

DELTA

Demonstration and Evaluation of Lighting Technologies and Applications • Lighting Research Center

# DELTA Portfolio

*Lighting Case Studies*

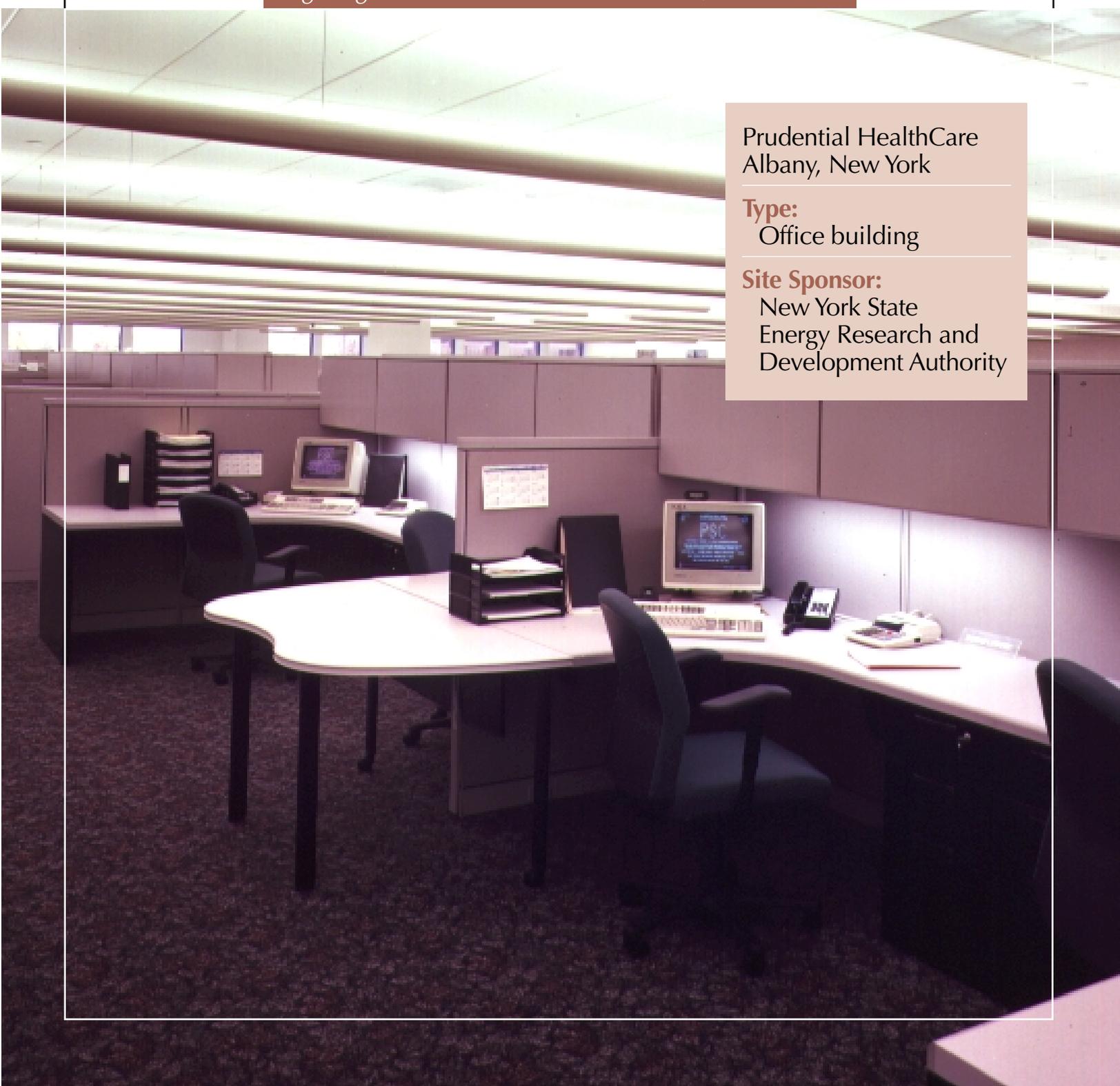


*Volume 1, Issue 5*

Prudential HealthCare  
Albany, New York

**Type:**  
Office building

**Site Sponsor:**  
New York State  
Energy Research and  
Development Authority





# Project Profile

Prudential HealthCare processes medical and dental claims for its New York State clients in a new 84,000 square foot (7800 square meter), three-story building in Albany, New York. Completed in May 1995, the building includes open office space with partitioned workstations, conference rooms, a central mailroom, and an employee cafeteria. The Prudential Service Company oversees construction of all Prudential office space and hired Gary Steffy Lighting Design to devise a cost-effective lighting scheme that optimizes energy savings while providing a pleasant work place for employees.

An employee's typical work day includes mail processing, data entry, and customer telephone calls. Linear fluorescent uplighting in open offices provides low-level ambient lighting for reading, while minimizing glare on each employee's video display terminal (VDT). Individual fluorescent task lights boost desktop light levels for difficult reading tasks. This lighted environment complies with standards set by the Illuminating Engineering Society of North America's (IESNA) recommended practice on lighting for VDT offices (see sidebar on RP-1, p. 3).

Lighting in the employee cafeteria contributes to the playful tone set by a base-

ball field motif. Compact fluorescent downlights with light-catching glass disks create pools of light. Employees also enjoy touching the pliable sconces that decorate the walls.

Occupancy sensors in small conference rooms and utility closets switch lights according to occupancy. Time clocks control the open office uplighting to accommodate flex-time work schedules from 6:00 a.m. to 10:00 p.m. The total connected lighting power density in the building is 0.99 W/ft<sup>2</sup> (10.7 W/m<sup>2</sup>), including task lighting.



*Front facade of Prudential HealthCare, Albany, New York*

## ● Lighting Objectives

- Create a pleasant workspace with low, balanced brightness for viewing VDTs.
- Use energy-efficient lighting products to reduce lighting energy use.
- Stay within a moderate construction budget.
- Limit the number of different lamps used on the project to simplify maintenance.
- Complement the warm color palette of the interior furnishings with a warm fluorescent lamp color.
- Provide individually controlled task lighting at employees' workstations to boost lights when needed.
- Create a whimsical environment in the employee cafeteria that is visually different from the office lighting.

## ▲ Lighting and Control Features

- ▲ **Indirect lighting.** Suspended uplights, wall slots, and recessed wall washers light surfaces while concealing the lamps.
- ▲ **Energy efficiency.** Primary light sources are T8 and compact fluorescent lamps, driven by electronic ballasts.
- ▲ **Occupancy sensors.** These turn the lights on and off automatically in small rooms with intermittent use.
- ▲ **Low brightness task lights.** Special optics in workstation undercabinet luminaires help balance work area brightness.

### Lighting standard for offices with VDTs - IESNA's RP-1

The Recommended Practice for Office Lighting (ANSI/IESNA RP-1-1993) is published by the IESNA and American National Standards Institute (ANSI) and addresses the technical and design issues of office lighting. RP-1 discusses the nature of visual tasks, the luminous environment, psychological effects, economics, energy considerations, and design issues for specific areas.

For offices with VDTs, RP-1 recommends:

#### A. Illuminance:

- For a combination of paper and screen-based tasks, provide a

maximum of 50 fc (500 lx) of general lighting on the workplane.

- Lower general illuminances may be appropriate if tasks are primarily screen-based, or if paper task illuminances are supplemented with task lighting.

#### B. Luminance balance:

High-luminance surfaces (such as windows, luminaires, and brightly lighted walls) can reflect in VDTs, competing with the displayed image. Keeping these surfaces similar in brightness, in order to limit the intensity of reflections on VDTs, improves visual comfort. Luminance ratios should not exceed:

- 3:1 or 1:3 (VDT: desktop/paper)
- 3:1 or 1:3 (VDT: workstation panel)
- 1:10 or 10:1 (paper: remote light surfaces)

#### C. Luminaire performance:

- For a direct lighting system, select luminaires that do not exceed 850 cd/m<sup>2</sup> at 65°, 350 cd/m<sup>2</sup> at 75°, and 175 cd/m<sup>2</sup> at 85°.
- For an indirect lighting system, select luminaires that limit maximum ceiling luminance to 850 cd/m<sup>2</sup> or less. Maximum to minimum ceiling luminance ratios should not exceed 4:1 to minimize "stripes" reflected in VDTs.

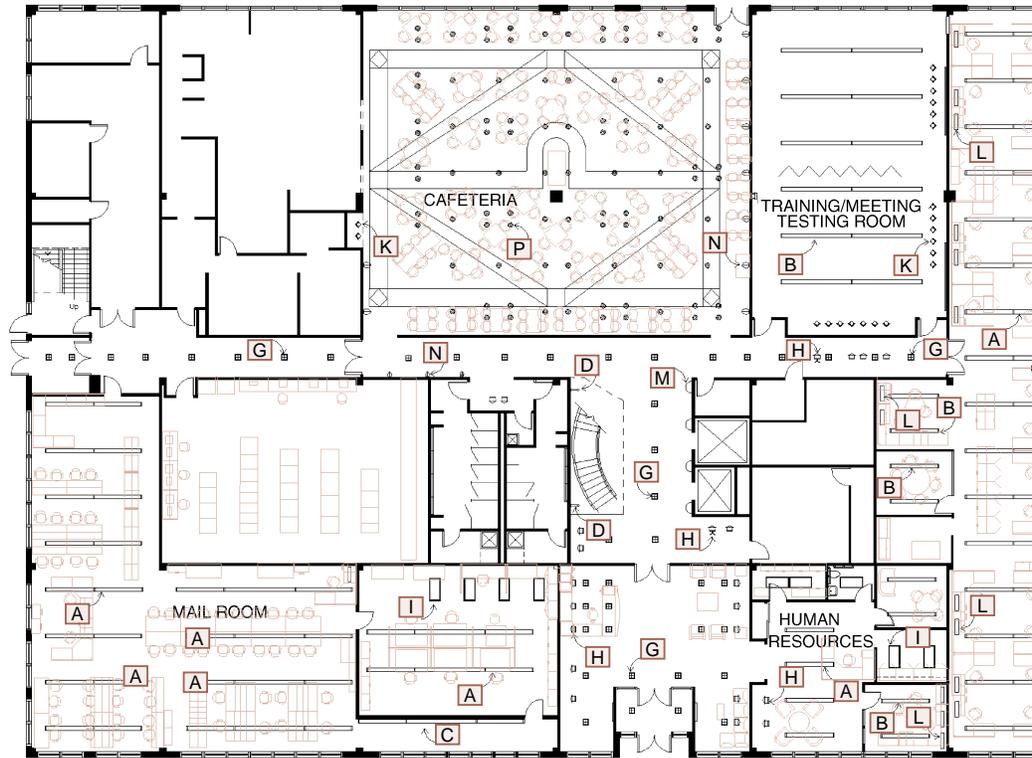


# Techniques

## Project Specifications

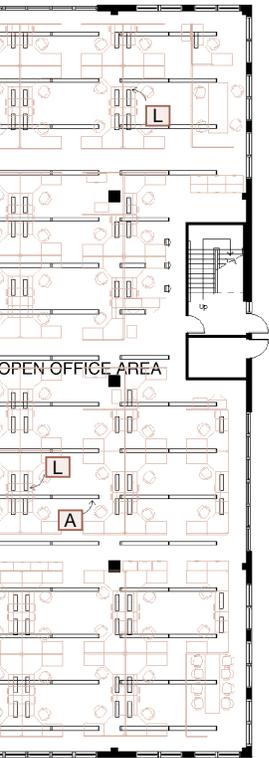
The building's principal light sources are F32T8 4' (1220 mm) rapid-start lamps with a color rendering index (CRI) of 75 and a correlated color temperature (CCT) of 3000 K (warm). These lamps are used in suspended uplights, concealed wall slots, and recessed troffers. Task lights use F25T8 or F32T8 lamps with a CCT of 3500 K (neutral). Most recessed downlights and wallwashers use compact fluorescent lamps, either FT18W 3000 K, 85 CRI or CFT13W 2700 K, 82 CRI. A small number of incandescent downlights use 50-W PAR20 halogen lamps (130V to extend lamp life). All T8 lamps and most compact fluorescent lamps are operated on electronic ballasts. Task-light ballasts are electronic, designed for reduced light output with a ballast factor (BF) of 0.77.

- A** Pendant-mounted fluorescent uplight, one lamp in cross section, with wide-spread distribution. Oval extruded aluminum housing, 3" x 8" (75 x 200 mm), in continuous rows. Two-, three-, and four-lamp rapid-start (RS) electronic ballasts. Lamps: F32T8/RE730.
- B** Same as A, except two lamps in cross section. Lamps: F32T8/RE730.
- C** Wall-mounted fluorescent uplight, one lamp in cross section, with asymmetrical distribution. Oval extruded aluminum housing, 3" x 9" (75 x 230 mm). Two- and three-lamp RS electronic ballasts. Lamps: F32T8/RE730 and F25T8/RE730.
- D** Special configuration of extruded aluminum light tube, 4" (100 mm) in diameter, one lamp in cross section. Two-, three-, and four-lamp RS electronic ballasts. Lamps: F32T8/RE730 and F25T8/RE730.
- E** Pendant-mounted fluorescent uplight, one lamp in cross section. Rectangular extruded aluminum housing, 2-1/2" x 2-3/4" (65 x 70 mm), in straight runs and patterns. Integral one- and

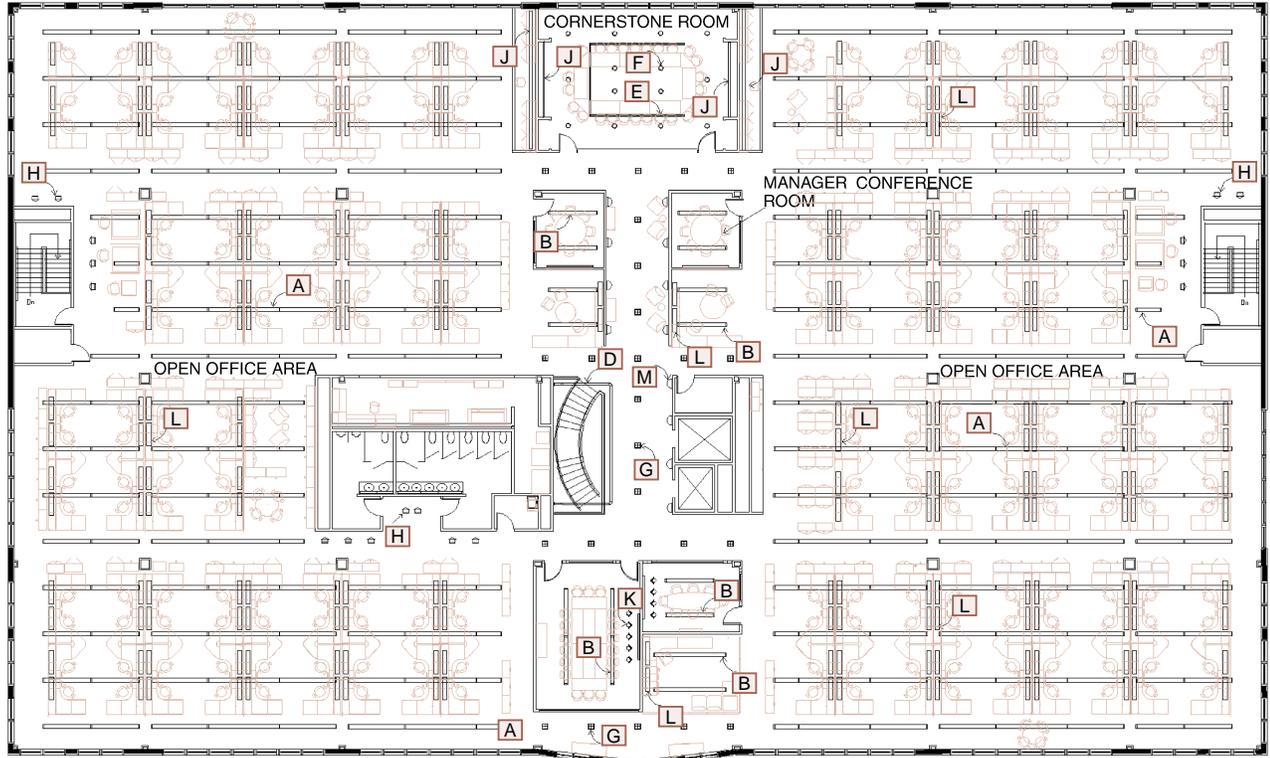


Lighting plan

- two-lamp RS miniature electronic ballasts. Lamps: F32T8/RE730 and F25T8/RE730.
- F** Recessed incandescent downlight with clear, polished aluminum cone. Aperture 4-3/8" (110 mm) in diameter. Lamp: (1) 50-W PAR20/NFL/ Halogen, 130V.
- G** Recessed 1' x 1' (300 x 300 mm) luminaire with 4-cell, 3" (76 mm) deep semi-specular parabolic louver. RS electronic ballast. Lamps: (2) FT18W/RS/RE830.
- H** Recessed 1' x 1' (300 x 300 mm) wallwash luminaire with asymmetrical polished aluminum reflector. Reflector wraps around lamp to conceal it from normal viewing angles. RS electronic ballast. Lamp: (1) FT18W/RS/RE830.
- I** Recessed 2' x 4' (0.6 x 1.2 m) fluorescent troffer with dropped opal acrylic
- diffuser. RS three-lamp electronic ballast. Lamps: (3) F32T8/RE730.
- J** Fluorescent striplight, one lamp in cross section, mounted in architectural slot for accent lighting of walls. One- and two-lamp RS electronic ballasts. Lamps: F32T8/RE730.
- K** Recessed compact fluorescent wall-washer with 8" (200 mm) diameter open aperture. High power factor (HPF) magnetic two-lamp ballast. Lamps: (2) CFT13W/RE827.
- L** Fluorescent task lights, 3' (900 mm) or 4' (1220 mm), mounted under overhead cabinets as needed to fit furniture system workstation. Lensed optical system designed to produce uniform illuminance across work surface and minimize reflected lamp image. One-lamp reduced-light-output RS electronic ballast with 0.77 BF. Lamps: (1) F25T8/RE735 in garden-



of garden level (1st floor)



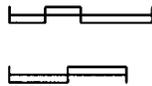
Lighting plan of 3rd floor  
(2nd floor similar)

level units; (1) F32T8/RE735 in second- and third-floor units.

**M** Decorative white acrylic wall sconce, mounted 6' (1.8 m) above floor, 14" wide x 12" high x 4" (360 x 300 x 100 mm) projection. High power factor magnetic ballasts.  
Lamps: (2) CFT13W/RE827.

**N** Decorative wall sconce with a soft-to-the-touch white molded silicone diffuser and cobalt blue plastic back-plate. Mounted 6' (1.8 m) above floor, 6-1/2" wide x 9" high x 4" (170 x 230 x 100 mm) projection. Normal power factor (NPF) magnetic ballasts.  
Lamps: (2) CFT9W/RE827.

**P** Recessed downlight with decorative glass disk suspended below downlight trim. 6" (150 mm) diameter polished aluminum cone. Horizontal lamps with single electronic ballast.  
Lamps: (2) CFQ13W/RE827/4-pin.



### Wattage

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

*T8 lamps in open luminaires (electronic ballast)*

F32T8 (4'): 30 W per lamp for 1-, 2-, 3-, or 4-lamp RS ballast

F25T8 (3'): 23 W per 1-lamp RS ballast

*T8 lamps in enclosed luminaires (electronic ballast)*

F32T8 (4'): 29 W per lamp for 2-, 3-, or 4-lamp RS ballast

*T8 lamps in enclosed task lights (reduced-output electronic ballast)*

F32T8 (4'): 27 W per 1-lamp RS ballast  
F25T8 (3'): 22 W per 1-lamp RS ballast

*FT RS long twin-tube fluorescent lamps (electronic ballast)*

FT18W (10"): 38 W per 2-lamp ballast  
FT18W (10"): 20 W per 1-lamp ballast

*Compact fluorescent lamps (electronic ballast)*

CFQ13W/4-pin: 28 W per 2-lamp ballast

*Compact fluorescent lamps (magnetic ballast)*

CFT13W: 34 W per 2-lamp HPF ballast  
CFT9W: 11 W per 1-lamp NPF ballast

*Incandescent lamps*

50PAR20/NFL/Halogen (130V): 44 W at 120V



# Details

**Typical open offices** Lighting in open office spaces is provided primarily by rows of pendant-mounted uplights (type A). The uplights are suspended from the 8'-9" (2.6 m) ceiling with aircraft cable, 1'-6" (460 mm) to the top of the luminaire. The uplighting scheme provides an average workplane illuminance of 28 footcandles

(fc) (300 lux [lx]). Task lights (type L) boost the workplane illuminance to an average of 36 fc (390 lx). The widespread distribution of the uplights allows 8' on-center spacing (2.4 m) with ceiling luminances ranging from 87 to 342 cd/m<sup>2</sup>. This 4:1 uniformity ratio meets the RP-1 standard. Because the uplights are rounded, the luminances on

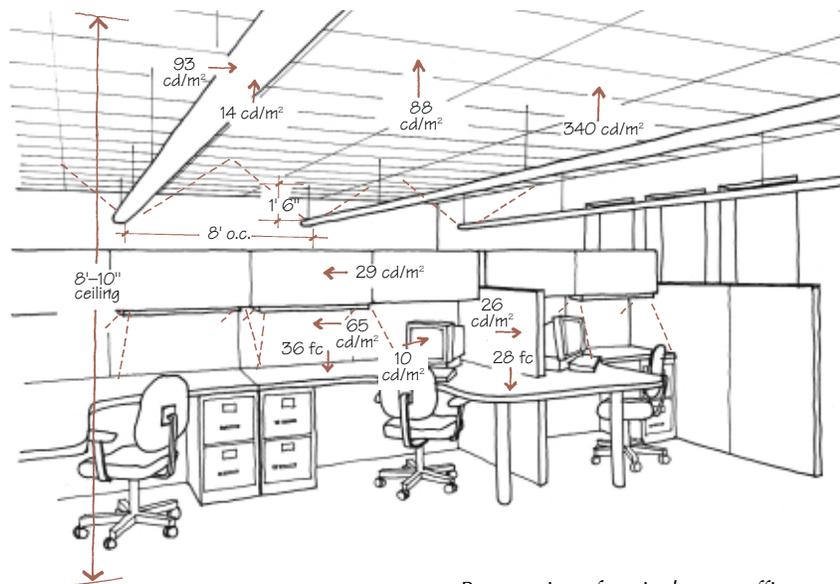
the bottom surface vary gradually, from 14 cd/m<sup>2</sup> at the bottom to 93 cd/m<sup>2</sup> on the sides, preventing competing sharp-edged luminaire reflections in VDTs.

Windows on all sides of the building provide a view from almost every workstation. The windows are tinted to allow 10% transmission of daylight. Because the tinting reduces the amount of daylight entering the space, it also results in a lighted environment that has better balanced luminances and does not change significantly in appearance from day to night.

A time clock on each floor switches the uplights on for the early-morning shift, and switches them off after the late shift is over and the cleaning crew is finished.



Typical open office area



Perspective of typical open office area

**Typical workstations** The partitioned workstations on the second and third floors have light- to medium-color finishes (between 30 and 50% reflectance). The partition height is 52" (1.3 m). Each desk has a side return and an overhead binder bin where task lights (type L) are mounted. Most of the employees use their task lights and conscientiously turn them off when they leave for meetings or go home at night.

These luminaires have a contoured prismatic lens projecting light toward the rear panel of the workstation, as well as down toward the task area. This optical system spreads the lamp image evenly over the large lensed area, reducing the brightness of any veiling reflection. The balanced luminances between the task and the immediate surround meet the RP-1 recommended ratio of 3:1.

Every employee has a VDT located in the corner between the main work area and the return, and may have a pleasant view to the outdoors through the perimeter windows. However, there is direct glare from sunlight on some VDTs near windows.

## Garden-level open offices and workstations

One-third of the garden level is dedicated to open office space. The uplighting (type A) and task-lighting (type L) systems are essentially the same as on the upper floors, but the workstation furniture, which was moved from their previous offices, has darker finishes. The filing cabinets and overhead bins are dark green, with a reflectance of 10%. The fabric panels have a reflectance of approximately 20% and the desk tops, 30%. The

average workplane illuminances are similar to those of the upper two floors (27 fc [290 lux]) on work surfaces without overhead bins, 33 fc [360 lx] on task-lighted work surfaces), but due to the darker furniture finishes, some people perceive that there is less light in this area.

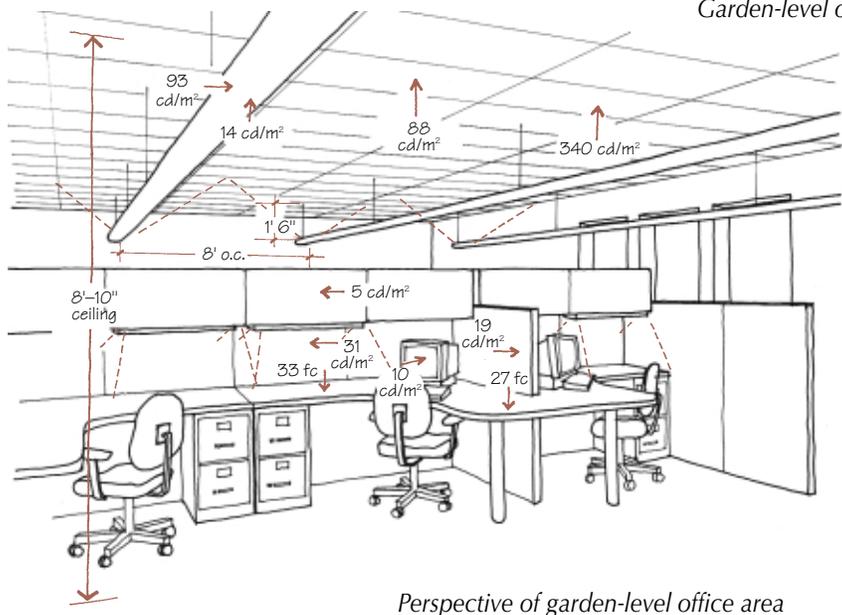
## Manager conference rooms

All managers have conference rooms adjacent to their workstations. Three walls are light gray in color (50%

reflectance); the fourth wall has partially frosted glass panels. Two 8' (2.4 m) uplights (type B) provide an average of 55 fc (600 lx) on the conference table and contribute useful vertical illuminance on the walls to highlight marker boards (30 to 48 fc [320 to 520 lx]). The uplights are controlled by a wall-switch occupancy sensor located inside the room just beyond the door swing (see pg. 12). DELTA observed that these lights were in use only 30% of the time, which supports Prudential's policy of using occupancy sensors in conference rooms and similar spaces to save energy.



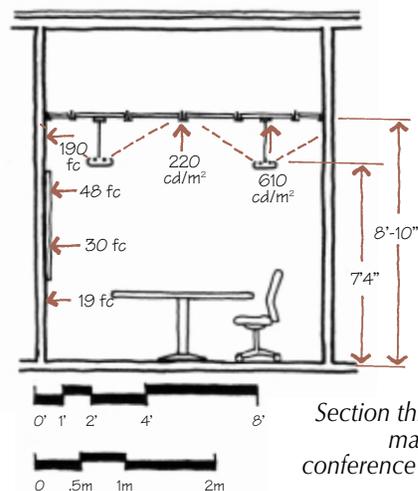
Garden-level office area



Perspective of garden-level office area



Manager conference room



Section through manager conference room



# Details

**Mailroom** Every week mailroom workers receive, sort, open, microfilm, and distribute up to 75,000 pieces of mail. Just before the workers moved in, the furniture in the mailroom was rearranged in an effort to streamline mail processing. Overhead bins reaching 6'-5" replaced the original 4'-7" units, but the lighting layout of indirect luminaires (type A) was

18 fc (190 lx) on the desk, with 20 fc (210 lx) on the overhead bins.

Even though some employees mentioned that more light would help them see their work better, mailroom productivity has increased, compared to Prudential's earlier operations. This increase is largely due to the consolidation of mail-

room operations into one building and to an innovative program in which each employee is trained to perform a variety of mailroom jobs and carries a tool box full of office supplies to different task locations over the course of a week.

**Cafeteria** The lighting scheme in the employee cafeteria, located on the west side of the garden level with a window wall,

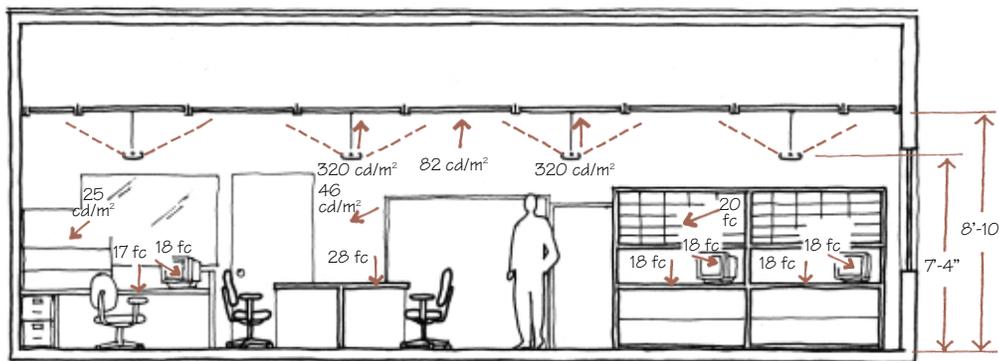
the light and blocks direct view of the lamps from most viewing angles. The downlights are arranged in groups of two and four in a pattern that puts some of the lunch tables in the spotlight with 30 fc (320 lx), and leaves others in more subdued lighting as low as 5 fc (55 lx). The lighting is supplemented with compact



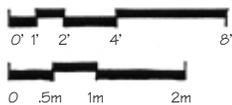
Mailroom



Cafeteria



Section through mailroom



Decorative cafeteria wall sconce

not modified to reflect this change. The resulting mailroom light levels are lower than intended. The horizontal illuminances of 25 to 28 fc (270 to 300 lx) are adequate for the large, easy visual tasks performed at the receiving area counters, vertical sorting bins, and central table. However, VDT workstations with high overhead bins receive only about

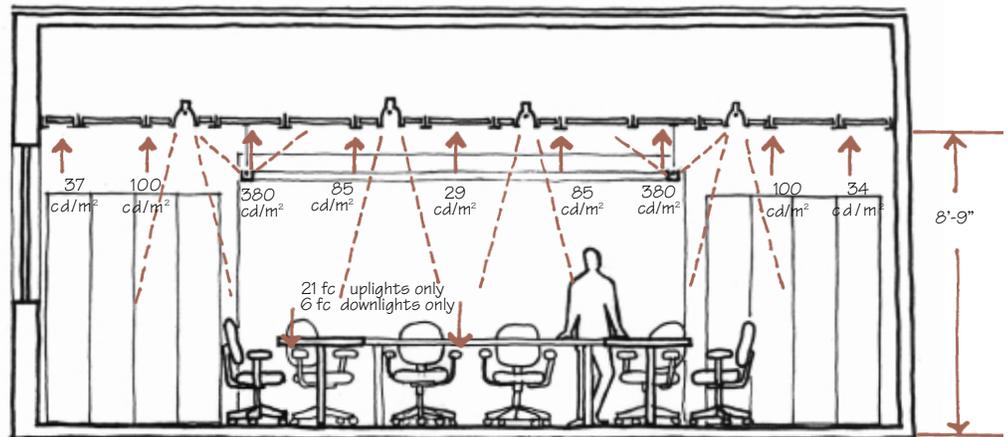
provides a total departure from the office lighting. The lighting contributes to the fun, relaxing atmosphere created by the cafeteria's "baseball field" motif. Compact fluorescent downlights (type P) with 8" (200 mm) glass disks suspended from the trim ring provide general lighting. The disks have a white dot pattern that catches

fluorescent wall sconces of translucent plastic (type N). Each sconce has a colored ring at the wall-plate, which casts an attractive blue halo on the wall behind it. These sconces feel "squishy" to the touch. New employees are encouraged to squeeze them.

**Cornerstone Room** The Cornerstone Room is a large multipurpose conference room for meetings and audio-visual presentations to clients. The lighting is a combination of T8 uplights and wall slots and recessed PAR20 incandescent downlights, all controlled on separate 3-way switches or dimmers. The uplights (type E) are configured in a U-shape and provide an average of 21 fc (230 lx) on the conference table. At full output, the dimmable downlights (type F) provide an average of 6 fc (65 lx) on the table tops. These downlights are used alone for note-taking during a video presentation when other room lighting would interfere with screen visibility. The wall slots at each end of the room (type J) smoothly wash the walls with a maximum to minimum vertical illuminance ratio of 6:1.

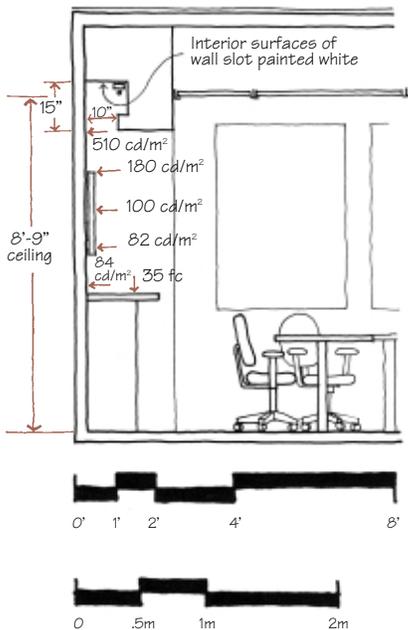
frosted glass panels. When the shades are up, afternoon sun can introduce as much as 150 fc (1600 lx) to the conference table. The appearance of the sunlight is pleasing,

but the strong projected patterns of light are distracting and visually uncomfortable, so the shades are usually pulled down when the room is in use.



Section through Cornerstone Room

The west side of the room is lined with windows fitted with pull-down blackout shades, while the east side has full-height



Enlargement of wall slot section



Cornerstone Room



# Project Evaluation

**Energy Impact** DELTA used input watts from the manufacturer's literature to calculate the lighting power density (LPD) for the entire office building. The maximum LPD for all conditioned space in the building is 0.99 W/ft<sup>2</sup> (10.7 W/m<sup>2</sup>). During the core business hours (9:00 a.m. to 3:00 p.m.), the in-use power density is 0.85 W/ft<sup>2</sup> (9.2 W/m<sup>2</sup>). Most of this difference (0.09 W/ft<sup>2</sup>) reflects DELTA's observation that only about half of the task lights were on during core hours. The table summarizes the power densities in the building compared to ASHRAE/IES 90.1-1989 energy standards and the New York State Energy Conservation Construction Code.

sensors turn lights on when they sense movement. If they don't detect motion after a preset time (field-adjustable from 7 seconds to 15 minutes), they turn the lights off.

The occupancy sensors have lenses with a detection area of 180 degrees from side to side. In most locations, the occupancy sensors are mounted just inside the room, adjacent to the door opening, and usually activate the lights as soon as someone enters. In the managers' conference rooms, the occupancy sensors are mounted inside the room just beyond the door swing. When these rooms are not in use, the doors are usually left open, so occasionally the lights come on when someone walks past the door outside the room. Employees have also

plans to reduce this glare by installing horizontal blinds on all perimeter windows.

## Environmental and Economic Analyses

This 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 is based on an ASHRAE/IES 90.1 whole-building LPD of 1.57W/ft<sup>2</sup> [16.9 W/m<sup>2</sup>] with the following assumptions:

- 100% of the open office uplights and cafeteria lighting on 18 hours/day
- 100% of egress lighting on 24 hours/day
- 100% of mechanical/electrical closet lighting on 1 hour/day
- 50% of the task lights on 6 hours/day (core hours); 25% on 9 hours/day (early and late shifts)
- 100% of the occupancy sensor-controlled conference rooms on 4 hours/day
- 100% of lighting in other conference rooms, training rooms and ancillary spaces on 12 hours/day

At this building's current electrical rate of 11¢/kWh, the calculated annual energy cost savings is \$41,456; \$33,008 from lighting and \$8,448 from reduced HVAC load.

This facility was a design-build project. The initial cost of the lighting for the entire building including luminaires, lamps, branch circuit layout, and installation was \$672,000, or \$8/ft<sup>2</sup> (\$86/m<sup>2</sup>). This cost is consistent with other installations of indirect lighting and electronic ballasts for VDT spaces.

According to estimates of the United States Environmental Protection Agency (EPA), reduced energy from this building (when compared to a building at the ASHRAE/IES 90.1 LPD of 1.57W/ft<sup>2</sup> (16.9 W/m<sup>2</sup>) will result in lower annual power plant emissions of 292 fewer tons (265 metric tons) of CO<sub>2</sub>, 5,069 fewer pounds (2,263 kg) of

**Building Areas and Lighting Power Densities**

Space	Total area (ft <sup>2</sup> )	Total connected LPD	ASHRAE Allowed LPD (system performance method)	ASHRAE Allowed LPD (prescriptive method)	NY State Conservation Construction Code	In-use LPD core hours
Open Offices	51,468	0.96	1.90			
All Other Spaces	32,510	1.01	1.63			
Total Building	83,978	0.99	1.79	1.57	2.40	0.85

ASHRAE=American Society of Heating, Refrigerating and Air-Conditioning Engineers      1 W/ft<sup>2</sup> = 10.76 W/m<sup>2</sup>

**Controls** Because the building has limited daylight penetration and low lighting power density, the owner and the lighting designer agreed that a sophisticated control system would not save enough energy to be a sound investment. Instead they chose an economical system of four time clocks. The clocks switch lights on for the early morning shift, which begins at 6:00 a.m., and off at 11:30 p.m., after the late shift and the cleaning crew have finished work.

**Occupancy Sensors** Wall switch occupancy sensors control three types of spaces: mechanical/electrical rooms, vending and copy areas, and managers' conference rooms. The sensors are passive infrared (PIR), which detect the movement of heat sources such as occupants. The

noticed that occasionally the sensor switches lights off when a person in the conference room sits quietly for a long period of time.

**Control of Daylight** All windows are tinted to allow only 10% transmission of radiant energy (light and heat), to provide employees a view while limiting heat gain. Unfortunately, direct sunlight during sunrise or sunset washes out displays on some workstation VDTs. Partitions block the sun for most workstations, but some VDTs on the southeast and northwest ends of the building have their displays obscured by sunlight for about 30 minutes in the early morning or late afternoon due to low sun angles. The VDT location is fixed in the workstation, so employees cannot move their screens out of the sun. Prudential



SO<sub>2</sub>, and 2,184 fewer pounds (975 kg) of NO<sub>x</sub> 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 and interviewed employees (282 respondents) about their impressions and experiences with the lighting in the open offices, the mailroom, and the cafeteria to find out which lighting features worked well and which, if any, could be improved. DELTA specifically asked about visual

*“It’s attractive overall. It provides adequate light with a softer feeling.”*  
—Associate Manager

workers mentioned that task lights at their workstations would be helpful.

Very few surveyed employees report reflection problems from electric lighting on VDTs. However, some employees in perimeter workstations on the southeast and northwest corners of the building mentioned problems with direct sunlight reflecting in their VDTs when the sun is low in the sky.

Employees had a very positive response to the cafeteria lighting. Over 87% of those who responded to the survey said that the space is comfortable and pleasant. One even remarked that the wall sconces are “groovy.”

*“I love the design. It adds a lot to the building.”*  
—Secretary

*“I like the indirect reflecting off the ceiling better than direct lighting.”*  
—Administrative Assistant

comfort, task visibility, window glare, reactions to the appearance of the lighting, maintenance issues, comparison to lighting in their previous offices, and any changes in the lighting the employees would sug-

*“This is so much better than the lighting in the office I came from.”*  
—Associate

gest. The employees DELTA interviewed were generally very satisfied with the appearance of the lighting in the open offices and the mailroom and considered it comfortable. Many have never before worked under indirect lighting. They seem to like the difference between the direct lighting in their previous offices and this new look. Over forty percent believe the lighting is better than in similar work spaces in other buildings. However, 13-15% of the open office employees and 27% of the mailroom employees said their workplaces are too dim. Several mailroom

*“It’s not bright enough for me. I would like it brighter.”*  
—Associate

## Maintenance and Product Performance

The property manager, Galesi Management, who is responsible for maintaining all luminaires except the task lights, indicated that they have not had any significant maintenance problems or failures.

Prudential employees’ responses to maintenance and performance issues were generally positive. The DELTA team noticed some differences in the color of light from some of the uplights. This difference is probably due to the fact that fluorescent lamps shift color slightly as they age, so when individual lamps are replaced, the color of the new lamps is a little different from lamps that have been in operation for several months. During the DELTA site visit, several employees pointed out one uplight that was buzzing; replacing the ballast eliminated the noise. The building manager noted that one of the occupancy sensors had failed to operate properly, but that the manufacturer had promptly replaced the unit.

### LIGHTING SURVEY—Percentages of People Who Agree:

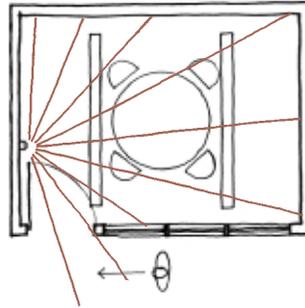
	Open Office Space:	Garden Level	2nd & 3rd Fl.	Mailrm.	Norm*
1. The lighting is comfortable.		78%	82%	80%	69%
2. The lighting is uncomfortably bright for tasks performed.		4%	8%	8%	16%
3. The lighting is uncomfortably dim for tasks performed.		13%	15%	27%	14%
4. The lighting is poorly distributed.		17%	10%	19%	25%
5. The lighting causes deep shadows.		0%	8%	11%	15%
6. Reflections from the light fixtures hinder work.		0%	13%	4%	19%
7. The light fixtures are too bright.		0%	4%	8%	14%
8. Skin has an unnatural tone under the lighting.		0%	7%	8%	9%
9. The lights flicker throughout the day.		0%	4%	0%	4%
10. The lighting is worse than similar workplaces in other buildings.		0%	8%	8%	19%
11. The lighting is about the same as similar workplaces in other buildings.		58%	48%	64%	60%
12. The lighting is better than similar workplaces in other buildings.		42%	44%	28%	22%
13. I can read up to 6-point type.		91%	94%	83%	94%
14. I can read up to 4-point type.		70%	78%	70%	76%

\* Normative data for this survey based on over 1,200 responses from employees in several offices throughout the northeast United States.

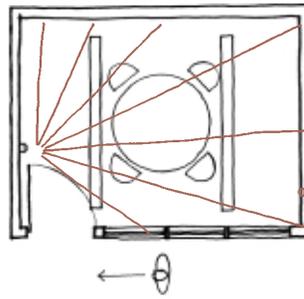
## Lessons Learned

- **“Luminance balancing” works.** Workers had very few complaints about glare or VDT reflections. The indirect lighting system and the task lighting were designed in conjunction with the interior finishes of the building to produce luminance ratios that meet RP-1 recommendations. The benefits of this design approach are evident in the survey responses, where approximately 80% of the employees said the lighting is comfortable.
- **Employees appreciate some whimsy in lighting design.** The cafeteria is more than just a place to eat lunch; it provides a visual break from the work routine. The pools of light and the playful atmosphere are very different from the uplighting and concentrated task lighting in the office areas, and workers really appreciate the change in environment.
- **Low transmission windows do not reduce direct sunlight enough to eliminate glare on VDT screens.** The low-transmission glass windows are cost effective in reducing HVAC loads, but are not sufficiently effective in blocking direct sunlight on VDT screens. Horizontal blinds will give employees the ability to block the sun.
- **Some people prefer higher illuminances for office spaces.** Some of the workers in this office space said that they would like more light, even though they could see well enough to do their work. Additional task lighting boosts light levels for reading tasks, but some employees still feel the level is insufficient or too localized. Increasing ambient light levels would help eliminate this complaint. However, significant increases in the lighting power density could also reduce VDT visibility and increase both the initial cost and the annual energy cost of the lighting system.
- **Passers-by can trigger occupancy sensors inside a room.** Occasionally, the lights come on when someone walks past an empty conference room. The

manufacturer of the PIR occupancy sensor suggests applying a small piece of opaque tape to cover the portion of the sensor’s lens that “sees” the doorway (below).



*Manager’s conference room—  
The normal occupancy sensor’s field of view “sees” passing traffic*



*Masked field of view—  
Occupancy sensor cannot detect passing traffic*

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