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First Edition

Frequently Asked Questions

Selection & Application of Safety Light Barriers

SCHMERSAL
EOT

With
Glossary of Light Curtain Terminology

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SCHMERSAL

Turning Workplaces Into Safeplaces®

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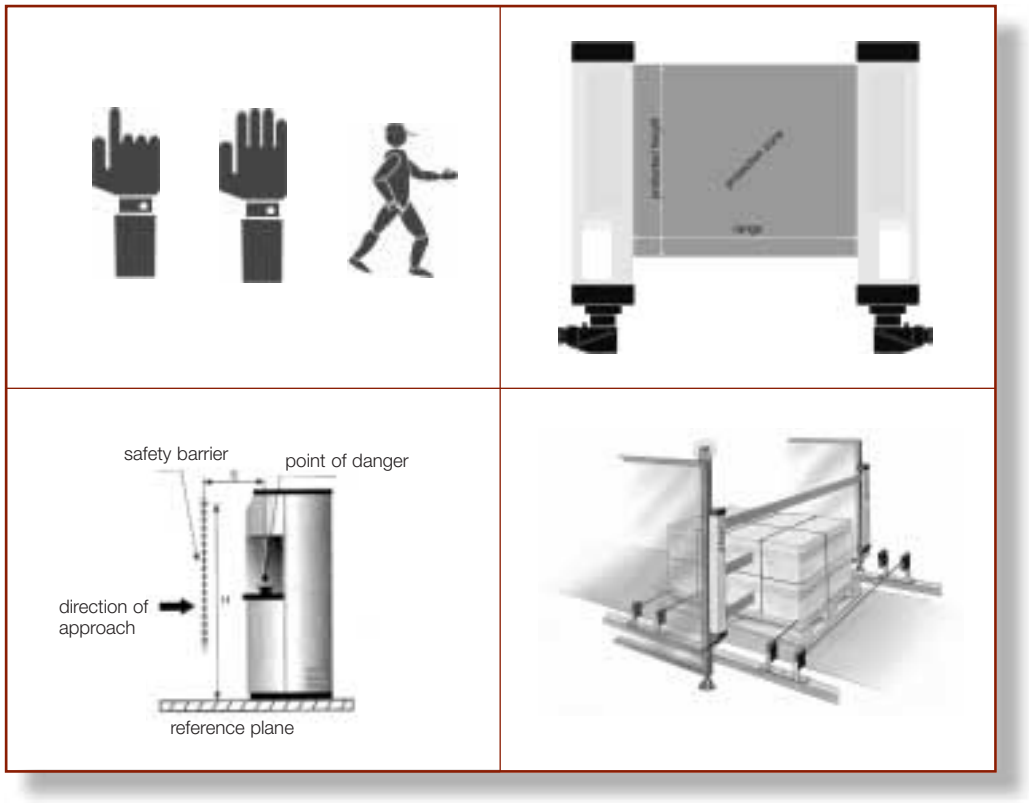
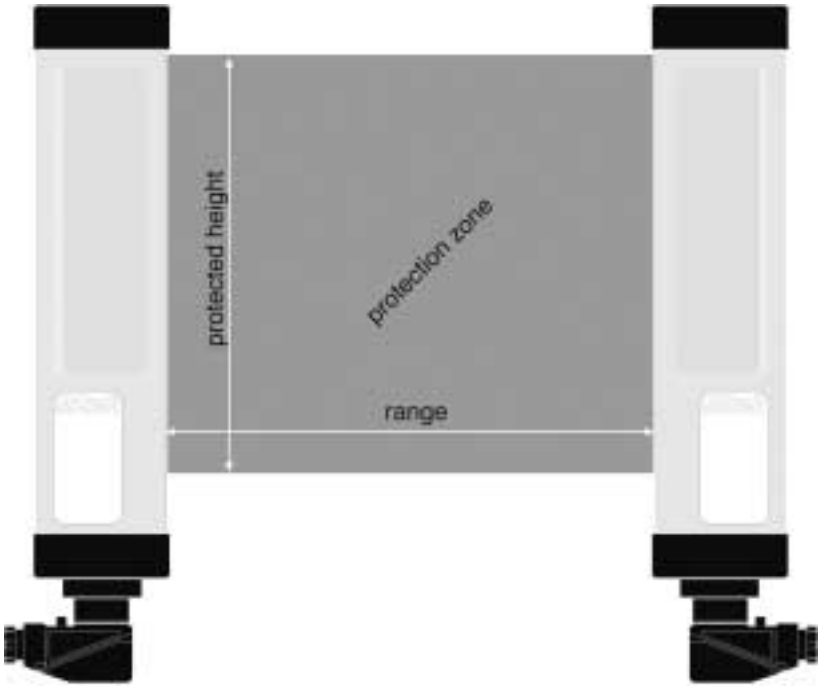


I. Selection & Application Characteristics

1 What is meant by "protected height"?

"Protected height" is the length of the light curtain's active sensing area… that is the distance from center of the first beam to the center of the last beam in the light curtain's transmitter/receiver array.



2 What is meant by "range" of a light curtain?

"Range" is the maximum effective distance that may exist between the light curtain's emitter (transmitter) and its receiver. The effective range is generally reduced by use of reflecting mirrors and environmental contaminants (such as fog, smoke, steam, dust, moisture, etc.)

3 What is meant by "response time" of a light curtain?

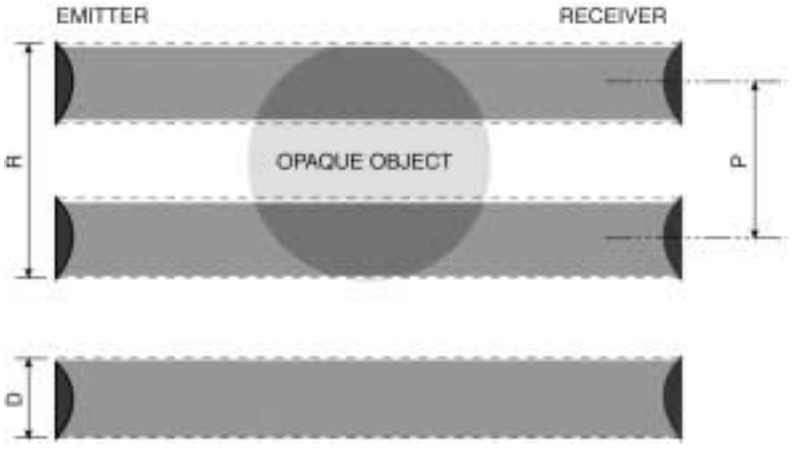
The "response time" of the light curtain is the time it takes for the light curtain to transmit the output (alarm) signal to the safety interface or machine control element after the protection field has been interrupted. The overall response time of the light curtain safety system includes the response time of the light curtain, the response time of any interposed interface (such as a safety controller or safety PLC), and the response time of the machine primary control elements (e.g. motor contactor or control relay). Response time is one of the important factors that must be considered when calculating the proper minimum safety distance.

4 What is meant by "minimum object sensitivity" and does it mean the same as "optical pitch" or "beam spacing"?

"Minimum object sensitivity" refers to the smallest object (diameter) that the light curtain can detect. It is commonly stated as the "resolution" of the light curtain and is also referred to as "detection capability".

"Optical" or "beam spacing" refers to the distance from the center line of one beam to the center line of the next beam.

It is important to understand that it is possible for an object to be in such a position that it does not block the path of a single beam even though it is the same diameter of the optical pitch. Therefore the resolution of a light curtain is equal to the optical pitch plus one lens diameter.



P=Pitch between two lenses
D= Diameter of one lens
R=Resolution

5 What light curtain resolutions are commonly used?

The most common light curtain resolutions are:

- 14mm (0.55 inches) for finger protection
- 30mm (1.25 inches) for hand protection
- 50mm (2.00 inches) to 90mm (3.5 inches) for body protection.

Finger Detection

Hand Detection

Whole Body Protection

6 What do “angle of divergence” and “angle of acceptance” mean and what are the application considerations that they imply?

“Angle of divergence” is the cone angle of the emitted light from the transmitter. “Angle of acceptance” is the cone angle within which the receiver will detect this emitted light. The wider the angles, the easier it is to align the light curtain. However, one must recognize that a wider angle of acceptance can result in possible interference from another photoelectric device emitting light energy within the receiver’s angle of acceptance. Contemporary light curtain standards (IEC 61496) require a maximum angle of divergence of ± 2.5 degrees for Safety Category 4 units. (SCHMERSAL Series SLC/SLG light curtains feature a coded signal, and hence are not affected by interference from other photoelectric devices).

7 What are "two box" and "three box" light curtain systems?

A "three box" light curtain system consists of an emitter, a receiver and a separate safety controller (safety relay module). A "two box" system consists of an emitter and a receiver with the safety controller functions integral to the emitter-receiver pair. A two box light curtain system generally results in lower wiring and installation cost.

8 What is an "OSSD"?

"OSSD" is the abbreviation for "Output Signal Switching Device" (also known as the light curtain's safety outputs). For example the SCHMERSAL Series SLC 410 light curtains have two OSSD's (two, 500mA PNP safety outputs).

9 What is "fixed blanking" and "floating blanking"?

"Fixed Blanking" is when a fixed set of adjacent light beams are rendered permanently inactive for the purpose of allowing product or part of the process to enter the sensing area without deactivating the light curtain safety outputs. An example would be the "blanking" of a small segment of the light curtain to allow finished parts to eject from a machining operation through this specific "opening" in the protected field.

"Floating blanking" is when a set number (one or more) of adjacent beams is allowed to ignore the presence of an object within their portion of the protection field. However, unlike fixed blanking (where the specific set of inactive beams are fixed), "floating blanking" allows the set number of adjacent beams to "float" within protected field … thus allowing the object to be ignored to move within the protected field without deactivating the light curtain safety outputs.

As long as no more than the selected number of adjacent beams is interrupted, the system remains operational and does not stop the machine. If one or more additional beams are interrupted, the light curtain system will provide a signal to initiate machine stoppage. An example would be similar to the ejected parts example above, but where the parts eject through a "moving opening" … that is, at different points through the protected field.

10 What is "muting"?

"Muting" is the provisional and automatic overriding of the light curtain safety output function during normal, uninterrupted machine cycle operation. This is an important function in applications in which the light curtain or light grid must be interrupted by some part of the machine or the materials being processed without stopping the operation or process.

An example is a palletizing system within which the palletized product must be allowed to pass through the opening protected by the light curtain, while the entry of a person must stop the machine.

Muting is typically accomplished using additional sensing devices (such as safety limit switches or photoelectric sensors that can be checked for functionality) in conjunction with a light curtain and a muting controller (such as SCHMERSAL's model SCM 3R) to detect the presence of the material/machine element and override the light curtain's safety function.

- **materials authorized**
- **people non-authorized**

to go through the barrier

11 What is "PSDI"?

"PSDI" (Presence Sensing Device Initiation) refers to the use of the sensing device (e.g. light curtain) to activate the machine/ manufacturing process once it has been determined that a human is no longer in the hazard area.

12 I want to set up my light curtain so it operates in PSDI mode. What are some of the requirements?

Use of a light curtain in the "PSDI" mode requires that it have a maximum object sensitivity of not less than 31.75 mm (1.25 inch) and be located at the correct "safety distance" from the point of the hazard. "Blanking" of the sensing field is not permitted when operating in this mode.

13 What application characteristics suggest that a light curtain may be a more suitable means of protection than some other alternative safety device? (such as a safety pressure mat, interlocked movable guards, or a laser scanner)?

Some of the application characteristics that may suggest use of a light curtain are:

- The hard guards require frequent (and costly) cleaning … such as in a food processing application.
- The operator is required to gain frequent access to the hazardous area … such that hard guards or movable guards are inconvenient and/or compromise efficient process operations.
- Products of different sizes/shapes are required to pass through the guarded area without interrupting production.
- A single light curtain might be less costly and may be used without compromising the safety of personnel.
- Fork lifts or other vehicles must frequently enter the hazardous area.

14 What questions might I ask to better evaluate if a light curtain is suitable solution for my application?

Typical application “screening" questions might include:

- Will the presence of dirt, dust, moisture, oil mist, or other environmental contaminants adversely affect a light curtain’s performance?
- Can the light curtains be installed such that their alignment and performance are maintained?
- Can the light curtains be installed to respect the required safety distance for the application?
- Will ambient light conditions (such as welding arcs, AGV or forklift strobe lights) adversely affect the light curtain’s performance?

II. Safety Distance Requirements

15 How do I define the "danger zone?"

The "danger zone" is that area of a machine or manufacturing cell within which a person will be exposed to a hazard and potential injury. When using safety light curtains it is important to locate them at the proper "safety distance" such that they initiate the stopping of the machine/process before personnel reach a point-of-hazard.

16 How important are "safety distance" calculations, and who should assume the responsibility for making this calculation?

"Safety distance" calculations are essential to the effective application and use of safety light curtains. Failure to respect the required safe distance in a given application may place personnel at risk of injury.

Since proper safety distance calculations require consideration of ambient conditions, equipment stop times, response times of other interposing light curtain safety system components (such as motor contactors, control relays, safety controllers, etc.), such calculations are best done by the OEM supplying the light curtain as an integral component to their machine or equipment, or alternatively by the end-user in whose facility the light curtain is being installed.

17 How do I calculate the correct "safety distance" between the hazard and the location of the light curtain?

For the U.S., the "safety distance" is typically calculated using OSHA's suggested formula:

Ds = Hs x (Ts+Tp+Tr+2Tm) Dp

Where:

Ds = Minimum safety distance (in inches).

Hs = Hand Speed constant of 63 inches per second (1.6 m/s).

Ts = Maximum machine stopping time (in seconds).

Tp = Maximum response time of the light curtain (in seconds).

Tr = Maximum response time of all other interposing control elements… e.g. safety controller, motor contactor, safety PLC (in seconds).

Tm = Increase in the press stopping time allowing for brake wear (in seconds).

Dp = Penetration depth factor (using the OSHA Penetration Depth Factor Calculation chart or formula)

In addition ANSI (American National Standards Institute) has established a formula that will result in a similar calculation.

In Europe, the following formula (adopted from EN 999) should be used and documented in the technical file:

S = K (t1+t2+t3) +C

Where

S = minimum safety distance (mm)

K = approach speed of object to the hazard (mm/sec)

t1 = response time of the safety light curtain (in seconds)

t2 = response time of the safety interface… e.g. safety controller, PLC (in seconds)

t3 = machine response time (in seconds)

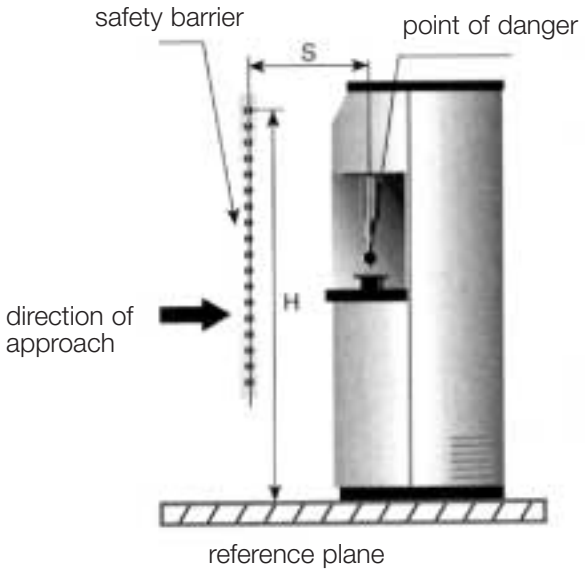
C = additional distance (safety factor)

Note: C and K will vary depending on application characteristics and light curtain resolution. For further details see SCHMERSAL Safety Light Curtain Catalog-Handbook GK-3.

Example: Calculate the safety distance required when using a 14mm resolution light curtain to guard a point-of-operation hazard for which the response time of the light curtain is 6ms, the response time of the interposing safety controller is 12ms, the machine stop time is 60ms and the safety factor is negligible.

S = 1600 mm/sec x (0.006 + 0.012 + 0.060)

S = 125 mm (5 inches)



18 How do I calculate the "Penetration Depth Factor?"

"Penetration Depth Factor" can be calculated using OSHA's Penetration Depth Factor Calculation chart or by using the following formula:

Dp = 3.4 (S - 0.276)

Where Dp = Depth penetration factor
S = Object Sensitivity or Light Curtain resolution (in inches)

19 After doing the "safety distance" calculations, I have found that due to space limitations I cannot locate my light curtain the required distance from the point-of-hazard to stop the machine in time. What can I do to provide a safe situation?

Depending upon the application, there are a few possible solutions. These include the following:

1. If the machine presenting the hazard is controlled by an AC motor, one can install a dynamic brake to reduce the stopping time of the machine.
2. If the equipment presenting the hazard is controlled pneumatically or hydraulically, one can install a safety valve that produces equal pressure on both sides of the control cylinder's actuator reducing the stopping time of the equipment.
3. One can install a movable hard guard (in lieu of a light curtain) that allows access to the hazardous area only after the system has stopped or the hazard no longer exists.

III. Wiring & Installation Considerations

20 How can I guard multiple sides of a machine with one light curtain?

Multiple sides of a machine or manufacturing cell can be guarded with a single light curtain using reflecting mirrors to bend the light beams around the corners … provided that the performance characteristics of the light curtain and mirrors are adequate to span the sensing distance effectively.

21 Does the use of reflecting mirrors affect the maximum sensing range of the light curtain?

Yes. Each mirror typically reduces the maximum sensing range by 10% to 25% depending upon the light curtain and the type of mirror used (e.g. front-surface reflecting, rear-surface reflecting, metal mirror, etc.)

22 What, if any, environmental conditions must be considered when using safety light curtains?

Abnormal or unusual environmental conditions can compromise the performance of a safety light curtain system. For example:

- Sudden changes in temperature may result in condensation on the light curtain lenses or deflecting mirrors.
- The presence of fog, smoke or dense fumes typically reduce the effective range of a light curtain.
- The presence of steam or dust also typically reduces the effective range of a light curtain.

23 Must I be concerned about other light sources creating problems with my light curtain?

Yes, one must be aware of other light sources (such as sunlight, reflections from nearby surfaces, welding arcs, light energy from other light curtains). Each should be considered when using safety light curtains.

24 Must light curtains only be used in the vertical position?

No, some applications call for light curtains to be used in the horizontal orientation. When using light curtains horizontally, relevant industry standards (such as ANSI-RIA 15.06) should be respected.

25 Some light curtains are "matched sets" and some are not. Why and what does that mean to a user?

A "matched set" means that the light curtain transmitter and receiver are matched at the factory (during manufacturing) for optimal performance. If during operation of the light curtain, the transmitter or receiver is damaged or fails, both must be replaced and returned to the factory for repair and adjustment.

If the light curtain's transmitter and receiver are not matched, and a receiver or transmitter unit fail or become damaged, it can simply be replaced with another unit. SCHMERSAL's light curtain pairs (transmitter and receiver) need not be matched.

26 Does my light curtain have to be hard-wired or may I use quick-disconnects?

Both types of terminations are permitted. In either case, disconnecting the receiver or transmitter will result in a shut-down.

27 If I am using a Safety PLC, do I still have to use a safety controller (safety relay module) with my light curtain?

A safety PLC may be used without a safety controller (safety relay module) provided that it:

- Can accept the light curtain's safety output signals,
- Has the correct diagnostics to meet the control reliability requirements, and
- Can provide a safety output suitable for initiating stoppage of the machine posing the hazard.

28 When using a light curtain with two safety outputs, may I use one for "safety" and one for "annunciation" (e.g. to send a signal to my PLC that the light curtain has been interrupted)?

The answer depends on the safety category desired, as well as other elements in the safety system. For higher safety categories (Category 3 or 4) dual (redundant) safety outputs are needed to satisfy control reliability requirements. For such applications the answer is no.

29 How does one select the proper light curtain system for a given application?

Typical selection factors include:

- How large is the object/body part that is being detected/protected? (This will determine the minimum required light curtain resolution.)
- What is the height/length of the area ("protected field") to be guarded?
- What is the maximum distance ("range") that will separate the emitter and the receiver in the application?
- How quickly must I stop the machine or process after interruption of the light curtain, and will the light curtain safety system have a fast enough "response time" to do so based on its intended location?
- What type of load will the light curtain safety outputs control, and are they sufficient for the application? (This will help determine the current capability required of the safety signals … e.g. semiconductor outputs for controlling a safety PLC or solid state relay vs. relay outputs for direct control of a motor contactor).
- What safety level or safety control category does the application's risk assessment indicate is required?