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# TDV Lighting Controls

2008 Title 24 Codes and Standards Enhancements  
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Analysis conducted by:

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For:

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# Background

- 2005 Title 24 allows Power Adjustment Factors (PAF) for various lighting controls
  - Bi-level enabled occupancy sensors
  - Manual Dimming and Multi-scene Programmable
  - Daylighting Controls
- PAFs listed in table 146-A
- PAF taken as a fixed reduction in wattage for all hours of occupancy in space
  - No accounting for timing of energy savings
  - Important with Time Dependent Valuation (TDV)

# CASE Scope and Workplan

- Account for the effect of TDV on lighting controls
  - TDV used to calculate prescriptive PAF's
    - Determine the need to change PAF's based on TDV effects
- Propose Hourly control credits for performance method
  - Based on best available monitoring data
  - Hourly credits to be implemented through reduction in hours of lighting system operation
  - Placeholders for controls without reliable data

# Data Collection

- Data collected from literature review and researchers
  - Good data for occupancy sensors in small areas from published studies
    - Small Private Offices
    - Classrooms
  - Manufacturer data on Warehouses, Libraries
  - No data on hallway occupancy sensor, manual dimming, multi-scene programmable controls
  - Daylighting controls not included in this CASE
- TDV spreadsheet model created
  - Compare savings from controls to prescriptive PAF's

# Analysis Terminology

| Term   | Abbrev.         | Explanation  |
|--|-----------------|--|
| Raw hourly adjustment factor                   | $rHAF_{h,d}$    | From the raw research data, savings as a proportion of baseline consumption for each hour and each day type (note, this value is the same whether TDV-weighted or not) |
| Raw daily adjustment factor                    | $rDAF_{TDV,d}$  | From the raw research data, average savings as a proportion of baseline for each day type (Saturday, Sunday, weekday), weighted by the varying TDV value of each hour  |
| Raw power adjustment factor (kWh)              | $rPAF_{kWh}$    | From the raw research data, average savings as a proportion of baseline for the whole week (note, this is not TDV-weighted)  |
| Raw power adjustment factor (TDV-weighted kWh) | $rPAF_{TDVkWh}$ | From the raw research data, average savings as a proportion of baseline for the whole week, weighted by the varying TDV value of each hour                             |
| Hourly adjustment factor                       | $HAF_{h,d}$     | Final, smoothed and adjusted hourly adjustment factors for each hour and each day type, proposed for use in Title 24 2008  |
| Power adjustment factor (kWh)                  | $PAF_{kWh}$     | Power adjustment factor based on total energy consumption.   |
| Power adjustment factor (TDV-weighted kWh)     | $PAF_{TDVkWh}$  | Power adjustment factor based on TDV-weighted energy consumption; can be compared with PAFs in table 146-A of Title 24 2005  |

# PAF Comparison

|  |                          | Raw Data from Research   |                          | PAFs from<br>T24 2005 |
|--|--------------------------|--------------------------|--------------------------|-----------------------|
|  |                          | kWh                      | TDV-weighted<br>kWh      |                       |
| Spaces <250 sq ft                                  | rDAF <sub>Saturday</sub> | no data                  | no data                  | 0.20                  |
|  | rDAF <sub>Sunday</sub>   | no data                  | no data                  | 0.20                  |
|  | rDAF <sub>weekday</sub>  | 0.37                     | 0.36                     | 0.20                  |
|  | <b>PAF</b>               | <b>0.27</b>              | <b>0.27</b>              | <b>0.20</b>           |
| Hallways of<br>hotels/motels                       | rDAF <sub>Saturday</sub> | insufficient data        | insufficient data        | 0.25                  |
|  | rDAF <sub>Sunday</sub>   | insufficient data        | insufficient data        | 0.25                  |
|  | rDAF <sub>weekday</sub>  | insufficient data        | insufficient data        | 0.25                  |
|  | <b>PAF</b>               | <b>insufficient data</b> | <b>insufficient data</b> | <b>0.25</b>           |
| Commercial and<br>industrial storage<br>rack areas | rDAF <sub>Saturday</sub> | 0.26                     | 0.26                     | 0.15                  |
|  | rDAF <sub>Sunday</sub>   | 0.27                     | 0.27                     | 0.15                  |
|  | rDAF <sub>weekday</sub>  | 0.29                     | 0.29                     | 0.15                  |
|  | <b>PAF</b>               | <b>0.28</b>              | <b>0.28</b>              | <b>0.15</b>           |
| Library stacks                                     | rDAF <sub>Saturday</sub> | 0.30                     | 0.30                     | 0.15                  |
|  | rDAF <sub>Sunday</sub>   | 0.24                     | 0.24                     | 0.15                  |
|  | rDAF <sub>weekday</sub>  | 0.33                     | 0.31                     | 0.15                  |
|  | <b>rPAF</b>              | <b>0.31</b>              | <b>0.30</b>              | <b>0.15</b>           |

# Results Summary

- Current PAF values adequate and appropriate
  - Spaces with good data, PAF's are 60% of raw savings
  - Insufficient data on most controls to justify change in PAF
  - Less longevity/reliability than electric lighting
    - DEER database: occupancy sensor life 8 – 10 years
- Prescriptive Compliance: TDV weighted PAF's to have same value as current PAF's
- Performance Method: Hourly Adjustment Factors for lighting schedule
  - Annual savings from HAF's same as Prescriptive PAF

# ACM Changes

- Add Controlled Lighting Schedules
  - Table N2-5: Nonresidential Occupancy Schedules (Other than Retail)
  - Controlled lighting schedule calculated as
    - Hourly uncontrolled lighting schedule x (1- HAF)
- Add 24-Hour lighting schedule for Hallways
  - Controlled lighting schedule for hallways based on this 24-hour schedule
- Method also applied to controls with no research data on savings
  - HAF's are constant for all hours of day



# Multiple controls in single space

- DOE-2.1E (reference program) allows only two schedules per space
  - Lighting
  - Task-Lighting (cannot use daylighting command)
- More than two controls – divide up into two spaces with separate lighting schedules
  - Divide spaces relative to wattage on each control
    - Floor area, wall area, fenestration area
- In daylit areas, create wattage weighted schedules
  - Non-daylit areas – Task-Lighting
  - Daylit area - Lighting

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# Combined Occupancy and Daylighting Controls

- When occupancy based controls used in conjunction with photocontrols
  - Occupancy control results in change in schedule
  - Daylighting control modeled using DAYLIGHTING command in reference program (DOE-2.1E)
    - Savings a function of daylight availability
- Methods of modeling daylighting in PG&E Sidelighting and Skylighting CASE studies

# Summary of Changes

- Has no effect on prescriptive method
  - PAF's are the same as in 2005
- Little change in the performance method
  - Savings balanced across peak and off-peak periods
- Sets the framework in place to credit controls that primarily reduce peak consumption
- Compatible with TDV
  - Lighting savings vary with respect to time of day

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