

## Safe School Design Task Force OBJECTIVE, RESEARCH, & TRENDS FRAMEWORK

### Healthy Schools: Daylight and Lighting

#### A. Objective Statement

Our AIA NJ Safe School Design Task Force is focusing attention on the timely and important topic of “**Daylight and Lighting**” and how it relates to the overall framework of designing safe and secure schools in New Jersey. Our Task Force objective is to share national best practices in K-12 school designs and to show how to apply these practices to local New Jersey communities to help meet our schools’ health, safety, welfare, and wellness needs. The strategies used by NJ Architects to design and renovate schools shall not only protect building occupants but also create highly successful learning environments by applying innovative design solutions to integrate facility management and physical security with spaces supporting mental health and wellness practices.

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#### **GOAL: Promote Daylight, Energy Reduction, and Better Learning Environments**

Light not only allows us to see, read, and write, but it also synchronizes our biological clock, allowing for proper sleep-wake cycles.

Studies have shown that proper light levels, color, and illuminance have reduced daytime sleepiness, raised alertness, and contributed to faster cognitive processing speed and better student concentration. In addition, “...[s]tudents in classrooms with access to green views through their windows have been observed to experience significantly faster recovery from stress and mental fatigue and performed significantly higher on tests of attentional functioning, compared to students in classrooms with no windows or windows looking out onto other buildings facades” (Schools for Health, Foundations for Student Success by T.H.Chan)

Both natural and artificial light have several properties: brightness, color (also known as temperature), and contrast, measured in Lumens, kelvin, and luminance, respectively. We can use light from the sun, also referred to as daylight, directly or through reflection, artificially through light fixtures, and a combination of both in our schools.

Those light properties mentioned above are essential in education environments as they impact the ability to see the contrast between images, read small fonts, and affect concentration and alertness. In addition, children are more sensitive to light exposure, having larger pupils and more significant light-induced melatonin suppression than adults.

To expand on that more, let's touch upon the three different components of light mentioned above:

### **Brightness**

Many still think of brightness as measured in watts, as they were familiar with while selecting incandescent bulbs. Using this measurement does not directly apply to lighting brightness today when we use fluorescents and LEDs (light-emitting diodes) as they use less power (watts) than their incandescent counterparts. Today, when discussing Brightness, two measurements are used: light sources are measured in Lumens, and the surfaces they illuminate are measured in foot-candles.

Measuring light at its source vs. at the surfaces they illuminate is an important distinction, as the distance the light fixture is from the surface will impact the amount of light that it actually provides. For example, a 600-lumen light fixture at 8'-0" above the floor will provide more light on the desk (foot-candles) than the same 600-lumen light fixture at 10'-0" above the floor. In addition, building codes and the New Jersey Department of Education require a certain amount of light for life safety and instruction on surfaces. Architects and Engineers will run calculations to ensure the light fixtures specified meet those requirements.

### **Color Temperature**

Light comes in a wide range of colors. You may have noticed the differences in your everyday life, say in how a piece of paper looks different while outside in the sun compared to inside your home, or while inside an office or in a hospital. These differences are determined by the color temperature of light, which brings about a different color balance of reds, yellows, blues, and whites, affecting your perceived color of them.

In more technical detail, daylight from the sun has a color temperature of 6500K, showing a color temperature with more whites and blues, and an incandescent light bulb has a temperature of 2700K, showing more reds and yellows. Not only does this impact the differences in the perceived color of objects, but also the feeling of the space. Low color temperatures give an impression of warmth, like you may notice in your home at 2700K - 3000K, then the impression of cold at higher color temperatures, like in a medical environment, which is 3500K - 5000K.

### **Daylight**

Even though there have been significant reductions in energy costs with LEDs, there is still a financial cost to operation that should not be ignored. If natural daylight is available, design measures should be taken to bring that light to schools and use it to reduce the need for artificial lighting all the time. In addition, daylight and views outside positively affect people and learning environments.

## **B. Design Innovations & Creative Solutions**

Revisiting our goals and accounting for the needs for Brightness, Color Temperature, and Contrast in educational settings, several solutions are recommended.

### **Lighting Type**

LED light fixtures have become the standard and leading technology for classrooms. This change is for good reasons: lower energy needs, long life, and good color rendition index (CRI) are available. Initial costs have also been significantly reduced over the years. In addition, LED fixtures are also available in high-bay types for spaces such as Gymnasiums, which are replacing older technologies. There may be exceptions, but most spaces within a school can be lit with LED.

### **Lighting Color**

As discussed earlier, lighting temperature affects the perceived color of objects in a room, sets spatial expectations, and affects students' alertness. There is not precisely the perfect temperature. However, 5500K has been shown to promote better concentration in the early morning during winter. 3500K has shown to have calming properties, reducing restless behavior. Studies have shown that students perform better with color temperatures over 3000K in either case.

### **Daylighting**

Integrating daylighting into the design of classrooms and common areas has many benefits and should be taken advantage of. Using daylight sensors with light fixtures will accommodate the amount of lighting provided by daylight by dimming or turning off rows of light fixtures. This addition will reduce energy costs and help with glare. Additionally, studies have shown that incorporating daylighting into educational spaces has improved vision, sleep quality, and reduced symptoms of nearsightedness, eyestrain, headache, and depression.

Besides adding windows to rooms, there are other options where a clear view is either not permissible or wanted. Options include skylights, solar tubes,

clerestories, or using translucent surfaces to get the benefits of light without the direct view.

**Light Levels**

The New Jersey Department of Education requires minimum light levels in educational spaces. In classrooms, this is 50 foot-candles at the desk height minimum, not average. This difference, between minimum and average, makes the decision of light fixture placement, spacing, and lighting output much more critical. Otherwise, the lighting will not be even, with hot spots in the middle and dim areas in the corners.

*Installed Lighting Intensity (NJDOE)*

<u>Locations</u>	<u>Minimum Foot-candles</u>
Classrooms and instructional areas - study halls, lecture rooms, art rooms, offices, libraries, conference rooms, work rooms, shops, laboratories, and secondary school cafeterias	50
Drafting, typing, and sewing rooms	70
Reception rooms, gymnasiums, auditoriums, primary school cafeterias, all-purpose rooms, and swimming pools	30
Locker rooms, washrooms, toilet rooms, corridors containing lockers, and stairways	10
Corridors without lockers and storerooms	5
Classrooms for the partially sighted	70

**C. Resource Reference Links**

**Resource Information on Daylight and Lighting and excerpts taken from:**

[The 9 Foundations of a Healthy Building, Healthy Buildings for Health](#), 2017 Harvard T.H. Chan School of Public Health by Joseph G. Allen, Ari Bernstein, Xiadong Cao, Erika Sita Eitland, Sky Flanigan, Maia Gokhale, Julie M. Goodman, Skylar Klager, Lacey Klingensmith, Jose Guillermo Cedeno Laurent, Steven W. Lockley, Piers Macnaughton, Sepideh Pakpour, Jack D. Spengler, Jose Vallarino, Augusta Williams, Anna Young, and Jie Yin.  
*“The 9 Foundations of a Healthy Building” was created by a multidisciplinary team of experts from the Healthy Buildings Program at the Harvard T.H. Chan School of Public Health. You can learn more about the team and our research at*

*www.ForHealth.org. The 9 Foundations curated summaries are designed to be a clear and actionable distillation of the core elements of healthy indoor environments. For each, we created a 2-page summary of the underlying science, fully cited back to the primary literature. These summaries are included in the following pages, along with a short guide for how to achieve each foundation. The 9 Foundations apply universally to all building types, including homes, but the supporting text focuses mainly on commercial office environments.*

### **Foundation For Student Success How School Buildings Influence Student Health, Thinking and Performance**

Harvard T.H. Chan School for Public Health by Erika Eitland, Lacey Klignesmith, Piers MacNaughton, Jose Cedeno Laurent, Jack Spengler, Ari Bernstein, and Joseph G. Allen

*Schools for Health: Foundations for Student Success was researched and produced by the Healthy Buildings program at the Harvard T.H. Chan School of Public Health under the direction of Dr. Joseph Allen. Our goal is to improve the lives of all people, in all buildings, everywhere, every day. The Schools for Health program is a platform to discuss, research, and disseminate information on how school buildings affect the health and productivity of students, teachers, and staff every day. Our team works to answer critical questions related to the environmental and contextual factors that influence chronic absenteeism, academic performance, and short- and long-term health performance indicators. Schools for Health: Foundations for Student Success is intended to serve as an evidence-based decision-making tool for key school stakeholders.*

### **Educational Facilities, N.J.A.C. 6A:26**

*The rules are adopted by the New Jersey State Board of Education to implement the Educational Facilities Construction and Financing Act (EFCFA), P.L. 2000, c.72, as amended and as defined in N.J.S.A. 18A:7G-1, as well as to consolidate, conform, and update other rules relating to educational facilities in this State. The rules are adopted to ensure that the educational facilities in the State are safe, healthy, and educationally adequate to support the delivery of the thorough and efficient education to which all students are entitled, as defined by the New Jersey Student Learning Standards. The rules apply to all district boards of education in the State. To the extent these rules are inconsistent with other rules in Titles 6 and 6A of the New Jersey Administrative Code, the rules in this chapter shall take precedence.*