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Taking a Look at Photoluminescent Systems

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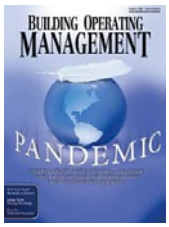

Photoluminescent Technology: Reliable Emergency Lighting in Buildings

Photoluminescent signs and markings glow in the dark, without electricity, to provide a reliable path to exits.

By Lynn Proctor Windle

When the electricity goes out and a building must be evacuated, photoluminescent technology could be the guiding light that leads tenants to safety.

Used for years in passenger aircraft, marine and other transportation applications, photoluminescent technology has moved into the facility arena in the past few years.

Powered only by ambient light, photoluminescent safety signs and path markers glow in the dark similar to children's novelty decals found at any craft store but at a much higher level.

"The purpose of photoluminescent technology is not the illumination of a space," says Jim Amy, senior consultant with Rolf Jensen & Associates. "The purpose is to provide definition of a space so people can orient themselves.

Photoluminescent material marks the leading edge of the steps, it marks the landing, and it marks the handrails.

Your mind kind of fills in the blanks so you can orient yourself, it's like cutting off the bottom of a word. You can't see all of it, but you know what's supposed to be there."

Photoluminescent technology offers advantages over electrically wired exit signs and emergency lighting. One is reliability. Because the glow is a chemical reaction, an adequately charged sign will not fail.

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"It is 100 percent reliable," Amy says. "You can't stop it from performing if it is charged. And it is being charged by lighting that would normally be on anyway. You're not depending on electrically powered systems during an emergency, and you're not depending on a charged battery."

It also saves energy. Charged by existing light, photoluminescent technology is the first Energy Star program with zero energy consumption, says Al Carlson, chairman of the International Photoluminescent Safety Product Council and vice president of Jessup Manufacturing.

New York City Code

Its high reliability factor is the main reason New York City has established a new city ordinance requiring all buildings over 75 feet tall to install photoluminescent safety systems.

Local Law 26 of 2004, passed last fall, requires that photoluminescent signs be installed on doors leading to exits and photoluminescent markings be installed in exit stairs, says Michael Rzeznik, manager of Schirmer Engineering's New York office.

Rzeznik says the changes were the result of recommendations by the city's World Trade Center Building Code Task Force. Among other things, the task force reviewed operating requirements and determined what modifications were needed in new and existing buildings to ensure public safety during extreme events. The recommendation for photoluminescent technology stemmed in part from failure of emergency battery-powered backup lighting during the first bombing of the World Trade Center in 1993.

The new law says that photoluminescent systems must be in place by July 2006. The measure applies to all high-rise buildings regardless of when they were built, Rzeznik says.

Regulations that will implement the new law are currently being developed, says Geoffrey Peckham, president of Jalite USA and a member of the task force looking into implementation standards. Among the issues involved are the configuration of photoluminescent components — where they should appear and what they should look like — and the physical properties of the photoluminescent materials.

Though photoluminescent safety markings are similar in concept to glow-in-the-dark decals, experts say there is a significant performance difference between commercial-grade and novelty-grade material.

Commercial-grade phosphorus holds energy for hours, though a majority is given off in the first 10 minutes. "The luminance may decrease, but it does so as your eyes are adapting to the darkness, compensating for the dimming of the sign in the first 40 or so minutes," Amy says.

Strontium oxide aluminates, a pigment introduced in 1995 has vastly improved product quality. The pigment can be contained in materials like ceramic, plastic, tape and even paint. The strength of the material's charge depends on three things: the type of available light, the intensity of the light, and how long the light is on, Amy says.

Fluorescent and halogen lights charge the material better than incandescent light. Sunlight charges the material well but causes deterioration over time.

Photoluminescent markers should be placed near or on the floor. Because smoke rises, positioning the markers close to or on the floor allows occupants to find their way even if they must exit on hands and knees. On the floor, the exit path should be illuminated with a continuous piece of material, says Amy. On the wall, it should be continuous except as the exit path is interrupted by doors.

‘This stuff glows’

The amount of material used depends on how much available light is present and how much afterglow is expected. If the passageway is 2 meters (6.5 feet) or more wide, the material should be placed on both walls.

A study by the Institute for Research in Construction, part of Canada’s National Research Council, showed that occupants who were not familiar with stairwell conditions could evacuate a stairwell marked by photoluminescent way finding systems as quickly as counterparts could in a fully lighted stairwell.

According to the study, “Effectiveness of a Photoluminescent Way guidance System,” occupants are comfortable with photoluminescent material (PLM) signs and a way guidance system in stairwells without any other illumination source. “The majority of the occupants who participated in the experiment encountered the PLM signs and way guidance system for the first time,” the study says. “Exclamations of people who first opened the door to Stairwell C were recorded on the videotapes; some said, ‘Gee, it is dark in here,’ others, ‘Wow, this stuff glows.’ On two occasions, a brief hesitation was observed before the person entered the stairwell, but nobody refused to leave and most people just followed the evacuation flow. These observations are important since this material is fairly unknown to most North Americans.”

Photoluminescent systems must be steadily lighted to be effective. “They don’t belong in a space not normally lighted or in some spaces controlled by motion-activated lighting sensors,” Amy says.

When it comes to photoluminescent systems, it’s important to distinguish between unlighted space and dimly lit space. While the technology is ideal for places such as hospitals and commercial office spaces, it also can be used in movie theaters and stadiums. Markers are charged enough when the lights are on so that they still glow but are not intrusive.

Role of photoluminescence

New York isn’t the only place that has looked into the issue of mandating photoluminescent markings and signs in high rises. In New Jersey, for example, state legislators are considering a change in the state building code to require photoluminescent systems in all high rises, according to Amy. He says that the idea has also come up in Chicago.

Those developments raise the question of whether photoluminescent systems should be used in all high-rise buildings. Daniel O’Connor, Schirmer Engineering’s vice president of engineering, doesn’t go that far. He says the usefulness of photoluminescent technology depends on the occupancy and life-safety features in a building.

“Current codes address the concerns for reliable lighting by requiring emergency lighting provisions,” O’Connor says. These codes often require many other safety features — sprinklers, smoke detection, smoke exhaust and emergency power — to provide a high degree of assurance that the spread of fire and smoke are limited, that people are warned of an emergency, and that egress routes are reliably lighted. “Photoluminescent technology may play a role for some buildings that lack some of these important features,” he says.

O’Connor doesn’t believe photoluminescent systems should be required in new buildings as a backup to traditional emergency lighting. Rather, he says, photoluminescent systems should be evaluated as an alternative to electrically powered emergency lighting.

In the past, photoluminescent technology was allowed only as a backup to electrically powered emergency lighting, Amy says. But he says he believes photoluminescent technology will increasingly be approved as an alternative to electric systems. “It has been accepted in some places, and I think it will continue to be accepted.”

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But Amy sees benefits to photoluminescent systems being used in tandem with electrically powered systems. “Even in a fully lighted building, it reinforces the right path,” he says. “I think it can be helpful.”

In any evaluation of photoluminescent technology, O’Connor says, both the benefits and the costs of those systems must be weighed, and he points out that the photoluminescent material itself accounts for only part of the overall installation cost. Aesthetic considerations may lead to interior finish modifications and other changes that could cost more than the material itself.

Carlson expects interior designers to become more creative with the technology as it becomes more widespread.

The results of the Canadian study demonstrated that facility executives should educate occupants on evacuation procedures. That education should include photoluminescent systems. If the lights are out, occupants will see the glowing markers and understand what they are.

“It’s very clear,” says Amy. “But if there is lighting and the occupants don’t know what pathway marking is, they may not notice it. They may not identify it as a help to finding their way out.”

Lynn Proctor Windle, a contributing editor to Building Operating Management, *is a freelance writer who has written extensively about real estate.*

What to do before the alarm goes off

When emergency alarms sound, it is critical that building occupants know how to respond.

“The first thing that key management needs to do is be upfront with the development of plans so that occupants know that there are different types of evacuations,” says Mark Hankewycz, senior manager for Gage Babcock’s security services. Not every evacuation alarm is a call to leave the building. Some events, like severe storms, require evacuation to a shelter within the building. When the alarm goes off, occupants should know from its sound and cadence what type of evacuation is required.

Next, they should know where they’re going. If the alarm calls for occupants to leave the building, they must know their egress routes and where to meet once they’re outside.

Occupants should have this information prior to any emergency, says Jon Evenson, senior consultant, Sako & Associates. He advises facility executives to develop handouts that include information like floor maps, directions on what to do, and the meanings of warning signs and sounds. “We don’t want occupants to hesitate or panic in an emergency,” he says.

When there is an emergency, occupants need to know where to turn for immediate information and directions. Each floor should have a floor warden and an alternate, someone trained in various emergency scenarios. Occupants should understand that floor wardens are in communication with building management. Everyone should be aware of who these people are and that occupants must follow their directions, Hankewycz says.

Occupants also should know to listen for the building’s intercom system. If necessary, the fire department will tap into this system to address occupants directly.

Evacuation plans should be as simple and direct as possible. The ultimate goal is for building occupants to understand their role in an evacuation and to take that role seriously. “We’re not looking for anyone to be a hero,” Evenson says. “Building occupants must know who to get information from and how to get out.”

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Safety & Security
Taking a Look at Photoluminescent Systems

Code changes, new laws and better technology have accelerated the adoption of photoluminescent systems.

By James Piper Email the BOM editors

Photoluminescent emergency marking systems have been used for years on planes, trains and ships to assist evacuations, particularly when power is out. Today, the systems are being adopted more widely by facilities to help guide occupants in emergencies when there is little or no light.

Photoluminescent marking systems are not intended to illuminate a space or an egress path. Rather, they glow in the dark to define a space or path so occupants can orient themselves and identify a safe route that avoids all obstacles.

The components require no electricity since they absorb energy from ambient light and re-emit it when the light is out. The performance of a photoluminescent component is measured primarily by brightness and the amount of time it produces light. Performance in an application depends on several factors, including the pigment concentration, the intensity of light used to charge the pigment, how long the pigment is charged and the type of light used to charge the pigment. Fully charged, most pigments produce light at least eight hours, with the light level slowly decreasing. The first 90 minutes is the most critical time in a building evacuation.

Photoluminescent signs and markers are fully automatic in operation and require little maintenance. They require no electricity, other than to power the ambient light sources used to recharge them. They do not deteriorate from use and are non-toxic and non-radioactive.

The aesthetic impact of photoluminescent markings should be carefully considered.

In December of 2000, a change was made to the NFPA 101 Life Safety Code that introduced criteria for using photoluminescent exit signs mounted above doors. The change specifically allowed use in locations where the sign was exposed to a minimum light level during all times the building was occupied.

This code change was critical in opening the door to the broader use of photoluminescent signs and materials in buildings. For the first time, building owners had the option of using photoluminescent exit signs instead of electric signs. Some owners now use photoluminescent informational signs even when there is no requirement for them.

In July of 2001, Underwriters Laboratories published UL Standard 924 Supplement, Photoluminescent Exit Signs. This standard set performance, durability and legibility requirements any photoluminescent exit sign must meet.

The real push for photoluminescent technology has come from New York City. One of the recommendations of the city's World Trade Centre Code Task Force was to require installation of photoluminescent signs on doors leading to exits and markings in all exit stairs. Their recommendation was based in part on failure of the emergency generator powering the emergency lighting circuit following the 1993 bombing of the World Trade Centre.

A New Standard

As a result of the findings of the task force, New York City passed Local Law 26 in 2004. The law requires installation of photoluminescent emergency markings in any office building more than 75 feet in height, regardless of age. Part of Local Law 26 establishes the technical standard, RS 6-1, for installation of the photoluminescent signs and markings to be in compliance with the law. The standard identifies the minimum requirements for low-level photoluminescent markings to aiding build evacuations. The standard requires photoluminescent markings on:

- All exit doors
- All doors that lead to corridors that serve as exit passageways
- The entire horizontal leading edge or side markings of all steps
- The entire leading edge of all landings
- The entire length of all handrails (in new buildings)
- The entire length of all building egress paths
- Edge markings for any obstacle that projects more than four inches into an egress path
- Direction signs that point towards the means of egress.

In addition, “not an exit” signs must be posted over dead ends in a building.

Similar legislation is now under consideration in other jurisdictions, including New Jersey and Chicago. Pathway marking was also required in California following the MGM Grand fire in Las Vegas in 1985. Also, NFPA 101 required pathway marking in special amusement buildings after a fire at an amusement park in New Jersey in 1984.

Answering Questions

Despite the code changes in New York, some have raised questions about whether the products will work as they are supposed to.

Will they be bright enough to guide occupants out of a dark building? Occupants moving from a fully lit area to one where the only illumination is provided by photoluminescent materials may require a few seconds to acclimate to the new light levels. Will that delay evacuation? Perhaps the most significant questions involve the fact that light output steadily declines as stored energy is emitted. This concern is addressed by testing the luminance of the systems at the end of the emergency period, 90 minutes in the case of exit signs. If the luminance of signs and marking is satisfactory at the end of the emergency period, they will be even more visible earlier in the emergency.

Photoluminescent performance has been examined in several studies. Interviews with people evacuated during building fires showed evacuations would be safer and quicker if more egress guidance information was available. Emergency lights and exit signs offered the best solution but did not always perform as expected in emergencies.

Researchers in the United Kingdom performed a series of tests where evacuation rates were timed under a wide range of conditions. They found that evacuation times for areas with photoluminescent systems were comparable to those with conventional emergency lighting systems. Other researchers who examined evacuation times under dense smoke conditions found that photoluminescent systems actually improved evacuation times.

While the materials are low or no maintenance, several issues must be considered for systems to function properly. To be effective, the material must be continually illuminated at a level sufficient to fully charge the pigments. Light levels must be measured prior to installation to ensure that they meet the requirements of the component manufacturer. It is also important to consider what happens if the lights are automatically switched off after hours. Facility executives should determine how long it takes pigments to charge fully when lights are turned on the next day and should consider what will happen if an emergency occurs during that time.

Environmental conditions must also be considered. Although pigments do not deteriorate with time as long as they are not exposed to direct sunlight, dust and dirt on the surface of the sign or marking will affect both the rate of absorption and the level of light released. So while the materials may require no maintenance, regular cleaning may be required to keep them functioning properly.

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Photoluminescent Product Choices

Although photoluminescent materials are available in a wide range of formats, two are most common: peel-and-stick components and rigid signs and markers. Peel-and-stick materials can be applied to concrete and wood floors, wallboard, equipment and furnishings. They are commonly used to mark a path of egress and to identify obstacles within that path. There have been reports of adhesion issues in some peel-and-stick installations in New York City.

Rigid signs and markers are typically mounted on walls, doors and building columns. They include direction signs that point towards exit doors and emergency evacuation areas and floor plans with evacuation routes. They can also be used to identify the location of emergency equipment — such as fire extinguishers, fire hoses and communication equipment — and to mark dangerous areas.

To define evacuation routes, facility executives should use continuous wall strips. Photoluminescent tape can also define the edges of equipment and other items that pose a hazard to occupants following the egress routes.

Signs and photoluminescent tape can be used to identify exits and the location of fire extinguishers, fire hoses, alarm pull stations, emergency telephones and first-aid stations. Photoluminescent signs can also label doors that lead to dead ends within the building.

— James Piper, Contributing Editor

Inside Photoluminescent Technology

Today's photoluminescent emergency marking systems use rare earth mineral crystals that absorb and store energy from ambient light. Materials with photoluminescent properties, such as zinc sulphide crystals, have been in widespread use for more than 50 years. Unfortunately, these materials have limited brightness and illumination duration times, restricting their use primarily to toys and novelties.

In 1995, a new photoluminescent material, strontium oxide aluminate, became commercially available. It offered a brightness level that is roughly 10 times greater and lasts 10 times longer than what could be achieved with other photoluminescent materials. Essentially a pigment, it can be contained in a wide range of materials, including ceramics, plastics, tape and paint. It can be charged with light produced by a wide range of sources, including incandescent, fluorescent and halogen lamps. While it can also be charged by sunlight, exposure of the material to direct sunlight will cause performance to deteriorate.

— James Piper, Contributing Editor

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BREAKING NEWS

New High-Rise Code Changes Based on World Trade Centre Investigation

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Safer buildings, especially tall structures that are more resistant to fire and more easily evacuated in emergencies are the goal of the first comprehensive set of building code changes recently approved by the International Code Council (ICC) based on recommendations from the U.S. Department of Commerce's National Institute of Standards and Technology (NIST).

The recommendations are based on the findings of NIST's three-year investigation of the collapses of New York City's World Trade Center (WTC) towers on Sept. 11, 2001. The changes will be incorporated into the 2007 supplement to the ICC's International Building Code (IBC), a model code used as the basis for building regulations promulgated and enforced by U.S. state and local jurisdictions.

The proposals addressed areas such as: increased resistance to building collapse from fire and other incidents; use of sprayed fire-resistive materials, commonly known as fireproofing; performance and redundancy of fire-protection systems, or automatic sprinklers; fuel-oil storage and piping; elevators for use by first responders and evacuating occupants; the number and location of stairwells; and exit-path markings.

The model code changes consistent with the WTC investigation recommendations that now are required by the IBC are:

- An additional exit stairway for buildings more than 420 feet in height.
- Minimum of one fire service access elevator for buildings more than 120 feet tall.
- Increased bond strength for fireproofing.

Field installation requirements for fireproofing to ensure that:

- Installation complies with the manufacturer's instructions;
- The substrates are clean and free of any condition that prevents adhesion;
- Testing is conducted to demonstrate that required adhesion is maintained for primed, painted or encapsulated steel surfaces.
- The finished condition of the installed fireproofing, upon complete drying or curing, does not exhibit cracks, voids, spalls, de-lamination or any exposure of the substrate.

For more information, including a web-based system for tracking the progress toward implementing all of the NIST WTC recommendations, visit http://wtc.nist.gov.

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