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**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

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Replacing GB/T 28780-2012

**Safety of machinery - Integral lighting system used for
machines**

机械安全 机器用整体照明系统

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3 Terms and definitions

3.1 machinery, machine: an assembly of connected parts having a specific application, at least one of which is movable and which is fitted or intended to be fitted with a power system. Note: the term machinery also covers an assembly of several machines arranged and controlled so as to function as one complete machine for the same purpose. Source: GB/T 15706-2012, 3.1, modified.

3.2 integral lighting system used for machine: a system permanently mounted on a machine and made up of the light sources used for lighting, the luminaires and their associated control gear. Note: the integral lighting system provides lighting of the working areas inside and outside the machine.

4 Technical requirements

4.1 General. A machine shall be provided with integral lighting suited to the operations concerned; the note observes that a hazard may arise without integral lighting even where the ambient lighting level is normal. Lamps shall be chosen that are safe to operate, energy efficient and harmless to the machine operator, and the luminaire design should give due weight to reducing premature ageing of the optical components. Ergonomic principles and lighting engineering principles should be considered in the design, the particular lighting conditions being settled by a detailed analysis of the task and taking account of 4.2 to 4.8. For the lighting required by a particular task, reference shall be made to the relevant standards on workplace lighting. Where failure of the integral lighting system would lead to a hazardous situation, the system shall have at least two luminaires, one of them supplied from a standby source. The system shall be able to provide lighting even when the machine

is switched off; the note adds that this does not exclude the requirement of GB/T 5226.1-2019 that the machine can be fully disconnected from the supply.

4.2 Illuminance. The illuminance provided shall let the operator see and work, and shall be bright and uniform enough for the safety and comfort of the operator at each stage of the work. A maintained illuminance of not less than 500 lx shall normally be provided and the uniformity over the task area shall be not less than 0.7; where there are several working areas inside or outside the machine, each should be considered separately. The illuminance of the immediate surrounding area shall be not less than 300 lx with a uniformity of not less than 0.3. Where a visual aid or a protective face shield is needed to operate the machine, the illuminance shall be multiplied by the reciprocal of the transmittance of that device; where the transmittance is unknown, the illuminance shall be raised by at least 50 %. In a control cabin, or in operations or situations affected by light, the above illuminance requirements may be reduced as appropriate.

4.3 Glare. The integral lighting system shall avoid direct glare, both disability and discomfort glare, to the machine operator and to other people in the vicinity, and glare caused by reflection within the working area shall be avoided in use. The note suggests suitable shielding of lamps, adjustment of the position, aiming or brightness of luminaires, and matt surfaces.

4.4 Direction of lighting. The design and adjustment of the system shall avoid shadows that interfere with the operator vision, and the direction of the lighting shall suit observation by the operator at the machine.

4.5 Colour quality. The colour rendering and colour appearance of the lamps or luminaires shall let the operator distinguish colours as the work requires and shall safeguard operator comfort; for machines needing much manual intervention or observation, lamps with a colour rendering index (CRI) of not less than 80 shall be used. Where lighting controls are used to adjust the brightness of lamps or luminaires, the colour rendering shall meet that minimum CRI at every possible setting.

4.6 Stroboscopic effects. The design shall avoid adverse stroboscopic effects, which can make a rotating or reciprocating movement of the machine be perceived wrongly and so create a hazard. The note explains that such effects are usually avoided by limiting the amplitude of the time modulation of the system or by keeping the modulation frequency of the light away from the movement or rotation frequency of the machine, for example by using direct current or high frequency lamps; LED or fluorescent lighting is a suitable system for minimising adverse stroboscopic effects, provided the control gear modulation frequency is high enough or the modulation depth of the remaining light low enough.

4.7 Ergonomic principles. The integral lighting system of the machine should take ergonomic principles into account, for example: an adjustable luminaire stays put in its position but is easily moved when needed, especially when the operator changes from

sitting to standing; the system is adjustable, or mounted so that the operator can work with either hand without disturbing shadows; ergonomic principles for hot surfaces that may be touched comply with GB/T 18153; and the actuators of the system suit the intended use.

4.8 Emergency lighting. Where the supply to the normal lighting of the machine fails, additional emergency lighting shall be provided if the size or arrangement of the machine parts still running would reduce the effectiveness of observation by the operator at the machine.

5 Lighting equipment and installation

5.1 Light sources. The light sources used shall comply with the corresponding product safety standards. Normally the light source should be safeguarded so that the operator is not injured by a broken lamp, by overheating or by harmful radiation.

5.2 Luminaires. The luminaires shall be easy to service, shall limit the accumulation of dust on the lamp and optical surfaces and shall above all be easy to clean; shall suit the intended environment, for instance as regards dust and water; shall be compatible with the machine, for instance able to withstand vibration and radiation; shall meet 15.2.4 of GB/T 5226.1-2019; shall meet the relevant parts of GB 7000 (all parts); the enclosures of the electrical equipment of the system shall meet GB/T 20138; luminaires for sewing machines, sewing units and sewing systems shall meet GB/T 5226.31; those for hoisting machinery GB/T 5226.32; and those for semiconductor equipment GB/T 5226.33.

5.3 Installation. Luminaires shall be installed firmly and reliably; shall be installed so as to give the operator the lighting needed for the work; shall avoid injuring the operator and shall not interfere with the work; shall limit the accumulation of dust on lamp and luminaire surfaces; and shall be easy to service. Examples of installation are given in Annex A.

6 Inspection methods

6.1 General items. Glare control, direction of lighting and colour quality are confirmed by visual inspection. Visual inspection confirms that there is no adverse stroboscopic effect in every mode of the lighting system, that is at every light level and direction, and in every relevant mode of the machine, that is in the moving and rotating modes and at the various angular speeds. Visual inspection confirms whether the system meets the ergonomic principles and whether the additional emergency lighting provided on failure of the supply to the normal lighting meets the requirement.

6.2 Illuminance. The illuminance of the task area and of the immediate surrounding area is measured, preferably with an illuminance meter having cosine and $V(\lambda)$ correction of the photocell. A grid system is set up to mark the points at which illuminance is measured; approximately square grid cells are preferred and the aspect ratio of a cell shall stay between 0.5 and 2. The largest grid size is calculated from Formula (1), whose key reads: p,

the largest grid cell size, in metres, p not greater than 10 m; d , the dimension of the long side of the calculation area, in metres, where if the ratio of long side to short side is 2 or more, d is the short side of the area. The note explains that the calculation area is the whole task area or the immediate surrounding area. The number of points in the relevant direction is given by the nearest whole number of d divided by p ; the resulting grid point spacing is used to work out the nearest whole number of grid points in the other direction, which brings the aspect ratio of the cells close to 1. There shall be not fewer than 3 grid points in either direction, that is a minimum grid of 3 by 3.

6.2 continued. Once the light sources are stable, the source being switched on for a suggested 15 min, the maintained illuminance of the task area and of the immediate surrounding area is checked from the values measured under a) using Formula (2), whose key reads: E , the maintained illuminance, in lux; n , the number of points measured under a); E_i , the i -th illuminance value measured under a), in lux. The uniformity U_0 of the task area and of the immediate surrounding area is then checked with Formula (3), whose key reads: U_0 , the illuminance uniformity over the grid of the measured area; E_{min} , the lowest illuminance measured over that grid, in lux; E , the maintained illuminance calculated from Formula (2), in lux. The three formulae reached this workstation damaged by the extraction and are not reproduced.

7 Information for use

Where the machine manufacturer has defined particular tasks bearing on compliance with the integral lighting requirements of the machine, the definition of those tasks shall be included in the information for use supplied with the machine.

The machine supplier shall supply with the machine a set of test and maintenance instructions and a schedule, so that the user can carry out routine maintenance and care. These include instructions for testing the integral lighting system by the methods of Clause 6 in line with the machine maintenance schedule and for the action to be taken to deal with any problem, and instructions for the care, cleaning and maintenance of the integral lighting system as set out in the machine maintenance schedule.