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Earth-moving machinery — Lighting, signalling and marking lights, and reflex-reflector devices

Engins de terrassement — Feux d'éclairage, de signalisation, de position et d'encombrement, et catadioptres

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Foreword

ISO (the International Organization for Standardization) is a world-wide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75% of the member bodies casting a vote.

International Standard ISO 12509 was prepared by Technical Committee ISO/TC 127, *Earth-moving machinery,* Sub-committee SC 2, *Safety requirements and human factors.*

Introduction

Earth-moving machines are designed to function in a variety of operations and work sites. Their size, mass, speed, combinations and equipment varies a lot. Therefore, the combination of lighting, signaling and marking lights, and reflex-reflector devices will differ.

This standard provides information needed for selection of lighting, signaling, and marking lights, and reflex-reflector devices based on machine application and speed.

There are three informative Annexes giving additional information above the requirements in the standard.

Earth-moving machinery - Lighting, signaling and marking lights, and reflex-reflector devices

1 Scope

This International Standard specifies the minimum requirements for installation and performance of lighting, signaling and marking lights, and reflex-reflector devices on earth-moving machines. This standard applies to self-propelled wheel or crawler earth-moving machines as defined in ISO 6165, intended for off-road use as well as on-road use. Pedestrian controlled machines are not included.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 303:1986, *Road vehicle - Installation of lighting and light signaling devices for motor vehicles and their trailers*

ISO 6016:1982, *Earth-moving machinery - Methods of measuring the masses of whole machines, their equipment and components*

ISO 6165:1987, *Earth-moving machinery - Basic types - Vocabulary*

ISO 6746-1:1987, *Earth-moving machinery - Definitions of dimensions and symbols - Part 1: Base machine*

ISO 6747:1988, *Earth-moving machinery - Tractor - Terminology and commercial specifications*

ISO 7131:1984, *Earth-moving machinery - Loaders - Terminology and commercial specifications*

ISO 7132:1990, *Earth-moving machinery - Dumpers - Terminology and commercial specifications*

ISO 7133:1985, *Earth-moving machinery - Tractor-Scrapers - Terminology and commercial specifications*

ISO 7134:1985, *Earth-moving machinery - Graders - Terminology and commercial specifications*

ISO 7135:1993, *Earth-moving machinery - Hydraulic excavators - Terminology and commercial specifications*

ISO 7136:1986, *Earth-moving machinery - Pipelayers - Terminology and commercial specifications*

ISO 7227:1987, *Road vehicles - Lighting and light signaling devices - Vocabulary*

3 Definitions and symbols

For the purpose of this International Standard, the definitions given in ISO 303, ISO 7227 and the following definitions and symbols apply.

3.1 zero Y plane: Vertical plane which passes through the longitudinal centreline of the machine. (See ISO 6746/1).

3.2 X plane: Any vertical plane normal to the Y plane. (see ISO 6746/1)

3.3 ground reference plane: Plane surface on which the machine stands and which should be substantially horizontal.

3.4 extreme outer edge: Plane parallel to the median longitudinal plane 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 and connections for tyre-pressure gauges;
- of any anti-skid device which may be mounted on the wheels;
- of rear-view mirrors;

- of side direction indicator lamps, front and rear position lamps and stopping lamps.

3.5 overall width: Distance between the two vertical planes defined in clause 3.4 above.

3.6 operating mass: According to ISO 6016.

3.7 lamp: Device designed to illuminate the road or ground (lighting) or to emit a light signal (light signaling). Light marking shall similarly be regarded as a lamp (see ISO 7227).

3.7.1 equivalent lamps: Lamps which have the same function and are geometrically interchangeable (see ISO 7227).

3.7.2 independent lamps: Lamps which have separate illuminating surfaces, separate light sources and separate lamp bodies (see ISO 7227).

3.7.3 grouped lamps: Devices which have separate illuminating sources, and separate light sources but a common lamp body (see ISO 7227).

3.7.4 combined lamps: Devices which have separate illuminating surfaces, but a common light source and a common lamp body (see ISO 7227).

3.7.5 reciprocally incorporated lamps: Devices which have separate light sources (or a single light source operating under different conditions), totally or partially common illuminating surfaces and a common lamp body (see ISO 7227).

3.7.6 reflex-reflector: A device, by the reflection of light emanating from a light-source not connected to the machine used to indicate the presence of a machine or to identify a specific part of a machine to an observer being near the source.

3.8 illuminating surface of a lighting device: See ISO 7227, clause 3.35 and Annex C in this standard.

3.9 illuminating surface of a signaling device: See ISO 7227, clause 3.36 and Annex C in this standard.

3.10 illuminating surface of a reflex-reflector: See ISO 7227, clause 3.37.

3.11 reference axis: Characteristic axis of the light signal for use as the reference direction
($\alpha = 0°$, $\beta = 0°$) for photometric measurements and when fitting the lamp on the machine.
The reference axis shall be determined by the manufacturer. (See Annex C, in this standard).

3.12 reference centre: Intersection of the reference axis with the light-emitting surface (see ISO 7227 and Annex C in this standard).

3.13 light emitting surface: All or part of the exterior surface of the transparent lens that encloses the lighting and light signaling devices and conforms to certain defined photometric and colorimetric conditions (see ISO 7227 and Annex C in this standard).

3.14 control device: Device indicating either that a device is operating correctly or is actuated.

3.14.1 tell-tale: Visible and/or audible device that indicates actuation and/or operating condition of lighting and light signaling devices or system. (See ISO 7227).

3.14.2 operational tell-tale: Tell-tale which informs the operator/driver whether a lighting or light signaling device or system that has been actuated is operating correctly or not. (See ISO 7227).

3.14.3 circuit-closed tell-tale: Tell-tale which informs the operator/driver whether a lighting or light signaling device or system has been switched on but not whether a lighting is operating correctly or not. (See ISO 7227).

3.15 angles of geometric visibility of a lamp: Angles which determine the widest solid angle in which the apparent surface of the lamp is visible.

This solid angle is determined by the segments of a sphere in which the centre coincides with the reference centre of the lamp and the equator is parallel to the ground. These segments are determined in relation to the reference axis. The horizontal angles correspond to the longitude and the vertical angle to the latitude. The horizontal angles shall be β_1 corresponding to the longitude outboard, and β_2 corresponding to longitude inboard, and the vertical angles shall be α_1 corresponding to the up latitude and α_2 corresponding to the down latitude (See data sheets diagram in Annex E).

3.16 symbols used in data sheet diagrams in Annex E

H_1 .... maximum height above ground (see clause 4.1.4);

H_2 .... minimum height above ground (see clause 4.1.4);

E .... distance between the outer edges of the machine and the illuminating surface of a lighting device (see clause 4.1.5);

D .... distance between two lamps (see clause 4.1.5);

K .... See Annex E.5.5;

K_1 .... See Annex E.5.6;

α_1................. vertical angles corresponding to the up latitude (see clause 3.15);

α_2................ vertical angles corresponding to the down latitude (see clause 3.15);

β_1.............. . horizontal angles corresponding to the longitude outboard (see clause 3.15);

β_2.............. . horizontal angles corresponding to the longitude inboard (see clause 3.15).

4 General requirements

4.1 Installation of lighting, signaling and marking lights, and reflex-reflector devices on earth-moving machinery

4.1.1 The lighting, signaling and marking lights, and reflex-reflector devices shall be so fitted that under normal conditions of use and specially regarding vibration to which they may be subjected, they retain the characteristics laid down in Annex E. In particular, it shall not be possible for the lamps to be inadvertently disturbed.

4.1.2 The position e.g. the height and orientation of the lamps shall be verified with the unladen machine on a flat, horizontal surface

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, except on machines with unsymmetrical shape;

b) satisfy the same colorimetric characteristics (see Annex D, table D.1);

c) have substantially identical photometric characteristics. (see Annex D, table D.2).

4.1.4 The maximum height (H_1) above ground shall be measured from the highest point, and the minimum height (H_2) from the lowest point of the illuminating surface. When the height requirements are substantially met, it is sufficient to refer to actual lamp edges (see ISO 303).

4.1.5 The width position shall be determined from the edge of the illuminating surface which is furthest from the zero Y plane of the earth-moving machine when referred to the overall width (***E***), and from the inner edges of the illuminating surfaces when referred to the distance between the lamps (***D***). When the width requirements are substantially met, it is sufficient to refer to the actual lamp edges
(see ISO 303).

4.1.6 No red light shall be visible towards the front. No white light shall be visible towards the rear that could lead to confusion emitted by a lamp, other than the white light from the reversing lamp(s) or the white light from the working lamp(s). The compliance with these requirements shall be tested according to ISO 303 and Annex B in this standard. The machine shall during the test be located on a horizontal plane, and in case of articulated frame steering, in a straight position.

4.1.6.1 There shall be no direct visibility of a red light if viewed by an observer moving within zone 1 in a transverse plane situated 25 m in front of the machine (see ISO 303 and Annex B, figure B.1, in this standard).

4.1.6.2 There shall be no direct visibility of a white light if viewed by an observer moving within zone 2 in transverse plane situated 25 m behind the machine (see ISO 303 and Annex B, figure B.2, in this standard).

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

4.1.8 The electrical connections shall be such that the main/upper beam headlamp (if applicable) and dipped/lower beam headlamp and rear fog lamp (if any), cannot be switched on, unless the lamps referred to in clause 4.1.7 are also switched on. This requirement shall not apply to main/upper beam or dipped/lower beam headlamps, when light signals are emitted.

4.1.9 The number of lamps fitted to the machine shall be equal to the number(s) specified in the data sheets in Annex E.

Annex A
(normative)

Lighting groups

A.1 Introduction

Lighting groups (I, II and III) are a combination of lighting, signaling and marking lights, and reflex-reflectors to be used on earth-moving machines (see page 11). The guidelines in table A.1 differentiate depending on where the machines are intended to be used and the maximum traveling speed of the machines.

NOTE: Following these guidelines does not ensure conformance to specific national roading standards or regulations. All lighting, signaling and marking lights, and reflex-reflector devices used on machines in Lighting Group II may need to be type approved according to the national regulations.

Table A.1 - Lighting combinations

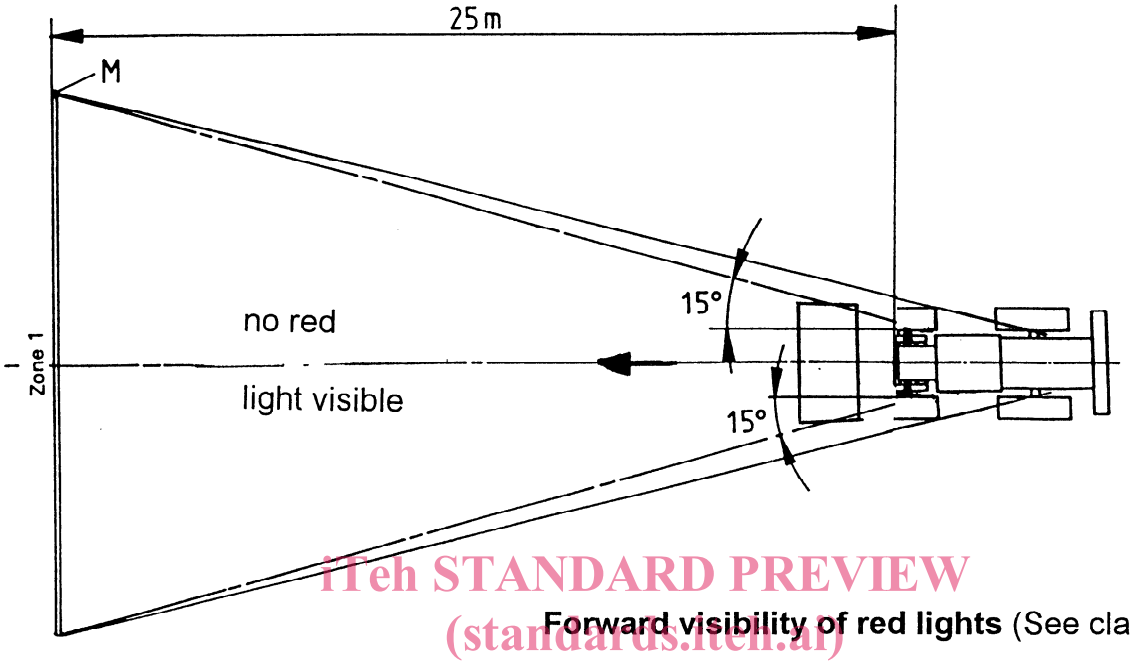
Application to machines	Lighting groups [1]	Rated maximum travelling speed: V (km/h)		
		A V ≤ 10	B 10 > V ≤ 40	C V > 40
Machines that **are not** intended for travel on public roads.[2]	I	e.g. Wheel/soft crawler tractor-dozer, wheel loader, wheel excavator, wheel backhoe-loader, wheel/soft crawler dumper, grader, rubber tyred roller and wheel trencher		
Machines that **are** intended for travel on public roads.	II	e.g. Wheel/soft crawler tractor-dozer, wheel loader, wheel excavator, wheel backhoe-loader, wheel/soft crawler dumper, grader, rubber tyred roller and wheel trencher		
Machines **not allowed** to travel on public roads due to physical characteristics exceeding road limits.	III	e.g. Wheel/crawler tractor-dozer, loader, excavator, dumper, tractor-scraper, grader, pipelayer and compactor		

1) See Annex E.

2) At manufacturer and user discretion.

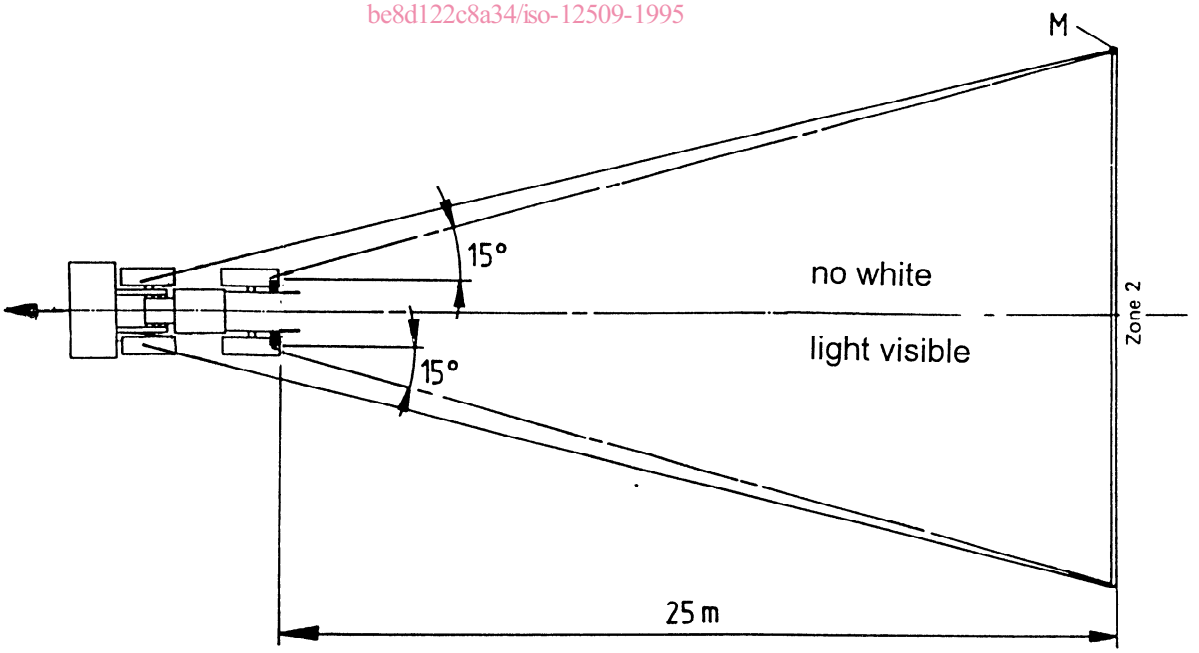
Annex B
(normative)

Forward visibility of red lights and rearward visibility of white lights
(See clause 4.1.6)



Forward visibility of red lights (See clause 4.1.6.1)

Figure B.1



Rearward visibility of white lights (See clause 4.1.6.2)

Figure B.2

Annex C
(normative)

Light signaling devices

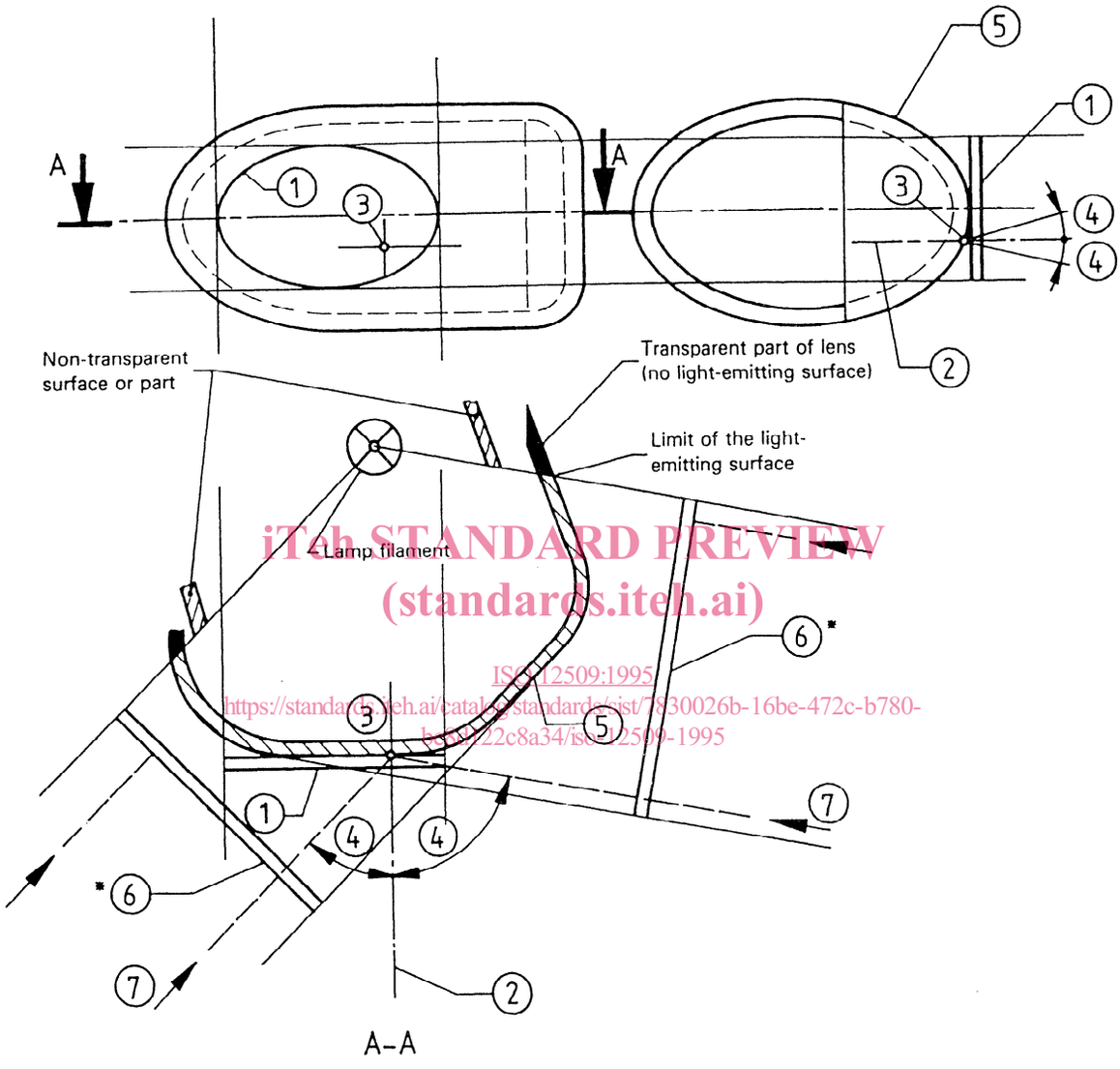


Figure C.1

* This surface shall be considered tangent to light-emitting surface.

1) Illuminating surface
2) Reference axis
3) Reference centre
4) Angle of geometric visibility
5) Light-emitting surface
6) Apparent surface
7) Direction of observation

Annex D
(normative)

Colorimetric characteristics of illuminating and signaling lights

D.1 Introduction

The colorimetric characteristics of illuminating and signaling lights (see ISO 303, Annex A) have been determined by the International Commission on Illumination (CIE), which thought it desirable in certain cases (designed by an asterisk *) to adopt different limits from those which had been recommended by Technical Committee CIE/TC 13.3, *Colour of light signals*. In fact, the voltages applied across lamp terminals are subject to extensive variation and it is important to avoid any confusion arising from too low or too high a voltage. In other *cases,* the colours specified below have not been considered by CIE.

Table D.1 - Trichromatic co-ordinantes

Red	limit towards yellow limit towards purple *)	$y \leq 0{,}335$ $z \leq 0{,}008$
White	limit towards blue limit towards yellow limit towards green limit towards green limit towards purple limit towards red	$x \geq 0{,}310$ $x \leq 0{,}500$ $y \leq 0{,}150 + 0{,}640\ x$ $y \leq 0{,}440$ $y \geq 0{,}050 + 0{,}750\ x$ $y \geq 0{,}382$
Amber	limit towards yellow *) limit towards red *) limit towards white *)	$y \leq 0{,}429$ $y \geq 0{,}398$ $z \leq 0{,}007$
Selective yellow	limit towards red *) limit towards green *) limit towards white *) limit towards spectral value *)	$y \geq 0{,}138 + 0{,}580\ x$ $y \leq 1{,}29\ x - 0{,}100$ $y \geq -\ x + 0{,}966$ $y \leq -\ x + 0{,}992$
Enlarged selective yellow	limit towards red limit towards green limit towards white limit towards spectral value	$y \geq 0{,}138 + 0{,}580\ x$ $y \leq 1{,}29\ x - 0{,}100$ $\begin{cases} y \geq -\ x + 0{,}940 \\ y \geq 0{,}440 \end{cases}$ $y \leq -\ x + 0{,}992$

* See clause A.1.

Table D.2 - Calorimetric zones corresponding to the recommended limits

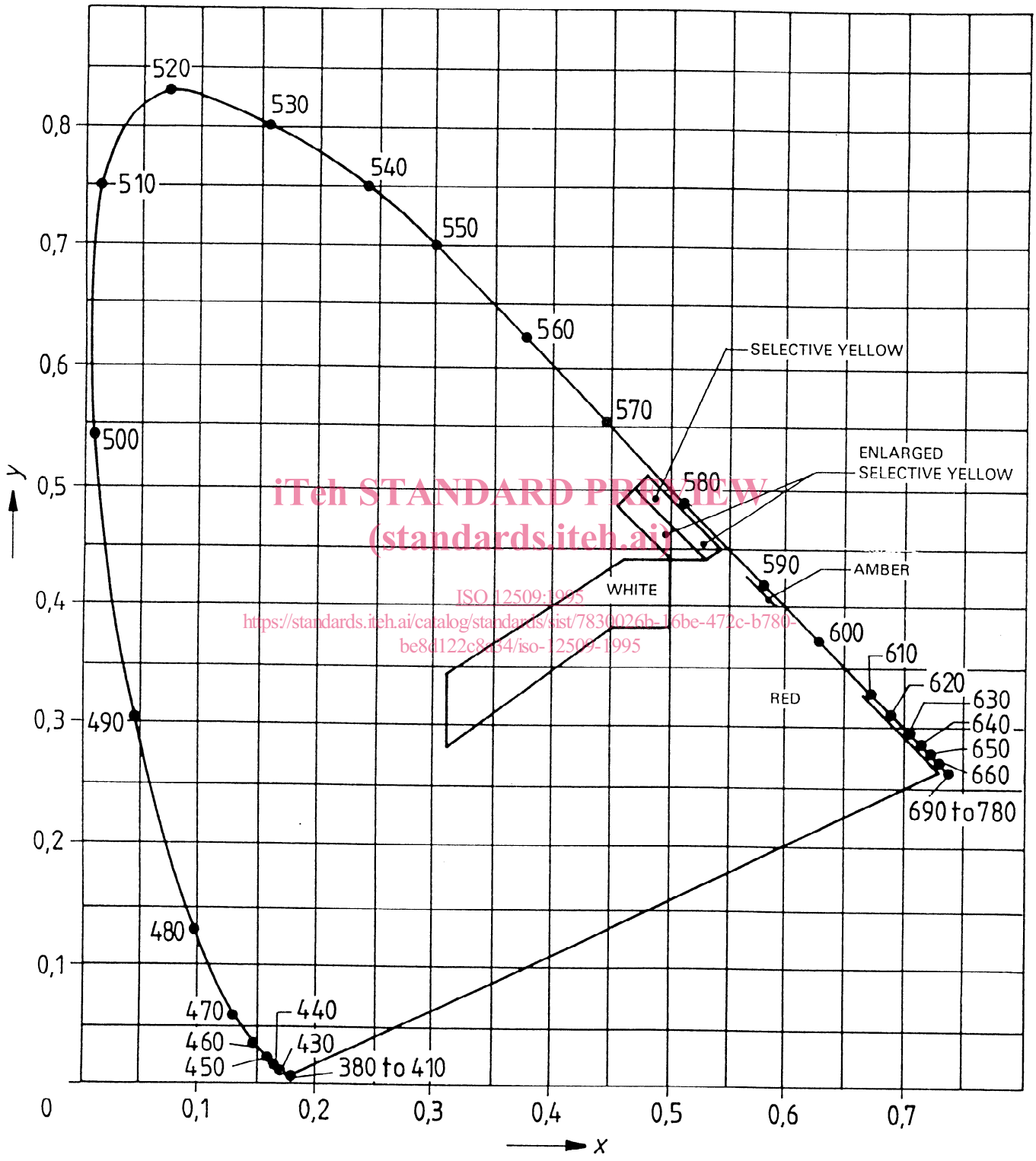


Diagram representing the zones of the CIE colour triangle, corresponding to the limits in table D.1 in Annex D.

Annex E
(normative)

Lighting, signaling and marking lights, and reflex-reflector devices

Data sheets no.

Lighting

E.1 ..... Dipped/lower Beam headlamp (dipped-beam light)
E.2 ..... Main/upper Beam (driving light)
E.3 ..... Work lamp (working light)

Signaling lights

E.4 ..... Reversing lamp
E.5 ..... Direction-indication lamp
E.6 ..... Hazard warning lamp
E.7 ..... Stop lamp

Marking lights

E.8 ..... Rear registration-plate lamp
E.9 ..... Front position lamp
E.10 ..... Rear position lamp
E.11 ..... Rear fog lamp
E.12 ..... Special warning lamp

Reflex-reflectors

E.13 ..... Rear reflex-reflector
E.14 ..... Front reflex-reflector
E.15 ..... Side reflex-reflector
E.16 ..... Slow-moving vehicle plate

NOTE 1) In data sheets E.1 to E.16 of this Annex three symbols are used for different applications:

S .... specifies minimum requirements regarding lighting, signaling and marking lights, and reflex-reflector devices for on- and/or off-road use.

O ..... optional lighting, signaling and marking lights, and reflex-reflector devices which may be installed on machines. When these lighting, signaling and marking lights, and reflex-reflector devices are used they should be in accordance to this standard.

n a ... not applicable.

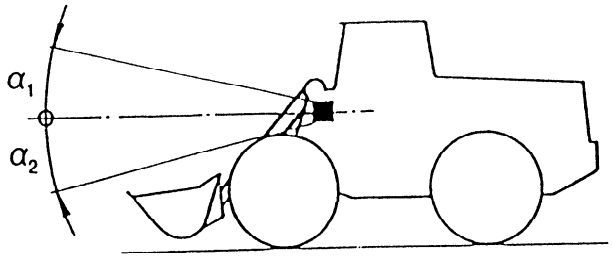
NOTE 2) The dimensions and geometric visibility specifications in the data sheets are based on transport and/or carry position of the earth-moving machines as specified by the manufacturer.

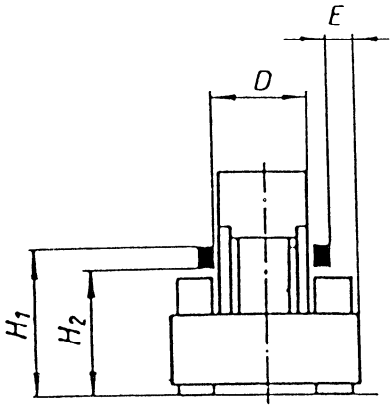
E. 1 - Data sheet

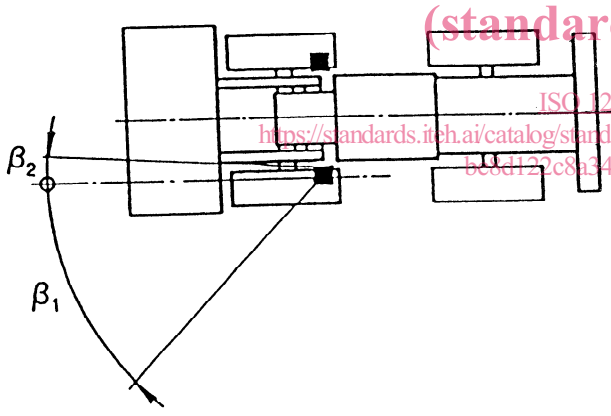
E.1.1 Dipped/lower Beam headlamp: the lamp used to illuminate the road or the ground ahead of the earth-moving machine without causing undue dazzle or discomfort to oncoming drivers and other road-users or workers.

E.1.1.1 Colour of the light: white

E.1.1.2 Alignment: towards the front







E.1.1.3 Configuration:

Dipped/lower beam headlamp:

- may be grouped with:
  - main/upper beam headlamp
  - any other front lamps

- may not be combined with:
  - any other front lamps

- may be reciprocally incorporated with:
  - main/upper beam headlight
  - any other front lamps

E.1.2 Requirements for dipped/lower beam headlamp

Lighting groups (see Annex A)	I			II			III		
	A	B	C	A	B	C	A	B	C
a) Application to machines	O[1]	O[1]	O[1]	S[1]	S[1]	S[1]	n a	O[1]	O[1]
b) Number	Two[2]						n a	Two[2]	
c) Dimensions in mm									
H_1	≤ 1500[3]						n a	≤ 2100[4]	
H_2	> 500						n a	> 500	
E	≤ 400[5]						n a	≤ 400[5]	
D	n a								
d) Geometric visibility, min angles									
α_1	10°						n a	10°	
α_2	10°[6]						n a	10°[6]	
β_1	45°						n a	45°	
β_2	5°[7]						n a	5°[7]	
e) Electrical connections	The dipped/lower beam light may remain switched on at the same time as the main/upper beam light. When the control switch for dipped/lower beam light is activated, all main/upper beam lights shall be switched off simultaneously.								
f) Tell-tale	n a								
g) Other requirements	Symmetrically in relation to the median longitudinal plane[8]								

Exceptions:

1) Not applicable to steel tracked and steel pad foot wheeled machines.

2) At front of the earth-moving machinery as far ahead as possible. The light may not cause discomfort to the operator/driver either directly or indirectly through the rear-view mirror and/or other reflecting surfaces. Two additional dipped/lower beam lights are optional. For additional lamps, when used on road, exception shall be granted.

3) May be > 1500 mm if the design of the bodywork makes it impossible to keep within 1500 mm, but maximum speed may be limited by national regulations.

4) May be > 2100 mm if the design of the bodywork makes it impossible to keep within 2100 mm.

5) May due to the design be > 400 mm from the extreme outer edge of the earth-moving machinery.

6) May be reduced to 5° if the design of the bodywork makes it necessary.

7) May be reduced to 3° if the design of the bodywork makes it necessary.

8) Initial adjustment of the cut-off line. The distance between the screen and the headlamp centre of reference shall be at 10 m.

When the highest point of the illuminating surface of the headlamp is:

- 1200 mm; the dipped/lower beam headlamp inclination shall be between 1,0 - 3 %.
- > 1200 mm; the adjustment of the additional dipped/lower beam headlamps mounted higher than 1200 mm shall be such that the horizontal part of the cut-off line at a distance of 15 m in front of the earth-moving machinery is half of the height of the centre of the dipped/lower beam headlamp.