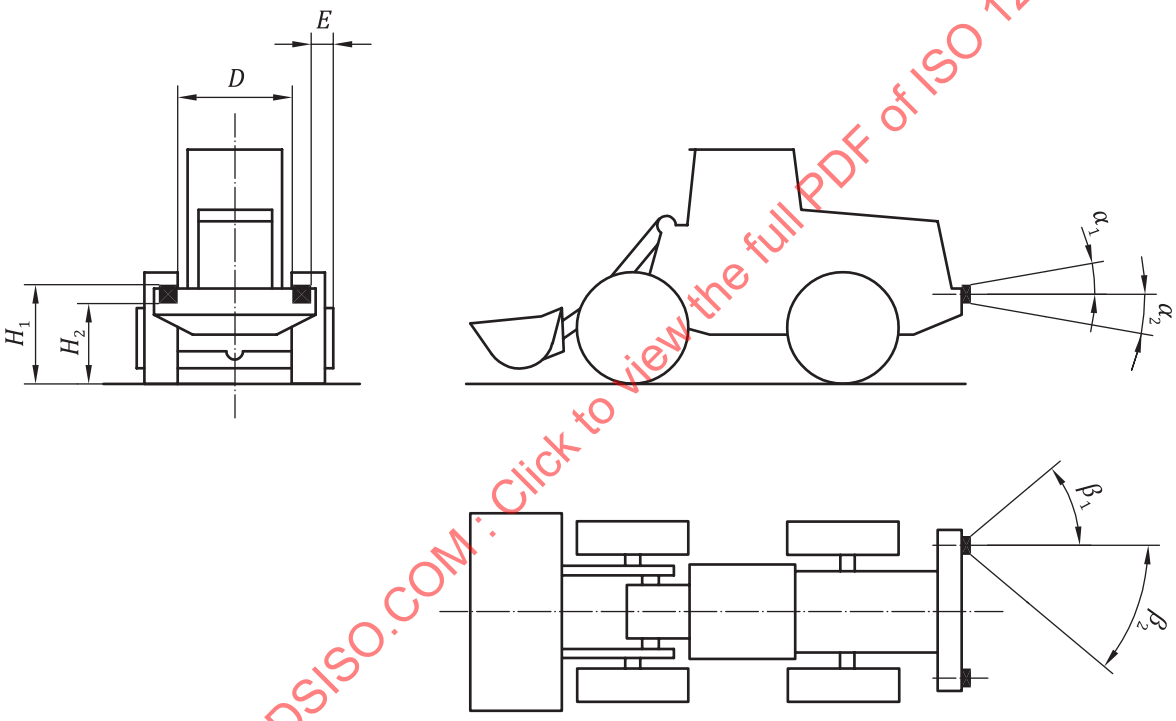


Figure C.7-1 — Stop lamp

Table C.7-1 — Requirements for stop lamp

Lighting combinations (see Annex A)	**I**			**II**			**III**		
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Application to machines	N/A	O	S	O	Sa	S	N/A	O	S
Number	N/A	Two		Two			N/A	Two	
Dimensions, in mm									
H_1	N/A	≤ 1 500[b]		≤ 1 500[c]			N/A	≤ 1 500[b]	
H_2	N/A	> 400					N/A	> 600	
E	N/A								
D	N/A	> 500[d]					N/A	> 500[d]	
Geometric visibility, minimum angles									
α_1	N/A	15°					N/A	10°	
α_2	N/A	15°[e]					N/A	15°[e]	
β_1	N/A	45°					N/A	30°[f]	
β_2	N/A	45°					N/A	30°[f]	
Electrical connections	N/A	[g]					N/A	[g]	
Tell-tale	N/A	[h]					N/A	[h]	
Other requirements	N/A	[i]					N/A	[i]	

a Not applicable to hydrostatic-driven machines with a designed speed of ≤ 20 km/h and without a brake pedal.

b May be fitted higher, if the design of the machine makes it impractical to meet the requirement of ≤ 1 500 mm.

c May be fitted higher if the design of the machine makes it impractical to meet the requirement of ≤ 1 500 mm: maximum height shall be 2 100 mm.

d May be reduced if the design of the machine makes it impractical to meet the requirement of > 500 mm, for example, on rear dump dumper.

e May be reduced to 5° depending on the structure of the machine.

f On machines with rear-mounted equipment and dumpers with a rear dump which are not subject to road travel, the angle may be reduced if the design of the machine makes it impractical to meet the requirement

g Actuation of the service brake control shall close the electrical circuit for the stop lamp.

h If any, it should be a non-flashing light which comes on in the event of the malfunctioning of the stop lamps.

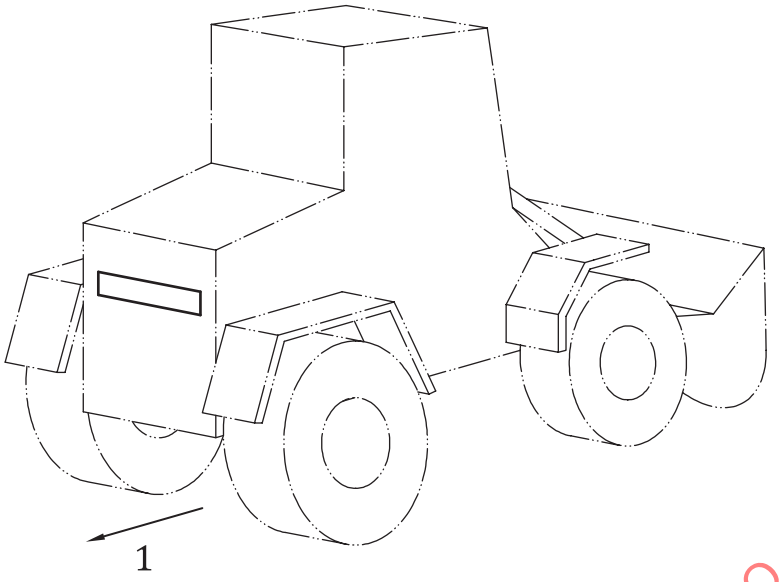
i The luminous intensity of the stop lamp shall be markedly brighter than that of the rear position lamp.

C.8 Rear registration plate lamp

C.8.1 Rear registration plate lamp: device used to illuminate the space intended to accommodate the rear registration plate; it may consist of different optical elements. See Figure C.8-1 and Table C.8-1.

C.8.1.1 Colour of light: white.

C.8.1.2 Alignment: any direction to illuminate the rear registration plate such that the lamp is not directly visible from Zone 2 specified in 4.1.6.b).



Key

1 rear

Figure C.8-1 — Rear registration plate lamp

Table C.8-1 — Requirements for rear registration plate lamp

Lighting combinations (see Annex A)	**I**			**II**			**III**		
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Application to machines	N/A				S[a]		N/A		
Number	N/A				[b]		N/A		
Dimensions, in mm									
H_1	N/A				[b]		N/A		
H_2	N/A				[b]		N/A		
E	N/A				[b]		N/A		
D	N/A				[b]		N/A		
Geometric visibility, minimum angles									
α_1	N/A				[b]		N/A		
α_2	N/A				[b]		N/A		
β_1	N/A				[b]		N/A		
β_2	N/A				[b]		N/A		
Electrical connections	N/A				[c]		N/A		
Tell-tale	N/A								
Other requirements	N/A				[d]		N/A		

a Only valid on machines subject to road approval and those which, according to national legislation, must be registered and equipped with a rear registration plate lamp.

b Such that device is capable of illuminating the space intended to accommodate the rear registration plate.

c The rear registration plate lamp shall be switched on together with the rear position lamps.

d The light shall not dazzle and shall not be directly visible towards the rear.

C.9 Front position lamp

C.9.1 Front position lamp: lamp used to indicate the presence and the width of the machine when viewed from the front. See Figure C.9-1 and Table C.9-1.

C.9.1.1 Colour of light: white.

NOTE Where national requirements differ from the requirement of this document, the national requirements can be applied.

C.9.1.2 Alignment: towards the front.

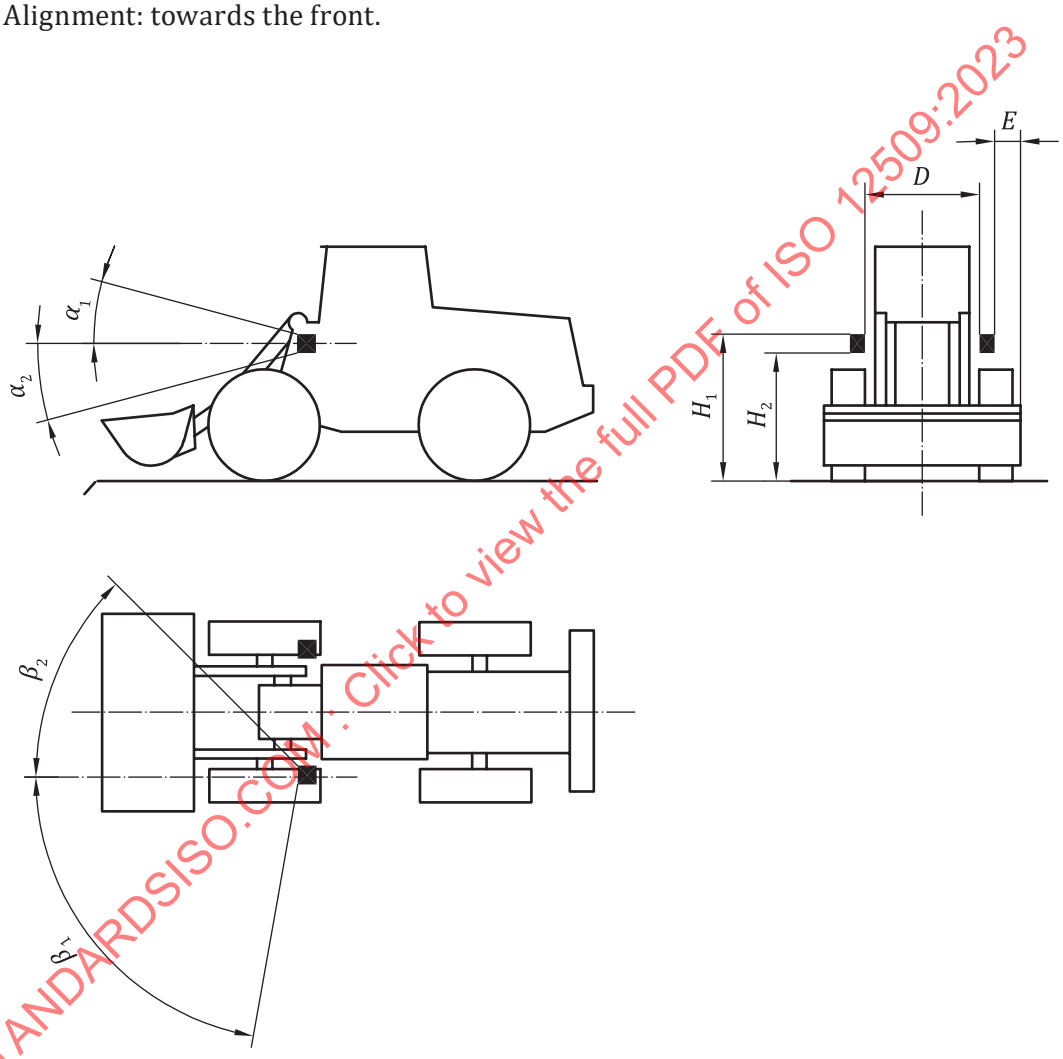


Figure C.9-1 — Front position lamp

Table C.9-1 — Requirements for front position lamp

Lighting combinations (see Annex A)	I			II			III		
	A	B	C	A	B	C	A	B	C
Application to machines	N/A			S	S	S	N/A		O
Number	N/A			Two[a]			N/A		Two[a]
Dimensions, in mm									
H_1	N/A			≤ 1 500[b]			N/A		≤ 1 500[c]
H_2	N/A			> 400			N/A		> 600
E	N/A			≤ 400			N/A		≤ 400[d]
D	N/A			> 500[e]			N/A		> 500[e]
Geometric visibility, minimum angles									
α_1	N/A			15°			N/A		15°
α_2	N/A			15°[f]			N/A		15°[f]
β_1	N/A			80°			N/A		80°
β_2	N/A			45°[g]			N/A		45°[h]
Electrical connections	N/A			[i]			N/A		[i]
Tell-tale	N/A			[j]			N/A		[j]
Other requirements	N/A			[k]			N/A		[k]
When national requirements differ from those presented here, the national requirements may be applied.									

a Four may be used. The additional front position lamps shall be grouped or reciprocally incorporated with additional lamps.

b May be fitted higher if the design of the machine makes it impractical to meet the requirement of ≤ 1 500 mm: maximum height shall be 2 100 mm.

c May be fitted higher, if the design of the machine makes it impractical to meet the requirement of ≤ 1 500 mm.

d May be > 400 mm if the design of the machine makes it impractical to meet the requirement of ≤ 400 mm.

e May be reduced if the design of the machine makes it impractical to meet the requirement of > 500 mm, for example, on rear-dump dumper.

f May be reduced to 5° depending on the machine structure.

g May be reduced to 10° if the structure or attachment makes 45° impractical.

h May be reduced to 5° if the structure or attachment makes 45° impractical.

i The electrical connections shall be such that the front position lamps, together with rear position lamps, are switched on when the dipped beam light and upper beam light are switched on. They shall be symmetrical in relation to the zero Y plane.

j If any, a circuit-closed tell-tale shall be non-flashing.

k The front position lamps shall not dazzle.

C.10 Rear position lamp

C.10.1 Rear position lamp: lamp used to indicate the presence and width of the machine when viewed from the rear. See Figure C.10-1 and Table C.10-1.

C.10.1.1 Colour of light: red.

C.10.1.2 Alignment: towards the rear.

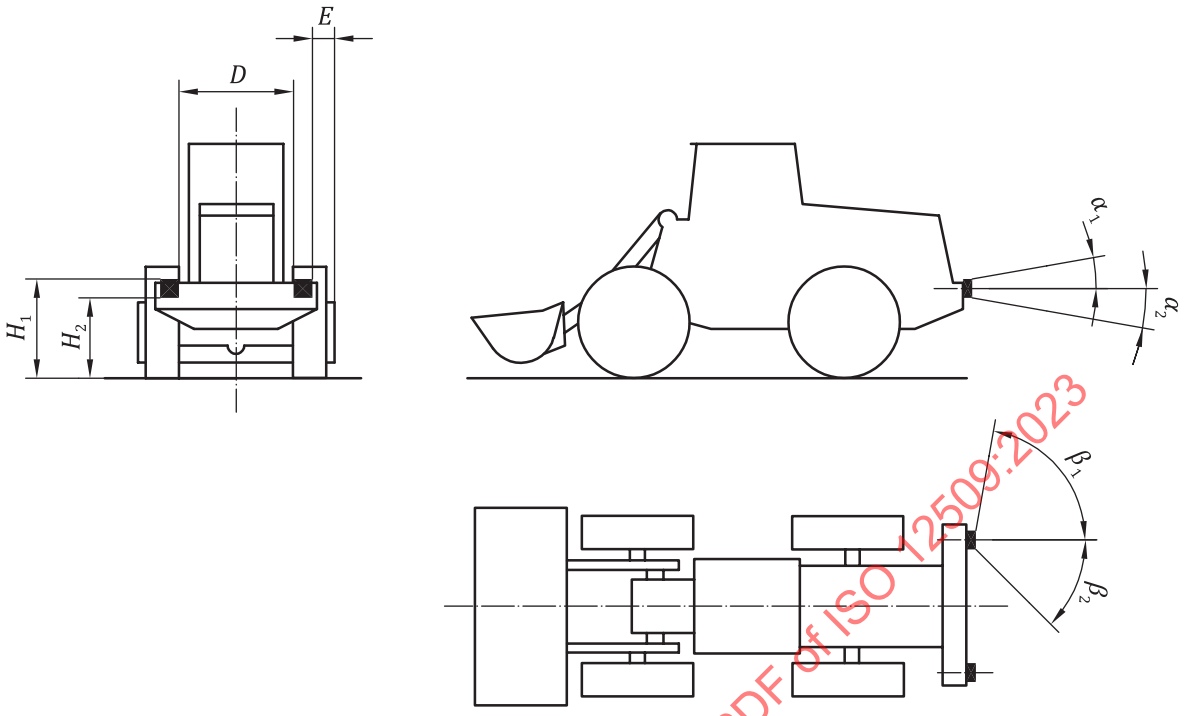


Figure C.10-1 — Rear position lamp

Table C.10-1 — Requirements for rear position lamp

Lighting combinations (see Annex A)	**I**			**II**			**III**		
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Application to machines	O	O	S	S	S	S	N/A	O	S
Number	Minimum of two						N/A	Minimum of two	
Dimensions, in mm									
H_1	≤ 1 500[a]						N/A	≤ 1 500[b]	
H_2	> 400						N/A	> 600	
E	≤ 400[c]			≤ 400			N/A	≤ 400[c]	
D	> 500[d]						N/A	> 500[d]	

a May be fitted higher if the design of the machine makes it impractical to meet the requirement of ≤ 1 500 mm: maximum height shall be 2 100 mm.

b May be fitted higher, if the design of the machine makes it impractical to meet the requirement of ≤ 1 500 mm.

c May be, depending on the machine structure, > 400 mm (from the extreme outer edge of the machine).

d May be reduced if the design of the machine makes it impractical to meet the requirement of > 500 mm, for example, on rear-dump dumper or machines with an overall width < 1 400 mm.

e May be reduced to 5°, depending on the structure of the machine.

f Horizontal angle of the two rear position lamps:

— either 45° inwards and 80° outwards,

— or 80° inwards and 45° outwards.

g The rear position lamps shall be switched on together with the front position lamps when the dipped beam and upper beam lights are switched on.

h If any, the tell-tale shall be non-flashing, circuit-closed and combined with the circuit-closed tell-tale of the front position lamps.

i The angle 80° may be reduced to 50° and the angle 45° to 30°, depending on the machine structure. These angles may be further reduced if the design of the machine makes 50° and 30° impractical on machines with rear-mounted working equipment or on rear-dump dumpers not used on the road.

Table C.10-1 *(continued)*

Lighting combinations (see Annex A)	I			II			III		
	A	B	C	A	B	C	A	B	C
Geometric visibility, minimum angles									
α_1	15°						N/A	15°	
α_2	15°[e]						N/A	15°[e]	
β_1	80°/45°[f]						N/A	80°/45°[f, i]	
β_2	80°/45°[f]						N/A	80°/45°[f, i]	
Electrical connections	g						N/A	g	
Tell-tale	h						N/A	h	
Other requirements	N/A								

a May be fitted higher if the design of the machine makes it impractical to meet the requirement of ≤ 1 500 mm: maximum height shall be 2 100 mm.

b May be fitted higher, if the design of the machine makes it impractical to meet the requirement of ≤ 1 500 mm.

c May be, depending on the machine structure, > 400 mm (from the extreme outer edge of the machine).

d May be reduced if the design of the machine makes it impractical to meet the requirement of > 500 mm, for example, on rear-dump dumper or machines with an overall width < 1 400 mm.

e May be reduced to 5°, depending on the structure of the machine.

f Horizontal angle of the two rear position lamps:

— either 45° inwards and 80° outwards,

— or 80° inwards and 45° outwards.

g The rear position lamps shall be switched on together with the front position lamps when the dipped beam and upper beam lights are switched on.

h If any, the tell-tale shall be non-flashing, circuit-closed and combined with the circuit-closed tell-tale of the front position lamps.

i The angle 80° may be reduced to 50° and the angle 45° to 30°, depending on the machine structure. These angles may be further reduced if the design of the machine makes 50° and 30° impractical on machines with rear-mounted working equipment or on rear-dump dumpers not used on the road.

C.11 Rear fog lamp

C.11.1 Rear fog lamp: lamp used to signal the presence of the machine from the rear in conditions of fog or other conditions which adversely affect visibility. See Figure C.11-1 and Table C.11-1.

C.11.1.1 Colour of light: red.

C.11.1.2 Alignment: towards the rear.

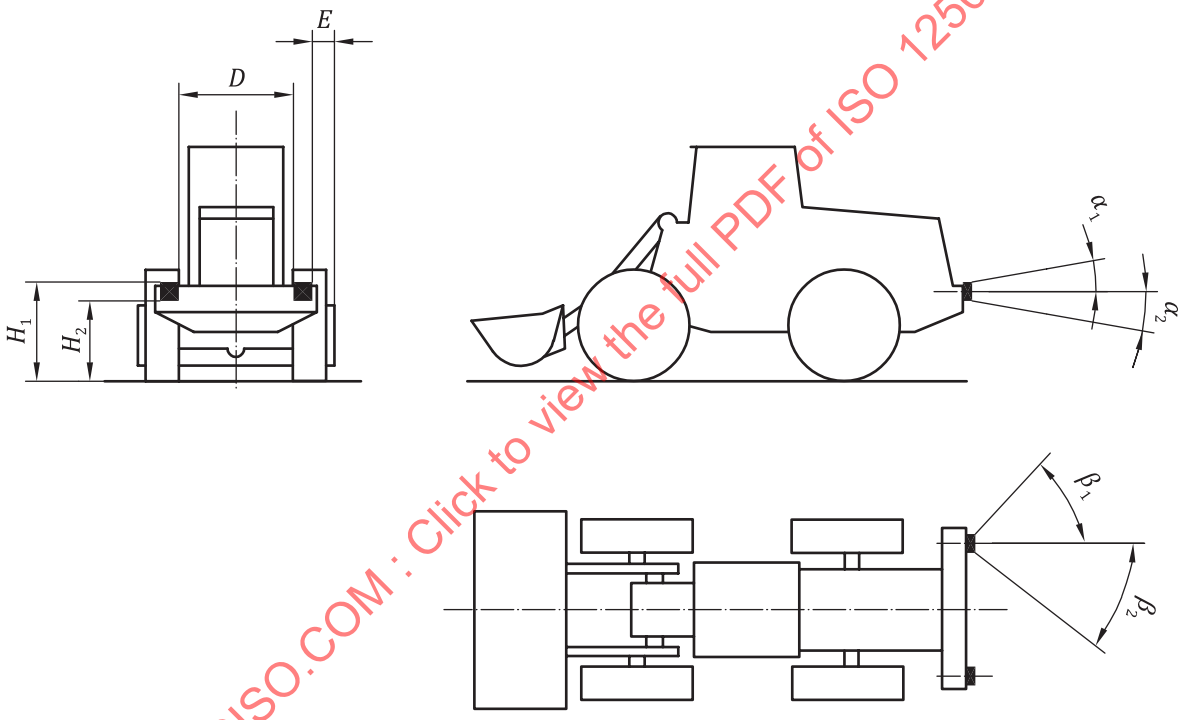


Figure C.11-1 — Rear fog lamp

Table C.11-1 — Requirements for rear fog lamp

Lighting combinations (see Annex A)	I			II			III		
	A	B	C	A	B	C	A	B	C
Application to machines	N/A				O	O[a]	N/A		
Number	N/A				One[b]		N/A		
Dimensions, in mm									
H_1	N/A				≤ 1 500[c]		N/A		
H_2	N/A				> 400		N/A		
E	N/A								
D	N/A								
Geometric visibility, minimum angles									
α_1	N/A				5°		N/A		
α_2	N/A				5°		N/A		
β_1	N/A				55°		N/A		
β_2	N/A				25°		N/A		
Electrical connections	N/A				[d]		N/A		
Tell-tale	N/A				[e]		N/A		
Other requirements	N/A				[f]		N/A		

a Application S shall be used if the maximum speed exceeds 60 km/h.

b Two are optional.

c May be fitted higher if the design of the machine makes it impractical to meet the requirement of ≤ 1 500 mm: maximum height shall be 2 100 mm.

d May only operate when the dipped beam headlamp or the upper beam headlamp are switched on.

e Circuit-closed, non-flashing, tell-tale is required.

f When only one rear fog lamp is fitted, it shall be positioned on the opposite side of the zero Y plane of the machine to the direction of traffic prescribed in the country where the machine is used. The distance between the rear fog lamp and the stop lamps shall be >100 mm.

C.12 Special warning lamp

C.12.1 Special warning lamp: flashing lamp, used to indicate the presence of the machine to other road users or exposed persons. See Figure C.12-1 and Table C.12-1.

C.12.1.1 Colour of light: yellow or amber.

C.12.1.2 Alignment: all around.

Dimensions in metres

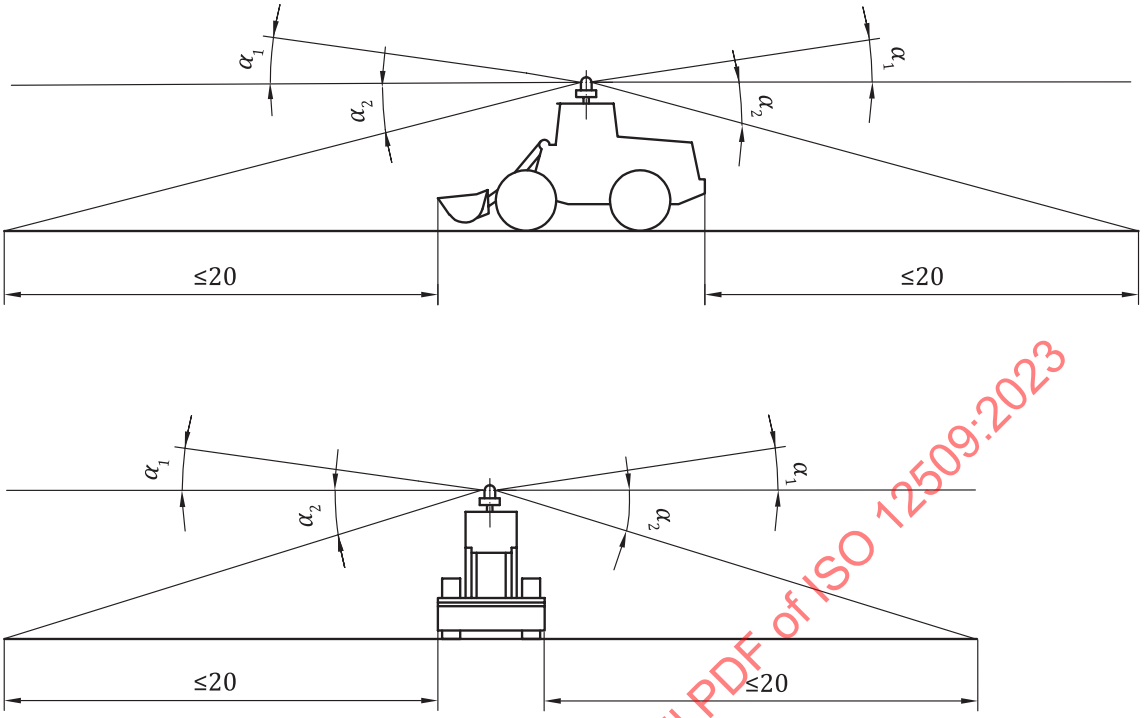


Figure C.12-1 — Special warning lamp

Table C.12-1 — Requirements for special warning lamp

Lighting combinations (see Annex A)	**I**			**II**			**III**		
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Application to machines	0	0	0	0	0	0	0	0	0
Number	One or more (when the horizontal and vertical visibility so requires)								
Dimensions, in mm									
H_1	Height and visibility[a]								
H_2	N/A								
E	N/A								
D	N/A								
Geometric visibility, minimum angles									
α_1	8°								
α_2	Shall light up the ground 20 m from the periphery of the machine.								
β_1	All around[c]								
β_2	N/A								
Electrical connections	N/A								
Tell-tale	Fixed amber lamp								
Other requirements	[b]								

a One special warning lamp shall always be visible within the zone prescribed by α_2.

b Flashing frequency 2 Hz to 4 Hz (120 times/min. to 240 times/min.). The special warning lamp shall be fitted in such a way (for example, on the top of the operator's cab) to avoid dazzling the operator. The special warning lamp may be foldable or detachable.

c Partial maskings caused by narrow machine features (for example, backhoe booms, excavator booms, layer masts) are permitted.

C.13 Rear reflex reflector (non-triangular)

C.13.1 Rear reflex reflector (non-triangular): device used to indicate the presence of the rear of a machine by the reflection of light emanating from a light source not connected to the machine, the observer being situated near the light source. See Figure C.13-1 and Table C.13-1.

C.13.1.1 Colour of retro-reflected light: red.

C.13.1.2 Alignment: towards the rear.

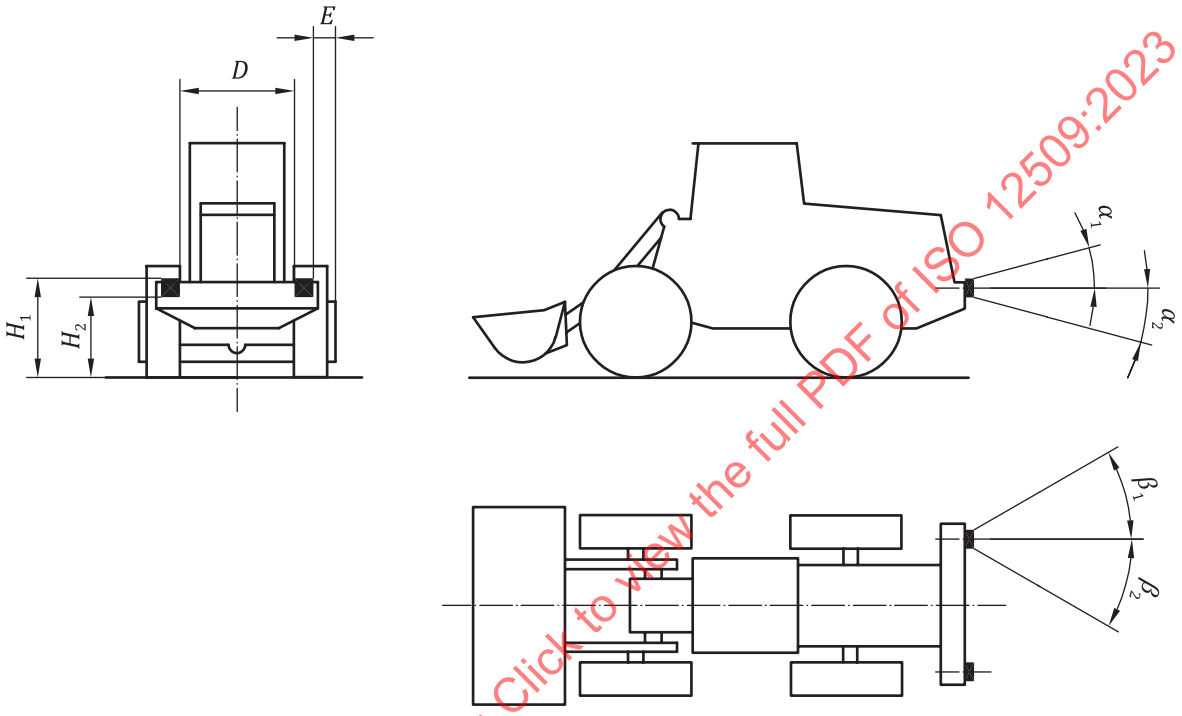


Figure C.13-1 — Rear reflex reflector (non-triangular)

C.13.1.3 Configuration: the illuminating surface of the rear reflex reflector may have common parts with any other rear lamp.

Table C.13-1 — Requirements for rear reflex reflector (non-triangular)

Lighting combinations (see Annex A)	I			II			III		
	A	B	C	A	B	C	A	B	C
Application to machines	S	S	S	S	S	S	S	S	S

a If it is not possible to comply with the position and visibility using two rear reflex reflectors, four may be fitted.

b May be > 900 mm from the ground reference plane if the design of the machine makes it impractical to meet the requirement of ≤ 900 mm.

c May be > 900 mm from the ground reference plane if the design of the machine makes it impractical to meet the requirement of ≤ 900 mm: maximum height shall be 1 500 mm.

d May be > 400 mm if the design of the machine makes it impractical to meet the requirement of ≤ 400 mm.

e May be reduced if the design of the machine makes it impractical to meet the requirement of > 500 mm.

f May be reduced to 5° if the rear reflex reflector minimum height above ground reference plane is 900 mm.

g May be complied with by using two separate rear reflex reflectors.

h May be reduced if the design of the machine makes 30° impractical.

Table C.13-1 *(continued)*

Lighting combinations (see Annex A)	**I**			**II**			**III**		
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Number	Two or four[a]								
Dimensions, in mm									
H_1	≤ 900[b]			≤ 900[c]			≤ 900[b]		
H_2	> 400						> 600		
E	≤ 400[d]			≤ 400			≤ 400[d]		
D	> 500[e]								
Geometric visibility, minimum angles									
α_1	15°								
α_2	15°[f]								
β_1	30°[g]						30°[h]		
β_2	30°[g]						30°[h]		
Electrical connections	N/A								

a If it is not possible to comply with the position and visibility using two rear reflex reflectors, four may be fitted.

b May be > 900 mm from the ground reference plane if the design of the machine makes it impractical to meet the requirement of ≤ 900 mm.

c May be > 900 mm from the ground reference plane if the design of the machine makes it impractical to meet the requirement of ≤ 900 mm: maximum height shall be 1 500 mm.

d May be > 400 mm if the design of the machine makes it impractical to meet the requirement of ≤ 400 mm.

e May be reduced if the design of the machine makes it impractical to meet the requirement of > 500 mm.

f May be reduced to 5° if the rear reflex reflector minimum height above ground reference plane is 900 mm.

g May be complied with by using two separate rear reflex reflectors.

h May be reduced if the design of the machine makes 30° impractical.

C.14 Front reflex reflector (non-triangular)

C.14.1 Front reflex reflector (non-triangular): device used to indicate the presence of the front of the machine by the reflection of light emanating from a light source not connected to the machine, the observer being situated near the light source. See Figure C.14-1 and Table C.14-1.

C.14.1.1 Colour of retro-reflected light: white or colourless.