Sacramento Municipal Utility District
Customer Service Center
Sacramento, California

**Type:**
Office Building

**Site Sponsors:**
Ledalite Architectural Products, Inc.
Advance Transformer Co.
Lighting Research Center
Project Profile

The new Customer Service Center (CSC) at the Sacramento Municipal Utility District (SMUD) consolidates all customer-related activities into one building near its administrative headquarters in Sacramento, California. The CSC is a 184,000 square foot (17,100 square meter) facility. Its four wings, linked by a central lobby hub, were specifically designed to use the abundant California sunshine as a light source.

Each wing is a 70-foot deep (21 meter) rectangle running east to west. The southwest and southeast wings are smaller and lower than the four-story northwest and northeast wings, allowing direct sunlight to strike all south-facing walls. North-facing walls have large windows, while south-facing walls have small windows with exterior and interior light shelves to limit glare and bounce light deeper into the office space. All windows have vertical blinds so that employees can manually control window glare. Additional deep-well skylights on the top floors of each wing provide diffuse daylighting for office workers on these floors.

Most CSC employees have open-office workstations, where they use computers and perform a variety of paper tasks. Direct/indirect linear fluorescent luminaires, dimmed by photosensor feedback during the day, maintain a low level of ambient lighting. Employees use adjustable compact fluorescent task lights to boost light levels at their desks as needed. A programmable energy management system (EMS) can switch ambient office lighting to accommodate flexible work schedules and after-hours maintenance crews.

A grove of native redwood trees is surrounded by a dramatic three-story glass-wall lobby; the trees filter the sunlight and serve as a focal point. At dusk, uplights in the lobby switch on to highlight the architectural design.

DELTA also studied small copy rooms with manual on/auto off occupancy sensors and sunny employee break rooms with vertical blinds, which offer a change of atmosphere from the offices.
Lighting Objectives

- Use energy-efficient lighting products to reduce the lighting power density to well below that allowed by the California energy code.
- Demonstrate the energy-saving potential of controlled daylighting in office spaces.
- Provide low-glare ambient lighting for computer users.
- Provide flexible, individually controlled task lighting at employees’ workstations to increase task illuminance when desired.
- Demonstrate the benefits of quality lighting design in an office space using commercially available technology.

Lighting and Control Features

- Direct/indirect lighting. Suspended linear fluorescent luminaires distribute light evenly across the ceiling while directly lighting work surfaces.
- Energy efficiency. Primary light sources are T8 fluorescent lamps powered by electronic dimming ballasts. Luminaire-mounted photosensors signal ballasts to dim electric lighting continuously in response to the available daylight.
- Architectural daylighting. Large windows, light shelves, and skylights admit controlled daylight into the open offices, while operable blinds and louvers provide additional glare control when needed.
- Low-power, adjustable task lights. Employees can move their adjustable-arm task lights to supplement ambient light levels in their workstations.
- Occupancy sensors. Lights in copy rooms and private offices are automatically switched off after occupants leave the room.

Techniques

Project Specifications
The principal light source for the CSC is the F32T8 4’ (1220 mm) rapid-start (RS) lamp with a color rendering index (CRI) of 75 and a correlated color temperature (CCT) of 3000 K (warm). These lamps are used in suspended up/downlights, wall-mounted uplights, architectural slots recessed in light shelves, and recessed troffers. CFT9W compact fluorescent lamps (CFLs) with a CRI of 82 and CCT of 2700 K are used in task lights and downlights. Lobby uplights use coated 400-W metal halide (MH) lamps, 3700 K and 70 CRI.

Ballasts for T8 lamps are two- and three-lamp RS electronic dimming ballasts, capable of continuous dimming down to 20% of maximum light output. (Newer versions of this ballast are capable of dimming down to 5% output.) Most of the CFL lamps are powered by high power factor (HPF) magnetic ballasts, although the adjustable task lights use two-lamp HPF electronic ballasts. HPF magnetic ballasts power the MH lamps.
A Pendant-mounted fluorescent direct/indirect luminaire (70% up/30% down), one lamp in cross section, with 2.25" high (57 mm) specular parabolic louvers spaced 3" (76 mm) apart in downlight aperture. Oval extruded aluminum housing, 3" x 10.5" (76 x 270 mm), in continuous rows. Lamp: F32T8/RE730

B Wall-mounted fluorescent uplight, one lamp in cross section, with asymmetric distribution. Oval extruded aluminum housing, 3.5" x 9" (89 x 230 mm). Lamp: F32T8/RE730

C Architectural light slot recessed in light shelf for accent lighting of vertical blinds below. Slot equipped with 6' (1.8 m) fluorescent striplight, one lamp in cross section, and 1" x 1" x 1" (25 x 25 x 25 mm) cell louver. Louver finish is matte gray. Lamps: (2) F25T8/RE730

D Recessed CFL downlight, 8" (200 mm) diameter aperture with 3" (76 mm) high, clear specular parabolic cross baffles. Lamps: (2) CFT9W/RE827

E Recessed CFL downlight, 8" (200 mm) diameter open aperture with black multigroove baffle. Lamps: (2) CFT9W/RE827
**F** Recessed 1’ x 4’ (0.3 x 1.2 m) luminaire with 9-cell, 3” (76 mm) deep semispecular parabolic louver. One lamp per luminaire, but lamps tandem-wired to adjacent luminaires to avoid use of one-lamp ballasts. Lamp: F32T8/RE730

**G** Wall-mounted MH upright located 27’ (7.9 m) above floor to light the ceiling of the main lobby. Yoke mounting provides aiming adjustment of the cylindrical extruded aluminum housing. 10” high x 16” wide x 24” projection (250 mm x 410 mm x 610 mm). Integral ballast. Lamp: MH400/CU

**H** Track-mounted CFL floodlight located in third-story window niches to uplight the perimeter of the lobby ceiling. Oval cast aluminum housing, 4” x 6” x 12” (100 x 150 x 300 mm). Lamps: (2) CFT13W/RE827

**J** Task light mounted to work-station partition. Rotatable head 8” wide x 10” long x 1-1/2” high (200 x 250 x 38 mm), attached to a hinged arm. A specular silver plastic louver with cells 5/8” x 5/8” x 3/8” (16 x 16 x 10 mm) blocks light above a 45° viewing angle. Lamps: (2) CFT9W/RE827

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**Wattage**

Input wattages for luminaires include ballast watts and are estimated from manufacturers’ published literature. All calculations were based on the following values:

- **T8 fluorescent lamps (electronic dimming ballast at full output)**
  - F32T8 (4’): 30 W per lamp for 2- or 3-lamp RS ballast
  - F25T8 (3’): 23 W per lamp for 2-lamp RS ballast

- **Compact fluorescent lamps (electronic ballast)**
  - CFT9W: 18.5 W per 2-lamp HPF ballast

- **Compact fluorescent lamps (magnetic ballast)**
  - CFT13W: 34 W per 2-lamp HPF ballast
  - CFT9W: 13 W per 1-lamp HPF ballast

- **Metal halide lamps**
  - MH400W: 458 W per 1-lamp HPF ballast
Details

**Third floor open office**

The open offices on this floor of the CSC’s northeast wing are representative of most of the offices in the building. Employees work flexible hours, but most are at their desks from 8:00 a.m. to 4:00 p.m. They respond to customer calls and correspondence, spending a large part of their day working at computers. During daylight hours, a combination of

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3rd floor, north wall

3rd floor, south wall

Cross section of 3rd floor, day

Cross section of 3rd floor, night
controlled daylight and electric lighting provides 28 to 98 footcandles (fc) (300 to 1100 lux [lx]) on the workplane, depending on proximity to windows. (See cross section.) Rows of direct/indirect luminaires (type A) are suspended 28” (700 mm) overall from the ceiling, spaced 8’ (2.4 m) on center. A photosensor mounted on the bottom side of each row of luminaires signals the electronic dimming ballasts to dim the lamps in response to the amount of light it senses. Within 15’ (6.1 m) of the windows, the system is set to maintain a minimum of 30 fc (320 lx) on the workplane. After dark the electric lighting alone provides 24 to 30 fc (260 to 330 lx) on the workplane.

The ceiling luminances are very uniform, ranging from 70 to 220 cd/m². This falls within the maximum 4:1 ratio recommended by the Illuminating Engineering Society of North America’s Recommended Practice for Office Lighting (ANSI/IESNA RP-1-1993). Only the section of ceiling directly above the interior light shelf at the south wall exceeds this luminance ratio. After sunset, the ceiling luminance patterns are even more uniform, not exceeding 3:1 maximum to minimum.

Built into each window light shelf is a louvered fluorescent light slot (type C) that washes the vertical blinds with light so that the blinds are not in silhouette against the bright window. At night, the lighted blinds provide vertical surface brightness, which helps the office look open and inviting to employees working late. Recessed CFL downlights (type E) perform the same function, accenting the columns between windows. After dark the electric lighting alone provides 24 to 30 fc (260 to 330 lx) on the workplane.

The architectural daylighting features windows, light shelves, and skylights. All windows are double-glazed for thermal insulation. South- and east-facing windows are divided by an exterior light shelf. The windows above the shelf are clear; the lower windows are low-e (“low-emissivity”) glass, tinted for 30% light transmission. The light shelves extend inside the glass and are painted white to maximize the reflection of low-angle sunlight onto the ceiling. A suspended translucent “sail” of woven white plastic extends the light shelf further into the office. It diffuses and redirects sunlight onto the ceiling, providing a pleasant glow while blocking upper window glare.

The light-colored, perforated vertical blinds block 95% of the daylight, allowing employees to eliminate glare while retaining the view.

North-facing windows in this area are larger than south-facing windows and are also fitted with blinds, but they have no light shelves or sails. DELTA observed that the blinds are rarely drawn on the north side because direct sun-light seldom reaches this face of the building. As a result, daytime illuminances here are higher, from 47 to 98 fc (500 to 1100 lx) with no blinds used. Nighttime illuminances at all window workstations are 24 to 29 fc (260 to 310 lx).

**Fourth floor open office**

The lighting system on the fourth floor differs from lighting on lower floors. Large 4’ x 6’ (1.2 x 1.8 m) skylights with splayed light wells are spaced on a 24’ x 20’ (7.3 x 6.1 m) grid. Each skylight distributes cheerful daylight to many workstations with no uncomfortable heat or glare.

The architectural daylighting features large skylights and light shelves. The skylights are splayed to allow daylight to enter the office without overheating. The light shelves are designed to wash the vertical blinds with light, creating an inviting atmosphere. Recessed lights accent the columns between windows, providing additional illumination.

**4th floor, day**

**4th floor, night**
The translucent skylight material is a triple layer of plastics with a prismatic layer sandwiched between clear layers to diffuse direct sunlight. Daytime desktop illuminances range as follows:

**Directly under skylights:**
- 35 to 150 fc (370 to 1600 lx)
**At the edge of skylight opening:**
- 27 to 57 fc (290 to 620 lx)
**Between skylights:**
- 18 to 50 fc (180 to 540 lx).

The south-facing wall is constructed with light shelves, but unlike the lower floors, these have no internal sail. In order to accommodate the pattern of skylights, the direct/indirect luminaires (type A) run north to south across the space, perpendicular to the linear luminaires on lower floors. The light output of all of these luminaires is controlled by photosensors mounted on the bottom side of the luminaires, regardless of their proximity to windows.

**Workstations and task lighting**

Most of the open office workstations have partitions that are 61” (1.5 m) high or less, but several offices have 81” (2.1 m) partitions. Unfortunately, taller partitions located next to windows block daylight and views for employees working near the center of the floor. All workstations have light- to medium-color finishes (between 30% and 50% reflectance), and most have an L-shaped work surface with a corner bookshelf above the computer screen.

Workstations were intentionally configured without overhead bins in order to reduce shadows on work surfaces.

Every workstation has a movable-arm task light mounted on a vertical joint in the panel. Employees can reposition their task lights within their workstations, so task light use varies widely. Some employees prefer the task light about 18” (460 mm) above the desktop for an additional 70 fc (750 lx) of reading light. Others extend the arm as high as 30” (760 mm) above the desktop, using it as an area light which puts an additional 30 fc (320 lx) on the desktop. A few individuals believe they have insufficient ambient light in their workstations and use two task lights at once; others do...
partially closed to block the morning sun. Downlights (type E) provide supplemental lighting on overcast days or after dark.

**Employee break rooms**

In these areas, direct sunlight is allowed to pour in freely. With light finishes and full-height windows, the break rooms are bright, cheerful places for employees to retreat from the office routine and take a visual break from their office interiors. Short sections of direct/indirect luminaires (type A) are suspended near the curved north wall, where the vertical blinds are usually open. Blinds on the east window wall can be not even turn on their task lights. (See Project Evaluation on p. 10 for more detail on employee reaction to task lights.)

**Main Lobby**

The lobby's three-story window walls encircle an open atrium that is home to a small grove of indigenous redwoods. The glass walls provide a view to the trees, which in turn shade the lobby from intense sunlight. At sundown, the segmented dry-wall ceiling is uplighted with MH wall sconces (type G), and the third-story window niches are uplighted with track-mounted CFL floodlights (type H). Nighttime floor illuminances range only from 6 to 7 fc (65 to 75 lx), but the space appears bright and visually appealing because wall and ceiling surfaces are lighted.
Project Evaluation

Energy Impact
DELA used input watts from manufacturers’ literature to calculate the lighting power density (LPD) for the entire CSC. The maximum LPD for all conditioned space in the building is 0.87 W/ft² (9.4 W/m²). However, the in-use power density during the core office hours (8:00 a.m. to 4:00 p.m.) drops to 0.58 W/ft² (6.2 W/m²). Most of the difference (0.18 W/ft² [1.94 W/m²]) reflects DELTA’s observation that during core hours the following conditions prevailed:

- Only about one-third of the task lights were on.
- Most of the automatically dimmable fluorescent luminaires were operating at reduced output.
- The lobby lighting was switched off by a photosensor.

The table below summarizes the power densities in the building compared to ASHRAE/IES 90.1-1989 energy standards and the California Energy Commission Energy Efficiency Standards (Title 24).

Controls
Lighting control in the CSC is primarily accomplished with three methods: architectural design for daylighting, photosensor-controlled electronic dimming ballasts, and an EMS. In addition, occupancy sensors are used in small rooms, and lumen maintenance strategies can be employed for general lighting.

Design for daylighting By controlling how much sunlight and heat enter the building, the architectural design of the CSC limits energy use by reducing the maximum capacity of the heating, ventilation, and air conditioning (HVAC) systems needed for occupant comfort. Introducing daylight also reduces the demand for electric lighting.

Dimming by daylight sensing The layout of the direct/indirect luminaires (type A) in the open office areas was designed to maintain 30 fc (320 lx) on the workplane. During the day, when daylight provides a substantial portion of that illumination, photosensors mounted on the bottom of the luminaires detect excess light levels and signal the ballasts to dim the electric lighting until the level is back to 30 fc (320 lx), or until the fluorescent lamps are dimmed to their lowest setting, 20% of their maximum light output. DELTA estimates that dimming by daylight sensing at the CSC saves 8% of the CSC’s connected load on average during core office hours.

Energy Management System SMUD employees are on flex-time work schedules, coming in as early as 6:00 a.m. and leaving as late as 7:00 p.m., but almost everyone is in the office between 8:00 a.m. and 4:00 p.m. The programmable EMS is capable of switching lighting circuits via relay panels according to work schedules, maintenance crew shifts, and weekend or after-hours use. For most of the building the EMS is currently programmed to switch lights on at 3:30 a.m. and off at 10:00 p.m. on weekdays. After hours and on weekends the EMS makes periodic sweeps to turn lights on that may have been left off. Lights in the southeast wing switch on three Saturdays a month for public access to meeting rooms. Open office areas have local override switches for employees working late. Task lights are not controlled by the EMS, but employees are conscientious about turning these off when they leave for the day.

Occupancy sensors Passive infrared (PIR) wall-switch occupancy sensors control lighting in individual offices and copy rooms. Employees manually switch lights on, but the sensors will automatically switch lights off if they detect no occupant movement for six minutes.

Lumen maintenance strategy Direct/indirect luminaires that are not near windows or skylights are still fitted with photosensors. These sensors can monitor the ambient brightness of the area below the luminaire, and can be set to dim the fluorescent lamps if they detect conditions that correspond to more than 30 fc at the workstation. Since most lighting is designed to deliver 10 to 25% more light than is needed initially, to account for light loss over life due to dirt accumulation or lamp aging, these sensors can automatically dim the lamps when the system is new. As lamps age and dirt accumulates, the photosensors signal ballasts to raise the power delivered to lamps until maximum power is reached. When luminaires are relamped and cleaned, the photosensors signal the ballasts to lower power once again.

Although the lighting in the CSC was designed to use this lumen maintenance strategy, DELTA observed that photosensors for these luminaires had been set for full light output in response to employee requests for more light.

<table>
<thead>
<tr>
<th>Space</th>
<th>Total Area (ft²)</th>
<th>Total Connected LPD</th>
<th>ASHRAE/IES* Allowed LPD (prescriptive method)</th>
<th>California Energy Efficiency Standards (complete building method)</th>
<th>In-use LPD during core hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>3rd flr—</td>
<td>18,700</td>
<td>0.89</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>NE wing</td>
<td>18,700</td>
<td>0.89</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>4th flr—</td>
<td>12,800</td>
<td>0.90</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>NE wing</td>
<td>12,800</td>
<td>0.90</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Remainder of building</td>
<td>152,130</td>
<td>0.86</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Total</td>
<td>183,630</td>
<td>0.87</td>
<td>1.57</td>
<td>1.5</td>
<td>0.58</td>
</tr>
</tbody>
</table>

1 W/ft² = 1.076 W/m²
*American Society of Heating, Refrigeration and Air Conditioning Engineers/Illuminating Engineering Society
Environmental and Economic Analyses

The CSC’s lighting design achieved significant energy efficiency and reduced costs by using energy-efficient luminaires, lamps, and ballasts. DELTA compared the annual energy cost based on observed day and night use with a hypothetical model. This model was based on a Title 24 complete building LPD of 1.5 W/ft² (16.1 W/m²) with the following assumptions:

- 100% of open office lighting on 18 hours/day
- 100% of lobby lighting on 24 hours/day
- 100% of mechanical room lighting on four hours/day
- 100% of public meeting space on for an additional 12 hours/month
- 10% of total lighting on 24 hours/day for night lighting

Because SMUD is an electric utility, the CSC is not charged for its energy use. However, the monthly electrical rate for a comparable commercially owned building would be $0.058/kWh plus a demand charge of $7.62/kW per month. The calculated annual energy cost savings is $56,328; reduced lighting load accounts for $43,073 and reductions in HVAC use due to the lower lighting load account for $13,255.

As a demonstration site for energy-efficient lighting, the CSC incorporates a variety of lighting and controls systems. The initial cost of the electric lighting, including luminaires, lamps, controls, and installation, was $1.56 million, or $8.50/ft² ($91/m²), which is about 50% higher than conventional office lighting, and provides a payback period of about 9–10 years. The premium for photosensor dimming is about $1/ft², and is responsible for extending the payback period by two years. This is because the energy savings due to dimming is a small percentage of an already very low connected lighting load. As the cost of these technologies continues to drop, the payback times will make them increasingly attractive to building owners.

According to estimates of the United States Environmental Protection Agency (EPA), reduced energy use from this building (when compared to a building at the Title 24 LPD of 1.5 W/ft² [16.1 W/m²]) will result in lower annual power plant emissions of 524 fewer tons (475 metric tons) of CO₂; 9,084 fewer pounds (4,055 kilograms) of SO₂; and 3,916 fewer pounds (1,748 kilograms) of NOₓ compounds. Reducing these emissions into the atmosphere means a smaller contribution to problems such as global warming, acid rain, and smog.

Staff Response

The DELTA team surveyed 156 employees on the third and fourth floors of the northeast wing of the CSC about their impressions and experiences with the lighting. They were asked about lighting in the open offices and their task lights to find out which lighting features worked well and which, if any, could be improved. DELTA specifically asked about visual comfort, task visibility, window glare, appearance of the lighting, maintenance, comparison to lighting in employees’ previous offices, and any suggestions for changes. The employees DELTA interviewed were generally very satisfied with the appearance of the lighting in the open offices.

Many had experienced glare problems in their previous offices and had noticed an improvement at their new workstations. Over 50% believed the lighting is better than in similar work spaces in other buildings.

Very few surveyed employees reported reflection problems from electric lighting on computer screens. Some employees in workstations near windows mentioned problems with daylight and direct sunlight reflecting in their screens, which they learned to eliminate by adjusting the vertical blinds.

Employees responded positively to their task lights; almost all the respondents agreed that the task light is useful for the reading and writing tasks they perform. More employees on the third floor use their task lights, and for more hours during the day, than on the fourth floor. This is probably due to the additional daylight available from the skylights on the fourth floor. All the employees agreed that the task light does not cause glare, but fewer third-floor employees think it is bright enough. Age does not seem to make a difference in task light use; the same percentage of under-40 workers uses their task lights as over-40 workers.

LIGHTING SURVEY—Percentages of People Who Agree:

<table>
<thead>
<tr>
<th>3rd Floor</th>
<th>4th Floor</th>
<th>Total</th>
<th>Norm*</th>
</tr>
</thead>
<tbody>
<tr>
<td>The lighting is comfortable</td>
<td>66%</td>
<td>96%</td>
<td>77%</td>
</tr>
<tr>
<td>The lighting is uncomfortably bright for tasks performed</td>
<td>2%</td>
<td>4%</td>
<td>3%</td>
</tr>
<tr>
<td>The lighting is uncomfortably dim for tasks performed</td>
<td>18%</td>
<td>4%</td>
<td>13%</td>
</tr>
<tr>
<td>The lighting is poorly distributed</td>
<td>16%</td>
<td>7%</td>
<td>13%</td>
</tr>
<tr>
<td>The lighting causes deep shadows</td>
<td>12%</td>
<td>0%</td>
<td>8%</td>
</tr>
<tr>
<td>Reflections from the light fixtures hinder work</td>
<td>2%</td>
<td>0%</td>
<td>1%</td>
</tr>
<tr>
<td>The light fixtures are too bright</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Skin has an unnatural tone under the lighting</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>The lights flicker throughout the day</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Compared to similar workplaces in other buildings, I think that:

<table>
<thead>
<tr>
<th>3rd Floor</th>
<th>4th Floor</th>
<th>Total</th>
<th>Norm*</th>
</tr>
</thead>
<tbody>
<tr>
<td>The lighting is worse</td>
<td>13%</td>
<td>7%</td>
<td>11%</td>
</tr>
<tr>
<td>The lighting is about the same</td>
<td>28%</td>
<td>46%</td>
<td>35%</td>
</tr>
<tr>
<td>The lighting is better</td>
<td>59%</td>
<td>46%</td>
<td>54%</td>
</tr>
<tr>
<td>Can read 6 point type or larger only</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Can read 4 point type or larger</td>
<td>79%</td>
<td>96%</td>
<td>86%</td>
</tr>
</tbody>
</table>

* Normative data for this survey based on over 1,200 responses from employees in similar offices throughout the northeast United States.
The DELTA team made an hours-of-use study of task light use during the day, discovering that the highest use of task lights is between 10:00 a.m. and 3:00 p.m. During this time an average of 37% of task lights were on when no one was present in the workstation, resulting in wasted energy.

“I’m very happy with the lighting in here. I like it a lot. Daylight and views really make a difference.”
— Demand Side specialist

**Maintenance and Product Performance**

SMUD has not experienced any significant lighting maintenance problems or product failures. However, the factory engineer had to make two visits to adjust the “set points” for the daylight photosensors. The first visit was routine: the engineer set each photosensor to dim when it detected the brightness equivalent of just over 30 fc (320 lx) beneath it. However, this adjustment was made in an unfurnished space. When furniture, partitions, and people moved in, lighting conditions changed radically and employees complained that light levels were too low for comfort. The engineer promptly returned to reset the set points. Employees now are generally happy with the amount of light, but DELTA noticed one area where employees had covered the photocells with bits of paper to fool the system into providing more electric lighting. Several employees commented that the the light sails, installed several months after the building was occupied, reduced window glare problems.

**Lessons Learned**

- Well-designed architectural daylighting measures can provide desirable contact with the outdoors while controlling heat and glare. The coordinated combination of light shelves, sails, low-e glass windows, skylights and blinds at SMUD’s CSC effectively controls direct sunlight and glare.
- Daylight sensing controls can save energy. The combination of photosensors and electronic dimming ballasts saved 8% of the building’s connected lighting load between 8:00 a.m. and 4:00 p.m. by dimming lamps near windows and in skylight areas in response to daylight. Although the controls cost extended the payback period in this installation, these controls could provide greater energy savings in buildings with higher connected loads or higher energy rates.
- Employees appreciate task lights. Energy-efficient, movable task lights give employees flexibility and control over the lighting conditions in their workspace without significantly increasing the lighting power density.
- Skylights can reduce the need for task lighting. The deep, splayed light well design distributes daylight without glare. The additional 10 to 100 fc (110 to 1100 lx) on desktops reduces the need for task lights.
- A daylight sensing system should be commissioned with workstations in place. Open-office furniture can trap light and alter patterns of brightness. Photosensor settings often require readjustment when furniture is added, rearranged, or removed.
- Operable window blinds are important in a daylighted space. Employees near windows can moderate excessive glare, heat, or illumination by changing the angle of the blinds as the sun tracks across the sky.

**DELTA Portfolio Lighting Case Studies**

**Volume 2, Issue 2**

**Sacramento Municipal Utility District**
Customer Service Center,
Sacramento, California

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- Ledalite Architectural Products Inc.
- Advance Transformer Co.

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**Luminaire Manufacturers:** A, B—Ledalite; C, F—Columbia; D, E, H—Prescolite; G—Insight Lighting; J—Waldmann
**Ballasts:** A, B, C, F—Advance; D, E, H—Robertson; J—Waldmann
**Occupancy Sensors:** Lightolier
**Photosensors:** PLC Multipoint, Inc.
**Energy Management System:** GE Total Lighting Controls

**DELTA Portfolio Graphic Design and Production:** JSG Communications, Inc.

**Photographer:** Kenneth Rice