

Advanced Energy Design Guide for K-12 School Buildings: Lighting and Daylighting Section

ASHRAE Summer Meeting – Seminar 60

June 25, 2008

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AEDG K-12

Lighting and Daylighting Subcommittee Members

- Mike Nicklas
 - Innovative Design
- Charles Eley
 - AEC
- Jim Benya
 - Benya Lighting Design
- Leslie Davis
 - Leslie Davis Lighting

Lighting Energy Use in Schools

- One of largest end uses
 - Up to 40% of total end uses
- One the top of the list for meeting 30% energy savings
 - Inexpensive and offer rapid payback
 - Helps to reduce cooling loads

K-12 AEDG: Lighting and Daylighting

- Recommendations developed for a daylit and a non-daylit option
 - Daylighting option provided due to significant energy savings potential combined with the many non-energy justifications of daylighting in a learning environment
 - Non-daylighting option provided due to projects with possible site or programming constraints
- Both options available for 30% savings over ASHRAE 90.1-1999

Daylighting Concepts in K-12 AEDGs

- Vertical fenestration and toplighting can provide interior illumination without excessive solar heat gain
- The key to good daylighting design is controls to take full advantage of the available daylight
- Sizing HVAC based on daylighting can offset additional costs of daylighting fenestrations

Daylighting Recommendations

- Sidelit, toplit, or combined sidelit/toplit options in all classrooms
- Toplit option in gym
- Daylighting fenestration area to floor area by daylighting type and orientation
- Daylighting controls
- Lighting Power Densities
- Interior surface reflectance
- No industry accepted “best” daylighting strategy

| Lighting | Interior Finishes | Exterior sun control (S, E, W only) | Projection factor > 0.5 |
|---|--|--|---|
| | | Interior room surface average reflectance | |
| Interior Lighting— Daylighted Option | Classroom daylighting (daylighting fenestration to floor area ratio) | | Toplighted— South-facing roof monitors: 8%–11% North-facing roof monitors: 12%–15% |
| | | | Sidelighted— South-facing: 8%–11% North-facing: 15%–20% |
| | | | Combined toplighted and sidelighted— South-facing sidelighted: 6%–8% Toplighted: 2%–3% North-facing sidelighted: 9%–13% Toplighted: 3%–5% |
| | | Gym toplighting (daylighting fenestration to floor area ratio) | South-facing roof monitors: 5%–8% North-facing roof monitors: 7%–10% |
| | | LPD | 1.2 W/ft ² maximum |
| | | Light source system efficacy (linear fluorescent) | 75 mean lm/W minimum |
| | | Light source system efficacy (all other sources) | 50 mean lm/W minimum |
| Interior Lighting— Non-Daylighted Option | Occupancy controls | | Manual on, auto off all zones |
| | Dimming controls daylight harvesting | | Dim all fixtures in classrooms and gym and other fixtures within 15 ft of sidelighting edge and within 10 ft of toplighting edge |
| | LPD | | 1.1 W/ft ² |
| | Light source system efficacy (linear fluorescent) | | 85 mean lm/W minimum |
| | Light source system efficacy (all other sources) | | 50 mean lm/W minimum |
| | Occupancy controls—general | | Manual on, auto off all zones |
| | Dimming controls daylight harvesting | | Dim fixtures within 15 ft of sidelighting edge and within 10 ft of toplighting edge |

Daylighting How-To-Tips in K-12 AEDGs

- Separate daylighting fenestration from view glass
- Design the daylighting system to provide enough, but not too much daylighting
- Daylighting must be “superior” to electrical lighting
 - Provide all lighting needs for 50% to 75% of occupied hours
- Daylighting in classrooms is the most critical, with gyms next
 - Also consider media center, cafeteria, offices, and corridors
- Orient classrooms to face either north or south

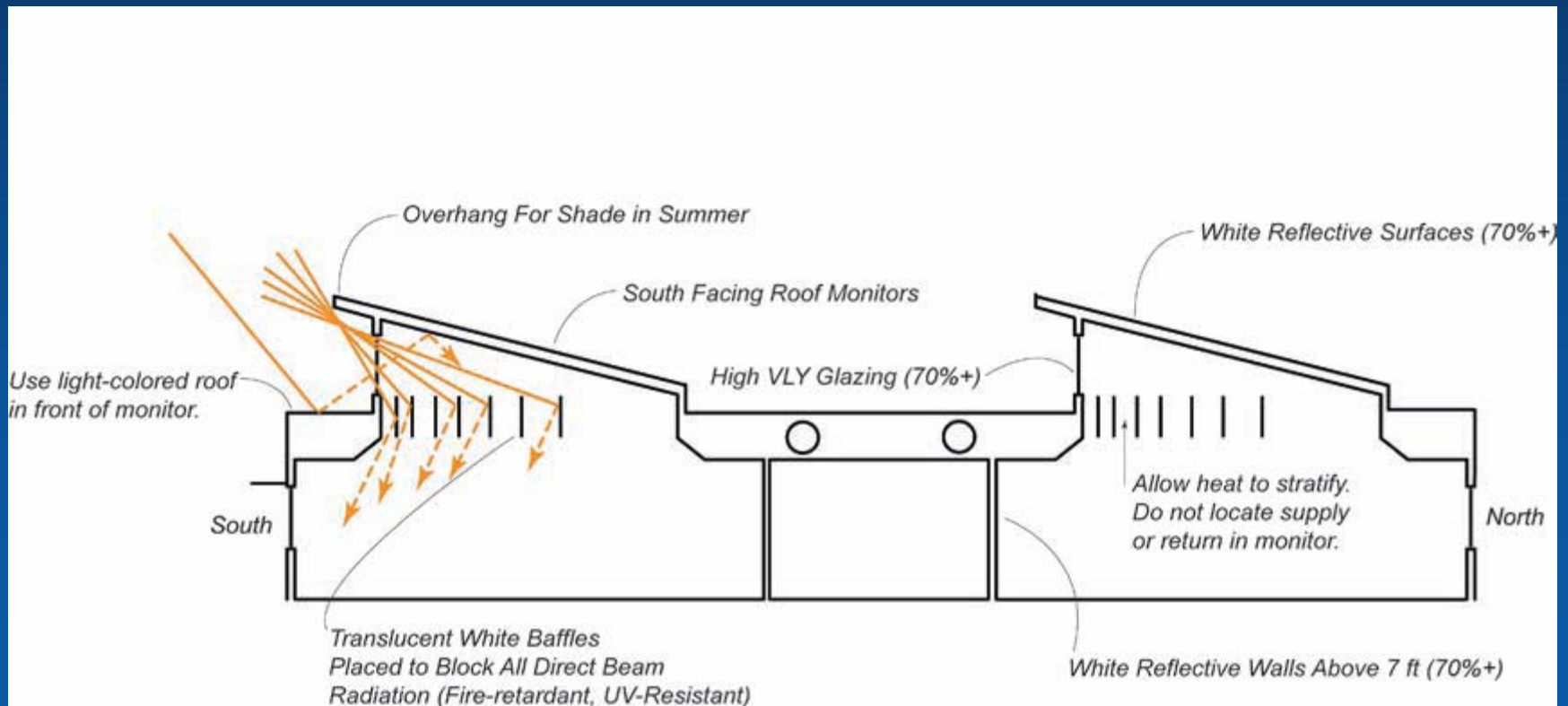


Daylighting How-To-Tips in K-12 AEDGs

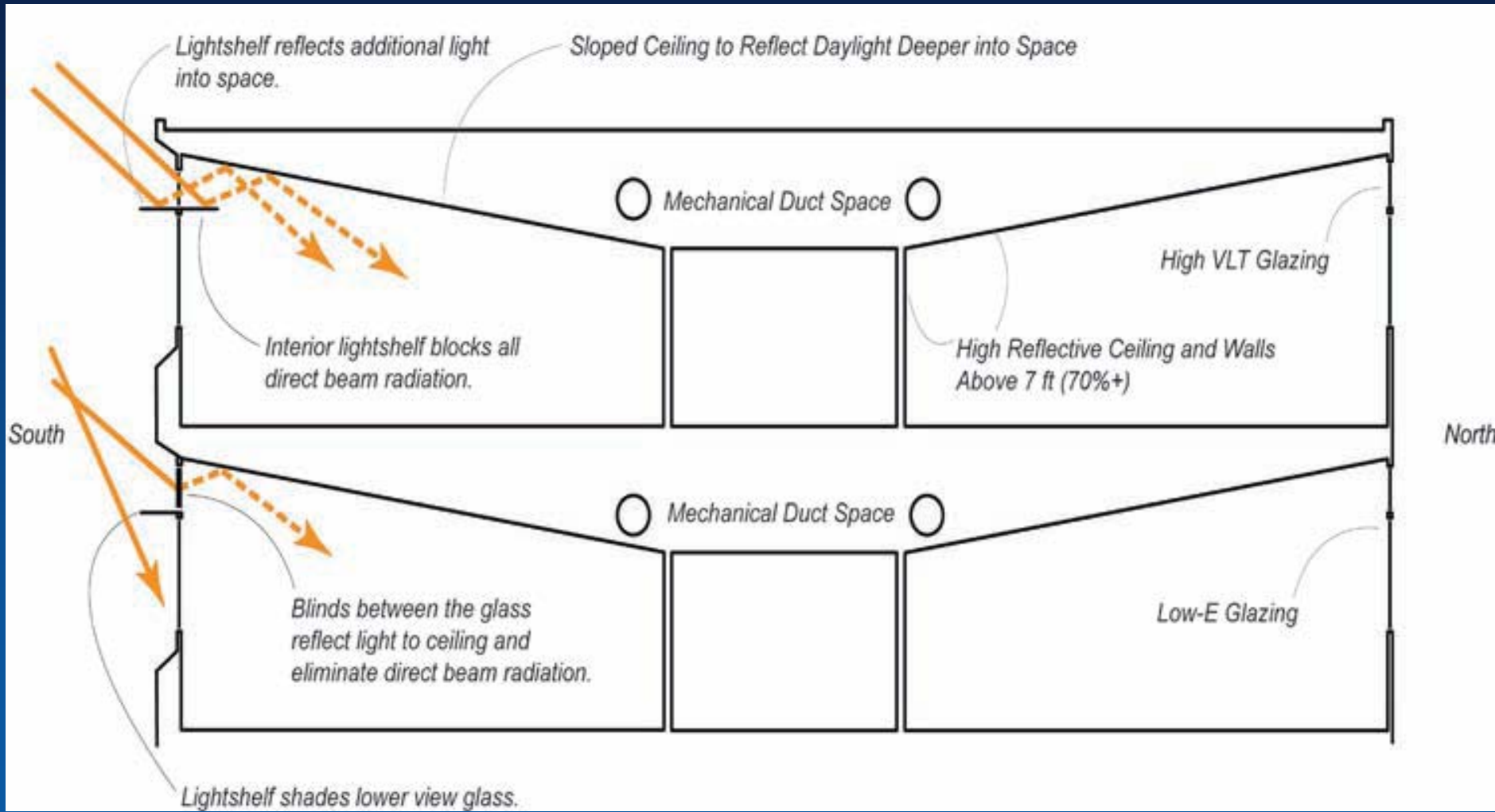
- High ceiling heights
 - Greater than 10'
- Eliminate direct beam penetration
 - Exterior shading
 - Light shelves
 - Diffusing films
 - Baffles
- High reflectance on ceiling surfaces
- Dimming controls
- High visible transmittance for daylighting fenestration
 - Greater than 60%

Classroom Toplighting

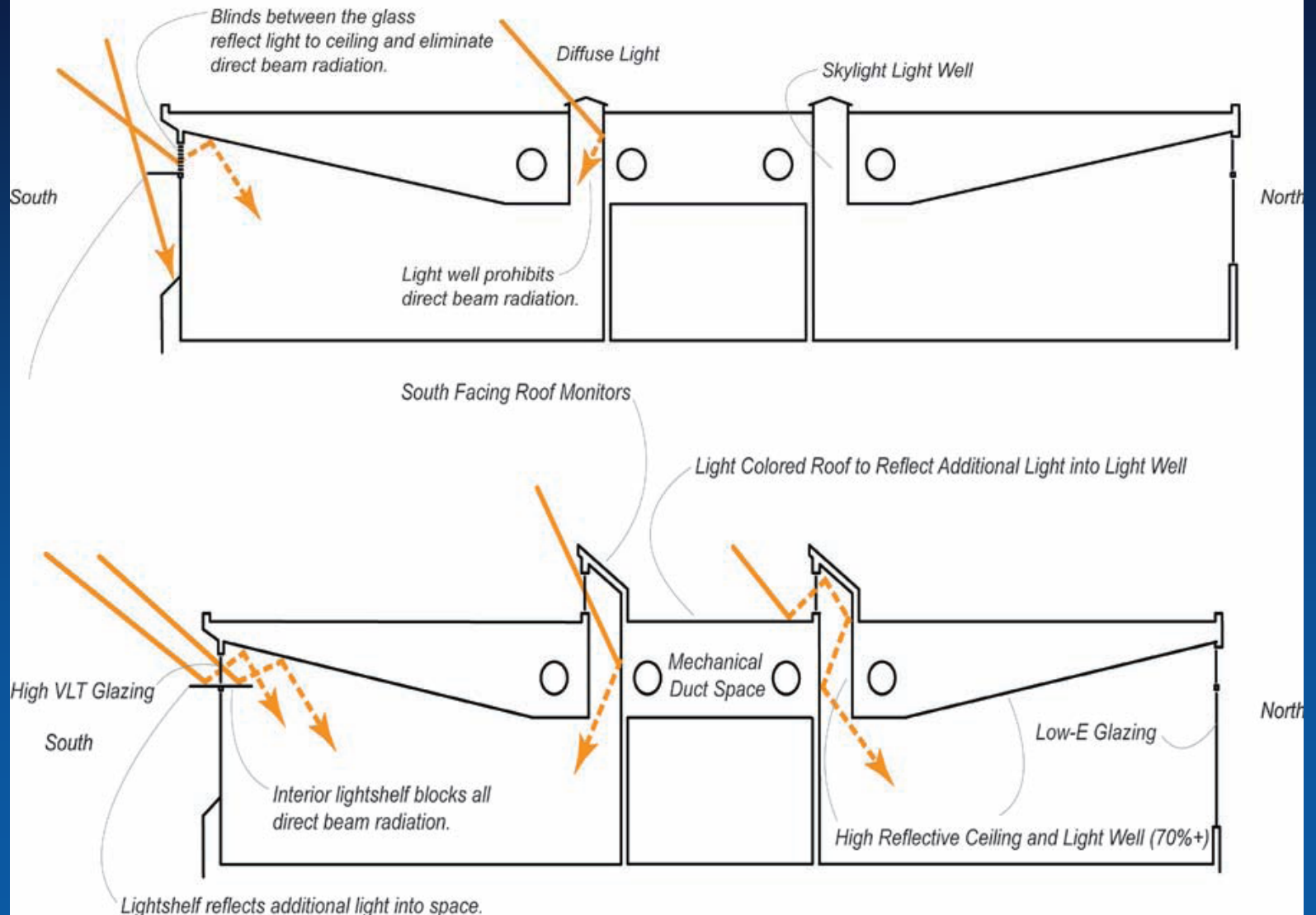
- Daylighting for top floor or single story schools
- North or South facing clerestories



Classroom Sidelighting



Classroom Sidelighting with Toplighting



Summary of Daylighting Fenestration to Floor Area Ratios

- K-12 AEDG provides general daylighting fenestration area
 - Guide recommends a detailed daylight analysis to make evaluating trade-offs and designs more precise

| Daylighting Strategy | Classroom | Gymnasium/Multipurpose Room |
|---|-----------|-----------------------------|
| South-Facing Roof Monitor | 8%–11% | 5%–8% |
| North-Facing Roof Monitor | 12%–15% | 7%–10% |
| South Light Shelf | 8%–11% | |
| South Light Shelf with Blinds Between Glazing | 15%–20% | |
| High, North Glazing | 15%–20% | |
| Skylights | | 3%–5% |
| Tubular Daylighting Devices | | 2%–3% |

Electrical Lighting Concepts

- Use the most current, state-of-the art lamps, ballasts, controls, and techniques to design electrical lighting
 - When daylighting options are not possible
- Lower lighting power density recommendations than daylighting option
 - Low LPDs not critical if lights are off
- Daylighting controls near windows and skylights

Electrical Lighting Recommendations

- Use when daylighting options can not be met
- Lower LPDs
 - 1.1 W/ft²
 - 0.9 W/ft² in CZ 3 and 4
- Light source efficacy
- Some daylighting controls
- Occupancy sensors

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Electrical Lighting How-To-Tips in K-12 AEDGs

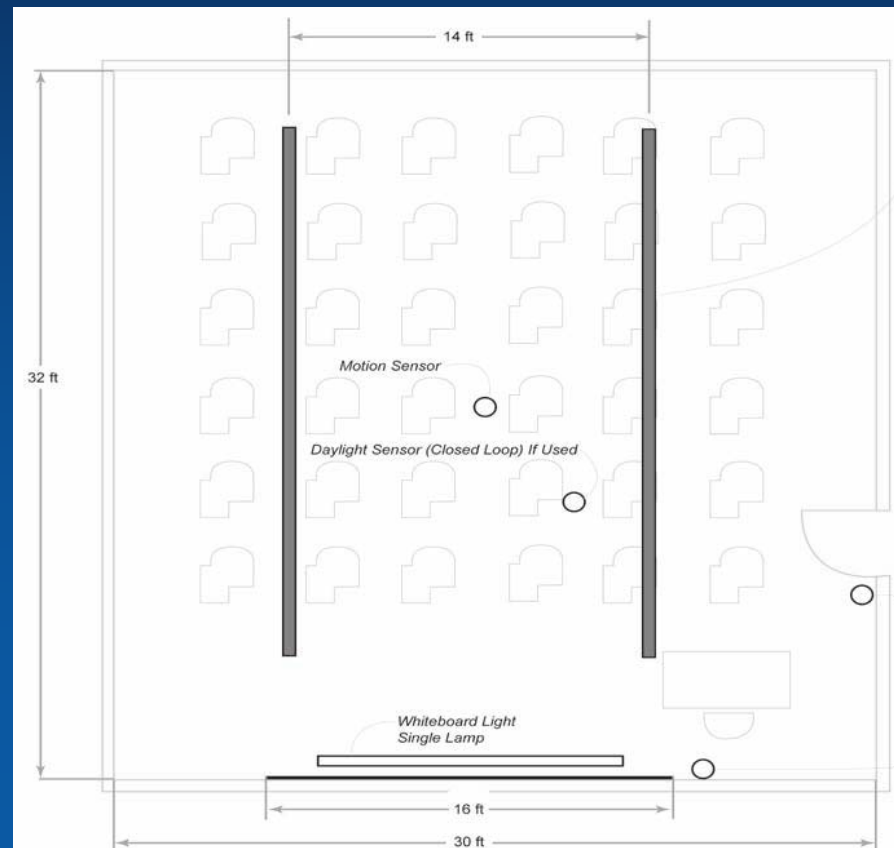
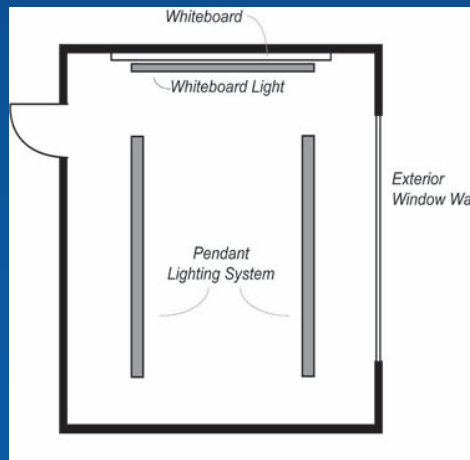
- Interior Finishes
 - Ceiling greater than 70%
- Efficacy of Linear Fluorescent
 - Mean lamp lumens per watt (MLPW) greater than 75
 - High efficiency T8s, or efficient instant start ballasts
- Lighting scenes for A/V

Electrical Lighting How-To-Tips in K-12 AEDGs

- T5 lamps greater than 75 MLPW
- Compact Fluorescent
 - 50 MLPW or greater
 - Electronic ballast
 - Use for utility lighting, down lighting, wall washing
 - Not for general lighting
- Metal halide
 - 50 MLPW or 75 MLPW
 - Electronic ballast, Pulse start
- Occupancy Sensors
 - Manual on/auto off in all classrooms, offices, restrooms, and special use spaces

Electrical Lighting Layout How-To-Tips in K-12 AEDGs

- Fixture layout by space type
- Luminaries distribution
 - Direct
 - Indirect
 - Combination



Questions?

