Stairwells and corridors in most residential buildings are not occupied continuously, yet they require continuous illumination. (See the December 2008 and March 2009 Tech Tips). This provides an energy savings opportunity that can be implemented by leaving some lamps on continuously, while controlling others with occupancy sensors. Occupancy sensors can be mounted on walls or ceilings and wired to control one or more fixtures. Bi-level fixtures, each of which contains a built-in occupancy sensor, are another way to maintain continuous illumination while saving energy during unoccupied periods.

Technology

Occupancy sensors rely on different technologies to detect the presence of occupants.

Passive Infrared Sensors

Passive infrared sensors respond to sudden changes in background heat energy, particularly at wavelengths emitted by humans. A PIR occupancy sensor requires direct line of sight to detect the presence of an occupant; it cannot "see" around corners. With increasing distance, larger movements are required to trigger the sensor.

PIR sensors are less expensive than ultrasonic occupancy sensors. They are well suited for use in corridors that are simple rectangles in plan view; in such corridors, a single PIR sensor can be used to control several fixtures. Multiple PIR sensors may be needed in long corridors or corridors that have complex shapes.

To avoid false triggers, PIR sensors should not be mounted within 8 feet of supply diffusers or on sources of vibration.

Ultrasonic Occupancy Sensors

Ultrasonic occupancy sensors radiate high frequency sound waves that are undetectable to the human ear. The sound waves bounce off surfaces, including people. Motion is detected via shifts in frequency. In rooms with hard surfaces, ultrasonic occupancy sensors can detect occupants around corners, out of the line of sight. They are more sensitive than PIR sensors in locations where people are moving toward or away from the sensor.

In general, ultrasonic occupancy sensors can cover a larger area than PIR sensors. They are well suited for use in stairwells, where sound waves can bounce off the hard surfaces and "see" around corners.

Like PIR sensors, ultrasonic occupancy sensors can be triggered by high levels of vibration or airflow. In stairwells, the opening of a door can trigger ultrasonic occupancy sensors as far away as the floors above and below the open door. In corridors, occupant activity in apartments with their doors ajar can trigger lights on unnecessarily (this is known as "nuisance triggering").

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Dual Technology Sensors

Dual technology sensors use both PIR and ultrasonic technology. Occupied mode begins when both sensors are triggered and continues as long as either sensor is triggered. This type of occupancy sensor is more expensive than either the ultrasonic or PIR sensor. While it can virtually eliminate problems of false triggering, it is probably not needed in stairwells and corridors.

Cost Issues

Remotely-mounted Sensors

The use of remotely mounted sensors allows a single occupancy sensor to control more than one fixture. Some manufacturers offer line voltage occupancy sensors that eliminate the cost of installing a low-voltage control circuit.

Bi-level Lighting

A bi-level lighting fixture contains a built-in occupancy sensor. Lamar Lighting's Occu-Smart fixtures and Surelite's STL-2 fixtures both use ultrasonic sensors. There are also other manufacturers, including at least one whose product uses PIR sensors.

Bi-level fixtures are more expensive than standard light fixtures but are less complicated to design and install than systems that require separate control circuits.

Layout

When evaluating the number of sensors required for a particular space, refer to manufacturers' data showing the range and coverage area for their products. For example, a ceiling-mounted ultrasonic sensor with an 18' detection range for hand motion might have a 25' range for full-body movements such as a person walking down a corridor.

To avoid false triggers, locate occupancy sensors at least six feet away from HVAC supply grilles or operable windows.

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Work Scope

To ensure proper performance and savings, an occupancy sensor work scope should address all of the following critical factors:

- Illumination levels: NYS and NYC building codes define the required illumination levels during occupied and unoccupied periods. See the December 2008 and March 2009 Tech Tips. During commissioning, light levels should be measured at multiple locations to ensure that code requirements are met.
- Location: Each sensor must be placed where it can detect people as soon as they enter the space and continue to "see" them as long as they need light from the fixtures controlled by that sensor.
  - o Ultrasonic sensor placement is less demanding than PIR placement; however, ultrasonic occupancy sensors should not be located near ventilation grilles or operable windows that could trigger their operation.
  - o Bi-level fixtures must be located and oriented to ensure proper sensor operation while also meeting required illumination levels.
- Unoccupied mode: The ERP should describe operation in the unoccupied mode, including which lamps should be left on, turned off, or dimmed to achieve required illumination levels. Lamar Lighting's Occu-Smart fixtures can be adjusted to dim to 33%, 20%, or 5% during unoccupied periods. Surelite's bi-level STL-2 fixture turns off one of a pair of lamps in unoccupied mode.
- Failure mode – Only occupancy sensors that fail in the "on" position qualify for use in stairwells. This requirement should be explicitly stated in the work scope.
- Sensitivity: Sensitivity can be adjusted to avoid false triggers. This adjustment is done in the field during installation and performance testing.
- Ballast: Programmed rapid start ballasts should be required for lamps that are controlled by occupancy sensors. By contrast to lamps that are on continuously, lamp life in fixtures controlled by occupancy sensors is limited by the number of starts before the electrodes wear out. Programmable ballasts help to extend lamp life by maintaining a small amount of current to the electrodes.
- "On time" duration: The length of time the sensor remains in occupied mode after it stops sensing an occupant is adjustable. We suggest a five minute "on-time," but we encourage Partners to experiment with shorter on-times and let us know if they are successful.
- Burn-in period: For optimum lamp life, new lamps should be "burned in" with a period of continuous hours of operation before they begin to cycle. Lamar Lighting's Occu-Smart bi-level fixtures automatically provide a 100-hour burn in period for new lamps.

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Sample Work Scope

The following is an example work scope for installation of bi-level lighting.

Stairwell lighting

Install bi-level lighting fixtures in stairwells (100 total fixtures).

Fixtures: Bi-level fixtures shall meet the following requirements:
♦ Fixtures shall be equipped with ultrasonic sensors
♦ Fixtures shall be equipped with programmable rapid-start ballast for all lamps that cycle on and off.
♦ Bi-level fixtures shall be capable of adjusting on time down to 5 minutes.
♦ Automatic burn in cycle for new lamps
♦ Failure mode is in "lights-on" position.

Execution:
♦ The lighting design shall provide a minimum of five foot-candles at tread level during occupied cycle and a minimum of two foot-candles at tread level during unoccupied cycle.
♦ The maximum lighting power density shall be 0.4 W/sf during the occupied cycle, 0.21 W/sf during the unoccupied cycle.
♦ Occupancy sensor sensitivity shall be adjusted by 1) turning sensitivity down to eliminate false triggers from air movements or other stimuli, then 2) increasing sensitivity until the sensor triggers when occupants enter the space illuminated by the bi-level fixture.
♦ Occupancy sensor orientation shall be adjusted to "see" occupants when they enter the space illuminated by the bi-level fixture.
♦ Occupancy sensor on-time/standby period shall be set for five minutes.

Performance verification:
♦ Record light levels at landing and stair treads in occupied and unoccupied mode. Confirm that illumination at floor/tread level meets requirements when measured under light fixtures, at the halfway point between fixtures, and from side to side across the tread at the halfway point.
♦ Confirm that sensors are operational by triggering them (i.e., walking into the space) from all possible entry points.
♦ Note the on time setting. Confirm proper function by timing the interval required before the lights dim/turn off.

Documentation:
♦ Instruct the owner or owner's representative about how the occupancy sensors function, their purpose, and how to adjust them. Provide written documentation.
♦ Provide the owner or owner's representative with a record of the locations measured and measurement results collected during performance verification.

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