
**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 worldwide 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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

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

This second edition cancels and replaces the first edition (ISO 12509:1995), which has been technically revised.

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Introduction

Earth-moving machines 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-reflector devices will differ.

This International Standard provides information needed for the selection of lighting, signalling and marking lights and reflex-reflector devices based on machine application and speed.

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

1 Scope

This International Standard specifies the minimum requirements for installation and performance of lighting, signalling and marking lights, and reflex-reflector devices on earth-moving machines. It is applicable to self-propelled wheel or crawler earth-moving machines as defined in ISO 6165, intended for off-road, as well as on-road, use. It is not applicable to pedestrian-controlled machines.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 303:2002, *Road vehicles — Installation of lighting and light signalling devices for motor vehicles and their trailers*

ISO 6165, *Earth-moving machinery — Basic types — Vocabulary*

ISO 7227:1987, *Road vehicles — Lighting and light signalling devices — Vocabulary*

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 303, ISO 7227 and the following apply.

3.1.1

zero Y plane

vertical plane which passes through the longitudinal centreline of the machine

NOTE See ISO 6746-1.

3.1.2

X plane

any vertical plane normal to the Y plane

NOTE See ISO 6746-1.

3.1.3

ground reference plane

GRP

plane surface on which the machine stands and which should be substantially horizontal

3.1.4

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, the projection of any anti-skid device mounted on the wheels, of rear-view mirrors, and of side direction indicator lamps, front and rear-position lamps and stopping lamps

3.1.5

overall width

distance between the two vertical planes of the extreme outer edge

3.1.6

operating mass

OM

mass of the base machine with equipment and empty attachment as specified by the manufacturer, and with the operator (75 kg), full fuel tank and all fluid systems at the levels specified by the manufacturer

[ISO 6016:1998, definition 3.2.1]

3.1.7

lamp

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

NOTE Light marking is similarly regarded as a *lamp* (see ISO 7227).

3.1.7.1

equivalent lamps

lamps which have the same function and are geometrically interchangeable

[ISO 7227:1987, definition 3.8]

3.1.7.2

independent lamps

lamps which have separate illuminating surfaces, separate light sources and separate lamp bodies

[ISO 7227:1987, definition 3.9]

3.1.7.3

grouped lamps

devices which have separate illuminating sources and separate light sources but a common lamp body

[ISO 7227:1987, definition 3.10]

3.1.7.4

combined lamps

devices which have separate illuminating surfaces, but a common light source and a common lamp body

[ISO 7227:1987, definition 3.11]

3.1.7.5

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)

[ISO 7227:1987, definition 3.12]

3.1.7.6

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

3.1.8**illuminating surface**

⟨lighting device⟩ orthogonal projection of the full aperture of a reflector in a transverse plane

NOTE 1 If the lighting device has no reflector, the definition of the illuminating surface of a **signalling device** (3.1.9) 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 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.

NOTE 3 Adapted from ISO 7227:1987.

NOTE 4 See Annex C.

3.1.9**illuminating surface**

⟨signalling device other than reflex reflector⟩ orthogonal projection of the lamp in a plane perpendicular to its reference axis and in contact with the exterior light-emitting surface of a lamp, this projection being bounded by the edges of screens situated in this plane, each allowing only 98 % of the total luminous intensity of the light to persist in the reference axis direction

[ISO 7227:1987, definition 3.36]

NOTE See Annex C.

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3.1.10**illuminating surface**

⟨reflex reflector⟩ illuminating surface in a plane perpendicular to the reference axis and bounded by planes on the outer edges of the light projection and ~~parallel to this axis~~

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[ISO 7227:1987, definition 3.37]

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3.1.11**reference axis**

characteristic axis of the light signal for use as the reference direction ($\alpha = 0^\circ$, $\beta = 0^\circ$) for photometric measurements and when fitting the lamp on the machine

NOTE The reference axis is determined by the manufacturer (see Annex C).

3.1.12**reference centre**

intersection of the reference axis with the light-emitting surface

[ISO 7227:1987, definition 3.41]

NOTE See Annex C.

3.1.13**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 colorimetric conditions

[ISO 7227:1987, definition 3.38]

NOTE See Annex C.

3.1.14

control device

device indicating either that a device is operating correctly or is actuated

3.1.14.1

tell-tale

visible and/or audible device that indicates actuation and/or operating condition of lighting and light signalling devices or system

[ISO 7227:1987, definition 3.32]

3.1.14.2

operational tell-tale

tell-tale which informs the operator/driver whether a lighting or light signalling device or system that has been actuated is operating correctly or not

[ISO 7227:1987, definition 3.33]

3.1.14.3

circuit-closed tell-tale

tell-tale which informs the operator/driver whether a lighting or light signalling device or system has been switched on but not whether a lighting is operating correctly or not

[ISO 7227:1987, definition 3.34]

3.1.15

angles of geometric visibility

angles which determine the widest solid angle in which the apparent surface of a lamp is visible

NOTE The 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 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 E).

3.2 Symbols

- H_1 maximum height above ground
- H_2 minimum height above ground
- E distance between outer edges of machine and illuminating surface of lighting device
- D distance between two lamps
- K distance from front of machine to edge of illuminating surface
- K_1 distance between edges of illuminating surface
- 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
- S minimum requirements regarding lighting, signalling and marking lights and reflex-reflector devices for on/off-road use

- optional lighting, signalling and marking lights and reflex-reflector devices 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 International Standard.
- N/A not applicable

4 General requirements

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

4.1.1 The lighting, signalling and marking lights, and reflex-reflector devices shall be so fitted that, under normal conditions of use and especially regarding any vibration to which they could 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. 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),
- c) have substantially identical photometric characteristics (see Annex D).

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 lap 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). Compliance with these requirements shall be tested according to ISO 303 and Annex B. During the test, the machine shall be located on a horizontal plane and, in the 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 from the front wheel/track. The width of Zone 1 is determined in respect of 15° angles starting from both sides of the wheel/track gauge [see Figure B.1 a)].

4.1.6.2 There shall be no direct visibility of a white light if viewed by an observer moving within Zone 2 in a transverse plane situated 25 m from the rear wheel/track. The width of Zone 2 is determined in respect of 15° angles starting from both sides of the wheel/track gauge [see Figure B.1 b)].

4.1.7 The electrical connections shall be such that the front and rear-position lamps, and 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 front and rear-position lamps, and rear registration plate lamp (if any), 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 presented in Annex E.

Annex A (normative)

Lighting groups

Lighting groups (I, II and III) are a combination of lighting, signalling and marking lights, and reflex reflectors, to be used on earth-moving machines. The guidelines given in Table A.1 differentiate depending on where the machines are intended to be used and on the maximum travelling speed of the machines.

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

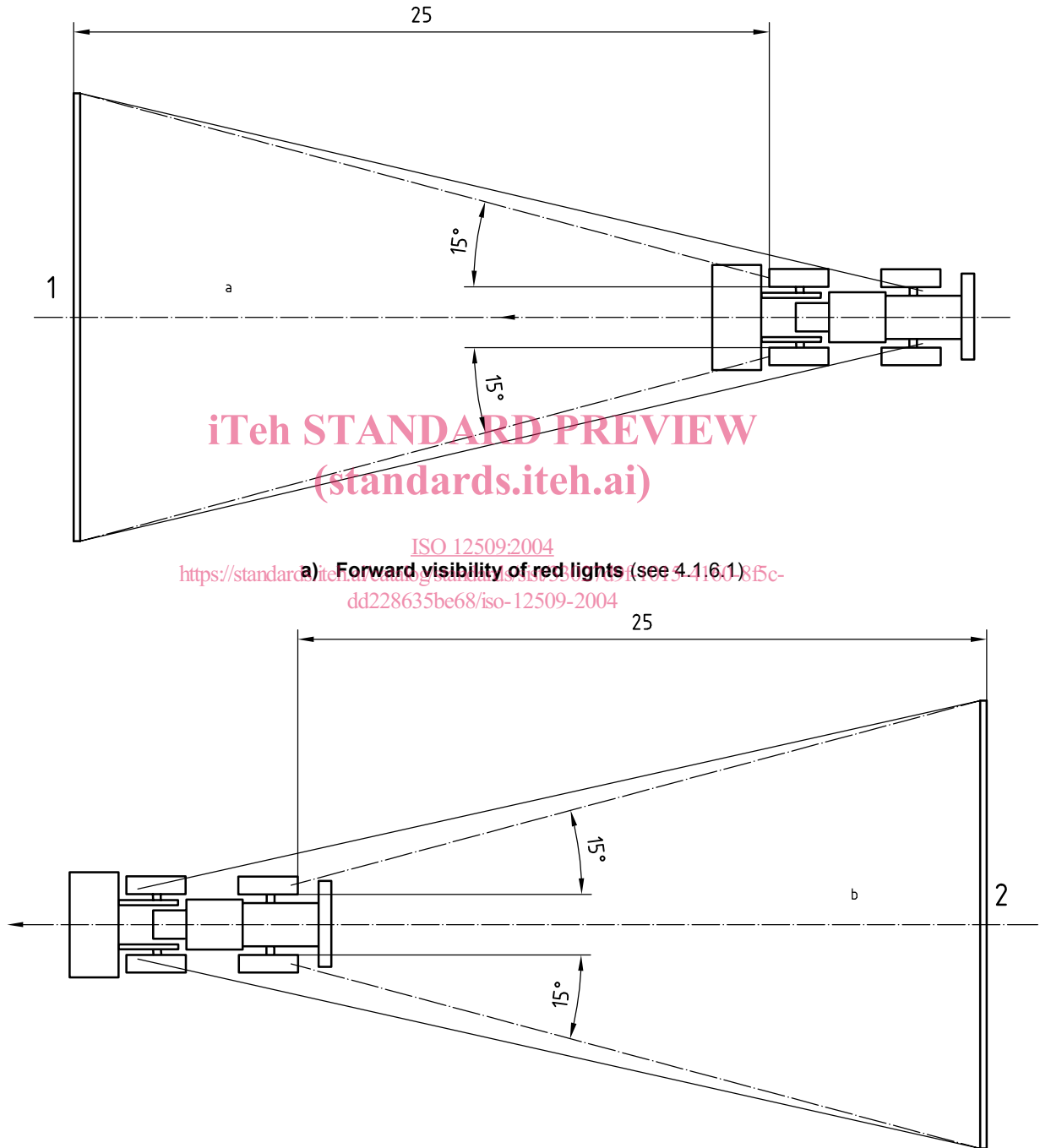
Table A.1 — Lighting combinations

Application to machines	Lighting groups ^a	Rated maximum travelling speed <i>v</i> (km/h)		
		A <i>v</i> ≤ 10	B 10 > <i>v</i> ≤ 40	C <i>v</i> > 40
Machines that are <i>not</i> intended for travel on public roads. ^b	I	EXAMPLE 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 <i>are</i> intended for travel on public roads.	II	EXAMPLE Wheel/soft crawler tractor-dozer, wheel loader, wheel excavator, wheel backhoe-loader, wheel/soft crawler dumper, grader, rubber-tyred roller and wheel trencher.		
Machines <i>not</i> allowed to travel on public roads due to physical characteristics exceeding road limits.	III	EXAMPLE Wheel/soft crawler tractor-dozer, loader, excavator, dumper, tractor-scraper, pipelayer and compactor.		
^a See Annex E. ^b At manufacturer and user discretion.				

Annex B
(informative)

Forward visibility of red lights and rearward visibility of white lights

Dimensions in metres



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a) Forward visibility of red lights (see 4.1.6.1)

b) Rearward visibility of white lights (see 4.1.6.2)

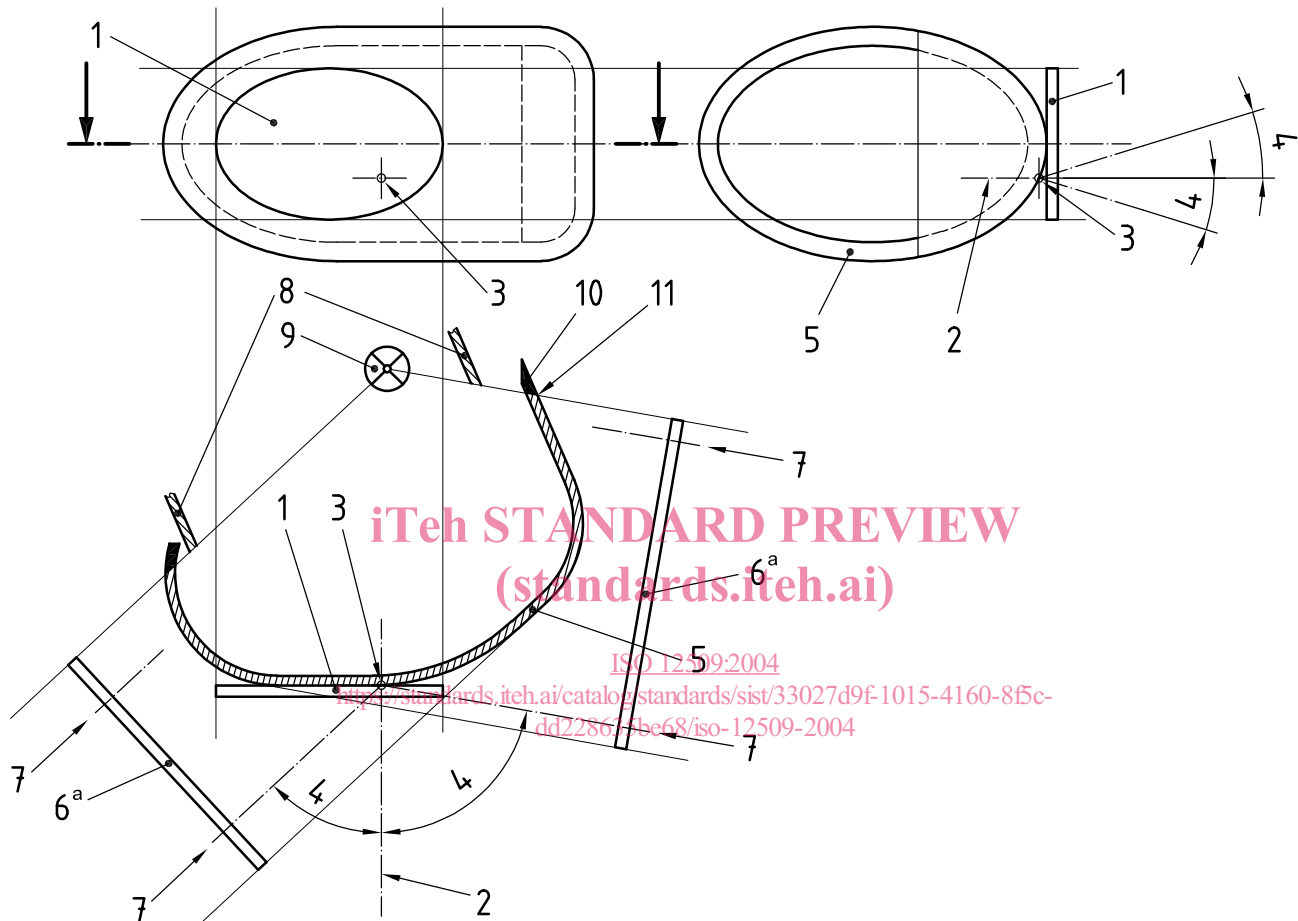
Key

- | | | | |
|---|--------|---|-------------------------|
| 1 | Zone 1 | a | No red light visible. |
| 2 | Zone 2 | b | No white light visible. |

Figure B.1

Annex C
(normative)

Light signalling devices



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Key

- 1 illuminating surface
- 2 reference axis
- 3 reference centre
- 4 angle of geometric visibility
- 5 light-emitting surface
- 6 apparent surface
- 7 direction of visibility
- 8 non-transparent surface or part
- 9 lamp filament
- 10 transparent part of lens
- 11 limit of light-emitting surface
- ^a This surface shall be considered tangent to the light-emitting surface.

Figure C.1

Annex D (normative)

Colorimetric characteristics of illuminating and signalling lights

D.1 Trichromatic coordinates

The trichromatic coordinates for illuminating and signalling lights shall be in accordance with Table D.1.

See Figure D.1.

NOTE The trichromatic coordinates specified here do not necessarily conform with CIE S004 [1].

Table D.1 — Trichromatic coordinates

Red	Limit towards:	yellow	$y \leq 0,335$
		purple	$z \leq 0,008$
White	Limit towards:	blue	$x \geq 0,310$
		yellow	$x \leq 0,500$
		green	$y \leq 0,150 + 0,640x$
		green	$y \leq 0,440$
		purple	$y \geq 0,050 + 0,750x$
Amber	Limit towards:	green	$y \leq x - 0,120$
		red	$y \geq 0,398$
		white	$y = 0,790 - 0,670x$
Selective yellow	Limit towards:	red	$y \geq 0,318 + 0,580x$
		green	$y \leq 1,29x - 0,100$
		white	$y \geq -x + 0,966$
		spectral value	$y \geq -x + 0,992$
Enlarged selective yellow	Limit towards:	red	$y \geq 0,138 + 0,580x$
		green	$y \leq 1,290x - 0,100$
		white	$y \geq -x + 0,940$
			$y \geq 0,440$
	spectral value	$y \leq -x + 0,992$	