

LIGHT CURTAINS AND PRESENCE-SENSING DEVICES FOR MACHINE SAFEGUARDING

1.0 GENERAL

For use in Europe, the qualification required for light curtains is that they be "CE" marked (CE) to indicate their construction complies with the relevant European Standards (EN) and that specific product certification has been given by a third party safety test agency (European Notified Body). Light curtains shall be provided with an EC Declaration of Conformity.

For use in North America, the additional qualification required for light curtains is that they be UL Listed (UL) and CSA Certified (CSA) and marked accordingly to certify compliance with the appropriate UL and CSA standards.

1.1 PURPOSE:

This Standard provides functional, performance, and installation requirements for Safety Light Curtains / Presence Sensing Devices (PSD) used for machine safeguarding, and for Presence Sensing Device Initiation (P.S.D.I.) to start a machine cycle.

Notes: This Standard refers to Safety Light Curtains as a "Presence Sensing Device" as defined in ANSI B11.19 and other standards. This is the same device known as a "Presence Sensing Safeguarding Device (PSSD)" as defined in ANSI/RIA R15.06, or as "Electro-Sensitive Protective Equipment (ESPE)" as called in IEC 61496 standards.

Section 3 "TECHNICAL REQUIREMENTS FOR PRESENCE SENSING DEVICE" applies to manufacturers of Presence Sensing Devices. Section 4 "APPLICATION REQUIREMENTS – INSTALLATION/SYSTEM" applies to the machine builder and/or safeguarding system installer.

- 1.1.1** EXCEPTION: P.S.D.I. **shall not** be used on mechanical or hydraulic power presses.
- 1.1.2** All P.S.D.I. applications shall be approved by Local plant and Corporate Safety activities. (See Figure 5, available as Word processing document.)
- 1.1.3** The installation requirements of this Standard do not apply when the PSD is not being used to provide a safeguarding function.

1.2 SCOPE:

This Standard describes Safety Light Curtains (light curtains), which are "control reliable" electronic safety devices actuated by sensing presence, and their associated interfaces. This Standard includes using such a device to either stop the machine, or to start the machine cycle automatically when the operator and other persons have left the protected area and the machine cycle can be safely initiated. In both cases the light curtain serves as a primary safeguarding device.

Light curtains should not be confused with simple photoelectric sensors which are designed for different applications and which can be adversely affected by various environmental conditions. Light curtains are built with self-checking electronics for as close to a "fail-safe" operation as achievable. This means that (referring to ANSI B11.19 item 5.5.1):

"When required by the performance requirements of safeguarding, the device, system, or interface shall be designed, constructed, and installed such that a single component failure within the device, interface, or system shall not prevent normal stopping action from taking place but shall prevent a successive machine cycle. This requirement does not apply to those components whose function does not affect the safe operation of the machine tool."

NOTE: In the United States, selection and application of safeguarding systems is provided in the appropriate ANSI B11 Safety Standard for the particular type of machine tool and shall take precedence over this standard.

1.3 DEFINITIONS:

1.3.1 LIGHT CURTAIN / PRESENCE-SENSING DEVICE: See ANSI B11.19 (2.39).

1.3.2 MINIMUM SAFETY DISTANCE: See ANSI B11.19 (2.50 & 4.4.3.3).

1.3.3 P.S.D.I.: Presence-Sensing Device Initiation. An operation mode of indirect manual initiation of a single cycle by a presence sensing device when it senses that work motions of the operator, related to feeding and/or removing parts, are completed and all parts of the operator's body or hand tools are safely clear of the point of operation.

1.3.4 The word "shall" is understood as a mandatory requirement; the word "should" as a recommendation.

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2.0 REFERENCE STANDARDS: Whenever a specific standard is mentioned in this Standard, it is understood it will be the latest revision thereof, unless otherwise specified.

2.1 Ford Motor Company – Global Manufacturing Standards w-EL3, w-EX1 (*to be published*).

2.2 INDUSTRY STANDARDS:

2.2.1 Code of Federal Regulations, Department of Labor, Occupational Safety and Health Administration (OSHA) 29 CFR 1910, particularly sections:

- 1910.211 (62) for Definitions,
- 1910.212 (a) (1) for machine guarding
- 1910.212 (a) (3) for point of operation guarding
- 1910.212 (a) (3) (ii) for General Requirements for All Machines
- 1910.217 (b) (13) for Control Reliability
- 1910.217 (h) (6)(xvii) for controls with internally stored programs
- 1910.217 (h) (9) (iv) for Minimum Object Sensitivity
- 1910.217 (h) (9) (v) for Safety Distance

2.2.2 American National Standards Institute (ANSI) B.11.19 "Safeguarding when Referenced by other B11 Machine Tool Safety Standards," particularly, but not limited to sections:

- 1.1, 1.2, 1.3.1 & 1.3.2 for Scope, Purpose, and Applications
- 2.1.5, 2.3.9, 2.4.6 for Definitions of Device, PSD, safeguarding.
- 3.1 for Responsibility
- 4.2.3 in its entirety as described below:
- 4.2.3.1 for Applications of the PSD
- 4.2.3.2 for Design and Construction
- 4.2.3.3 for Operation
- 4.2.3.5 for Safety Distance
- 5.5 for Control Reliability
- 6.2.3 for Presence Sensing safeguarding devices

IEEE C37.90.1 (superseded ANSI C37.90A) "Surge Withstand Capability."

2.2.3 Underwriters Laboratories UL491, "Power Operated Machine Controls and Systems", proposed First Edition, November, 1991 or it's subsequent replacements, such as the proposed "UL61496-1 and -2" and/or IEC 61496-1, -2 with supplements. Also, UL508, "Industrial Control Equipment," UL991 " Tests for Safety-Related Controls Employing Solid-State Devices," and UL1998, "Safety for Software in Programmable Components."

- 2.2.4** National Electrical Manufacturers Association (NEMA) ICS 1 "Industrial Control and Systems: General Requirements", and ICS 1.1 "Safety Guidelines for Application, Installation, and Maintenance of Solid State Control."
- 2.2.5** Canadian Standards Association CAN/CSA C22.2 No. 0.8 - M86, "Safety Functions Incorporating Electronic Technology, CSA C22.2 No.14, "Industrial Control Equipment" and CSA C22.1, "Canadian Electrical Code, Part 1" and supplements issued by Electrical Safety Authority (ESA) in Canada (previously known as Ontario Hydro).
- 2.2.6** International Electrotechnical Commission (IEC), Publications IEC 61000-4-1 through 61000-4-6 (inclusive) and 61000-4-11, "Electromagnetic Compatibility for Electrical and Electronic Equipment" covering EMC testing for ESD, radiated RFI/EMI, transient/burst immunity, surge immunity, conducted/induced RFI, and voltage dips/variatioins.
- 2.2.7** European Committee for Electrotechnical Standardization (CENELEC), IEC/EN 61496-1 "Safety of machinery – Electro-sensitive protective equipment - Part 1: General Requirements and tests," and IEC 61496-2 "Safety of machinery – Electro-sensitive protective equipment - Part 2: Particular Requirements for equipment using active opto-electronic protective devices (AOPDs)."
- 2.2.8** ANSI/RIA R15.06 "Industrial Robots & Robot Systems – Safety Requirements."

2.3 CONFORMANCE:

- 2.3.1 SUPPLIER'S RESPONSIBILITY:** All components and equipment supplied in conformance with this Standard shall be equivalent in all respects to items upon which approval was originally granted. Any deviations from this Standard, without written notice and subsequent review and re-approval by the Ford Global Manufacturing Standards - Electrical Technical Committee, shall be sufficient cause for removal from the Ford Manufacturing Standards – Electrical Qualified Source List (E1-QSL) previously known as Electrical Conforming Components List (E1- CCL).
- 2.3.2 QUALIFICATIONS:** All products submitted for evaluation shall be "off the shelf" catalog items manufactured with normal production procedures and quality control. Prototype units shall not be tested. Qualifications shall be made based on conformance to this Standard as certified by the Supplier in writing, required agency approvals, as well as laboratory and performance

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tests where necessary. All subject to the review of the Ford Global Manufacturing Standards (GMS) Electrical Standards Technical Committee.

2.3.3 All PSDs used in USA shall be tested and certified by an OSHA approved Nationally Recognized Testing Laboratory (NRTL) and "UL Listed," "C-UL-US Listed," or "CSA/NTRL Certified." In Canada all PSDs shall be "CSA Certified," or "C-UL Listed" or "CSA/NRTL/C Certified." PSDs used in Europe shall be "CE" marked.

2.3.4 Suppliers shall submit an itemized DATA SHEET, correspondingly numbered with this Standard, stating their compliance with each provision of this Standard. The Data Sheet or a letter accompanying and referring to the Data Sheet shall be signed by the Vice President of Engineering or higher officer of the company that manufactured the PSD.

3.0 TECHNICAL REQUIREMENTS FOR PRESENCE SENSING DEVICE:

3.1 ENCLOSURE:

3.1.1 Enclosure shall meet requirements of SAE HS-1738, Chapter 9 "Control Enclosures and Compartments" and shall be strong enough to withstand the compression and deflection performance tests in IEC 60529 and/or NEMA 250 as referenced in IEC 61496 and UL508 respectively.

3.2 OPERATION (of the PSD):

3.2.1 The PSD shall not be affected by ambient light or light from other sources such as flood lights, fluorescent lights, sun rays (i.e. through windows or roof openings, etc.), strobe lights, weld flash, photoelectric devices, other PSDs in the vicinity, or any other type of light sources.

3.2.2 The light curtain and PSD shall not fail to sense and respond to any part of the operator's, or any person's, body due to the presence of shiny materials, such as parts being processed or tooling on the machine (fixture, ram, etc.). The unit shall avoid an "Optical Short Circuit" due to reflection.

3.2.3 Angle of Divergence and Acceptance shall not exceed +/- 2.5 degrees per IEC 61496. If the PSD has adjustable gain, this angle shall be determined at the maximum gain setting.

3.2.4 The PSD shall be provided with a removable/replaceable lens protection method, to facilitate reasonable maintenance for damages from welding sparks, scratches, etc.

3.2.5 Minimum Object Sensitivity shall be 1-1/4 inches (31.75mm) or less.

EXCEPTION: Light curtains that are "Blanked" shall not be used in P.S.D.I. operation (due to minimum object sensitivity requirement). See Section 4.3.5.

For Europe/UK: Hand speed is linked to minimum object sensitivity via BS IEC 61496-2 par. 4.1.2.1: " The sensing device of a light curtain shall be actuated when a test piece is placed anywhere within the detection zone at any angle, either static or moving, at any speed between: 0 m/s and 2.5 m/s for an AOPD detection capability less than or equal to 40mm, 0 m/s and 1.6 m/s for an AOPD detection capability greater than 40 mm."

3.2.6 Control Reliability: Light curtains shall meet the requirements stated in ANSI B11.19 Section 5.5.1; see also IEC 60204-1 par. 9.4 for European requirements.

3.2.7 The Light Curtain shall be qualified for use in P.S.D.I. applications per OSHA 29 CFR 1910.217.

3.3. ELECTRICAL:

3.3.1. ENVIRONMENTAL: The PSD shall operate properly in compliance with this Standard over a supply voltage range of 85 to 110 percent of the nominal 120 (or 230) VAC supply at 50/60 Hz, or the same percentage variations from a nominal 24 VDC for DC operated units. Voltage variations may be the result of gradual and/or instantaneous supply variations. Additionally, the PSD shall be capable of operating in a temperature range of 0 degrees C (32 deg. F) to 60 degrees C (140 deg. F), and in a humidity range of 5 to 95 percent, non-condensing. PSD shall operate in both ungrounded and grounded control circuits (120 VAC or 24 VDC as provided) without modification.

3.3.2 OUTPUT RELAYS: Relays shall have direct-drive (force-guided or captive) contacts to meet ANSI B11.19, Section 5.5, "Control Reliability." Off-the-shelf relays are preferred for ease of replacement, if the design permits replacement. Two redundant output relays shall be required.

Contact Life and Bounce: PSD output relays shall have a minimum contact life of 10 million operations under stated full rated load. PSD shall be tested for contact bounce both before and after completion of all other tests required in this Standard.

3.3.3 VIBRATION AND SHOCK TEST: PSD shall meet IEC 61496-1 section 5.4 "Mechanical influences" requirements.

3.3.4 IMMUNITY TO INTERFERENCE AND ENVIRONMENTAL CONDITIONS:
PSD shall not be affected by any of the following:

Radio Frequency Interference (RFI) – PSD shall be immune to RFI as required by the **Industry Standards referenced in Section 2.2** and in accordance with the following practical field test:

The RFI tests shall be conducted with a hand-held VHF transceiver with a rated power of five watts and fully charged batteries. There shall be no change in the state of the Light Curtain outputs when the transceiver is turned ON and OFF; also when the transceiver is keyed and its antenna held parallel, within 0.25 inches (6.3 mm), to any part of the PSD enclosure. The antenna then will be moved parallel to and within 0.25 in. of the output cable or wiring connected to the PSD for a distance of four feet along the cable without change of output state.

- (2) Electromagnetic Interference (EMI).
- (3) Power Line Noise Interference, Voltage Variations, Transients.
- (4) Electrostatic Discharge - in accordance with IEC Publication 61000-4-1 at 2kV, 4kV, 8kV, and 15kV levels.
- (5) Strobe, Fluorescent, Sunlight, or Ambient Light Interference, per IEC 61496-2, section 5.4.6.
- (6) Application and Removal of Power: There shall be no change in the state of output from the PSD when the power is applied or removed.
- (8) Accumulation of dirt, oil, or water on or around the PSD.
- (9) Ferrous or non-ferrous metals on, or, within close proximity to the PSD.

3.3.5 RESPONSE TIME: The response time of the PSD shall not change due to degradation of its light source or for any other reason.

3.3.6 ACTUATION INDICATORS: The PSD shall have lights readily visible to the operator that indicate its status. The recommended colors are:

Green - PSD Outputs On (Actuated), Safe/Machine Ready. No part of the body of the operator, or any other person, or object is present in the active portion of the sensing field.