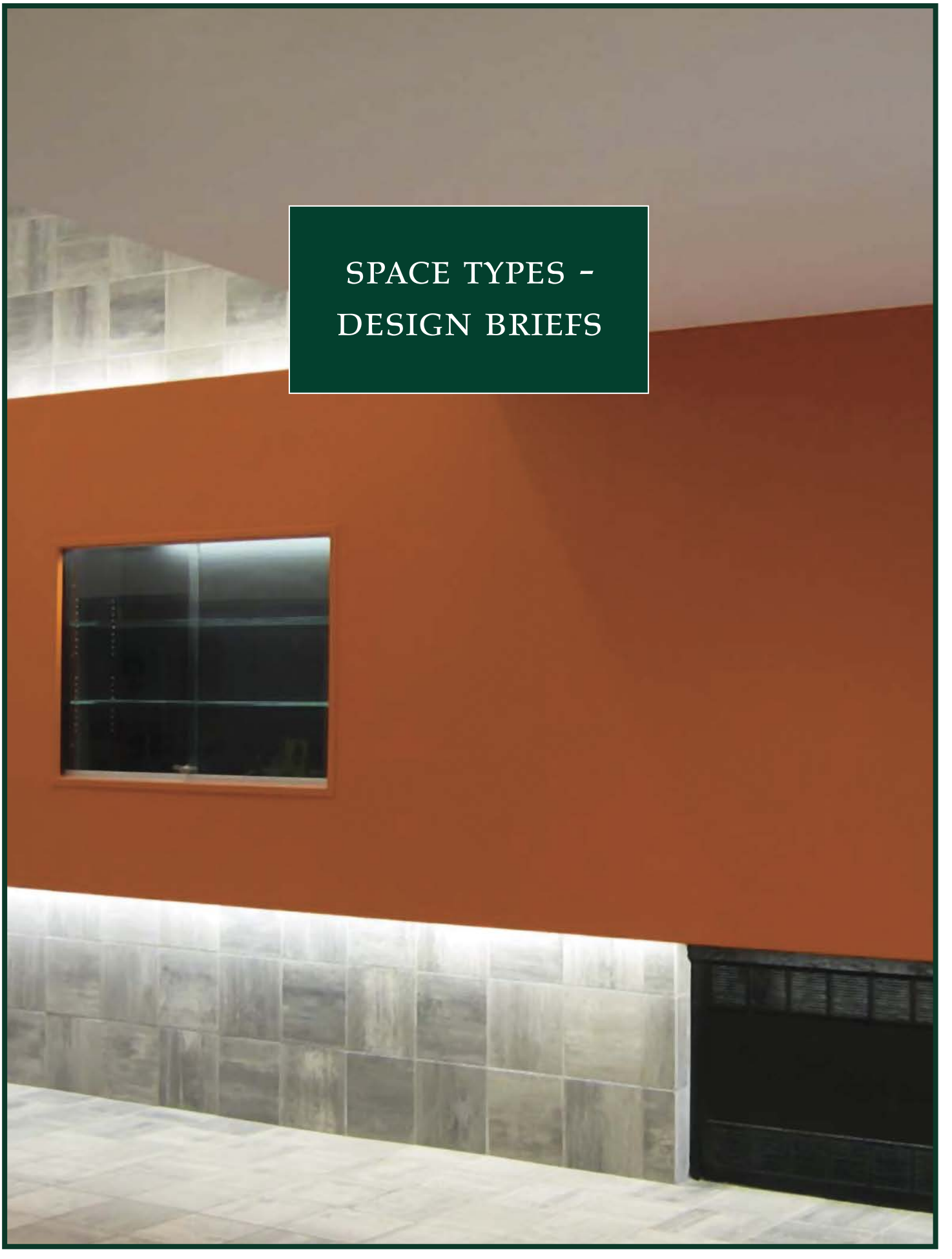


SPACE TYPES - DESIGN BRIEFS

LIBRARY DESIGN BRIEF

The NYC Department of Design and Construction (DDC) manages the construction and renovation of NYC's municipal buildings, including libraries. These may be parts of larger offices, judicial or educational projects, may be specialized by topic (e.g., law or medicine) or user (e.g., children, visually impaired), or may be stand-alone buildings open to the public. Public libraries today not only house book collections, but they often serve as community centers, with auditoriums, classrooms, language labs, public book reading areas, displays and exhibits. To compete with retail bookstores, New York libraries often offer enticing displays of recent publications, magazines, videos, books on tape, and lively children's areas. The lighting guidelines below focus on a few key space types that are common to most libraries: book stacks, reading areas, and special collections with rare and delicate materials.

LIGHTING QUALITY AND QUANTITY STRATEGIES

Libraries have specific considerations because of their function and spatial characteristics. Please review and use the guidelines below, in concert with the basic issues of lighting quality and design strategies set forth earlier in the Design Team Strategies section of this manual.

LIBRARY—SPECIFIC LIGHTING QUALITY AND QUANTITY ISSUES

ISSUE	IMPORTANCE
Relationship between light source and visual task and viewer	Very Important
Reflected Glare	Very Important
Direct Glare	Very Important
Color Appearance and Color Contrast	Very Important
Light Distribution on Surfaces	Very Important
Degradation factors	Very Important
Appearance of Space and Luminaires	Important
Modeling of Faces or Objects	Important

From The IESNA Lighting Handbook, 9th Edition.

Relationship Between Light Source And Visual Task And Viewer

Some visual tasks in a library are similar to those in offices – reading at a desk or table or using a computer. Others are more specialized, like finding a book on a shelf. This requires looking above and below eye level in narrow aisles, while attempting to identify a title, author or code number on narrow spines with a variety of typefaces, colors and potentially shiny materials. Bookstack viewing is subject to direct glare and veiling reflections, so the relationship of both the lighting source to the book spines and the viewer to the book spines is very important. On the other hand, veiling reflections (a form of glare that puts a reflective veil of light on a surface, obscuring the task behind), can be overcome by movement of the viewer to a better viewing angle, or by eliminating the use of shiny materials to label books. See "Improving the Task," later in this Brief. Light levels for stacks are measured on the vertical face of the books (with standards set for 30" above the floor).

courtesy: Gruzen Samton

Luminaires are oriented parallel to the stacks in this school library.

Glare Control –Reflected And Direct Glare

In libraries, microfilm and microfiche readers creates the most serious potential for reflected glare, followed by computers and electronic card cataloguing. Direct glare is a particular problem when looking for books above eye level in the stacks, but glare control should be considered for all library tasks such as computer usage, lectures or story telling, where the viewer is looking ahead rather than downward. Even lighting fixtures outside of the field of view can cause overhead glare, so shiny (specular) louvers and high-output lamps visible from any angle should be avoided in work areas. Use white painted or brushed metal (semi-specular) louvers and baffles.

Color

As libraries have become more like retail bookstores in their character, color has become more prevalent, especially in children's areas, and at racks of newest releases, videos, displays and exhibits. In order to limit the number of lamp types on a project, select one color per lamp type to be used for most applications. Fluorescent lamps with high color rendering (CRI 85+) and color temperatures between 3500 and 4100 are appropriate for library functions. For example, The Brooklyn Public Library System currently prefers color temperatures of 3500. Compact fluorescent or low wattage metal halide lamps at 3000 Kelvin, or very limited use of halogen sources, may be acceptable for decorative lighting or displays.

Luminances of Room Surfaces

Luminance ratios (representing the contrast between bright and dark surfaces) in reading rooms and work areas should be close to uniform, not exceeding 20:1 ratio between the brightest and darkest surface. However, within the stack areas, the tall, narrow configuration of the aisles will result in a considerably wider distribution of illuminances and luminances.

Degradation Factors

Paper is very sensitive to ultra violet (UV) radiation, heat and light. Delicate and rare books should be restricted to areas where the light exposure is controllable, deliberate, and limited. Windows and electric light sources should be shielded or provided with UV filters. See "Rare Book Archives" below.

Reflectances and Finishes

In order to achieve the desired luminance ratios and uniformity, reflectances should be high and finishes should be matte or eggshell. Ceilings should be a minimum of 80% reflectance - 90% if direct/indirect pendants are oriented perpendicular to the stacks and greater inter-reflections are required Walls should be a minimum of 70% reflective, bookshelves and furniture should be at least 60% reflective, and floors not less than 20% reflective. Darker wood accents may be used at the ends of stacks, but the shelving itself should be a light colored as possible to increase inter-reflection in the narrow aisles. Polished, glossy and shiny surfaces should be avoided, because specular reflections can reduce visibility and be distracting for the viewer. The most matte finish available that will provide acceptable maintenance should be used. Use eggshell or semi-gloss paints.

Appearance of Space and Luminaires

The luminaire layout and appearance of lighted surfaces affect how a library is perceived, and can be an important contribution to the orientation of the visitor. The architect and lighting designer should work together to create surfaces and room variations that reinforce a visual hierarchy. For example, dropped fascias with large graphics over circulation desks and information counters can be enhanced with light to visually organize the space. Different lighting approaches in circulation spaces, stack areas and reading areas further serve to orient the user. Care should be taken to avoid chaotic lighting patterns that will be disorienting. The style of light fixtures is particularly important in libraries in historic buildings.

Three-dimensional Modeling

The natural appearance of faces and objects in a library contribute to the feeling of comfort and sense of well being for both visitors and staff. Light that is directed totally downward can cause unflattering and even confusing shadows, and is the least desirable approach. Lighting strategies that combine direct and indirect distributions generally achieve the most natural appearance for the space and occupants.

LIGHT LEVELS (RECOMMENDED AVERAGE MAINTAINED ILLUMINANCE, IN FOOTCANDLES (FC)

TASK	HORIZONTAL FC AT 30" ABOVE FLOOR	VERTICAL FC AT 30" ABOVE FLOOR	NOTES
Reading Tasks	30-50		1
Bookstacks, Active Use - Lights parallel	30	20-30	2
Bookstacks, Active Use - Lights perpendicular	20	10-20	2
Bookstacks, Inactive	15	5	2
Book repair or binding	30-50	3	1
Cataloguing	30-50		1
Card files	30-50	5	1
Carrels, individual study desks	30-50		1
Circulation desk	30-50		1
Audiovisual areas	30-50		1
Audio listening areas	30		
Microform areas	30		

Values from IESNA Lighting Handbook, Eighth and Ninth Editions, unless otherwise noted. 1. Higher values to be provided by local task lighting or in specially designated areas, in order to accommodate older eyes and visual impairments. 2 – Lower values recommended by authors to respond to energy restraints and need for flexibility.

DESIGN AND LAYOUT STRATEGIES

READING AREAS

photo: Steve Rosenthal courtesy: Gruzen Samton

Undershelf task light with local rocker switch in study carrels.

Unlike offices, where workers have fixed desks and environments, libraries typically offer a selection of areas with different character, from group tables to lounge chairs to individual study carrels. This approach also offers lighting variations can meet the needs of a wide range of users. Good quality lighting and adequate glare control should be provided in all reading areas, although a wider range of light levels throughout the library is acceptable when the user may choose where to sit. Most reading areas should be located close to windows, to provide more light and to give occupants a connection to the out-of-doors. Direct sun penetration should be controlled since it can be damaging to the books, even though a few readers might actually choose to sit in a sunlighted location. Reading areas interspersed with the stacks typically provide higher light levels than average, and should be clearly labeled as a high-light level area with priority seating for he elderly and visually impaired. Glare control is especially important for those individuals. In historic reading rooms, or any library with high ceilings, the primary source of light for reading is often task lights mounted in study carrels or along the centerline of reading tables, supplemented by a low level of ambient light. Unfortunately, table lamps in this position create veiling reflections and reduce flexibility, so a greater ratio of ambient to task lighting is preferred when feasible.

Finally, individual study carrels are often the choice of those requiring extra focus and protection from distractions. The side panels and carrel shelf can block some of the ambient lighting in a room, so supplemental task lighting should be included. Even without a shelf, an occupant-controlled task light can give the user a desirable degree of control and focus.

STACK LIGHTING

Illuminance standards for bookstacks are based on the light reaching the vertical plane of the books, not the horizontal plane common to other tasks. The configuration created by tall stacks (typically 7'-0") and narrow aisles (typically 3' clear width) absorbs most of the light before it reaches the bottom shelves. There are two design approaches to lighting tall bookstacks: Running the luminaires continuously and parallel to the stacks (attached to the stacks or centered above the aisle), or orienting the luminaires perpendicular to the stacks. Both have their advantages and disadvantages:

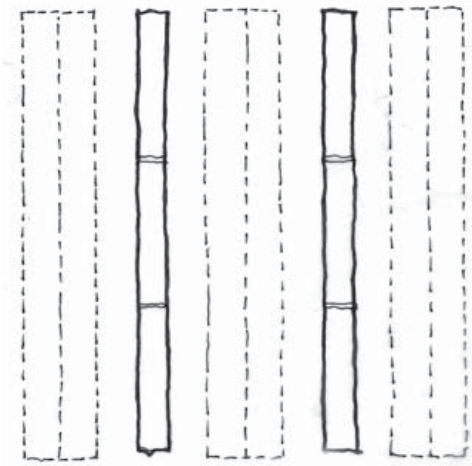
PARALLEL TO STACKS (DIRECT DOWNWARD DISTRIBUTION)

Advantages:

- Efficiency: Half the watts of perpendicular to achieve IESNA recommended light levels.
- Easier to control with occupancy sensors. Preferred for rare books or archives.

Disadvantages:

- Requires special luminaires with narrow "stacklight" distribution (see Sample Luminaire Schedule).
- Restricted to permanent stack locations. Change in stacks requires change in lights.
- Shiny reflector required to achieve narrow distribution can cause glare from some angles.
- Totally directional light can be harsh. 10% uplight helps a little.
- More linear footage of luminaires required.



Luminaires are oriented parallel to stacks.

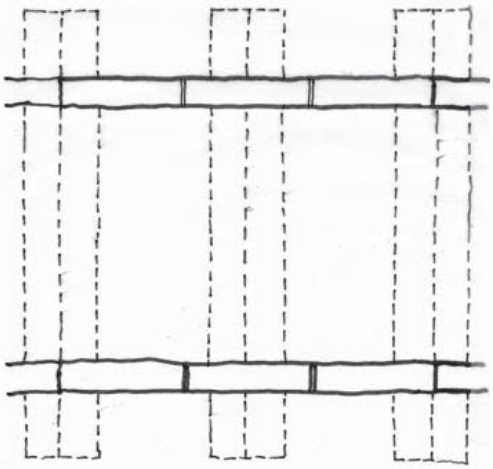
PERPENDICULAR TO STACKS

Advantages:

- Flexible stack layouts. Allows addition and relocation of stacks.
- More comfortable. Indirect lighting contributes a higher proportion of light to stacks that with direct stacklights.
- Use same direct/indirect luminaire in adjacent or interspersed reading areas.

Disadvantages:

- Less efficient: Uses twice the energy to achieve IESNA recommendations.
- Less uniformity on face of stack between luminaires.
- Harder to control, but two level switching and zoning is still possible



Luminaires are oriented perpendicular to stacks.

FLEXIBILITY VERSUS ENERGY SAVINGS

Whenever feasible, specialized stacklight luminaires oriented parallel to the stacks should be used for better utilization of energy. These fixtures must be mounted about 6" above the top of the stack to achieve the IESNA recommended illuminance with a single-lamp fixture run continuously. About 10% uplight will help reduce the apparent brightness of the light fixture and provide reflected light that helps reduce shadows.

Although many librarians prefer perpendicular layouts to maximize future flexibility for stack layouts, it is very difficult to meet the newest energy codes with this configuration and still meet the IESNA recommendations for light levels. The real benefits of flexibility should be carefully addressed: in many cases flexibility is designed in but never used. Since the perpendicular orientation of direct/indirect luminaires provides better visual comfort (due to increased indirect light), a lower vertical light level should be allowed on the face of the books at 30" above finished floor. The light levels given in the chart above reflect this trade-off.

RARE BOOK OR ARCHIVAL STORAGE

Paper is extremely sensitive to degeneration, not only from visible light, but also from ultra violet radiation, heat, and humidity. Controlling the intensity, spectrum and duration of light mitigates the first three culprits. Energy efficient sources by definition emit a greater portion of light than heat, so fluorescent remains the lamp of choice compared to incandescent or halogen. Ultra violet radiation is emitted by natural light and all conventional lamps, particularly fluorescent and metal halide, but can be controlled at the source by UV filters in clear acetate sleeves, or by UV filtering lenses. Window glass and low-e filters absorbs some, but not all of UV wavelengths. About 80% of UV is absorbed during reflection off of white paint containing titanium dioxide, as well.

Since these areas are restricted to staff rather than the general public, light levels can be reduced in both the stacks and the staff work areas and some levels raised only when the staff needs the extra light. In rooms that entirely house stacks for book storage and retrieval by staff only, such as rare and precious book collections, one-lamp luminaires that distribute light directly downward are a good choice. Locate the fixtures parallel to the aisles to light the vertical surfaces of the stacks. In this application, each row or partial row of lights can be separately controlled, using switches or occupancy sensors to protect rare/precious books and save energy. Only that specific row of luminaires located above the retrieved book are turned on. A staff dedicated to the preservation of materials is often motivated enough that manual controls can be effective in rare book archives. However, some form of automatic-off is required in all library spaces.

Old books and historic papers are often faded and hard to read, requiring higher levels of light for close examination or repair. This examination-level of light should be provided only by supplemental task lights. The use of task lights combined with magnifiers can make the task easier and reduce the need for lighting. Again, fluorescent and compact fluorescent sources with UV filters are the best choice, due to the potential for thermal degradation caused by the heat of incandescent and halogen sources. Even incandescent and halogen lamps contain a measure of ultra violet light, so all sources should have UV shields. *The Museum Environment* (see References) is an excellent reference source for protection of sensitive materials.

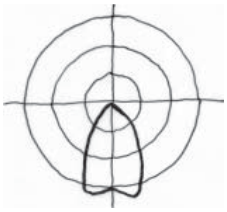
ENERGY EFFICIENCY STRATEGIES

Daylighting: Daylighting can be a wonderful lighting strategy for reading rooms and staff areas of libraries, and has historically been an organizing principle for some of the world's great libraries, (some of which were designed before safe, inexpensive, electric light was available) such as Labroust's bibliotheques in Paris, or the many Beaux Arts libraries in New York and Boston. Nonetheless daylighting should be limited to reading rooms and staff areas to avoid material degradation from natural light. Daylight harvesting is an excellent strategy for library reading rooms: it provides more and better light; plus the hours of daylight coincide with the primary operating hours of libraries. Consider using local task lights to supplement the daylight. Separately control the luminaires near windows. Since short-term exposure to sunlight or long-term exposure to daylight can harm books and paper based materials, orient shelving so that the ends of stacks face toward any windows. Avoid or carefully control natural lighting in any rare book or archival rooms.

Boston Public Library

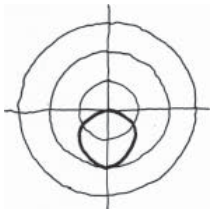
Energy efficient sources: High performance fluorescent lighting is a good choice for libraries. It is diffuse, linear, easily controlled, and restrikes instantly for emergency usage. Semi-indirect metal halide solutions have been successful in some libraries, although the metal halide sources create a phosphorescent effect with some types of paper. A separate solution for emergency lighting must also be designed, since the metal halide lamps will not instantly re-strike when power has been interrupted. Consider metal halide PAR lamps for exhibit or display in spaces with high ceilings.

Narrow distribution luminaires: The first stack-lighting fixture shown in the luminaire schedule (on the last page of this Brief) has a narrow distribution that directs the light to the lower portion of the shelves, and is an excellent choice for parallel stack lighting. A diagram of its "photometric curve" is shown on the right.



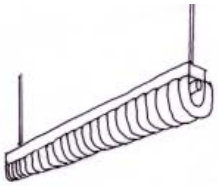
Photometric curve

There is another style of luminaire with a bare lamp and radial baffles, shown below, which is also called a stacklight by many manufacturers and has been widely used in the past. However, without a reflector, this luminaire has a much wider photometric curve, with less of its light distributed directly downward. This is more effective in schemes running perpendicular to the stacks, but the exposed lamp may cause glare. Both fixture types have the same luminaire "Efficiency" rating (about 60%), but the designer must select the appropriate photometric distribution for the specific application as well.



Photometric curve

Improving the task: The reference numbers on the spines of books represent the visual task that, if improved, will achieve the greatest lighting improvement. The largest point size, boldface lettering, and an easy to read typeface will make the task more visible, requiring less light. In addition, matte-finished adhesive tapes should be used to protect the numbers, rather than shiny tapes or acetate, to reduce veiling reflections.



Radial baffled luminaire

ENERGY CODES: WATTS / SQUARE FOOT BUDGETS

	NYS ENERGY CODE		ANSI/ASHRAE/IESNA STD.90.1		
FUNCTION	**2002**	**+/-2006**	**1999/2001**	**2004**	**NOTES**
Library – Whole Building (Building Type Method Only)	1.8	1.3	1.5	1.3	1,2
Library – Tenant Space	1.8	1.7			2,3,4
Card File and Cataloging Areas			1.4	1.1	2,4
Stack Areas			1.9	1.7	2,4
Reading Areas			1.8	1.2	2,4

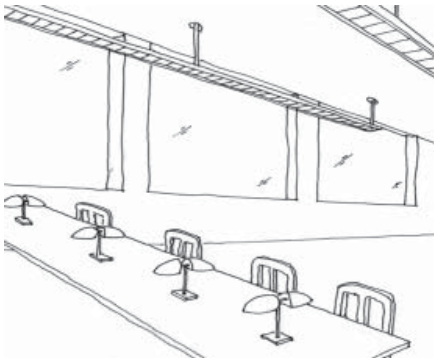
1. Multiply this value by the total square footage of the building, to determine the total building interior power allowance, using the Building Type method. 2. Multiply this value by the square footage of the dedicated space function. Sum the results of all the individual spaces in the building to determine the total building interior power allowance using the space-by-space method. The design of an individual space is not required to meet the watt/sf limits, as long as the total building connected load does not exceed the total interior power allowance. 3. NYS Energy Code states, "Where lighting equipment is specified to be installed for decorative appearances in addition to lighting equipment specified for general lighting and is switched or dimmed on circuits different from the circuits for general lighting, the smaller of the actual wattage of the decorative lighting equipment or 1.0 w/ft2 times the area of the space that the decorative lighting equipment is in shall be added to the interior lighting power determined in accordance with this line item. 4. NYS Energy Codes do not list power densities for the individual types of spaces within the library.

LIGHTING CONTROLS

Reading Areas: Control lighting near windows separately. If daylight can be effectively utilized, specify continuous daylight dimming controls and dimming ballasts in all luminaires located in the daylight zone. In areas that are infrequently occupied, consider placing 50% to 75% of the lights on occupancy sensors, so that only moderate levels of light are operating while the reading area is unoccupied. All lights should be turned off by an automatic timeclock with an override for staff. After hours night lighting should be no more than the minimum necessary for emergency personnel.

Task Lighting Controls: The reading table lamps and carrel lights should be integrated into the furniture with a local switch or dimmer for users to turn on the fixture, plus ancillary wiring to turn off all of the table lamps or carrels at the end of the day. In addition to local switches, many lighting manufacturers are able to provide electrical receptacles and computer jacks at the base of luminaires, specifically for applications such as libraries and schools.

Luminaires Perpendicular to Public Stacks: If flexible layout and bookstack flexibility is a primary issue, then it is likely that the typical stack lighting layout will be extended to adjacent areas not currently occupied by stacks. The lighting designed for stacks will often produce two to three times the light levels required for an unobstructed reading area. For this reason, the potential stack area should be realistically sized, and the luminaire wiring should be broken down into a pattern of control zones, so that individual areas can be flexibly controlled. These control zones will be much smaller than a typical electrical circuit. Another strategy is to provide multiple-lamp luminaires with in-line wiring to allow multiple-level switching while maintaining a uniform distribution. This way, lamps can actually be removed in luminaires over areas not currently used for stacks, until such time as the space function changes.



Control lights near windows to respond to daylight. Consider individual local switches for reading lights on table.

Luminaires Parallel to Public Stacks: It is easier to control lighting oriented parallel to the bookstacks, because every luminaire is associated with an aisle. There are several common control strategies for this orientation. For isolated stack areas infrequently used, the adjacent pedestrian pathways can be lighted, but the stack aisles left unlighted until an individual enters that row. Infra-red occupancy sensors work well for this function. The sensors should detect motion when a person is two to three feet into the stack aisle, but should not respond to movement outside of the stack. There is generally enough spill light from the main pathways so that this design is neither a safety or security hazard. The occupancy sensors should have at least a 15 minute time delay before turning the lights off, to increase lamp life. Since the lights running parallel to the stacks are typically one-lamp fixtures, a uniform "low-high" alternative to this approach would require a two- or three-stepped ballast. A constant low level of light is present in the stacks, until the stack is entered. This approach is preferred when the stacks are visible from reading areas, and the contrast from totally off to full on would be visually distracting. When stack use is heavy throughout the operating hours of the library, these strategies are probably not cost effective, and the aisle lighting should remain on.

Rare Book Archives: Two factors affect the lighting controls in archival spaces: protecting the books from light is a top priority; in addition, these areas are typically under the control of experienced librarians, rather than the general public. Luminaires oriented parallel to the stacks, with a tightly focused stack lighting distribution, help create more uniform light levels from the top to bottom shelves, but, the lights should be kept off as much as possible. Even the ambient lighting in the pedestrian paths at the end of the aisles should not have a wide distribution, should provide minimal light levels, and should be off whenever the room is unoccupied. The individual seeking a book should be able to find the correct aisle, and then go down that aisle to the desired book, while activating the fewest number of lamps. Infrared occupancy sensors located at the ends of each row are appropriate for short rows, and intermediate sensors can be located for longer rows. Another strategy is to provide timer switches at the end of each aisle. The librarian would push the switch upon entering the aisle and could turn it off upon leaving. If not turned off, the lights would be extinguished automatically after a set time. The time delay setting of the timer switches or occupancy sensors should be based on the fragility of the book collection. Programmed start ballast should be considered for luminaires where it is likely that they will be turned on and off significantly more than five times a day.

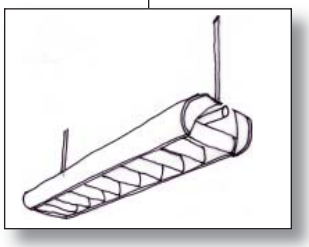
OTHER CONSIDERATIONS

Commissioning: The specialized nature of the lighting controls for a library mandate their careful calibration and commissioning. This is the opportunity to tailor the lighting for the current configuration, even though it has been designed for a range of future layouts. This not only improves the lighting quality, but saves considerable energy and cost of operation. Controls should be re-commissioned every three years, or whenever there is a significant relocation of stacks or furniture.

Emergency Lighting: Special care should be taken to ensure all exits and paths of egress are clearly visible, especially for people situated in stack areas, during a power outage or emergency.

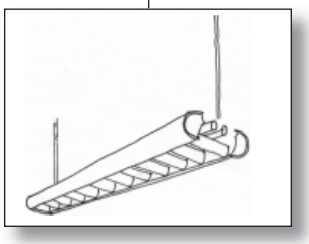
Electromagnetic Interference: Book theft detection systems manufactured prior to 1992 are susceptible to high frequency interference from electronic ballasts. Such systems emit a low intensity, high frequency magnetic field that interacts with the "tattle-tape" attached to the book jacket and sounds an alarm. Electronic ballasts located within 20' of these older systems (including the floor above and below) could overload the system and cause it to shut down. Since 1992, detection equipment manufacturers have been producing digital equipment with frequency filters that eliminate the interaction.

SAMPLE LUMINAIRE SCHEDULE FOR LIBRARIES



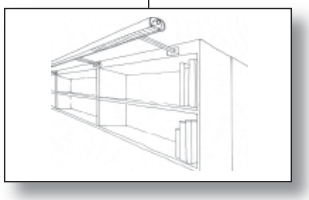
ONE-LAMP "STACK" DISTRIBUTION FLUORESCENT LUMINAIRE - SURFACE OR PENDANT

Location: Stacks (parallel), Rare book archives.
Lamps: (1) 28-32W, High Performance T8, 835 – 841 color
Description: Stem-mounted fluorescent luminaire in lengths of 8' or 12'. Minimum 90% downlight. Minimum fixture efficiency 62%. Cross baffles 1-3/4" deep x 2" on center. Semi-specular low-iridescent or white painted cross baffles. Total 2-lamps per 8' long fixture. Two-lamp electronic instant-start ballast, nominal 55 input watts. Also available in 12' lengths and continuous rows. Mount a maximum of 1'-6" above top of stacks, 6" preferred. Provide ultraviolet filter sleeves for rare book collection.



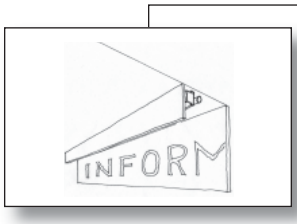
TWO-LAMP PENDANT FLUORESCENT DIRECT/INDIRECT

Location: Offices, Reading Areas, Stacks (perpendicular)
Lamps: (2) 28-32W, High Performance T8, 835 – 841 color
Description: Stem-mounted fluorescent luminaire in lengths of 8'-0" or 12'-0". White baked enamel finish. Minimum 30% uplight. Minimum 40% downlight. Cross baffles 1-3/4" deep x 2" on center. Semi-specular low iridescent or white painted cross baffles. Total 4-lamps per 8' long fixture. Four-lamp electronic instant-start ballast, nominal 110 input watts. Minimum fixture efficiency 80%. Also available in 12' lengths and continuous rows. Mount a minimum of 6'-8" above finished floor. Minimum 12" stem, 18" preferred.



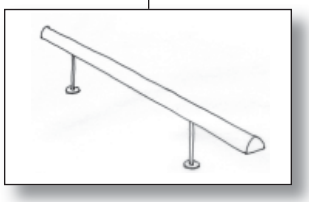
STACK-MOUNTED STACKLIGHT

Location: Stacks (may supplement ambient lights, or provide all stack lighting)
Lamps: (1) 28-32W, High Performance T8, 835 – 841 color
Description: Surface-mounted cantilevered fluorescent with narrow distribution. Total 2-lamps per 8' long fixture. Two-lamp electronic instant-start ballast, nominal 55 input watts. Mount a minimum of 12" from shelf edge, 18" preferred.



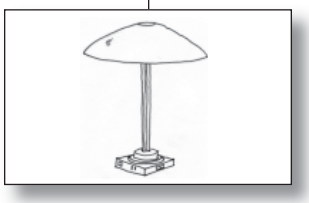
FLUORESCENT VALANCE LIGHT

Location: Graphics, signage, display racks
Lamps: (1) 28-32W, High Performance T8, 835 - 841 color
Description: Standard fluorescent industrial strip with single lamp, mounted on side to back of valance. Nominal 8'housing with two lamps in line. Two-lamp electronic instant start ballasts, 55 nominal input watts. Use compact-fluorescent continuous socket-strips for curved valances.



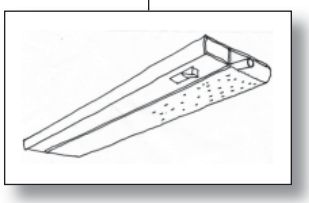
LINEAR TABLE LAMPS WITH OPTIONAL PLUG-IN COMPUTER HOOKUPS

Location: Reading Room tables
Lamps: (1) 25W or 28-32W, High Performance T8, 835 - 841 color
Description: Tabletop linear fluorescent, pedestal mounted to top of reading table . Integral multi-lamp 120v ballasts. Bolt-through- mounting. Maximum stem length 24" above the table top.



INDIVIDUAL TABLE LAMPS WITH PLUG-IN COMPUTER HOOKUPS

Location: Reading Room tables
Lamps: (1) CFL, 26 watt quad, 4-pin, 830 – 835 color
Description: Tabletop compact fluorescent. Integral 120v ballast. Computer ports and convenience 120v outlets. Maximum stem length 24" above the table top.



STUDY CARREL AND UNDER-SHELF TASK LIGHTS

Location: Reading areas, Staff work areas,
Lamps: (1) 17W, 25W or 28-32W, High Performance T8, 835 – 841 color
Description: Surface-mounted fluorescent with solid front. Nominal 2', 3' or 4' in length. Lateral prism task lens. One-lamp instant-start electronic ballast. Integral rocker switch. Mount under shelf.