MANDATORY LIGHTING CONTROLS

1. 130.1 (a) Area Controls: Manual controls that control lighting in each area separately

2. 130.1 (b) Multi-level Controls: “Dimmability.” Allow occupants to choose the appropriate light level for each area

3. 130.1 (c) Shut-off Controls: Automatically shut off lighting or reduce light levels when illumination is not needed

4. 130.1 (d) Automatic Daylighting Controls: Adjust electric lighting in response to the presence of daylight

5. 130.1 (e) Automated Demand Response: Receive and automatically respond to demand response (DR) signals
MANUAL ON/OFF CONTROLS

An “area” is a space enclosed by ceiling-height partitions.

All lighting in each area must be controlled separately from luminaires in other areas by manual on/off lighting controls that are:

1. Readily accessible
2. Located in the same room or area as the lighting they control and with the lighting in view
3. Able to provide any required dimming or multi-level controls steps in addition to on/off
EGRESS LIGHTING

Up to 0.2 watts per square foot of lighting may remain on during occupied hours only for emergency egress. This lighting must be designated for emergency egress on building plans.

When controls are required to shut off all lighting in a building, this includes emergency egress lighting.
SEPARATELY CONTROLLED LIGHTING SYSTEMS

General lighting must be controlled separately from all other lighting systems in an area.

Display lighting must each be separately controlled on circuits of 20 amps or less. For example, window displays must be controlled separately from wall displays, which must also be controlled separately from case displays.

When using track lighting:
General, display, ornamental, and special effects lighting must be separately controlled.
PUBLIC RESTROOMS

Any public restroom with two or more stalls may use a manual switch that is not accessible to unauthorized personnel. All other lighting controls are still required.
MULTI-LEVEL LIGHTING CONTROLS

Title 24 sets a minimum number of control steps and illuminance uniformity requirements for most major luminaire types (see TABLE 130.1-A). These requirements are required *in addition to* any mandatory manual, daylight, shut-off, or demand response controls.

The criteria in 130.1 (b) applies to *general lighting* for enclosed areas that:

- Are at least 100 ft$^2$ in size
- Have a connected lighting load over 0.5 W/ft$^2$
- Have more than one luminaire or more than two lamps
- Controlled lighting in daylit zones over 0.3 W/ft$^2$
MULTI-LEVEL LIGHTING CONTROLS

Each luminaire must meet the multi-level control requirements. Controlling alternating luminaires or rows of luminaires does not meet the requirements.

50% Power

100% Power

Section 130.1 (b)
### TABLE 130.1-A: MULTI-LEVEL LIGHTING CONTROLS AND UNIFORMITY REQUIREMENTS

<table>
<thead>
<tr>
<th>LUMINAIRE TYPE</th>
<th>MINIMUM REQUIRED CONTROL STEPS (% of full rated power)</th>
<th>UNIFORM LEVEL OF ILLUMINANCE ACHIEVED BY:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line-voltage sockets except GU-24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low-voltage incandescent systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LED luminaires &amp; LED source systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GU-24 rated for LED</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GU-24 sockets rated for fluorescent &gt; 20W</td>
<td>Continuous dimming 10–100%</td>
<td></td>
</tr>
<tr>
<td>Pin-based compact fluorescent &gt; 20W²</td>
<td>Continuous dimming 20–100%</td>
<td></td>
</tr>
<tr>
<td>GU-24 sockets rated for fluorescent ≤ 20W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pin-based compact fluorescent ≤ 20W²</td>
<td>Minimum one step between 30–70%</td>
<td>Stepped dimming; or continuous dimming; or switching alternate lamps in a luminaire.</td>
</tr>
<tr>
<td>Linear &amp; U-bent fluorescent ≤ 13W</td>
<td>Minimum one step in each range:</td>
<td></td>
</tr>
<tr>
<td>Linear &amp; U-bent fluorescent &gt; 13W</td>
<td>20–40%</td>
<td>50–70%</td>
</tr>
<tr>
<td>Track Lighting</td>
<td>Minimum one step between 30–70%</td>
<td>Stepped dimming; or continuous dimming; or separately switching circuits in a multi-circuit track with a minimum of two circuits.</td>
</tr>
<tr>
<td>HID&gt;20W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Induction &gt; 25W</td>
<td>Minimum one step between 50–70%</td>
<td>Stepped dimming; or continuous dimming; or switching alternate lamps in each luminaire, having a minimum of two lamps per luminaire, illuminating the same area and in the same manner.</td>
</tr>
<tr>
<td>Other light sources</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Full rated input power of ballast and lamp, corresponding to maximum ballast factor.
2. Includes only pin based lamps: twin tube, multiple twin tube, and spiral lamps.

**NOTE:** Multi-level controls must not override the functionality of other controls required for compliance.
In addition to meeting the dimmability requirements, each luminaire must also be controlled with one of the following strategies:

- Manual dimming
- Lumen maintenance
- Tuning
- Automatic daylighting
- Demand response
Automatic shut-off controls turn lights off when a space is unoccupied. All lighting must be controlled by one or more of the following:

1. Occupant sensing control
2. Automatic time-switch
3. Building Energy Management System
4. Other control mechanism capable of automatically shutting off all lights for vacant periods

A single control may not monitor more than 5,000 ft²
AUTOMATIC SHUT-OFF CONTROLS

Space parameters
Each room needs to be separately controlled. A single control may not monitor more than 5,000 square feet of floor area (20,000 square feet in malls and single-tenant retail spaces).

Applications
The following types of lighting must be separately controlled:
1. General
2. Display
3. Ornamental
4. Display case
AUTOMATIC SHUT-OFF CONTROLS

Countdown timer switches may only be used in:

1. Single-stall bathrooms smaller than 70 ft\(^2\)
2. Closets smaller than 70 ft\(^2\)
3. Server rooms smaller than 500 ft\(^2\)
AUTOMATIC SHUT-OFF CONTROLS

If time-based controls are used, occupants there after hours must be able to activate lighting as needed:

- Manual switch
- Temporary override
- Occupancy-based control
AUTOMATIC SHUT-OFF CONTROLS

Adaptive controls in secondary spaces
Controls for lighting in corridors and stairwells must be capable of:

• Partially reducing lighting power during hours of operation *in addition to*
• Providing full shut-off functionality when the building is vacant.
AUTOMATIC SHUT-OFF CONTROLS

Warehouse aisles and open areas

1. Each aisle must be independently controlled

2. Minimum automatic 50% reduction in lighting power when vacant
AUTOMATIC SHUT-OFF CONTROLS

Corridors and stairwells

- Sensors/controls should be activated from all potential entrances
- Minimum automatic 50% reduction in lighting power when vacant
- Exceptions for hospitality and residential applications
ADAPTIVE LIGHTING IN PARKING GARAGES

Parking garages are considered **interior** nonresidential spaces, except for the top level of each multi-tier garage.

- General lighting must have occupant sensing controls with at least one control step between 20% and 50% of design lighting power.
- No more than 500 watts of rated lighting power may be controlled together.
### CASE STUDY: SAN MARCOS CIVIC CENTER PARKING GARAGE

<table>
<thead>
<tr>
<th>TECHNOLOGY</th>
<th>SYSTEM SIZE (W)</th>
<th>ANNUAL ENERGY CONSUMPTION (kWh)</th>
<th>ANNUAL ENERGY COST</th>
<th>ANNUAL MAINTENANCE COST</th>
<th>TOTAL ANNUAL COST</th>
<th>LIFE-CYCLE ENERGY COST</th>
<th>LIFE-CYCLE MAINTENANCE COST</th>
<th>TOTAL LIFE-CYCLE COST</th>
<th>TOTAL LIFE-CYCLE COST FOR ALL FIXTURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPS</td>
<td>210</td>
<td>1,840</td>
<td>$235</td>
<td>$25</td>
<td>$260</td>
<td>$2,688</td>
<td>$280</td>
<td>$2,968</td>
<td>$47,488</td>
</tr>
<tr>
<td>HPS PERIMETER</td>
<td>210</td>
<td>920</td>
<td>$118</td>
<td>$25</td>
<td>$142</td>
<td>$1,344</td>
<td>$280</td>
<td>$1,624</td>
<td>$11,368</td>
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<tr>
<td>LED CANOPY 7 (Low)</td>
<td>354</td>
<td>$45</td>
<td>$0</td>
<td>$45</td>
<td>$517</td>
<td>$0</td>
<td>$517</td>
<td>$8,272</td>
<td></td>
</tr>
<tr>
<td>LED CANOPY 70 (High)</td>
<td>177</td>
<td>$23</td>
<td>$0</td>
<td>$23</td>
<td>$258</td>
<td>$0</td>
<td>$259</td>
<td>$1,809</td>
<td></td>
</tr>
<tr>
<td>LED TOTAL</td>
<td>531</td>
<td>$68</td>
<td>$0</td>
<td>$68</td>
<td>$775</td>
<td>$0</td>
<td>$776</td>
<td>$10,081</td>
<td></td>
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<tr>
<td>SAVINGS</td>
<td>2,229</td>
<td>$285</td>
<td>$50</td>
<td>$334</td>
<td>$3,257</td>
<td>$560</td>
<td>$3,816</td>
<td>$48,775</td>
<td></td>
</tr>
</tbody>
</table>

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AUTOMATIC SHUT-OFF CONTROLS

Spaces that are exempt from automatic shut-off controls requirements:

1. Buildings with lighting in continuous use 24 hours/day, 365 days/year
2. Areas where partial on/off controls are required instead of shut-off controls (such as stairwells and corridors)
3. Electrical equipment rooms
4. Emergency egress lighting
AUTOMATIC DAYLIGHTING CONTROLS

Automatic daylight controls adjust electric lighting power when ample daylight is available. “Ample daylight” is defined by the standards as 150% of the designed light level for electric lighting.

Automatic daylighting controls are required for luminaires that:

1. Provide general lighting
2. Are at least half in a skylit or sidelit area
3. Are in an area where the total installed general lighting power is at least 120 watts
4. Are located in an area which has at least 24 ft² of glazing
Automatic daylighting controls requirements:

1. Controlled lighting with an LPD greater than 0.3 W/ft$^2$ must have multi-level lighting in accordance with Table 130.1-A.

2. Controlled lighting + daylight must equal or exceed the controlled electric lighting level without daylight.

3. When there is ample daylight detected, the general lighting power in that space must be reduced by at least 65%.
DAYLIGHT CONTROLS IN PARKING GARAGES

- Parking garage areas with at least 36 ft² of glazing or opening must have automatic daylighting controls.
- Controlled lighting can be multilevel, continuous dimming or ON/OFF.
- When primary sidelit zones receive illuminance levels greater than 150% of the illuminance provided by the controlled lighting when no daylight is available, lighting is off.

Luminaires in the following areas do not need to use photocontrols:

- **Daylight transition zone**: The pathway vehicles use to enter a parking garage.
- **Dedicated ramps**: Driveways specifically meant to move vehicles between the floors of a parking garage and which have no adjacent parking.
- **Some sidelit zones**: Daylighting controls are not required if the total combined general lighting power in the primary sidelit daylight zones is less than 60 watts.
DEMAND RESPONSE

When the demand for electricity threatens to exceed supply, the power grid becomes less stable and the risk of outages increases.

Demand response (DR) programs allow end users to temporarily reduce their electricity use in response to a notice or automated signal sent from a utility, independent system operator (ISO) or other power provider.

This flexibility helps reduce peak demand and maintain grid stability. Currently, participating customers also receive financial incentives.
DEMAND RESPONSE

How DR Works
In traditional, non-automated DR programs, a local service provider sends notification of a pending DR event to facility managers, via e-mail, phone call or text message, requesting a reduction in electricity consumption for a limited period of time.

Auto DR
Automated demand response (ADR) programs make use of energy management technologies and controls to respond to DR events more quickly and reliably. The provider issues an automated DR signal to energy management control systems enrolled in ADR programs. The systems then automatically respond by reducing electricity use according to pre-programmed load shed strategies.
DEMAND RESPONSE

Lighting is extremely well-suited to DR

1. Peak demand periods typically overlap daylight hours
2. Research indicates illuminance levels can be reduced by as much as 20% without occupants detecting the change
3. Light levels can be immediately restored when DR events end

Buildings larger than 10,000 ft\(^2\) must be capable of responding to a DR signal by automatically reducing lighting power at least 15% below the total installed lighting power while maintaining the uniformity requirements listed in Table 130.1-A.

Spaces that use less than 0.5 W/ft\(^2\) and non-habitable spaces, such as storage closets, are exempt and cannot be counted toward ADR compliance.
CHECK YOUR UNDERSTANDING: DEMAND RESPONSE

An 80,000 ft$^2$ building is being constructed. It will contain 10 tenant spaces, each 8,000 ft$^2$ in size. Do these tenant spaces need to comply with the requirements for automatic demand response?
SUMMARY OF MANDATORY LIGHTING CONTROLS

DISCUSSION: What types of controls will retail spaces typically require?

1. **Manual switches** (What needs to be switched separately?)
2. **Automatic shut-off controls** (Where are they required?)
3. **Automatic daylighting controls** (Which lighting systems must comply?)
4. **ADR** (How large does a building need to be?)