FLIGHT SAFETY FOUNDATION
CABIN CREW SAFETY
Vol. 39 No. 1 *For Everyone Concerned With the Safety of Flight* January–February 2004

Photoluminescent Escape-path Marking Alters Few Duties of Flight Attendants

Some airlines require the cabin crew to ensure correct charging with ceiling lights, a process that prepares tracks or strips bordering the aisles to emit a green glow during an emergency evacuation.

FSF Editorial Staff

Approval of photoluminescent types of floor-proximity emergency escape-path marking (FPEEPM) systems in the late 1990s has prompted their installation on more than 4,600 aircraft operated by hundreds of airlines worldwide.[1] "Photoluminescent" means that a chemical compound in the system emits light (glows in the dark) for some time after the separate light source used for "charging" (also called "conditioning") is removed. Photoluminescent escape-path markings do not emit enough light to illuminate the area of an aircraft aisle; rather, the markings provide a visual-guidance system.

Airlines have found that photoluminescent escape-path markings require minimal maintenance and eliminate common failures of electrically powered systems as a source of flight-dispatch delays.

"The requirement for electricity to power [FPEEPM] systems has made them vulnerable to a variety of problems, including battery [failures] and wiring failures, burned-out light bulbs and physical disruption caused by vibration, passenger traffic, galley-cart strikes and hull breakage in accidents," said an October 2003 report by the U.S. General Accounting Office (GAO).[2] "Floor-track marking using photoluminescent materials is currently available but not required for U.S. commercial airliners. According to industry and government officials, such photoluminescent marking systems are also cheaper to install than electric-light systems and require little to no maintenance."

Electrically powered systems typically have a single row of lights along cabin aisles and cross-cabin aisles and battery power for at least 10 minutes in the critical ambient conditions after an emergency landing.[3] The operational duration of a photoluminescent system is measured in hours and technically begins when cabin-ceiling lights are selected OFF or fail; in practice, charging of the system occurs whenever the ON or BRIGHT setting of cabin-ceiling lights has been selected and/or the system is exposed to sunlight reflected by surfaces inside the cabin. (BRIGHT settings typically are used on cabin-lighting switches equipped with a DIM setting or a NIGHT setting.)

All FPEEPM systems are only one component of a complete aircraft emergency-lighting system, which is independent of the main cabin-lighting system and includes illuminated emergency-exit-marking signs and exit-locating signs, emergency sources of general cabin illumination, interior lighting in emergency-exit areas and exterior emergency lighting.

When all sources of light more than 4.0 feet (1.2 meters) above the aisle floor are obscured totally by smoke, escape-path marking provides backup visual guidance in the relatively clear air near the cabin floor to enable emergency evacuation. Passengers are expected to become familiar with the cabin layout under cabin-ceiling lighting before an accident occurs. The escape-path markings then enable them to move — in the dark of night and unassisted — from their seats to the first exit or pair of exits forward or aft of their seats.

The green glow of photoluminescent strips or tracks along both sides of aisles becomes readily visible in darkness. (Lufthansa Technik photos)

After using the escape-path markings to arrive at an exit, passengers must be able to readily identify the exit from other markings and visual features located not more than four feet above the cabin floor, and to proceed immediately to that exit, whether the exit is in the open position or closed position.[4]

Photoluminescent escape-path markings became acceptable after civil aviation authorities in France, Germany, the United Kingdom and the United States were persuaded by prototype testing in the late 1990s (including naive-subject cabin-evacuation demonstrations) that these markings are safe and effective.[5] Passengers guided by photoluminescent markings must be able to "traverse the escape path in the direction of an exit without significant hesitation, delay or apparent confusion."[6]

"While photoluminescent elements may not totally illuminate the cabin floor, the technology has progressed to the point that, with appropriate limitations, some illumination of adjoining cabin furnishings is provided, and, more importantly, visual guidance to allow [passengers] to identify the width and vertical location of the escape path can be provided," the U.S. Federal Aviation Administration said. "Continuous photoluminescent marking strips must be installed at floor level along both sides of the main passenger aisle(s). … The photoluminescent aisle-marking elements must be combined with the more typical battery-powered exit markers and cross-aisle markers (applicable only on multi-aisle airplanes) in making up the total [FPEEPM system], creating a so-called hybrid system."

When first introduced, some photoluminescent systems required the cabin crew to select ceiling lights ON or BRIGHT periodically during night flights. Current-generation systems, however, require charging only for the first flight of the day because of advances in a phosphorescent pigment based on "strontium aluminate activated with rare earth metals," said Nemoto and Co. of Tokyo, Japan, which calls its proprietary pigment LumiNova.[7] Although some formulations of this chemical compound emit blue light or violet light, pigments that emit green light have optimum characteristics for escape-path markings.[8]

Unlike radioactive compounds, which constantly emit light and are strictly regulated, strontium-aluminate pigments alternately absorb energy from light, then emit energy as visible light for an unlimited number of cycles, are *not* radioactive and do not contain hazardous substances, Nemoto said. The manufacturers of photoluminescent FPEEPM systems incorporate the company's pigments into proprietary coatings on materials encapsulated into tracks, sleeves or strips suitable for airliner cabins.

One U.S. airline found that changes for cabin crews were simple to implement in its transition to photoluminescent escape-path marking, which began in 1999.

"The major difference is that we did not have preflight duties associated with the electrically powered system, but we do have to verify that the photoluminescent system is properly charged before takeoff," said Heidi Giles, manager of in-flight regulatory procedures and publications for Southwest Airlines. "From the outset, however, we have tried to make these checks as seamless as possible for our cabin crews. Flight attendants check that the system is clean and undamaged, like any other component of the cabin, as part of normal preflight procedures. They report anything unusual to the captain. In their passenger safety briefings, they say that signs overhead and lights on the floor lead to exits. Otherwise, the beauty of the photoluminescent system is that it is always there and always on — automatically."[9]

The charging procedure for the airline's Boeing 737-series aircraft — which are operated for approximately 5.5 hours on the longest flights — requires adjusting the fluorescent ceiling lights to the BRIGHT setting for 30 minutes before takeoff on the first flight of the day. Only this first-flight charging has to be monitored by the cabin crew, and no documentation of these charging cycles is required because they are a standard operating procedure, she said.

"The supplemental type certificate [STC] held by Kennco Support Services determines how our photoluminescent system will be installed, maintained and operated," said Prewitt Reaves, manager of avionics engineering for Southwest Airlines. "Under the STC, charging the Guideline system, manufactured by Lufthansa Technik, for 30 minutes is sufficient for an operational duration of 11 hours. Full discharge of the photoluminescent strips can take as long as 72 hours. In a low-visibility situation, passengers will be crawling or walking low to the floor for evacuation. When they get to end of a photoluminescent strip, they are within 40 inches [100 centimeters] of the incandescent EXIT sign."

Minimum-equipment-list (MEL) requirements for the system have become simpler since the system was introduced, Reaves said.

"Our MEL says that any ceiling fluorescent tube can be inoperative as long as the opposite fluorescent tube is operative; no two adjacent fluorescent lights can be inoperative," he said. "If the lighting does not meet this requirement, we must replace the tubes before dispatch. We do not have MEL provisions for any alternate method of charging the photoluminescent strips."

Ceiling lights are not selected OFF during any flight, but when the NIGHT setting is selected by a flight attendant — for the comfort of passengers who want to sleep — the photoluminescent strips help flight attendants avoid contacting any arms or legs protruding into an aisle because they are seen in silhouette against the strips, said Giles.

"When we select the ceiling-light NIGHT setting, the photoluminescent strips are not any more noticeable than other low-level sources of ambient light, and I am not aware of passenger comments about the system," she said. "Flight attendants try to be vigilant to keep anything near aisles from being a tripping hazard, but this does not require special attention to the photoluminescent strips."

The converging parallel lines of photoluminescent escape-path markings provide depth perception as part of visual guidance to exits, said Alexander Muir, sales and marketing director for STG Aerospace, manufacturer of the SafTGlo system in the United Kingdom.[10]

The company's system typically has an operational duration of 16 hours with a 45-minute charge and as long as four hours with a five-minute charge. Various track configurations or sleeve configurations are used on aisles, cross aisles and galley floors, varying in width from 1.4 inches to 1.8 inches (36.0 millimeters to 46.3 millimeters). Most of these sytems use marker inserts with the word EXIT and an arrow, and double-dot symbols where the markings terminate along an aisle at an exit.

A table of charge times and conditions shows what activities can be conducted in the cabin, depending on the flight duration and corresponding charge time, Muir said. The master MEL dispatch deviation for the system says, "The overhead ceiling lighting may contain missing lights not to exceed 10 percent of the total quantity and no two adjacent lamps in the longitudinal direction. No more than two missing lamps may be adjacent to each other in the lateral direction. All missing lamps must be clear of galley, cabinets and life-raft stowage areas, etc." The dispatch operating procedures for the system say, "During initial charging, cabin activity is limited to minor aisle traffic of crew and personnel. Passenger boarding may shadow the system during charging and is not allowed during the required charging time. The cabin aisle must be clear of obstructions, and overhead bin doors [must be] in the closed position for initial charge. … No more than 10 percent of the [photoluminescent] element length shall be heavily stained or obscured. No markings or exit spurs [tracks/sleeves leading from an aisle to an exit] shall be obscured."

The photoluminescent element in a track/sleeve is encapsulated in sealed polycarbonate for protection from spilled liquids and other contaminants. The exterior should be cleaned regularly using mild soap and water. Detergents and other products containing solvents should not be used because they can damage the polycarbonate cover/sleeve, said Muir.

Another system for photoluminescent escape-path marking is a one-piece strip — with or without a protective cover — with adhesive tape on the back, said Christian Lierow, head of the Guideline project team for Lufthansa Technik, Hamburg, Germany.[11] The photoluminescent layer (element) of the strip is protected under transparent polycarbonate. Typically, visual guidance is provided by strips without EXIT/arrow inserts, except when an aircraft has a dead-end section, which requires a strip with arrows that indicate the correct direction to an exit.

"In 2002, we improved our system for very-low-light cabins like the Boeing 747-400," Lierow said. "With our new material, a charging time of 30 minutes, only using cabin lights, is sufficient for a flight in total darkness of 20.5 hours. For one customer in the United States, we have issued a short-departure procedure: 15 minutes charging time and a flight length of 6.5 hours."

Typically, the cabin crew is not required to conduct any specific preflight check of the photoluminescent system, although normal procedures require the aircraft crew to call for replacement of ceiling lights by a maintenance technician

if a cabin appears dark because more than four lamps are inoperative, he said. The company recommends a visual inspection of its system by the airline every three months.

In general, differences exist in cabin crew procedures for photoluminescent FPEEPM systems because of many possible combinations of system capabilities and ceiling-light capabilities. Each airline's specific STCs, MELs and dispatch procedures supersede any general information about photoluminescent systems.♦

Notes

1. The total is only for systems manufactured by STG Aerospace in the United Kingdom and by Lufthansa Technik in Germany.

2. U.S. General Accounting Office. *Aviation Safety: Advancements Being Pursued to Improve Airliner Cabin Occupant Safety and Health.* Report no. GAO-04-33. October 2003.

3. No specific number, spacing or location of light sources is required. U.S. Federal Aviation Administration (FAA) Advisory Circular (AC) 25.812-1A, *Floor Proximity Emergency Escape Path Marking*, says that acceptable methods for cabin-aisle floors, for example, may comprise electroluminescent light strips along the floor or mounted on seats, incandescent light tracks/assemblies along the floor, seat-mounted incandescent light assemblies, seat-mounted electroluminescent lighting strips or remotely activated incandescent floodlights. AC 25.812-2, *Floor Proximity Emergency Escape Path Marking Systems Incorporating Photoluminescent Elements*, said that all systems powered by electricity use batteries.

4. FAA. AC 25.812-1A.

5. McLean, Garnet A.; Chittum, Charles B. *Performance Demonstrations of Zinc Sulfide and Strontium Aluminate Photoluminescent Floor Proximity Escape Path Marking Systems*. Civil Aerospace Medical Institute, FAA. Publication no. DOT/FAA/AM-98/2. February 1998.

6. FAA. AC 25.812-2.

7. Murayama, Yoshihiko. "Super-bright Long-afterglow Phosphorescent Pigment — LumiNova." <www.nemoto.co.jp/column_e.html> Feb. 20, 2002. Murayama is technical adviser of Nemoto and Co., Tokyo, Japan.

8. STG Aerospace. "Floor Proximity Emergency Escape Path Marking (FPEEPM)." <www.stgaerospace.com> Feb. 15, 2004.

9. Giles, Heidi; Reaves, Prewitt. Telephone interview by Rosenkrans, Wayne. Alexandria, Virginia, U.S. Feb. 9, 2004. Flight Safety Foundation, Alexandria, Virginia, U.S.

10. Muir, Alexander. E-mail communication with Rosenkrans, Wayne. Alexandria, Virginia, U.S. Feb. 11, 2004. Flight Safety Foundation, Alexandria, Virginia, U.S.

11. Lierow, Christian. E-mail communication with Rosenkrans, Wayne. Alexandria, Virginia, U.S. Feb. 12, 2004. Flight Safety Foundation, Alexandria, Virginia, U.S.

Cabin Crew Safety

Staff: Roger Rozelle, director of publications; Mark Lacagnina, senior editor; Wayne Rosenkrans, senior editor; Linda Werfelman, senior editor; Rick Darby, associate editor; Karen K. Ehrlich, web and print production coordinator; Ann L. Mullikin, production designer; Susan D. Reed, production specialist; and Patricia Setze, librarian, Jerry Lederer Aviation Safety Library

Subscriptions: One year subscription for six issues includes postage and handling: US$240. Include old and new addresses when requesting address change. • Attention: Ahlam Wahdan, membership services coordinator, Flight Safety Foundation, Suite 300, 601 Madison Street, Alexandria, VA 22314 U.S. • Telephone: +1 (703) 739-6700 • Fax: +1 (703) 739-6708