Advancements in Lighting

A Peek at the New Lighting Requirements for ASHRAE/IESNA Standard 90.1-2010

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Standard 90.1 Basics

- Jointly sponsored by ASHRAE and IESNA
- 2007 is the current published version…but many states have older versions in place (2004, 2001, 1999, 1989)
- Many State-specific codes and the IECC are based on 90.1. IECC references 90.1 as compliance option
- 2004 version is the commercial building energy code reference in NFPA 5000

Review of Changes for 2010 – Caveats

- As of today (July 24, 2008) These changes are either:

  Approved as addenda to 90.1-2007

  OR

  Proposed as addenda to 90.1-2007 (in review process)

  OR

  Under consideration (in subcommittee)

- When these become part of 90.1-2010…..they will **only** be effective when 90.1-2010 is adopted by a jurisdiction
- Note that some of these provisions will find there way into upcoming versions of IECC.

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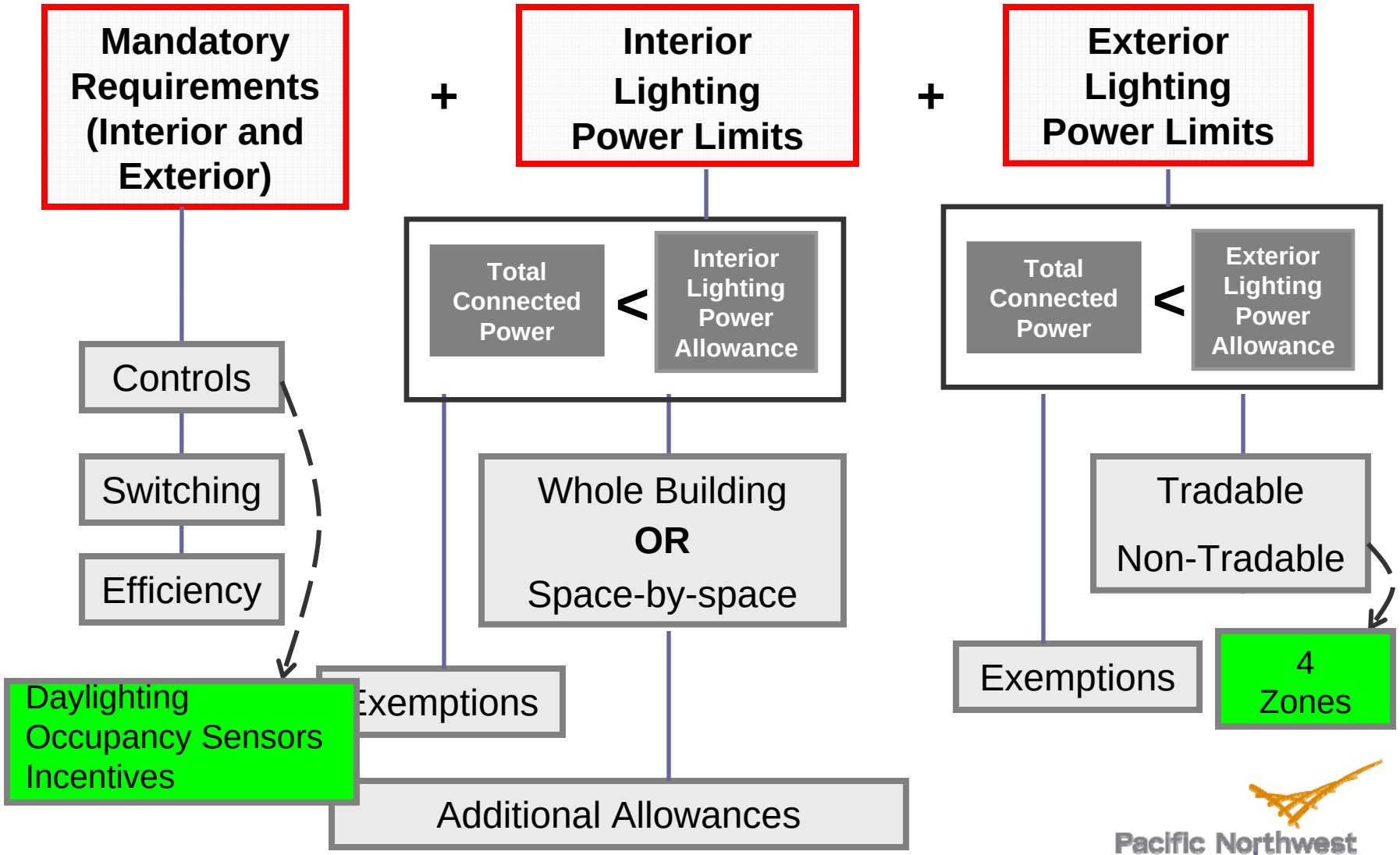
Basic Lighting Requirements



Hotel Room Bathroom Lighting Exception/Control Revision

- Guestrooms in hotels, motels, boarding houses or similar buildings shall have one or more control device(s) at the entry door that collectively control all permanently installed luminaires and switched receptacles, except those in the bathroom(s).
- Suites shall have control(s) meeting these requirements at the entry to each room or at the primary entry to the suite.
- Bathrooms shall have a control device installed to automatically turn off the bathroom lighting, except for night lighting not exceeding 5 watts, within 60 minutes of the occupant leaving the space.

[Addenda "aw" to 90.1-2007 – Completed review]

Occupancy Based Control Additions

Requirement for specific occupancy sensor control in additional spaces (red).

- conference,/meeting rooms, and training rooms,
- classrooms and lecture halls
- employee lunch and break rooms.,
- storage and supply rooms up to 1000 ft^2,
- rooms used for document copying and printing,
- office spaces up to 250 ft^2,
- restrooms
- dressing, locker, and fitting rooms.

[Addenda "x" to 90.1-2007 – Completed review]

Exceptions updated (moved):

- Spaces with multi-scene lighting control systems
- Shop and laboratory classrooms
- Spaces where an automatic shutoff would endanger the safety or security of the room or building occupant(s)
- Lighting required for 24-hour operation

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Occupancy Manual-on Control Requirement

Automatic control devices shall not be set to Automatically turn the lighting on.

- This effectively requires manual-on function for automatic controls
- Commonly known as a “vacancy sensor” in occupancy sensor industry

Exceptions (where automatic-on is allowed):

- public corridors and stairwells,
- restrooms,
- primary building entrance areas and lobbies ,
- areas where manual-on operation would endanger the safety or security of the room or building occupant(s).

[Addenda “aa” to 90.1-2007 - in review]

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Advanced Control Incentives

When all mandatory control requirements are met for a space AND advanced controls are installed in that space, THAN additional limited lighting power is allowed:

- The allowance is based on conservative estimates of tradeoff (low percentage of expected savings)
- Additional power can be used anywhere in the building
- Additional Interior Lighting Power Allowance is calculated as:

Lighting Power Under Control x Control Factor

Where:

Lighting Power Under Control = the total wattage of all lighting fixtures that are controlled in the given space using the control method indicated

Control Factor = the value given in the Table for the corresponding space type and control method.

[Addenda "ac" to 90.1-2007 - completed review]

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Control Factors for Advanced Controls

Control Factors Varying by space type				
	Space Type			
Additional Control Method	Open AND Private offices	Conference meeting Classroom (lect./train.)	Retail Sales area	Lobby, Atrium, Dining, Corridor/stairs, Gym/pool Mall concourse, Parking garage
Manual, continuous dimming control OR Programmable multi-level dimming control	0.05	0.10*	0.1	0
Programmable multi-level dimming control using programmable time scheduling	0.05	0.10*	0.1	0.1
Multi-level occupancy sensors	0.05	0.05	0	0
Automatic bi-level or multi level switching in *primary sidelighted areas* when *EA* > 0.15	0	0	0.1	0

*These control factors may only be used if the requirements of section 9.4.1.2 are met using an occupancy sensor.

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…more Control Factors for Advanced Controls

Control Factors Equivalent for All Space Types	
Additional Control Method	**All Space Types**
Automatic bi-level or multi-level switching in *primary sidelighted areas* when *EA* > 0.15 and when *primary sidelighted area* < 1,000 sq.ft.	0.1
Automatic *continuous daylight dimming* in *primary sidelighted areas* when *EA* > 0.15 and when *primary sidelighted area* < 1,000 sq.ft.	0.2
Automatic *continuous daylight dimming* in *primary sidelighted areas* when *EA* > 0.15 and when *primary sidelighted area* > 1,000 sq.ft.	0.1
Automatic *continuous daylight dimming* in *secondary sidelighted areas* when *EA* > 0.3	0.1
Automatic *continuous daylight dimming* in *daylighted areas under skylights* when the total of those areas is less than 4,000 sq.ft. and when *skylight EA* > 0.01	0.2
Automatic *continuous daylight dimming* in *daylighted areas under skylights* when the total of those areas is greater than 4,000 sq.ft. and when *skylight EA* > 0.01	0.1

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Zonal Exterior Power Allowance Revision

- The existing single set of exterior power limits is expanded to be lighting zone based.
- Follows the current IESNA development work on Model Lighting Ordinances (MLO)

Exterior Lighting Zones

Lighting Zone	Description
1	Developed areas of National Parks, State Parks, Forest Land, and Rural areas
2	Areas predominantly consisting of residential zoning, neighborhood business districts, light industrial with limited nighttime use and residential mixed use areas
3	All other areas
4	High activity commercial districts in major metropolitan areas as designated by the local jurisdiction

[Addenda "i" to 90.1-2007 - completed review]

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Zonal Exterior Power Allowance Revision

		Zone 1	Zone 2	Zone 3	Zone 4
Base Site Allowance		500 W	600 W	750 W	1300 W
Tradable Surfaces	**Uncovered Parking Areas**				
	Parking areas and drives	0.04 W/ft^2	0.06 W/ft^2	0.10 W/ft^2	*(0.15)* 0.13 W/ft^2
	Building Grounds				
	Walkways less than 10 feet wide	0.7 W/linear foot	0.7 W/linear foot	0.8 W/linear foot	1.0 W/linear foot
	Walkways 10 feet wide or greater Plaza areas Special Feature Areas	0.14 W/ft^2	0.14 W/ft^2	0.16 W/ft^2	0.2 W/ft^2
	Stairways	0.75 W/ft^2	1.0 W/ft^2	1.0 W/ft^2	1.0 W/ft^2
	Pedestrian Tunnels	0.15 W/ft^2	0.15 W/ft^2	0.2 W/ft^2	0.3 W/ft^2
	Landscaping	0.04 W/ft^2	0.05 W/ft^2	0.05 W/ft^2	0.05 W/ft^2

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Zonal Exterior Power Allowance Revision

		Zone 1	Zone 2	Zone 3	Zone 4
Tradable Surfaces	**Building Entrances and Exits**				
	Main entries	20 W/linear foot of door width	20 W/linear foot of door width	30 W/linear foot of door width	30 W/linear foot of door width
	Other doors	20 W/linear foot of door width	20 W/linear foot of door width	20 W/linear foot of door width	20 W/linear foot of door width
	Entry Canopies	0.25 W/ft^2	0.25 W/ft^2	0.4 W/ft^2	*(1.25)* 0.4 W/ft^2
	Sales Canopies				
	free standing and attached	0.6 W/ft^2	0.6 W/ft^2	0.8 W/ft^2	*(1.25)* 1.0 W/ft^2
	Outdoor Sales				
	Open areas (including vehicle sales lots)	0.25 W/ft^2	0.25 W/ft^2	0.5 W/ft^2	*(0.5)* 0.7 W/ft^2
	Street frontage for vehicle sales lots in addition to "open area" allowance	**No allowance**	10 W/linear foot	10 W/linear foot	*(20)* 30 W/linear foot

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Zonal Exterior Power Allowance Revision

Non-Tradable Surfaces	**Building Facades**	**No allowance**	0.1 W/ft^2 for each illuminated wall or surface or 2.5 W/linear foot for each illuminated wall or surface length	0.15 W/ft^2 for each illuminated wall or surface or 3.75 W/linear foot for each illuminated wall or surface length	0.2 W/ft^2 for each illuminated wall or surface or 5.0 W/linear foot for each illuminated wall or surface length
	Automated teller machines and night depositories	270 W per location plus 90 W per additional ATM per location	270 W per location plus 90 W per additional ATM per location	270 W per location plus 90 W per additional ATM per location	270 W per location plus 90 W per additional ATM per location
	Entrances and gatehouse inspection stations at guarded fac.	0.75 W/ft^2 of covered and uncovered area	0.75 W/ft^2 of covered and uncovered area	0.75 W/ft^2 of covered and uncovered area	*(1.25)* 0.75 W/ft^2 of covered and uncovered area
	Loading areas for law enforcement, fire, ambulance and other emergency service vehicles	0.5 W/ft^2 of covered and uncovered area	0.5 W/ft^2 of covered and uncovered area	0.5 W/ft^2 of covered and uncovered area	0.5 W/ft^2 of covered and uncovered area
	Drive-up windows/doors	400 W per drive-through	400 W per drive-through	400 W per drive-through	400 W per drive-through
	Parking near 24-hour retail entrances	800 W per main entry	800 W per main entry	800 W per main entry	800 W per main entry

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Daylighting Changes…..

- Three separate addenda (“d”, “ab”, “al”) that:

  Require the control of electric lighting when top and side daylight is present

  …AND…

  Require the design and installation of skylights when appropriate
- Developed with DOE funded subcontract – Heschong-Mahone Group
- Based on previous work for California Title 24

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Lighting Control for Toplighting

Requires control of electric lighting when toplighting daylight is available

- Applied based on “daylight area under skylights” + “daylight area under rooftop monitors” that exceed 4000 ft^2
- Control is required for the general lighting over these areas
- Control must be multi-level photocontrol
  - At least two output levels at 0% - 35% and 50% - 70%

    OR
  - Continuous dimming

[Addenda “d” and “ab” to 90.1-2007 – Completed review]

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“Daylight Area Under Skylights”

The daylight area under skylights is the combined daylight area under each skylight without double counting overlapping areas.

- The basic area under each skylight is the skylight opening plus horizontally in each direction, 70% of the ceiling height (CH)
- These areas are reduced by:
  - The presence of any “primary sidelighted area”,
  - Areas under rooftop monitors, or
  - The distance to the front face of any vertical obstruction depending on location and height (OH).

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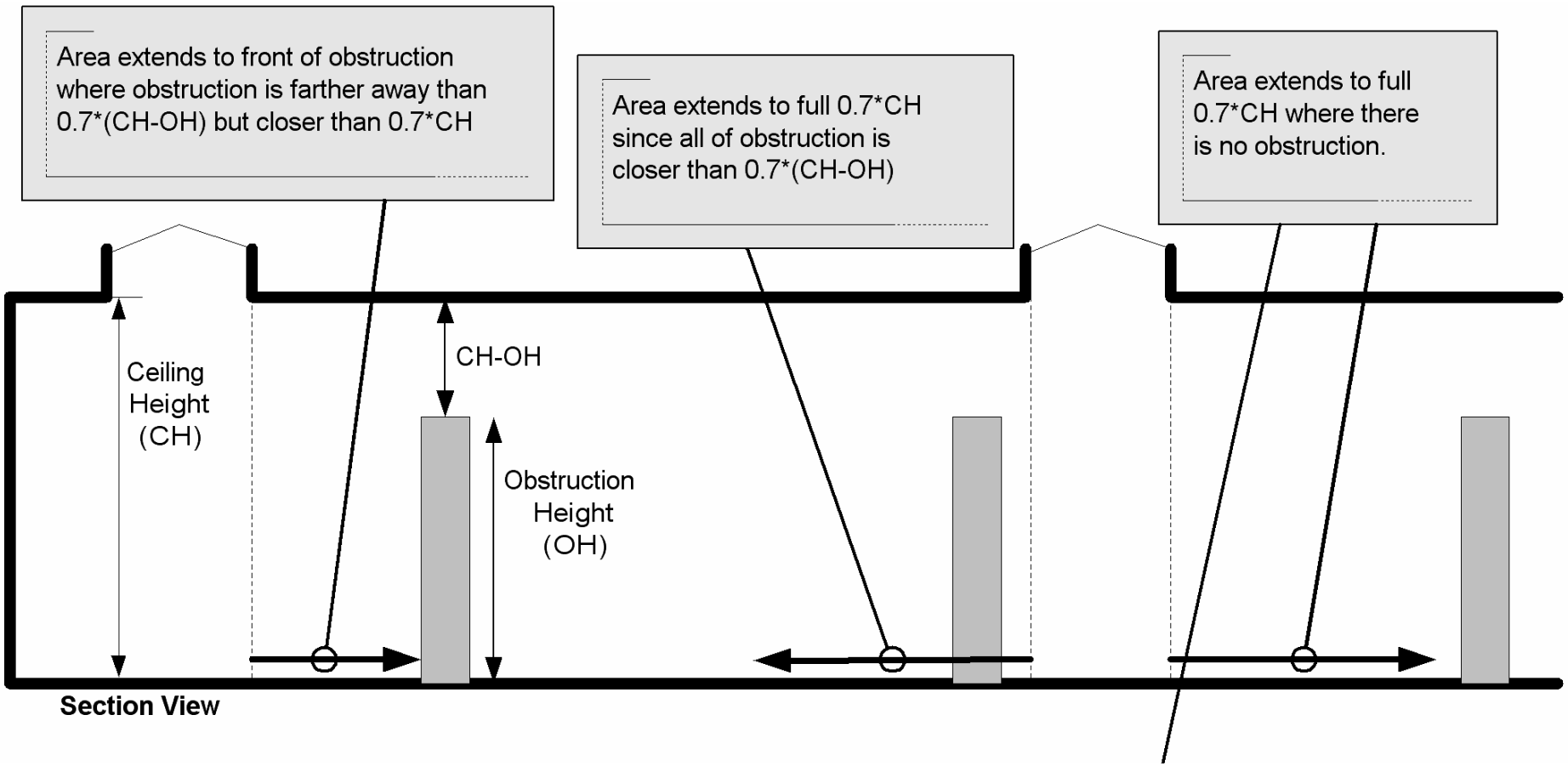
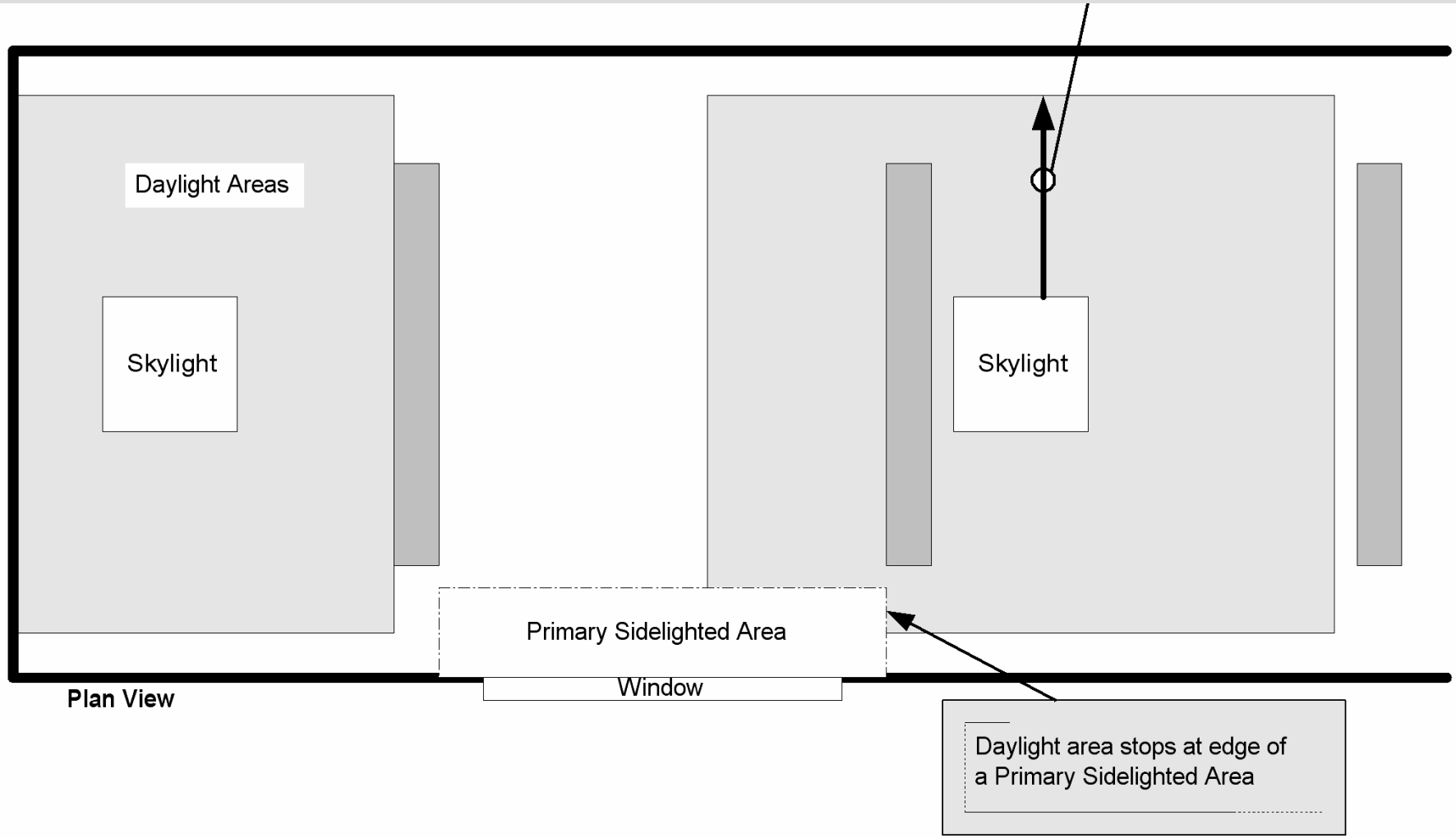
“Daylight Area Under Skylights”





“Daylight Area Under Skylights”

“Daylight Area Under Rooftop Monitors”

Under rooftop monitors: the daylight area under rooftop monitors is the combined daylight area under each rooftop monitor without double counting overlapping areas.

- The basic area under each monitor is the width of the vertical glazing times the the monitor sill height (MSH, floor to the bottom of monitor), or
- These areas are reduced by:
  - The presence of any “primary sidelighted area”, or
  - The distance to the front face of any vertical obstruction that is farther away than the difference between the obstruction height (OH) and the monitor sill height

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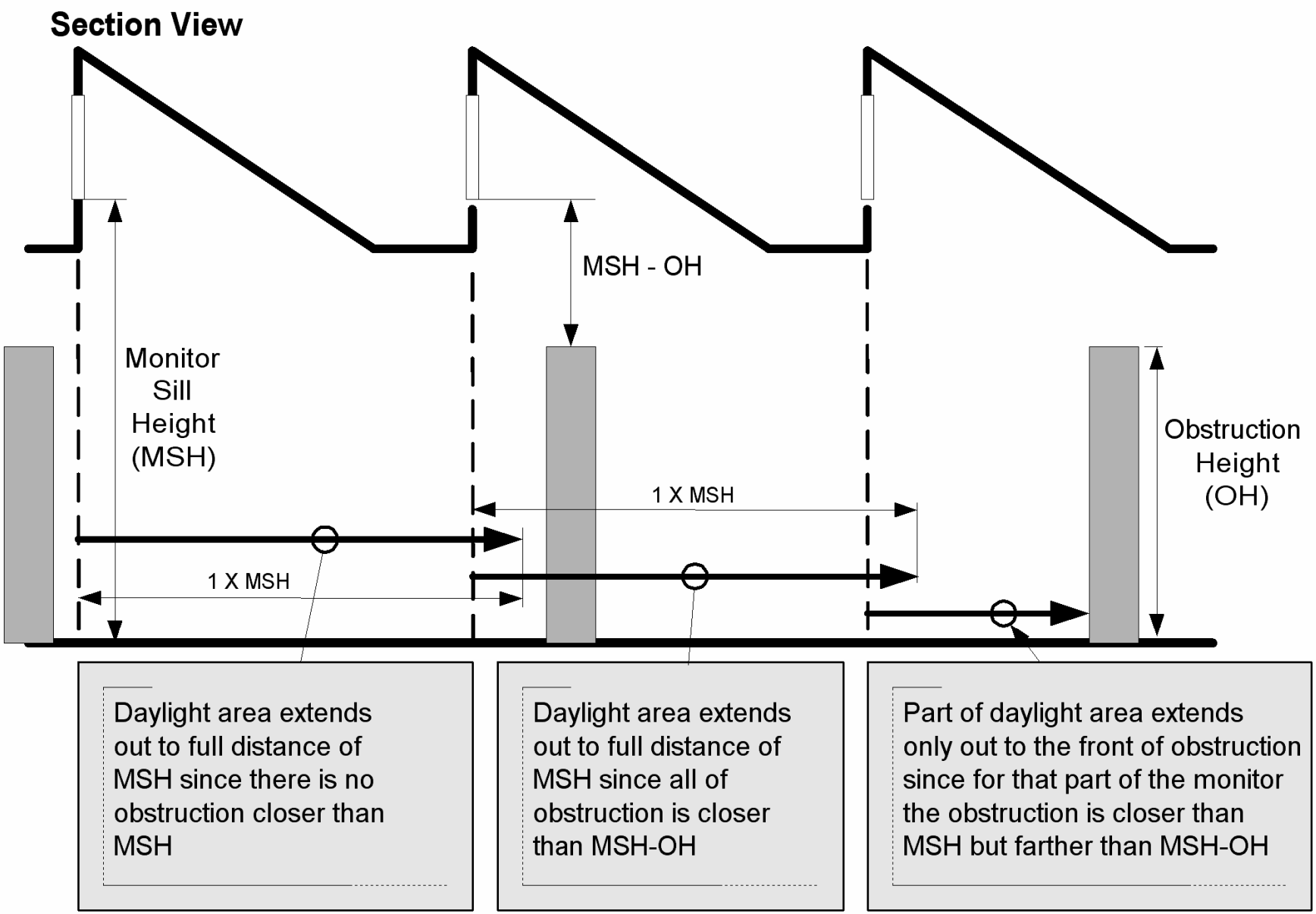
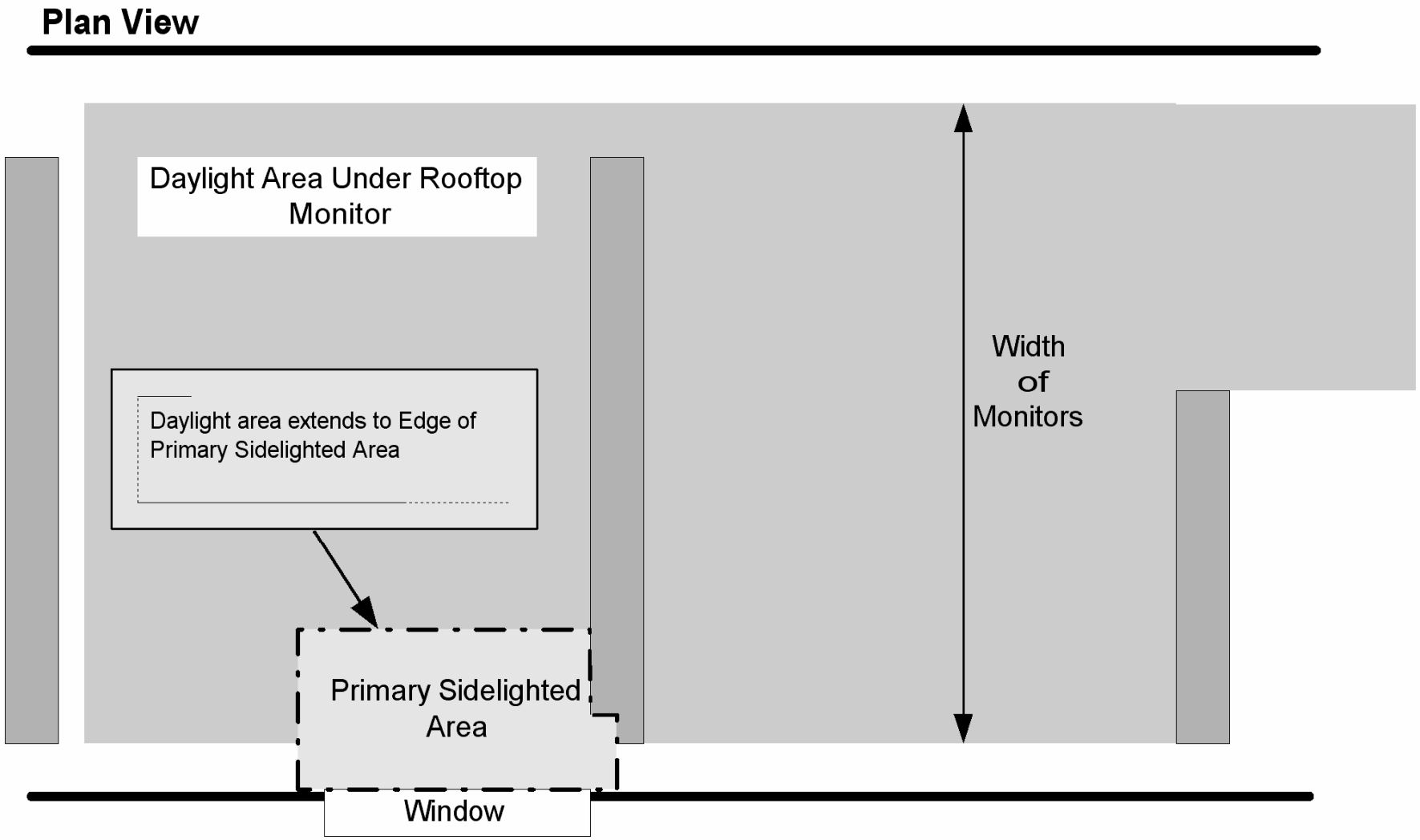
“Daylight Area Under Rooftop Monitors”





“Daylight Area Under Rooftop Monitors”

Lighting Control for Toplighting…Exceptions

The following are exempted from this requirement:

- Areas where direct beam sunlight is blocked by existing adjacent structures or natural objects for more than 1,500 daytime hours per year between 8 am and 4 pm.
- Areas where the “skylight effective aperture” (EA) of glazing is less than 0.006 (0.6%).
- Buildings in climate zone 8 with daylight areas totaling less than 8000 ft^2 in an enclosed space

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“Skylight Effective Aperture”

Skylight Effective Aperture is the overall amount of visible light transmittance of the roof via skylights:

$$\text{Skylight Effective Aperature} = \frac{0.85 \text{ x Skylight Area x Skylight VLT x WF}}{\text{Daylight area under skylights}}$$

Where,

Skylight area = total *fenestration area* of skylights

Skylight VLT = Area weighted average visible light transmittance of skylights as determined in accordance with Section 5.8.2.6

WF = Area weighted average well factor, where well factor is 0.9 if light well depth is less than 2 ft, or 0.7 if light well depth is 2 ft, or greater. Light well depth is measured vertically from the underside of the lowest point on the skylight glazing to the ceiling plane under the skylight.

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Lighting Control for Sidelighting

Requires control of electric lighting when sidelighting daylight is available in appropriate areas

- Applied based on “primary sidelighted area” exceeding 1000 ft^2.
- Control is required for the general lighting over these areas
- Control must be multi-level photocontrol
  - At least two output levels at 0% - 35% and 50% - 70%

    OR
  - Continuous dimming

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“Primary Sidelighted Area”

Primary sidelighted area is the combined primary sidelighted area without double counting overlapping areas.

- The basic sidelighted area is the sidelighted area width times the sidelighted area depth.
- The sidelighted area width is the width of the window plus, on each side, the smallest of:
  - 2 ft, or
  - the distance to any 5-foot or higher vertical obstruction.
- The sidelighted area depth is the smaller of:
  - one window head height (floor to the top of the glazing), or
  - the distance to any 5-foot or higher vertical obstruction.

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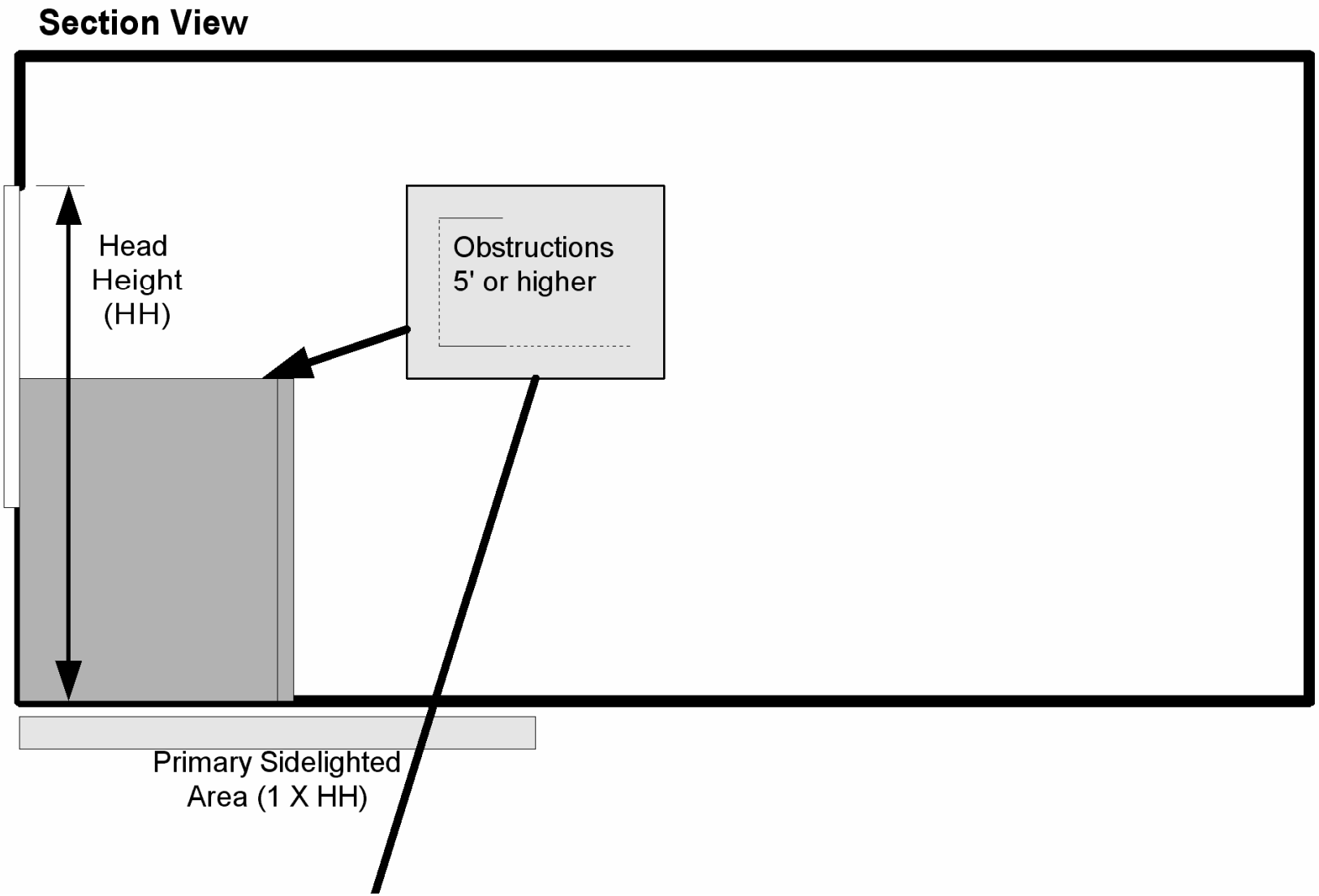
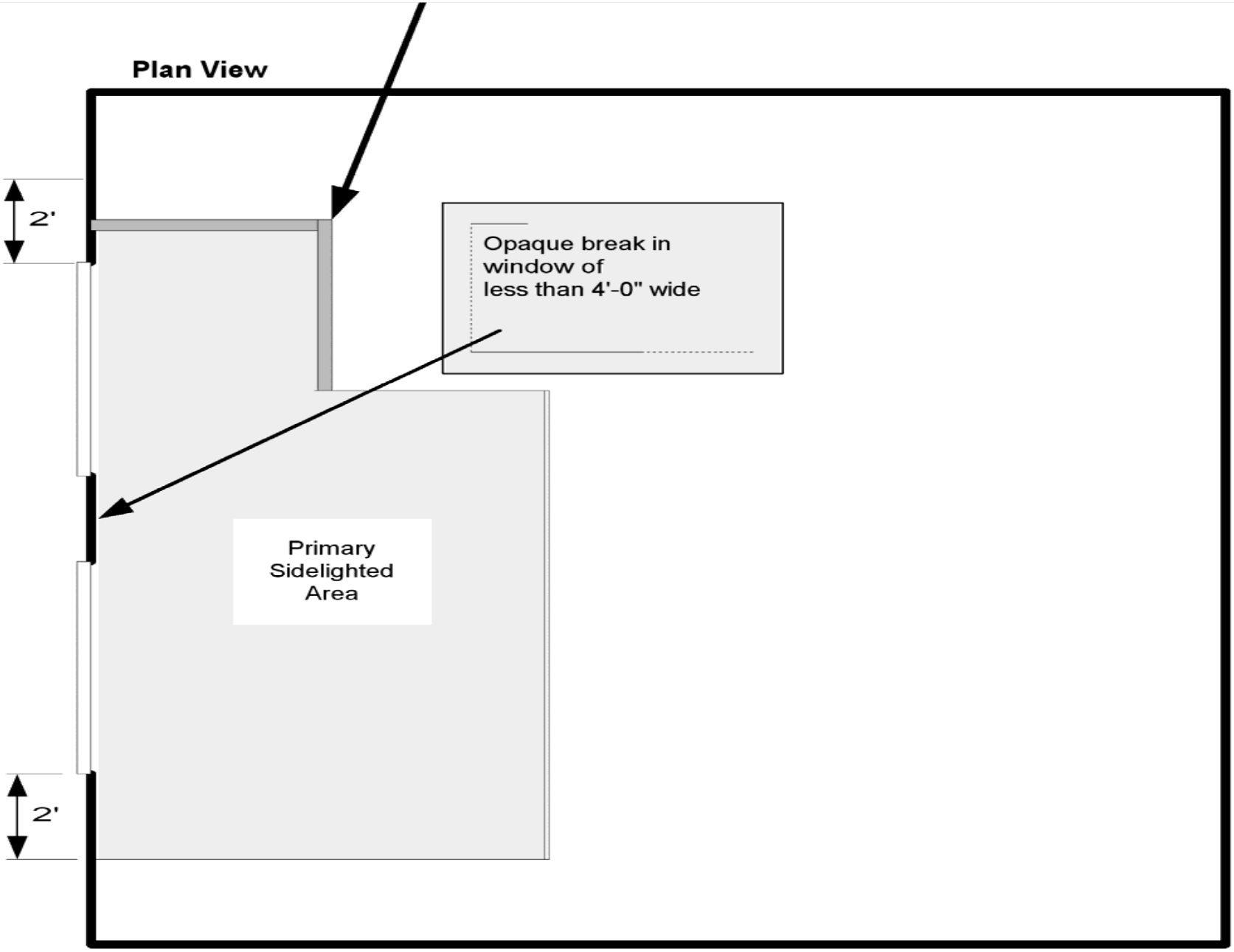
“Primary Sidelighted Area”





“Primary Sidelighted Area”

Lighting Control for Sidelighting…Exceptions

The following are exempted from this requirement:

- Areas where the top of existing adjacent structures are twice as high above the windows as their distance away from the windows.
- Areas where the “sidelighting effective aperture” is less than 0.1 (10%).
- Retail spaces

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“Sidelighting Effective Aperture”

Sidelighting Effective Aperture is the relationship of daylight transmitted through windows to the primary sidelighted areas:

$$Sidelighting\ Effective\ Aperture = \frac{\sum Window\ Area \times Window\ VLT}{Area\ of\ \mathrm{Pr}imary\ Sidelighted\ Area}$$

Where,

Window VLT, is the visible light transmittance of windows as determined in accordance with Section 5.8.2.6

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Required Skylight Design and Installation

Requires installation of skylights where appropriate

- Placed in the Envelope section
- Retains the existing max 5% skylight-to-roof area limit
- Applied based on calculated "daylight area under skylights"
- The "daylight area…" used for compliance must be at least 50% of enclosed area
- Requirement for each enclosed space (two options):
  - Total area of Installed skylights must be at least 3% of the "daylight area…" with VLT of at least 0.40 - OR -
  - The calculated "skylight effective aperture" in the space must be at least 1%.

[Addendum "al" to 90.1-2007 – In review]

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Required Skylights … Exceptions

The following are exempted from this requirement:

- Enclosed spaces in climate zones 6 through 8,
- Enclosed spaces with designed general lighting power densities less than 0.5 W/ft2
- Areas where direct beam sunlight is blocked for at least half the roof area over an enclosed area by existing adjacent structures or natural objects for more than 1,500 daytime hours per year between 8 am and 4 pm.
- Areas where the daylight area under rooftop monitors is greater than 50% of the enclosed space floor area.

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Other Potential Proposals for 90.1-2010

All very preliminary and in the consideration, data collection phase by the subcommittee

- Interior LPD revision
  - Would be based on lighting technical advancements
- New space/Bldg types
  - Always looking to increase the lists for better application
- Commissioning
- Ceiling height adjustment factor
  - Being considered for unusual space geometries
- Additional power allowance revision
  - Being considered based on possible favorable economics of technologies

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A few words about interpretations

Several options:

- Ask ASHRAE (www.ashrae.org) for an **official** interpretation
  - Considered the same as the written standard and published by ASHRAE
  - Response timeframe: Typically multiple months
- Ask ASHRAE (www.ashrae.org) for an **unofficial** interpretation
  - Considered an opinion from development staff – not published
  - Response timeframe: Typically days to weeks
- Email question to www.energycodes.gov
  - Not a formal interpretation but knowledgeable on the Intent, Compliance, and appropriate application
  - Response timeframe: Typically 24-48 hours
- State building department staff
  - Especially for State specific codes and amendments (MN, FL, WA, etc.)
  - Listing of State building contacts at “Status of Sate Codes” webpage on www.energycodes.gov

Questions? Comments? Issues?

Your input is very valuable to the Standards/Codes development process

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