IMEG

K-12 SECURITY + LIGHTING:
Notification and Safer Egress for Active Assailant Events and Environmental Emergencies

As active assailant attacks continue to occur, many schools, hospitals, offices, retail establishments, and other organizations are seeking technologies and protocols that may help deter or diminish the impact of these events at their facilities.

This paper outlines innovative early warning strategies that combine a building's new or existing security and lighting systems to function as a notification resource during an active assailant event or during environmental emergencies such as fires or tornados. The goal of this document is to identify the ways in which security and lighting control systems may be combined into one cohesive platform for detecting and identifying various types of threats and communicating their locations.

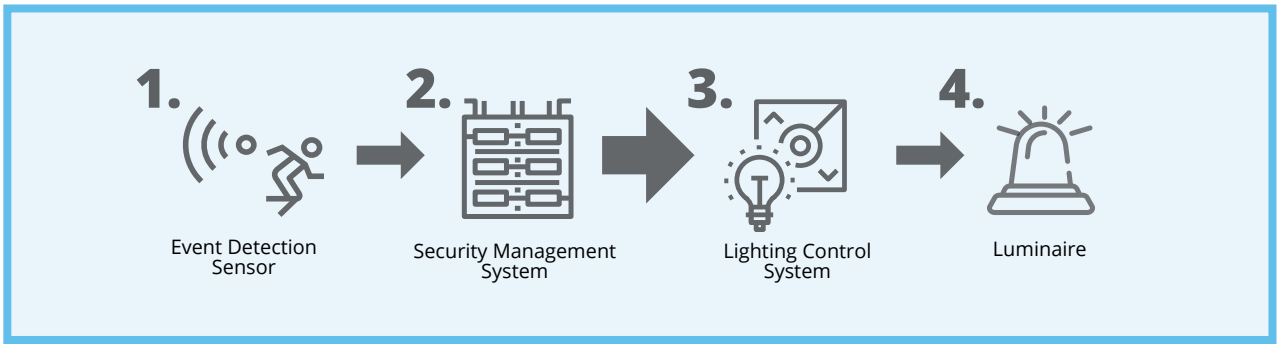
Depending on the type of emergency the platform also may communicate probable areas of safety, means of egress information, as well as other helpful directives such as identifying the location of medical kits.

While every facility will have its own unique needs and characteristics that will drive the overall design, the information that follows provides a high-level overview of the key components of this proposed strategy and how it could be implemented. Lighting control sequences are provided in two separate sections – one for active assailant events and the other for environmental emergencies.

An opportunity to apply this process to a case study project is offered at the end of the paper.

SECURITY AND LIGHTING SYSTEMS INTEGRATION

For a lighting system to react to security events on a real-time basis and produce predetermined lighting conditions, an integration chain of four basic elements is required:



Event detection sensors

The first element of this integration chain involves a "trigger event" to start the response procedures necessary to initiate the event notification process. Several sensors or devices can serve as the event trigger including, but not limited to, duress buttons/pull stations, gunshot detection, emergency assistance stations, video analytic systems, or manual activation by security staff.

These devices and others available in the security marketplace are all designed to help with early mass notification and identifying active assailant events. There are different options and configurations in the market that can be customized for a particular location and budget. Following are explanations of several of the possible detection systems that can be considered and categorized by technology type. For the purpose of this paper, a gun threat/gunshot detection sensor will be assumed to be the event trigger device for an active assalilant event. For an environmental emergency the trigger device may be a fire alarm or a human trigger; confirmation of the trigger by a staff member may be advisable. The system also could be reset in the event of an all-clear or false alarm.

Gunshot detection sensors: This class of detector utilizes a combination of sensors that are calibrated to detect certain characteristics of a gunshot such as sound waveform, percussion signature, acoustic intensity, infrared muzzle flash, etc. These devices are typically deployed at strategic locations (similarly to smoke detector units) in zones throughout a facility based on the floor layout, entry locations, and detection points. Should an assailant discharge their weapon, the gunshot sensor(s) in the zone will be activated and will signal that a security event has occurred in that location. This alarm signal is transmitted (wirelessly or hard-wired) to an alarm-monitoring application such as a security management system (SMS) to process the information and determine the appropriate response protocol.

Audio analytic gunshot detection: This technology uses an audio microphone and an audio analytic application to process sounds and determine if they meet the characteristics of a gunshot event. The audio analytic application can be loaded onto the camera and run using the spare processing capacity of an existing high-quality surveillance camera's on-board processor. This technological approach allows the audio microphone to be plugged into the "AUDIO IN" jack of the camera to capture audio signals and assess them to determine if they represent a security threat. In addition to detecting gunshot events, these analytic algorithms can be processed "at the edge" – i.e., the camera processor runs the analytic like a smartphone app – to identify other events such as aggressive speech, breaking glass, or car alarm activation. Leveraging existing camera installations and their spare processing capacity reduces deployment costs by eliminating the need for additional infrastructure (power/data) or dedicated analytic head-end servers.

Video analytic weapon detection: One of the newest innovations coming to market is a video analytic product that can analyze video data from an existing surveillance system to identify exposed weapons such as hand guns, long guns, or knives by comparing their video signature to that of over 900 learned weapon profiles. This type of detection can allow for the identification of a threat before a single shot is fired or even before an armed individual can enter the building. These AI-based algorithms also can analyze the body movements or posture of a perpetrator to trigger an alarm response based on aggressive or threatening behavior.

Security Management System (SMS)

An SMS is a software application that monitors security field devices and sensors, such as those listed previously, and communicates detected incidents to security personnel. It assists in activating the proper response actions based on established protocols and records a history of incidents for on-site review or off-site forensic analysis.

Once the SMS processes the alarm event, it performs two important functions. First, it communicates the event to security staff through a graphic user interface (GUI) to allow personnel to acknowledge, assess, and respond to identified threats. Secondly, it automatically executes a series of pre-programmed response instructions through the use of relay outputs or through a series of command codes to communicate with other control systems (e.g., lighting control systems).

Once a monitoring sensor detects a "trigger event," it will signal the SMS to pull up all camera views in proximity of the alarm event to allow security personnel to evaluate the alarm event to confirm that it is an actual threat and not simply a false alarm. The SMS will also automatically display a floor plan of the facility with flashing alarm symbols indicating the location of the alarm. Customized control icons/buttons can be placed on these floor plans to enable personnel to initiate commands such as "ALARM RESET," "MANUAL ACTIVATION," etc.

Once an interface between the SMS and the lighting control system is established, the SMS will be able to activate the desired lighting sequences to assist in the event response and evacuation process.

The interface between the SMS and the lighting control system is what makes this solution novel and unique. This seamless integration facilitates visual cues for guidance and defines the area of hostility for building occupants and first responders.

CONTROL SEQUENCES AND LUMINAIRES FOR ACTIVE ASSAILANT EVENTS

Once the security system or staff has confirmed that an active assailant event is taking place in the building and the lighting control system has been triggered, one of several lighting control sequences shall be initiated. The intent of each of these sequences is to visually notify occupants of the threat, provide direction to hide or exit, and further help visualize the means of egress to primary and secondary exit points, as well as the location of medical kits. These notifications may or may not be coordinated with an audio notification.

Three tiers of luminaire and associated lighting control sequences have been designed to meet a wide range of available funding while maintaining the same intent. These tiers are presented below as "Good," "Better," and "Best."

Good: Static white

This tier utilizes static white luminaires that can be controlled via traditional hard-wired relays or wireless individual luminaire controls. Wireless controls offer greater installation flexibility, particularly for existing buildings with hard-to-wire applications.

Better – Option 1: Color indicator luminaires with zone-level control

This tier utilizes relays to control luminaires with one or two additional color LED boards, which will function as a visual indicator during an emergency. A stand-alone indicator luminaire may be utilized in lieu of an integrated source, but this creates a less-clean lighting scheme or architectural solution. Relays do have several disadvantages: they require each similarly controlled lighting group to be wired together, they require more wiring than an individually addressable lighting control system, and they are not easily reconfigurable for future modifications. An alternative control solution is to utilize a multi-channel DALI driver and control system.

Better – Option 2: Static white luminaires with luminaire-level control

Use of this tier depends on the location of the assailant event and consists of static white luminaires with individual luminaire controllability. Individual luminaire controls, via DALI, provide flexibility, allowing each luminaire to be individually addressed, controlled, and easily grouped and reconfigured without re-wiring.

Best: RGB color-changing luminaires with luminaire-level control

This tier consists of color-changing luminaires in conjunction with individual luminaire controllability. Color-changing luminaires will provide white light for normal day-to-day operation yet can change to a color of choice during an active assailant event. Individual luminaire controls, via DALI- or DMX-based controls, provide ultimate flexibility, allowing each luminaire to be individually addressed, controlled, and easily grouped and reconfigured without re-wiring.

Color changing may also be used to convey other non-verbal messages for other types of

emergencies – such as a fire or tornado (see later sections) – as well as messages related to school spirit. These luminaires also may be used to implement circadian rhythm entrainment.

Of all the options, this control system will require the most significant understanding of and comfort with the technology, user education, and institutional knowledge.

Lighting control sequence by space type

The following paragraphs explain the proposed lighting control sequences for various general space types following a security trigger. Click on each photo caption to watch a video of select sequences.

Classrooms and other lockable/ contained spaces during active assailant events

Luminaires in lockable spaces shall provide visual indication in one of the following ways:

Good: Static white. If luminaires are static white only, one or all luminaires shall slowly flash. If only one luminaire is selected, this shall be located at a teaching wall or other previously selected location for maximum visibility. The remaining luminaires shall remain on at a dimmed level for a specified time (10 to 20 seconds) to allow staff to direct students to move into hiding positions. Following this, luminaires shall go to full off. (See figure 1.)

Better: Color-indicator luminaires with zone-level control. The luminaire, provided with a color indicator light, shall be located at the teaching wall or other previously selected location for maximum visibility. The white shall switch off and indicator shall turn on. The remaining luminaires shall remain on at a dimmed level for a specified time (10 to 20 seconds) to allow staff to direct students to move into hiding positions. Following this, luminaires shall go to full off. (See figure 2.) If linear pendants are implemented in lieu of recessed 2x2 or 2x4s, an additional downlight or another type of luminaire may be provided as an indicator luminaire.

Figure 1 – Center luminaire at teacher wall shall flash slowly.

Figure 2 – Red light at teacher wall for maximum visibility.

Best: Color-changing luminaires with luminaire-level control. Luminaires shall switch from white to red, amber, or other previously selected color. The luminaires shall remain on at a dimmed level for a specified time (10 to 20 seconds) to allow staff to direct students to move into hiding positions. Following this, luminaires shall go to full off. This type of luminaire also has potential circadian benefits but carries higher cost.

Open, non-containable spaces during an active assailant event

Luminaires in all open corridors or similar spaces that are NOT containable shall have one of the following sequences during the event:

Good: Static white. If static-white-only luminaires are provided, at intersections only, luminaires shall flash. If intersections are visible and luminaires are wired individually, these also may be used to create a slow running pattern moving traffic along the means of egress toward primary and secondary exits. (See figure 3.)

Better: Static white luminaires with luminaire-level control. Luminaires along corridors shall create a slow running light pattern moving traffic away from the incident. This is similar to airplane evacuation lights. (See figure 4.)

Best: Color-changing luminaires with luminaire-level control. Luminaires along corridors shall create a slow running light pattern moving traffic along the means of egress toward primary and secondary exits. This is similar to airplane evacuation lights. (See figure 5.)

Figure 3 – Lights flash to move traffic away from incident.

Figure 4: White lights move in chasing pattern away from incident.

Figure 5 – Running lights move traffic away from incident.

Control options to indicate location of wall-hung medical kits

Better: Color-indicator luminaires with zone-level control. If luminaires have two different color LED indicator lights, the luminaires adjacent to medical kits shall change to red or other specified color. (See illustration at right.) While a red light can be interpreted as a warning to stop, it has been used as an example here since it coincides with the color of medical kits and other safety devices such as fire extinguishers.

Luminaires adjacent to medical kits shall change to red or other specified color.

Best: Color-changing luminaires with luminaire-level control. If luminaires are color changing, they shall change to red or a previously selected color. (See illustration at right.)

CONTROL SEQUENCES AND LUMINAIRES FOR ENVIRONMENTAL EMERGENCIES

Once the security system or staff has confirmed that an environmental emergency event is taking place in the building and the lighting control system has been triggered, one of several lighting control sequences shall be initiated. The intent of each of these sequences is to provide a visual notification to building occupants and first responders. For environmental emergencies, the visual indicators would notify occupants of the threat, provide primary and secondary paths of egress in the case of a fire (and conduct first responders to the fire's starting point), and provide direction to areas of safety in the case of a tornado or other dangerous weather.

Three tiers of luminaire and associated lighting control sequences have been designed to meet a wide range of available funding while maintaining the same intent. These tiers are presented on the next page as "Good," "Better," and "Best."

Good: Static white

This tier utilizes static white luminaires that can be controlled via traditional hard-wired relays or wireless individual luminaire controls. Wireless controls offer greater installation flexibility, particularly for existing buildings with hard-to-wire applications. The luminaires will flash at different rates to indicate the potential adjacency of an emergency incident.

Better: Color indicator luminaires with zone-level control

This tier utilizes relays to control luminaires with one or two additional color LED boards, which will function as a visual indicator during an emergency. A stand-alone indicator luminaire may be utilized in lieu of an integrated source, but this creates a less clean lighting scheme or architectural solution. Relays do have several disadvantages: They require each similarly controlled lighting group to be wired together, they require more wiring than an individually addressable lighting control system, and they are not easily reconfigurable for future modifications. An alternative control solution is to utilize a multi-channel DALI driver and control system.

Best: RGB color-changing luminaires with luminaire-level control

This tier consists of color-changing luminaires in conjunction with individual luminaire controllability. Color-changing luminaires will provide white light for normal day-to-day operation yet can change to a color of choice during an emergency incident. Individual luminaire controls, via DALI- or DMX-based controls, provide ultimate flexibility, allowing each luminaire to be individually addressed, controlled, and easily grouped and reconfigured without re-wiring.

Color changing may also be used to convey non-verbal messages regarding the type of emergency event or could be related to other non-emergency messaging such as school spirit. These luminaires may also be used to implement circadian rhythm entrainment.

Of all the options, this control system will require the most significant understanding of and comfort with the technology, user education, and institutional knowledge.

Lighting control sequence by space type

The following paragraphs explain the proposed lighting control sequences for various general space types following an emergency trigger. Click on each photo caption to watch a video of select sequences.

Classrooms or similar spaces

Luminaires in lockable spaces shall provide visual indication in one of the following ways:

Good: Static white. If luminaires are static white only, one or all luminaires shall slowly flash. If only one luminaire is selected, this shall be located at a teaching wall or other previously selected location for maximum visibility. (See figure 6.)

Better: Color-indicator luminaires with zone-level control. The luminaire, provided with a color indicator light, shall be located at the teaching wall or other previously selected location for maximum visibility. The white shall switch off and indicator shall turn on. (See figure 7.) If linear pendants are implemented in lieu of recessed 2x2 or 2x4s, an additional downlight or another type of luminaire may be provided as an indicator luminaire.

Best: Color-changing luminaires with luminaire-level control. Luminaires shall switch from white to a previously selected color to indicate what type of an emergency event is taking place. This type of luminaire also has potential circadian benefits but carries higher cost.

Figure 6 – Center luminaire at teacher wall shall flash slowly.

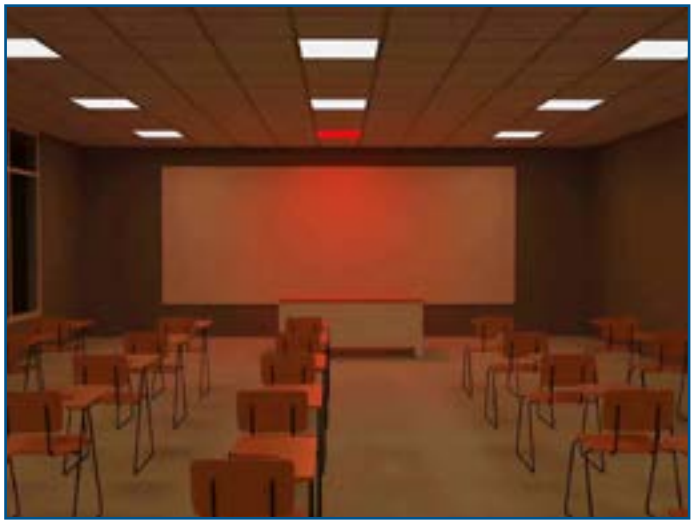


Figure 7: Red light at teacher wall for maximum visibility.

Open spaces in an environmental emergency

Luminaires at intersections and major collection points shall employ one of the following sequences during a non-assailant emergency such as a fire. The intent is to illustrate potential paths of egress toward primary and secondary exit points from the initial emergency. In a tornado or similar emergency these visual directives may move building occupants toward the selected shelter location.

Good: Static white. If static-white-only luminaires are provided, at intersections only, luminaires shall flash. These also may be used to create a slow running pattern moving traffic away from the incident. (See figure 8.)

Better: Color-indicator luminaires with zone-level control. If luminaires have two different color LED indicator lights, the luminaires at the intersections shall change to yellow or other specified color and flash. The selected color shall be discernable from red (for the color blind) and flash. These may be used to create a slow running pattern moving traffic away from the incident. (See figure 9.)

Best: Color-changing luminaires with luminaire-level control. Luminaires along corridors shall create a slow running light pattern moving traffic away from the incident. This is similar to airplane evacuation lights. (See figure 10.)

Figure 8 – Lights flash to move traffic away from incident.

Figure 9 – Yellow lights move traffic away from incident.

Figure 10 – Running lights move traffic away from incident.

Exterior during an environmental emergency

Luminaires at egress doors shall have one of the following sequences during environmental emergency situations:

Good: Static white. If static-white-only is available, luminaires at the egress doors nearest the danger will flash rapidly (but not fast enough to create an epileptic or similar response). Those not adjacent to the incident shall flash slowly. (See figure 11.)

Best: Color-changing luminaires. If color changing is available, luminaires at the egress doors closest to the danger shall change to red (or another selected color) and flash. Those not adjacent to the incident shall change to yellow (or another selected color) and flash. (See figure 12.)

Figure 11– White lights flash at doors nearest the danger.

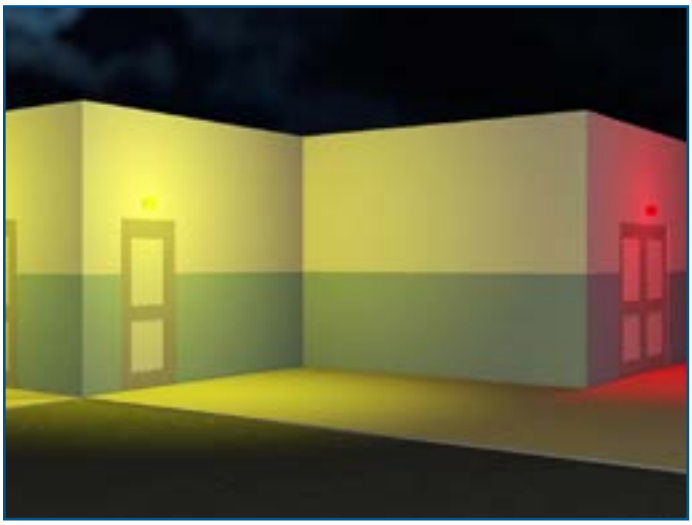


Figure 12 – Red lights flash at door nearest the danger; yellow lights flash at doors not adjacent to danger.

FINANCIAL IMPLICATIONS FOR LUMINAIRES AND CONTROLS

Financial implications will vary pending selected luminaires, options, and what it is being compared against. For continuity's sake, the cost increases below should be considered an order of magnitude and are in comparison to a baseline of code minimum IECC 2015 with an electrical contractor.

Good: Static white. There would be no increase for the luminaire cost and only a moderate increase of approximately 5 percent to 8 percent for the additional relays and associated labor.

Better, Option 1: Color indicator luminaires with zone-level control. There will be an increased cost to provide a secondary LED board and an additional relay. The quantity of luminaires

will not be significant, but for each luminaire that has the additional LED board, expect a 10 percent to 15 percent cost increase.

Better, Option 2: Static white luminaires with luminaire-level control. Moving from a static-white 0-10V dimming relay system to a DALI control system may include a cost increase of 20 percent, but the labor savings for a contractor familiar with implementing a DALI system could negate the increase, making the controls portion cost neutral. (This consideration also applies to the following "Best" option.)

Best: Color-changing luminaires with luminaire-level control. RGBW color-changing 2x2s and 2x4s are, as of early 2020, a significant three to four times the cost of a static-white 0-10v comparable luminaire. RGBW color-changing exterior luminaires may be 30 percent to 50 percent above static-white 0-10V dimming luminaires. Color-changing luminaires are commonly less efficacious than static white luminaires. They may require greater output or additional luminaire quantity, which may increase the cost of energy and/or the initial luminaire and controls cost.

Employing the "good" option in classrooms with either a DALI or a relay control solution, while maintaining color changing in corridors and at the exterior, may provide a more cost-effective alternative to either of the "best" options while still providing the benefits of the wayfinding techniques.

APPLYING THE STRATEGY

Having identified how security and lighting systems may be used in tandem as an early warning strategy during active assailant and other emergency events – communicating the location of the incident, areas of safety, and egress information – it's now time to put this innovative design into the real world.

With that in mind, IMEG is currently seeking partners to implement this proposed concept. Architects or facilities managers with an upcoming educational renovation or new project who are interested in participating in a case study – or who are simply interested in learning more about this approach – are encouraged to contact one of our designers listed at right.

Once we have a project designed and in operation, we'll provide a case study and follow-up report for others who might want to adopt this process. We're confident that our first project will validate the efficacy of these innovative design and technology solutions – and provide an opportunity to improve the safety of our schools and other public and private buildings.

Special thanks to controls specialist Kyle Hiskey for his input on lighting controls, and to Brijesh Panchal of IMEG's virtual design team for creating the lighting animations.

Learn more

To learn more about this new strategy or to inquire about participating in a case study, contact IMEG Lighting Team Leader Shanna Olson, Security Team Project Executive Charles LeBlanc, or Security Assessment Consultant Ryan Searles.

Shanna Olson, LC, MIES,
Architectural Lighting Leader
P: 312.931.3712
M: 414. 530.0847
E: Shanna.L.Olson@imegcorp.com

Charles LeBlanc, PE, CPP
Security Team Project Executive
P: 512.581.4832
E: Charles.G.LeBlanc@imegcorp.com

Ryan Searles, CPD
Security Assessment Consultant
P: 210.570.7894
E: Ryan.T.Searles@imegcorp.com