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Building Egress Using Photoluminescent Markings

by Noureddine Benichou and Guylene Proulx

The use of photoluminescent material systems in buildings is gaining acceptance in North America as a valuable safety feature for users of exits and stairwells in the event of power failure and the loss of emergency lighting. This Update describes the characteristics and installation of photoluminescent markings.

Introduction

Photoluminescent markings can be used to aid in the safe evacuation of buildings in the event of failure of both the power and back-up power for lighting and illuminated exit signs. The National Research Council - Institute for Research in Construction (NRC-IRC) has published **a guide on the installation of photoluminescent material markings in buildings**. The purpose of this Update is to provide a summary of the Guide to inform specifiers about the properties, uses, performance requirements and installation of photoluminescent material (PLM) markings in buildings.

In Canada, PLM markings have been developed primarily for federal office buildings. However, the requirements are applicable to other types of buildings that rely on enclosed exit stairways as means of egress. The markings are in addition to, and not a substitute for, any other signage required under the National Building Code of Canada. All PLM marking installations should be reviewed and approved by the authority having jurisdiction.

PLM Characteristics

Photoluminescent material has the ability to absorb light energy and emit light for a period of time after the excitation light source is no longer active. The material can be recharged by re-exposure to light. PLM markings are not designed to provide enough light to illuminate a dark egress path, but rather to provide luminescent direction signs and to outline the egress path, stairs, handrails, and obstacles, so that occupants can discern these features in dark conditions.

C.D. Howe Building in Ottawa

PLM markings were first used in remote locations such as offshore platforms. They have been installed in office buildings such as the former World Trade Center towers where their usefulness was demonstrated. They were tested in the C.D. Howe Building in Ottawa and are under consideration for other federal buildings. In blackout situations resulting from power failures, fires or other emergencies, PLM markings in the form of paint, plastic strips and signs can aid safe evacuation by guiding and directing people to designated exits or safer locations.

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Design Principles for PLM Exit Path Markings

There are several general principles governing the design and installation of PLM markings. PLM markings should be placed in a continuous and unbroken manner along the escape routes of a building and should be spaced to provide consistent direction.

The NRC Guide specifies where to locate PLM markings: on exit door handles or opening devices, exit door frames, leading edges of steps, landings, handrails, exit signs, and obstacles. Continuous PLM marking should be provided inside each exit stairway. All firefighting and emergency equipment should be labelled with appropriate PLM signs to provide additional visual orientation cues to evacuees and information to firefighters.

The markings should clearly indicate intermediary and final destinations along an escape route and be placed so that a designated route is clear and there is no uncertainty or confusion during evacuation. They should direct evacuees away from dead ends toward designated places of safety.

Every storey of a building should have a floor evacuation plan made with PLM to help with directions and orientation. To avoid confusion, signs that are not intended to assist in safe evacuation (such as public information signs) should not be made of PLM and should be of different size and colour than PLM markings.

PLM markings should be a "safety" colour, which is usually green/yellow (the natural colour of PLM pigments). Signage needs to provide sufficient contrast between the symbols on the sign and the background of the sign to maintain visual characteristics. They should also have the appropriate luminance and contrast with the surrounding environment.

It is important that the activation illumination for energizing and charging PLM is adequate for this task.

Required PLM Properties

PLM materials are required to have a minimum brightness rating (BR) (mcd/m^2) of at least 30.0 at 10 minutes, 7.0 at 60 minutes and 5.0 at 90 minutes. The material needs to meet the washability requirements of ASTM D 4828-1994 (2003), *Standard Test Methods for Practical Washability of Organic Coatings.**

One test specimen of each distinct PLM product material needs to be tested in flaming and non-flaming modes to ensure toxicity does not exceed the limits set out in Bombardier SMP 800-C (Rev. 4, 11/1/2000), *Toxic Gas Generation Test*. The radioactivity of PLM material must not exceed the limits of ASTM D 3648-2004, *Standard Practices for the Measurement of Radioactivity.**

Flame spread testing for PLM material must meet the requirements of ASTM E 162-2002, *Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source*,* or ASTM D 635 2003, *Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.**

The materials need to have sufficient resistance to abrasion. Certain thin films and paints may be sufficient where stairs have alarms and are only used in emergencies. Where occupants use stairs regularly, more-durable products should be specified. The slip resistance of PLM markings should not be less than the slip resistance of the existing surface on which the PLM is to be installed.

All approved PLMs are to be labelled with the model number and indicate testing by an independent laboratory to certify the following: brightness rating; washability; toxicity; radioactivity; flame spread; and activating illumination.

** These standards, while referenced in the NRC-IRC Guide, were all updated in recent years.*

Installation Locations of PLM Markings

The recommended installation locations are based on the findings of a study conducted by NRC-IRC and Public Works and Government Services Canada (PWGSC) as follows:

Exit Doors at Exit Stairway Shafts

Markings are required on:

1. Doors opening to exits or exit passageways to an exit stair shaft;
2. Doors opening to corridors that serve as required exit passageways connecting two vertical exits; and
3. Doors serving as horizontal exits.

Markings are not required for exit at main-entrance doors.

The point of entry or door to exit a stairway shaft should be marked with a PLM exit sign made in safety green, with the standard emergency exit symbol (Figure 1) as indicated in the **2010 National Building Code of Canada** (NBC 3.4.5.1.).

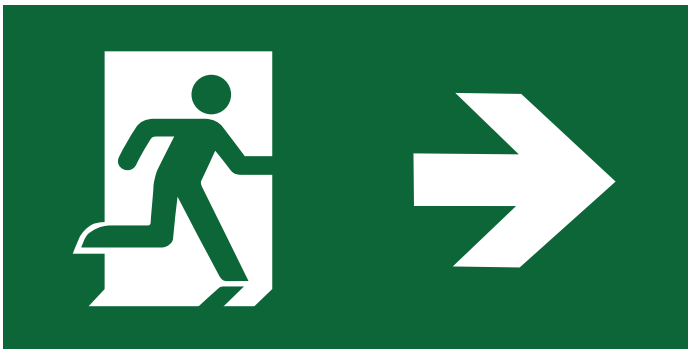

Figure 1. Exit sign

Door handles or opening devices on emergency exit doors should be highlighted with PLM. Doorknobs and latches should be marked by placing a piece of PLM behind the hardware or by applying a strip of PLM directly to push-pads, bars or panic hardware (Figure 2). The entire perimeter of the frame of exit doors should be marked with strips of PLM (Figure 2).

A PLM sign indicating the floor number and stairway name should be mounted permanently on the wall at the latch side of the door to an exit stair shaft.

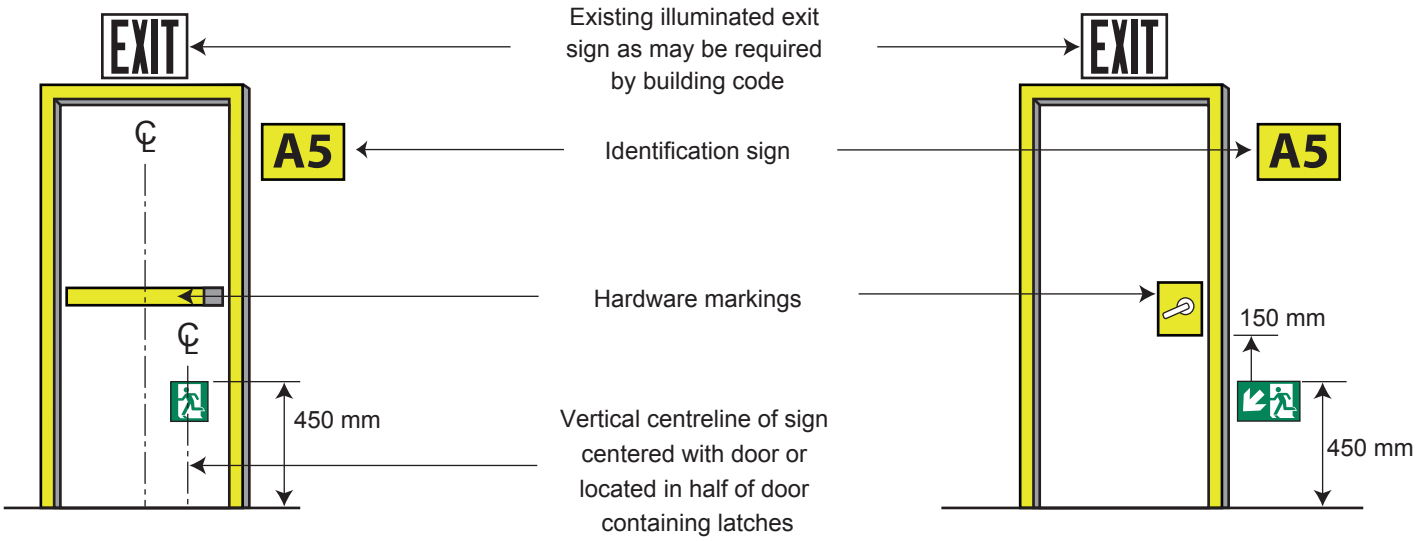

Figure 2. Signs at exit doors: door-mounted (left) and wall-mounted (right)

Exit Stairs

Minimum requirements for exit stairs include markings within vertical exits (e.g., stairway, ramp), horizontal extensions in vertical exits (e.g., extended landing or corridor within a stairway), horizontal exits (e.g., bridge or tunnel between two buildings), supplemental vertical exits (e.g., stairway or ramp from an area of refuge), and exit passageways (e.g., passage leading from a yard or court to an exterior space). Such markings are not required in street level lobbies, exterior stairs, or exterior balconies.

The entire horizontal leading edge of each step should be marked with a solid and continuous strip of PLM. The dimensions, distances and locations should be consistent and uniform throughout the same exit (Figure 3). The strips should extend the full width of each step and must not create tripping or slipping hazards.

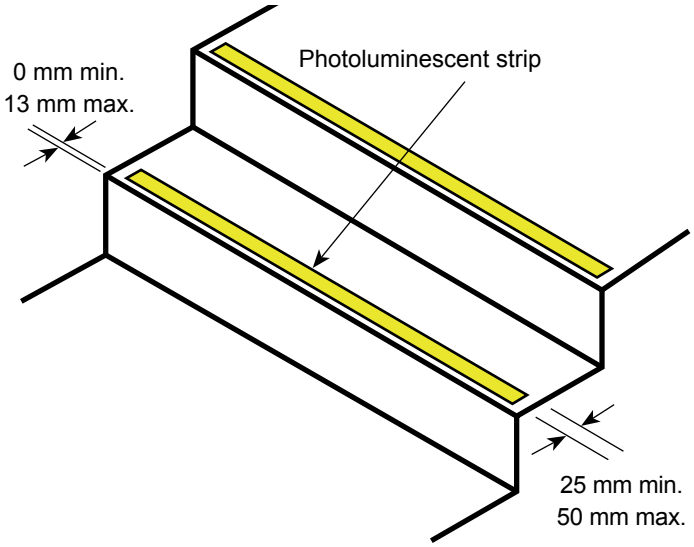

Figure 3. Stair strips

The leading edge of all landings (e.g., the platforms at the top of stairs) should be marked in a consistent and uniform manner throughout a given exit. Leading edge markings should follow the same requirements as for steps in size and location so that they are consistent with the strips on the steps, and extend the full length of the leading edge of the landing (Figure 4).

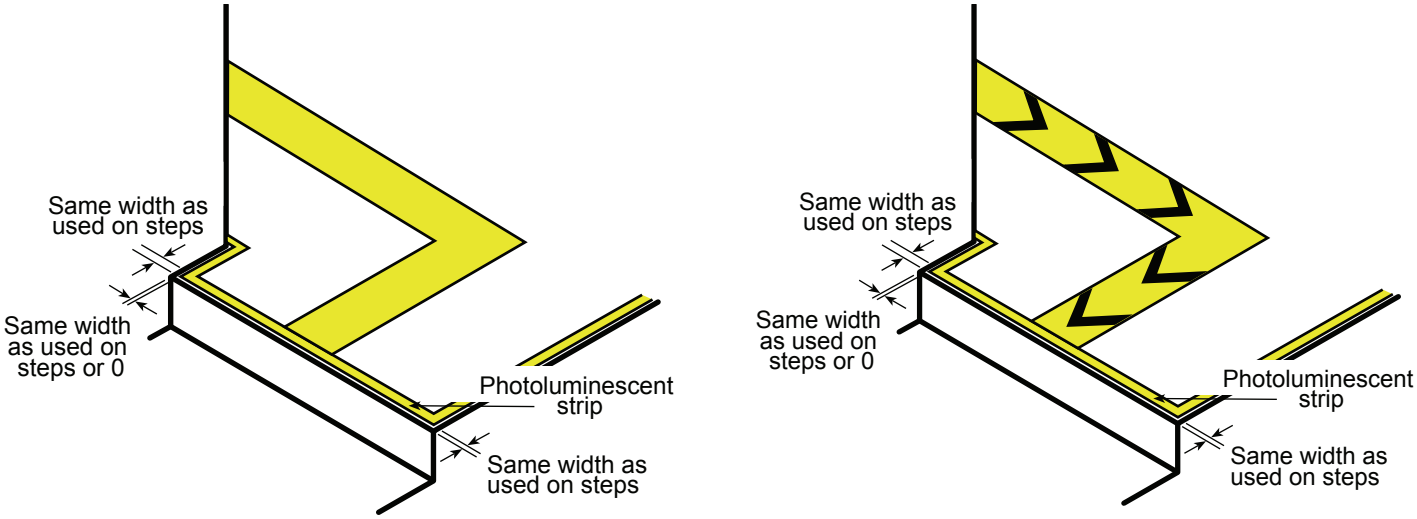

Figure 4. Marking on leading edges of landings

All handrails and handrail extensions should be marked with a solid and continuous strip of PLM. The dimensions, distances and locations should be consistent and uniform throughout the same exit (Figure 5).

Where handrails or handrail extensions bend or turn corners, PLM strips should be as continuous as practicable and no discontinuity should be greater than 100 mm. In existing buildings where handrail material or design makes it difficult to apply PLM on the top surface, a PLM strip at least 90 mm wide may be placed behind a handrail to silhouette it.

Stair landings and other parts of the egress route should be provided with floor perimeter demarcation lines. The continuity of the demarcation lines may be interrupted to accommodate obstructions such as conduits, mouldings, corners or bends, but discontinuities should not exceed 100 mm. The dimensions, distances and locations should be uniform and consistent throughout the same exit. Demarcation lines should be located on the floor, or on the walls/vertical surface, or a combination of the two.

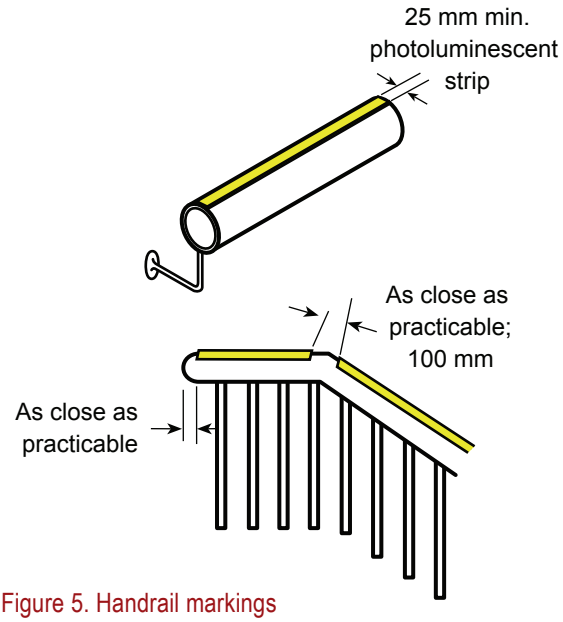

Figure 5. Handrail markings

Landings, mid-landings, passageways or corridors within a stairway should be marked in the centre line with a continuous strip of PLM (Figures 6 and 7). The direction of movement can be indicated with either a black or see-through chevron or arrow 25 mm wide at every metre and every change of direction.

If chevrons are used, the same pattern should be used on all the landings in an exit. Alternatively, the landing marking should be a solid strip of PLM throughout the installation.

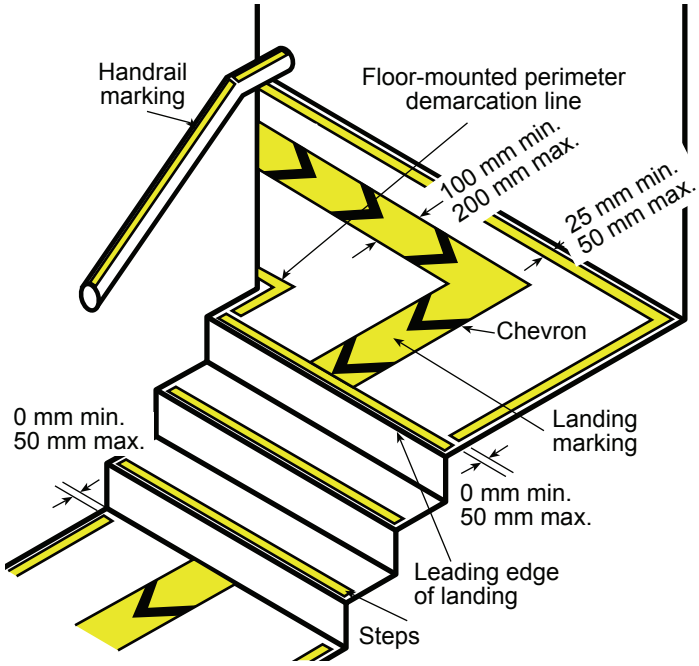

Figure 6. Pathway marking line: floor-mounted option

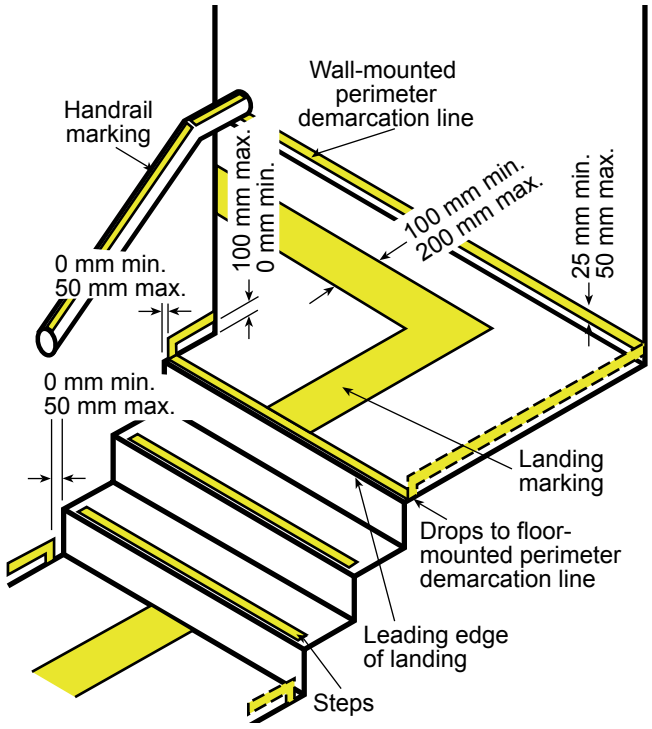

Figure 7. Pathway marking line: wall-mounted option

Obstacles (e.g., standpipes, hose cabinets, wall projections, and restricted height areas) at or below 1980 mm in height and projecting more than 100 mm into an egress path should be outlined with PLM markings (Figure 8).

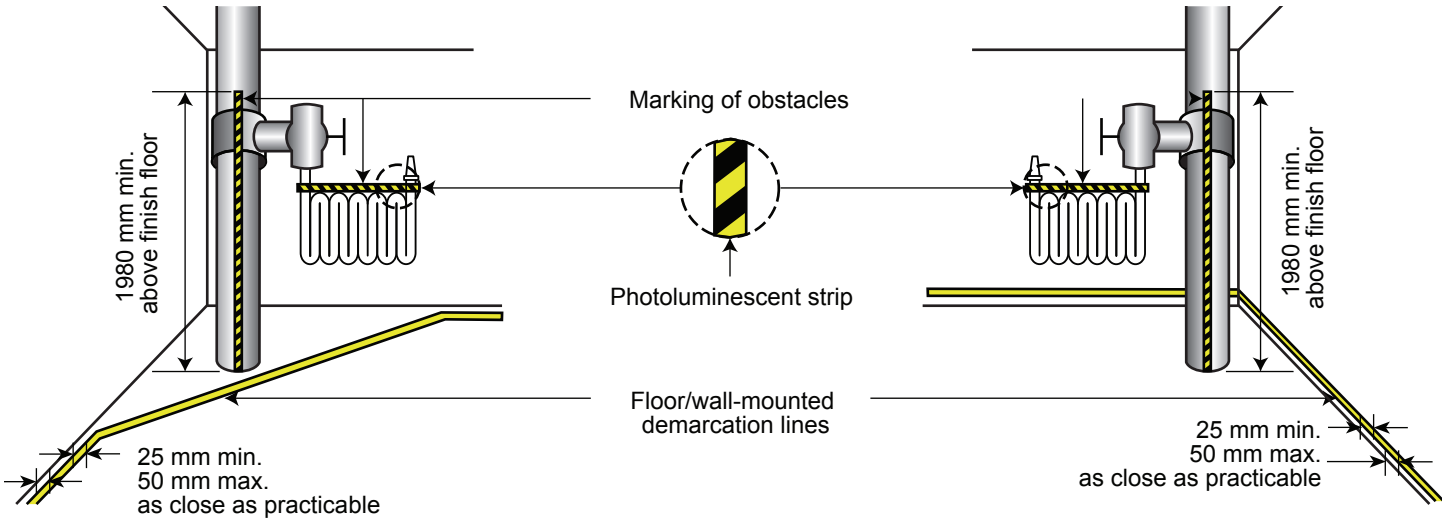

Figure 8. Obstacles and pathway marking lines

At a final exit door (a door leading directly to the exterior or a street level lobby), a door-mounted sign should contain text such as *Final Exit, Exit through Lobby, Exit to Street, Exit to Chambers Street, etc.* (Figure 9).

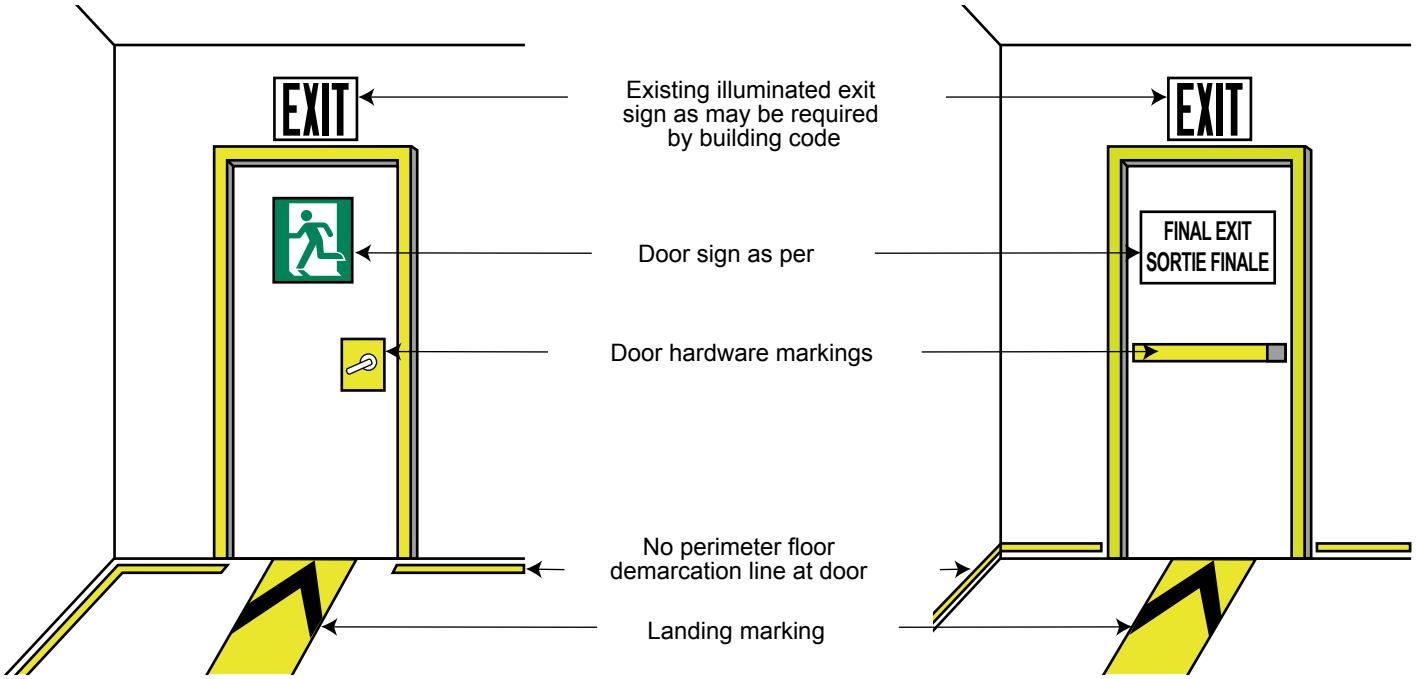

Figure 9. Intermediate and final exits

Additional Markings

PLM signs should be placed adjacent to an exit door inside the stairway to identify the floor number and the stairway number and/or name. PLM directional signs should be provided in safety green, including the word **TRANSFER LEVEL** or **CROSSOVER FLOOR**, and should be posted next to the exit door wherever re-entry to a floor or transfer to another means of egress is permitted.

Wherever direction is not clear, additional signage should be provided. **NOT AN EXIT** PLM signs should be placed on doors along the egress path that lead to dead ends (mechanical rooms, storage closets, etc.). In buildings where roof access is not possible for building occupants, PLM signs including the words **NO ROOF ACCESS** should be placed on mid-landing walls every three floors and on each of the five top floors of a stairway.

Maintenance of PLM Markings

PLM markings are usually affixed with adhesives for permanent installation. Building owners and managers should keep the required photoluminescent signs and markings in good repair. An inspection should be conducted at least every 12 months to identify any deficiencies. PLM markings should be kept clean. Signs and markings that are deteriorated, discoloured, damaged, loose, or that show signs of wear or missing labels should be scheduled for immediate replacement or repair. Illuminating sources should be checked for functionality.

Implications for Property Managers

Where PLM markings are required in federal buildings, the NRC-IRC Guide provides useful information for owners and managers of these buildings. PLM markings may also be employed by owners of other types of buildings where it is desired to provide exit security that exceeds minimum code requirements.

Additional specifications and installation details can be found in the publication **Guide for the Installation of Photoluminescent Exit Stairway Markings in Buildings**.

Dr. Noureddine Benichou is a senior research officer in the Fire Research program of the NRC Institute for Research in Construction.

The late Dr. Guylene Proulx was a senior research officer in the same program.

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