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

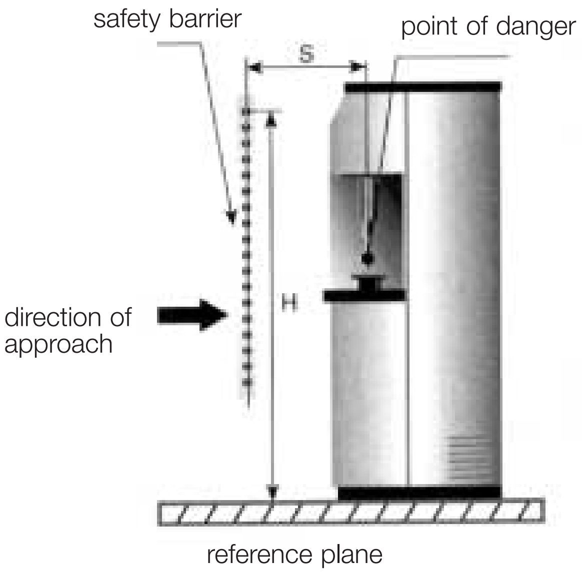
S =	minimum safety distance (mm)
K =	approach speed of object to the hazard (mm/sec)
t1 =	response time of the safety light curtain (in seconds)
t2 =	response time of the safety interface… e.g. safety controller, PLC (in seconds)
t3 =	machine response time (in seconds)
C =	additional distance (safety 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.