DELTA

# Portfolio

Demonstration and Evaluation of Lighting Technologies and Applications ▲ Lighting Case Studies

Volume 3 Issue 3

HEALTH CARE FACILITIES

## SARATOGA MEDICAL ASSOCIATES

**Saratoga Springs, New York**

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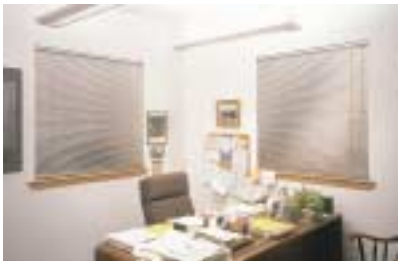


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# Project Profile

In 1999, Saratoga Medical Associates moved into their new suite of medical offices on the third floor of a modern building in Saratoga Springs, New York. The suite contains a reception and waiting area, doctors' offices, examination rooms, nurses' stations, treatment rooms, and administrative offices.

Patients arrive to the reception and waiting area; then meet with nurses or doctors in the examination rooms. Nurses have workstations and the doctors have private offices.

DELTA conducted an evaluation of the existing lighting in five spaces within the suite: the reception and waiting area, one nurses' station, two examination rooms, and one doctor's office. DELTA then installed and evaluated new lighting in those same spaces. This publication provides the results of the two evaluations.

## Lighting Objectives for New Lighting

- Provide good visibility and visual comfort
- Enhance visual appeal
- Eliminate the need for supplementary lighting in the reception and waiting area
- Utilize energy-efficient technologies
- Allow flexibility of light levels in the examination rooms

# Lighting and Control Features of New Lighting

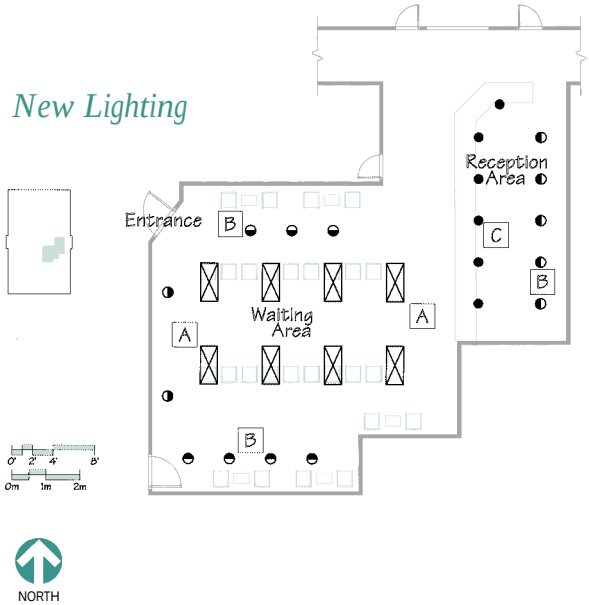
- **Visibility and Visual Comfort.** Evenly spaced downlights above the reception counter provide uniform illumination adequate for tasks such as filling out small-print medical forms. Ceiling-mounted indirect luminaires in the examination rooms provide uniform diffuse illumination, which reduce shadows and veiling reflections. These luminaires also conceal the view of the lamp and prevent direct glare for the patient. Pendant direct/indirect luminaires in the nurses' station and doctor's office deliver light to the ceiling and walls to help minimize excessive brightness differences between the lower and upper parts of the rooms.
- **Visual Appeal.** Recessed wall washers in the reception and waiting area deliver light to the walls, making the space look brighter and more attractive.
- **Eliminate the Need for Supplementary Lighting.** Recessed wallwashers and recessed indirect luminaires in the waiting area provide sufficient of ambient illumination and eliminate the need for additional lighting from table lamps or torchieres.
- **Energy-efficient Technologies.** Linear and compact fluorescent lamps with electronic ballasts are used in most luminaires. An occupancy sensor in the doctor's office switches off lamps when the office is unoccupied.
- **Flexibility.** The lighting in the examination rooms can be dimmed. A separate, wall-mounted examination light is also available.

*"A few of the regular patients were impressed. One said 'Wow! We've got new lighting in here, eh?' "*

— A receptionist, describing patients' reactions

# Reception and Waiting Area

*New Lighting*




A B C

*See page 12 for Specifications*

*"A lot better. A lot brighter.*
*Before we used to have table lamps in there.*
*The elderly always used to have to sit next to the table lamps.*
*Now patients can see their books when they're waiting.*
*Now you never see anybody near the table lamps."*

— A receptionist,
about the new lighting in the waiting area

*"The lights are too bright and hard at the edges."*

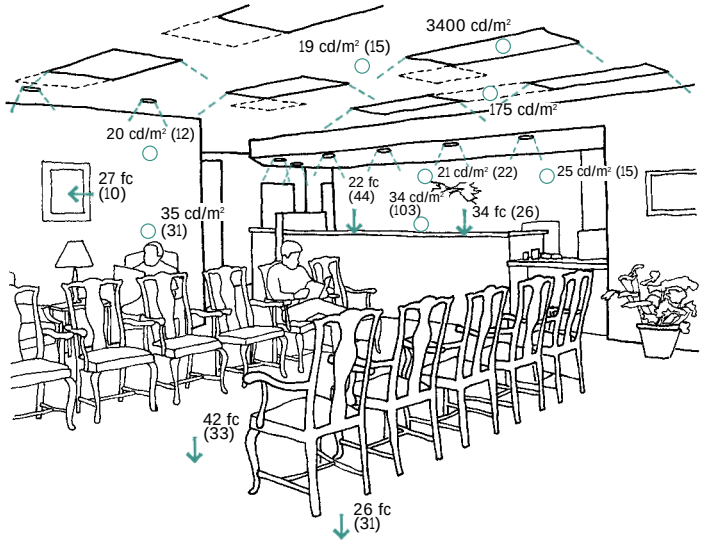
— A patient, about the new lighting
in the waiting area

The first space people encounter upon entering the Saratoga Medical Associates suite is the reception and waiting area. This area is a windowless room, with the reception counter located at the opposite end from the entrance door. Most of the walls have light green vinyl wallpaper (60% reflectance), and the floor is covered with blue-green carpet (10% reflectance). The waiting area is furnished with a set of Chippendale style chairs in the center of the space, a television, a few small paintings, and magazines on small side tables.

## *Reception and Waiting Area* *(continued)*

**Original lighting: reception and waiting area**

- Recessed 2' x 2' and 2' x 4' parabolic luminaires. In the reception area, the luminaires provided plenty of light on some parts of the reception desk, as well as bright patches on the wall behind the counter. Unfortunately these bright patches did not correspond to the decorative elements on the wall.
- Incandescent torchiere and table lamps (not shown in photograph). The parabolic luminaires that minimize reflected images on computer screens are commonly installed in offices where computer use is widespread. In the reception and waiting area, the light distribution from these luminaires made the walls and ceilings appear dark, giving an impression of gloom. Staff members attempted to alleviate this effect by using portable lighting.




**Perspective of reception and waiting area (Measurements of original lighting shown in parentheses. Original luminaires shown in black dashed lines.)**

**New lighting: reception and waiting area**

- The recessed indirect luminaires (type A) in the central part of the waiting area have a much wider light distribution that reduces shadows compared to the parabolic luminaires used in the original lighting.
- Wall washers (type B) placed near the walls of the waiting area and behind the reception desk light the walls evenly.
- Downlights (type C) laid out to conform to the curve of the reception counter provide additional illumination for reading and writing on medical forms.
- The torchiere was removed from the space. Although the table lamps are not turned on, they have not been removed because they provide a home-like appearance in the space.

## Patients' response

DELTA used questionnaires to assess patients' perceptions of the waiting area at Saratoga Medical Associates compared to waiting areas of other medical facilities they had visited. Survey results (see below) suggest that the change in lighting did produce a small improvement in opinion, since slightly more people considered it better and slightly fewer considered it worse than other waiting areas.

**Compared to other health care waiting areas, the lighting in this waiting area is:**

| Lighting | Much better | Better | About the same | Worse | Much worse |
|---|---|---|---|---|---|
| Original (n = 60) | 10% | 35% | 38% | 13% | 4% |
| New (n = 84) | 10% | 45% | 36% | 9% | 0% |

The table below shows the percentage of patients who agree with the statements about the lighting in the waiting area. More patients considered the space to be brighter with the new lighting, but fewer thought it was relaxing. An increased number of patients also found the luminaires too bright.This probably occurred because although there is no direct view of the lamp, the reflector in the luminaire is large and becomes a light source in itself, which can be seen from anywhere in the waiting area.

| Statements about the lighting waiting area | Original lighting (n = 60) | New lighting (n = 84) |
|---|---|---|
| Overall, the lighting in this waiting area is comfortable | 83% | 85% |
| The lighting of the reception desk is good | 83% | 88% |
| There is plenty of light in the waiting area for reading magazines | 87% | 95% |
| The lighting makes the waiting area look attractive | 84% | 75% |
| The lighting of the waiting area is relaxing | 76% | 61% |
| People look good under this lighting | 83% | 77% |
| The lighting in this waiting room is depressing | 7% | 7% |
| The luminaires are uncomfortably bright | 17% | 24% |
| The lights sometimes flicker | 7% | 6% |

## Receptionists' Response

DELTA interviewed the office manager responsible for the reception and waiting area and one of the receptionists. Their comments indicated the original lighting in the reception area provided sufficient light in some areas and not enough in others. Staff regarded the original lighting in the waiting area as slightly better than in other doctors' offices, but still considered it dim and patchy. Overall, the new lighting in these spaces was considered brighter, and, therefore, an improvement.

## Energy Analysis

| Reception and Waiting Area | Area ($ft^2$)† | Total LPD* ($W/ft^2$)† | ASHRAE/IESNA* Allowed LPD ($W/ft^2$)† | NY State Energy Conservation Construction Code 1991** ($W/ft^2$)† |
|---|---|---|---|---|
| **Original lighting** | **1142** | **1.2** | **1.8** | **2.4** |
| **New lighting** | **1142** | **1.1** | **1.8** | **2.4** |

* See *Abbreviations* on page 13
** Applicable in New York State only, on a whole-building basis
† 1 $ft^2$ = 0.093 $m^2$; 1 $W/ft^2$ = 10.76 $W/m^2$

# Examination rooms

DELTA retrofitted and evaluated two examination rooms: a room with an arched east-facing window and a slightly smaller one without a window. Both rooms have gray vinyl floors (60% reflectance) and off-white walls (90% reflectance). The rooms are furnished with a small sink, storage cabinet, disposal bins, an examination table, a chair, and a stool for the physician. The examination rooms are connected to the nurses' station (see page 8).

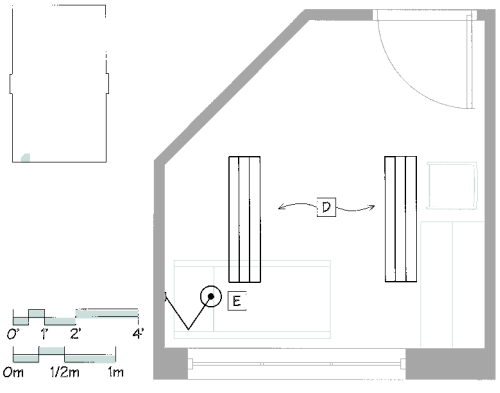
**New lighting: examination room with window**

(Original lighting same as windowless room; see page 7)

- Two ceiling-mounted indirect/direct luminaires (type D) are controlled by a dimmer (replacing the original switch by the door).
- Wall-mounted, swing-arm examination luminaire (type E) is fitted with incandescent and circular fluorescent lamps that can be individually switched (not shown in photograph).

## Examination Room with Window

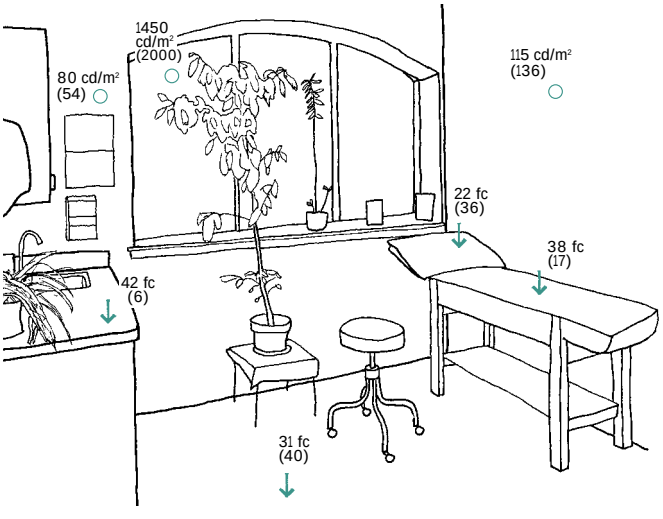
### New Lighting




NORTH

D E

See page 12 for Specifications




**Perspective of examination room with window (Measurements of original lighting shown in parentheses. Type E examination luminaire turned off for all measurements.)**

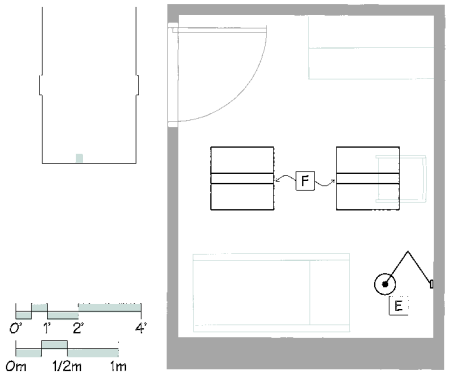
## Energy Analysis

| Examination Room with Window | Area ($ft^2$)† | Total LPD* Examination Light Off ($W/ft^2$)† | Total LPD* Examination Light On ($W/ft^2$)† | ASHRAE/IESNA* Allowed LPD ($W/ft^2$)† | NY State Energy Conservation Construction Code 1991*** ($W/ft^2$)† |
|---|---|---|---|---|---|
| Original lighting | 97 | 0.9 | 1.5 | 1.6 | 2.4 |
| New lighting | 97 | 1.4 | 2.2** | 1.6 | 2.4 |

* See *Abbreviations* on page 13
** Compact fluorescent and incandescent lamps both on in examination light
*** Applicable in New York State only, on a whole-building basis
† 1 $ft^2$ = 0.093 $m^2$; 1 $W/ft^2$ = 10.76 $W/m^2$

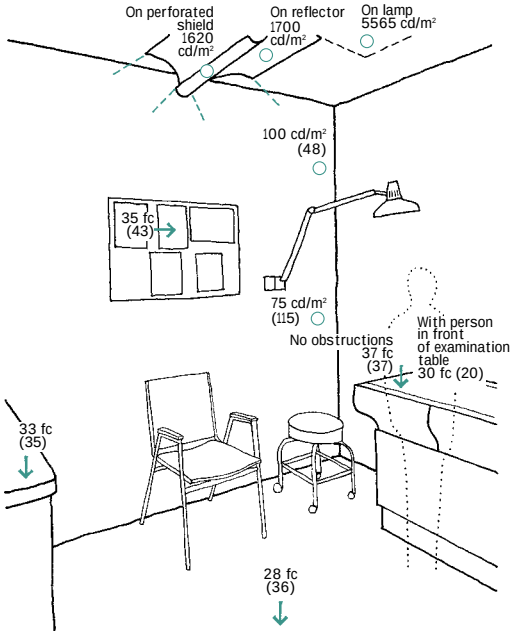
# *Windowless Examination Room*

## *New Lighting*




*"I don't like going in there, [but the dimmable lighting] is useful for patients experiencing migraines."*

— A nurse, about the windowless examination room




**Perspective of windowless examination room (Measurements of original lighting shown in parentheses. Original luminaires shown in black dashed lines. Type E examination luminaire turned off for all measurements.)**

NORTH

E F

*See page 12 for Specifications*

**Original lighting: windowless examination room**

- Recessed 2' x 4' parabolic luminaire were operated from a switch by the door.
- Moveable floor examination light used an incandescent lamp (not shown in photograph).

**New lighting: windowless examination room**

- Two ceiling-mounted indirect/direct luminaires (type F) are controlled by a dimmer (replacing the original switch by the door).
- Wall-mounted, swing-arm examination luminaire (type E) is fitted with incandescent and circular fluorescent lamps that can be individually switched.

## Energy Analysis

| Windowless Examination Room | Area ($ft^2$)† | Total LPD* Examination Light Off ($W/ft^2$)† | Total LPD* Examination Light On ($W/ft^2$)† | ASHRAE/IESNA* Allowed LPD ($W/ft^2$)† | NY State Energy Conservation Construction Code 1991*** ($W/ft^2$)† |
|---|---|---|---|---|---|
| Original lighting | 84 | 1.0 | 1.8 | 1.6 | 2.4 |
| New lighting | 84 | 1.2 | 2.2** | 1.6 | 2.4 |

* See *Abbreviations* on page 13
** Compact fluorescent and incandescent lamps both on in examination light
*** Applicable in New York State only, on a whole-building basis
† 1 $ft^2$ = 0.093 $m^2$; 1 $W/ft^2$ = 10.76 $W/m^2$

## *Examination rooms* *(continued)*

### Doctors' and Nurses' Opinions

DELTA interviewed two doctors and two nurses who regularly use the examination rooms. They generally preferred the examination room with the window over the windowless one, mainly because it was bigger and brighter. However one of the doctors reported that the room with the window became uncomfortably warm during the summer months. The windowless room was considered claustrophobic.

The original lighting had little effect on the staff opinions of the room with the window because there was usually plenty of daylight and the electric lighting was not used very often. However, the windowless examination room was considered insufficiently illuminated by the original lighting. One of the doctors commented that a moveable examination light was needed for detailed work, such as the removal of splinters.

The doctors and nurses specifically commented on two features of the new lighting in the two examination rooms: the dimming capability (considered very useful) and the tendency of the examination light swing-arm mechanism to pinch fingers. In the windowless examination room, the examination table was repositioned because the wall-mounted examination luminaire was useful for gynecological examinations and other special tasks.

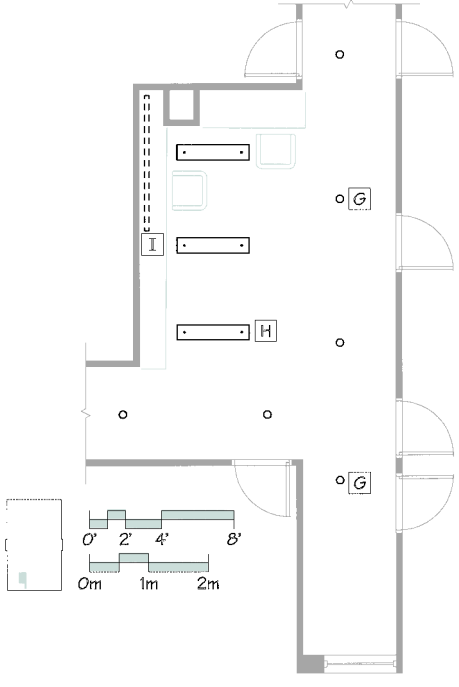
For general patient visits, however, the windowless room was considered insufficiently bright. One doctor went so far as to tell the staff to avoid using this room whenever possible. Since the light levels for the original and new lighting were approximately equal, DELTA believes that the negative responses may have two causes. The original lighting's parabolic luminaires allow a view of the lamp at some angles, perhaps adding to the increased perception of brightness. Also, higher color temperature light is often considered brighter; the color temperature of the new lighting appears to be much lower than the original lighting because the type F luminaires bounce light off an off-white reflector and then cream-colored walls, giving the light a yellowish tinge. The color difference is particularly noticeable because the examination room immediately adjacent has the original lighting.

# *Nurses' Station*

*New Lighting*


G H I

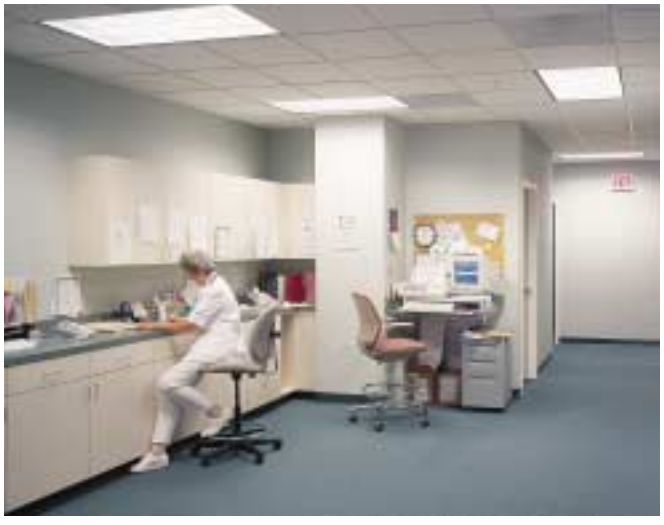
*See page 12 for Specifications*




The nurses' station is an open space within a corridor with doors to examination rooms and doctors' offices. The nurses do most of their work in this area while sitting or standing at a countertop. Wall cabinets are located above the countertop. The same blue-green carpet and light green vinyl wallpaper as in the reception and waiting area cover the floor and walls of the nurses' station.

*"Very acceptable, very good I should say."*

— A nurse, about the new lighting



**Original lighting: nurses' station**

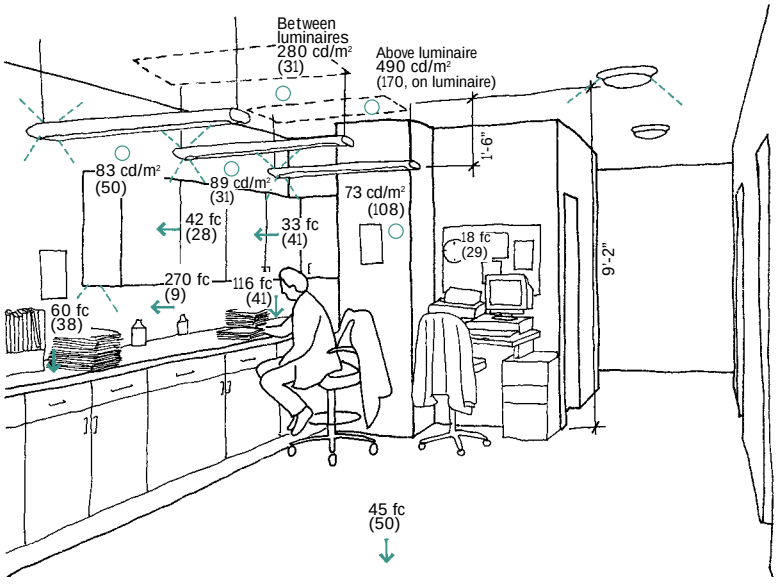
- Recessed 2' x 4' parabolic luminaires. The light distribution from these luminaires and their wide spacing provided little light on the ceiling and upper parts of the walls. Of particular note were the strong shadows under the wall cabinets and on the work surface.

**New lighting: nurses' station**

- Ceiling-mounted luminaires (type G) visually separate the corridor area from the nurses' station.
- Pendant direct/indirect luminaries (type H) in the nurses' station provide light directly to the work area and distribute light to the ceiling and walls, making the space look brighter and more uniformly lighted.
- Two under-cabinet luminaires (type I) provide task lighting on the countertop.

## Nurses' opinions

DELTA interviewed the two nurses who regularly use the station. Neither had negative comments about the original lighting. They thought that there was sufficient light for them to do their work and that there were no poorly lighted locations. As for the new lighting, one of them thought it was very good. The other thought it was a little dim on the countertop; however, when the under-cabinet luminaires were pointed out, the nurse liked the new lighting better. When they were initially installed, one person thought the type H pendants seemed to be mounted too low, giving the impression that it was necessary to duck one's head when walking underneath them. Overall, the new lighting was considered very good but not much of an improvement over the original lighting.




**Perspective of nurses' station**
**(Measurements of original lighting shown in parentheses. Original luminaires shown in black dashed lines.)**

## Energy Analysis

| Nurses' Station | Area ($ft^2$)† | Total LPD* ($W/ft^2$)† | ASHRAE/IESNA* Allowed LPD ($W/ft^2$)† | NY State Energy Conservation Construction Code 1991** ($W/ft^2$)† |
|---|---|---|---|---|
| **Original lighting** | **287** | **0.9** | **1.8** | **2.4** |
| **New lighting** | **287** | **1.1** | **1.8** | **2.4** |

* See *Abbreviations* on page 13
** Applicable in New York State only, on a whole-building basis
† 1 $ft^2$ = 0.093 $m^2$; 1 $W/ft^2$ = 10.76 $W/m^2$

# Doctor's office

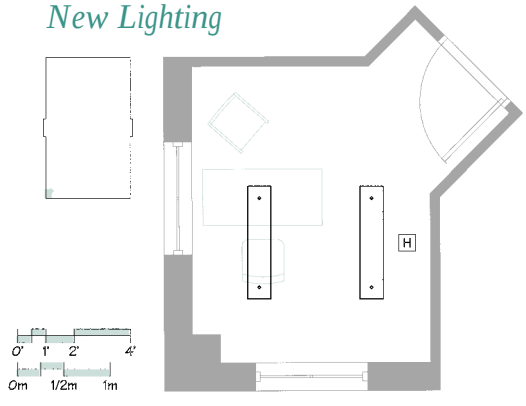
**Original lighting: doctor's office**

- Recessed 2' x 4' parabolic were operated from a switch by the door.

**New lighting: doctor's office**

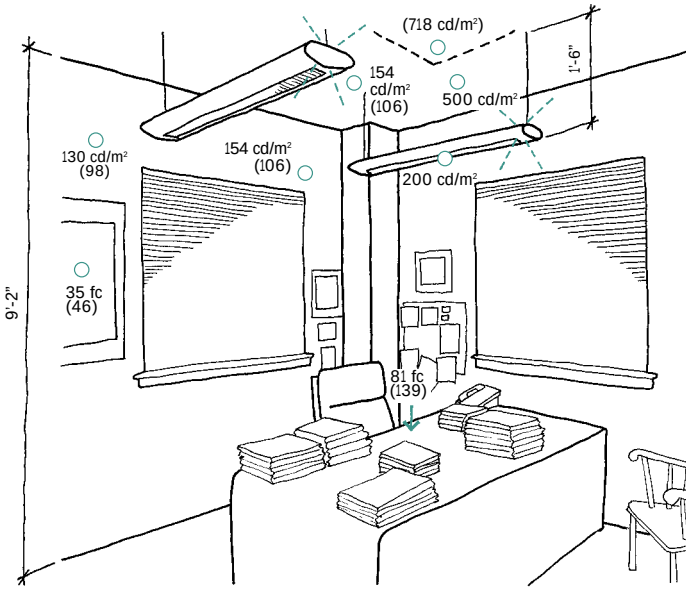
- Two pendant direct/indirect luminaires (type H) are controlled by an occupancy sensor with manual override (replacing the original switch by the door).

## New Lighting




H See page 12 for Specifications

**D**ELTA retrofitted and evaluated the lighting in one of the doctors' offices. The corner office has two windows, one facing east and the other south. The doctor who occupies this office suffers from Seasonal Affective Disorder (or "winter depression"), so he prefers spaces with abundant light. The floor is covered with the same blue-green carpet used elsewhere in the office and the walls are painted off-white.




**Perspective of doctor's office**
**(Measurements of original lighting shown in parentheses. Original luminaires shown in black dashed lines.)**

*" I love my office!"*

— A doctor, about the new lighting in his office

## Doctor's opinions

In an interview, the doctor occupying the office expressed the view that the original lighting was not bright enough on a cloudy day. The new lighting, in turn, did not seem as bright to him during the day, compared with the original lighting. However, the new lighting seem much brighter after dark, and he appreciated this fact. DELTA believes that the room appeared that much brighter because the new luminaires provided light not only to the task area but to the walls and ceiling as well. He also liked the occupancy sensor because it made him feel that he was saving energy.

## Energy Analysis

| Doctor's Office | Area ($ft^2$)† | Total LPD* ($W/ft^2$)† | ASHRAE/IESNA* Allowed LPD ($W/ft^2$)† | NY State Energy Conservation Construction Code 1991** ($W/ft^2$)† |
|---|---|---|---|---|
| **Original lighting** | **100** | **0.9** | **1.5** | **2.4** |
| **New lighting, without occupancy sensor** | **100** | **1.2** | **1.5** | **2.4** |

* See *Abbreviations* on page 13
** Applicable in New York State only, on a whole-building basis
† 1 $ft^2$ = 0.093 $m^2$; 1 $W/ft^2$ = 10.76 $W/m^2$

# *Project Evaluation*

## Maintenance

Ballasts failed in several different luminaires at a rate that was greater than expected. DELTA checked the wiring of luminaires in the building. Although one failure was caused by wiring problems in a luminaire, no clear reason was found for the rest of the ballast failures.

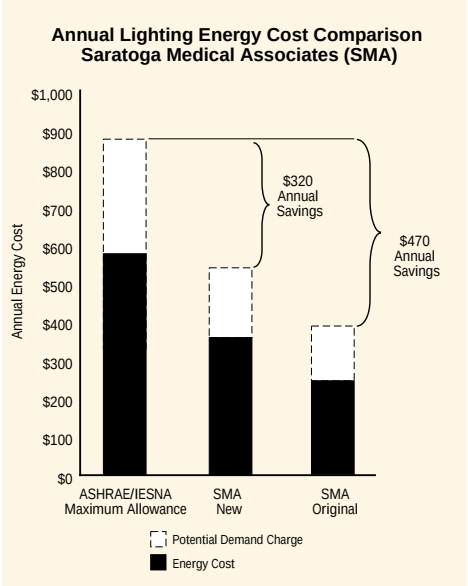
To meet the lighting objectives, the new lighting required the use of different types of luminaires and lamps. The facilites manager did not consider it a problem to stock multiple lamp types.

## Occupant Response

Saratoga Medical Associates moved to their new building two years ago, and were generally satisfied with the original lighting. They thought it was an improvement over their earlier facility. Staff liked the new installation's occupancy sensors, examination lights and undercabinet lights, but some people thought there was too much light in waiting area and not enough light in exam rooms. The new condition did increase the lighting power density to a slight extent overall, but there was a slight increase in satisfaction as well.

## Energy Impact

The lighting systems in both the original and the new installations use less energy than the maximum standards delineated in the energy standard ASHRAE/IESNA 90.1 (1999). Excluding any use of examination lights, these systems save $320-470 per year due to reduced energy costs and power demand in the five rooms alone (see chart at right). The savings would be greater if occupancy sensors and dimming were taken into account.




## Environmental Impact

Reduced energy use will result in lower annual power plant emissions (see table below).

### Reduced Pollution Compared to System Operating at ASHRAE/IESNA Maximum Lighting Power Density

| | $SO_2$ | | $NO_X$ | | $CO_2$ | |
|---|---|---|---|---|---|---|
| | lbs | kg | lbs | kg | lbs | kg |
| **Annual savings, Original** | **32** | **14** | **12** | **5** | **4,645** | **2,109** |
| **Annual savings, New** | **22** | **10** | **8** | **4** | **3,196** | **1,451** |

*Sulfur dioxide ($SO_2$) is associated with visible pollution (haze) and acid rain.*
*Nitrogen oxides ($NO_X$) are one of the main causes of ground level ozone (smog) and acid rain.*
*Carbon dioxide ($CO_2$) is a possible contributor to future climate changes such as global warming.*

# Specifications

**A**

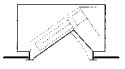
Recessed indirect luminaire, white finish with perforated steel shields and white acrylic diffusers, 2' W x 4' L (610 mm x 1.2 m), two linear fluorescent lamps in cross section.

Lamps: (2) F28T5/835

Ballast: Electronic, program start ballast, high power factor (HPF)

Wattage: 62 W per 2-lamp ballast

**B**



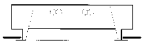
Recessed lensed wall washer, 7" aperture (180 mm), with two compact fluorescent lamps in cross section.

Lamps: (2) CFT18W/G24d/835

Ballast: Electronic ballast, rapid start (RS), HPF

Wattage: 38 W per 2-lamp ballast

**C**



Recessed lensed downlight luminaire, 7" aperture (180mm), with two compact fluorescent lamps in cross section.

Lamps: (2) CFT13W/GX23/830

Ballast: Magnetic ballast

Wattage: 33 W per 2-lamp ballast

**D**

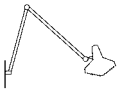
Ceiling-mounted indirect/direct luminaire, 1' W x 4' L (300 mm x 1.2 m), with two linear fluorescent lamps in cross section within a perforated shield and dimming ballast.

Lamps: (2) F32T8/835

Ballast: Dimming electronic ballast

Wattage: 67 W per 2-lamp ballast

**E**



Wall-mounted, swing-arm examination luminaire, white finish, 4'-2" (1.3 m) extension reach, with 7' (2.1 m) cord and plug.

Lamps: (1) 60A19 and (1) FC8T9/830

Ballast: (Information not available)

Wattage: 82 W, total (excluding ballast wattage)

**F**

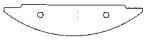
Ceiling-mounted indirect/direct luminaire, white powder coat finish, 2' W x 2' L (610 mm x 610 mm), with three linear fluorescent lamps in cross section within perforated shield and dimming ballast.

Lamps: (3) F17T8/835

Ballast: Dimming electronic ballast

Wattage: 50 W per 3-lamp dimming ballast

**G**



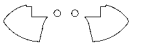
Ceiling-mounted luminaire with white acrylic diffuser, 16" diameter (410mm), 4" (102 mm) projection below ceiling.

Lamp: (1) CFS28W/GR10q-4/835

Ballast: Electronic program start, HPF

Wattage: 29 W per 1-lamp ballast

**H**



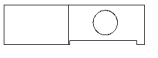
Pendant direct/indirect luminaire, white finish, 8" W x 4' L x 2.5" D (200 mm x 1.2 m x 60 mm), steel cable suspension system with coiled power cord, two linear fluorescent lamps in cross-section.

Lamps: (2) F28T5/835

Ballast: Electronic, program start, HPF

Wattage: 62 W per 2-lamp ballast

**I**



Under-cabinet luminaire, white finish with prismatic acrylic diffuser, 1.5" D x 3' L (40 mm x 0.9 m), one linear fluorescent lamp in cross section, with integral rocker switch.

Lamps: (1) F25T8/835

Ballast: (Information not available)

Wattage: 25 W (excluding ballast wattage)

# Methodology

This section gives details about testing methods and assumptions used in this publication.

## Photometric Measurements

DELTA performed illuminance and luminance measurements for all spaces after the lighting had been on for at least 30 minutes and the luminaires were operating at full light output. For the doctor's office, these measurements were taken with the blinds closed on both windows. In the examination room with the window, no blinds were available. Illuminance and luminance measurements were made during the day with the electric lighting both on and off, in order to show the contribution of the electric lighting alone.

## Surveys

Questionnaires were used to obtain patients' opinions about the lighting in the reception and waiting area. DELTA collected questionnaires from 60 patients for the original lighting and 84 patients for the new lighting. Structured interviews were used to obtain the opinions of doctors, nurses, and receptionists.

## Energy Analysis

To analyze annual electrical cost savings, DELTA interviewed the building's facilities manager, who estimated hours of use and reported energy rates charged by the local utility. Multiplying daily hours of use by 50 weeks per year (DELTA's assumption) yielded just over 2600 annual hours of use. These hours were multiplied by the wattages of both the original and new lighting. These calculations excluded examination task lights, as these are used only when needed.

DELTA compared these energy use estimates with ASHRAE-IESNA 90.1 (1999) standard power densities for lighting in hospital/health care buildings (space-by-space method). These LPD values were multiplied by the total area of the rooms and the hours listed previously. Subsequent electrical cost savings were calculated using actual rates charged to the facility of 7.3¢ per kWh and a monthly demand charge of $8.32 per kW (assuming the lighting is on at the point of peak monthly building demand).

## Environmental Analysis

DELTA based the environmental impact figures in the table on page 11 on the U.S. Environmental Protection Agency's September 1996 publication, "Conservation News Online." This document is available online at http://www.epa.gov/oaintrnt/.

## Abbreviations

Abbreviations mentioned in this report include:

LPD = Lighting Power Density

ASHRAE = American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

IESNA = Illuminating Engineering Society of North America

# *Lessons Learned*

## Medical patients may have higher priorities than the appearance of lighting.

Despite the fact that the new lighting in the reception and waiting area followed guidelines recommended by lighting professionals such as removing the “cave effect”, increasing illuminance uniformity, and decreasing shadows on the floor, there was only a slight improvement in the patients’ perceptions of the space.

## For people who perform high stress tasks, such as doctors and nurses, the lighting of the task is more important than the lighting of the space.

Before designing lighting for a space, it is important to determine the visual difficulties of the tasks people have at hand. Doctors and nurses found it difficult to carry out some tasks in an examination room, although they found the lighting useful for other activities such as treating patients suffering from migraines.

## Flexibility is valued in spaces where there are a wide variety of visual tasks.

Both doctors and nurses commented on the value of having dimming available in the examination rooms, which enhances the flexibility of the lighting.

## Lighting specifiers should assess the occupants’ satisfaction about a space prior to implementing a lighting retrofit.

Occupants will resist change if their level of satisfaction about their environment is high, regardless of whether the lighting conforms to what may be considered “better lighting practice” by lighting professionals.

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