

## APPENDIX 4.8 – A

### **REDUCING BARRIERS TO THE USE OF LIGHTING CONTROLS** **Problems encountered during installation and commissioning of sensors**

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AUDIENCE: DOE program administrators

REPORT SECTION: Best Practices for Installing Occupancy Sensors

#### **Background**

Andrew Bierman, a researcher at the Lighting Research Center in Troy, NY, traveled to Titusville, New Jersey to witness occupancy sensor installations at the a company's headquarters. The work was conducted the night of June 27, 2002 from 5:00pm until 2:30am. The following are his observations, problems encountered, and recommendations for improving efforts to reduce barriers to the use of lighting controls.

#### **Customer familiar with sensors**

The contractor had installed ultrasonic occupancy sensors throughout most of the building's private offices and some of the open plan offices approximately four years earlier. Now, the customer wanted more occupancy sensors installed in the remaining open plan offices and hallways, and photosensors installed in the throughways between buildings and daylit reception areas. The contractor explained that this particular job of installing sensors would be more time consuming than typical installations because the easy application areas for occupancy sensors had already been exploited, and what remained were the more challenging locations.

#### **Training customer's maintenance staff before installation**

On the day of the installation, the installer met with the customer and some of the maintenance staff to present a basic training session about operating the new sensors. The installer appeared to have a good relationship with the customer, but a lack of communication appeared to exist between the customers' management and maintenance staff. During a question and answer session, the customer discovered that maintenance personnel had removed a number of the existing occupancy sensors because they had encountered problems. Management, not informed about the removals until the training session, had assumed that all of the sensors were being utilized. Also, during the training session, the customer's staff displayed a distrust of and

annoyance with the sensor products. The information most sought by the maintenance staff was how to override, or disable the device when it fails or causes complaints.

## Installation time difficult to estimate

The time required to install occupancy and photosensors is difficult to estimate and prone to take longer than expected because of the complexity and uniqueness of each installation. Finding and tracing circuits takes time, and the installers report that “as-built” drawings are rarely accurate. For most products installing the sensor part of the control is only half the job. Connecting to the lighting circuit that the sensor will control is the other half and it is not trivial. As an example, a photosensor was installed the previous night with the low voltage signal wiring run back to the electrical panel box. The installer had about two additional hours of work consisting of drilling into the main panel box and add an auxiliary box for the necessary power packs that supply electricity to the sensors and contain the switching relays, adding new wires that must be connected to the appropriate circuit breakers and the new power packs, connecting the low voltage wires to the power pack relays and securing all wires and components. This work is time consuming partly because each panel box is somewhat unique in its size, shape, wiring and location making custom fittings necessary.

## Problems encountered

In this installation, the contractors had to break circuits and put in special wiring and relay controls on panel boxes to control atrium area lights. One technician installed only two sensors during the evening...but neither worked when finished. He did not know for sure what the problem was and decided to return during the day to commissioned the sensors. In another example, three technicians worked four hours to install two occupancy sensors in a hallway, plus get an open-plan office area wired with relay power packs so that occupancy sensors could be installed the following night.

When wiring the hallway, the installers tried to use sensors manufactured by one manufacturer and power packs (with relays) manufactured by another manufacturer. Neither manufacturer supplied circuit schematics or documentation explaining the inputs and outputs to the sensors and power packs, and each used different wire colors. This resulted in trial-and-error installation and troubleshooting, which was very time consuming. Even more time would have been used if the installers had to turn off the electricity each time they tried a different wiring combination as the instructions suggest. After several failed attempts, the installers replaced the power packs with Novitas equipment and the sensors worked. Although I was not present when these particular sensors were commissioned, I did witness the technicians commissioning other sensors and this too is a trial-and-error technique, which obviously was expedited by the installers' experience using this particular product. Had an inexperienced technician installed the sensors, commissioning would have been much more difficult.

Lighting controls are often installed in two stages; first the power packs and relays are installed, then the sensors are added. Installers rely on overriding the system after the power packs and relays are installed so the lights will work while awaiting installation of sensors. However, the installers often don't know how to override because they don't have sufficient documentation by manufacturer. The installers guessed at which connections would turn the lights on with no sensor attached, unaware of any damage that may be incurred by shorting different wires together in a trial-and-error approach.

When walking around the installation site (11:00pm), some private office lights were on with no one present. The technicians checked and found many of the previously installed sensors' sensitivity adjustments were turned all the way up, perhaps by facilities technicians who were trying to avoid complaints. Oversensitive sensors tend to keep the lights on all the time. The technicians also pointed out that some of the installations of wall mounted occupancy sensors in the private offices were not the ideal location for such a sensor because of obstructions such as file cabinets and book cases. In these cases a ceiling mounted sensors would probably have worked better, but would have been about twice as expensive to install.

The installers offered an important tip: Never disable manual controls when installing automatic shut-off controls. If a hallway, for example, already has a light switch, add the automatic control in series with the existing switch. In this way, the automatic control supplements the light switch rather than replacing it. The light switch does not override the sensor. Rather, the light switch and the sensor work in combination, either one able to switch the lights.

## Commissioning

The commissioning procedure used by the installers for the occupancy sensors is as follows:

1. Turn time delay to minimum and put sensitivity dial in middle position (the dial has no other indication).
2. Walk through the area monitored by the sensors. If the light does not turn on, increase the sensitivity.
3. Wait for light to turn off (after minimum time delay) and test again.
4. If the lights turn on, but then don't turn off, turn down the sensitivity.
5. After the sensitivity is set correctly, set the desired time delay remembering that lower sensitivity can be somewhat compensated by increased time delay.

These repetitive tasks take time, as the installers must repeatedly wait for the lights to turn off before they can retest the sensitivity. The objective is to adjust the sensitivity so the lights turn on only when needed, but not when not needed. The installers commented that even for similar applications, similar settings do not guarantee similar performance because dial positions do not correspond to similar sensitivity settings from sensor to sensor.

## Lessons learned

The following lessons learned were gleaned from observations of, and discussions with the installers, product information, manufacturers' web sites and Training Videos provided by Sensor Switch, Inc.

1. Professional installers are needed to properly install and commission occupancy sensors.
2. Installer: "People should realize that sensors can not be placed just anywhere. Some areas are just not appropriate for sensors."
3. Current commissioning procedures take too much time! The time delay features alone require waiting for the lights to turn off before the installers can retest the sensor for movement detection.
4. Blueprints cannot be trusted. Installers often find circuits are different than the drawings indicate so wire paths must always be verified.
5. Open plan areas with cubicles need sufficient numbers of sensors placed appropriately. Too few sensors are commonly used in an attempt reduce costs, resulting in lack of coverage and poor performance.
6. A lot of judgment goes into placement of sensors. Installers must assess each situation individually. The experience of a professional installer is very beneficial.
7. Installers should place occupancy sensors near areas where small movements are made...near desks, over bathroom stalls, etc., and not worry about sensors picking up large motions such as opening doors, people entering rooms, which sensors easily detect.
8. A trick used by installers in hallways is to put two sensors, one at each end, pointing toward the center of the controlled area. This provides good coverage in the hallway and minimizes the risk of the lights turning on when someone walks near, but not in, the hallway.
9. The type of wiring affects how easily circuits can be broken. Conduit requires more circuit tracing because of multiple wires within the conduit. BX cable, which is armored, is easier to use.
10. Modular wiring can be problematic. One problem is by cutting cable doesn't provide enough slack, so they have to piece in new wiring. This requires junction boxes, extra cost, extra time, etc.
11. Since installation is often done at night, so as not to interfere with company's business activities, installers don't have manufacturer support available during installation.
12. Ceiling mounted sensors are nearly twice the cost of wall switch replacement sensors, because you have to install the sensor and the power pack, plus the extra wiring involved and more difficult access.
13. During commissioning or re-commissioning, when turning down sensor sensitivity, installers should increase the time delay to somewhat compensate for the reduced sensitivity to

motion. Although a longer time delay is not a substitute for sensitivity, longer time delays allow the lights to stay on longer without demanding movement.

14. Device failures: Alan Rhode estimated product failure rates at less than two percent. Most failures are immediate and are dealt with during installation. Actual callbacks for failed devices are estimated by Alan Rhode to be less than  $\frac{1}{4}$  of one percent.

## Recommendations

Based on Andrew Bierman's observations and on knowledge gained at the Lighting Research Center, we recommend the following:

1. Manufacturers should include labeled circuit schematics on the devices or in the packaging identifying the signals, and/or function of all the electrical connections. Presently, manufacturers seem to keep information from contractors, perhaps to encourage them to purchase all components from same manufacturer, or from fear of confusing installers. The more information installers have, the better they can cope with all the different situations that arise in the field.
2. Industry should develop a diagnostic interface that installers/facility technicians can plug into each power pack or sensor to speed up commissioning and diagnosing problems. The currently practice of trial-and-error is much too time consuming and prone to non-optimal solutions.
3. All manufacturers should include a "zero delay" setting on the sensor to allow faster commissioning. This would allow the lights to turn off immediately so installers would not wait several seconds or minutes between each test.

## Bottom line

The lighting industry does not seem to have the financial resources, or the willingness to develop low cost, sophisticated sensor systems. If as much money were spent on lighting control systems as is spent on cell phone development, for example, barriers to controls use could be quickly and greatly reduced.