Lighting Controls Best Practices for Warehouses

Acuity Brands has been helping to design warehouse environments and other spaces for many years, and we want to share our lighting control best practices that we learned over time. Warehouses are characterized by fast-moving forklifts, loud noises, and employees focused on tasks at hand. These traits necessitate having a safely lit space designed with the occupants' tasks and functionality in mind while offering maximum flexibility.

The considerations below illustrate the lighting control requirements of a warehouse and touch on some subtle nuances.

Common Code Requirements

The following lighting control strategies are needed to aid in compliance with many energy code requirements for a warehouse. It is most beneficial to select a lighting controls solution with all these capabilities, to allow for alternative strategies and future flexibility.

- Full or partial auto-on via occupancy sensors
- Full or partial auto-off via occupancy sensors
- Daylight responsive controls via photocells
- Where occupancy sensor controls are not used, timeclock control and a manual override is required

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Building Owner and Occupant Expectations

Building owners expect a return on investment, and occupants expect a mission-oriented space where they can accomplish tasks that they've been assigned with little to no complications. Warehouse spaces need to be primed to save energy while providing enough light to keep the space well-lit and safe for employees to receive a quick return on investment. Maintaining a well-lit space while recognizing energy savings can be considered conflicting goals, and there is often a tradeoff in most applications.

Fortunately, modern lighting systems allow for customization of light outputs through variable high-end and low-end trim settings. Combining adjustable trims with occupancy sensors in the space results in energy savings without sacrificing a well-lit, task-focused area.

According to a recent DesignLights Consortium® (DLC) report[1], the average energy savings from all networked lighting control systems is 49%. The DLC report states that an warehouse has a average savings of 68%.

Consider These Solution Elements

The below are additional items to consider when selecting a warehouse lighting control system.

Luminaire level lighting control – luminaire level lighting control (LLLC) is perhaps the easiest way to recognize energy savings without sacrificing light distribution, and in the warehouse space, LLLC is a necessity. Code commonly requires occupancy sensor control or timeclock control, and because of the commonality of LLLC, the choice between timeclock control or occupancy sensor control is simple: occupancy control wins. With various lighting manufacturers offering LLLC with their fixtures, building owners don't have to lessen or adjust their expectations on performance or aesthetics, and with 14%-28% higher savings than non-LLLC systems, the saved dollars are hard to ignore. Combined occupancy sensor, photocell, and on/off control in all fixtures results in simpler installation, fewer wires, more energy savings, and a safer environment. The ample application of occupancy sensors throughout a space causes better occupancy detection, better light distribution, and avoids the worry of a timeclock turning lights off unexpectedly.

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Out-of-Box Behavior – Fixtures can often be ordered with a variety of controls options with various combinations of settings and capabilities. When looking for fixtures in a warehouse, start by selecting fixtures that include controls. Narrow your search by selecting fixtures that allow for various control adjustments and control options from the factory to benefit the installer (this ultimately benefits the customer, too). Programming from the factory reduces the up-front work needed to get a system functional, and many systems include default settings that are adequate for most needs.

Customization – Many manufacturers ship devices preprogrammed from the factory with settings that exactly match or closely match what an end-user initially expects. Some example settings are:

- Enable/disable occupancy operation out of the box
- Enable/disable photocell operation out of the box
- Disable OFF functionality out of the box. This is commonly used in applications where a timeclock will turn off the fixtures after-hours, but users still want an occupancy sensor to raise/lower light levels based on occupancy

Wireless Customization – Modern lighting systems offer a variety of ways to customize performance in the space, and many systems allow settings adjustments from the ground using wireless communication. Some go a step further to allow groups of devices to be configured/updated in batches through the same general process, and some systems allow for devices to be customized "over-the-air" from across the building or farther away. The tradeoff for increased comfort and programming speed is typically cost. However, the ability to program wirelessly is so common that push-button programming should never be considered. It is highly likely that customization will be desired after initial installation, so planning to have the ability to adjust wirelessly will pay off.

Remote Customization – To aid in customization, several controls manufacturers offer maintenance plans to support connected sites. Using cellular routers, cloud connectivity, or VPN access, manufacturers never have to send a person to a site and instead remote into customers' systems to make updates. The ability to call the manufacturer and request assistance removes the stress of learning a new lighting control system's user interface for the handful of updates and optimizations needed throughout a year, and changes can sometimes be made the same day by professionals that know the system well. The fee for connectivity service often pays off through the additional savings recognized through a service plan (adjusting occupancy timeouts or brightness levels after initial install, adjusting holiday schedules and business hours, implementing schedule override requests for one-off events like inspections and inventory events, etc.).

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Emergency – Emergency lighting is widespread throughout a warehouse. Fixture-embedded battery backup options are sometimes used, but the mounting height of most fixtures precludes the use of batteries due to requirements to check for substantial battery output on a regular basis (normally done through push-button testing). Thus, the most common emergency solution is via generator backup. Generator backup offers several advantages over battery backup; however, a detriment to this solution is the necessity to install additional wiring to each LLLC emergency fixture for "normal power sense", and some "normal power sense" is required to let controls know that lights should be at full output when normal power is lost. For generator backup scenarios, some LLLC control solutions offer options to detect power blips in lieu of requiring normal sense wiring. These solutions provide full light output for 90 minutes or more upon detection of a power blip. Detecting a power blip is useful because a blip is expected when normal power is lost and an automatic transfer switch shifts to generator power. The savings recognized by control systems with power blip sensing technology is often substantial because emergency wiring can often account for 30-40% of the wiring across a warehouse ceiling, and eliminating even a single conductor saves significant cost.

Design Guidance

Considerations should be given to the following items:

- Mounting height of the luminaires for occupancy sensor selection
- Emergency circuit presence throughout the application
- Presence of obstructions in the space that could impede wireless traffic
- Location for a backup, manual override (if desired)

At a minimum, your warehouse design should include:

- Occupancy sensors
- Daylight responsive controls
- Emergency controls
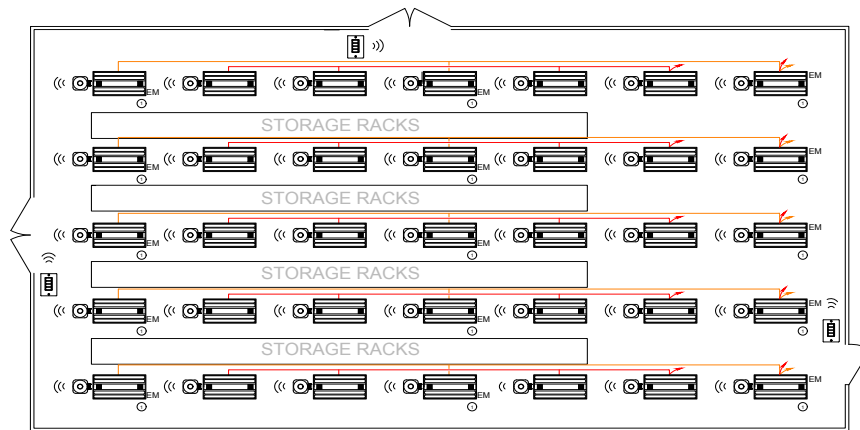
(1) Fixture(s) assumed to include emergency option.
For battery backup option, no dedicated EM circuit necessary.

Line Voltage Wires	Normal Power Feed	EM Power Feed

Additional Considerations:

- **Code** – code commonly allows for timeclock control and manual overrides to be used in place of occupancy sensors. However, occupancy sensors offer easier installation and much greater savings over time.

- **Group-Wide Response** – simpler control solutions offer fixture-by-fixture response, but some offer group-wide response. Group-wide response increases safety by illuminating a path far in front of a forklift or occupant while reducing the distraction of overhead luminaires turning on one-by-one

- **Programming and Management** – control settings adjustments are likely to be needed after initial install, and we suggest considering hardware that supports the kind of management the facility manager desires—wireless, across a connected lighting control network, or remote programming by the control manufacturer.

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Specification Guidance

These are specification items that define our recommendations for lighting controls in a warehouse, adding to what code requires without going over the budget.

Requirement	Reason	Example Language
Luminaire level lighting control	Lower cost of install and increased energy savings throughout the life of the system.	In the luminaire specification, add the requirement for "Includes provisions for luminaire level lighting control, including occupancy and light level detection".
Mobile app configuration of the space	Easy adjustment of settings by the occupant.	In the System Software section of the specification, include a requirement to, "Support programming of devices via mobile application or personal computer".

Other Specification Considerations

To increase safety and accelerate ROI, specify networked solution capabilities like the below.

Requirement	Reason	Example Language
Group-Wide Response	Greater safety for forklift drivers and occupants.	In the luminaire specification, add the word "networked" to the LLLC requirement, so the line says "Includes provisions for networked luminaire level lighting control, including occupancy and light level detection".
Remote Management	Let the experts review and make adjustments to the lighting system via a networked lighting system.	In Section 3 of the specification, under Service Agreements include a requirement for manufacturer to provide "Remote system performance checks and system optimization" for some length of time.

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Conclusion

For a warehouse, well-lit spaces and energy savings can be realized concurrently. Using LLLC as a basis of design allows us to light spaces well, save energy, remove stress for what code requires, and to drive more value by focusing on items like user experience and system sustainment.

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References

[1] Wen, Y., Frey, M., Luntz, B., Springfield, A., Kisch, T., & Kehmeier, E. (2020, September 24). Energy Savings from Networked Lighting Control (NLC) Systems with and without LLLC. Retrieved November 16, 2020, from https://www.designlights.org/lighting-controls/reports-tools-resources/

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