INSIDE THE NGLS INDOOR LIVING LABS

Presence Detection in Connected Lighting Systems

Pacific Northwest NATIONAL LABORATORY

February 2022

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operated by
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for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC05-76RL01830

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For energy-saving purposes, most connected lighting systems include a presence detection component that signals lights to turn off when spaces are empty. Functioning presence detection serves as one of the most cost-effective energy-saving measures available today. When it doesn't work, energy is wasted, occupants are inconvenienced, and systems are often intentionally disabled.

Presence detection describes a sensor that detects occupancy in a space together with a relay controlling lights. When occupancy is not detected, lights turn off. When occupancy is detected (generally by sensing motion) lights turn on or stay on.

Sensors for presence detection were introduced in the 1950's, primarily to turn lights on for security. By the 1980s, the need for energy conservation led presence detection to be applied more broadly to lighting, with its incorporation as an option in energy standards as early as 1989. Presence detection became a requirement for automatic shut off in selected interior spaces in the 2007 edition of ASHRAE-IES Standard 90.1.

The Next Generation Lighting Systems program (NGLS) included presence detection in its field evaluation of 14 code-compliant connected lighting systems deemed by manufacturers to be "easy to install and configure." Installation of the systems began in 2017, at the NGLS Living Lab at the Parsons School of Design in New York City, with evaluation continuing into 2021.

NEXT GENERATION LIGHTING SYSTEMS

NGLS is organized by the Department of Energy in partnership with the Illuminating Engineering Society and the International Association of Lighting Designers, and is managed by Pacific Northwest National Laboratory. NGLS uses "Living Labs" to conduct observational research in real-world settings—indoors at Parsons School of Design in New York City and outdoors at the Corporate Research Center adjacent to the Virginia Tech Transportation Institute in Blacksburg, Virginia. NGLS teams consist of a broad range of industry experts, including lighting designers, engineers, and utility professionals.

NGLS evaluators use detailed protocols to observe, document, and measure how systems are installed and configured, how well they perform, and how users operate them. NGLS seeks to learn from manufacturers' varied approaches—identifying those that work, revealing needed improvements, articulating effective principles and practices, and publishing findings for the benefit of

Despite established technology and decades of experience, presence detection still faces challenges, including resistance to its use. This report provides context for current presence detection in lighting, considers various failure modes and their causes, characterizes various approaches to implementing presence detection, and describes performance evaluation as conducted in classrooms and offices at the Living Lab.

PRESENCE DETECTION BASICS

The two technologies most used for presence detection in lighting are passive infrared (PIR) and ultrasonic. Both detect motion and signal a relay to control the lights but use different sensing electronics.

PIR uses a segmented lens and circuit board to sense thermal radiation received from the space. When a moving person emits a thermal image that changes across lens segments, the sensor detects the motion and occupancy. The passive nature of the sensor also requires a line of sight through the space to detect presence.

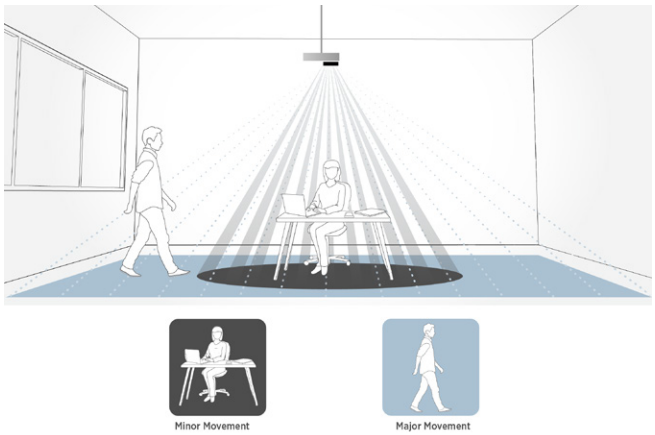
Ultrasonic sensors emit inaudible sound waves that reflect off all surfaces within range. Waves reflecting off a moving object change frequency. When the sensor records a frequency change, motion and occupancy are detected. No line of sight is required.

Four attributes of sensors affect the performance of both technologies: sensitivity, coverage, timeout period, and on/off configurations.

Sensitivity refers to the ability of the device to detect various degrees of motion. Sensitivity may be a fixed or field-configurable attribute of the sensor.

Coverage describes the area within which the sensor can detect motion with reasonable reliability. Coverage area is determined by the design of the sensor and its distance from occupant motion. (See Appendix A for specifics on coverage areas.)

The coverage area of a sensor varies according to the design of the device and the degree of motion to be detected. Most manufacturers specify the coverage area by the mounting height of the sensor (generally using the floor as reference) and the extent of motion. “Major motion” is typically defined as a walking and “minor motion” is typically modest arm or hand motion—but something more significant than merely typing.



The timeout period represents the length of time the sensor must detect a stable response (no motion) before signaling lights to turn off. If the sensor detects motion within the timeout period, lights stay on and the timeout period resets.

Timeout period is typically field configurable from 30 seconds to 30 minutes, or more. A long timeout period saves less energy but avoids turning lights off during periods of intermittent inactivity. Conversely, a short timeout period minimizes wasted energy but may turn lights off when occupants lack movement over a short period of time.

The on/off mode is also field configurable with two options: in auto on/auto off (“occupancy” mode) the sensor signals lights to turn on when it first detects presence and signals lights off after the timeout period expires without presence detected. In manual on/auto off (“vacancy” mode) an occupant must turn lights on; after presence is no longer detected, lights turn off automatically.

Sensors can be installed in switch boxes (along with the relay), in the ceiling or high on the wall (typically wired to a nearby relay and power source), or in luminaires (where the driver may supply power).

Ultrasonic sensors are preferred for spaces with partitions, such as restrooms, or spaces with tall shelving. PIR sensors, which are smaller and less costly, are used more often in luminaires where the density of sensors provides multiple lines of sight. Many contractors prefer “dual tech” devices, which have proved less prone to user complaints.

FAILURES WITH PRESENCE DETECTION

From the point of view of users and owners, five characteristic failure modes can be found with presence detection, as highlighted in the gray box.

These failures typically result in wasted energy from overused lights and diminished productivity from darkened, unusable spaces and inconvenienced and annoyed occupants.

From the point of view of manufacturers, specifiers, installers, and maintenance personnel, failure modes result from a variety of underlying causes.

Faulty Device

Sensors can fail due to internal faults of circuitry, damage to the lens, or other problems within the device that might result from failures in the device itself. Replacement is the likely remedy.

Wiring Mistake

Sensors may be installed incorrectly so that no power reaches the device or the signal does not reach the relay controlling the lights. Mistaken wiring may occur in the ceiling or a luminaire. Repair is the likely remedy.

Insufficient Coverage

Sensors may be positioned so that they do not fully cover the space to be controlled. PIR sensors are particularly prone to this problem because they are located where partitions, furniture, door swings, or body shadows block line-of-sight. Relocation, additional sensors, or non-PIR sensors are likely remedies.

Presence Detection Failure Modes

1) Lights fail to turn off when the space is no longer occupied. The result is wasted energy and electricity cost, as well as a perception of lax maintenance.
2) Lights fail to stay on while the space is occupied ("false off"). The result is occupant annoyance and complaints, often leading to disabling the presence detection system (and wasted energy).
3) Lights fail to turn on. The result is a darkened and unusable space and inconvenience to displaced occupants.
4) Lights turn on erroneously in "occupancy mode" when the space is unoccupied. The result is wasted energy.
5) Lights turn on automatically in "vacancy mode". The result is wasted energy.

Excessive Coverage

Sensors may "see" into areas outside of the desired coverage area, keeping lights on when a space is unoccupied or turning them on when someone strays too near the sensor. With a PIR sensor, relocation or masking may solve the problem. An ultrasonic sensor will likely need replacement by a PIR device.

	Faulty Device	Wiring Mistake	Insufficient Coverage	Excessive Coverage	Inappropriate Timeout	Insufficient Sensitivity	Configuration Mistake
Lights fail to turn off	•	•			•		
Lights fail to stay on	•		•		•	•	
Lights fail to turn on	•	•					
Lights turn on in empty space				•			
Lights turn on in "vacancy" mode	•						•

Inappropriate Timeout Period

Sensors may be configured with a timeout period that doesn't match the use of the space. If too short, lights can turn out when occupants are stationary. If too long, lights stay on when they're not needed.

Configuration Mistake

Typical errors include mistakenly setting for "occupancy" mode when "vacancy" is needed, and vice versa.

Insufficient Sensitivity

The sensor may not react to small motions, such as typing on a computer, and turn lights off while the space is occupied. Adjusting the setting (where possible) or the timeout period may correct the problem; otherwise, additional sensors or relocation may be needed.

PRESENCE DETECTION IN THE NGLS LIVING LAB

Beginning in 2017, NGLS installed 14 connected lighting systems of luminaires and lighting controls in its Living Lab at the Parsons School of Design. The systems were designed to meet the controls requirements of ANSI/ASHRAE/IES STANDARD 90.1-2016 and to provide illuminance consistent with *ANSI/IES RP-1, Recommended Practice for Lighting Offices*.

Installation of Controls

Nine systems featured factory-installed controls in the luminaires, so no field wiring or fastening was required.

Two systems required the installing electricians to mount and wire sensors into the luminaires, which the installers found more difficult.

Three systems used ceiling-mounted sensors with wireless connectivity to the luminaires and battery power, making installation quick and simple. Connection to the power source was not difficult. (One of the systems, however, required external wireless nodes, which had to be wired to the luminaires and proved a serious challenge to installers.)

"Vacancy" mode required the installation of new switches with wireless connection to the luminaires. In practice, all systems provided manual dimming in the same device.

Installers found retrofitting the wall controls problematic at times.

Configuration of Controls

Configuring the functionality of presence detection involved several steps. As with controls generally, configuration for each system used different tools (smart phone, computer, configuration tool), followed a different sequence (some with different steps entirely), and different terminology.

In general, the configuration steps included:

1) Selecting vacancy operation (manual on/auto off)
2) Grouping the luminaires into two zones for manual on and manual dimming of two zones
3) Setting the timeout period
4) Adjusting sensitivity, if applicable

As discussed in the next section on characterization, some systems enabled installers to group luminaires into a single zone for auto off and two zones for manual on and dimming, an additional step.

Installers, were generally unfamiliar with the systems they were handling and encountered considerable challenges with configuration; these challenges did not relate to presence detection in most cases.

Following its installation and configuration, installers tested each system for basic functionality, reconfiguring as needed. For presence detection, testing involved entering the room without lights turning on automatically (confirming vacancy operation), and then leaving the room and verifying that lights turned off after the timeout period expired. At the end of this phase of the evaluation, all but two of the systems appeared to have functional presence detection.

CHARACTERIZING PRESENCE DETECTION

The NGLS characterization study of installed presence detection in the Living Lab reveals some consistency and considerable variation among the 14 systems. The table on page 10 summarizes the characterization.

Entrants

The 14 systems split evenly between those using controls branded by the luminaire manufacturer (single entries) and those using controls and luminaires from different manufacturers (collaborative entries). The sensors for each system may have been manufactured by an independent third party in either single or collaborative entries.

Three entrants used the same type of control system; the others appeared to use sensors from different manufacturers. A total of 11 unique systems have been installed so far.

Sensor Technology

All systems currently in place use PIR sensors. All but two of the sensors combine presence detection and light measurement (for daylight harvesting) in the same device.

The small size and relatively low cost of PIR sensors serve as important considerations for the 11 systems that integrate sensors into luminaires.

An array of sensor-equipped luminaires reduces the risk of "false off" PIR failures.

Sensor Location

Eleven systems integrated sensors in the luminaire. Nine of these included a sensor in each luminaire; two used a "master satellite" arrangement with a sensor in one luminaire controlling two luminaires via wireless communication. The area to be covered by each sensor, based on the area of the room and the number of luminaires or sensors, varied from 30 to 179 square feet.

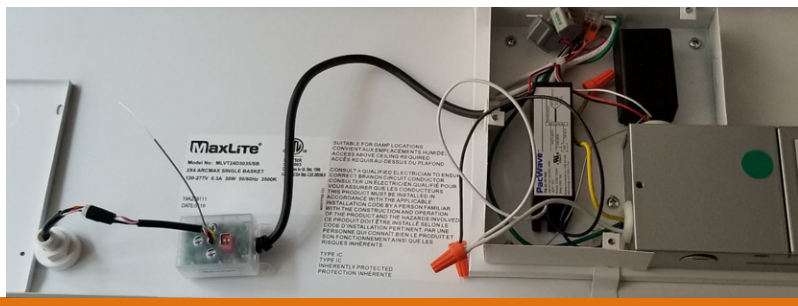
Ceiling-mounted sensors were placed near the middle of the room, as specified by their manufacturers in design submittals. Room area per sensor varied from 490 to 715 square feet.

Connectivity

Luminaire-mounted sensors connect directly to the LED driver in the luminaire. Photosensors and wireless nodes packaged with the sensors communicate to wall controls and configuration apps and tools.

Ceiling-mounted sensors incorporate wireless nodes to communicate with luminaires.

Systems used a wide variety of wireless protocols, mostly proprietary to some degree. Although several manufacturers offered their controls to luminaire manufacturers, none of the systems proved interoperable.



Coverage

Appendix A shows sensor coverage as reflected in entrant data sheets. Some offered estimated ranges for both major motion (walking) and minor motion, others a single number. For all but one of the sensor types, the coverage pattern was circular, with radii from six to 16 feet. The other type offers rectangular coverage.

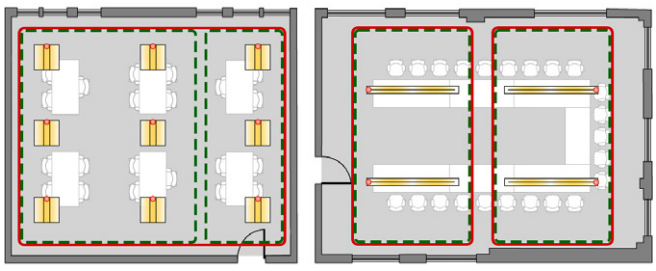
Grouping

Luminaire-mounted sensors in the Living Lab can be grouped into one or more zones for presence detection. With sensors grouped into a single zone, presence detected by any sensor keeps all lights on; lights turn off only after all sensors no longer detect presence. Thus, a single occupant keeps all lights on (with appropriate coverage and sensitivity).

When grouped into multiple zones (two as specified for manual control in the Living Lab), lights in each zone turn off after the sensors in that zone no longer detect presence, potentially saving energy when the space is partially occupied. However, lights may stay on in an unoccupied zone (a "false on") if sensors controlling that zone detect presence in an adjacent zone—an example of excessive coverage.

Nine systems, including the three with ceiling-mounted sensors, grouped sensors into one zone for presence detection and also provided two zones for manual control.

Five entrants grouped sensors into two zones. In practice, lights turned off in one zone with occupancy only in the other zone; this was a system failure *per se*, although occupants found this situation uncomfortable in the small rooms of the Lab. In larger spaces, this occurrence might not be a problem. Only one of the four systems could be reconfigured into the preferred single zone.



Early luminaire-mounted presence detection devices controlled only that luminaire; no grouping was included. While this in theory maximized energy savings in a partially occupied space, it produced an irregular pattern of switching lights on and off as people moved within the space. It also required occupancy mode operation. None of the systems in the Living Lab used this approach.

ASSESSING PRESENCE DETECTION IN THE NGLS LIVING LAB

The NGLS controls evaluation began after installation and configuration with a preliminary verification of basic functionality. System failures were corrected where possible.

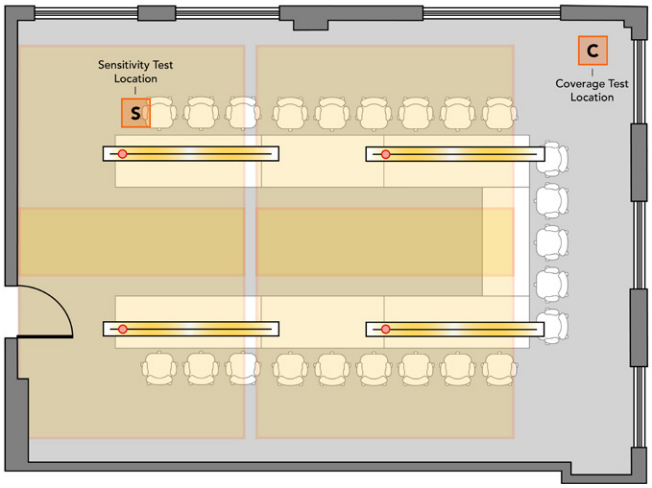
The Assessment Plan

In 2019, teams of two NGLS evaluators conducted a detailed performance assessment: one served as the room occupant while the other recorded the date, timeout period, and test results for the room. The assessment protocol tested three attributes of performance:

1) Function: When the occupant exits the space, do lights turn off at the end of the timeout period?
2) Sensitivity: When the occupant demonstrates small motions, do the lights remain on?
3) Coverage: When the occupant sits in the "worst position" relative to sensors, do the lights remain on?

The tests were performed in the order shown above. Once a system failed a test, testing stopped. In some cases, the coverage test was omitted based on the coverage pattern from that sensor's data sheet.

One of the 14 systems was not fully functional at the time of assessment and not tested. Test results are shown in the table on page nine and the Appendix.



Function Test

The timeout period was set to five minutes (to shorten the duration of the test). With all lights on, the occupant exited the room and closed the door. The recorder (outside the room) activated a timer. If the lights turned off at the end of the timeout period, the system passed the function test. If the lights remained on, the system failed.

Overall result: 10 of 13 systems passed; one of the failures resulted from a zoning problem.

Sensitivity Test

Judges evaluated sensitivity twice: once for minor motion (moderate hand and arm movement) and once for micro motion (finger and very limited hand movement). After general observation of functioning sensors, evaluators opted not to systematically test for major motion (walking).

With lights on, the occupant sat in a central location in the closed room with line of sight to several sensors. The occupant performed minor motions, and the recorder started the timer. If the lights remained on at the end of the timeout period (five minutes, plus a one-two minute grace period), the system passed the minor motion test. If lights turned off, the system failed. The occupant then repeated the process performing micro motions.

Overall result: All 11 tested systems passed the minor motion test. Of these, seven also passed micro motion.

Coverage Test

Only systems with coverage patterns (Appendix A) showing gaps were tested for coverage.

For this test, the occupant sat in a corner of the room or other location where coverage was in doubt. With the lights on, the occupant performed minor motion. If the lights remained on at the end of the timeout period (five minutes, plus a one-two minute grace period), the system passed the coverage test. If the lights turned off, the system failed.

Overall result: Two of the five tested systems passed; one experienced a grouping issue; and two failed. Coverage of six systems was deemed more than adequate and those systems were not tested.

LESSONS LEARNED INSIDE THE NGLS LIVING LAB

The characterization and testing for function, sensitivity, and coverage of presence detection sensors yielded three broad lessons that can inform the next generation of connected lighting systems and the professionals who specify them.

Presence Detection Systems Are Diverse

Of the 11 unique systems evaluated, three used a single ceiling-mounted sensor, six used sensors in every luminaire, and two used one sensor for each pair of luminaires. Three systems (five entries) were configured in two groups; nine in one group. There were seven different coverage patterns. The only consistency across all systems was the use of PIR technology.

The lack of standardization in presence detection matches other reports from the NGLS Living Lab and may reflect the specification for wireless connected lighting systems.

The use of presence detection in these systems (and connected lighting itself) is relatively new when compared with the decades-long use of sensors in wallbox switches.

No.	System	Sensor Location	Luminaire		Sq. ft./ Sensor	Grouping	Function	Sensitivity (Minor Motion)	Sensitivity (Micro Motion)	Coverage
1	Collaboration	Luminaire	Pendant	4	179	2 Groups	Pass	Pass*	Pass*	Fail*
2	Collaboration	Luminaire	Pendant	4	179	2 Groups	Pass	Pass	Fail	Fail
3	Collaboration	Ceiling	Pendant	4	715	1 Group	Fail**	Pass	Fail	NT
4	Single	Luminaire	Pendant	4	179	2 Groups	Pass	Pass	Pass	Fail
5	Single	Ceiling	Troffer	9	490	1 Group	Fail	Not Tested	Not Tested	Not Tested
6	Single	Luminaire	Troffer	9	54	1 Group	Pass	Pass	Fail	NT
7	Collaboration	Ceiling	Troffer	9	544	1 Group	Pass	Pass	Pass	Pass
8	Single	Luminaire	Retrofit	6	54	2 Groups	Pass	Pass	Pass	Pass
9	Single	Luminaire	Retrofit	6	57	1 Group	Pass	Pass	Pass	NT
10	Single	Luminaire	Retrofit	4	133	2 Groups	Fail	Not Tested	Not Tested	Not Tested
11	Collaboration	Luminaire	Retrofit	9	30	1 Group	Pass	Pass	Pass	NT
12	Single	Luminaire	Retrofit	6	84	1 Group	Pass	Pass	Pass	NT
13	Collaboration	Luminaire	Troffer	8	61	1 Group	Pass	Pass	Fail	NT
14	Collaboration	Luminaire	Pendant	8	60	1 Group	NT	NT	NT	NT

*Coverage failure due to grouping
**Functional failure due to zone configuration

Generally Good Performance

Based on NGLS evaluations, the performance of PIR presence detection in open office and classroom applications is generally good, particularly for luminaire-mounted systems.

- 10 of 13 systems passed the function test. Two of the three failures showed serious issues elsewhere in the system; the third failure (an uncontrolled uplight zone) probably resulted from a manufacturing error in coordinating the luminaire and controls.
- All systems passing the function test also passed the minor motion test for sensitivity. Seven of 11 passed the micro-motion test. These sensitivity tests were rigorous with a single occupant, a brief timeout period, and very limited micro motion.
- Seven systems passing the function test also passed the coverage test, with one of the failures due to the two-group configuration.

Coverage is a Challenge for Specifiers

With a single PIR sensor, regardless of the coverage area, occupants produced a body shadow when facing away from the sensor. Even line of sight to minor motion could be blocked in this way.

With multiple luminaire-mounted sensors, the location of the luminaires, together with individual sensor coverage, determined whether an occupant could be “out of range.”

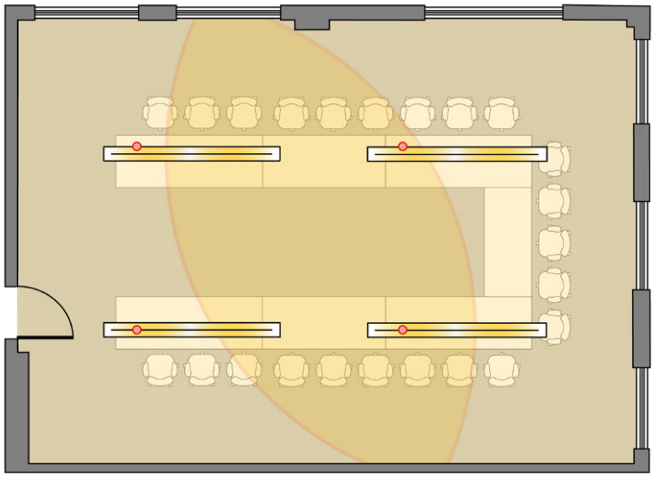
The problem typically appeared with a sensor installed in an eight- or 12-feet linear pendant; such units had the potential be spaced further apart than the sensor’s coverage area, such as what happened with entrants two and four. (See Appendix A.)

Lighting designers should carefully consider sensor coverage and placement during the selection and layout of luminaires to assure successful control operation. Once the design is complete—or worse, once the luminaires are installed—modification can be quite costly.

APPENDIX A

NGLS Presence Detection Evaluation Results

Evaluation Results



Entry 1

2 West 13th Street, Room 612

Area: 715 ft²

Luminaire: 4 - 4’ x 8’ linear pendant

Controls: Luminaire-mounted PIR sensor
16’ coverage radius (804 ft²)
179 ft² per sensor
2 groups

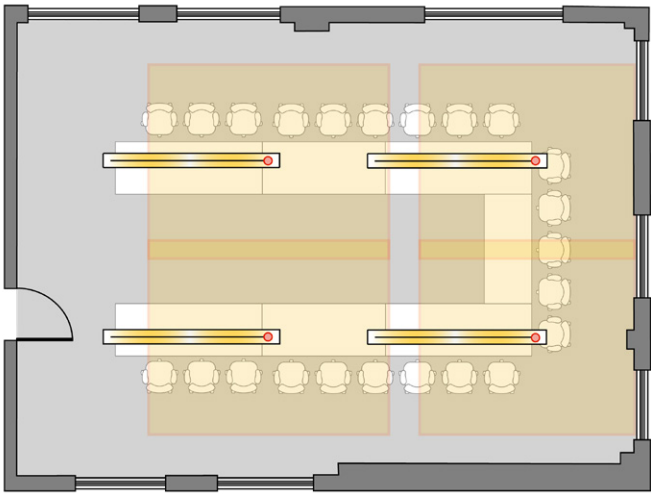
Test Results

Function: Pass

Sensitivity – Minor: Pass

Sensitivity – Micro: Pass

Coverage: Failure due to grouping. Lights in front of the room turned OFF with the occupant in the back of the room.



Entry 2

2 West 13th Street, Room 811

Area: 715 ft²

Luminaire: 4 - 4’ x 8’ linear pendant

Controls: Luminaire-mounted PIR sensor
10’ x 9’ minor motion (90 ft²)
179 ft² per sensor
2 groups

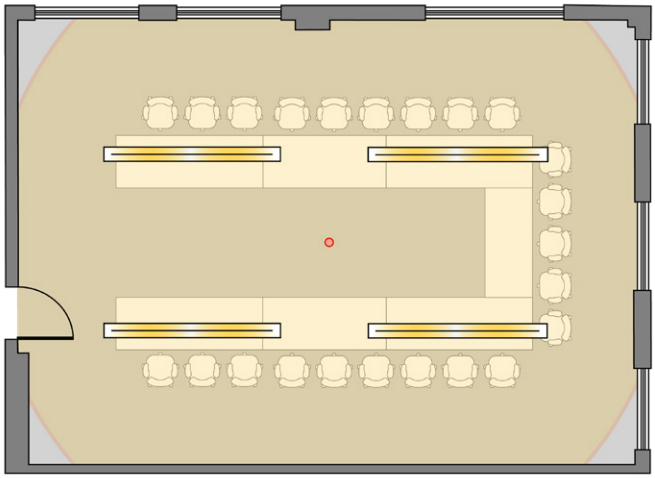
Test Results

Function: Pass

Sensitivity – Minor: Pass

Sensitivity – Micro: Failure

Coverage: Failure due to gaps around edges of room and grouping. Lights in front of the room turned OFF with the occupant in the back of the room.



Entry 3

2 West 13th Street, Room 511

Area: 715 ft²

Luminaire: 4 - 4’ x 8’ linear pendant

Controls: Ceiling-mounted PIR sensor
16’ coverage radius (804 ft²)
715 ft² per sensor
1 group

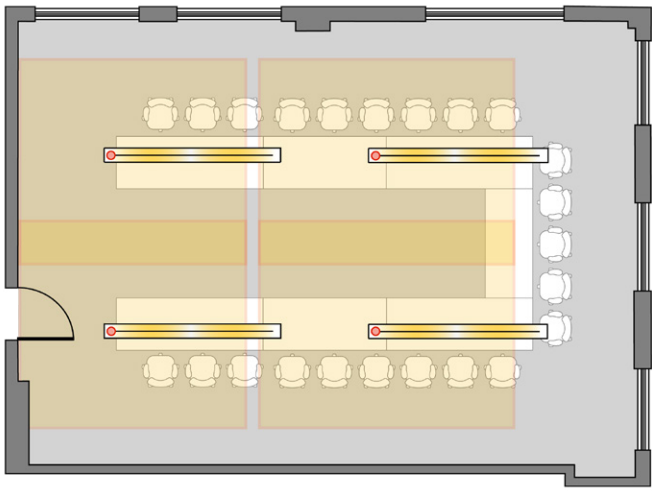
Test Results

Function: Failure due to luminaire uplight zone not configured for presence detection. Lights in front of the room turned OFF with the occupant in the back of the room.

Sensitivity – Minor: Pass

Sensitivity – Micro: Failure

Coverage: Not tested but assumed to pass due to coverage pattern.



Entry 4

2 West 13th Street, Room 311

Area: 715 ft²

Luminaire: 4 - 4’ x 8’ linear pendant

Controls: Luminaire-mounted PIR sensor
11’ x 10’ minor motion (110 ft²)
179 ft² per sensor
2 groups

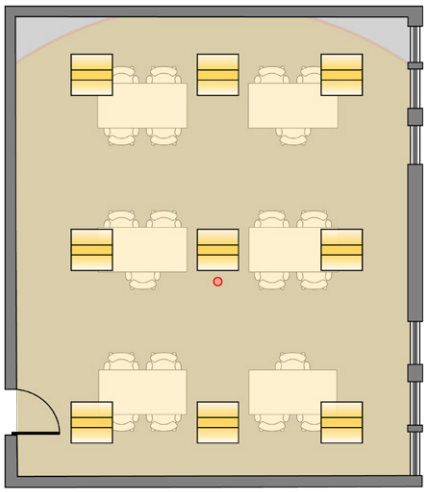
Test Results

Function: Pass

Sensitivity – Minor: Pass

Sensitivity – Micro: Pass

Coverage: Failure due to gaps around room and grouping. Lights in front of the room turned OFF with the occupant in the back of the room.



Entry 5

6 East 16th Street, Room 908

Area: 490 ft²

Luminaire: 9 - 2’ x 2’ recessed troffer

Controls: Ceiling-mounted PIR sensor
15’ coverage radius (707 ft²)
490 ft² per sensor
1 group

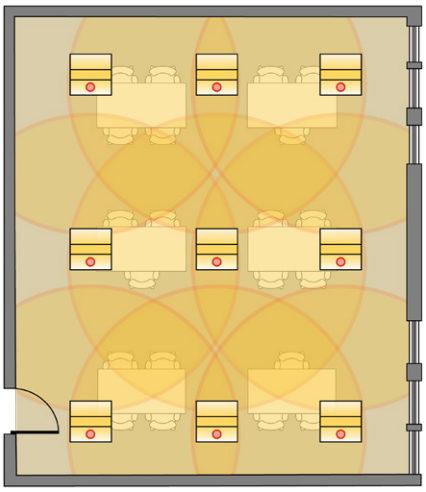
Test Results

Function: Failure

Sensitivity – Minor: Not tested

Sensitivity – Micro: Not tested

Coverage: Not tested



Entry 6

6 East 16th Street, Room 1106

Area: 490 ft²

Luminaire: 9 - 2’ x 2’ recessed troffer

Controls: Luminaire-mounted PIR sensor
6’ coverage radius (113 ft²)
54 ft² per sensor
1 group

Test Results

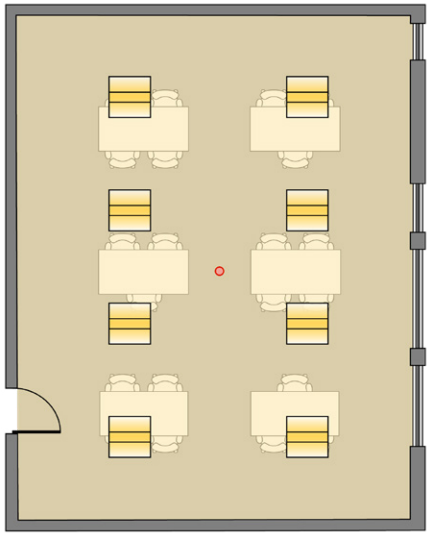
Function: Pass

Sensitivity – Minor: Pass

Sensitivity – Micro: Failure

Coverage: Not tested but assumed to pass due to coverage pattern.

Comment: A hand wave within 10 seconds turned lights back ON after failing micro test.



Entry 7

6 East 16th Street, Room 910

Area: 490 ft²

Luminaire: 8 - 2’ x 2’ recessed troffer

Controls: Ceiling-mounted PIR sensor
16’ coverage radius (806 ft²)
544 ft² per sensor
1 group

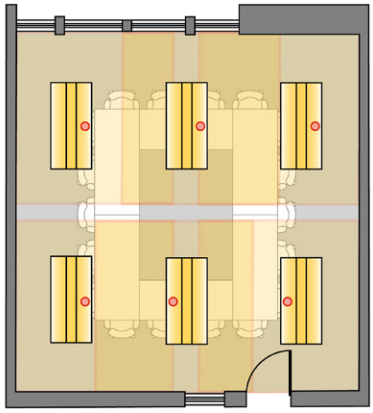
Test Results

Function: Pass

Sensitivity – Minor: Pass

Sensitivity – Micro: Pass

Coverage: Pass



Entry 8

6 East 16th Street, Room 1108

Area: 324 ft²

Luminaire: 6 - 2’ x 4’ troffer retrofit kits

Controls: Luminaire-mounted PIR sensor
10’ x 9’ minor motion (90 ft²)
54 ft² per sensor
2 groups

Test Results

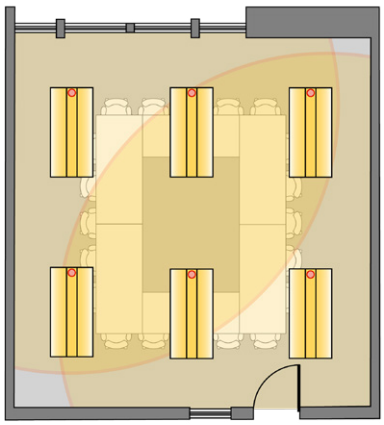
Function: Pass

Sensitivity – Minor: Pass

Sensitivity – Micro: Pass

Coverage: Pass

Comment: Passed coverage due to close spacing of luminaires and would have passed with typical 8’ x 10’ luminaire spacing, absent tall partitions.



Entry 9

6 East 16th Street, Room 912

Area: 342 ft²

Luminaire: 6 - 2’ x 4’ troffer retrofit kits

Controls: Luminaire-mounted PIR sensor
12’ coverage radius (450 ft²)
57 ft² per sensor
1 group

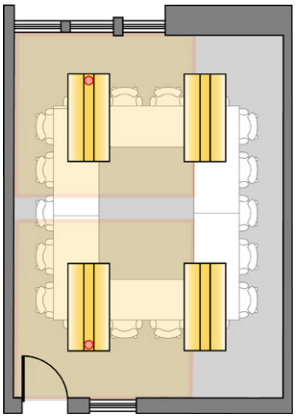
Test Results

Function: Pass

Sensitivity – Minor: Pass

Sensitivity – Micro: Pass

Coverage: Pass



Entry 10

6 East 16th Street, Room 1008

Area: 266 ft²

Luminaire: 4 - 2’ x 4’ troffer retrofit kits

Controls: Luminaire-mounted PIR sensor
14’ x 18’ coverage radius (320 ft²)
133 ft² per sensor
2 groups

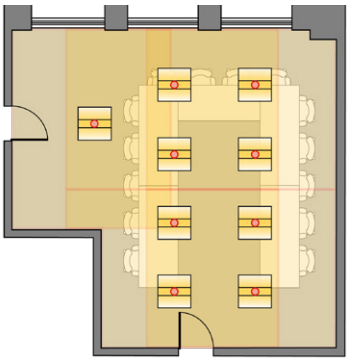
Test Results

Function: Failure

Sensitivity – Minor: Not tested

Sensitivity – Micro: Not tested

Coverage: Not tested



Entry 11

2 West 13th Street, Room 307B

Area: 270 ft²

Luminaire: 9 - 2' x 2' troffer retrofit kits

Controls: Luminaire-mounted PIR sensor
12' coverage radius (450 ft²)
30 ft² per sensor
2 groups

Test Results

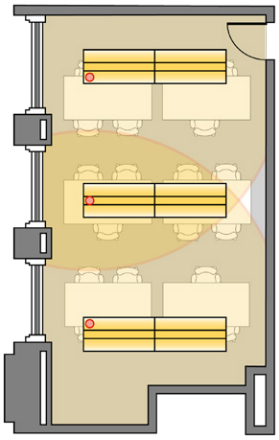
Function: Pass

Sensitivity – Minor: Pass

Sensitivity – Micro: Pass

Coverage: Not tested but assumed to pass due to coverage pattern.

Comment: System initially configured for two presence detection zones, which caused failures during the sensitivity tests. After re-configuration, system passed.



Entry 12

55 West 13th Street, Room 623

Area: 342 ft²

Luminaire: 6 - 1' x 4' troffer retrofit kits

Controls: Luminaire-mounted PIR sensor
12' coverage radius (450 ft²)
84 ft² per sensor
1 group

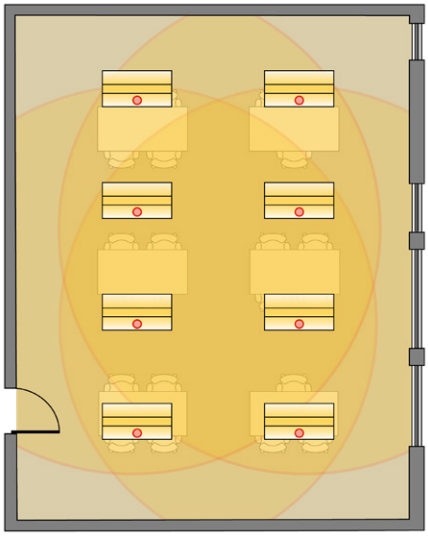
Test Results

Function: Pass

Sensitivity – Minor: Pass

Sensitivity – Micro: Pass

Coverage: Pass



Entry 13

6 East 16th Street, Room 910

Area: 490 ft²

Luminaire: 8 - 2’ x 4’ recessed troffer

Controls: Luminaire-mounted PIR sensor
15’ coverage radius (707 ft²)
61 ft² per sensor
1 group

Test Results

Function: Failure

Sensitivity – Minor: Not tested

Sensitivity – Micro: Not tested

Coverage: Not tested

Pacific Northwest
NATIONAL LABORATORY

Next Generation
LIGHTING SYSTEMS

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PNNL-32659 | Updated February 8, 2022