

DELTA

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

DELTA Portfolio

Lighting Case Studies



Volume 2, Issue 1

Sony Disc Manufacturing
Springfield, Oregon

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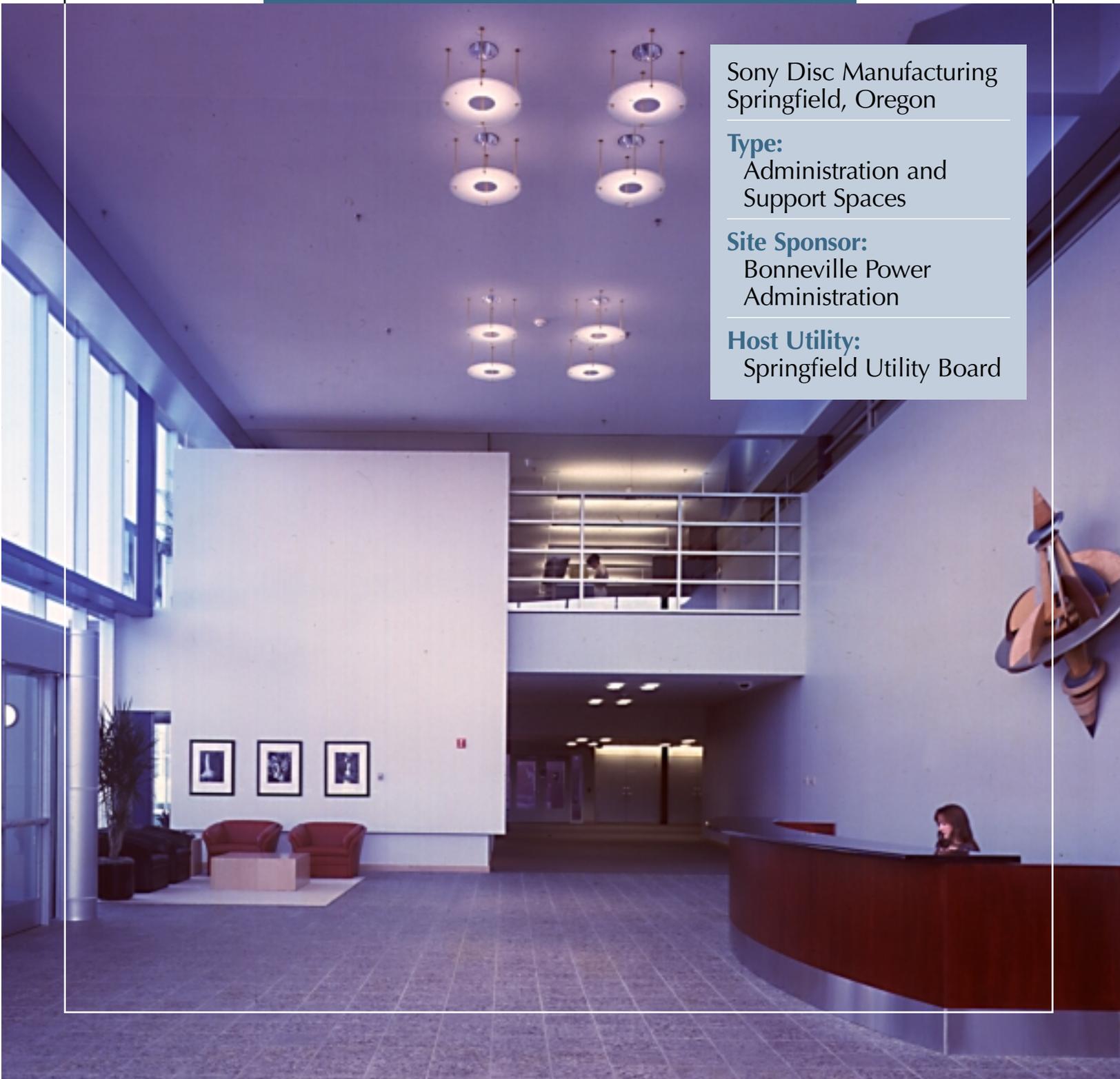
Administration and
Support Spaces

Site Sponsor:

Bonneville Power
Administration

Host Utility:

Springfield Utility Board





Project Profile

Sony Disc Manufacturing in Springfield, Oregon, opened in 1995 as a state-of-the-art manufacturing facility, producing as many as 6.5 million digital optical discs per month for the education, entertainment, and information industries. Situated on a 120-acre park-like site, the 324,800 square foot (31,000 square meter) facility operates around the clock, seven days a week.

While the manufacturing process takes place in one part of the building, administration and support spaces comprise an additional 98,000 square feet (9100 square meters), including offices, corridors (the concourse), a dining area,

and an exercise facility (“wellness center”). The design team, Boucher Mouchka Larson, Architects and PAE Consulting Engineers, incorporated large windows in most of these spaces to provide daylight and take advantage of the view of the surrounding hills.

The goal of the lighting design was to provide good task visibility with minimal glare, while enhancing the architectural design and providing visual interest. Throughout the building, the lighting design is coordinated with the industrial character of the building, expressed by exposed ducts, pipes, and equipment in open ceilings.

Direct/indirect pendant luminaires were used in open offices, with F32T8 lamps operating on reduced harmonics electronic ballasts. Corridors have a variety of compact fluorescent products using FT40 lamps and 26-W quad lamps. The dining area combines T8 fluorescent uplights and downlights with decorative pendants using 150-W metal halide lamps. All of these spaces are controlled with an energy management system (EMS), which is programmed to switch off most of the lighting when photosensors on the roof signal a preset level of daylight.



Sony Disc Manufacturing in Springfield, Oregon

● *Lighting Objectives*

- Create work spaces with good task visibility and visual comfort for employees.
- Use energy-efficient lighting and controls products to reduce connected load and qualify for utility-sponsored rebates.
- Enhance the appearance of people, finishes, and architectural features.
- Provide windows and clerestories for daylighting and a visual connection to the outdoors.
- Reduce electric lighting power levels in circulation and dining spaces when there is sufficient daylight from windows.
- Minimize glare for exercisers in wellness center.

▲ *Lighting and Control Features*

- ▲ Energy-efficient lamps and ballasts
- ▲ Brightness control through the use of baffles, diffusing rings, precise optical control, or indirect lighting
- ▲ Photosensor switching of daylit spaces
- ▲ EMS for automatic switching of lights after business hours
- ▲ Good color-rendering, long-life lamps for easy maintenance and pleasing appearance

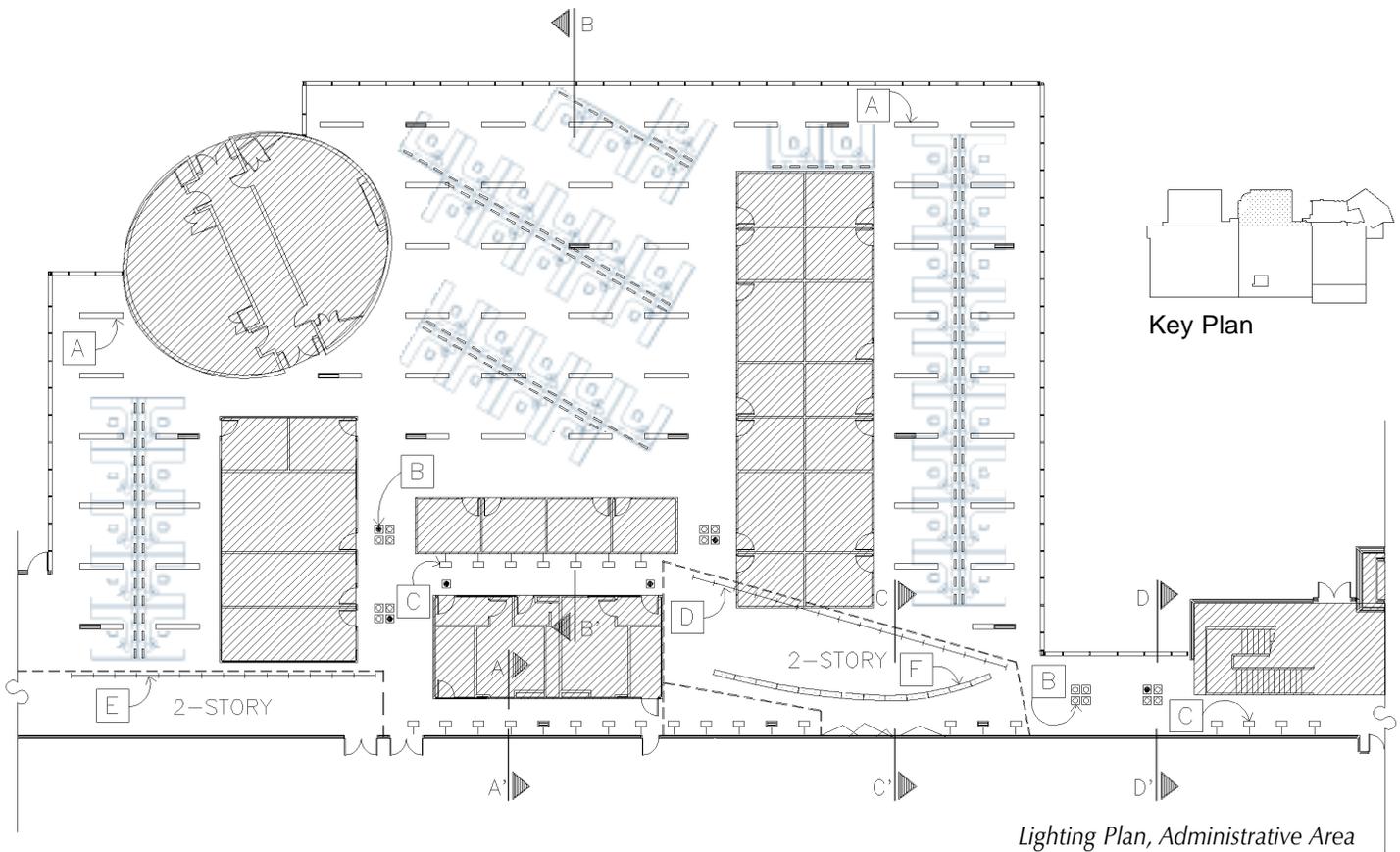
Techniques

Project Specifications

The principal lighting sources used in the open offices, dining area, wellness center, and concourse are T8 4' (1200 mm) rapid-start lamps with a color rendering index (CRI) of 75 and a correlated color temperature (CCT) of 3500 K (neutral). Most downlights and wall washers in the dining area and the concourse use FT40W, CFQ18W, or

CFQ26W compact fluorescent lamps, all with a CCT of 3500 K and a CRI of 80. F32T8 and FT40 lamps are operated on two-lamp rapid-start (RS) electronic ballasts. The ballasts are low total harmonic distortion (THD) in order to reduce interference with sensitive electrical equipment in the building. High power factor (HPF) magnetic ballasts drive the CFQ compact fluorescent lamps.

Metal halide lamps with a warm color phosphor coating, rated for operation in open luminaires, are used with magnetic ballasts in two dining area luminaire types. Decorative pendants use 150-W lamps (3200 K, 70 CRI), and downlights on columns use 100-W lamps (2900 K, 75 CRI).



A Pendant-mounted 8' (2.4 m) long direct/indirect luminaire, three lamps in cross section, with 10" x 4" (250 x 100 mm) rounded extruded aluminum housing. Downlight aperture has semi-specular parabolic baffles, 1.6" (40 mm) high spaced 4" (100 mm) on center. Lamps: F32T8/RE735

B Recessed compact fluorescent downlight with 7" (180 mm) diameter clear aluminum cone. Decorative 9" (230 mm) diameter glass ring with stippled pattern suspended below cone. Lamps: (2) CFQ26/RE835

C Recessed 1' x 2' (310 x 610 mm) wall washer, single lamp in cross section, with specular aluminum reflector and cross baffle. Lamps in

adjacent luminaires tandem-wired. Lamp: FT40/RE835

D Fluorescent striplight, 4' (1200 mm) long, two lamps in cross section with symmetrical reflectors, mounted as uplight in architectural cove at base of clerestory window. Lamps: (2) F32T8/RE735

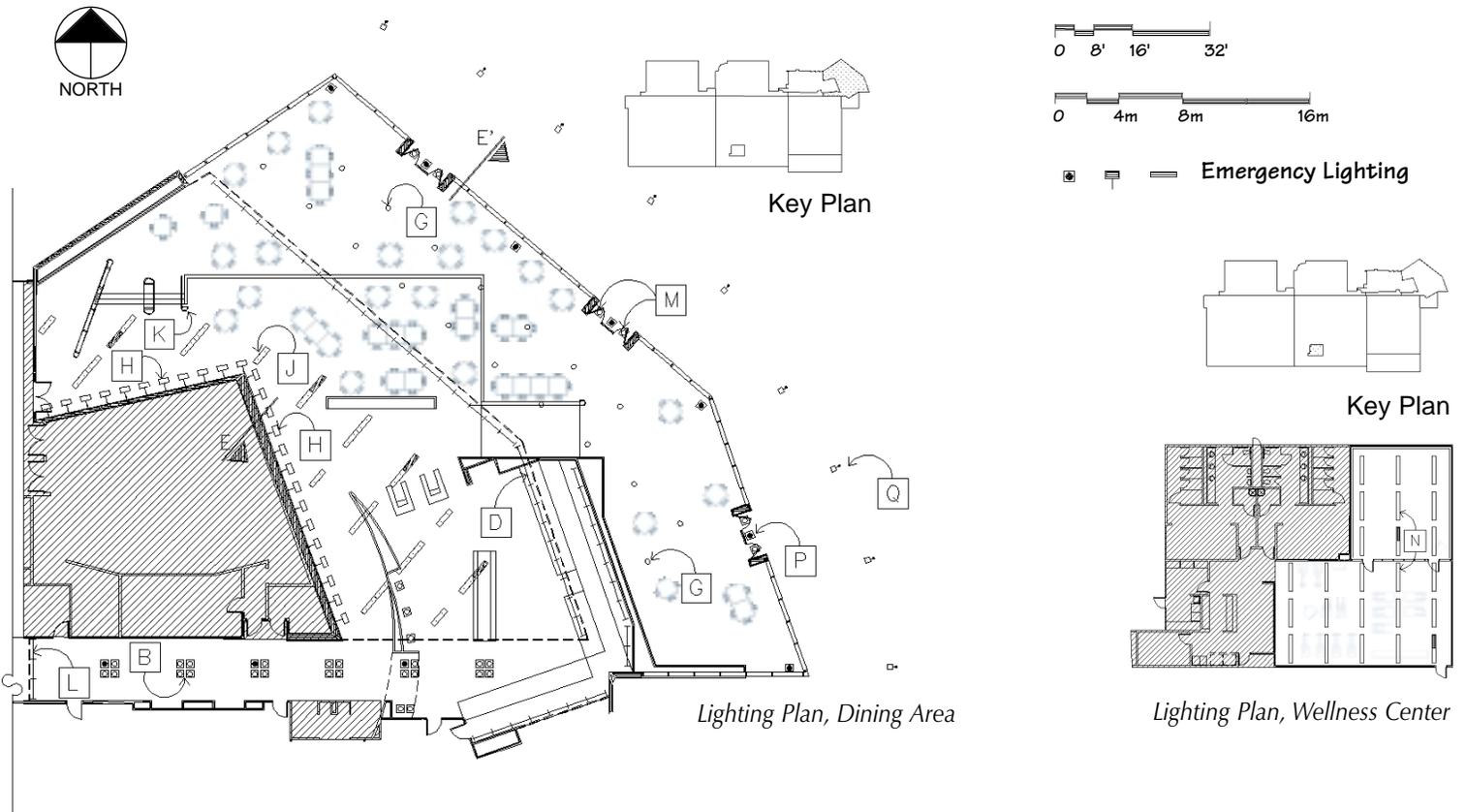
E Fluorescent striplight, same as D, but three lamps in cross section. Lamps: F32T8/RE735

F Fluorescent "stack" light, 4' (1200 mm) long, single lamp in cross section, with U-shaped aluminum baffles. White-painted finish on housing and baffles. Luminaires suspended with guy wires to create a long, curved "caterpillar." Lamps: F32T8/RE735

G Decorative 26" (660 mm) diameter elliptical pendant with graduated white-painted reflector shades and concealing cones. Mostly downlight light distribution. Open-fixture-rated metal halide lamp. Remote ballast mounted in ceiling on resilient pads to minimize noise. Lamp: MH150/3K coating/Medium base/Open fixture

H 8" x 2' (200 x 610 mm) luminaire with extruded aluminum housing and specular wall-wash distribution reflector. Yoke-mounted for aiming flexibility. Remote-mounted ballast. Lamp: FT40/RE835

J Recessed 8" x 4' (200 x 1200 mm) luminaire, two lamps in cross section, with 3" (76 mm) deep semi-specular baffles. Lamps: (2) F32T8/RE735



K Recessed steplight with 10" (250 mm) diameter white-painted louvered face. Lamp: CFQ18/RE835

L Architectural soffit, housing two-lamp fluorescent striplight and 7" (180 mm) wide white baffle. Aluminum baffle blades 1" (25 mm) high spaced 1" on center. Lamps: F32T8/RE735

M Recessed compact fluorescent downlight with 7" (180 mm) diameter clear aluminum cone. Lamps: (2) CFQ18/RE835

N Pendant-mounted fluorescent strip-light, two lamps in cross section, with perforated metal reflectors, mounted as uplight. Lamps: F32T8/RE735

P Recessed metal halide downlight with 7" (180 mm) diameter aperture and narrow distribution. Clear aluminum cone. Lamp: MH100/3K coating/ Medium base/Open fixture

Q Decorative outdoor post-top luminaire, on a 12' (3.7 m) pole, with internal silver-finish louvers to control lamp glare. Lamp: MH100/3K coating/ Medium base

Wattage

Input wattages for luminaires include ballast watts. Wattages are prescribed by the Oregon State Energy Code, an amended version of the Uniform Building Code's Chapter 53, "Energy Conservation." The Code's tables provide input wattage values (called luminaire power) for use in energy calculations for various combinations of lamps and ballasts.

T8 fluorescent lamps (electronic ballast)
 F32T8 (4'): 114 W per 4-lamp ballast
 F32T8 (4'): 93 W per 3-lamp ballast
 F32T8 (4'): 57 W per 2-lamp ballast
 F32T8 (4'): 31 W per 1-lamp ballast

Compact fluorescent lamps (magnetic ballast)
 CFQ18: 22 W per 1-lamp ballast

CFQ18: 44 W per 2-lamp ballast
 CFQ26: 66 W per 2-lamp ballast

Compact fluorescent lamps (electronic ballast)
 FT40: 36 W per 1-lamp ballast

Metal halide lamps
 MH150: 185 W
 MH100: 142 W



Details

Open Offices An office staff of about 60 supports the Sony disc manufacturing facility. These employees include process engineers, marketing and communications specialists, administrative and clerical staff, and facility managers, who perform paper tasks and work at computers. The open office area has two shifts: 8 a.m. to 5 p.m., 5 days a week; and 6 a.m. to 6 p.m., 4 days on, 4 days off.

Open office areas have an industrial appearance because of the exposed corrugated steel roof deck, truss work, pipes, and ductwork, all painted white for high light reflectance. The ceiling height is approximately 15'-6" (4.7 m).

Diagonal rows of 8' x 10' (2.4 x 3 m) workstations with either 4'-6" or 5'-9" (1.4 m or 1.8 m) high partitions fill the office area. Direct/indirect fluorescent luminaires are suspended 9'-8" (2.9 m) above the floor in a regular pattern, providing ambient light for the flexible workstation layout below. The luminaires (type A) have three electronically ballasted F32T8 lamps in cross section. They are 68% upright and use semi-specular aluminum baffles for downward glare shielding. As a result, glare on video display terminal (VDT) screens is not a problem; very few employees report annoying reflections from the luminaires in their VDT screens. The software these employees use usually displays a light-colored background, which makes bright reflections less noticeable. DELTA measured a vertical

Perspective of workstation, near window

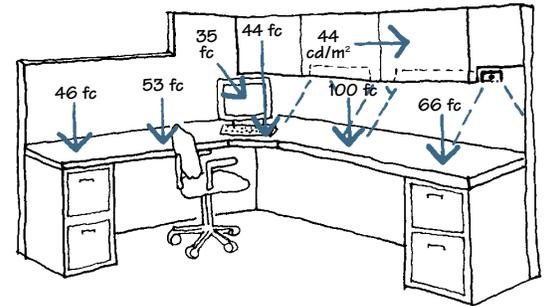
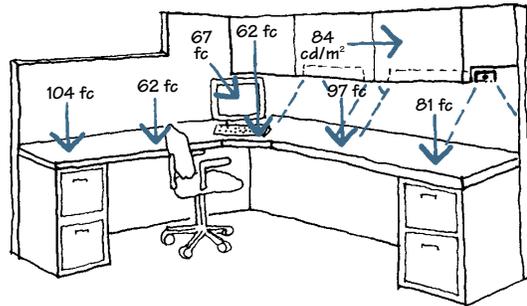
illuminance of 35 footcandles (fc) (380 lux [lx]) at a representative workstation screen.

Light from windows, however, does cause distracting reflections on the VDT screens of a few workstations. Even though no direct sunlight illuminates the screens from the full-height north-facing windows in this area, vertical illuminance on VDT screens facing windows is high. DELTA measured 67 fc (720 lx) late in the afternoon on an overcast winter day, almost twice the illuminance of screens where employees did not report annoying reflections. Some individuals have developed solutions for this screen glare: one had a

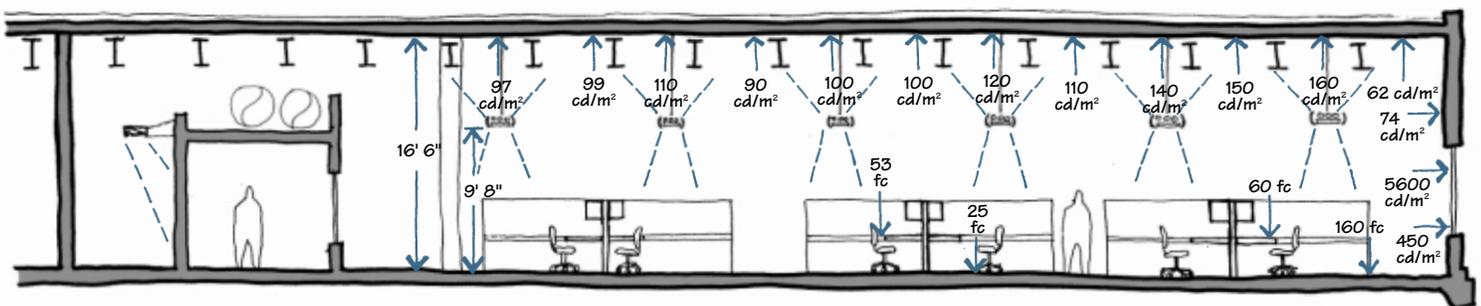
Perspective of interior workstation

black micro-louver glare screen attached to his display monitor; another leaves the flap of his overhead cabinet open, which acts as a shading device.

Luminaires run directly above the heads of a small number of office employees. The bare T8 lamps are visible between the blades of the parabolic baffle, and one employee complained of



Open office area



Section B-B'. Open office area

discomfort from this high-angle glare. The 1-1/2" (38 mm) high blades of the baffle are spaced 4" (100 mm) on center, and are too far apart to shield the view of lamps from common viewing angles. This situation could be improved by changing the baffle to one with more blades spaced closer together. (See *Lessons Learned* on p. 12.)

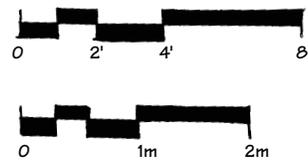
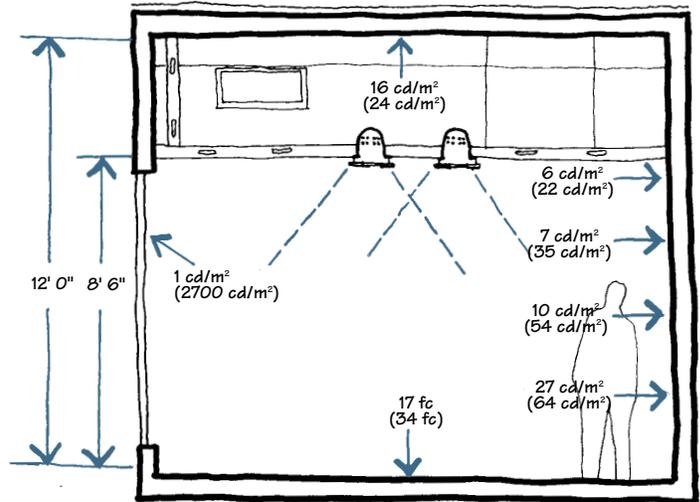
Typical workstation illuminances are 38 to 100 fc (420 to 1100 lx), with two of the three 2' (0.6 m) long undercabinet task lights switched on. (VDT screen locations vary within the workstation, but almost all workstation occupants choose not to switch on the task light directly above their VDT screens.) These task lights contribute 37 to 65 fc (400 to 700 lx) to the work surfaces directly below them, but direct no light towards the VDT screen.

Concourse The manufacturing and administration sides of the facility are separated by a corridor that is over 600' (180 m) long. This concourse is the main thoroughfare of the building, connecting offices and manufacturing spaces to the dining room and lobby. To avoid the appearance of an endless corridor, the architects have presented the pedestrian with a variety of consecutive spaces. Each space has a different width, height, view, and lighting system. Many sections of the concourse have north-facing window walls or clerestory windows, and during the day much of the electric

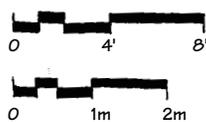
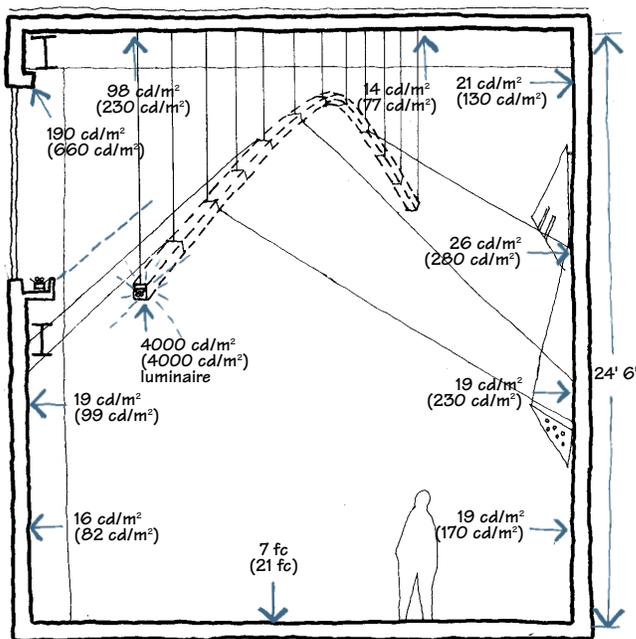
lighting is automatically switched off through photosensor controls. (See *Controls* on p. 10.)

During construction, a decision was made to save money by eliminating suspended ceilings in the concourse, offices, and dining area, leaving all ducts, pipes, and luminaire housings visible. All steel decking and exposed systems were painted white for maximum reflectance. This decision contributes to the informal, industrial aesthetic of the building.

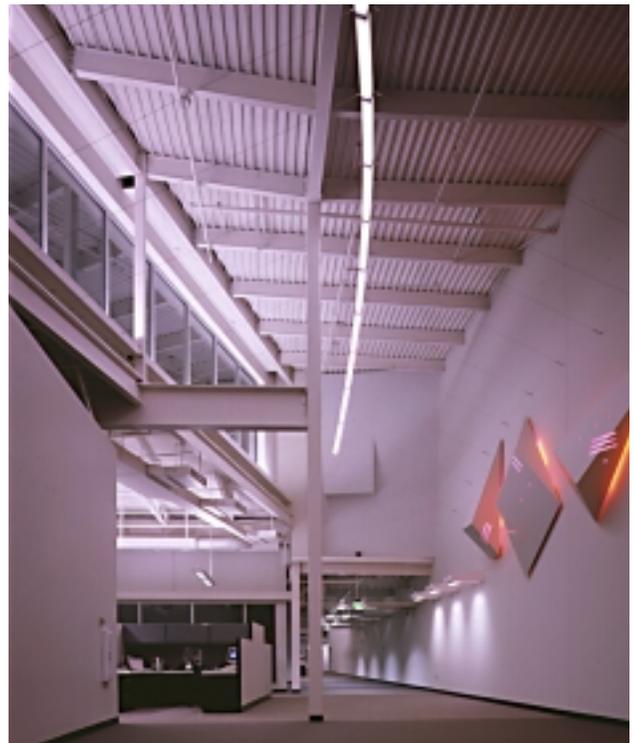
Some corridor segments use recessed 1' x 2' (310 x 610 mm) compact fluorescent wall washers (type C) with 40-W lamps to brighten walls. Their housings are rough in appearance when exposed to view.



Section D-D'.
Concourse
(daytime values in parentheses)



Section C-C'. Concourse
(daytime values in parentheses)



Concourse



Details

Concourse (continued)

In other corridor segments, recessed compact fluorescent downlights with decorative glass rings suggesting compact discs are mounted in square patterns (type B). The venting holes in the top of the housing are normally concealed but the missing ceiling permits a direct view of the bright 26-W lamps. This is distracting and glaring at night, but during the day the bare lamp looks less bright when contrasted with the bright windows. Because the downlights are positioned close to the center of the corridor, little light reaches the walls. These segments appear darker than the others because the light is concentrated on the floor rather than on walls or ceilings, which would otherwise contribute more to the appearance of brightness.

Some corridor segments are as high as 25' (7.6 m), with clerestory windows. When little or no daylight is available, the white-painted corrugated metal ceilings are illuminated with two-lamp striplights (type D) with F32T8 lamps and electronic ballasts concealed in a cove at the base of the window, emphasizing the height of the space and making it look bright and cheerful. Certain segments also have a caterpillar-like configuration of fluorescent "stacklights" (type F) with curved white baffles. The "caterpillar" is suspended with aircraft cable guy wires, so that it curves both in the vertical and horizontal planes. Visual interest is also piqued by 3-D lighted wall sculptures, commissioned from local artists, echoing the theme and colors of the manufacturing operation. The sculptures are backlit

with fluorescent lamps colored with theatrical gels for a lively effect.

Parts of the concourse seem too dark to pedestrians adapted to the higher light levels in the offices, especially during the day. When the EMS had switched off photosensor-controlled lighting circuits on a partly cloudy day, DELTA measured ten times the surface brightness in windowed segments than in the low-height areas without windows. This 10 to 1 ratio may be too extreme. An alternative might be to recircuit the lighting in the smaller windowless segments so that it is not switched off during the day. Night-time light levels are more uniform and better accepted. The surface brightness ratios drop to only 5 to 1.

Dining

Because shifts at Sony are continuous, the dining area/cafeteria space is open 24 hours a day, but only staffed from 5:30 a.m. to 7:30 p.m. The room is a 9500 ft² (880 m²) irregularly shaped space with a two-level exposed ceiling and two levels of open-area seating. Daylight enters through full-height, north-facing windows on the lower level and clerestory windows on the upper level.

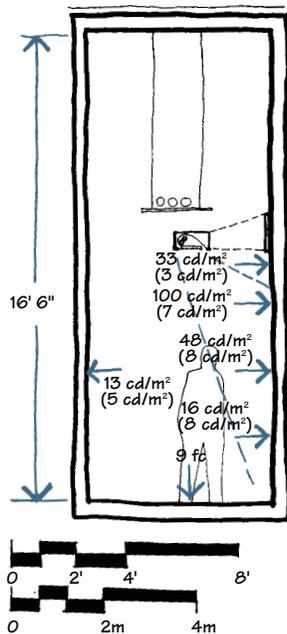
In the lower level, large decorative pendants provide ambient lighting. These pendants (type G) are lamped with 150-W metal halide lamps specifically designed for use in open luminaires. These luminaires emit light in almost all directions, but any direct view of the lamp is concealed by curved, white-painted metal reflectors. Columns along the outside glass wall are accented with 100-W metal halide downlights (type P), highlighting the structure as an architectural feature and adding to the sense of brightness in the space. Outside the windows, post-top luminaires (type Q) with 100-W metal halide lamps switch on



Dining area, day



Dining area, night



Section A-A'. Concourse
(daytime values in
parentheses, all lights off)

at night to light the grass and concrete path to a light level slightly higher than the interior ambient level. This lighting renders the glass more transparent and draws the view through the glass to the outdoors.

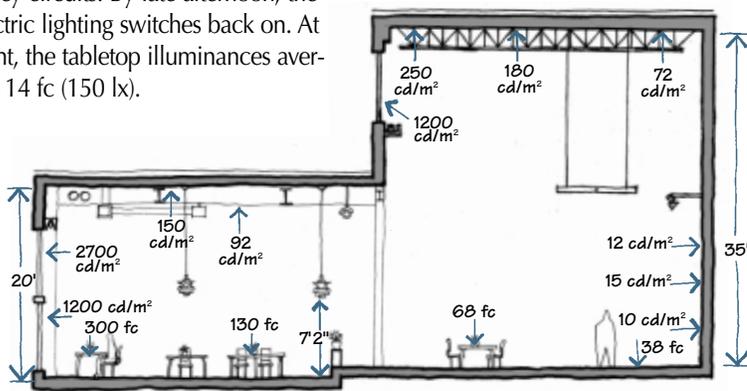
On the upper level, general lighting is provided by suspended rows of baffled 8" x 4' (200 x 1200 mm) fluorescent luminaires (type J), originally designed to be recessed. Fluorescent strip-lights concealed on a ledge at the base of the clerestory windows (type D) uplight the exposed ceiling and upper walls at night. The 26' (7.9 m) high interior wall is lighted with a row of 2' (0.6 m) long wall washers (type H) with FT40 long twin-tube fluorescent lamps. The wall's deep burgundy color absorbs most of the light, so it is dramatic in appearance but contributes little to the ambient light in the space.

Most of the lights in the cafeteria are switched through the EMS based on the input of a roof-mounted photocell input. The electric lights remain on all night, but switch off to save energy when the photocell reads a preset daylight level, corresponding roughly to a table illuminance of 50 fc (540 lx) on the upper level. On a typical winter day, lights switch off mid-morning, leaving on only the luminaires on emergency circuits. By late afternoon, the electric lighting switches back on. At night, the tabletop illuminances average 14 fc (150 lx).

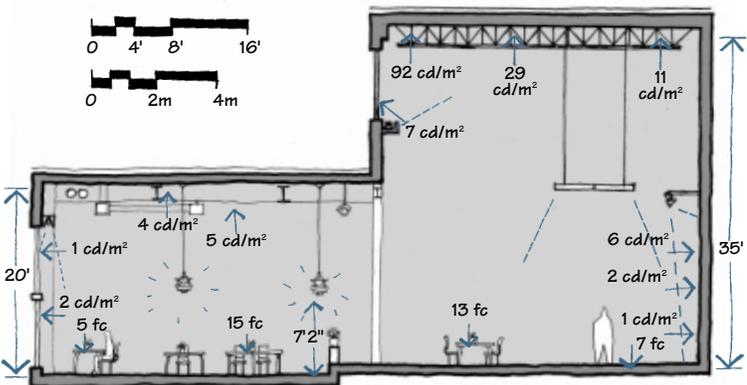
Wellness Center

The wellness center is open 24 hours a day and has two interior rooms for workouts: an exercise machine room with TVs for music videos and a mirrored studio space for aerobics classes. The luminaires in both rooms are inexpensive inverted striplights (type N) with perforated reflectors and two F32T8 lamps in cross section. The 8' (2.4 m)

In a space where people are looking at themselves in mirrors, it is especially important to have enough bounced light to help wash out harsh shadows from face and body features, and a good color-rendering light source.



Section E-E'. Dining area, daytime

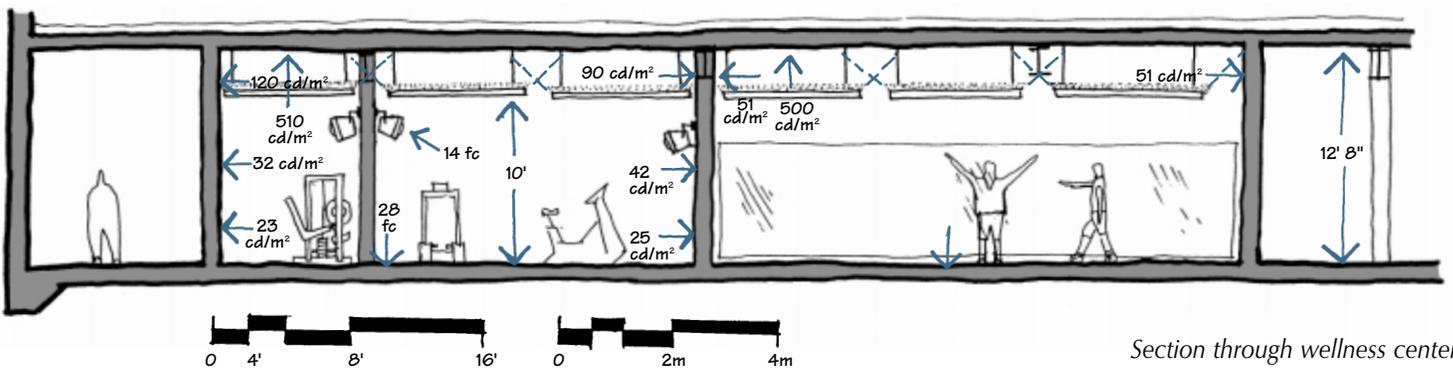


Section E-E'. Dining area, nighttime

luminaires are pendant-mounted 32" (500 mm) from the ceiling, 10' (3 m) on center. The reflector perforations add visual interest and a small amount of luminaire brightness (910 to 950 cd/m²) without glare. The large percentage of indirect lighting produces a very uniform floor illuminance of 28 fc (300 lx), limits the distracting reflections off mirrors and TV screens, and minimizes glare for exercisers who may gaze upward at the ceiling during their workouts.



Wellness center



Section through wellness center



Project Evaluation

Energy Impact DELTA calculated lighting power densities (LPDs) for the industrial and the administrative parts of the Sony facility. The total connected LPD in the administrative areas is 1.16 W/ft² (12.5 W/m²). Daylight switching of dining area and concourse lighting for several hours per day reduces the in-use LPD to 0.95 W/ft² (10.2 W/m²). At night, the EMS switches off the luminaires in the office areas for several hours, so the nighttime in-use LPD in the administrative area drops to 0.61 W/ft² (6.6 W/m²). The table summarizes the lighting power densities, compared to ASHRAE/IES 90.1 1989 energy standards and the Oregon State Energy Code.

Controls The EMS controls all the lighting circuits as well as other electrical equipment in the building. During some hours of the day, daylighting alone is sufficient for the visual tasks performed in the concourse and the dining area, and most lighting circuits are switched off. A single roof-mounted photocell continuously monitors illuminance from the sky. The EMS is programmed to switch individual circuits according to the photocell reading. Each circuit can be tuned to switch at a unique illuminance, ensuring that rooms with different orientations and window sizes will not be plunged into gloom when sufficient daylight is sensed for another larger window space. (See *Maintenance and Product Performance* on p. 11.)

A built-in time delay in the photosensor prevents passing clouds from switching lights too frequently. The time delay is the period of time over which the illuminance striking the photocell is averaged. The EMS actually signals the lighting circuit to switch only after the photocell has detected the change.

The EMS also acts as a time clock to switch lights on and off at certain hours; in this facility, the time clock function and the photocell switching each save about 15% of the lighting energy used in the open offices, concourse, and dining area combined. Lights in offices used to operate 24 hours a day until facility managers noticed that the open office spaces

Space	Building Areas and Lighting Power Densities				
	Total area (ft ²)	Total connected LPD	ASHRAE/IES Allowed LPD (prescriptive method)	Oregon State Allowed LPD	In-use LPD during day
Office	34,255	1.29	—	—	—
Concourse	7,804	0.50	—	—	—
Dining	10,811	1.14	—	—	—
Wellness Center	4,819	1.26	—	—	—
Other Administrative Areas	39,990	1.10	—	—	—
Total Administrative Area	97,679	1.16	1.57**	1.2	0.95
Total Industrial Area	227,121	1.04	2.5	NA*	1.04
Grand Total for Building	324,800	1.07	—	—	1.01

1 W/ft² = 10.76 W/m²
 *Not available (NA) because Oregon State Code excludes manufacturing from lighting energy use requirements.
 **From ASHRAE/IES 90.1 1989 Table 6.5 ULPA for offices of 50,000–250,000 ft²

were not used late at night. The EMS was then programmed to shut off office lighting from 11:00 p.m. to 5:30 a.m.

Environmental and Economic Analyses The lighting design features and the EMS switching control in the administrative spaces resulted in significant energy savings for the Sony facility. Using a hypothetical model, DELTA compared the annual energy cost based on the day and night lighting use recorded by the EMS over one week. The model is based on the ASHRAE/IES 90.1 1989 maximum allowed LPD for each of two parts of the building: a whole building LPD of 2.5 W/ft² for the manufacturing area, and a whole-building LPD of 1.57 W/ft² for the administrative area (using the prescriptive method). For the model, DELTA assumed the following usage:

- 100% of office lighting on 17.5 hours/day; 10% on 6.5 hours/night
- 100% of lighting in the non-evaluated administrative spaces on 24 hours/day
- 100% of dining area lighting on 19 hours/day; 50% on for 5 daylight hours/day
- 100% of concourse and wellness center lighting on 24 hours/day
- 100% of manufacturing area lighting on 24 hours/day

The initial cost of the lighting equipment and controls for the whole building was \$150,000 higher than a conventional design. However, much of the difference was compensated by a large rebate from the local utility, the Springfield Utility Board, and the power distributor, Bonneville Power Administration. Sony Disc Manufacturing qualified for a rebate of \$102,000 to help defray future energy generation costs in the Pacific Northwest.

The annual cost savings for lighting in the administration and support spaces of the building is \$13,448, assuming a \$4.80/kWh demand charge and a standard industrial rate for Springfield customers that averages about \$.026/kWh for this load size. The average energy rate is weighted for all quantities used, times of day, and times of year. The building's mechanical system, which uses an economizer cycle in this mild climate, was designed so that the lighting loads have little effect on HVAC operating costs. As a result, DELTA did not calculate energy savings from reduced use.

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 1.57 W/ft² [16.9 W/m²]) will result in



lower power plant emissions of 342 fewer tons (310 metric tons) of CO₂, 2.9 fewer tons (2.6 metric tons) of SO₂, and 1.3 fewer tons (1.2 metric tons) of NO_x compounds emitted from power plants per year. 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 employees in several of the administrative areas of Sony to learn about their impressions and experiences with the lighting. DELTA asked specifically about task visibility, visual comfort, problems with the lighting or window glare, and overall satisfaction with the lighting.

"We wanted [the building] to have a personality, different from one in a typical manufacturing plant. We had a mission; we wanted to portray a particular corporate image."
—Director of Engineering

Lighting in the open offices was successful. It was rated as comfortable by 81% of the survey respondents. Ninety-five percent of those surveyed were able to read 6 point type, and 75% could read 4 point type, a very good level of performance. As noted, the few employees whose VDT screens directly faced the windows commented that they see annoying window reflections. One individual complained of overhead glare because the bare T8 lamps of the direct/indirect luminaire above his workstation were visible.

Most people found the lighting in the concourse comfortable (77%). They agreed that there was enough light throughout (77%), and found it a pleasant place to use (67%). During the daytime, slightly more people thought there was enough light (80% vs. 74%) and that it was comfortable (80% vs. 74%) than at night. For both day and night, just over one-quarter thought the lighting was too dim. One user commented that the low-ceiling segments looked dim during the day, probably because he or she was adapted to the brighter daylight segments of the concourse.

Averaged over all three mealtimes, 76% of the diners liked the dining lighting. Slightly more diners liked the lighting during the daytime than at night (78% vs. 73%), probably because they appreciated the daylight. A few employees commented that the room looked dim on a rainy or cloudy day with lights switched off. Gray skies may create a psychological need for increased brightness indoors.

The lighting in the wellness center was slightly less satisfactory, although at least 73% of users agreed that the lighting was comfortable and sufficient for their exercise routines. The 18% who thought the lighting was too bright may have been responding to the brightness of the ceiling, the perforated reflector, or reflections on the TV screens.

Maintenance and Product Performance

In the time that the Sony facility has been open, it has had few problems with lighting maintenance. Facility managers now appreciate the concerted effort the designers made to select lamps with lamp lives of 10,000 hours or more. The managers report that frequent lamp burnouts requiring continued maintenance have occurred only in the few locations, such as the company store, where incandescent lamps are used (spaces not evaluated in this study). They also made a considerable initial effort to adjust the photosensor-controlled EMS settings so that lights would switch off when an acceptable level of daylight had been reached in the concourse and dining areas. An engineering student was assigned to monitor light levels and feed back

information to the building engineers to help them select the photosensor reading at which each lighting circuit should switch. Because these levels were programmed into the EMS and tested, all the equipment has functioned reliably.

The facilities staff also reports that when a small number of lamps burn out in a type of luminaire in a space, they group relamp, saving the additional labor involved in spot relamping. They are very pleased that the lighting design has minimized electric utility bills by keeping energy use low.

"This facility is a lot lower maintenance than other manufacturing buildings."
—Manager of Facilities Engineering

LIGHTING SURVEY—Percentages of People Who Agree:

	Open Offices	Norm*
The lighting is comfortable	81	69
The lighting is uncomfortably bright	4	16
The lighting is uncomfortably dim	2	14
The lighting is poorly distributed	4	25
The lighting causes deep shadows	0	15
Reflections from the lighting hinder work	4	19
The light fixtures are too bright	4	14
Skin is an unnatural color with this lighting	4	9
The lights flicker	2	4

Compared to similar workplaces in other buildings, I think that:		
The lighting is worse	2	19
The lighting is about the same	56	60
The lighting is better	42	22
Can read 8 point type or larger	100	100
Can read 6 point type or larger only	95	94
Can read 4 point type or larger	75	76

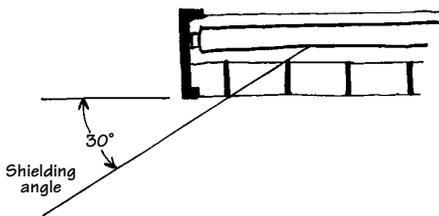
*Normative data for this survey based on over 1,200 responses from employees in several offices throughout the northeast United States.

	Dining**	Concourse**	Wellness Center
I like the lighting in this area	76	71	68
The lighting is comfortable	76	77	73
There is enough light for activities in this room	81	77	73
The lighting is too bright	13	12	18
The lighting is glaring	16	10	18
Food appears natural	71	—	—
The lighting is too dim	22	27	4
This space is pleasant to use	—	67	—

** Combined response to both daytime and nighttime lighting conditions for people using the space at all times of day

Lessons Learned

- **Direct/indirect luminaires and furniture-mounted task lighting can work well in open offices.** With appropriate illuminances and high-angle brightness control, both VDT and paper tasks are easy to perform, and visual comfort is high. If baffles are used on the downward side of a luminaire, be careful to specify a baffle spacing that shields the bare lamps from view with a minimum 30° shielding angle.



- **Reflected glare from bright windows can seriously interfere with VDT visibility.** If employees can't reorient their computer monitors to face away from the window, then blinds or shades are needed to control the window brightness.

- **An EMS saves energy when managed by attentive facility managers.** Sophisticated whole-building controls save energy when programmed to switch lighting circuits off after work hours and in response to available daylight. A well-trained facilities staff, which is technically versed in the use of the system and conscientious about trimming energy use, can obtain significant energy savings from the system without causing any user hardship.

"It's good lighting for working out, no problems with glare or shadows. I think it's great."
—Director, wellness center

- **Indirect lighting in exercise spaces can minimize glare.** Exercisers frequently look up at the ceiling from the floor mat or an apparatus, an angle from which most downlighting would appear too bright. Using some indirect lighting in the design provides ambient light while reducing the perception of glare.

- **Adjacent spaces should not vary too widely in overall brightness.** If they do, the darker space will be perceived as dim. Keep adjacent work or circulation spaces within a 5 to 1 ratio (or lower) of illuminance. This ratio will still produce a noticeable difference, but the lower brightness space will not appear distractingly dark.

- **Confine photocell-controlled lighting circuits to a group of spaces with similar size, height, and window orientation.** Avoid linking the control of a widely varied group of spaces to a single "trigger-point" of a photosensor. This could result in some spaces appearing too dark when all the lights are switched off at the same time. The photosensor should be adjusted for a higher level of daylight illuminance in some smaller spaces.

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Sony Disc Manufacturing, Springfield, OR

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