

DELTA

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

DELTA Portfolio

Lighting Case Studies



Volume 2, Issue 4



South Mall Towers Apartments
Albany, New York

Type:

Senior residential facility

Site Sponsors:

Capital Area Consortium on
Aging and Disability

New York State Energy Research
and Development Authority

Northeast Utilities

Philips Lighting



Project Profile

South Mall Towers is an apartment complex for seniors and disabled adults in Albany, New York, built in 1974. The complex consists of two ten-story towers. The upper nine floors in each tower are private apartments. The ground floor of each tower houses common areas, administrative offices, and building services spaces. The two towers have a sheltered garden area between them but are otherwise surrounded by busy urban streets.

Most of South Mall Towers' residents are seniors with low or moderate incomes, although some are young people with disabilities. Residents range in age from 20 to 90 years. A significant proportion of the residents are disabled in some way; about one-quarter of the residents are partially sighted.

The complex consists of two types of apartments, one-bedroom apartments and

"alcove" apartments, where the bed is set in an alcove off the living room. (This DELTA Portfolio examines only the more popular one-bedroom apartments.) Both types have an entryway, a bathroom, and a kitchen area connected to a dining area/living room.

Three factors influenced the decision to relight South Mall Towers:

- The previous lighting was coming to the end of its useful life and needed replacement.
- The sponsors strongly believed that improving the lighting would lead to a better quality of life for the residents.
- The sponsors expected that better lighting would enhance the appearance of the complex and would lead to a higher occupancy level.

South Mall Towers also proved to be an ideal site for testing lighting principles for senior facilities. As part of this project, the Lighting Research Center produced designs for renovating lighting in both the common areas and apartments. These designs used different types of lighting equipment, but all followed principles based on the optical characteristics of the aging eye. As people age, light is increasingly absorbed and scattered in the eye. Increased absorption means that seniors benefit more from higher illuminances than young people. Increased scattering means seniors are more sensitive to glare than younger people, and they see less clearly. Increased absorption and scattering together render seniors less able to make fine color discriminations. The new lighting was designed to provide more light on all the surfaces of the rooms, to increase illuminances at task locations, to control glare, and to use better color-rendering light sources.



South Mall Towers Apartments, Albany, New York

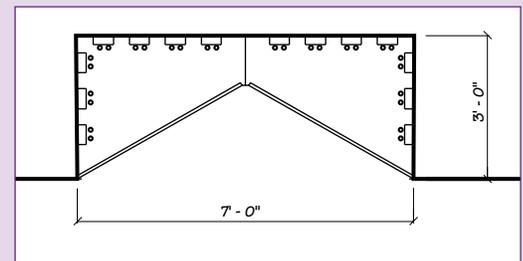
● Lighting Objectives

- Provide lighting that improves the visual capabilities of seniors.
- Provide lighting that seniors find attractive and comfortable.
- Use energy-efficient lighting products to minimize the lighting power density.
- Use reliable lighting products to minimize maintenance costs.



▲ Lighting and Control Features

- ▲ Uniform Illumination. Suspended direct / indirect luminaires using fluorescent lamps distribute light evenly across the ceiling and walls, while directly illuminating the tables in the community room. In the corridors, ceiling luminaires are closely spaced to ensure uniform illumination. In the apartments, a component of indirect lighting is used to spread light over the whole room.
- ▲ Glare control. Direct view of lamps is limited by using indirect lighting, baffles on the downward component of the lighting, and fascias and valances for wall-mounted lighting.
- ▲ Task lighting. Luminaires are positioned to provide high illuminances in places where difficult visual tasks are performed, for example, on counters in apartment kitchens, on the administrative office counter, and on the bulletin board.
- ▲ Energy efficiency. Primary light sources are all fluorescent, either linear or compact fluorescent, operated on electronic ballasts wherever possible. Occupancy sensors reduce corridor light levels when no one is present.
- ▲ Environmental responsibility. The T8 fluorescent lamps installed have a low mercury content.
- ▲ Flexible control. Compact fluorescent lamp ballasts that allow three-level switching provide individual control of table and floor lamps in apartments. Linear fluorescent lighting in the community room can be dimmed with a wallbox dimmer as needed.
- ▲ Brightness adaptation. Lobby cove lighting dims after dark to reduce the difference in brightness between the outdoors and the lobby at night.

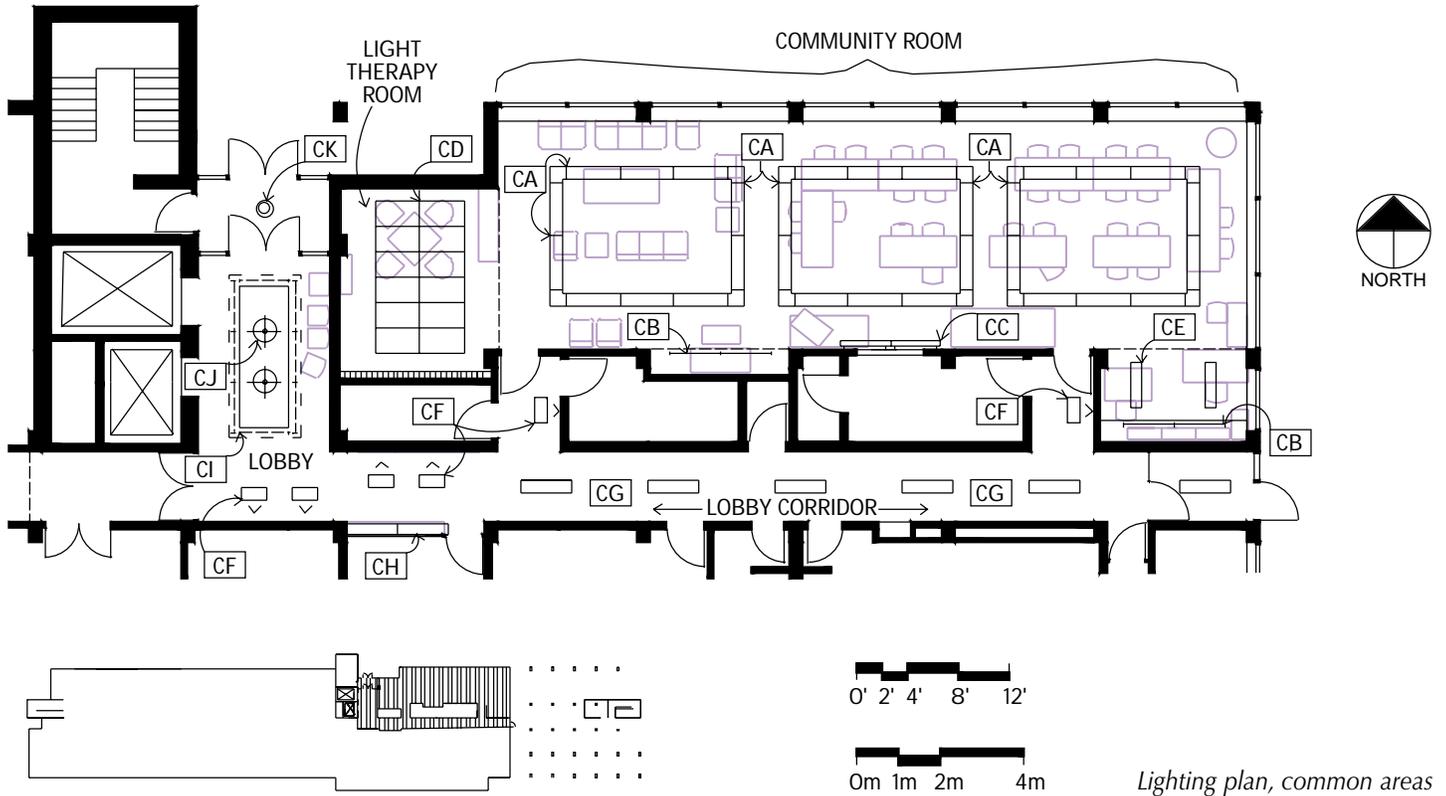


Section through electric skylight

Seniors are more likely than younger people to be partially sighted and to suffer from shallow, fragmented sleep. Exposure to bright light can help overcome the effects of some forms of partial sight and can improve the quality of sleep. The challenge for the lighting designer is to provide bright light exposure without visual discomfort. At South Mall Towers, this problem was solved by providing an electric skylight in the mail area open to the community room. The light output of the skylight is variable, the maximum illuminance at the eye being 300 fc (3200 lx). The large acrylic prismatic panels minimize glare. The residents' initial response to this light therapy area has been positive.



Techniques



Lighting plan, common areas

Project Specifications: Common Areas

When South Mall Towers was built in 1974, the principal light source used in the common areas was the 40-W T12 CW (cool-white) fluorescent lamp operated on a magnetic ballast. In 1990, a utility-sponsored retrofit changed these lamps to 34-W T12 CW fluorescent lamps operated on electronic ballasts. These lamps had a correlated color temperature (CCT) of 4100 K and a color-rendering index (CRI) of 62. In 1998, the lighting systems evaluated for this report were installed. Now the principal light sources are 32-W T8 low-mercury rapid-start (RS) fluorescent lamps, operated on electronic ballasts. These lamps have a CCT of 3500 K (neutral) and a CRI of 75. Many of these lamps are driven by dimming electronic ballasts, either a two-wire continuous-dimming ballast for easy retrofit with a companion wall-box dimmer (types CA, CB), or a 0- to 10-V control ballast where time clocks or occupancy sensors trigger either maximum or minimum output (types CD, CI, CL). Both kinds of dimming ballasts are capable of dimming the lamps to 8% of maxi-

imum light output. All other T8 lamps are driven with instant-start, high power factor (HPF), low total harmonic distortion (THD) electronic ballasts.

In addition, the new design uses many luminaires with compact fluorescent lamps (CFLs) driven by electronic ballasts. Decorative round ceiling-mounted luminaires use CFQ26W lamps, decorative pendants in the lobby use FT18W lamps, and recessed wall washers use FT40W lamps. All the lamps have a CCT of 3500 K (neutral) and a CRI of 82. All electronic ballasts are RS, HPF with an end-of-life sensing safety feature.

CA Pendant-mounted up/downlight (60% up; 40% down), two fluorescent lamps in cross section. Rounded extruded aluminum housing, 3.5" x 12" (89 x 310 mm), assembled in rectangular configurations. Electronic dimming ballasts. Downward aperture uses white-painted aluminum baffles, 1.5" (38 mm) high by 3" (76 mm) on center. Lamps: (2) F32T8/735 per 4' (1220 mm) length.

CB Ceiling-mounted striplight, 8' (2440 mm) long, one fluorescent lamp in cross section. Striplight concealed behind job-built wood fascia. Electronic dimming ballasts. Lamps: (2) F32T8/735

CC Wall-mounted downlight luminaire, 6" x 6" x 8' long (150 mm x 150 mm x 2440 mm), one fluorescent lamp in cross section. Downlight aperture has 3/4" high x 3/4" on center (18 mm x 18 mm) white-painted aluminum baffles. Lamps: (2) F32T8/735

CD Simulated skylight with T8 fluorescent lamp striplights, dimming ballasts, and prismatic lenses. Skylight (see page 3) used for experimental light therapy. (Results not addressed in this publication.)

CE Surface-mounted downlight, 6" x 4' (150 mm x 1220 mm), two fluorescent lamps in cross section. White-painted baffles 1" high x 1" on center (25 mm x 25 mm). Lamps: (2) F32T8/735

CF Recessed linear wall washer, 8" x 2' (200 mm x 1220 mm), one CFL in cross section. White-painted 1" (75 mm) high baffles. Lamp: FT40W/2G11/RS/835

CG Recessed luminaire, 1' x 4' (300 mm x 1220 mm), two fluorescent lamps in cross section, with white-painted 3" (76 mm) high parabolic baffles. Wide light distribution perpendicular to lamps; narrow, lengthwise. Lamps: (2) F32T8/735

CH Recessed downlight, 8" x 4' (200 mm x 1220 mm), two fluorescent lamps in cross section, with 3" high white-painted parabolic baffles. Lamps: (2) F32T8/735

CI Striplight, 8' (2440 mm) or 4' (1220 mm) long, one fluorescent lamp in cross section, mounted as upright in lobby cove. Electronic dimming ballast. Lamp: F32T8/735

CJ Pendant-mounted CFL luminaire, with decorative translucent acrylic bowl, 22" (560 mm) in diameter. Lamps: (4) FT18W/2G11/RS/835

CK Ceiling-mounted semi-direct luminaire, two CFLs in cross section. White-painted egg-crate louver in downlight aperture with 1/2" x 1/2" x 1/2" (12 mm x 12 mm x 12 mm) cells. Lamps: (2) CFQ26W/G24q/835

CL Surface-mounted "stacklight" luminaire, one fluorescent lamp in cross section, with U-shaped white-painted aluminum baffles spaced 1" (25 mm) apart. Electronic dimming ballast. Lamp: F32T8/735

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 (with 2- or 3-lamp electronic continuous-dimming ballast, at full light output)

F32T8 (4'): 35 W per lamp

T8 fluorescent lamps (with 2-lamp electronic 0-10V control dimming ballast, at full light output)

F32T8 (4'): 35 W per lamp

T8 fluorescent lamps (with 2-lamp non-dimming instant-start electronic ballast, at full light output)

F32T8 (4'): 29 W per lamp

CFL lamps (electronic ballast)

CFQ26: 29 W per lamp

FT18: 18 W per lamp

FT40: 44 W per lamp

Details

Common Areas

The lighting in the South Mall Towers common spaces was replaced in 1998. It was designed to meet the needs of seniors and the partially sighted by:

- Providing more light on all surfaces
- Providing even light with minimal shadows
- Controlling glare from luminaires.

These principles were implemented by:

- Specifying luminaires which control glare by directing light onto room surfaces and task locations, but not into the eyes of users
- Reducing luminaire brightness by specifying luminaires with baffles or louvers, which often appear less glaring than luminaires with lenses, diffusers, or shiny elements that allow a reflected view of the lamp

- Locating luminaires near places where specific tasks are performed, such as over a food service counter.

Community Room The community room is the social center of South Mall Towers. Residents come here throughout the day for meals, activities, and companionship. Entertainment in the form of craft classes, bingo, television, movies, talks, and birthday parties takes place in the community room. Residents also collect their mail and meet their friends and relatives.

The main part of the community room is 60' (18 m) long by 19' (5.7 m) wide with a ceiling height of 11.5' (3.5 m). It is furnished as two

parts; a dining area with institutional-looking tables and chairs, and a relaxation area where easy chairs are arranged around coffee tables. Attached to the main area are a small office area, a kitchen with servery, and a mailbox area, all with a ceiling height of 8' (2.4 m) and are not treated in this publication.

During the day, the lighting of the main area is dominated by daylight admitted through large windows on the north and east walls. Daylight is reduced in winter when 4' (1.2 m) high sheets of insulating material are placed against the lower parts of the windows to reduce discomfort from radiant cooling and drafts. After dark, the electric lighting becomes more prominent.

Details



Community room showing previous lighting



Community room showing new lighting (type CA)

Previous conditions The original lighting of the community room consisted of ten 4' x 4' (1.2 m x 1.2 m) ceiling-mounted opal diffuser luminaires, each using six 34-W T12 CW fluorescent lamps and three RS electronic ballasts. The small office area and mailbox area off the community room were primarily lighted with

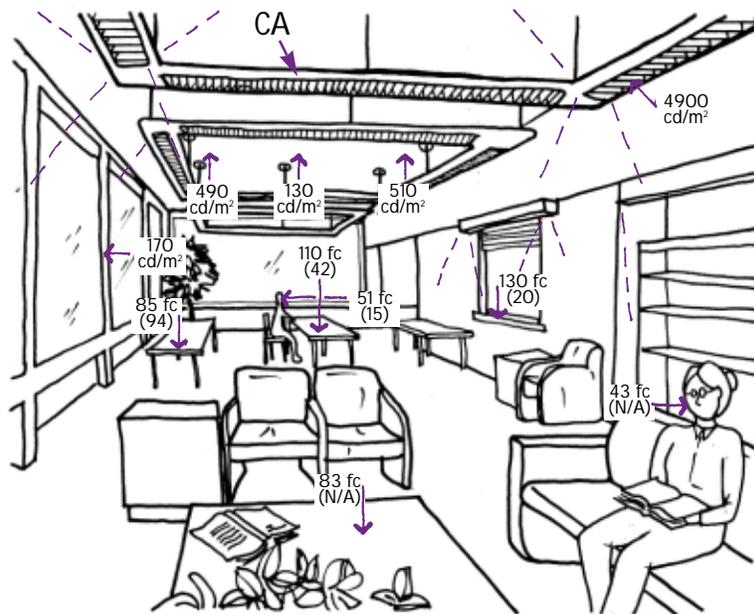
the same wraparound fluorescent lamp luminaires used in the lobby and corridors. After dark, the space appeared dim, but evenly lighted, with some glare.

New conditions The old acoustical ceiling in the Community Room was replaced during the

lighting renovation, in order to maximize the amount of reflected light in the space. Up/down lights (type CA) were installed 2' (0.6 m) from the ceiling, in three 8' x 12' rectangles (2.4 m x 3.6 m). These brighten up the ceiling and upper parts of the walls, and the lamp brightness on the bottom side is blocked by white baffles. This luminaire provides most of the task and ambient lighting in the space. In the small office and in the alcove at the edge of the room, there is a simple valance luminaire that draws attention to the bookshelves. This is created with a fluorescent striplight concealed with an 8" (200 mm) tall wood fascia. Wall-mounted over the window to the kitchen is an 8' long (2.4 m) luminaire (type CC), directing light down onto the food service counter.

The mailroom has been remodeled into a light therapy area that opens to the Community Room (see sidebar on page 3).

During a sunny day in May, the combinations of daylight and the old electric lighting system produced illuminances on the food and coffee tables ranging from 20 to 110 footcandles (fc) [210 to 1100 lux (lx)], the higher illuminances being measured close to the windows. By itself, the previous electric lighting system delivered an average of only 19 fc (200 lx) of ambi-



Perspective of community room. (The values for the new lighting are for electric lighting only. Previous values shown in parentheses include both electric lighting and daylight.)

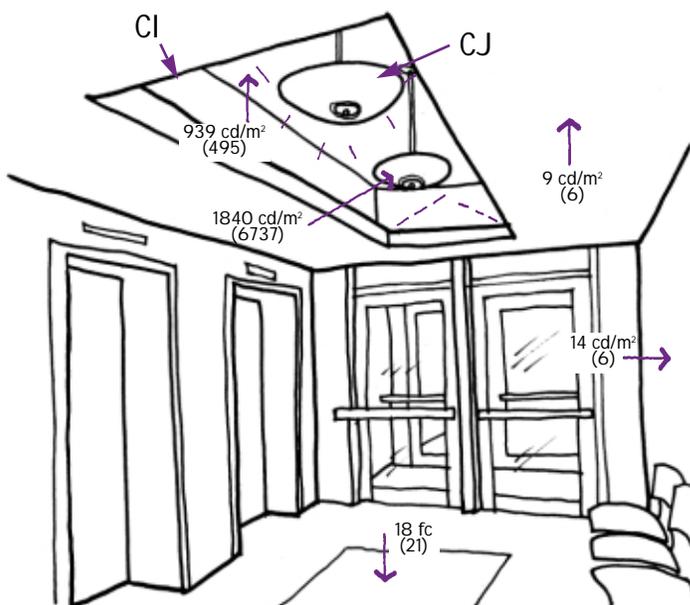


Lobby showing previous lighting



Lobby showing new lighting (types CI and CJ)

ent light. The new electric lighting alone produces 51 to 110 fc (550 to 1200 lx) of ambient light, easily exceeding illuminances recommended in the Illuminating Engineering Society of North America's Recommended Practice 28, "Lighting and the Visual Environment for Senior Living" (see *Evaluation*).



Perspective of lobby, night (previous values shown in parentheses)

Lobby The lobby of South Mall Towers is a small space, 21' by 10' with an 8' ceiling (6.4 m x 3.1 m x 2.4 m). On the north side are double glass entrance doors forming an entry vestibule that reduces heat loss. Two elevator doors open in the west wall, and a large photomural decorates the south wall. The only furnishings are three small chairs and a newspaper vending machine. The lobby is primarily used for circulation and for meeting people.

Previous conditions The lobby's previous lighting consisted of two 4' (1.2 m) long, ceiling-mounted fluorescent luminaires with prismatic wraparound lenses. A third such

luminaire was used to light the vestibule. Each two-lamp luminaire used 34-W T12 CW fluorescent lamps on an electronic ballast. The photomural was lit with two eyeball-type luminaires, each luminaire containing one 65-W incandescent floodlight, but was uneven. In daytime, daylight reaches the lobby through the glass doors, making it appear bright and evenly lit. After dark, however, the lobby lighting was seen as uneven and glaring. Because seniors' eyes take longer to adapt to a change in brightness, the difference in brightness between the lobby and the outdoors made it difficult for residents to see clearly immediately after leaving the building.



Details



Lobby corridor, showing previous lighting

New conditions In 1998, the lobby lighting was replaced with cove lighting (type CI), pendants (type CJ), and recessed wall washers (type CF). The apparent size of the lobby has been increased by opening up the plenum to install a 2'-6" (0.76 m) high coffer containing two pendants for decorative effect. Glare has been reduced because the whole coffer acts as a large area light source. The cove lighting is automatically dimmed to 8% of full light output at night by a time clock, reducing the brightness difference between lobby and outdoors. The photomural is now lighted by using two recessed CFL wall-washing luminaires (type CF) centered 28" (710 mm) from the wall.

After dark, with the cove lighting dimmed, illuminances on the floor of the lobby are very similar to previous values, but the brightness of the cove is considerably less than that of the previous luminaire (see values on illustration on page 7). As for the photomural wall, illuminances are much higher than before, but the illuminance distribution is still uneven, particularly at the top of the wall (visible in lobby corridor photos and drawing on page 9).



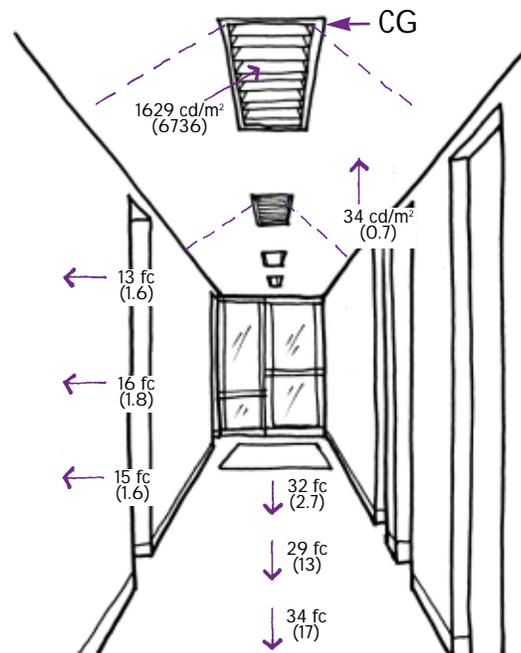
Lobby corridor, showing new lighting (type CG)

Lobby corridor The lobby corridor is one of the main circulation routes in South Mall Towers. It provides access from the lobby and elevators to the community room, the main administrative office, the laundry room, and another exit door. It is 64' (19 m) long by 6' (1.8 m) wide with an 8' (2.4 m) ceiling. The corridor contains the administrative office window/counter, a bulletin board where notices and event advertising are posted, a pay phone, and a water fountain.

Previous conditions Very little daylight reaches this corridor through the small entry lobby, so the lighting is similar both day and

night. The previous lighting of the corridor consisted of three 4' (1.2 m) long fluorescent lamp wraparound luminaires, two luminaires along the corridor and one in the small entry lobby. The two short corridors giving access to the community room were not lighted. Both day and night, the corridor appeared dim, and the light was unevenly distributed. Points of interest received only incidental light from the corridor lighting.

New conditions Luminaires were located to make it easier to read notices on the bulletin board, to read and write while at the main administrative office counter, to see the pay phone push buttons more easily, and to provide more light in the short corridors giving access to the community room. The



Perspective of lobby corridor (previous values shown in parentheses)



Administrative office counter in lobby corridor, showing previous lighting



Administrative office counter in lobby corridor, showing new lighting (type CH)

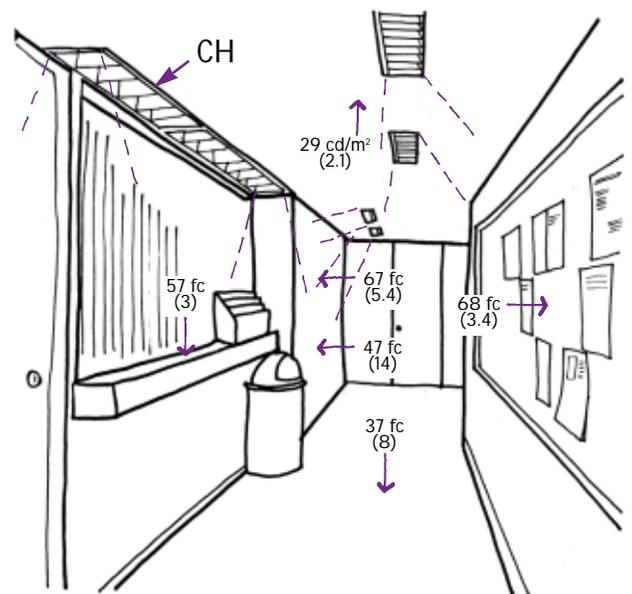
corridor now is lighted with six recessed 1' x 4' (0.3 x 1.2 m) recessed, baffled luminaires (type CG), spaced 10' (3 m) on center. Additional 2' (0.6 m) wall-washing luminaires (type CF) are installed in each of the short corridors leading to the community room and adjacent to the bulletin board. Task lighting over the main administrative office counter is provided by two recessed 9" x 4' (230 x 1200 mm) fluorescent luminaires (type CH) with baffles.

The new lighting increases average illuminance on the floor of the corridor and improves uniformity (new average/minimum illuminance = 1.7; previous average/minimum illuminance = 5.9). The maximum brightness of the luminaires is reduced, thereby reducing glare, while the illuminances on work surfaces are dramatically increased.

Residential corridor The nine apartment floors of South Mall Towers have a series of corridors lined with irregularly spaced doors

(see Lighting plan, retrofitted apartments, on page 11). One of these residential corridors was relighted as part of this project. This corridor is 5.5' (1.7 m) wide with an 8' (2.4 m) high ceiling. At one end of the corridor is a small elevator lobby, while at the other a vestibule gives access to the street. Residential corridors that are not at street level have a large window at their ends.

Previous conditions The residential corridor was lighted 24 hours a day by 4' (1.2 m) ceiling-mounted luminaires with wraparound opal diffusers, spaced 16' to 30' (4.9 to 9.1 m) on center, oriented cross-wise to the corridor. Daylight from the end of the corridor contributed little to its illuminance, but the windows or doors were a disturbing source of glare during the day. After



Perspective of administrative office counter in lobby corridor (previous values shown in parentheses)



Details



Residential corridor, showing previous lighting

dark, the previous lighting was seen as glaring and uneven.

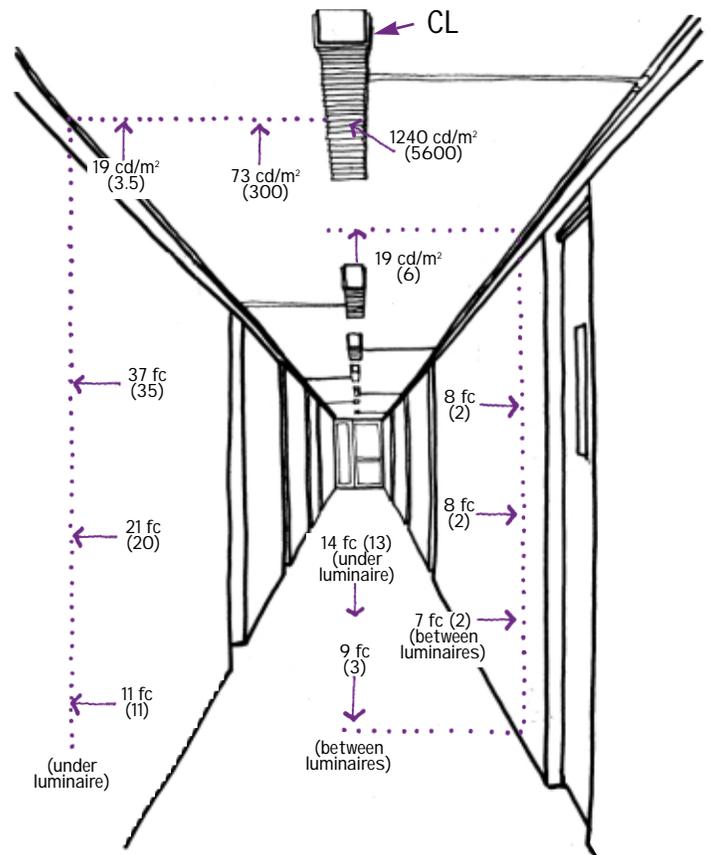
New conditions Because the ceiling is concrete, the newly installed lighting system was limited to surface-mounted luminaires and wiring. “Stacklight” luminaires (type CL) are spaced 12’ (3.6 m) on center parallel to the length of the corridor. These luminaires spread light on the side walls, but U-shaped white baffles block the direct view of the lamp as residents travel the corridor. Round ceiling-mounted luminaires (type CK) are used to distinguish elevator and entry lobbies, as well as turning points in the corridors. These CFL units have opaque sides but feature upward spill light and louvered downlight to reduce direct glare and the relative brightness of the luminaire against the ceiling.

To save energy, the stacklight luminaires are connected to three occupancy sensors. When any one of the occupancy sensors detects someone entering the corridor, all the luminaires are turned to full light output. They stay in this condition until 20 seconds after the space becomes vacant, then revert to 8% of full light output. For safety reasons, the luminaires are never fully switched off.

At full output, the new lighting in the corridor provides higher illuminances on the floor of the corridor than the previous lighting (see ranges on illustration above). Horizontal illuminances are more uniform (new average/minimum = 1.09 ; previous average/minimum = 2.78). Luminaire brightness is also lower, reducing glare from the electric lighting, but the daylight glare is still a problem.

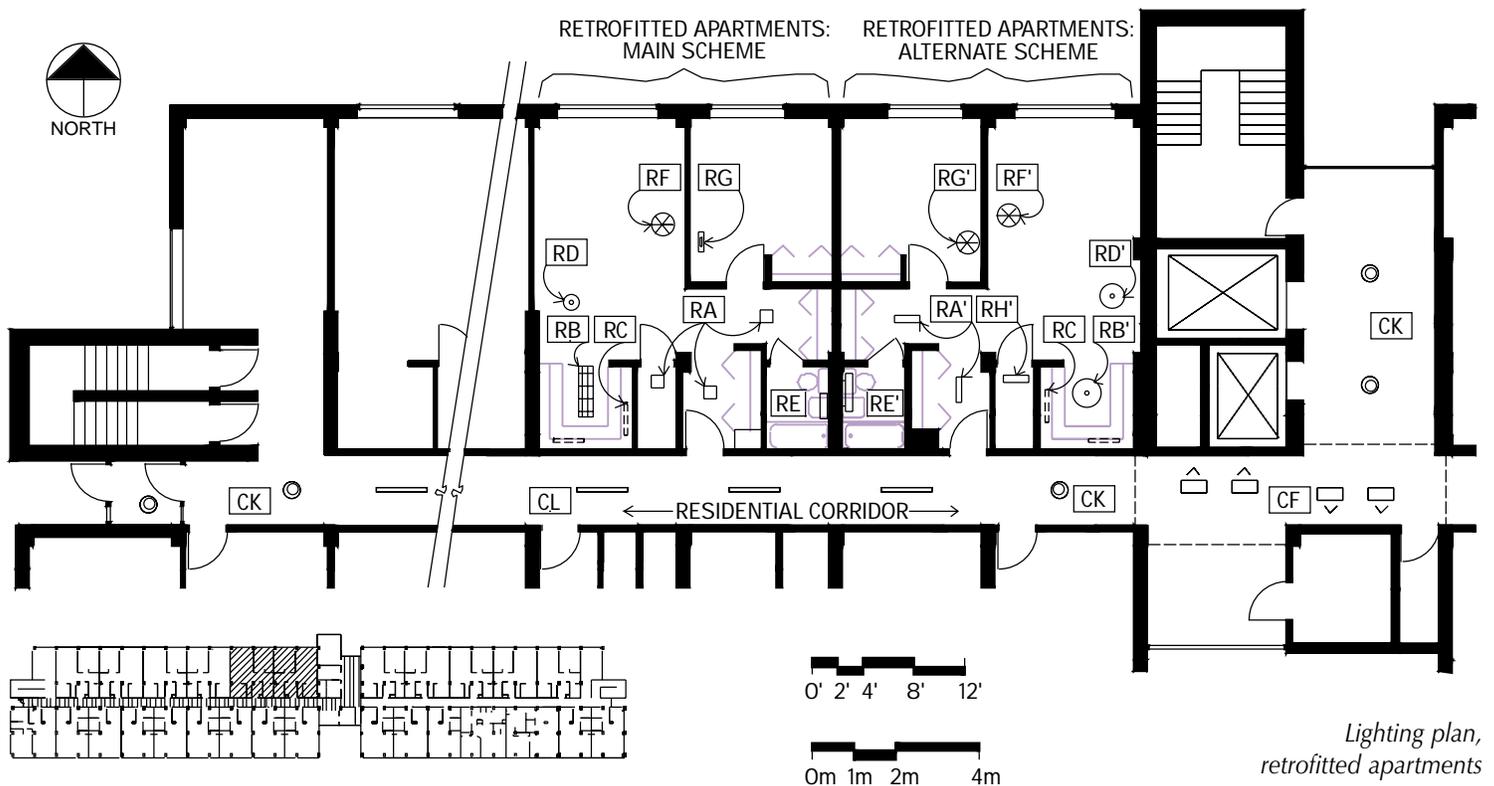


Residential corridor, showing new lighting (type CL)



Perspective of residential corridor, new lighting (previous values shown in parentheses)

Techniques



Project Specifications: Retrofitted Apartments

This phase of the project was designed to test whether a simple lighting retrofit in the one-bedroom apartments could improve visual conditions and energy efficiency. Every apartment measures 600 ft² (56 m²) with an entryway, hall, separate bedroom, bathroom, storage closet, kitchen, and combined living/dining room. The short entryway has a closet on one side. Both the living/dining room and bedroom have large windows.

Previous conditions Until 1997, standard incandescent A-lamps of various wattages and T12 CW fluorescent lamps were commonly used in these apartments. The incandescent lamps were used in surface-mounted frosted globes in the entryway, hallway, and closet. A-lamps were also used in table lamps provided

by the residents in the bedroom and living room. Fluorescent lamps were used in two-lamp 4' (1.2 m) prismatic wraparound luminaires in the kitchen and dining area, and 2' (0.6 m) two-lamp luminaires with yellowing polystyrene diffusers mounted above the mirror in the bathroom.

New conditions In 1997, twelve one-bedroom apartments were temporarily retrofitted with new lighting. All luminaires were either connected directly to existing electrical boxes or plugged into existing outlets. They used linear or compact fluorescent lamps with warm CCTs (2700 K or 3000 K). The twelve apartments received one of two lighting schemes, in order to test alternative products. (The alternate luminaires have the same letter code, with a " ' " added.) Wherever possible, electronic ballasts were used to minimize noise,

flicker, and wattage (types RA', RB, RC, RD, RE, RE', RG, and RH'). All other products used HPF RS magnetic ballasts (type RA) or electronically ballasted screwbase CFL products (types RB', RD', RF, RF', and RG').

RA Ceiling-mounted CFL luminaire, two lamps in cross section, 1' x 1' (300 mm x 300 mm) square, with clear prismatic lens.
Lamps: (2) FT18W/2G11/RS/830.

RA' Ceiling-mounted fluorescent lamp luminaire, 2' x 3" (600 mm x 76 mm), two lamps in cross section, with U-shaped acrylic lens; sides of lens are clear prismatic, bottom is opaque white.
Lamps: (2) F17T8/730



Techniques

RB  Ceiling-mounted fluorescent lamp luminaire, 14" x 4' (350 mm x 1220 mm), two lamps in cross section with solid, white-painted wood frame and white acrylic diffuser panel.
Lamps: (2) F32T8/730

RB'  Close-to-ceiling up/downlight pendant with sandblasted glass diffuser and an etched glass centerpiece. Unit is designed for three medium-base incandescent lamps, but installed with three screwbase CFLs.
Lamps: (3) Triple tube 23/827

RC  Undercabinet fluorescent lamp luminaire, 2' x 5" x 2" (600 mm x 130 mm x 51 mm), one lamp in cross section, with clear prismatic acrylic lens, mounted at front edge of cabinet.
Lamp: F17T8/730

RD  Close-to-ceiling CFL up/downlight. Cone-shaped opal glass diffuser and 1/2" x 1/2" x 1/2" (13 mm x 13 mm x 13 mm) aluminum cube louver to control downlight brightness.
Lamp: CFM42W/GX24z

RD'  Pendant-mounted mostly downlight luminaire, 15" (380 mm) in diameter, with white acrylic diffuser on bottom aperture and lighted reveal. Unit is designed for three medium-base incandescent lamps, but installed with three screwbase CFLs.
Lamps: (3) Triple tube 23/827

RE  Wall-mounted fluorescent lamp luminaire with opaque front, 6" x 2' (150 mm x 600 mm), two lamps in cross section, mounted above mirror in bathroom. Up aperture is open; clear acrylic prismatic lens faces downward. Lamps: (2) F17T8/730

RE'  Wall-mounted fluorescent luminaire, 6-1/2" x 3' (160 mm x 900 mm), two lamps in cross section, mounted above mirror in bathroom. Up aperture is open; white acrylic diffuser faces downward. Front is opaque, with decorative slot for spill light.
Lamps: (2) F25T8/730

RF  Portable CFL floor lamp with three-way socket designed for incandescent lamp. Installed with screwbase electronic ballast that allows 3 levels of light output for replaceable CFLs.
Lamp: CFS38W/827

RF'  Portable CFL table lamp with three-way socket designed for incandescent lamp. Installed with screwbase electronic ballast that allows 3 levels of light output for replaceable CFLs.
Lamp: CFS38W/827

RG  Portable CFL torchiere, 6' (1.8 m). Integral switches permit three levels of light: one lamp, two lamps, or all three.
Lamps: (3) FT36W/2G11/830

RG'  Portable CFL floor lamp, with three-way socket and electronic ballast that allows 3 levels of light output for replaceable CFL lamp.
Lamp: CFS38W/827

RH'  Ceiling-mounted fluorescent luminaire, 5" x 2' (130 mm x 600 mm), one lamp in cross section, with L-shaped clear acrylic linear prismatic lens.
Lamp: F17T8/RE730

Wattage

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

T8 fluorescent lamps (electronic ballast)
F17T8 (2'): 20 W per lamp for 2-lamp ballast
F17T8 (2'): 17 W per lamp for 1-lamp ballast
F25T8 (3'): 23 W per lamp for 2-lamp ballast
F32T8 (4'): 29 W per lamp

Compact fluorescent lamps:
FT18: 21 W per lamp for 2-lamp magnetic ballast
FT36: 35 W per lamp for 2-lamp electronic ballast
CFS38: 34 W per lamp for electronic stepped-dimming ballast
CFM42: 48 W per lamp for electronic ballast

Screwbase compact fluorescent lamps (integral electronic ballast)
Triple tube 23: 23 W per lamp

Details

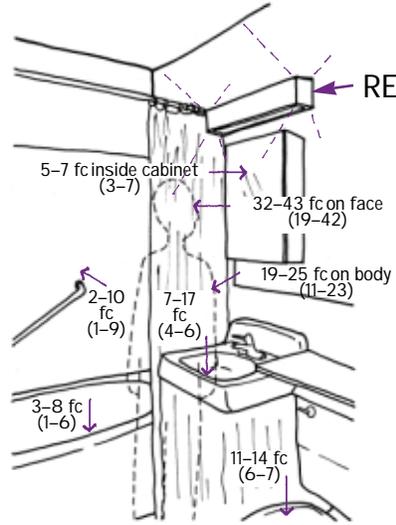
Retrofitted Apartments

The residents at South Mall Towers spend a lot of time in their apartments. Typically, they are in and out of their apartments in the mornings and early afternoons, but by mid-to-late afternoon they retire to their apartments for the day. The retrofitted lighting was designed to provide more light without glare.

Bathroom

Previous conditions The previous fluorescent lamp luminaire was mounted above the mirror over the sink. Illuminances elsewhere in the bathroom were low (see ranges on illustrations at right).

New conditions The retrofitted luminaires are also mounted over the mirror, but both types RE and RE' have an opaque panel facing the viewer. This panel blocks much of the direct glare and sends more light upward to produce diffuse indirect light on the face and body. These luminaires distribute light more



Perspective of bathroom, new lighting conditions (previous values shown in parentheses)

widely around the bathroom, increasing illuminance on the body, sink, and elsewhere in the bathroom (see ranges on illustrations above and at right).



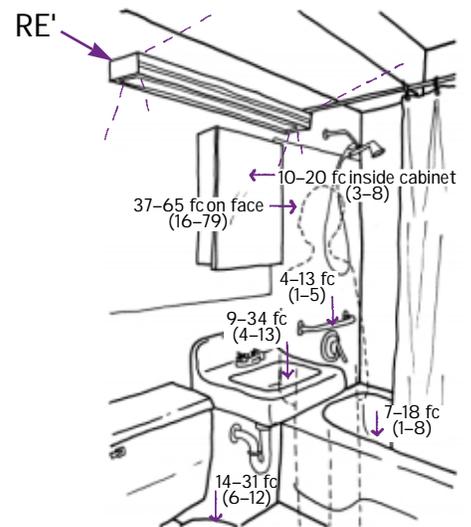
Bathroom, showing new lighting (type RE)



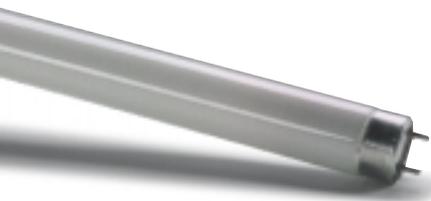
Bathroom, showing previous lighting



Bathroom, showing new lighting (type RE')



Perspective of bathroom, new lighting conditions (previous values shown in parentheses)



Details

Bedroom

Previous conditions Typical lighting consisted of one or two portable table or floor lamps, furnished by the residents and fitted with 60- to 100-W A-lamps. Illuminances were low in the main part of the bedrooms and in the closets (see ranges on illustration below).

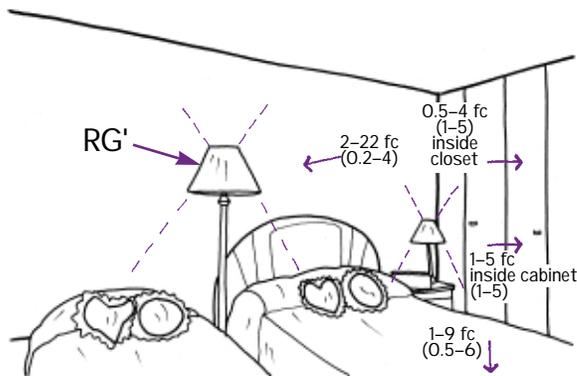
New conditions Both retrofit luminaires were chosen to provide more light, widely distributed in the bedrooms, to minimize glare. The CFL torchiere (type RG) increased



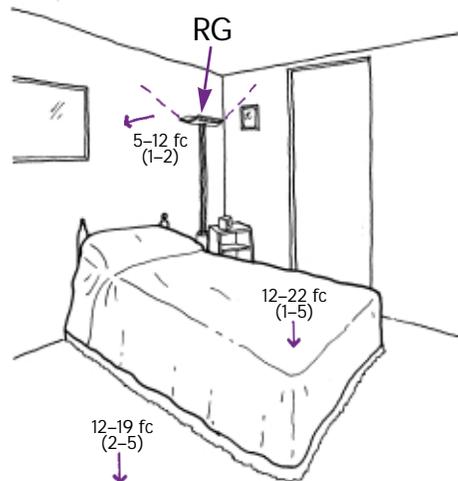
Bedroom, previous lighting conditions



Bedroom, new lighting conditions (type RG')



Perspective of bedroom (previous values shown in parentheses)



Perspective of bedroom (previous values shown in parentheses)

illuminances in the bedrooms and in the closets when used at full light output. The floor lamp (type RG') provided somewhat less light in the bedroom and in the closet (see ranges on illustration at left).

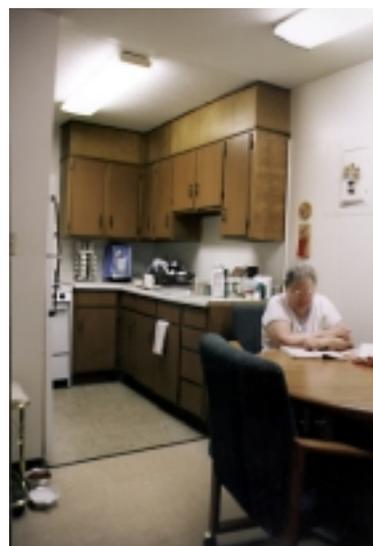
Kitchen

Previous conditions A central ceiling-mounted wraparound fluorescent luminaire provided low illuminances on the working surfaces in a typical kitchen.

New conditions Narrow-profile undercabinet lighting is a key feature of



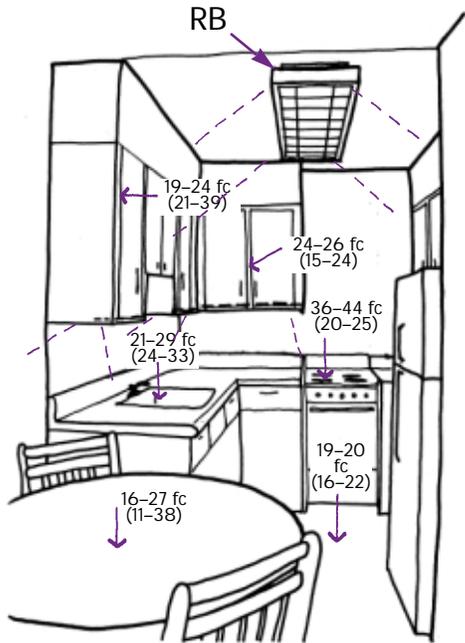
Bedroom, new lighting conditions (type RG)



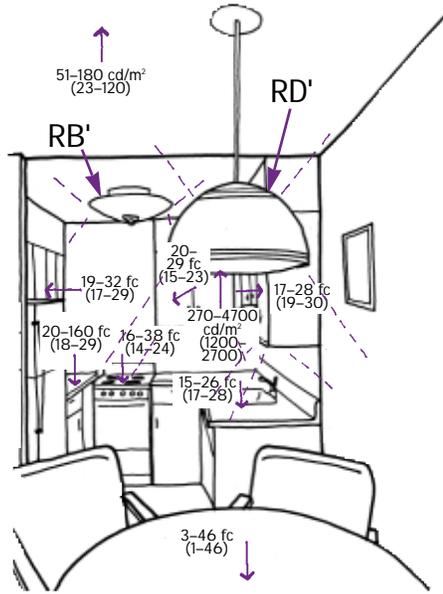
Kitchen, previous lighting conditions



Kitchen, new lighting conditions (types RD and RB)



Perspective of kitchen (previous values shown in parentheses)



Perspective of kitchen (previous values shown in parentheses)

faulty ballast, produced poor illuminances, and was poorly received by residents. The pendant luminaire (type RD') performed well, and together with the CFL table lamp near the sofa (type RF'), produced more light on the floor, walls, and sofa. This retrofitted pendant luminaire (type RD') is much less bright than the previous wraparound luminaire. The performance of the three-way floor lamp (type RF) is similar to that of the CFL table lamp on the floor and walls, but it puts a much higher illuminance on the sofa.



Living/dining room, new lighting conditions (type RF)

the retrofitted lighting. It provides light on the countertops without causing glare. The luminaire (type RC) is mounted at the front edge of the cabi-

nets, with its lens facing the back wall, so that the direct glare of the lens is never visible. Both types of ceiling-mounted luminaires (types RB and RB') maintain or increase illuminances in the space (see ranges on illustrations above).

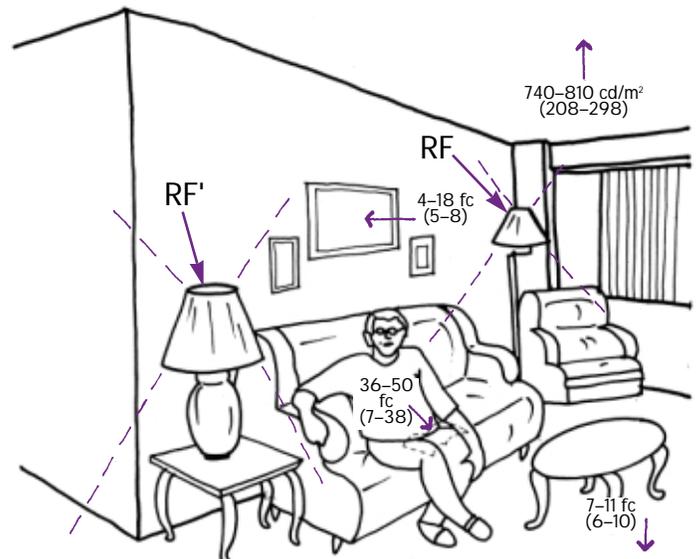
Living/Dining room

Previous conditions These areas were lighted by a ceiling-mounted wraparound fluorescent luminaire over the dining area, as well as by the residents' own incandescent table lamps. The previous luminaire over the table was perceived as too bright (see ranges on illustration at right).

New conditions The retrofitted luminaires were chosen to be more residential in appearance, provide more light around the room, and reduce luminaire brightness. Unfortunately, the close-to-ceiling CFL luminaire (type RD) over the table had a



Kitchen, new lighting conditions (types RB' and RD')



Perspective of living/dining room (previous values shown in parentheses) (types RF and RF')



Project Evaluation

Common Areas

Energy Impact DELTA used manufacturers' data to calculate lighting power densities (LPDs). LPDs for the new lighting are consistently higher at full light output than those of the previous lighting installation. This is not because the new installations are inefficient, but because they provide more light and use more luminaires to place additional light on specific surfaces, such as the bulletin board in the lobby corridor. The benefits of providing these higher illuminances are evident in the residents' positive evaluations. Automatic controls reduce these illuminances when they are not required in the lobby and the residential corridors. In the residential corridor, the LPD of the new lighting is reduced to less than that of the previous lighting.

Note: DELTA did not perform environmental and economic benefit analyses for the common areas because most of the renovated spaces have higher LPDs than the previous conditions. This publication instead focuses on the benefits of lighting quality in senior living facilities.

Installation Costs The new lighting in the common areas of South Mall Towers cost \$36,000, including the prime light therapy space, which translates to approximately \$10/ft² (\$110/m²). The luminaires cost \$3/ft² (\$32/m²), labor to install lighting and controls cost \$5/ft² (\$54/m²), and special ballasts and controls cost approximately \$2/ft² (\$22/m²). This was a small experimental project; if the lighting design were applied to a larger area

and luminaires were purchased in larger quantities, all costs would have been reduced.

Residents' Responses The DELTA team surveyed the residents of South Mall Towers about the lighting before and after the new lighting was installed in the common areas. Ninety-two residents completed the questionnaire for the previ-

"The lighting has added much to the inside beauty of this senior center and enhanced the dignity of its residents."
—South Mall Towers resident

ous lighting, and seventy-four replied after the new lighting was installed. They were asked for their opinions on the quality of the lighting, its suitability for different tasks, and how the new lighting compared with the previous lighting.

The vast majority of the residents considered the new lighting to be good or very good, and much better than the previous lighting; they rated it more suitable for reading and other activities, brighter, more even, and more comfortable both by day and night. Perception of glare was the only factor for which residents noted no difference between the previous and new lighting installations. Both previous and new lighting was described as glaring by about 20% of the residents; this problem may be due to increased light scatter in the aging eye that makes some people sensitive to the amount of light, no matter how it is delivered, or it may be a lack of understanding of the term "glare." It is notable that perceptions of glare did not increase despite the increased illuminance produced by the new lighting.

Common Areas and Retrofitted Apartments—Lighting Power Densities

Common Spaces	Total Area (ft ²)	Previous Total Connected Load (W)	Previous LPD (W/ft ²)	New Total Connected Load (W)	Total LPD (W/ft ²)	In-Use ^a LPD (W/ft ²)	ASHRAE/IES ^b Allowed LPD (W/ft ²)
Community Room	1224	1930	1.58	2378	1.94	—	1.8
Lobby	291	310	1.07	490	1.68	1.36	1.0
Lobby Corridor	506	180	0.36	640	1.26	—	1.3
Residential Corridor	1288	700	0.52	829	0.64	0.48	1.3
Retrofitted Apartments	Total Area (ft ²)	Previous Total Connected Load (W)	Previous LPD (W/ft ²)	New Total Connected Load (W)	Total LPD (W/ft ²)	Frequently Used Spaces ^c LPD (W/ft ²)	Pattern Book ^d LPD (W/ft ²)
Main Scheme (4, total)	2400	4160	1.73	3180	1.33	1.33	2.0
Alternate Scheme (8, total)	4800	7448	1.55	5504	1.15	1.23	2.0
Whole Building (if retrofit were applied to whole building)	61,200	98,668	1.61	73,814	1.21	—	—

^a In-Use = These spaces are illuminated 24 hours per day, but are dimmed during nighttime hours. Wattages are reduced to reflect dimming.

^b ASHRAE = American Society of Heating, Refrigerating, and Air Conditioning Engineers. Although ASHRAE/IES does not apply to residential facilities, LPD's were drawn from the category "Nursing Homes" for comparison only. IES=Illuminating Engineering Society of North America.

^c Including only kitchen, living/dining room, bedroom, and bathroom. See "Retrofitted Apartments—Energy Impact." This compares to 1.57 W/ft² for the previous frequently used spaces. See page 18.

^d LPD's in typical American homes, including kitchens, living rooms, bedrooms, and bathrooms, based on data from *Lighting Pattern Book for Homes* (1996)

1 W/ft² = 10.76 W/m²

LIGHTING SURVEY: COMMON AREAS
Percentages of Senior Residents Who Agree:

	Community Room		Lobby		Lobby Corridor		Residential Corridor	
	Previous	New	Previous	New	Previous	New	Previous	New
Lighting is good or very good by day	40	91	42	92	46	95	55	91
Lighting is good or very good after dark	22	96	25	90	34	92	50	92
New lighting is much better than previous by day	—	84	—	82	—	79	—	80
New lighting is much better than previous after dark	—	89	—	82	—	79	—	80
There is enough light for reading	70	98	—	—	75	98	—	—
There is enough light to play bingo, puzzles, crafts	77	95	—	—	—	—	—	—
There is enough light to see faces	90	98	88	98	86	98	87	93
Lighting is even after dark	40	94	57	98	60	92	68	90
Lighting is comfortable by day	62	99	—	—	—	—	—	—
Lighting is comfortable after dark	43	96	—	—	—	—	—	—
Lighting is glaring after dark	25	25	12	21	15	19	12	25
Lighting is of good color after dark	42	99	—	—	61	96	70	96

“I just like the lighting in the hallways. I like the community room. It is such an improvement all the way round. I work in the community room five days a week, and I enjoy the lights every day.”

—South Mall Towers resident

duces improved visual capabilities relative to the previous lighting. For the tests in these areas, most of the residents showed an improvement in performance under the new lighting, although a few showed no change. The only space where visual capabilities did not improve was in the residential corridor. This can probably be explained by the similarity of illuminance provided by the previous and new lighting in this space and the presence of uncontrolled glare from a doorway at the end of the corridor that was studied.

Residents’ Visual Capabilities To test whether the new lighting installation had any effect on the visual capabilities of seniors, 6 to 8 residents volunteered to carry out visual performance tests under the previous lighting and under the new lighting. The tests measured:

- the smallest detail that could be resolved at a distance of 20’ (6.1 m) (distance visual acuity)
- the smallest print size that could be read at 19” (480 mm) (near visual acuity)
- the lowest luminance contrast that could be detected for a constant size target (threshold contrast)
- the minimum amount of color saturation that was needed to recognize a specific color
- the speed with which residents could see a number of small blocks scattered on the floor.

The table below gives the range of values of each of these measurements for the same group of people under the previous and the new lighting.

Overall, the new lighting in the community room, the lobby, and the lobby corridor pro-

“The new lighting makes the apartments much easier to rent.”

—South Mall Towers Executive Director

Common Areas—Visual Performance Tests

Performance Test	Community Room after dark	Lobby	Lobby Corridor	Residential Corridor
Distance visual acuity (min arc) (smaller is better)	Prev: 1.0–3.0 New: 0.6–1.7	— —	Prev: 1.4–3.4 New: 0.6–2.3	Prev: 0.8–4.2 New: 0.6–4.2
Near visual acuity (print point size) (smaller is better)	Prev: 6–12 New: 4–12	Prev: 6–12 New: 5–12	Prev: 6–13 New: 5–10	Prev: 8–24 New: 6–24
Minimum detectable luminance contrast (lower is better)	Prev: 0.02–0.05 New: 0.01–0.02	— —	— —	— —
Chroma required for color recognition (lower is better)	Prev: 2.9–3.6 New: 2.4–3.1	— —	— —	— —
Number of blocks detected per second (higher is better)	— —	— —	Prev: 0.9–2.5 New: 1.0–3.3	Prev: 0.3–2.2 New: 0.6–2.5

“The lighting is a lot brighter, and you can see peoples’ faces and where you are walking.”

—South Mall Towers resident



Project Evaluation

Maintenance and Product Performance

The initial installation of the residential corridor occupancy sensors proved to be a problem. One occupancy sensor was originally set to operate all 4' (1.2 m) long luminaires together, so that all the luminaires were at 100% light output when the corridor was occupied. However, the corridor was too long for a single occupancy sensor to pick up movement. Three sensors were then wired together so that if any sensor detected movement, all lights were switched to full output. Unfortunately, the electrical contractor had limited experience in the wiring of controls, and this logic required a more sophisticated wiring scheme than the electricians could handle. After several unsuccessful attempts to correct partial switching, a new electrical contractor was hired to follow wiring instructions from the manufacturer. The corridor lighting now works as intended.

South Mall Towers has experienced only one major problem with product performance since the new lighting was installed. The lamps installed in the pendant luminaires (type CJ) in the lobby failed after fewer than a thousand hours. These lamps were returned to the manufacturer, who declared them to be part of a defective batch and supplied replacements. The replacement lamps have been operating satisfactorily for approximately one year.

Retrofitted Apartments

Energy Impact DELTA adopted manufacturers' data to calculate the power demand of the luminaires used in the previous lighting and the new lighting. Because each apartment had different luminaires brought in by the residents, DELTA calculated the LPD for the apartments as the average of the total power demand for the twelve one-bedroom apartments divided by their combined floor area. The resulting LPD is an average value for the twelve apartments. The luminaires contributing to the calculated LPD in each apartment were the fixed lighting and all portable luminaires that the residents said they used regularly. For the retrofitted

lighting, one of the previous portable luminaires was replaced by a new CFL portable luminaire. The LPD for the previous lighting was 1.61 W/ft² (17.3 W/m²), while LPDs for the new lighting were 1.33 W/ft² (14.3 W/m²) for one design and 1.15 W/ft² (12.4 W/m²) for the other. However, these LPD reductions may be misleading because some luminaires are used for more hours per day than others. Luminaires in the entryway, hall, and pantry are rarely used, while living/dining area, kitchen, bathroom, and bedroom luminaires are used for the longest periods. Recalculating the LPDs for these frequently used areas only gives an LPD for the previous lighting of 1.57 W/ft² (16.9 W/m²) and 1.33 W/ft² (14.3 W/m²) and 1.23 W/ft² (13.2 W/m²) for the two retrofitted installations.

and third set of apartments, for a total of twelve retrofitted apartments. The cost of the four sets of material and initial installation on the first four apartments was approximately \$5100, or approximately \$2/ft² (\$22/m²) for luminaires and lamps, and \$0.12/ft² (\$1.30/m²) for installation.

Residents' Response The DELTA team conducted structured interviews with the residents of the twelve one-bedroom retrofitted apartments. The table below gives the percentage of residents expressing positive, negative, and neutral views about the previous and new lighting.

Overall, the residents were neutral or dissatisfied with the previous lighting of their apartments. Those who were neutral thought the previous lighting was adequate. Those who were

LIGHTING SURVEY
Percentages of People Expressing Positive, Neutral and Negative Opinions

Retrofitted Apartments: Area	Previous Positive	Previous Neutral	Previous Negative	New Positive	New Neutral	New Negative
Whole apartment	8	50	42	75	25	0
Bathroom	0	33	67	75	8	17
Bedroom	50	25	25	64	9	27
Kitchen	0	17	83	59	8	33
Dining area	8	33	59	42	16	42
Living room	42	50	8	58	25	17

Note: DELTA did not perform a life-cycle cost and environmental analysis for the retrofitted apartments because some installations were temporary, usage patterns and occupancy varied widely, and different types of heating/cooling systems were used throughout the apartments. This publication focuses instead on the benefits of lighting quality in senior living facilities.

Installation Costs Four sets of lighting equipment were purchased, installed, and evaluated; the equipment was then moved to a second

negative were usually dissatisfied with the amount of light. The majority of residents liked the new retrofitted lighting. Those who were neutral liked some parts and not others. No one was totally negative about the new lighting.

Residents were dissatisfied with the previous bathroom lighting. Many of the acrylic lenses had yellowed, reducing light output. Some residents had removed the lenses to increase the amount of light. In contrast, residents were much more enthusiastic about both new forms of bathroom lighting. They thought the new

lighting was “much brighter,” lighting the whole bathroom without glare or shadows.

The previous lighting in the bedroom was furnished individually by each resident. Most residents had one or more table lamps. Not surprisingly, most of the residents considered their previous lighting at least adequate, if not satisfactory. Even so, those who received the CFL torchiere (type RG) appreciated having the additional light. They commented that the torchiere brightened the whole bedroom without glare and made it easy to see into closets and dressers. A few thought that the maximum light output setting made the

*On the new lighting in the bathroom—
“Everybody wishes they had
a light like this.”*

bedroom too bright, but were happy with the lower output settings. A few objected to the high-tech style of the torchiere and considered it unsuitable for a residence. The alternative CFL floor lamp (type RG’) was also appreciated, even though the additional illuminance provided was less than that produced by the torchiere. However, some residents were concerned that the switch (at the base of the lamp socket) was difficult to reach from a seated position.

Residents vary in how frequently they use their kitchens. Some are active cooks, and others prepare food only occasionally. Most residents thought the previous lighting of the kitchen was poor because often they were working in their own shadows, particularly at the sink. Residents complained about

*On the new lighting in the bedroom—
“It’s beautiful. When (the torchiere)
is on the whole room lights up.
I can see everything better, including
the dresser.”*

glare and insufficient light to see into kitchen cabinets. They appreciated the lighting of both retrofitted designs, which made the kitchen look brighter, especially when the undercabinet lighting was used. Residents who had the close-to-ceiling pendant (type RB’) liked the glow on the ceiling. The undercabinet lighting was considered effective because it helped them see stove controls, food labels, medicine labels, and other small print. Some thought the lighting distribution could be improved by directing more light to the front of the counter top rather than the back.

The residents were not satisfied with the previous lighting of the dining area. They considered the fluorescent lamp wraparound luminaire inappropriate for a dining area. In addition, some said the lighting was too bright and glaring, while others said the lighting of the dining table was too dim. The new lighting was considered better, particularly the pendant luminaire (type RD’). The close-to-ceiling luminaire (type RD) was criticized for providing insufficient light; this result was expected because the ballast was faulty.

The previous lighting of the living room was provided by the wraparound fluorescent luminaire over the dining area together with whatever lighting the residents already had. Again, the residents were broadly satisfied with the previous lighting in the living room. For most people the new lighting (types RF and RF’) provided only a slight improvement. Residents appreciated the three levels of light output provided by the electronic ballast.

Maintenance and Product Performance

DELTA did not evaluate maintenance and product performance of the lighting in the retrofitted apartments because the installations were temporary. However, it is worth noting that the fluorescent lamps used require low maintenance because of long lamp life.

Lessons Learned

- **Lighting designed with the requirements of seniors in mind can enhance their quality of life.** The new lighting installations in the common areas and retrofitted apartments were considered by the residents to be much better than the previous installations and produced improvements in the residents’ visual capabilities. Residents say they spend more time socializing with others in the community room.

- **Improving the lighting in a space can alter the way seniors use the space.** When light levels are very uneven in a living room, for example, residents tend to use only the well-lighted areas. When light levels are higher and more uniform, residents are able to use more of the space.

- **Retrofitted fluorescent lamp luminaires were well received by residents.** A thoughtful retrofit design using fluorescent lamps can improve the amount and distribution of light without introducing such factors as poor color, flicker, and noise.

- **Combining a dimming system and occupancy sensors is an effective way to save energy in an intermittently used space where some lighting is necessary for safety reasons.** The lighting system in the second-floor residential corridor was well-liked by the residents. The controls reduce light output to 8% of full whenever the corridor is unoccupied for 20 seconds. This scheme saves energy and avoids having residents step out of their apartments into a dark corridor.

- **Look for contractors who are experienced with installing unusual equipment combinations.** The contractors on this project made several attempts to coordinate occupancy sensors and the dimming system in the second floor residential corridor. They were familiar with occupancy sensors and dimming ballasts separately, but not familiar



with combining these two types of equipment in the same system.

• **Commissioning can be difficult when multiple controls influence the same luminaires.**

Commissioning the lighting installation in the second-floor residential corridor was time-consuming because it was difficult to adjust the sensitivity of an individual occupancy sensor until the other sensors had been isolated. Some provision for trouble-shooting multiple controls should be included in the control system design.

• **Better lighting for seniors may use more energy.** Improved uniformity and higher illuminances often necessitate higher lighting power densities than would be found in typical residential facilities. It is important to offset this by using automatic lighting controls and energy-efficient lighting systems.

DELTA Portfolio Lighting Case Studies

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