Classroom Lighting System Demonstration Research Study
Final Report

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NOTICE

This report was prepared by the following individuals: Marc McMillan of Finelite, Terry Clark of Finelite, Jennifer Brons of the Lighting Research Center, Peter Morante of the Lighting Research Center, Brian Blackhart of Finelite, Vickie Lauck of Finelite, and Aloke Gaur of Finelite in the course of performing work contracted for and sponsored by the New York State Energy Research and Development Authority and Finelite, Inc. (hereafter the "Sponsors"). The opinions expressed in this report do not necessarily reflect those of the Sponsors or the State of New York, and reference to any specific product, service, process, or method does not constitute an implied or expressed recommendation or endorsement of it. Further, the Sponsors and the State of New York make no warranties or representations, expressed or implied, as to the fitness for particular purpose or merchantability of any product, apparatus, or service, or the usefulness, completeness, or accuracy of any processes, methods, or other information contained, described, disclosed, or referred to in this report. The Sponsors, the State of New York, and the contractor make no representation that the use of any product, apparatus, process, method, or other information will not infringe privately owned rights and will assume no liability for any loss, injury, or damage resulting from, or occurring in connection with, the use of information contained, described, disclosed, or referred to in this report.

ABSTRACT

This project demonstrated how changing teaching methodology requires a new approach to classroom lighting - one that gives teachers the necessary tools to improve the learning environment, while reducing energy consumption.

An Integrated Classroom Lighting System was installed in 28 classrooms in 7 different K-12 and university level schools in the state of New York. The study used direct and indirect research methods to assess how the lighting system was used to benefit the learning environment. 3rd party researchers conducted teacher and student preference surveys, and electronic data loggers were connected to the system to map usage patterns as well as energy consumption. 16 million data points were collected showing the Integrated Classroom Lighting System met the needs of today's teaching methodology. The research developed a flexible easy-to-use design and lighting layout template enabling school designers to quickly adapt the research findings. Preference studies showed teachers unanimously preferred the Integrated Classroom Lighting System over existing lighting systems and that it had impact on the way they taught. The system delivered an average 48% energy savings compared to national codes and data presented demonstrates the system is affordable.

Keywords: Classroom lighting, teacher preference, integrated system, sustainability, high performance, school design, energy efficiency, student performance, daylighting

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Finelite, Inc: Finelite supplied the Integrated Classroom Lighting System, coordinated the product installations, monitored the data obtained during the research period and developed the Final Report, AIA presentation and Contractor Estimator Guide. Project Director: Terry Clark. Project Support: Tom Ward, Jane White, Marc McMillan, Vickie Lauck, Brian Blackhart, Aloke Gaur, Nelty Tanaday, Jennifer Langsam, and Mary Latimore.

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Executive Summary

High performance schools begin in the classroom and the high performance classroom must support new teaching methodologies. In addition to the dramatic increase in video presentations throughout every level of education, today's classroom must also accommodate the use of whiteboards, laptops, tablet PC's, and even electronic "smart" boards.

The demonstration project sponsored by the New York State Energy Research and Development Authority (NYSERDA) helps conclusively demonstrate that the latest generation Integrated Classroom Lighting System meets the needs of today's high performance classroom. The NYSERDA demonstration project installed 28 classrooms at 7 different schools and universities and collected more than 16 million data points to support the findings. Experts and end users supported and directed the research at every step of the way and many of the research findings have been incorporated into the best practices developed by the Collaborative for High Performance Schools (www.chps.net) and LEED for Schools (www.usgbc.org) enabling every school district to benefit.

Key Findings of the NYSERDA Research Project

Finding # 1: Lighting a high performance classroom requires a system approach.

The classroom and how teachers teach has changed forever. Today's classroom will have whiteboards, computers, video projectors and screens. Today's teachers employ teaching methodologies that move beyond traditional paper tasks and chalkboard instruction. They use PowerPoint presentations, the Internet, animation, videos, and other technologies common to the corporate and residential sector alike, and these trends are only expected to increase.

Energy codes used for classroom design have also changed. The lighting power density available to design classrooms no longer supports the old method of lighting classrooms. Energy codes have been reduced to a maximum of 1.4 watts per square foot (w/ft^2) under ASHRAE 90.1 (2004), 1.2 w/ft^2 under California's Title 24 and are as low as 1.0 w/ft^2 in some states.

It takes a systems approach to meet the needs of the updated classroom while meeting today's sustainable energy codes. The system must incorporate luminaires that enhance the effectiveness of the new technology. The system must provide the teachers with easy-to-use and effective control over the lighting and maximize energy savings through the use of advanced occupancy sensor technology that prevents disruption in the classroom.

Breaking the integrity of the system causes fundamental problems for the learning environment. The wrong luminaire choice will reduce the effectiveness of new teaching technologies or drive energy consumption above sustainable levels. The wrong sensor, or the correct sensor improperly placed, will reduce the effectiveness and possibly cause disruption to the classroom. Eliminating or improperly placing effective teacher controls drastically reduces the effectiveness of the system and reduces potential energy savings. Adhering to the system approach ensures all components work together to meet the needs of how teachers teach, how students learn, and deliver maximum energy savings.

Finding # 2: The Integrated Classroom Lighting System template is new, but it is easy to grasp and implement.

The Integrated Classroom Lighting System template has 5 major parts:

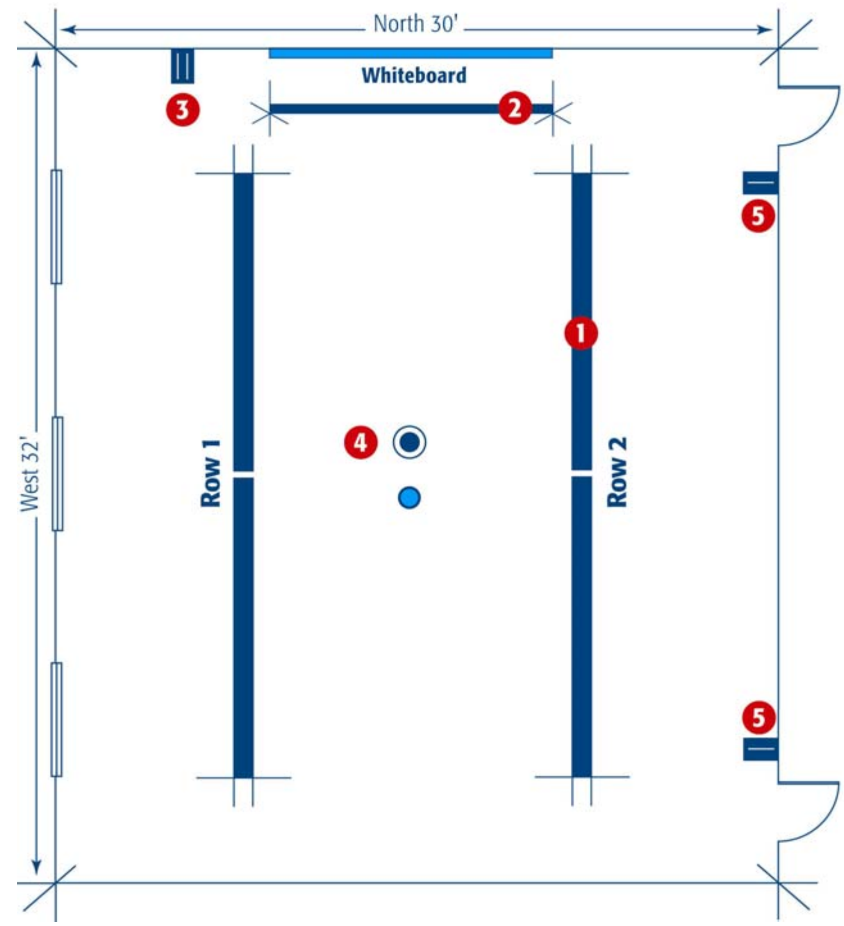


Figure 1 –Integrated Classroom Lighting System Template

1) Two rows of two-scene indirect/direct luminaires mounted perpendicular to the main teaching wall (parallel to window wall) and spaced 14-15' apart.
2) A dedicated luminaire is used to illuminate the whiteboard on the main teaching wall.
3) Teacher control is placed at the front of the classroom. For easy teacher access place controls within 6" of the whiteboard.
4) Sensors are placed in the center of the classroom. Sensors always include occupancy and daylight harvesting is added where appropriate.
5) A master on/off switch is by every door to the classroom.

Finding #3: Teachers unanimously prefer the Integrated Classroom Lighting System

Comparative surveys conducted by the Lighting Research Center of Rensselaer Polytechnic Institute confirm that the teachers surveyed unanimously preferred the Integrated Classroom Lighting System to existing lighting products. Teachers believe the quality of light provided by the indirect/direct luminaires is better than the previous luminaires. The teachers understood and used the two-scene indirect/direct luminaires to improve the learning environment. Teachers and students rated the general and audiovisual modes highly and appreciated the ability to dim the audiovisual mode to the proper light level to satisfy the needs of the presentation.

The whiteboard luminaire was an important addition to the NYSERDA research project as it was not included in the original PIER 4.5 study. Note- some teachers in that study felt an increase in light levels was needed. The addition of the whiteboard dramatically improved the survey results regarding the overall light levels and gave teachers another tool to improve the teaching experience.

Preference surveys also demonstrate that teachers understand the importance of placing controls at the front of the classroom.

Complete s*urvey results are detailed in Appendix A – Human Factor Analysis.*

Finding #4: The Integrated Classroom Lighting System is sustainable.

The Integrated Classroom Lighting System is a sustainable design approach that reduces energy consumption 48% below ASHRAE 90.1 (2004) levels. The NYSERDA project is the culmination of several years of research in which more than 36 million data points have been collected demonstrating the actual energy consumption in the average classroom will be 0.73 w/ft^2. Energy consumption is expected to decrease even further as the use of audiovisual presentations become commonplace in the classroom. The Integrated Classroom Lighting System is also sustainable as it requires fewer luminaires, lamps, ballasts, packaging, and contractor supplied parts than traditional designs.

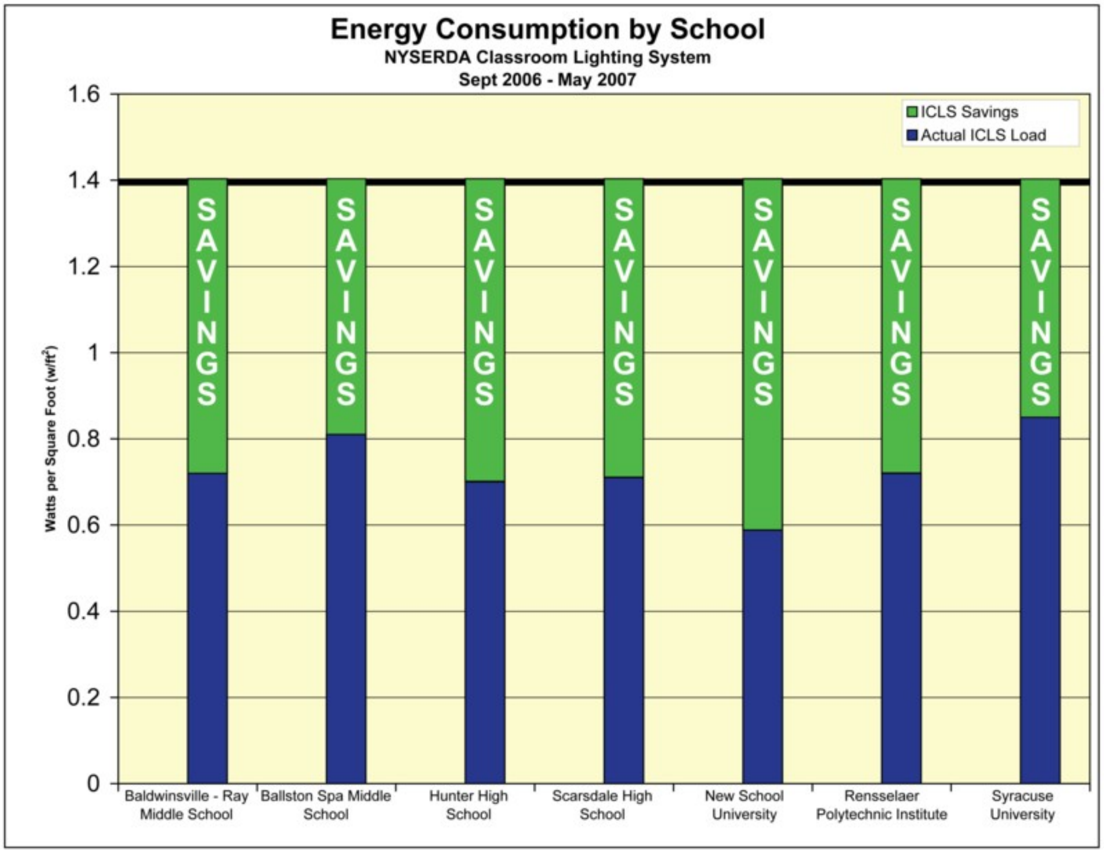


Chart 1 – Average Lighting Power Density is 0.73 w/ft^2 (48% below ASHRAE 90.1 - 2004)

The Integrated Classroom Lighting System is affordable.

The Integrated Classroom Lighting System uses affordable luminaires, controls and sensors that are available from several luminaire manufacturers. The Integrated Classroom Lighting System used in the NYSERDA research was an integrated system provided by one manufacturer. The integrated approach ensures one manufacturer assumes primary responsibility for layout, pricing, luminaires, controls, sensors, and warranty. This Integrated Classroom Lighting System uses low voltage plug and play wiring, and pre-wired control devices, which drastically reduce labor costs and risk for contractors. Appendix XX contains a detailed specification for the Integrated Classroom Lighting System, which enables any manufacturer to develop this very affordable system to meet any school construction budget.

The Importance of School Design Choices

Design decisions made for today's schools have a 40-50 year life and the new Integrated Classroom Lighting System template should be part of every new school project. These findings are important because the template presented meets the needs of today's classroom, and is flexible enough to accommodate future technology and teaching methodology changes. Using this template will provide immediate and long-term positive impact on energy consumption in every school, thus reducing the impact on school utility expenses as well as the environment.

INTRODUCTION

This document presents the findings of demonstration project conducted for the New York State Energy Research and Development Authority (NYSERDA). The research examined the changing learning environment, focusing on how technology currently used to instruct students was not being supported by existing lighting products. Specifically, recessed lighting products commonly used do not sufficiently accommodate the increased use of audiovisual presentations, the technology supporting A/V presentations, computers, or interactive electronic whiteboards, that are used to create high performance classrooms. The research installed a 3rd generation Integrated Classroom Lighting System to demonstrate such an integrated approach could meet the needs of the new teaching methodologies, would be preferred by teachers, reduce energy consumption, and be affordable enough to meet the construction budgets for new construction projects across the state of New York and beyond.

The study builds on prior research conducted for the California Energy Commission through its Public Interest Energy Research (PIER) program where the 1st and 2nd generation systems were developed to address lighting quality issues in the classroom, reduce energy consumption, and address the challenges involved in classroom construction projects. The research concluded a systems approach whereby one manufacturer would provide layout design, pricing, products, and warranty support which would yield sufficient benefit to the classroom construction process to ensure better quality lighting products would be installed. This systems approach addressed the following issue: Classroom lighting is specified and purchased in such a way that at least five different firms supply luminaires, lamps, sensors, controls, and interconnection devices for each project. No manufacturer takes responsibility to ensure overall system performance, energy savings or installed costs. This means the electrical contractor has to assume this responsibility. Faced with this task and its associated risks, electrical contractors add costs to their bids. In many cases, the costs added to bids are so great that high-quality, energy-efficient systems are deleted from the project. As a result, energy efficient solutions that do not properly address the issues of affordability and reducing contractor risks are never implemented beyond a few demonstration projects. The PIER project developed the Integrated Classroom Lighting System to address this issue so high performance classrooms could be installed in every project.

The goal of the NYSERDA Integrated Classroom Lighting System Demonstration Research was to use a 3rd generation Integrated Classroom Lighting System and prove that such a system met the needs of today's teaching methodologies, was flexible enough to be installed in a variety of different classroom shapes and education levels, could reduce the amount of energy consumed in the classroom and was affordable for today's school construction budgets.

Project Goals and Objectives

1. Install 28 Integrated Classroom Lighting Systems at 7 different schools in New York State, thus building a significant database to document energy savings and teacher preference. The project installed Integrated Classroom Lighting Systems at the following schools:
    - Syracuse University – Syracuse, NY
    - Rensselaer Polytechnic Institute – Troy, NY
    - New School University – New York, NY
    - Hunter High School – New York, NY
    - Ray Middle School - Baldwinsville NY
    - Ballston Spa Middle School – Ballston Spa, NY
    - Scarsdale High School – Scarsdale, NY
2. Develop questionnaires to gain data on teacher and student preferences. The Lighting Research Center developed and conducted the human factor analysis for this project.
3. Demonstrate that the Integrated Classroom Lighting System can work equally well at K-12 and university level classrooms.
4. Demonstrate the addition of a whiteboard luminaire will improve user acceptance and result in energy savings.
5. Develop education materials including a contractor estimator guide and an AIA presentation to speed adoption of the integrated classroom lighting system and the resulting energy savings.

FINDING #1: LIGHTING A HIGH PERFORMANCE CLASSROOM REQUIRES A SYSTEMS APPROACH.

A new systems approach is necessary to develop high performance classrooms and must address two critical factors of classroom design. First, the learning environment has fundamentally changed requiring a new way of illuminating classrooms in order to meet the needs of the new teaching methods and the supporting technologies. Second, there is a national drive toward using more sustainable design practices, which requires a systems approach to reduce energy consumption and excessive component usage.

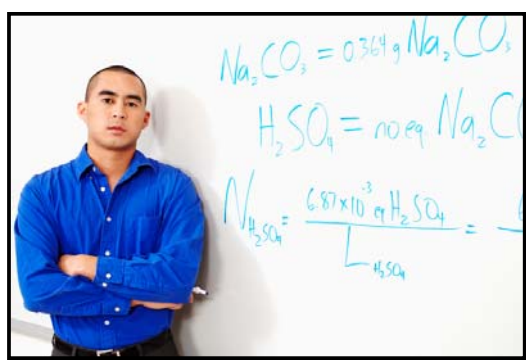
<u>The Changing Classroom</u>

The traditional classroom had things on the wall, used a blackboard and chalk and involved a great deal of paper tasks. New teaching methods have added to this classroom design, and the classroom of today involves a great many changes that require a new classroom lighting system. Some things will stay the same. The walls will still be primary teaching surfaces. Whiteboards will continue to be used for instruction and reading and writing will still be important in the classroom.

Every surface is a teaching surface.

Many of today's classroom and probably the vast majority of future classrooms will have a whiteboard, computers or tablet PC's, video projectors and screens and maybe even an electronic "smart" board. Let's look at a few of these in more detail in order to understand the impact of the lighting selection on these teaching tools.

<u>The whiteboard</u>: The whiteboard provides the teacher with the ability to use color and improve the presentation effectiveness and improves the air quality by eliminating the chalk dust common to blackboards. Visibility of the text is very good when pens are new. As the pens age, however, the contrast diminishes requiring more vertical illumination to realize the same impact. The challenge is to provide enough vertical illumination on the whiteboard to achieve great contrast without over-lighting the entire classroom thus unnecessarily increasing energy consumption.

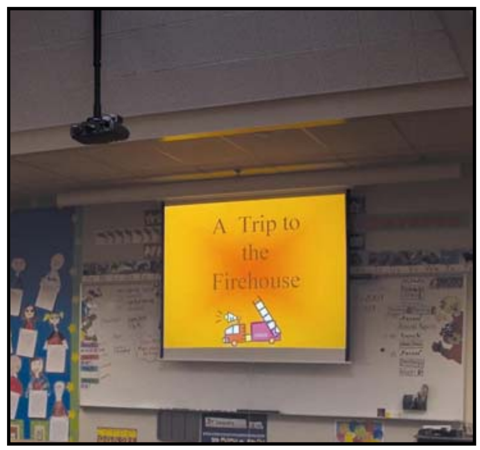


The whiteboard will remain an important communication tool.

Laptops and tablet PC's: While paper is still an important component of the classroom, more and more students are shifting from paper to the video display medium. The number of college students using computers at school has increased from 63% in 1997 to 85% in 2003[1]. Laptops require special consideration as it relates to luminance and Illuminance as screen brightness isn't expected to increase and recessed luminaires can cause glare and wash out the screen, thus limiting effectiveness.

Use of laptops in the classroom will increase.

Video Projectors: Video projectors have replaced overhead projectors. These new technologies provide teachers with increased flexibility, allowing them to use PowerPoint presentations, Internet, show videos and animations but these system also pose certain challenges for lighting systems. The old style overhead projectors were effective and very bright. The brightness of the overhead projector allowed you to see the image relatively clearly even with ample amounts of electric light or sunlight flooding the space. The image of video projectors common to today's schools will be washed out when vertical illuminance on the projection screen is too great, thus limiting their effectiveness.



Ceiling mounted projector controlled from teacher's desk.

Smartboards: Smart boards, or interactive whiteboards, combine the simplicity of a whiteboard with the power of the computer. The touch sensitive display connects to your computer and digital projector to show the computer image. Computer applications can be controlled from the display and notes can be made on the board and captured for later use. These powerful teaching tools can also be washed out when using traditional recessed products.

Teacher using electronic smart board.
Source: Smart Technologies, Inc.

[1] Snyder, T.D, Dillow, S.A., and Hoffman, C.M, (2007) Digest of Education Statistics 2006.

The Changing Energy Requirements

Three important factors contribute to the change in energy consumption in the classroom. First, there is a national drive towards more sustainable practices that reduce our impact on the environment. Energy conservation efforts seek to reduce the amount of greenhouse gases and other pollutants emitted into our environment. The second important factor is the impact lighting energy has on school utility expenses. Lighting typically represents more than 30-40% of the energy costs in most schools. Reduction in energy costs makes more funds available for classroom supplies, facility upgrades, and increased salaries for school employees.

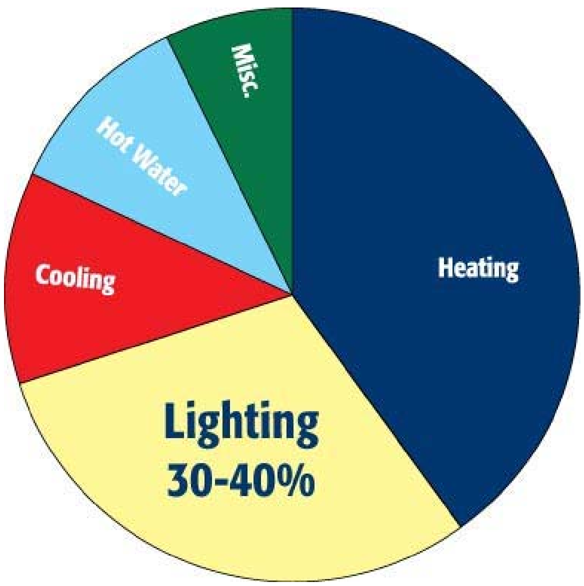
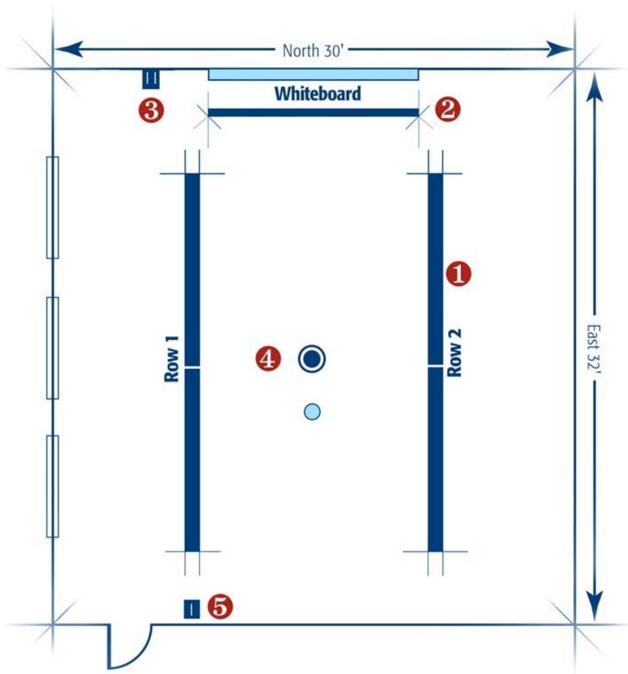


Figure 2 - Typical energy consumption breakdown for school utility expenses.

Finally, energy codes driving design have reduced the amount of lighting power that can be used to light a classroom and these codes are expected to continue along this path. The national code ASHRAE 90.1 (2004) permits a maximum lighting power density of 1.4 watts per square foot (w/ft^2) for classrooms. Other codes including California's Title 24 drive the consumption to 1.2 w/ w/ft^2. Some states even require the consumption to be no greater than 1.0 w/ w/ft^2.

FINDING #2: THE INTEGRATED CLASSROOM LIGHTING SYSTEM TEMPLATE IS NEW, BUT IT IS EASY TO GRASP AND IMPLEMENT.

<u>The Integrated Classroom Lighting System Template</u>
The Integrated Classroom Lighting System Template has 5 major parts detailed below. A historical view of the how the Integrated Classroom Lighting System template was developed is available in Appendix L.

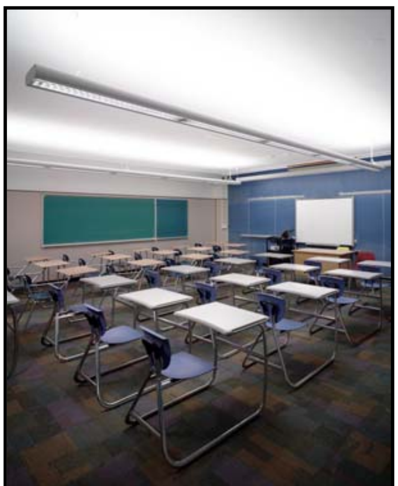


				
Indirect/Direct Luminaires:	Whiteboard Luminaire:	Teacher Controls:	Sensors:	Master Switch:
1) Two rows of two-scene indirect/direct luminaires mounted perpendicular to the main teaching wall (parallel to the window wall) and spaced 14-15' apart.	2) A dedicated luminaire is used to illuminate the whiteboard on the main teaching wall.	3) Teacher control is placed at the front of the classroom. Place teacher controls within 6" of the whiteboard for easy access.	4) Sensors are placed in the center of the classroom. Sensors always include occupancy and daylight harvesting is added where appropriate.	5) A master on/off switch is by every door to the classroom.

<u>Integrated Classroom Lighting System – Component Review</u>

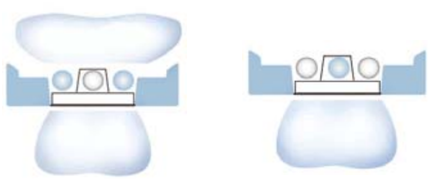
1) Two rows of two-scene indirect/direct luminaires mounted perpendicular to the main teaching wall (parallel to window wall) and spaced 14-15' apart.

CHPS and LEED for Schools recommend providing two scenes for the classroom. While LEED for Schools allows the designer to choose any of the luminaires detailed above to achieve the two-scenes, CHPS was involved in the PIER 4.5 research projects and went even further to recommend the use of indirect/direct luminaries. As described above, indirect/direct luminaires provide quality glare-free illumination and yield evenly illuminate ceilings and walls. Removing indirect/direct luminaires from the system in favor or recessed products will break the integrity of the system leading to lighting quality issues, improper handling of the two modes, higher energy consumption, and increased jobsite costs and materials.



General Mode

Figure 3 – Two-scene indirect/direct luminaire



A/V Mode

The two-scene indirect/direct luminaire was developed during the PIER 4.5 research project in response to the dramatic increase in audiovisual use in the classroom. A highly efficient 96% reflective material was developed and an optical system was designed enabling the luminaire's center lamp to be separated optically as shown in Figure 1 above. When in the General Mode, the two outboard lamps are turned on and the center lamp is turned off. When in the Audiovisual Mode the center lamp is turned on and the two outboard lamps are turned off directing 100% of the light downward reducing the light on the projection screen to recommended levels (<7fc), while providing enough light in the classroom to keep students alert, take notes, while enabling teachers to maintain eye contact. The system has an interlock mechanism to ensure all three lamps are not on at one time, which ensures the maximum energy load for the system is approximately 0.8 w/ft^2.

[2] Photo credits this page: JDN Photography, Inc

Luminaire Selection

Figure 4 – Indirect/direct pendant luminaire.
Source: Finelite

Indirect/direct luminaires were chosen for the template for a variety of reasons including: These luminaires are recommended in the best practice developed by the CHPS-NY. "EQ1.3: Electric Lighting: "Provide multi-scene indirect/direct lighting systems for all classrooms, with the exception of chemistry laboratories, art rooms, shops, music rooms, and dance/exercise studios." Indirect/direct luminaires are available from several luminaire manufacturers ensuring competitive bidding for school districts. These luminaires are available in a wide variety of shapes and finishes enabling them to be easily integrated into any school design.

Indirect/Direct luminaires make it easier to achieve audiovisual mode. This audiovisual method is the most affordable as it uses economical on/off ballasts and extremely simple luminaire wiring. The second way to achieve A/V with simple on/off ballasts is through the use of 2T8 cross-section luminaires wired at the factory to turn off a row of lamps in each row of luminaires in addition to turning off the first four feet closest to the whiteboard. This method uses fewer ballasts, but will require a luminaire manufacturer able to provide custom wiring configurations.

Lamp Selection

The two-scene luminaire uses 3100 Lumen T8 lamps, which deliver approximately 9% more light than the general 2850 lumen lamps. These 3100 lumen lamps are available from Osram-Sylvania, GE, and Philips. The incremental cost of these lamps is less than $0.05/ft^2$ making them a very affordable element of the entire system. See Appendix K for an explanation why the system uses T8 lamps as opposed to T5HO lamps.

[3] Photo credits this page: JDN Photography, Inc.

2) A dedicated luminaire is used to illuminate the whiteboard on the main teaching wall.

The 3rd generation Integrated Classroom Lighting System has an integrated whiteboard luminaire to meet best practices, meet the needs of the changing classroom, and reduce energy consumption. The NYSERDA study demonstrates teachers use and prefer the whiteboard luminaire in K-12 and University settings. Teacher preference results are found in Appendix A – Human Factor Report. Best practices including CHPS recommend a separately switched whiteboard luminaire and specify the vertical illumination be at least 30fc with a maximum uniformity of 8:1 or better. These best practices ensure the appropriate amount of light is placed on this important communication tool.

Teacher using whiteboard.

As today's school becomes a more important part of the community, the need for appropriate illumination on the main teaching surface increases with older users will requiring more light on the whiteboard than younger students. The whiteboard is an excellent communication tool and the addition of color improves the message impact. The elimination of chalk dust also improves the environment. However, the contrast of some colors and aged pens require more light to deliver maximum impact. The separately switched whiteboard luminaire puts the appropriate amount of light where and when the teachers need it.

Whiteboard Luminaire Usage

CHPS- NY outlines in the requirements for the whiteboard in the EQ1.3.3 Electric Lighting: "Provide a separately switched lighting system for the teaching wall that provides white board vertical illumination of at least 30 footcandles average with a maximum uniformity of 8:1 or better." The unit selected exceeded the minimum vertical footcandle requirement while generally providing uniformity on the whiteboard of 2:1.

Luminaire Options – Installation Details

The NYSERDA research featured a pendant mounted whiteboard luminaire. There are recessed options to achieve whiteboard illumination, but the study focused on the pendant version to reduce first cost as well as installation costs. The unit selected features adjustable mounting points that made installation easier

Whiteboard luminaire with adjustable mounting points

[4] Photo credits (luminaires) this page: JDN Photography, Inc

as the contractor was able to pick up suspension points on the existing ceiling grid. Recessed units require alterations to the ceilings, which increases labor in new construction and pose more challenges in retrofit situations. In general, the whiteboard luminaire is installed parallel to the main teaching surface and set back 30". The units installed for the NYSERDA research classrooms were suspended 8'6" AFF.

Settle Mode

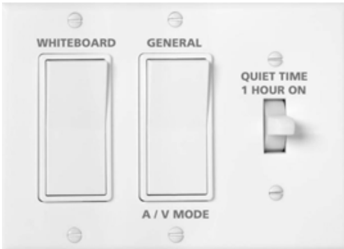
During the research process teachers found a new use for the whiteboard luminaire. Teachers combined the whiteboard luminaire with the Audiovisual Mode to create a lighting mode that was calming for the students and focused attention. The audiovisual mode would reduce the overall ambient illumination in the classroom while the whiteboard luminaire would focus attention on an assignment. This mode was used in both K-12 and the university setting. It is assumed the university students do not need 'calming', and the professors used the mode primarily to focus attention during whiteboard intensive instruction.

Settle Mode

Whiteboard Lamp Selection

The whiteboard luminaire uses the same 3100 Lumen T8 lamps as the indirect/direct luminaires. Note only do these lamps deliver the right amount of light on the teaching surface, but the consistent lamp specification ensures the maintenance teams will only have to stock one type of lamp and ballast combination.

[5] Photo credits this page: JDN Photography, Inc.



3) Teacher Control is placed at the front of the classroom. Place teacher controls within 6" of the whiteboard for easy teacher access.

The Classroom Lighting System places controls at the front of the classroom. These controls (generally referred to as the Teacher Control Center) enable teachers to switch between General, Audiovisual, and Settle Mode quickly and easily ensuring the different modes are used regularly to meet the classroom needs that change on a daily basis. Figure 2 shows the unit retrofitted at Syracuse University using affordable wire mold products.

Figure 5 – Controls Near Chalkboard at Syracuse

Control Placement

For optimal system use teacher controls must be placed at the front of the classroom. See the Teacher preference section of this report for further details on the dynamic that drives this requirement. The controls in the NYSERDA research in general were placed next to the whiteboard for easy access.

Control Installation

Controls can be either line voltage or low voltage. The integrated classroom lighting system used in the NYSERDA research used a plug and play low voltage connection to the controls, which reduces installation costs by reducing labor and risk for the contractor. Controls are received on the jobsite fully assembled and connections are made via a commonly used Cat5 plenum rated low voltage line.

[6] Photo credits this page: Control Switch (top of page): JDN Photography, Inc.
Control rendering (bottom right): Architectural Imaging – Bruce Clement

<u>Easy to Understand Labeling for Controls</u>

Easy to understand controls are necessary for the classroom environment. Controls need to do more as the functionality of the classroom lighting is increased. The challenge is to provide teacher controls that are easy to understand. Terms like "scenes" do not resonate with teachers and certainly not with substitutes. There are many very sophisticated controls on the market today that can deliver amazing results. The classroom environment, however, requires simple, easy to use controls that require a minimum amount of training. K-12 schools may be able to coordinate a training session with the teaching staff, but this research indicates it is very difficult to coordinate training sessions for university professors. K-12 teachers are resident in one classroom throughout the year, or even yearly and as such have a great sense of ownership over the space and are open to training sessions. The university environment has many professors using the same classroom and they feel no such ownership over the classroom. Therefore, controls need to be extremely easy to use and understand. The teacher controls used in this experiment had laser engraved labels like "General Mode", "A/V Mode" and "Whiteboard".

4) Sensors are placed in the center of the classroom. Sensors always include occupancy and daylight harvesting is added where appropriate.

Classroom Dynamics Require Ceiling Mounted Occupancy Sensors.

The research resulting in the 2nd generation Classroom Lighting System demonstrated the need for ceiling mounted sensors. Wall mounted sensors are easily blocked as teachers, unaware of the technical requirements of the occupancy sensors, would often place mobiles or other items normally found in a classroom directly in front of them, thus resulting in the luminaires being turned off unexpectedly. Ceiling mounted dual technology occupancy sensors use ultrasonic and PIR technologies to detect motion in the classroom. The sensor is generally placed in the center of the classroom. Certain classroom configurations may require alternate sensor placement or even the use of more than one sensor.

<u>Occupancy Sensor Sensitivity</u>

More important than energy performance in the classroom is student performance, and occupancy sensor sensitivity must be set to minimize disruption in the classroom. Usage charts show the impact of the occupancy sensors on energy savings in the classrooms. Teacher responses identified in the human factor analysis indicate that false-offs were kept to a minimum.

[7] Photo credits: JDN Photography, Inc.

5) Place Master on/off switches at every entrance

Every entrance to the room shall have master on/off control switches over the lighting. The importance of this inexpensive switch is two-fold. First, studies prove that giving occupants control over their environment leads to increased satisfaction. Teachers do not want to have the occupancy sensors turn the lights on for them. As they tend to feel a large degree of ownership over the classroom taking that simple level of control away from them will result in reduced satisfaction. The second reason for giving teachers on/off system control at the entrance is for energy savings. Teachers – especially in the K-12 environment – use them. They turn the lights off as they leave the room. By providing teachers the ability to turn off the lighting manually, the school avoids the additional 10 minutes of energy required for the occupancy sensor to turn off the lights.

<u>Installation Options</u>

The Master on/off switches provided for the NYSERDA research were line voltage and controlled the all the lights in the classroom. Currently, manufacturers are also working on providing a low voltage option for the Master on/off switch, which will reduce installation costs.

[8] Photo credits: JDN Photography, Inc

Template Modifications

Flexibility is important for classroom lighting systems. The Classroom Lighting System was designed to accommodate a wide variety of different classroom types, shapes, ceiling heights, sizes, and finishes. The NYSERDA research installed CLS into existing classrooms and the system was able to accommodate the unique designs, achieve recommended practices, and save energy. A detailed review of these templates is found in Appendix B – Classroom Lighting Templates. Most luminaire representatives and manufacturers will provide design assistance to school districts to ensure the CLS meets specific requirements.

Ceiling Heights: CLS can be installed in a wide range of ceiling heights, including ceilings as low as 8'3". This is made possible because of a few manufacturers developing indirect/direct luminaires specifically suited for low ceiling environments, which can be mounted just 3" from the ceiling and deliver recommended quality. Using these low ceiling luminaires with the CLS system will meet the needs of classrooms with low ceilings. The whiteboard luminaire, teacher controls, sensors and master on/off switches remain the same.

Room Sizes and widths: Learning spaces come in many different sizes and CLS can be adapted to meet specific design needs. Narrow conference rooms can be designed using one row of pendant indirect/direct luminaires. Classroom designs like Baldwinsville (Figure 3) were nominally 24' x 35'. These wide and shallow classrooms were accommodated using three 16' rows of pendant indirect/direct luminaires. Some room designs, such as Ballston Spa Middle School, were best illuminated using independent luminaires mounted parallel to the teaching surface and separated 4'. The length of the whiteboard would be changed to meet the needs of the narrower or wider teaching surface. Teacher controls, sensors, and master on/off switches would remain the same.

Figure 6 – Baldwinsville – Ray Middle School

Figure 7 – Ballston Spa Middle School

[9] Photo credits (luminaire): Ken Rice Photography

Figure 8 – Barrett Ranch Elementary – Antelope, CA

Classrooms with Daylight Harvesting: Daylighting was not part of the NYSERDA research, but studies prove a connection between daylight and student performance. Classrooms with daylighting also provide additional energy saving opportunities. CLS integrates easily with daylight strategies for both toplighting and sidelighting strategies using dimming and switching. The indirect/direct luminaires provide excellent illumination even with large skylights. Classrooms with daylight harvesting require easy changes to the luminaire to meet the particular harvesting strategy employed. Most manufacturers make the necessary wiring changes at the factory so the luminaires are easy to install on the site. Teacher control placement remains the same, but dimming controls will be added to daylight dimming classrooms. Sensors are easily plugged into the CLS system and master on/off switches are still located at every classroom entrance. Commissioning is required for each classroom using daylight harvesting, which must be factored into the project costs.

Classrooms with Darker Wall Finishes:

Classrooms are learning spaces and every surface is a teaching surface. Finishes in the classroom can vary from bright white paint to dark slate, as it was in Rensselaer Polytechnic Institute classrooms. Hunter High School had large blue chalkboards in the space, with dark wood cabinets lining the sides. The CLS template accommodates these unique wall finishes, as the performance of indirect lighting is not adversely affected by wall finish. Ceilings and walls are evenly illuminated and the recommended illumination levels were attained on the student desks.

Figure 9 – Hunter High School

[10] Photo credits: Barrett Ranch – Farrell Scott Photodesign.
Hunter High School – JDN Photography, Inc

Sloped Ceilings: The research did not study sloped ceiling classrooms, but the template also easily accommodates these types of classrooms. In general, only minimal changes are required for ceilings up to a height of 14 or 15'. The luminaires remain the same. Ballast factors may be adjusted to meet illumination levels. Teacher controls remain the same. Given the degree of slope it may be advantageous to include a second occupancy sensor to minimize disruption in the classroom.

Figure 10 – Coyote Creek Elementary-San Ramon, CA

Template Modification Summary

Flexibility is important in classroom design and the NYSERDA research project demonstrated that the Classroom Lighting System could be adapted to a wide variety of classroom types. In addition to templates available in Appendix C, most luminaire manufacturers and the independent representatives selling their products generally provide free layout services to ensure the lighting system meets the schools specific requirements.

FINDING #3: TEACHERS PREFER THE INTEGRATED CLASSROOM LIGHTING SYSTEM

The Lighting Research Center (LRC) out of Rensselaer Polytechnic Institute conducted the human factor analysis for the NYSERDA classroom research project. The complete report can be found in Appendix A – Human Factor Analysis. The response to the 3rd Generation Classroom Lighting System was extremely positive with consistently high praise for the whiteboard luminaire.

The human factor analysis used interviews and surveys to gather teacher feedback on lighting modes and how these modes impacted student behavior. Further, the study focused on the components of the Integrated Classroom Lighting System, including the whiteboard luminaire, controls, and occupancy sensor technology. Teachers were surveyed on their understanding of the system, how they used the system, and the overall benefit to the classroom environment. A post study comparison survey was conducted to compare and contrast the Integrated Classroom Lighting System to the previous systems used (Figure 11 below). This comparison survey showed the teachers surveyed unanimously preferred the Integrated Classroom Lighting System to the previous lighting system. Teachers at the middle and high school level reported understanding and using the controls to the benefit of the classroom and overall the control placement was found to be acceptable.

Students were also surveyed with regards to the lighting. LRC reports, "Although the instructor responses showed a disparity between the universities and the middle/high schools, the student reactions were more similar regardless of location." Regarding light levels LRC writes, "Students consider room brightnesses to be 'just right.' They think the room gets dark enough to see projections, while providing enough light to take notes."

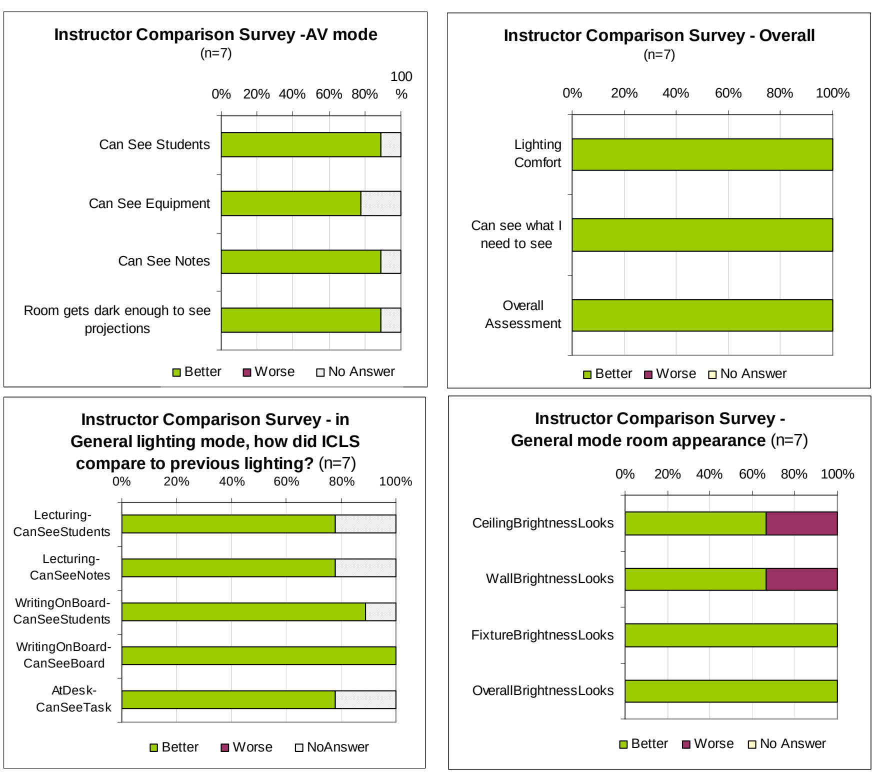


Figure 11 – Comparison Survey Results from Human Factor Analysis – Pg. 33

Usage Data Supports Survey Results

In addition to direct feedback from the teachers, the research also collected data from monitoring equipment connected to the luminaires and controls. An extensive review of the data collection methodology is available in the Project Methodology section of this report. In summary, data loggers were connected to the luminaires, teacher controls, sensors, and master on/off switch and captured data every minute of every day. A total of 16 million data points were collected over the course of the study, showing exactly how the teachers used the Classroom Lighting System.

The raw data is captured every minute of every day using data loggers connected to the system components and reads the current generated by the individual relays and sensors. Data is captured and the output in the raw state is presented in Figure 12.

Teacher activity can be tracked to develop a picture of how the lighting system was used and how the use changed throughout the day, from week to week, and over the course of the school year to meet the changing needs of the curriculum.

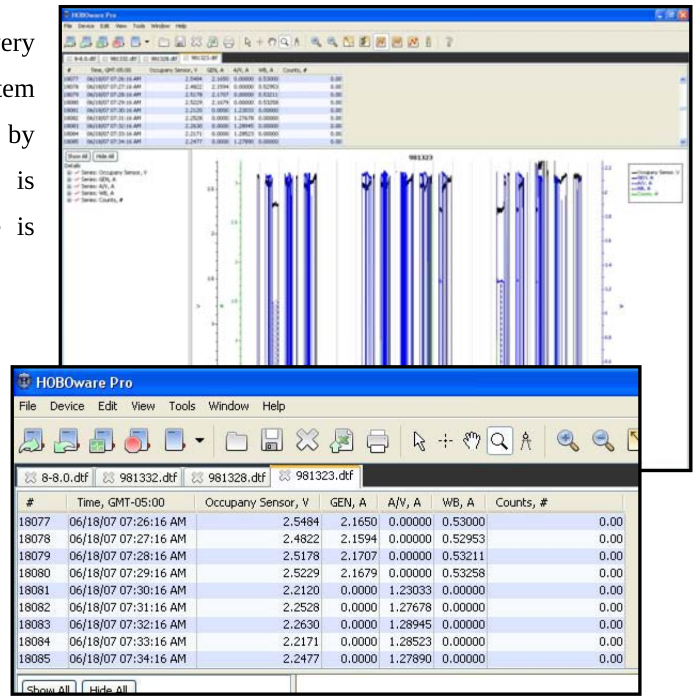


Figure 12 – Raw data captured by data loggers.

Usage Can be Visually Mapped Out

The raw data captured by the data loggers is brought into custom software developed to, among other things, visually chart changes in the classroom. The data shows when teachers use each of the individual modes throughout the course of a school day. Chart 2 shows how a teacher switched between General and AV mode through the course of a single morning. Chart 3 shows the Settle Mode – teachers turn on the AV Mode to reduce the overall light levels in the room and turn on the whiteboard luminaire. This increases the light on the whiteboard making it the brightest thing in the room. The end result is students are focused on the material being presented on the whiteboard. It is called the Settle Mode because some teachers found this mode to calm students when they came in from after recess or lunch breaks. The length of time can be a few minutes, or in this case 4.5 hours, which is important, as the energy consumed during this mode is just 0.45 w/ft^2.

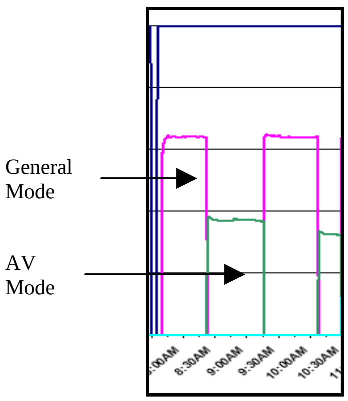


Chart 2 – General and AV Mode

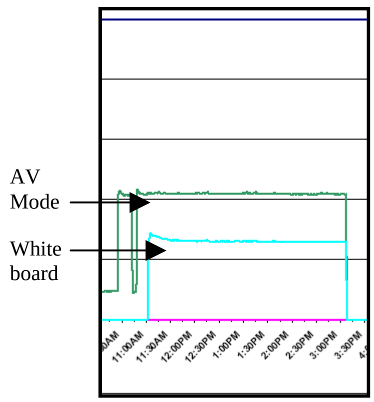


Chart 3 –Settle Mode

As shown in Chart 4 teachers will use the General Mode with and without the whiteboard depending on the needs of the lesson plan. This points to the need to have the whiteboard luminaire separately switched in order to provide the appropriate amount of flexibility for the classroom.

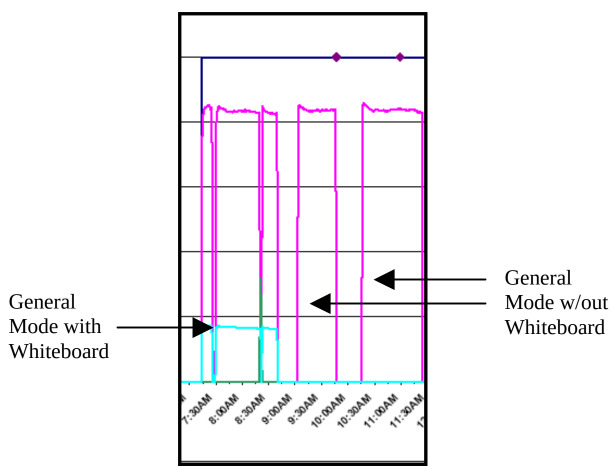


Chart 4 – General Mode with and without Whiteboard

Luminaire Shutoff Pattern

The Classroom Lighting System uses both occupancy sensors and manual switches to turn off the lights. The occupancy sensors will be talked about in more detail in the Sustainability section later in this report, but it is important to understand the importance of each component. Teachers do use the manual on/off switch to control the lights and this simple and affordable level of control leads to greater user satisfaction in addition to energy savings. Chart 5 shows the occupancy sensor signal terminates at the same time the lights are turned off thus showing the occupancy sensor controlling the lights in this classroom. Chart 6 shows the lights being turned off before the occupancy signal is terminated, thus showing the teacher turned off the lights manually.

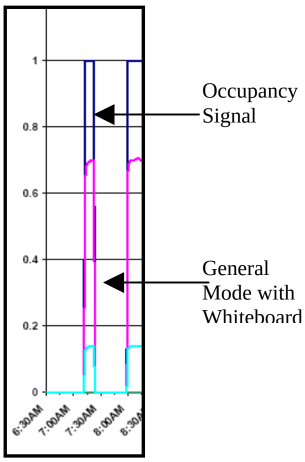


Chart 5 – Occupancy Sensor controls lights

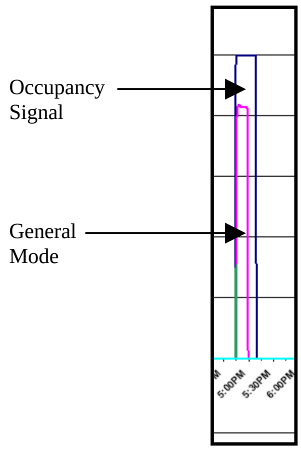


Chart 6 Manual Switch Controls lights

Controls Room Usage

In contrast to the Classroom Lighting System rooms, the control room lighting does not vary significantly throughout the day, or from day to day. Chart 7 shows a control room at Hunter High School where the lights were turned on and left on throughout the entire day. Switching strategies varied in the Control rooms with some classrooms being either "all on" or "all off" and some classrooms have a degree of flexibility in the lighting. Control locations varied from the front to the rear of the room. In general switches located at the front were used even in the Control rooms. Switches located at the back of the room were rarely used. Teachers communicated they did not like to lose control over the classroom by walking to the back of the room and thus left the lights all on for most of the day.

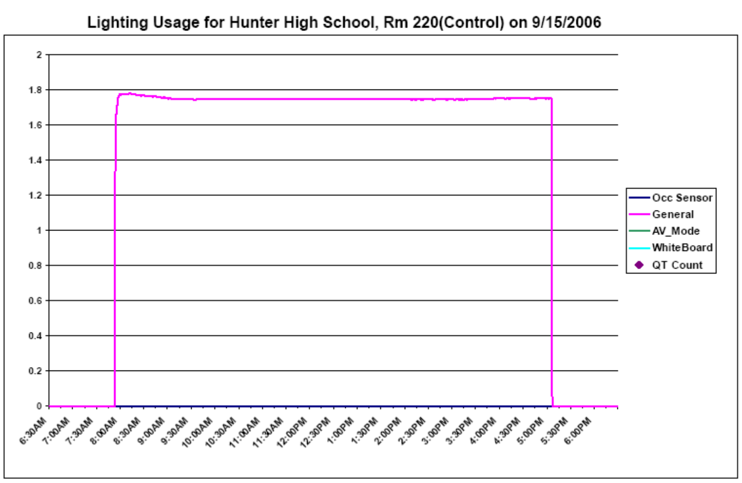
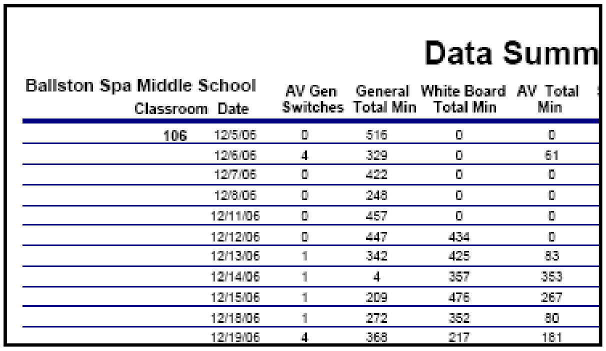


Chart 7 – System usage chart. Hunter High School Control Room 220

Usage Patterns Change Over the Course of the School Year



Data Summ

Ballston Spa Middle School

Classroom	Date	AV Gen Switches	General Total Min	White Board Total Min	AV Total Min
106	12/5/06	0	516	0	0
	12/6/06	4	329	0	61
	12/7/06	0	422	0	0
	12/8/06	0	248	0	0
	12/11/06	0	457	0	0
	12/12/06	0	447	434	0
	12/13/06	1	342	425	83
	12/14/06	1	4	357	353
	12/15/06	1	209	476	267
	12/18/06	1	272	352	80
	12/19/06	4	368	217	161

Chart 8– Data Summary Report mapping curriculum changes

Usage patterns not only change on a daily basis to meet specific teaching requirements, but they also change throughout the school year as the curriculum shifts from one heavy with paper and reading tasks to one using more visual presentations. The research captured this data in summary format to see how teaching patterns changed on a weekly basis to meet these changing needs. Summary reports like the one in Chart 8 captured the amount of time spent in General Mode, Audiovisual Mode, Settle Mode, as well as the amount of time spent with the whiteboard turned on. The data showed major shifts in mode usage over the course of the school year. Teachers would use the Audiovisual Mode extensively for a length of time and then switch to the General Mode as the curriculum required. The data summary in Chart 8 shows how the teacher in Room 106 at Ballston Spa Middle School transitioned on a weekly basis from using the General Mode nearly exclusively to a using a great deal of Audiovisual Mode as well as the whiteboard luminaire.

Annual Summary of Usage

The data collected throughout the year is summarized to develop a global view of usage patterns. Charts are available for each school and can be found in the appendices.

These charts present the average system usage demonstrating teachers quickly integrated the different modes into the teaching curriculum. On a daily basis the Audiovisual Mode was used nearly 25% of the day and a maximum of 53% of the day. The Settle Mode was used nearly 8% of the day and the Whiteboard Luminaire was turned on nearly 46% of the day on average.

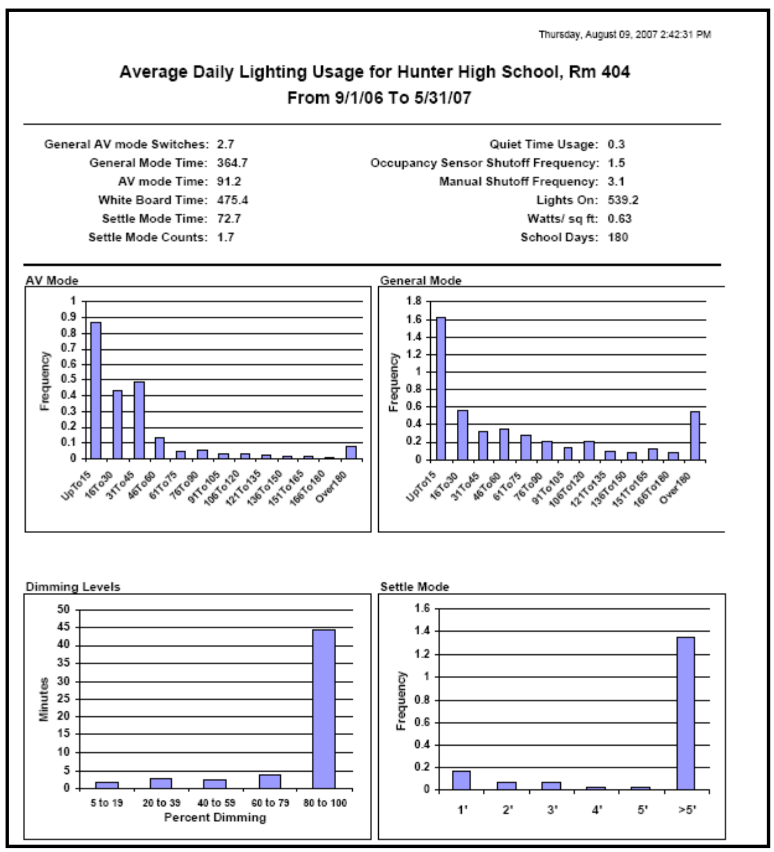


Chart 9 – Annual Data Summary

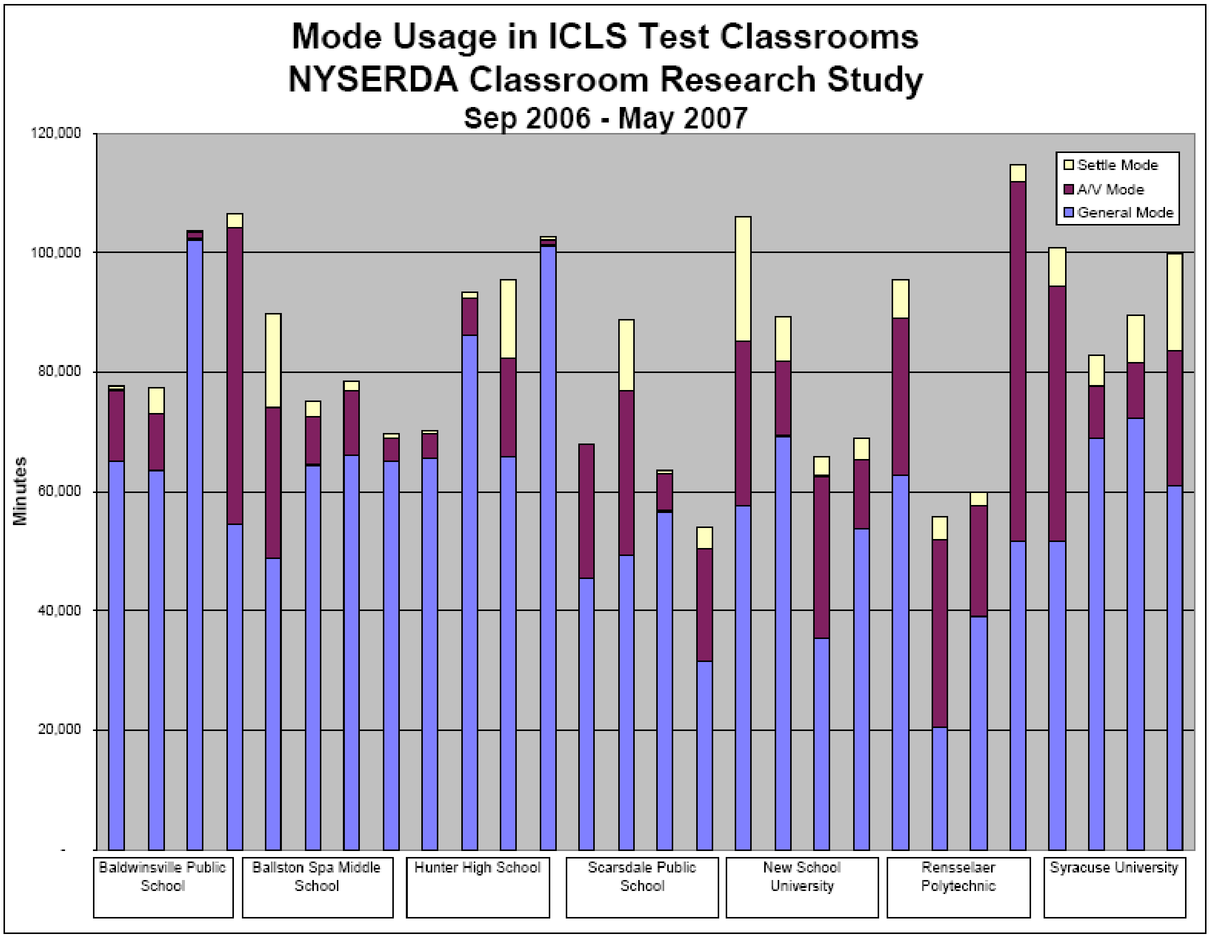


Chart 10 – Annual Mode Usage Summary Chart

Mode Usage Summary

Chart 10 above presents a global view at the mode usage for each of the classrooms in the study. The chart demonstrates a few different points. First, Audiovisual Mode was used more in the university level classrooms. Usage of Audiovisual Mode at the K-12 is expected to increase as the new schools incorporate better audiovisual equipment and as new teachers – exposed to the increased use at the university level – filter into K-12. Second, the modes were on for different lengths of time at each of the classrooms regardless of school level demonstrating the different needs from teacher to teacher and subject to subject. This speaks to the importance of system flexibility in order to meet the different needs of each subject matter as well as the teachers. University level instructors used the Settle Mode, suggesting the ability to reduce the ambient illumination and focus attention on the whiteboard had an instructional benefit beyond the need to calm or settle students.

<u>Usage Patterns Change by Teacher and Subject Taught</u>

It is important to note that the teachers participating in the study taught a variety of subject matters leading to different usage patterns of the individual lighting modes. Some teachers used predominantly General Mode and Whiteboard, while others spent 50-60% of their teaching day in Audiovisual Mode. The Classroom Lighting System provided teachers with the flexibility to meet the daily needs of the classroom, the changing curriculum needs throughout the year, as well as the varying requirements from subject to subject and teacher to teacher.

<u>Important Conclusions</u>

The abundance of qualitative and quantitative data points to several important conclusions with regards to the changing classroom.

1) <u>Audiovisual use in the classroom will increase</u>: Teaching methodologies will continue to incorporate the use of the Internet, PowerPoint presentations and video in daily lesson plans. New school designs across the country now commonly include ceiling mounted projectors that are controlled directly from the teacher's desk. New teachers entering the workforce have been taught at the university level using this same technology and will bring that knowledge with them to teach at all grade levels. The lighting system must accommodate the use of this important teaching tool.

Figure 13 – Audiovisual Mode

2) <u>Flexibility for alternate technology is required</u>: While we can make certain assumptions about changes in usage patterns and teaching methodology, we cannot say with 100% certainty what technologies will be used in the classroom to support these changes. We cannot say the whiteboard will remain in its current form, or that the electronic smart board will increase in use or that tablet pc's will be the primary tool used by students. This degree of uncertainty requires a classroom lighting system that is flexible enough to accommodate a variety of different teaching technologies. Different modes and the ability to switch quickly among them are important.

[11] Photo credits: Figure 13 – Farrell Scott Photodesign

3) Flexibility within the school is required: Different subjects have different lighting requirements. Different teachers regardless of subject use lighting in different ways to support their unique teaching style. The lighting system must be flexible enough to accommodate for the diverse needs of every teachers in order to truly develop a high performance classroom. “All on / all off” systems no longer work. The Classroom Lighting System gives the right amount of flexibility to meet the needs of the high performance classroom.

Every teacher is unique.

4) Teacher control placement is important: Two important facts came out regarding control placement. First, teacher controls must be placed at the front of the classroom in order to have maximum impact. The teachers surveyed proved this fact. Controls placed at the back of the room were not used. Second, flexibility in control position might benefit the classroom even further. Teachers commented on the need or design to move controls to accommodate classroom configuration changes. This suggests the need to investigate the potential for wireless control stations or portable handheld controls that interface with the wall controls. Manufacturers will need to develop the technology further and ensure that handheld remotes are either prevented from leaving the room or easily (and affordably) replaced.

5) Training Teachers on System Use is Important: Achieving maximum benefit from the system requires training for teachers. Given the nature of the teaching environments, training teachers is easier in K-12 than the university setting. K-12 teachers have ownership over their classroom and want to understand how to get the most out of the systems. Many professors share university classrooms, and arranging a time to train these professors is challenging. This information points to two important points. First, the lighting system controls need to be easy to understand. Clearly labeled and easy to understand controls ensure every teacher and even substitutes can benefit from the lighting system. Second, training teachers on all aspects of the high performance school is a subject the building community needs to research further. The industry needs to find the best way to ensure leave-behind users guides get into the hands of teachers, or even provide face-to-face training for teachers of every new school.

FINDING #4: THE INTEGRATED CLASSROOM LIGHTING SYSTEM IS SUSTAINABLE

Today's high performance school not only provides a safe, healthy, and comfortable environment where teachers can teach and students can learn, but it is also one that reduces its impact on the environment and school utility expenses. The Integrated Classroom Lighting System delivers sustainable results by reducing energy consumption as well as the number of lamps, ballasts, and contractor supplied components required to install the system.

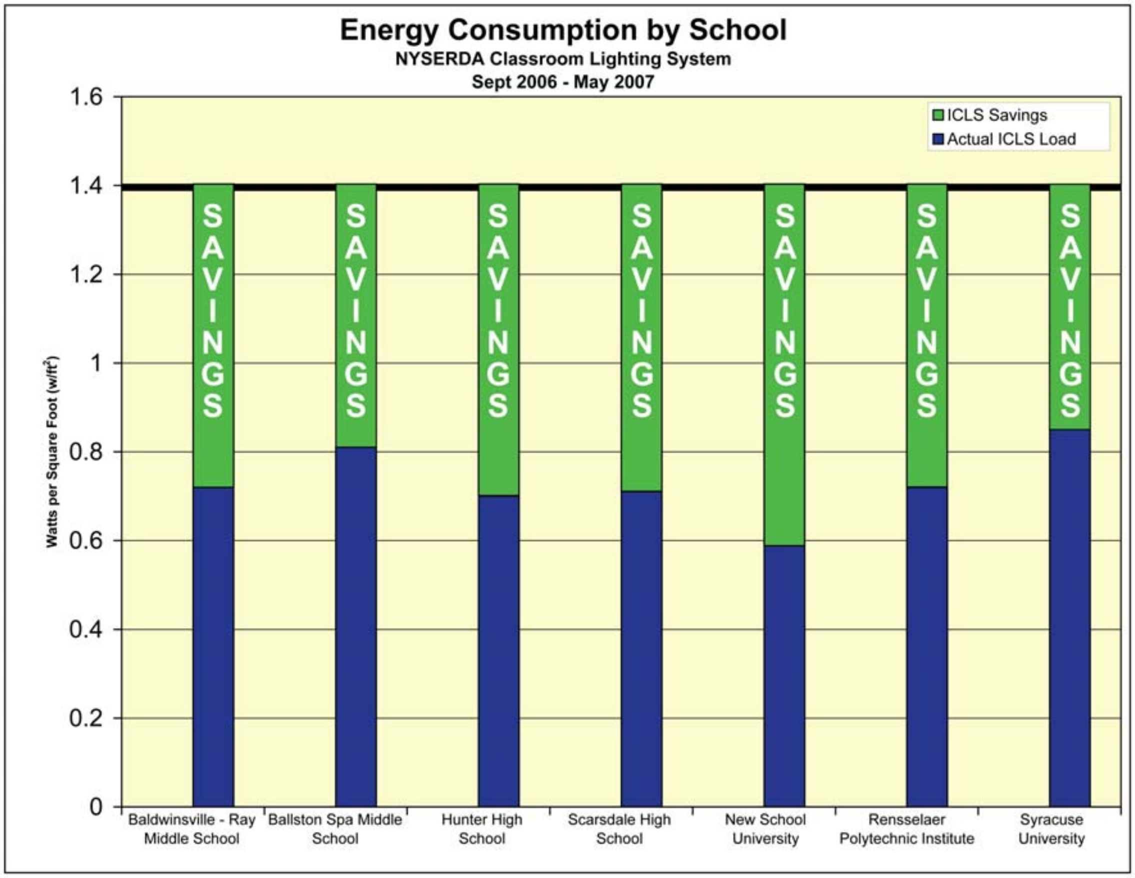


Chart 11 – Average Lighting Power Density is 0.73 w/ft^2 (48% below ASHRAE 90.1 - 2004)

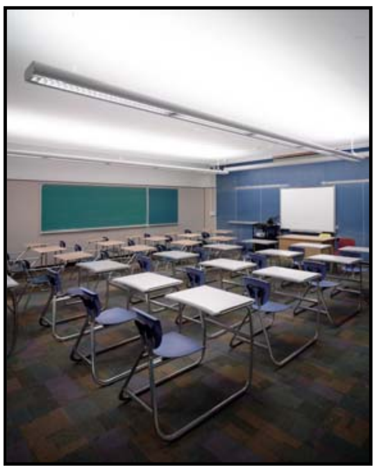
Reduced Energy Consumption

The NYSERDA research classrooms reduced total energy consumption 48% below ASHRAE 90.1 (2004) levels using the Integrated Classroom Lighting System. The average lighting power density for the classrooms with ICLS was 0.73 w/ft^2 as presented in Chart 11. Savings varied by classroom with a maximum savings of 64% compared to ASHRAE 90.1 (2004) standards and will only increase as the use of audiovisual presentations increases. Savings will also be greater at new school facilities as the audiovisual equipment should be even easier to use. The NYSERDA test classrooms had a wide variety of audiovisual equipment, and not all had ceiling mounted projects. New schools are typically being built with the latest audiovisual equipment, including ceiling mounted projectors that are linked directly to computers on the teachers' desk.

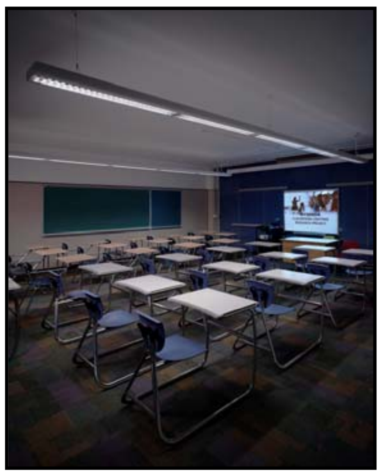
This technology allows them to quickly and easily bring up presentations, streaming video, or other images. As the ability to use audiovisual presentation becomes easier, so shall the energy savings increase. The energy consumption for each school can be found in the appendices.

Lighting Design and Sustainability

The Integrated Classroom Lighting System reduces energy consumption through the use of highly efficient and effective indirect/direct luminaires. Using recessed parabolic or lensed units to illuminate classrooms typically leads to excess energy consumption in addition to excess ballast, lamp, and construction materials, which will be described below. For example, a common strategy using 15-3T8 parabolic luminaires in a 960ft^2 classroom would consume approximately 1.32 w/ft^2 ((15 * 3 lamps * 32 watts * 0.88 BF) / 960) compared to 0.8 w/ft^2 consumed by the Integrated Classroom Lighting System. Therefore, without any additional flexibility in the form of lighting modes, the Integrated Classroom Lighting System will lead to energy savings compared to traditional lighting solutions.



General Mode–Hunter HS



AV Mode-Hunter HS

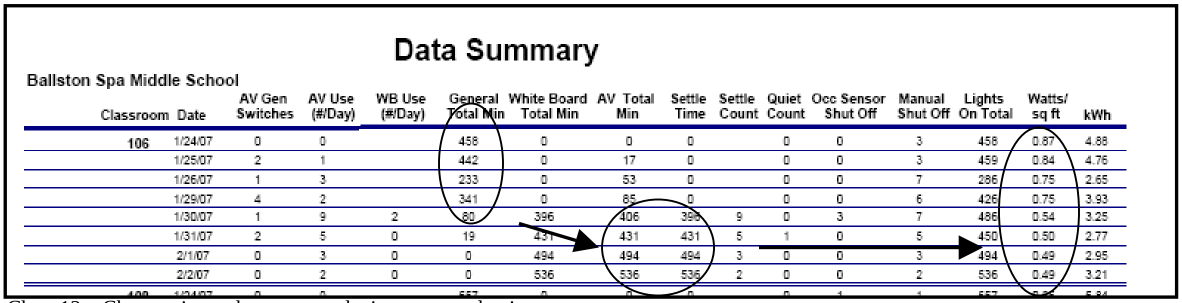
Settle Mode–Hunter HS

Lighting Modes and Energy Savings

The Integrated Classroom Lighting System provides immediate savings due to the improved lighting design. Extra energy savings are realized from the added flexibility that comes with the various lighting modes. The basic Integrated Classroom Lighting System template consumes 0.8 w/ft^2 in General Mode, 0.35 w/ft^2 in Audiovisual Mode, and 0.44 w/ft^2 in Settle Mode and these different modes translate into energy savings. For example, the teachers in this NYSERDA study used Audiovisual Mode an average of 25% of the day, which means 25% of the day the energy being consumed was just 0.35 w/ft^2 compared to the “all on / all off” classroom that consume the maximum energy all day long. The data summary below shows a transition from a heavy General Mode Usage to a week where increased use of the AV and Settle Modes which translates into

[12] Photo credits: JDN Photography, Inc.

lower kWh consumption. Chart 12 below shows how curriculum changes result in energy savings. The teacher changed from heavy General Mode usage to heavy AV and Settle Mode, which dropped the average lighting power density from 0.80 w/ft^2 to 0.51 ft^2.



Data Summary

Ballston Spa Middle School

Classroom	Date	AV Gen Switches	AV Use (#/Day)	WB Use (#/Day)	General Total Min	White Board Total Min	AV Total Min	Settle Time	Settle Count	Quiet Count	Occ Sensor Shut Off	Manual Shut Off	Lights On Total	Watts/ sq ft	kWh
106	1/24/07	0	0		458	0	0	0		0	0	3	458	0.87	4.88
	1/25/07	2	1		442	0	17	0		0	0	3	459	0.84	4.76
	1/26/07	1	3		233	0	53	0		0	0	7	286	0.75	2.65
	1/29/07	4	2		341	0	85	0		0	0	6	426	0.75	3.93
	1/30/07	1	9	2	80	396	406	396	9	0	3	7	486	0.54	3.25
	1/31/07	2	5	0	19	431	431	431	5	1	0	5	450	0.50	2.77
	2/1/07	0	3	0	0	494	494	494	3	0	0	3	494	0.49	2.95
	2/2/07	0	2	0	0	536	536	536	2	0	0	2	536	0.49	3.21

Chart 12 – Changes in mode usage results in energy reduction.

Whiteboard and Energy Savings

The whiteboard luminaire places the right amount of light on the primary teaching surface, which delivers energy savings in two ways. First, incorporating the whiteboard into the Integrated Classroom Lighting System enables the design to use fewer rows of pendant luminaires, thus reducing the quantity of lamps and ballasts used in illuminate the classroom. Second, usage of the unique Settle Mode delivers increased energy savings. The lighting power density drops from approximately 0.8 w/ft^2 in General Mode (27 lamps in use) to 0.44 w/ft^2 in Settle Mode (15 lamps in use). Utility expenses will reduce as teachers use the Settle Mode more to focus student attention.

Energy Savings from Occupancy Sensors

The Integrated Classroom Lighting System template uses ceiling mounted dual technology occupancy sensors for optimum energy savings. Savings related to occupancy sensors was realized at all education levels with particular savings in the university classrooms.

Occupancy Sensor Energy Savings - Beginning of the Day

The data showed a unique trend demonstrating the need for occupancy sensors. As shown in Chart 13 teachers would enter the classrooms first thing in the morning to check the room and drop off any supplies they were carrying. The teachers would then quickly vacate the room. It is thought they go to the offices to check mail, or talk to colleagues. In this instance the teacher returned to the

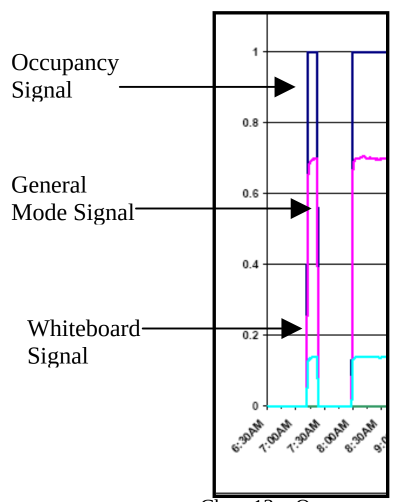


Chart 13 – Occupancy Sensor Usage

[13] Photo credits (sensor): JDN Photography

classroom at 8am for the start of class. The occupancy sensors provided an immediate savings of 30 minutes, when set for 10-minute delay.

Occupancy Sensor Energy Savings - End of Day Savings

Chart 14 demonstrates a typical situation where the occupancy sensor leads to savings in the classroom. The occupancy signal terminates at the same time the lights in general mode terminate, indicating the occupancy sensor shut the lights off at 4:30pm on this day. The lights remained off until 5:30pm when a janitor came through the room. The lights were again turned off by the occupancy sensor at 6pm and remained off until the next morning.

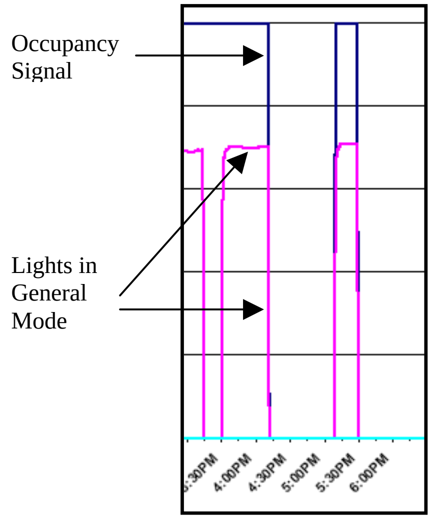


Chart 14 – Occupancy Sensor Usage – End of Day

Master On/Off Switch Energy Savings

K-12 teachers are great energy savers. Providing the extremely affordable Master On/Off switch at every entrance leads to additional savings since the teachers will turn off the lights instead of waiting the additional 10 minutes for the occupancy sensor to turn off the lights. Chart 15 shows this occurring at the end of the day. The General Mode lights are turned off before the occupancy signal terminates, showing the lights were turned off manually.

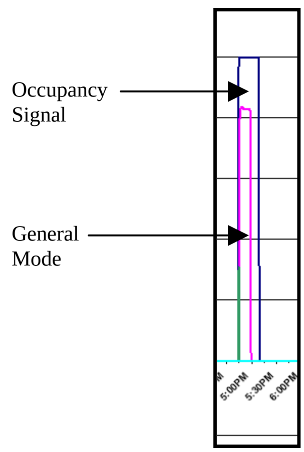


Chart 15 Manual Switch Controls lights

Importance of Occupancy Sensors in the University Setting

K-12 teachers tend to have ownership over their classrooms. They are the first ones in the classroom in the morning and the last ones to leave. This ownership generally leads them to turn off the lights manually as they leave the room. The university setting does not have such an ownership over the classroom and the data gathered showed the university setting is much more reliant on the use of occupancy sensors as shown in Chart 16 below.

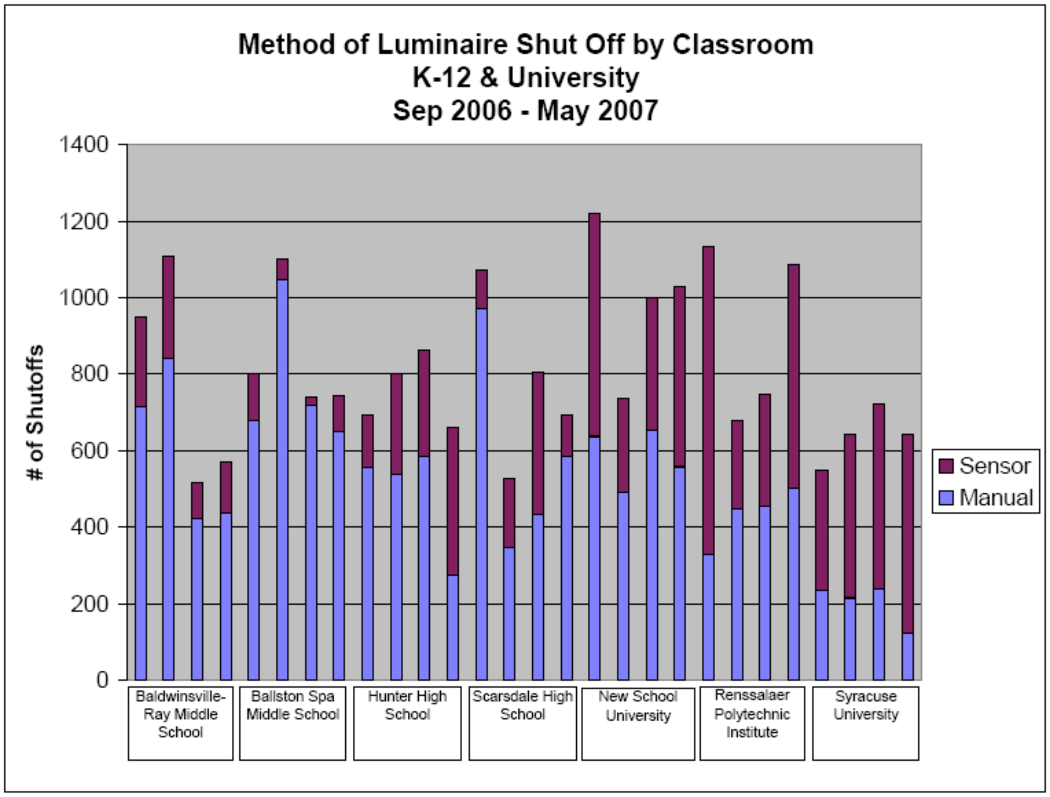


Chart 16 – Method of Luminaire Shutoff by Classroom

Other Sustainable Elements Attributed to the Classroom Lighting System

Lamp and Ballast Life

Ballast technology has improved and manufacturers are now able to deliver 60,000 hour ballast life which translates into 40+ year of usable life. Similarly, lamp life has also increased to 36,000-42,000 hours. The two lighting modes translate into different savings levels. General Mode (two outboard lamps) would be used approximately 6.5 hours a day or 1391 hours over the course of a school year. This translates into a 17-25 year life when used with instant start ballasts and 25-30 years when used on a program start ballast. The Audiovisual Mode (inner lamp) could actually last 75-110 years given the time used and lamp life. The majority of the lamps and ballasts will fail in the infancy stage, which will be covered under manufacturers warranty (generally 2 years on lamps and 5 years on ballasts).

Reduction in System Parts

The Integrated Classroom Lighting System requires fewer components than the traditional recessed products; including ballasts, lamps, support wires, and electrical conduit and fittings. For example, the Integrated Classroom Lighting System template for a 960 ft^2 room would require at least 2 fewer ballasts and 6 fewer lamps compared to a typical layout using 15 3T8 recessed parabolic luminaires.

Reduction in Construction Components

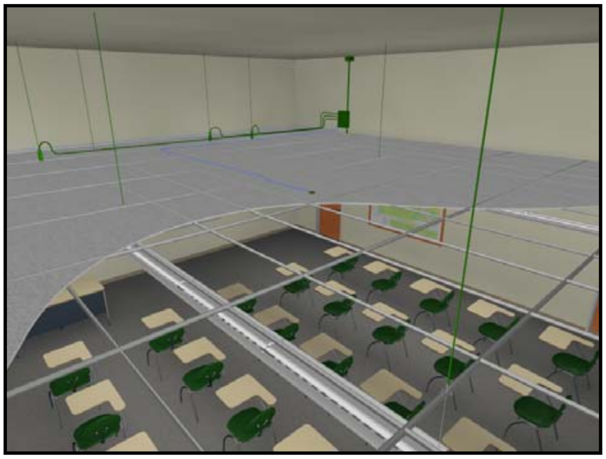


Figure 14 – Typical ICLS Classroom
(Ceiling grid supports omitted)

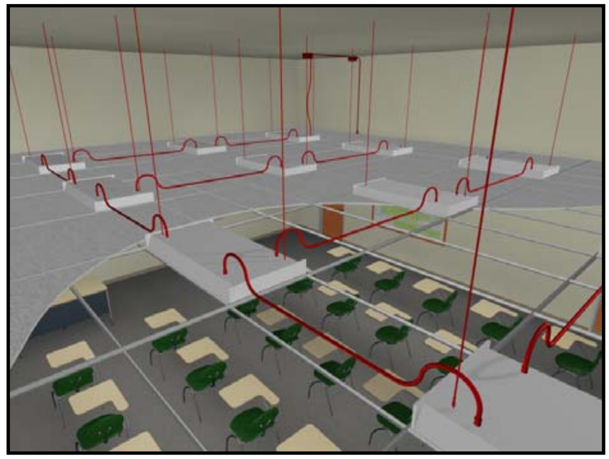


Figure 15 – Typical Recessed Classroom
(Ceiling grid supports omitted)

The ICLS system also requires fewer installation components, including electrical components, flexible conduit and pipe, and ceiling support wires. Indirect/direct luminaires typically require only one electrical connection per row of luminaires, meaning the template would require just 3 electrical connections compared to 9-15 connections required for a typical recessed product layout. These differences also translate into reduced amounts of flexible conduit being used since recessed products are typically wired together using a daisy chain technique requiring flexible conduit to run from luminaire to luminaire throughout the classroom. The number of ceiling support wires is also reduced using the Integrated Classroom Lighting System. Each recessed luminaire will generally require 2 ceiling support thus requiring 30 supports to structure compared to 8 that would be required for the Integrated Classroom Lighting System. The system installed in the NYSERDA research project was an integrated design from one manufacturer using low plug and play cables provided by the manufacturer, which further reduced materials requirements as the low voltage line replaced flexible conduit for powering the teacher controls and sensors.

Figure 16 - ICLS luminaire wiring runs through the luminaire, reducing the amount of flex required requires fewer electrical connections

Reduced Jobsite Waste

Reducing jobsite waste is important for LEED and CHPS projects. Some manufacturers of indirect/direct luminaires will ship luminaires on recyclable cardboard saddles to minimize jobsite waste. These saddles also speed up installation, as the contractor does not need to spend time removing luminaire cartons.

Cardboard saddles reduce waste.

[14] Photo credits: Renderings (top of page): Architectural Imaging – Bruce Clement
All others: JDN Photography, Inc.

FINDING #5: THE CLASSROOM LIGHTING SYSTEM IS AFFORDABLE

The NYSERDA Integrated Classroom Lighting System is a cost-effective solution for every school district. The research installations were retrofitted into existing classrooms requiring additional contractor labor and components, and yet the installation costs were still affordable. Chart 17 below shows the actual labor and material costs for the classrooms installed for the NYSERDA research project. Chart 18 takes these actual costs and compares them to total school construction costs for average construction projects to demonstrate that even with retrofit labor and material costs, the Integrated Classroom Lighting System will represent 1% of construction costs in the NY, NJ, and PA area. Costs presented are from a construction report put out by School Construction and Management magazine (February 2007).

NYSERDA Research Cost Estimates			
School	Labor Cost Per Classroom - for Retrofitted space	Materials Cost Per Classroom (luminaires, lamps, controls, and interconnection cable)	Total Cost Per Classroom
Baldwinsville Public Schools	$3,136	$4,370	$7,506
Ballston Spa Middle School	$2,600	$3,421	$6,021
Hunter High School	$2,109	$3,817	$5,926
New School University	$1,750	$3,080	$4,830
Rensselaer Polytechnic	$3,370	$4,312	$7,681
Scarsdale Public Schools	$2,560	$3,280	$5,840
Syracuse University	$4,030	$3,432	$7,462

Chart 17 – Actual NYSERDA Classroom Lighting System Costs

Construction Costs in NY, NJ, PA* Using Retrofit Labor & Material Estimates								
	# of Students	**Building Size (sq.ft.)**	**Project Cost ($'000)**	**Project Cost/ft^2**	**Est. # of Classrooms**	**Total ICLS Installed Cost**	**Total ICLS cost/ft^2**	**Total ICLS % of Project Costs**
Elementary	604	84,602	$19,000	$239.03	30	$193,999	$ 2.29	1.0%
Middle School Junior HS	625	121,260	$28,246	$236.17	31	$200,466	$ 1.65	0.7%
High School	1694	300,000	$88,500	$296.67	85	$549,665	$ 1.83	0.6%
* Source: School Planning and Management February 2007 Construction Report								

Chart 18 – Projected Construction costs based on retrofit labor and materials compared to total project costs.

New Construction Projects

Installing the Integrated Classroom Lighting System in new construction projects is much more affordable for several reasons. Larger projects will yield very competitive bids for materials. Contractors will also be more competitive with labor bids on larger projects, as they will be more efficient installing an entire project. The contractors in this project had never installed the Integrated Classroom Lighting System and only had the opportunity to install a few classrooms, leading to higher costs. The charts below track the construction costs for ICLS in new construction projects and demonstrate the cost of the ICLS classroom is as low as 0.4% of the construction costs in the NY region. Chart 19 below compares these costs to a national average of construction costs resulting in a range 0.8% to 1.4% of school construction costs.

New Construction Costs in NY, NJ, PA*								
	# of Students	**Building Size**	**Project Cost ($'000)**	**Project Cost/ft^2**	**Est. # of Classrooms**	**Total ICLS Installed Cost**	**Total ICLS cost/ft^2**	**Total ICLS % of Project Costs**
Elementary	604	84,602	$19,000	$239.03	30	$ 135,000	$ 1.60	0.7%
Middle School/Junior HS	625	121,260	$28,246	$236.17	31	$ 139,500	$ 1.15	0.5%
High School	1694	300,000	$88,500	$296.67	85	$ 382,500	$ 1.28	0.4%
* Source: School Planning and Management February 2007 Construction Report								

Chart 19 – Projected Construction costs based on retrofit labor and materials compared to total project costs.

Construction Costs -National Average*								
	# of Students	**Building Size (ft^2)**	**Project Cost ($'000)**	**Project Cost/ft^2**	**Est. # of Classrooms**	**Total ICLS Installed Cost**	**Total ICLS cost/ft^2**	**Total ICLS % of Project Costs**
Elementary	700	80,000	$11,600	$148.15	35	$ 157,500	$ 1.97	1.4%
Middle School/ Junior HS	825	119,900	$18,000	$149.79	41	$ 184,500	$ 1.54	1.0%
High School	1200	224,000	$35,000	$151.52	60	$ 270,000	$ 1.21	0.8%
* Source: School Planning and Management February 2007 Construction Report								

Chart 20 – Projected Construction costs based on retrofit labor and materials compared to total project costs.

ICLS System Design Yields Installation Cost Savings

The system installed in the NYSERDA classroom research was an Integrated Classroom Lighting System produced by one manufacturer. This system uses plug and play wiring components to reduce labor cost by reducing the time, and construction components used to wire the system. The manufacturer provides the low voltage plenum-rated Cat5 cable for each project. This Integrated Classroom Lighting System, unlike some systems on the market requires no software costs or commissioning, which ensures system affordability and minimizes impact to the maintenance teams over the life of the system.

Single Source Warranty Reduces Costs

The Integrated Classroom Lighting System is to be provided as a system by one manufacturer. This systems approach to classroom construction ensures the school district, contractor, and facility maintenance personnel have one point of contact for system design, pricing, luminaires, controls, and any warranty work that is required. By delivering the Integrated Classroom Lighting System form one manufacturer the project team improves project coordination, ensures budgets are met, and savings are obtained.

PROJECT OUTCOMES

Final Report

The final report summarizes the research findings, and provides tools necessary to present the importance and applicability of high performance classroom lighting design to the decision makers involved in school construction in New York and the rest of the United States. The report reviews the needs of today's learning environment and evaluates the lighting technology available to meet those needs. Presented in the report are facts and figures showing teachers prefer the system, that it has impact on the learning environment, drastically reduces energy consumption, and is affordable for every new school construction project. Templates are provided to aid school facility planners in implementing the Integrated Classroom Lighting System into their next school project.

DELTA Snapshot

DELTA (Demonstration and Evaluation of Lighting Technologies and Applications) is a program to design, evaluate and publicize energy-efficient lighting solutions.

The sites selected contain lighting and controls systems that are evaluated for energy use, human response, cost, how well the technologies work and how easy they are to maintain. Plans, details and color photos illustrate each case study. Combined into a portfolio, the publications illustrate a wide array of effective lighting applications for common building types.

More information on the DELTA program, including downloadable reports for a variety of topics, can be found at the following link. http://www.lrc.rpi.edu/programs/DELTA/index.asp

Public System Specification

A system specification has been developed and is available to the specification community and lighting manufacturers and is available in Appendix O. This specification will enable the school lighting specifiers to communicate with the design team ensuring this tested system is used in the school project. By using this specification, the design team can be sure they meet the current best practices as outlined in CHPS-NY and LEED for Schools. Lighting manufacturers can use the specification to understand what must be provided for the high performance classroom and ensure they meet the specific system requirement.

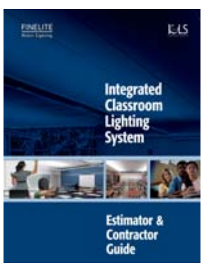
Teacher Training Element

The research pointed out the challenges involved in training teachers on the high performance elements in classroom design. Training is necessary to maximize the full potential of a lighting or any other high performance classroom system. A "Helpful Hints Guide" was created to supplement the face-to-face training. This 11x17" color training tool quickly reviewed the features of the system and instructed the teachers how to use the different lighting modes to meet the classroom requirements.

AIA Presentation

An AIA (American Institute of Architects) approved presentation was developed. The AIA requires each of its members to continue with their education by attending seminars on topics pertinent to profession. By creating an AIA approved presentation on he findings of this research, we ensure the findings reach a wide audience of architects in the business of school design. This method of presenting data is also beneficial when meeting with engineers and school districts.

Contractor Estimator Guide

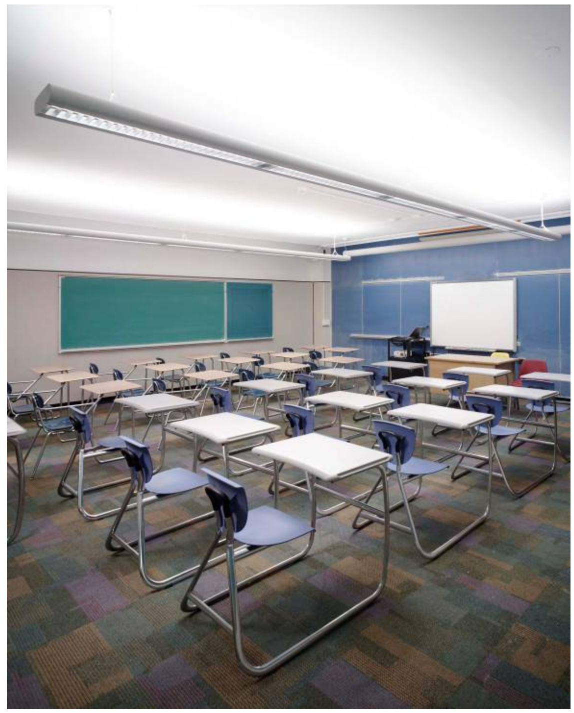


A Contractor Estimator Guide was developed to demonstrate the installation features of this system. Contractors unfamiliar with this system will not have the experience to appropriately bid the project. This document will outline the steps involved in installing the system and give conservative estimates with regards to installation times so the contractor may provide a competitive bid. An electronic copy of the Estimator Guide can be found on www.finelite.com.

Appendix A – Human Factor Analysis Report

Integrated Classroom Lighting System

Human Factors Report



Compiled by

Lighting Research Center
Rensselaer Polytechnic Institute

Jennifer Brons
Peter Morante

Submitted to:
Finelite, Inc., and
New York State Energy Research and Development Authority

October 22, 2007

Appendix A – Human Factor Analysis Report

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Appendix A – Human Factor Analysis Report

Executive Summary

The Integrated Classroom Lighting System (ICLS) was installed in 7 educational facilities in New York State, each with its own unique set of students, curricula, building geometries, lighting layouts, window geometries, shading devices, and weather conditions.

The Lighting Research Center (LRC) did not control the site selection, room selection, or layout of luminaires. Due to limited funding, the LRC was not able to develop an experimental design to support inferential statistics nor was the LRC able to perform a formal energy audit Rather, with the available resources the LRC utilized observations and limited data sampling to draw conclusions about this particular lighting system. The data gathered in this study, together with observations by the authors, were used to draw general conclusions about the ICLS.

LRC's Demonstration and Evaluation of Lighting Technologies and Applications (DELTA) Program has for 13 years created case studies to help lighting professionals learn how to use lighting more effectively. The LRC also has extensive experience with field applications of lighting control systems and user acceptance of these technologies. Although the data gathered in this study certainly framed the authors' inferences, LRC relied on its extensive experience to draw conclusions about the success of ICLS in New York State schools.

The ICLS does seem to be well-appreciated by instructors when the classroom has only one teacher responsible for one room and she/he understands the control functions. However where a room has intermittent use by many instructors, such as in the university environment, the features of the ICLS may not be obvious and therefore may be confusing to teachers.

The "AV" lighting mode seems to be successful because it creates a dim environment for projected images while simultaneously providing light for student notetaking.

Although the "General" mode does not create direct glare caused by direct view of the lamps, it does create bright patches on the ceiling directly above the luminaires. However, few instructors complained about the ceiling hotspots, and most instructors use the "General" mode more often than the "AV" mode.

The "Whiteboard" light was a novel feature to the instructors in the study. Having this task light on the main teaching board was widely appreciated at all teaching levels.

Although beyond the scope of this study, observations of lighting use suggest that the ICLS saves energy at most schools because the system features are used to reduce time of lighting operation and because the system uses a lower lighting power density than the lighting system previously used in six of the seven sites. The LRC review of the Finelite energy data indicates an average energy savings per square foot of ICLS classroom space of 38% as compared to the control classrooms.

Introduction

From grade schools to universities, the classroom environment is changing. To an increasing extent, teachers are taking advantage of new instructional technologies to communicate with students. Some classrooms use individual computers, but more widespread is the need to show audio-visual projections. In addition to traditional overhead projectors, teachers are now using computers with LCD projectors, television screens with video feeds, and interactive SMARTboards™.

Traditional instructional technology (e.g., chalkboards) required only one mode of general lighting. These new instructional technologies require a second lighting mode: dim in the front of the room while illuminating student seating areas.

Some schools are acknowledging the need for multiple lighting modes by hiring professionals to specify and integrate multiple lighting technologies. The Integrated Classroom Lighting System (ICLS) built by Finelite, Inc., is unique because it integrates several classroom lighting features into one pre-engineered system.

This report summarizes the human factors evaluation of the ICLS in 28 classrooms at 7 schools in New York State. Middle/high schools included Hunter College Campus School in New York City, Scarsdale High School in Westchester County, Ballston Spa Middle School (located in the Capital Region), and Ray Middle School (in Baldwinsville, near Syracuse). The university sites included New School University in New York City, Rensselaer Polytechnic Institute (Capital Region), and Syracuse University. Each school retrofitted four classrooms over the summer of 2006. At each school, four ICLS classrooms and one control classroom had monitoring equipment installed to allow project researchers to monitor typical usage patterns.

This demonstration was a follow-up to the original development and demonstration in the State of California[1]. The ICLS was developed for K-12 classrooms; the university setting in the New York demonstration was a new test for the ICLS.

The manufacturer, Finelite Inc., worked with each school to determine which classrooms should be used. Finelite determined layout and details of the ICLS components. Finelite hired electricians, and followed-up with site coordination.

LRC visited all the sites and spoke to teachers and students, both before and after the ICLS installation. LRC used interviews and surveys to assess feedback on the ICLS. LRC also performed illuminance measurements at each of the schools. A review of Finelite energy data was also conducted.

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[1] See Case study: (Accessed on-line on October 16, 2007) http://www.archenergy.com/lrp/products/brochures/deliverable_6.2.5_CaseStudy_4.5.pdf

Appendix A – Human Factor

ICLS Features

The ICLS typically includes two rows of pendant direct/indirect luminaires, and a separate wallwash luminaire for the main board area. Controls include an occupancy sensor, a master on/off switch at the door, and a 4-gang teacher control center. The teacher control center (TCC) allows the teacher to change the lighting distribution from “General” mode (both uplight and downlight) to “AV” mode (downlight only). The AV mode is intended to be used during audio-visual presentations, and includes an adjustable dimmer. A “Quiet Time” mode allows the teacher to override the occupancy sensor for one hour at a time during long periods of occupied non-movement, such as standardized testing. Teachers can switch between these modes using the TCC located near the main teaching board.

Figure 1: Before retrofit

Figure 2: After retrofit with ICLS (General Mode and Whiteboard on)

Figure 3: AV Mode on (downlight only)

Figure 4: Teacher Control Center

Instructor Feedback– Before ICLS

When visiting the schools in Spring 2006, LRC asked teachers about the lighting in that was use before ICLS was installed. Table 1 below shows the number of instructors responding on behalf of each of the rooms. “Control” rooms (indicated in *italics*) were rooms in which monitoring was established, but no changes to lighting system were due to take place. Blank survey forms are shown in Appendix 1.

Table 1: Room Numbers and Number of Instructor Responses

Ballston Spa	*104*	106	108	110	112	**Total**
n=	*1*	1	0	1	1	**4**
Hunter	(not available)					
Ray	*113*	130	179	181	284	
n=	*1*	1	0	1	1	**4**
Scarsdale	*304*	305	307	309	311	
n=	*1*	1	1	1	1	**5**
New School	1111	*502*	503	713	822*	
	0	*0*	0	1	1	**2**
RPI	*Carn112*	Carn113**	Rkts212	Sage2707	Sage2715	
n=	*2*	0	3	0	1	**6**
Syracuse	Carn100	Carn114	Carn208	Carn219	*Carn316*	
n=	0	0	2	0	*1*	**3**

*Note: The fourth room at New School was changed from 822 to 1013 after these surveys took place.
**Note: This room at RPI was changed from 113 to 201 after these surveys took place.

The results of these “before” surveys are summarized in graphs on pages 6-9. Responses were translated to percent to enable comparison between schools.

Before the demo, teachers unanimously reported that they had enough light to see their students and to read their notes. Nearly all said they had enough light at their desk, and enough light to see what their writing on the board.

Teachers commented about the brightness of their room surfaces. Responses varied from one school to another. Some thought the room surfaces were too bright, some too dark, but most found room brightnesses to be “just right.”

Teachers at nearly all the schools (exception, Syracuse Univ.) explained that they used multiple audiovisual tools in their classroom.

Finelite encourages the use of ICLS to change the behavior of students. Since LRC intended to ask whether this was the case after ICLS retrofit, this question was also asked before retrofit. Although not widespread, a few of the teachers did say that they already used the old lighting system to change student behavior. These few explained that they used the old lighting system to direct attention to something, and to make students more alert. A few said they used their lighting to calm students down.

LRC asked whether teachers experienced false-offs with the occupancy sensors. Teachers at Scarsdale, New School, RPI, and Syracuse did not have a complaint about occupancy sensors with their old lighting system. Teachers at Ballston Spa and Ray said that their lights did turn off when they were still in the room. (Quote: “After 15 min. of inactivity - annoying after school.”)

LRC asked about convenience of switch location. Teachers at Ballston Spa, Ray, Scarsdale, and RPI generally found their old switch locations to be convenient. Syracuse responses were mixed. New School instructors reported that their switch locations were very inconvenient.

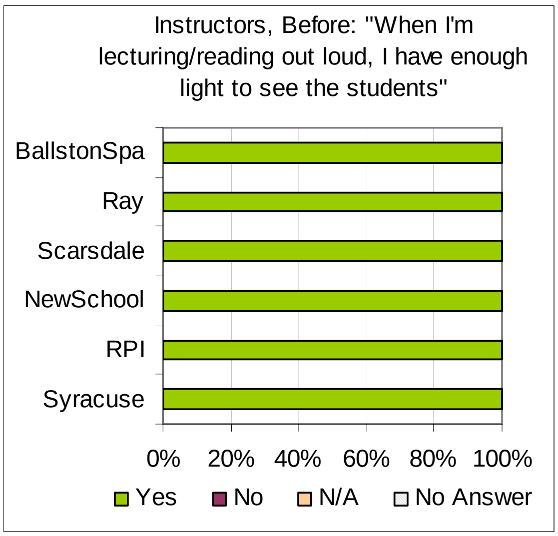
These “before” surveys showed that the previous lighting at the school sites was considered by the teachers to be “about the same” as other schools, not better, not worse. Thus, any positive feedback as a result of the ICLS installation was expected to have merit.

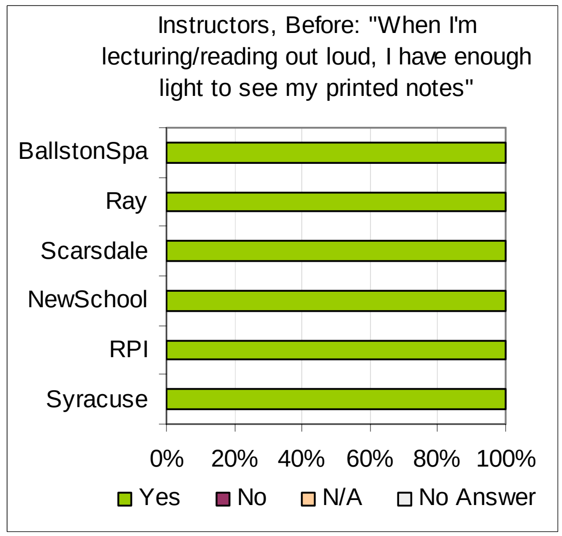
Additional comments from instructors about previous lighting, before ICLS retrofit:

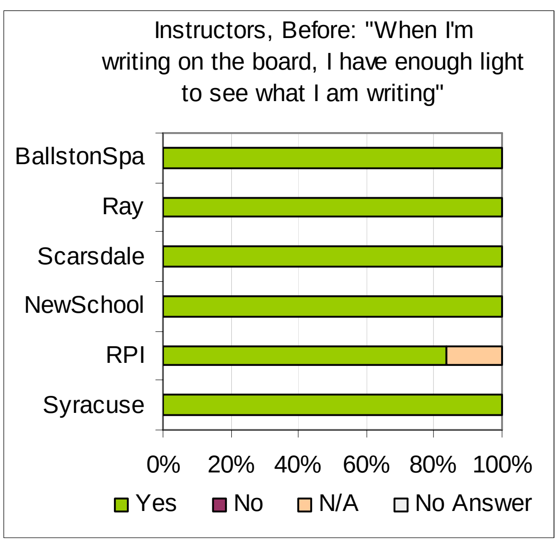
- Regarding Occupancy sensor false-offs:
  - “After 15 min. of inactivity - annoying after school.”
- *For what other reasons do you have to make this classroom totally dark?*
  - “Movies”
- *In what other ways do you darken the room?*
  - ”The room does not have blinds.”
- *If you could change the lighting in the classroom, what changes would you make?*
  - “Add more lights. Paint the ceiling.”
  - “Better distribution of light fixtures. More switches to control the # of lights on and off.”
  - “Better more functional windows and shades.”
  - “Brighter lighting”
  - “Have more control of individual lights.”
  - “I would make it less prison like.”
  - “Just a bit brighter - esp. in the winter”
  - “More lighting throughout the room, especially in the front of the room.”
  - “Natural lighting fixtures”
  - “Put the light switch in a better place”
- *If you could change the lighting controls, what changes would you make?*
  - “Be able to switch on additional lights”
  - “Control from podium.”
  - “Could benefit from a dimmer switch”
  - ”Dimmer”
  - “Dimming capability”
  - “It would be nice to have a dimmer switch”
  - "Place a switch in front of room near teacher computer station make it possible to dim lighting without shutting off totally"

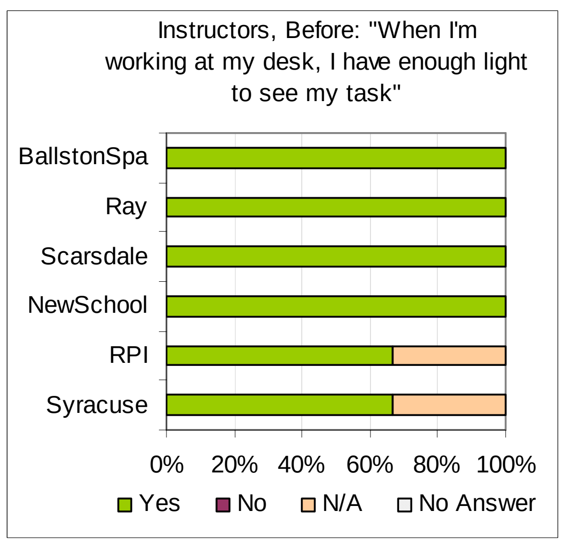
- *Other comments?*
  - "Key issue every where is how to see the screen and the speaker simultaneously. Hard to control lighting appropriately."
  - "Light fixtures are falling apart. The room gets dark enough to see projected images... More yes than no."
  - "Mostly the other features of the room need to be updated."
  - "Overall I feel the lighting in this classroom needs to be brighter."
  - "Room looks crowded."
  - "The large window allow for ample daylight."
  - "When one light goes on it makes a huge difference in the room."

Instructor Survey Graphs – Before ICLS

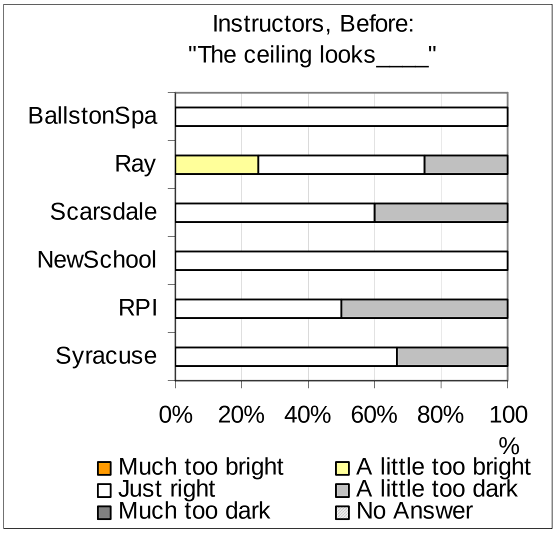


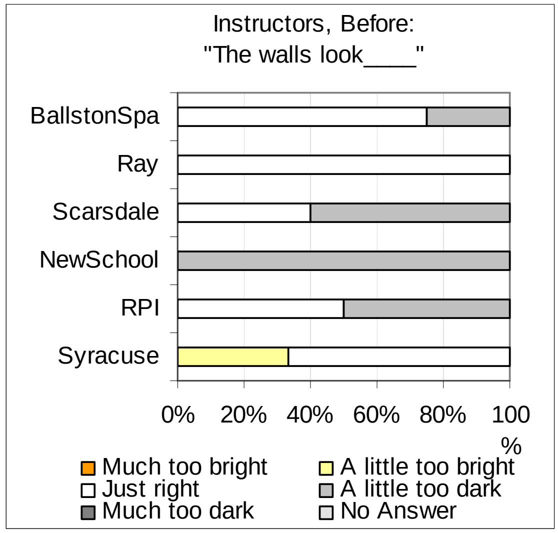


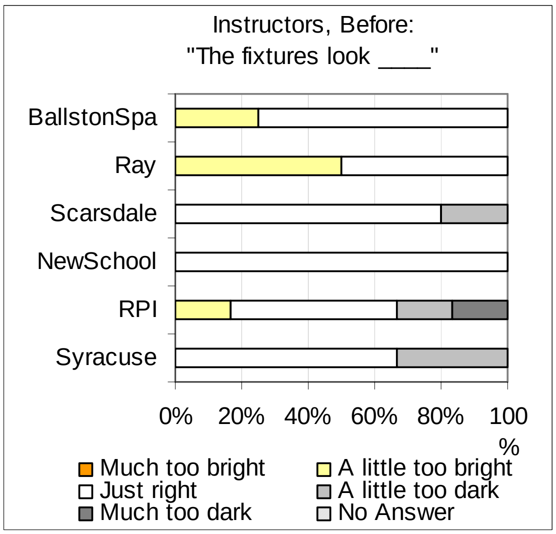


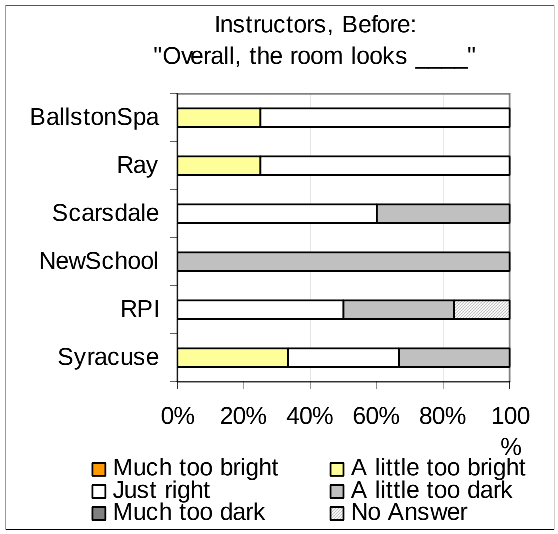


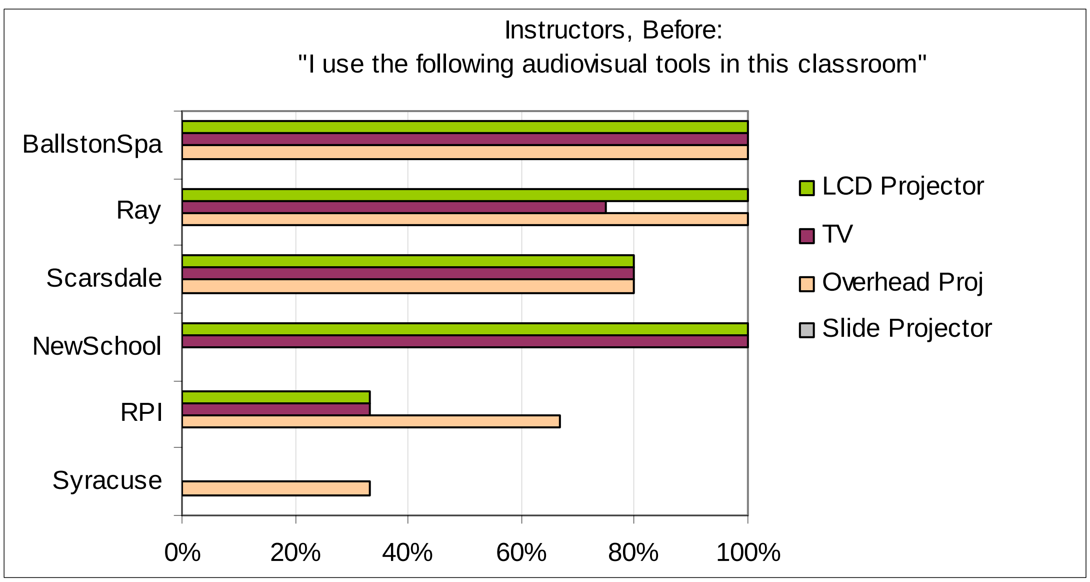
Appendix A – Human Factor Analysis Report

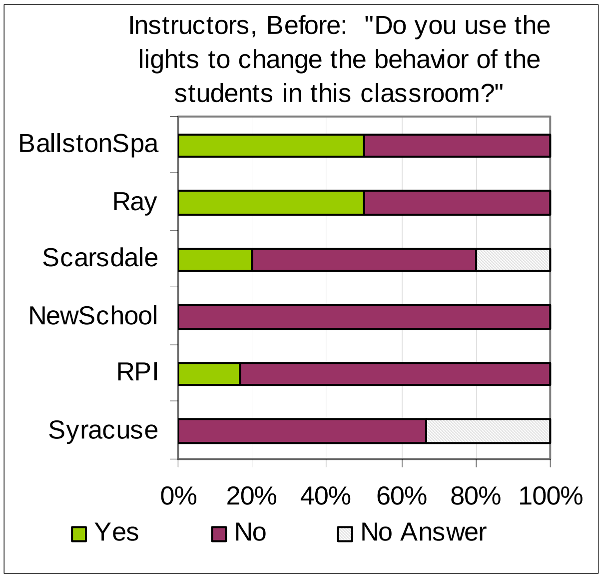


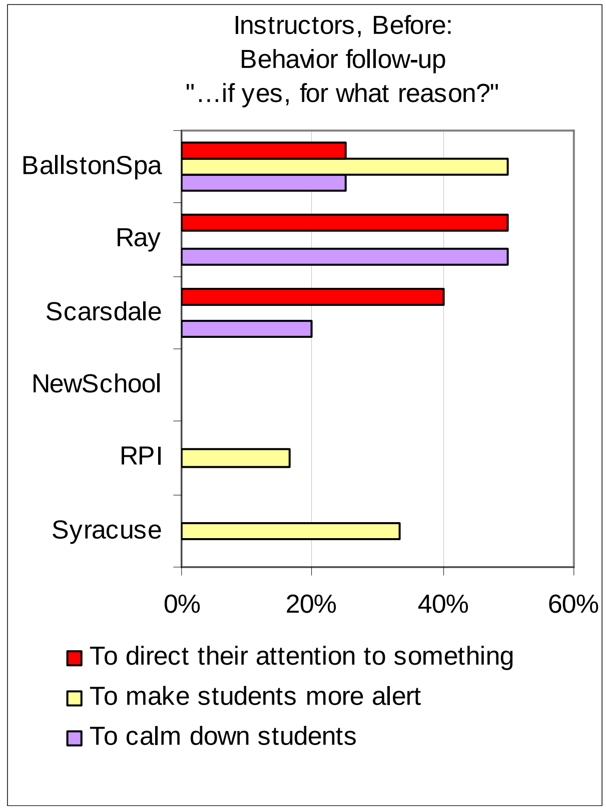


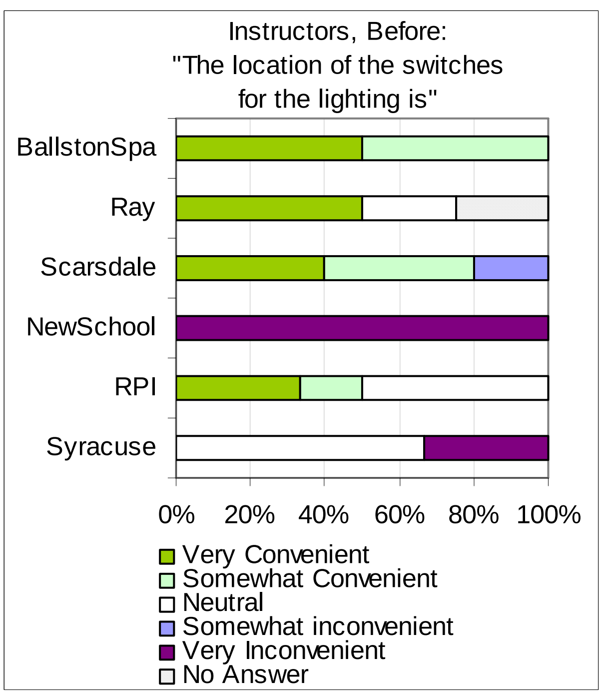


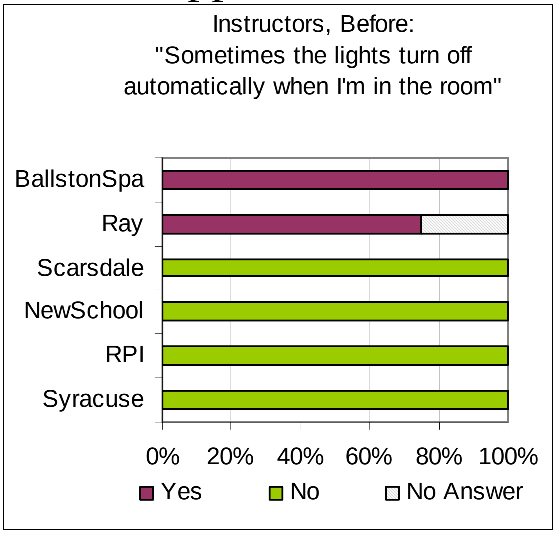


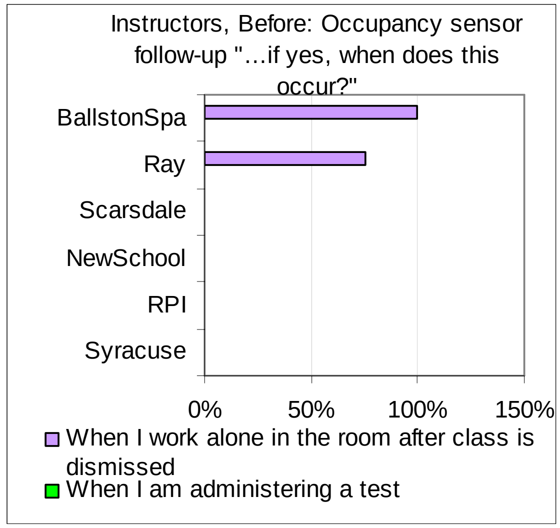



Instructors, Before: "Do you use the lights to change the behavior of the students in this classroom?"
BallstonSpa
Ray
Scarsdale
NewSchool
RPI
Syracuse
0%
20%
40%
60%
80%
100%
Yes
No
No Answer


Instructors, Before: Behavior follow-up "…if yes, for what reason?"
BallstonSpa
Ray
Scarsdale
NewSchool
RPI
Syracuse
0%
20%
40%
60%
To direct their attention to something
To make students more alert
To calm down students


Instructors, Before: "The location of the switches for the lighting is"
BallstonSpa
Ray
Scarsdale
NewSchool
RPI
Syracuse
0%
20%
40%
60%
80%
100%
Very Convenient
Somewhat Convenient
Neutral
Somewhat inconvenient
Very Inconvenient
No Answer


Instructors, Before:
"Sometimes the lights turn off automatically when I'm in the room"
BallstonSpa
Ray
Scarsdale
NewSchool
RPI
Syracuse
0%
20%
40%
60%
80%
100%
Yes
No
No Answer


Instructors, Before: Occupancy sensor follow-up "…if yes, when does this occur?"
BallstonSpa
Ray
Scarsdale
NewSchool
RPI
Syracuse
0%
50%
100%
150%
When I work alone in the room after class is dismissed
When I am administering a test

Student Feedback – Before ICLS

After visiting the schools in Spring 2006, LRC asked teachers to circulate a short questionnaire to their students about the lighting in use before ICLS was installed. Table 2 below shows the number of students responding about each of the rooms. “Control” rooms (indicated in *italics*) were rooms in which monitoring was established, but no changes to lighting system were due to take place. Blank survey forms are shown in Appendix 1.

Table 2: Student Surveys with Old Lighting
Room Numbers and Number of Responses

Ballston Spa	*104*	106	108	110	112	**Total**
n=	*23*	21	22	17	22	**105**
Hunter	204	*220*	222	312*	324*	
n=	12	*0*	24	20	0	**56**
Ray	*113*	130	179	181	284	
n=	*25*	25	0	24	20	**94**
Scarsdale	*304*	305	307	309	311	
n=	*12*	23	20	22	21	**98**
New School	(N/A)					
RPI	*Carn112*	Carn113**	Rkts212	Sage2707	Sage2715	
n=	*35*	0	11	0	0	**46**
Syracuse	100	114	208	219	*316*	
n=	0	0	10	0	*0*	**10**

*Hunter classrooms were changed after students completed these surveys. (Hunter 312 and 324 were replaced with 404 and 410.)
**RPI classrooms were changed after these surveys were taken. (Carnegie 113 was replaced with 201.)

The results of these “before” surveys are summarized in graphs on pages 11-14. Responses were translated to percent to enable comparison between schools.

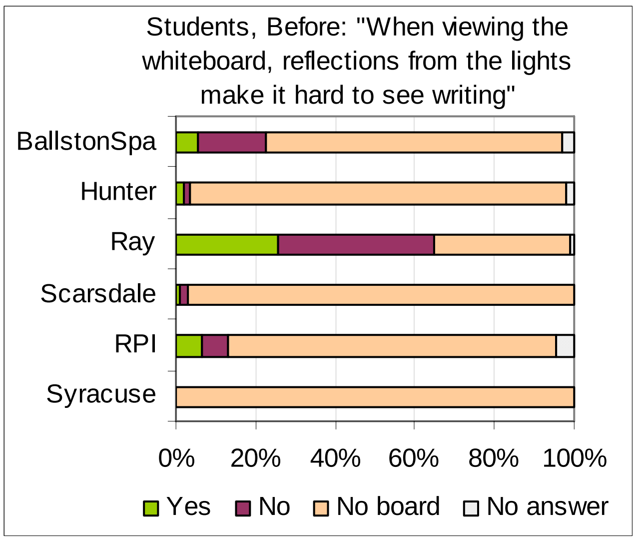
With the old lighting systems, the vast majority of all the students indicated that they had enough light to take notes at their desks and see writing on the board. Veiling reflections from whiteboards were a non-issue because few had whiteboards in the rooms.

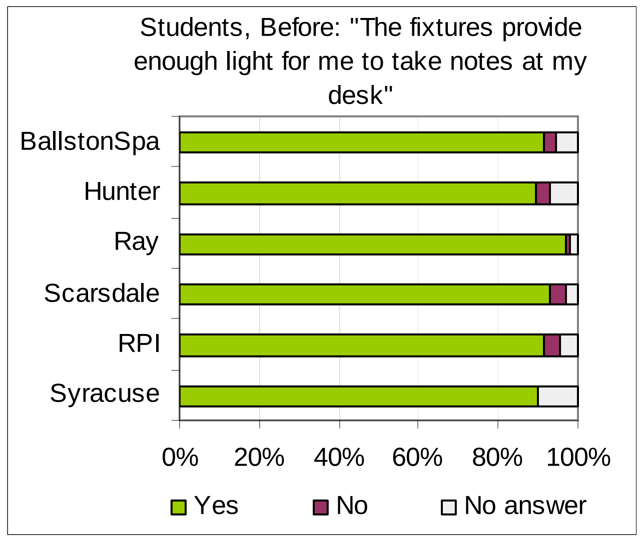
The brightness of room surfaces was generally rated to be “just right,” not generally “too dark” or “too bright.”

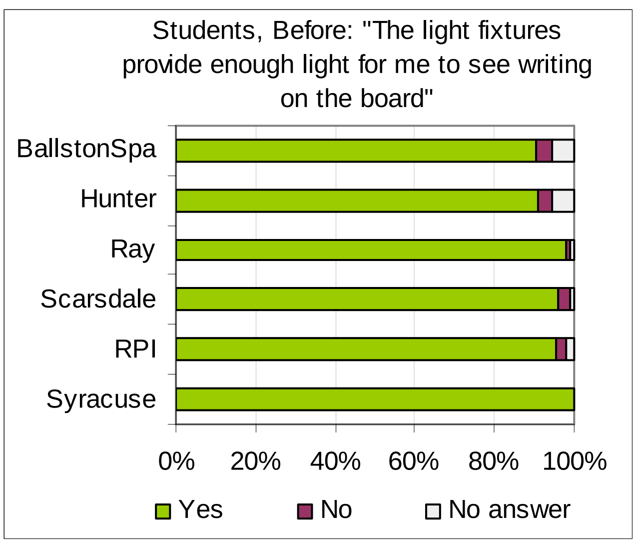
LRC asked the students to indicate how their teachers used the old lighting when showing projected images. Students reported that their teachers turned some or all of the lights off. In this mode, most students reported they had enough light to take notes. The students agreed that their room got dark enough to view projected images in the front of the room. However, many of the students commented that reflections from the lights made it hard for them to see images on the TV.

Overall, the students found their old lighting to be comfortable. They reported that it was easy to see what they needed to see. Compared to other classrooms, their old lighting was generally not better or worse, but generally "about the same." Because the old lighting was considered to not be especially bad, any positive feedback from the students as a result of the ICLS installation was expected to have merit.

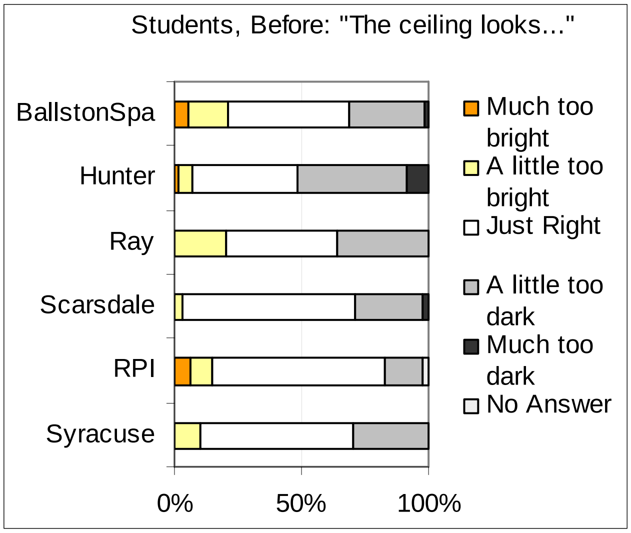
Student Survey Graphs – Before ICLS

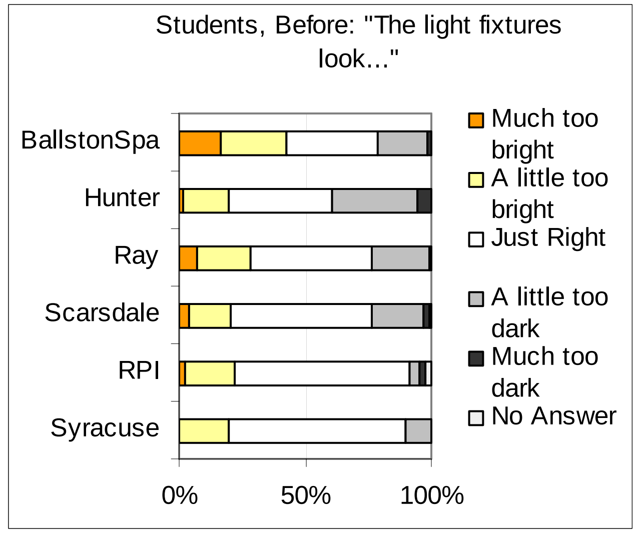


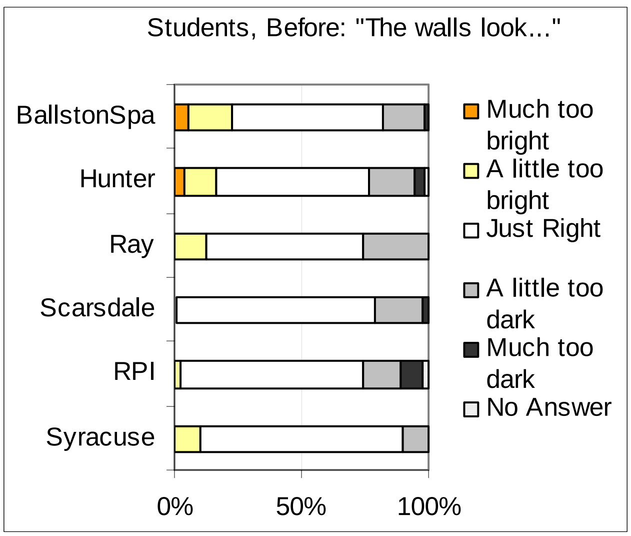


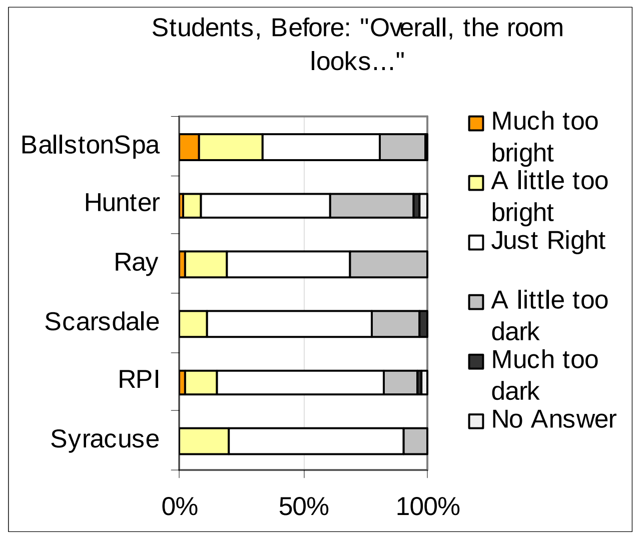


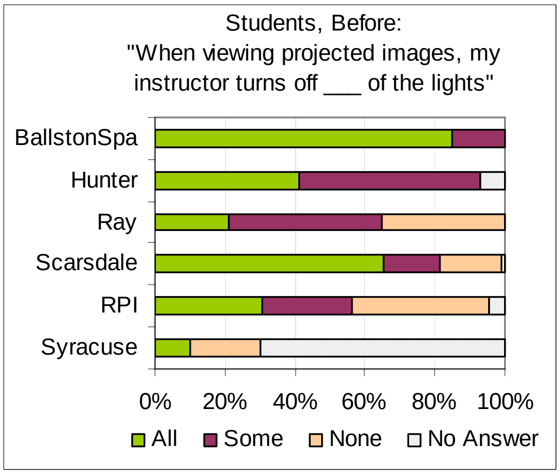
Appendix A – Human Factor Analysis Report

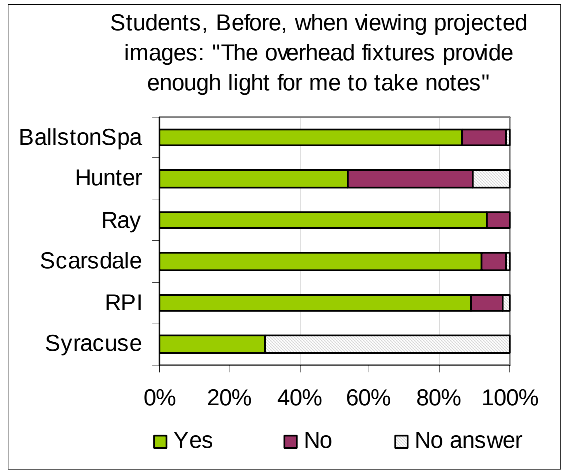


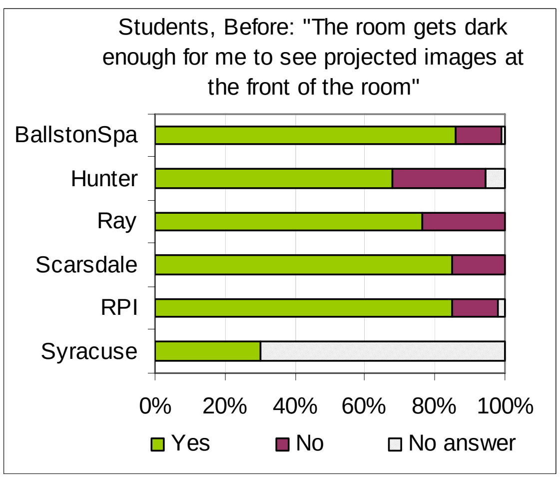


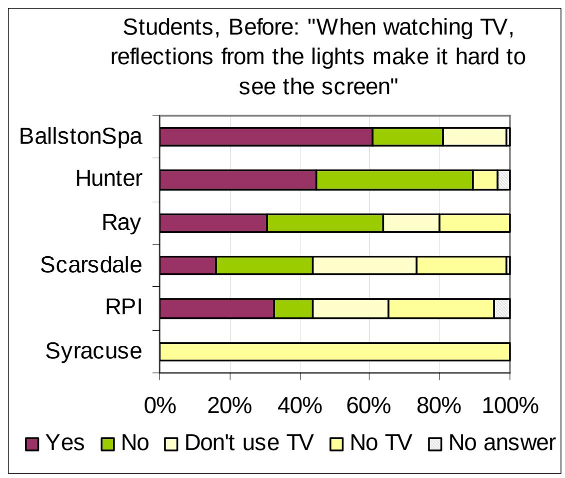


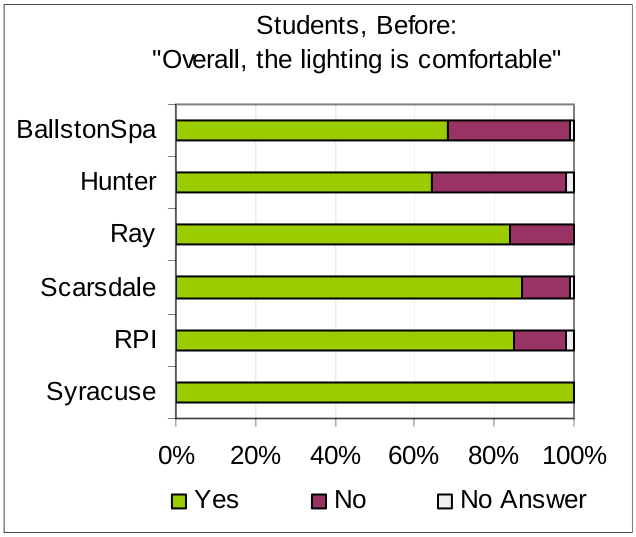


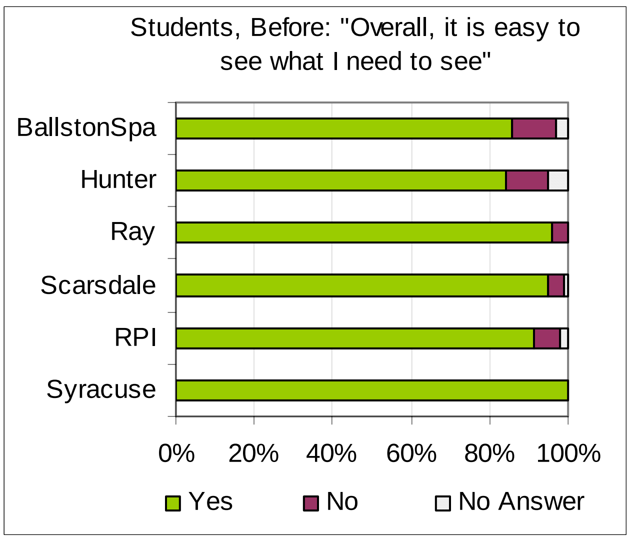

Students, Before:
"When viewing projected images, my instructor turns off ___ of the lights"
BallstonSpa
Hunter
Ray
Scarsdale
RPI
Syracuse
0%
20%
40%
60%
80%
100%
All
Some
None
No Answer

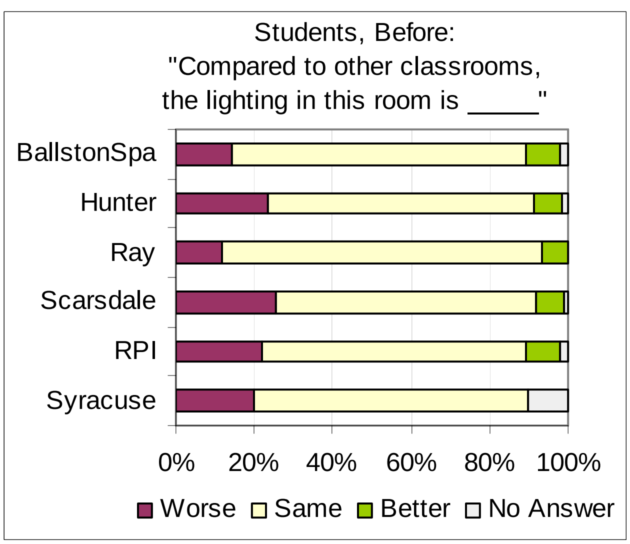

Students, Before, when viewing projected images: "The overhead fixtures provide enough light for me to take notes"
BallstonSpa
Hunter
Ray
Scarsdale
RPI
Syracuse
0%
20%
40%
60%
80%
100%
Yes
No
No answer


Students, Before: "The room gets dark enough for me to see projected images at the front of the room"
BallstonSpa
Hunter
Ray
Scarsdale
RPI
Syracuse
0%
20%
40%
60%
80%
100%
Yes
No
No answer


Students, Before: "When watching TV, reflections from the lights make it hard to see the screen"
BallstonSpa
Hunter
Ray
Scarsdale
RPI
Syracuse
0%
20%
40%
60%
80%
100%
Yes
No
Don't use TV
No TV
No answer


Students, Before:
"Overall, the lighting is comfortable"
BallstonSpa
Hunter
Ray
Scarsdale
RPI
Syracuse
0%
20%
40%
60%
80%
100%
Yes
No
No Answer


Students, Before: "Overall, it is easy to see what I need to see"
BallstonSpa
Hunter
Ray
Scarsdale
RPI
Syracuse
0%
20%
40%
60%
80%
100%
Yes
No
No Answer


Students, Before:
"Compared to other classrooms, the lighting in this room is _____"
BallstonSpa
Hunter
Ray
Scarsdale
RPI
Syracuse
0%
20%
40%
60%
80%
100%
Worse
Same
Better
No Answer

Additional Comments from Students about lighting before ICLS retrofit:

Note: A few[2] comments that were clearly sarcastic have been removed.

Middle/High School Student comments:

- "The lights aren't that stylish. You could make the room look prettier. It is better to have the lights off when projecting because the light burns. The light is uncomfortable because of glare. In comparison to other classrooms, I don't pay attention."
- "The lights flicker a lot."
- "The lights go out some times."
- "The lights make the room a little dim."
- "The projecting screen in the front is broken so we project on the side wall which the lighting is terrible. The lighting is too fluorescent."
- "The projector screen does not stay down, so we have to resort to using the wall as a projecting surface. It is quite ineffective."
- "The projector screen is broken and projections must go on the wall."
- "The projector screen is broken, so we shine the projector onto the wall and then half the room can't see. TV clips are hard to see because it is either too dark or too light."
- "The projector screen is broken."
- "The room is ugly and needs to be renovated."
- "The sun helps."
- "The windows do not have blinds so even when we turn off the lights, it is hard to see the overhead. Also a lot of the lights do not work."
- "The windows really help."
- "There are 2 lights out in this room."
- "There are too many lights."
- "There are two lights out in the third row to the right (if facing the front of the room)."
- "They are not as energy efficient as possible."
- "They should not use the lights as much."
- This is not an important issue. Nobody really cares about the lighting in the rooms because we have windows."
- "This survey is pointless."
- "Tremendous amount of light from the windows."
- "Use tax $ to get more desks, chairs, not to improve the lighting."
- "We can do better than this!"
- "We need new lights. Darker ones."
- "We use a smartboard with lights on it is great"
- "We usually have the lights on low."
- "Well, the projector's broken, so we have to use the wall and that not too helpful."
- "Whenever you look away, my eyes get way too much light and they start to hurt."
- "Windows and outside condition determine light in the room. We should have shades on all of them to better control the light on a given day."

University Student comments, before retrofit

- "Great natural light from big windows"
- "I don't usually look at the ceiling or light fixtures though."

[2] Sarcastic comments that were removed included: four from middle/high school students, and four from university students.

Appendix A – Human Factor Analysis Report

- “I have never really had complaints about the lighting at this school”
- “In all honesty, I really don't care about the lights.”
- “It works”
- “Lighting is fine. We need bigger desks.“
- “Most of the problems in this room are due to the fact that the sunlight does not get sufficiently blocked out by the blinds, making it difficult to see the projector screen at times.”
- “No projected images used.”
- “One of the tubes is orange.”
- “Only building without internet! Lights are fine!”
- “Projector not used in this class.”
- “Since we are in here during the day, we do not have many issues with the lighting.”
- “This lighting doesn't give me headaches like some lighting does.”
- “Too much sunlight”
- “We open the window and get awesome natural light when the sun comes out.”

Instructor Survey Summary – After ICLS

LRC compiled a series of interview survey questions about how the teachers use the ICLS. These questions were asked in person at the middle/high school sites, and were distributed electronically and in print at the university sites. The results of these interview questions are summarized below, and a blank version is shown in Appendix 1. As shown in Table 2 below, LRC received responses from teachers at each school. Some university instructors merely replied with one or two comments, most instructors attempted to answer all the interview questions.

Table 2: Instructor Surveys with ICLS
Room Numbers and Number of Responses

Ballston Spa	106	108	110	112	**Total**
n=	1	1	1	1	**4**
Hunter	204	222	404	410	
n=	1	1	1	0	**3**
Ray	130	179	181	284	
n=	1	1	1	1	**4**
Scarsdale	305	307	309	311	
n=	1	1	1	0	**3**
New School	503	713	1013	1111	
n=	0	3	0	1	**4**
RPI	Carnegie 201	Ricketts212	Sage2707	Sage2715	
n=	5	5	4	2	**16**
Syracuse	Carn100	Carn114	Carn208	Carn219	
n=	0	3	6	5	**14**

Middle/high school teachers typically enjoyed the features of the ICLS. University instructors tended to be less enthusiastic about ICLS, possibly because ICLS has many operational modes, these instructors tend not to receive much training. The Whiteboard light was appreciated by all, while the Quiet Time mode was not generally useful.

Modes

For each of the lighting features (General mode, AV mode, Dimmer, Quiet Time, Whiteboard) LRC asked whether the feature is helpful to teaching. Teachers in the middle/high school context consider the following features to be helpful: General mode, and AV mode, and dimming capability. University instructors were generally neutral in their impressions about these features.

The Whiteboard light received widespread praise. Middle/high school teachers appreciated having the extra attention at the front of the room. Of those that responded at the university level, the Whiteboard light was rated as being helpful or at least neutral. One professor did complain[3] that the whiteboard light blocked projected images. At Scarsdale HS, a shelf blocks part of the whiteboard light. Despite these isolated incidents, there were not widespread challenges with integrating the whiteboard light into actual classrooms. (See “Integration”)

While the Whiteboard light was universally appreciated, the Quiet Time mode was not rated as particularly helpful at any of the schools. There was one instructor who used it to override the occupancy sensor when working in her classroom after hours, as an alternative to waiving her arms to turn the lights back on after a false-off. (See “Occupancy sensor” below). Monitoring data show that the Quiet Time mode is used approximately once a week in each classroom.

LRC asked how often instructors adjusted the dimmer in the AV mode. Again, the middle/high school teachers were favorable on this feature of the system. Although there were some specific favorable comments about the dimmer from university instructors, generally they indicated they rarely ever used the dimmer. Monitoring data showed that middle/high school instructors adjust the dimmer more than universities.

LRC also asked what type of teaching activities were associated with each of the lighting features. We offered several options including: lecture, discussion, homework, test, working at the board, other, and “don’t use”. General mode seems to be popular at all schools for lecturing and discussion. AV mode seems to be appreciated for its intended use: AV presentations. Teachers at the middle/high school find the whiteboard light to be useful for lecture, discussion, and when working at the board. Monitoring data show that the whiteboard light is used at all schools.

The Quiet Time mode was used during tests by one teacher at Ray Middle School and one at Syracuse University, but overall most teachers reported that they did not use this mode for any teaching activity.

Behavior

Because Finelite promotes in their literature that ICLS can be used to change the behavior of students, LRC asked teachers whether this was the case in their experience. Although not widespread, a few of the teachers at all educational levels do use the lighting to change student behavior. These few explained that the system was useful “to direct attention to something.” A few agreed that they use the system “to calm students down”, and a few use it “to make students more alert”.

[3] RPI Ricketts 212: “The lighting bar for the Whiteboard light obscures part of the overhead projector screen that I use in my lectures. I do not use this lighting and find it annoying every time I lecture in this room.”

Occupancy Sensing

One of the features of the ICLS is an occupancy sensor, located in the center of each room. This is a hybrid infrared ultrasonic occupancy sensor that should not require line of sight to movement. We asked the teachers whether the system turns off while occupied. Ballston Spa had one teacher who reported false-offs, when working alone after hours. Interviews at Ray MS revealed another instance of this experience; one teacher works after hours at a computer in the corner of the room, with her back to the occupancy sensor. The sensor cannot "see" the small movements of her hands, so it turns off the lights when she's working late after hours. She explained that when this happens, she can reach over to the teacher control center and trigger the "quiet time" switch. This overrides the occupancy sensor for 1 hour. Although the Quiet Time mode may be intended for use during tests, it is also useful for avoiding false-offs during after-hours work. This innovative use of the Quiet Time switch shows that this teacher understands how the system works.

The occupancy sensors appear to be working as planned for the most part. At Ray MS, two of the teachers reported that their sensors do not seem to turn off the lights despite the room being vacant for long durations. Monitoring data support this conclusion.

Switches, Lighting Control Features

The teachers responded to questions about the lighting controls of the ICLS.
We asked whether they understood the labels on the switches. All of the Middle/high school teachers understand the labels, perhaps due to the fact that they had training about the system (see "Training" below.) A few of the university instructors reported that the labels were unclear to them. Although some classrooms used traditional chalkboards instead of whiteboards, none of the teachers expressed confusion by the label "whiteboard" on the switch.

Middle/high school teachers reported that the location of the switches was convenient, while university instructor response was more mixed. There were comments at Ray MS that the teacher control center could have been positioned more conveniently. (See "Instructor Comments" below.)

The dimming ballasts used in the AV mode are a program-start type, thus there is a delay of approximately 1 second when switching between General and AV modes. We asked whether the teachers notice this delay, and whether they find it acceptable. Many of the middle/high School teachers have noticed this delay, and most find it acceptable, with one exception. Responses from university instructors were also generally favorable.

The one exception about the switching delay was at Hunter HS. Hunter classrooms are unusual because they have no windows, so when lights turn off briefly, the room becomes entirely dark. As shown in the graphs on page 31, those teachers find this feature to be "Somewhat unacceptable."

Room impressions
LRC asked about teachers' impressions about the appearance of the space. They reported that their room looks either "spacious" or "neutral" but not particularly "confining."

Training
LRC asked instructors questions about training. Teachers from Scarsdale, Ray, and Ballston Spa reported receiving training from manufacturer representatives and from a brochure. One teacher at Ray MS reported consulting the manufacturer website.
The university instructors typically reported that they received no training. A few university respondents commented that the LRC survey itself raised their awareness of the capabilities of the system. (New School instructor: "I was unaware of the different lighting options, which sound very helpful."; Syracuse instructor: "I don't always adjust the lights, but maybe now I'll think about utilizing the lighting system")

Teachers at Ballston Spa and Ray MS reported that they used the instructional brochure. Teachers at most of the other schools said they did not use the brochure, or simply did not respond to this question. LRC noted that at some schools (Syracuse University and Ray MS), the brochure is laminated and posted on the wall. One RPI professor commented that he wished for availability of "info about the switches somewhere. But it might be there someplace."

Instructor Comments about ICLS:

LRC asked the teachers to provide their comments on many aspects of the ICLS. These comments are compiled below.

Overall:

- The instructors all love the whiteboard light (except if it blocks a projection)
- They don't need the Quiet time switch
- K-12 institutions love the lighting
- University instructors don't get training, and seem confused/overwhelmed
- Even university instructors appreciate whiteboard light
- Nobody complains that the light from the ICLS is glaring or in any way uncomfortable.
- In general instructors like having the ability to darken the front of the room.

Ballston Spa MS

- *If you could change anything about the lighting:*
  - "I would make them energy efficient for these changing times. Maybe they already are, I don't know."
  - "Nothing… delay?" (i.e., possibly would suggest changing the delay when turning on AV mode)
- *If you could change the controls:*
  - "Give a remote control"
  - "Remote control"

- "Thanks for the lights; they have been fun!"
- "I like the lighting and so do the students."
- "Nice lights!"
- "It is much better than the lighting in my former room. Less glare and the students really like them now!"
- A/V mode, one teacher noted that he uses it for giving test directions
- Whiteboard light: one teacher mentioned it is useful for writing notes on the board

Baldwinsville Ray MS

- One person said they felt like they had to "duck" a little when the lights were first installed, but not anymore.
- Rooms 179 and 181, occupancy sensor seems to not function. Lights are still on when returning after long absence.
- Confusing to electricians?: 284 had a problem with a sensor which they fixed but then all 3 lights came on at the same time. (Presumably they had to fix again since that problem was corrected.)
- In 284, lights did turn off when the teacher was sitting quietly after hours at a computer in the corner. When a (false off) happened, she reached over and used the "quiet time" button to override the occupancy sensor. This teacher did not rate the "quiet time" switch as useful to her teaching, even though she uses it in this unorthodox manner.
- 130 originally had a sporadically-flickering lamp. At first the kids noticed it but the teacher didn't believe it, until she saw it herself. The maintenance person told her that the lamp wasn't seated properly in the socket. No further complaints about flickering lamps.
- "Whiteboard light kinda makes other walls look dark in comparison, but that's not a criticism."
- They *love* the whiteboard light, unanimously
- One teacher posted info sheets about the system herself on her wall
- Room 179 has a segment of blackboard missing, but no Smartboard at the moment (maybe someday). Presently, the Teacher Control Center (TCC) is located there, which would prevent the teacher from using the space effectively. (There was a complaint about the TCC being in the way, inconvenient, too central. Although this teacher did not rate the "convenience" of the controls poorly, there was a verbal and written comment from this teacher; see comments and Figure 5 below)

Figure 5: Location of this Teacher Control Center presently obstructs posting of visual aids, and may prevent future installation of a Smartboard.

- *If you could change anything about the lighting:*
  - "Lights wouldn't hang from the ceiling"
  - "Maybe more rows of lights; there are dark parts in certain corners of the room."
  - "I would have a white board by my farthest black board on the left side of the room."
- *If you could change anything about the controls:*
  - " I would (like to) be able to turn off the light completely from the (Teacher Control) panel."
  - "I don't like losing space for my boards in the front of the room"
  - "the controls work well where they are"
  - "the sensor timer shorter the shut off time to conserve energy" (i.e., the occupancy sensors seem to not be working)
- Other comments:
  - " I like the variety of lighting that I can control"
  - " I enjoy having the AV control for when I use the smart board for certain applications"
  - " I like the AV mode when using the Smartboard; the projector is intense and the AV mode softens the lighting."

Hunter College High School

- *If you could change anything about the lighting:*
  - With the use of "smart" boards, the Whiteboard lighting can be eliminated
- *If you could change anything about the controls:*
  - Not certain what the quiet time button is for. Never use it.
  - Move controls next to smart boards instead of white boards.
  - The delay when changing from general mode to A/V mode is somewhat unacceptable. The first time it happened the students screamed.
  - Would like greater range of dimming.
- Other comments

- The teachers claim they received no training on the operation of the system. However, they believed the system operation is somewhat self explanatory.
- Teachers find the quality of lighting in the A/V mode to be very helpful.
- The dimming feature was considered a great asset. It allowed the teachers to adjust light levels to what they wanted.
- The Finelite lighting system was considered better than the old system because it is easier on the eyes, better control in the A/V mode and quality of light better. Note: System was changed from T12 magnetic ballasts to T8 electronic.

Scarsdale High School

- *If you could change anything about the lighting:*
  - The white board lighting in one of the rooms (307) is partially blocked by a shelf over the white board.
- *If you could change anything about the controls:*
  - Not certain what the quiet time button is for. Never use it.
- Other comments
  - One teacher uses the dimmer to quiet down students. She finds that it works wonderfully.
  - The use of the dimmer in the A/V mode is wonderful on sunny days to reduce light levels.
  - The new lighting system is better than the old because the teacher can emphasize activities, control the attention of the students and the system provides a variety of lighting options.
  - The teachers “really like it”

Syracuse University – Mathematics Professors

- *If you could change anything about the lighting:*
  - “The ability to adjust shades for exterior light.”
  - “The wiring showing outside the walls.”
  - “It’s OK now.”
- *If you could change anything about the controls:*
  - “The dimmer switch would be nice for all of the lights without hitting AV mode first”
  - “Location: The way the desk, the overhead transparency unit, the lack of good projection space, etc., all work against each other… Not even a doc can in the room can project use chalk board at the same time etc., etc.”
  - “All I want is a switch” (i.e., too complex)
  - Use of switches, “unclear at first”
- General mode:
  - “‘What is this? I think I use it.”
  - General and AV mode, (I) use with overhead calculator.
- AV mode:
  - “Is this dimming the board light? If so, I use it.”
  - “Overhead calculator, use with dimmer.”
  - “Don’t know how A/V is used”

- Other comments
  - Instructional brochure “I didn’t know there was one!”
  - (Whiteboard rated by one as “very helpful”)
  - (After reading survey) “I don’t always adjust the lights, but maybe now I’ll think about utilizing the lighting system”
  - “Sometimes I think I have the switches in the on position but the lights don’t come on for a few seconds[4]; or I switch the light switch to the off position (at least what I think is “off”) and they come on. I do believe that the whiteboard light is great”
  - “This is a waste of time. A light is a light.”
  - “This (survey) is useless. I have no idea what these things are. I usually have all the lights on. If I display something with the projector I turn off the light at the board. That is a very nice feature since the students can still take notes and see[5].”
  - “I turn them off and on and that’s it.“

Rensselaer Polytechnic Institute (RPI)

- *If you could change anything about the lighting:*
  - “Sometimes I use both the projector and the blackboard. It would be helpful if I can turn on the whiteboard light for only one part of the board.”
  - “I haven’t played with the lights, so don’t know what features are there. AV sounds good, if it lights the back but not the front.”
  - “Brighter, and easier to dim the front.”
- *If you could change anything about the controls:*
  - “Put them in the center of the front wall”
  - “Make them more self explanatory”
  - “1. Have the switches near the door rather than in the corner. 2.Have info about the switches somewhere. But it might be there someplace.”
- Other comments:
  - “I never got a brochure about lighting in this room”
  - “I did not know or notice that there is something special about the lights.”
  - “Unclear what all of the modes are supposed to accomplish”
  - “I only recently noticed that there had been changes. No one had mentioned them to me. I have switched from general to AV when I use Powerpoint and it seems helpful.”
  - “The lighting bar for the Whiteboard light obscures part of the overhead projector screen that I use in my lectures. I do not use this lighting and find it annoying every time I lecture in this room.”
  - “Lighting- no; survey, yes. These options aren’t sufficient. How about an N/A choice for follow-up questions where the one before was answered “I don’t use this.” Also, the general lighting is more/less helpful, compared to what?”
  - “The ventilation in this classroom is so bad that the effect of lighting is somewhat negligible compared to the discomfort due to lack of oxygen.”
- Whiteboard light: “Had trouble finding the switch”

[4] Handwriting obscured by stamp. Not clear that the unit of time is “minutes”
[5] The end of the sentence was cut off, explaining what the students could see.

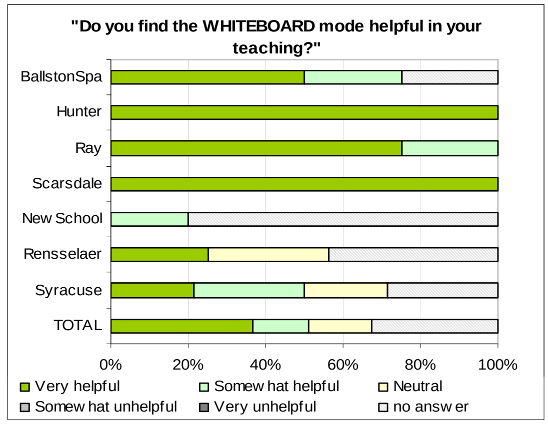
- *Use lights to change behavior?* “Illuminate the board, which may increase alertness.”
- Quiet time comments:
  - “Would be better if lights could dim” (during quiet time)
  - “There’s a ‘quiet time’ button?”
- A/V mode:
  - “I didn’t notice this option – haven’t tried it”
  - “would be better if there were a podium light”
  - “Showing video” (i.e., it’s helpful to have AV when showing video.)
- General mode: “The room is lit- I don’t really choose this”

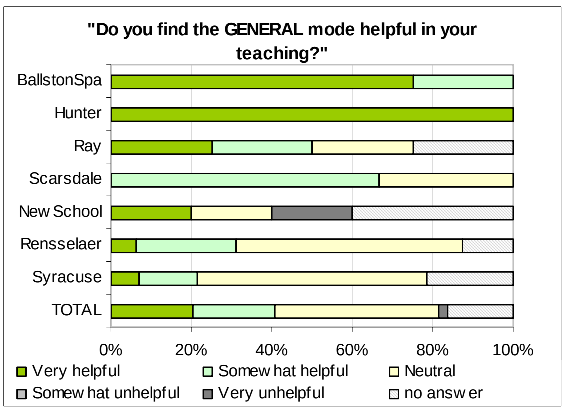
New School:

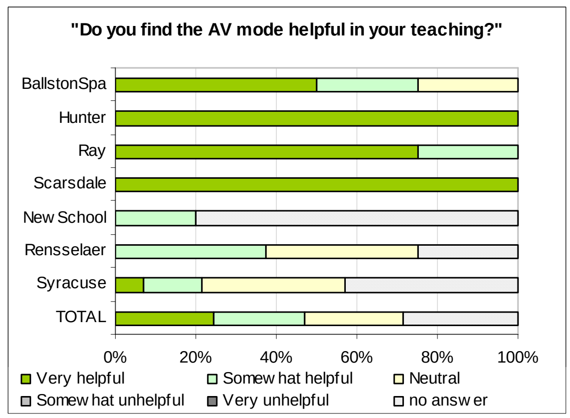
- *If you could change anything about the lighting:*
  - “At first I thought it was too complicated, but then I became accustomed to what was intended and it seemed cool.”
  - Per Color Theory instructor: “I would have more incandescent lighting in addition to the fluorescent lighting and perhaps the option to switch from one to the other. In color theory it is very important to have both. It is also very difficult to look at student work under fluorescent.”
- *If you could change anything about the controls:*
  - (no responses)
- Other comments:
  - “ I do teach in room 713, but do not know all of the settings for the lights. I basically use the basic switch and it seems to be fine.”
  - “I was unaware of the different lighting options, which sound very helpful.”
- General mode: “Did not use the lighting.”
- The following comments came from an instructor supposedly in room 1111. However, all the comments indicated that there was not ICLS in her room:
  - AV mode: “There is no A-V mode”
  - Quiet time: “there is nothing with a “quiet time” button on it”
  - Whiteboard: “No whiteboard light either”
- Color Theory instructor: “I bring in my own lights to show diff- in color.”

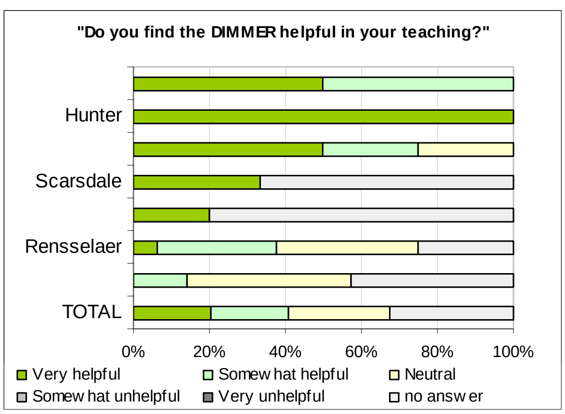
Instructor Survey Graphs, After Retrofit

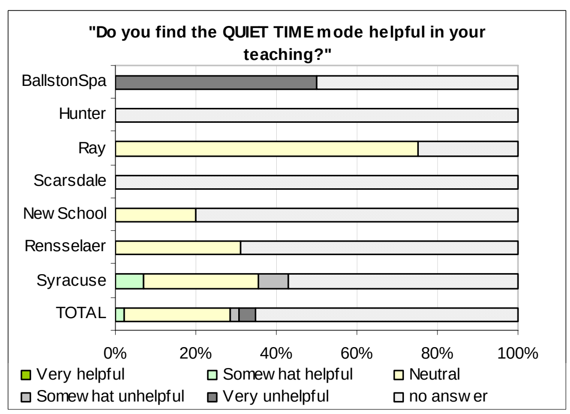
School:	**n-value**
Ballston Spa	4
Hunter	3
Ray MS	4
Scarsdale	3
New School	4
RPI	16
Syracuse	14

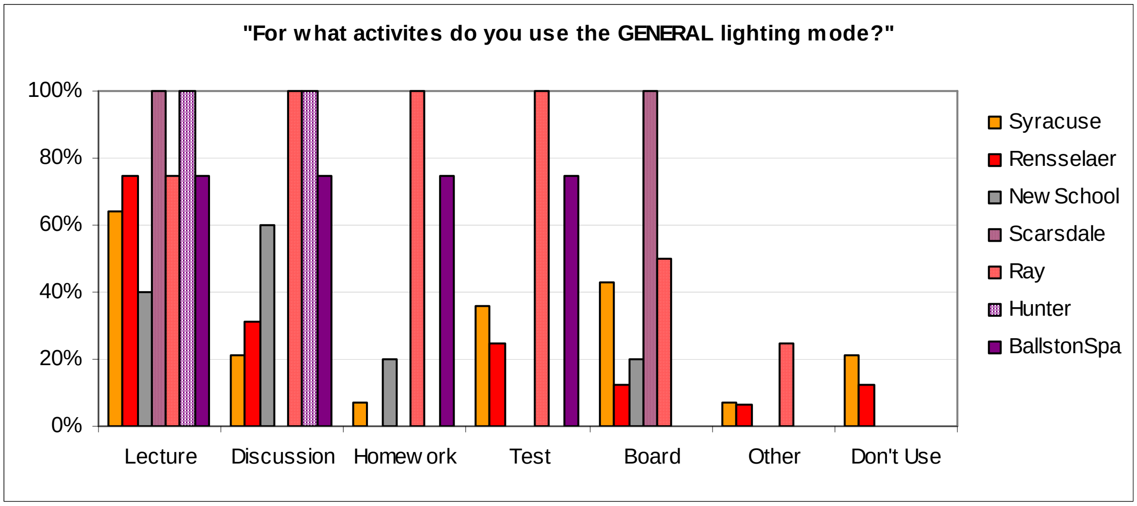


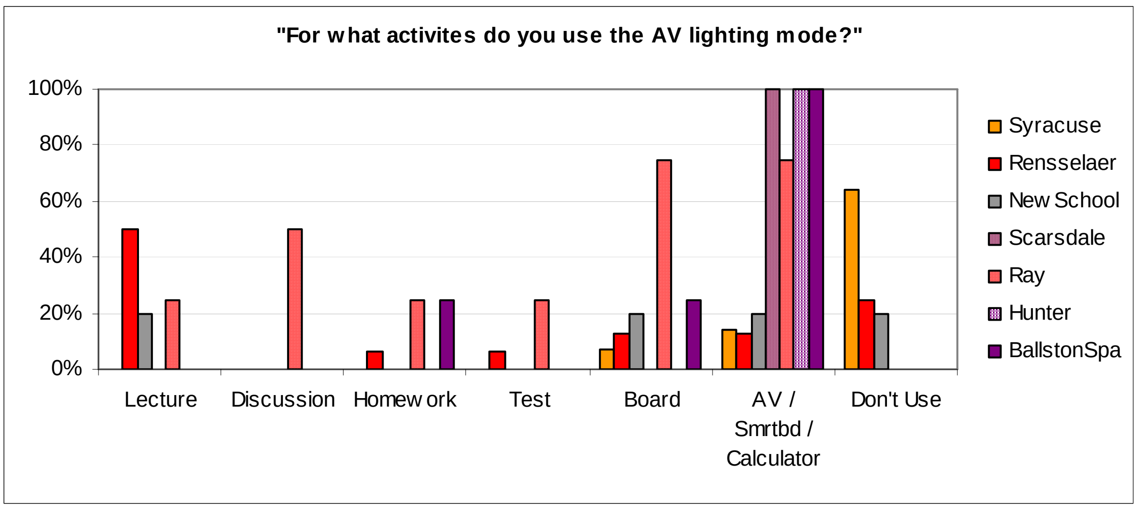


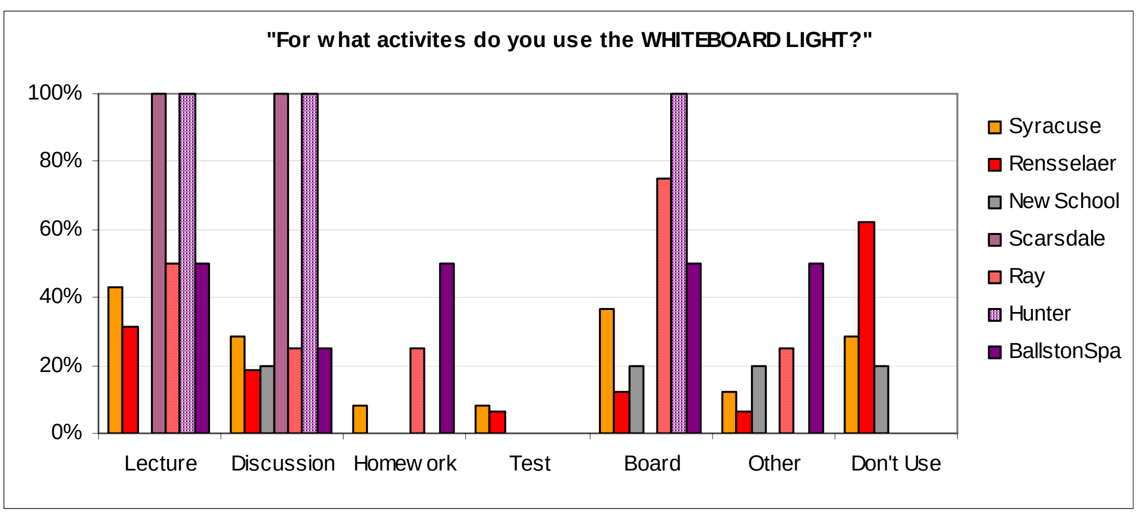




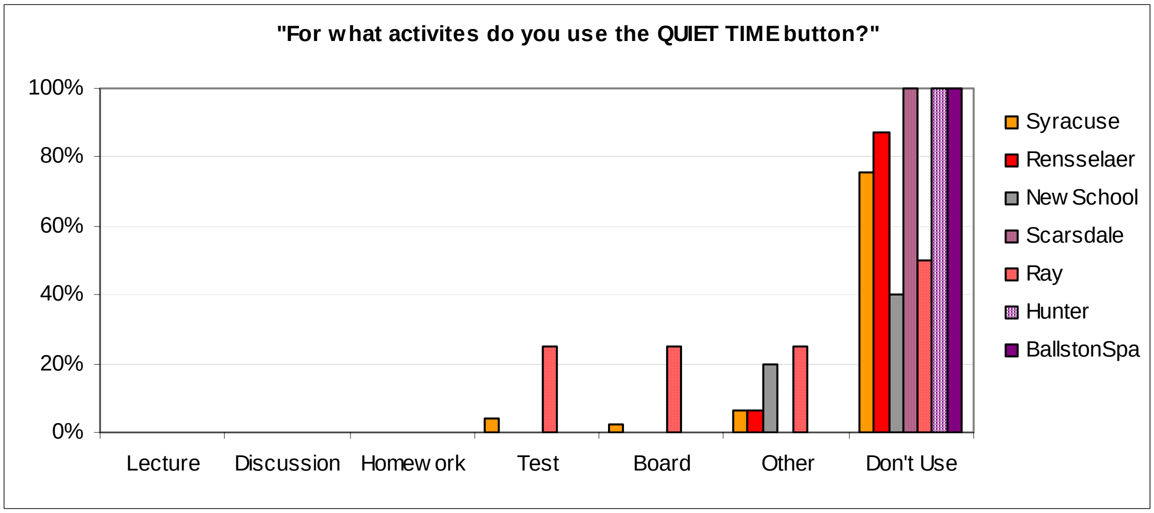


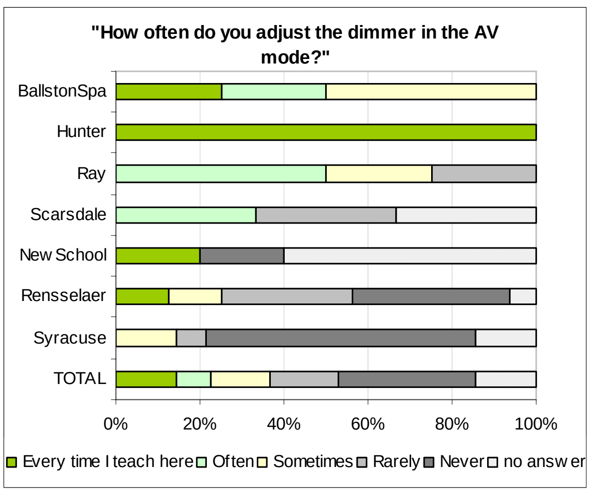

"For what activites do you use the GENERAL lighting mode?"
100%
80%
60%
40%
20%
0%
Lecture
Discussion
Homework
Test
Board
Other
Don't Use
Syracuse
Rensselaer
New School
Scarsdale
Ray
Hunter
BallstonSpa

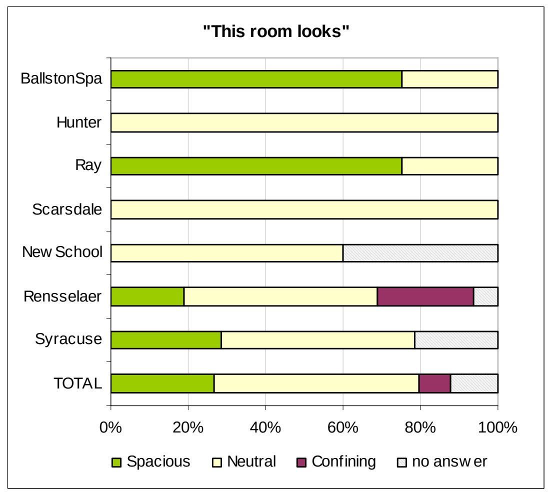

"For what activites do you use the AV lighting mode?"
100%
80%
60%
40%
20%
0%
Lecture
Discussion
Homework
Test
Board
AV / Smrtbd / Calculator
Don't Use
Syracuse
Rensselaer
New School
Scarsdale
Ray
Hunter
BallstonSpa

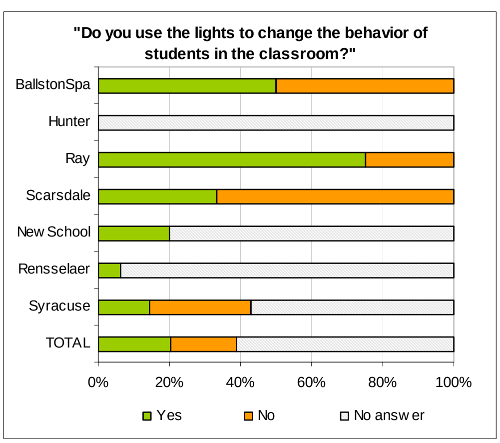

"For what activites do you use the WHITEBOARD LIGHT?"
100%
80%
60%
40%
20%
0%
Lecture
Discussion
Homework
Test
Board
Other
Don't Use
Syracuse
Rensselaer
New School
Scarsdale
Ray
Hunter
BallstonSpa

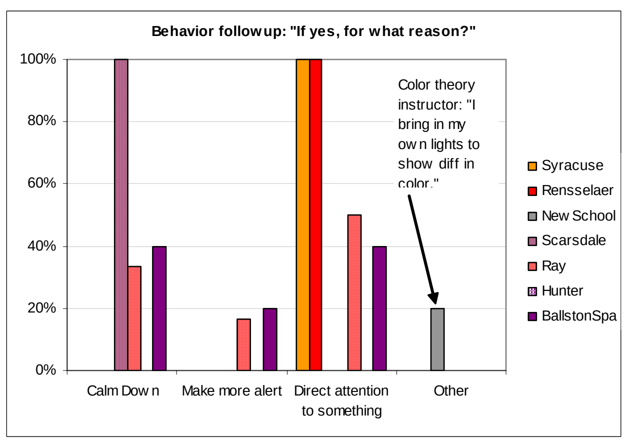
Appendix A – Human Factor Analysis Report



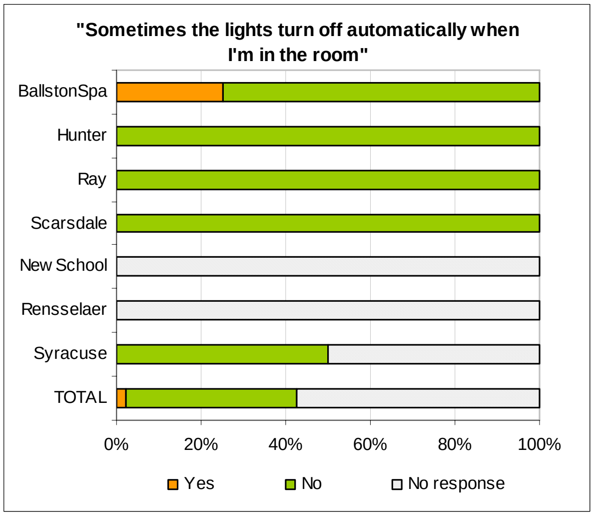


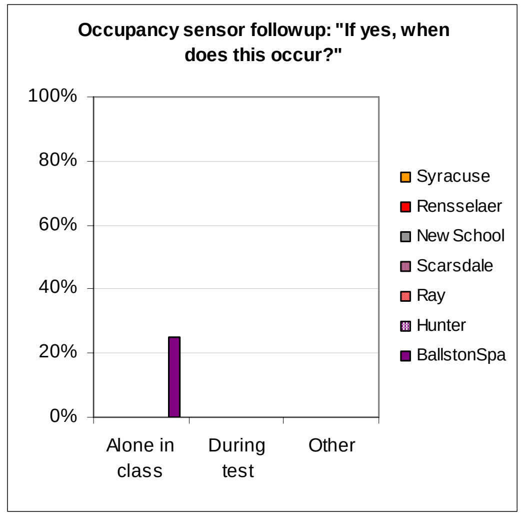


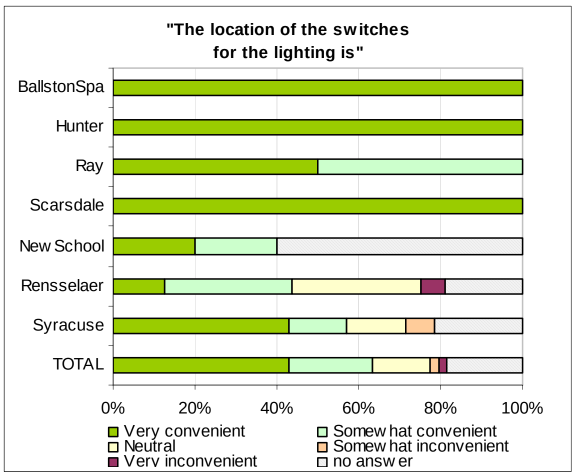


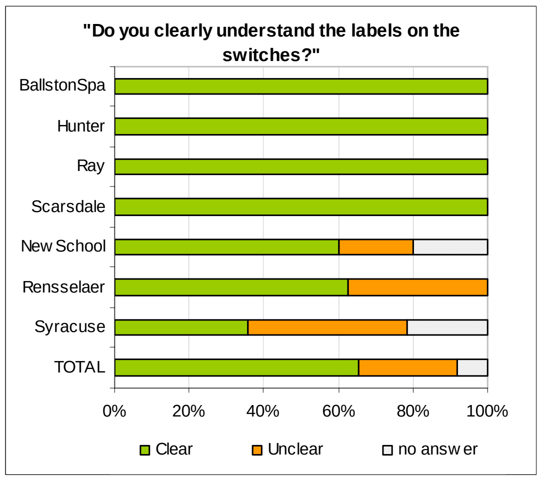


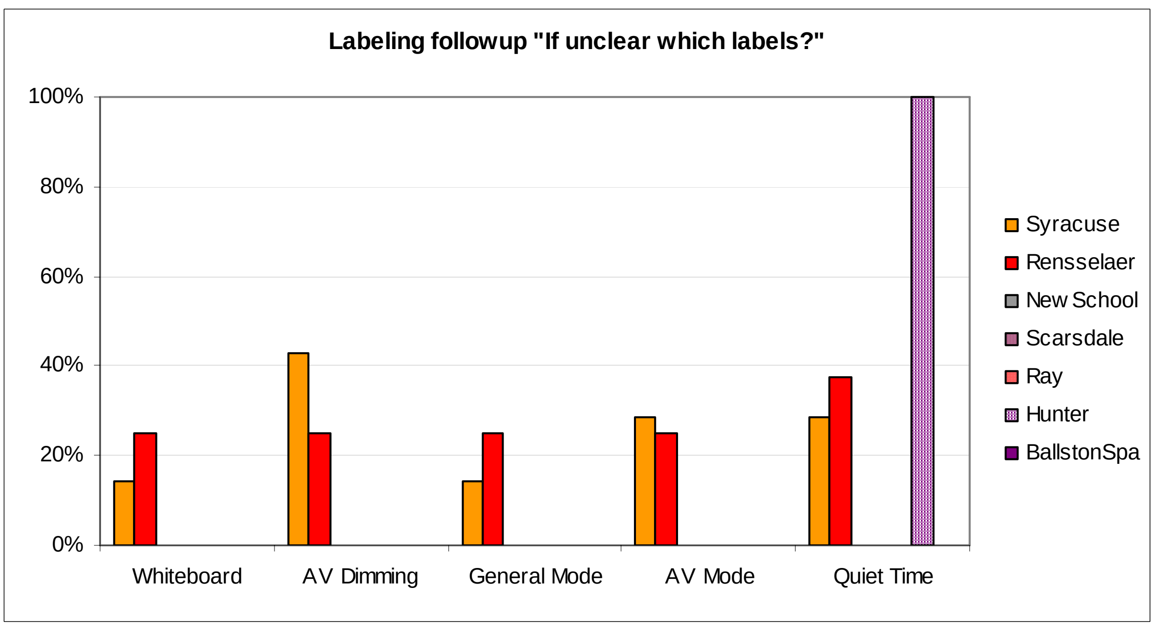
Appendix A – Human Factor Analysis Report

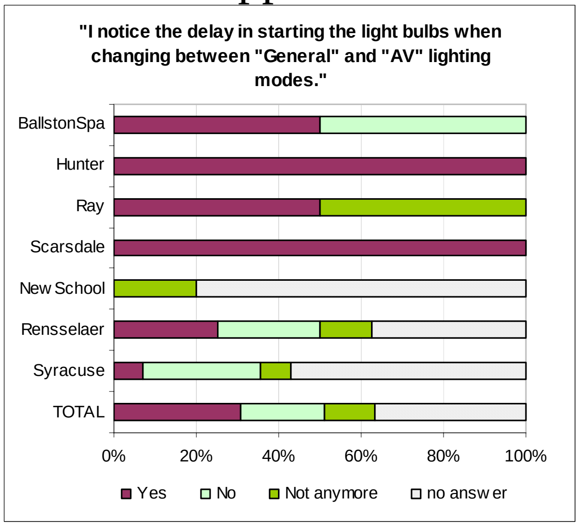


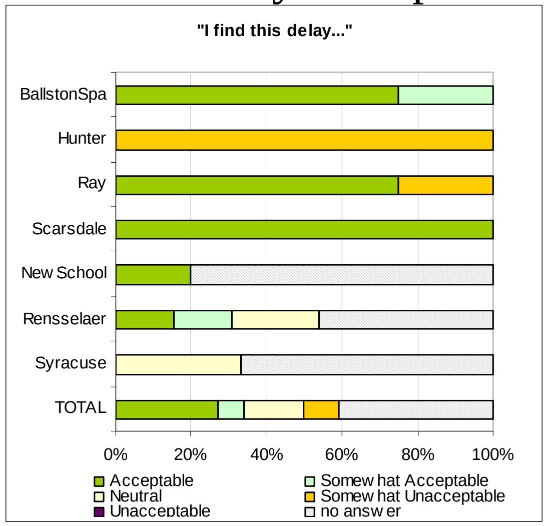


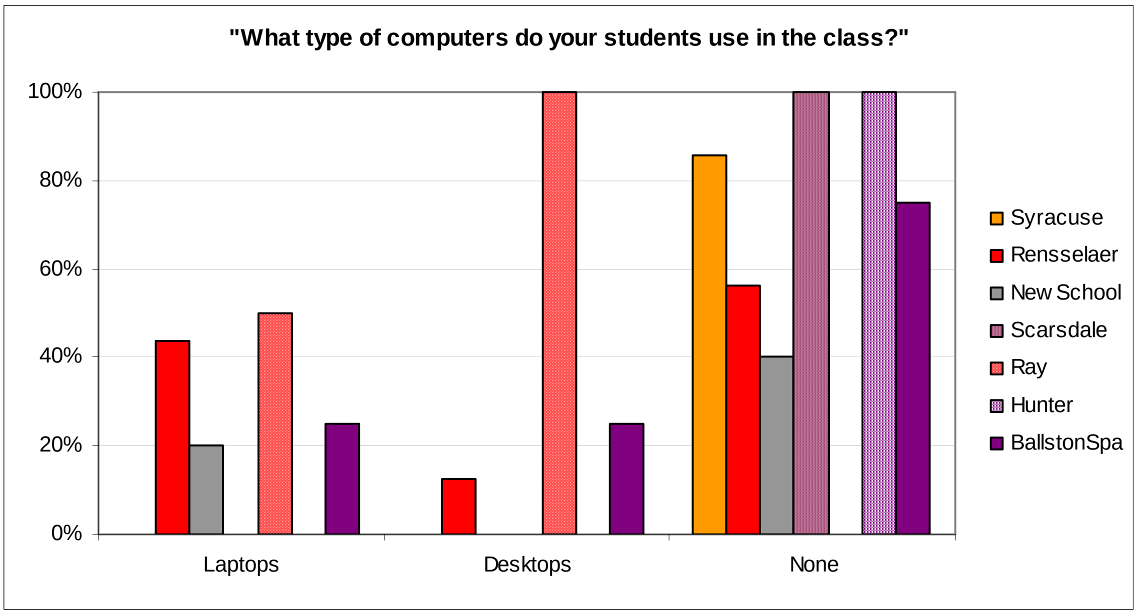


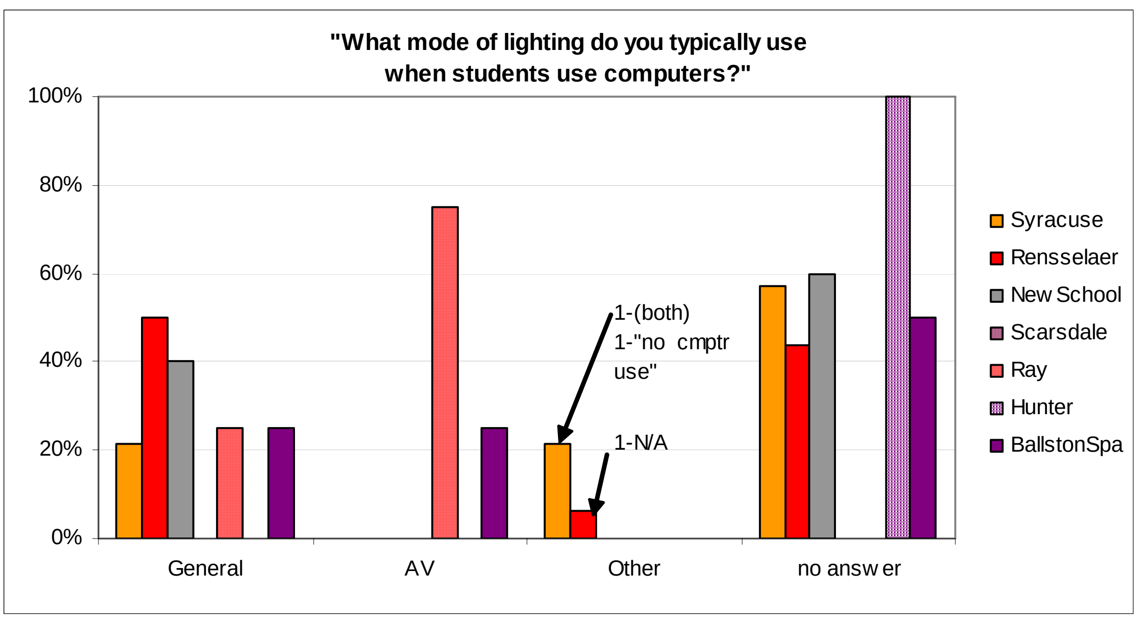


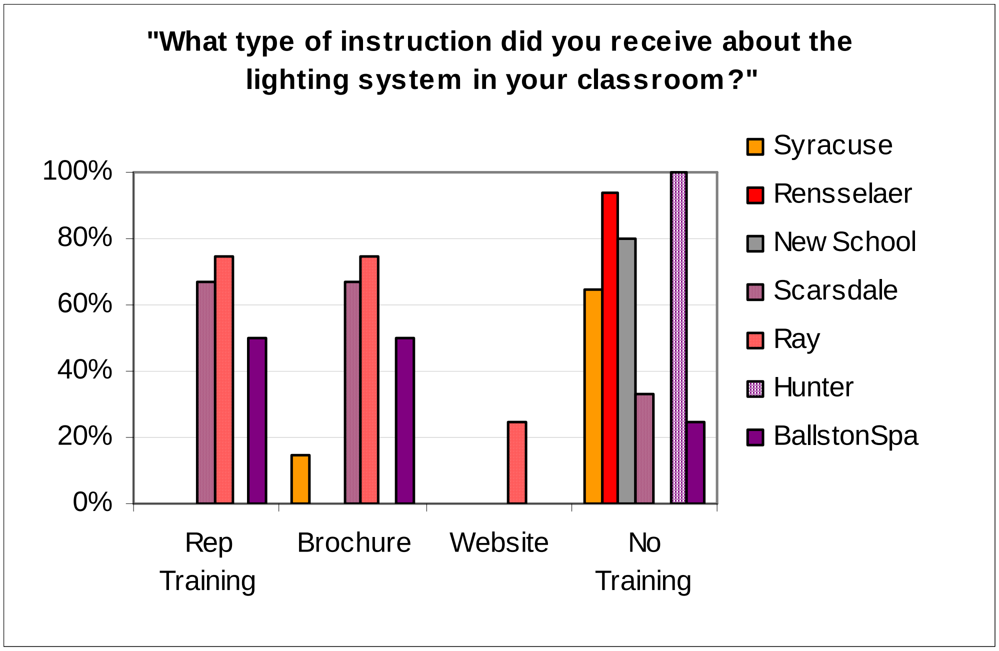


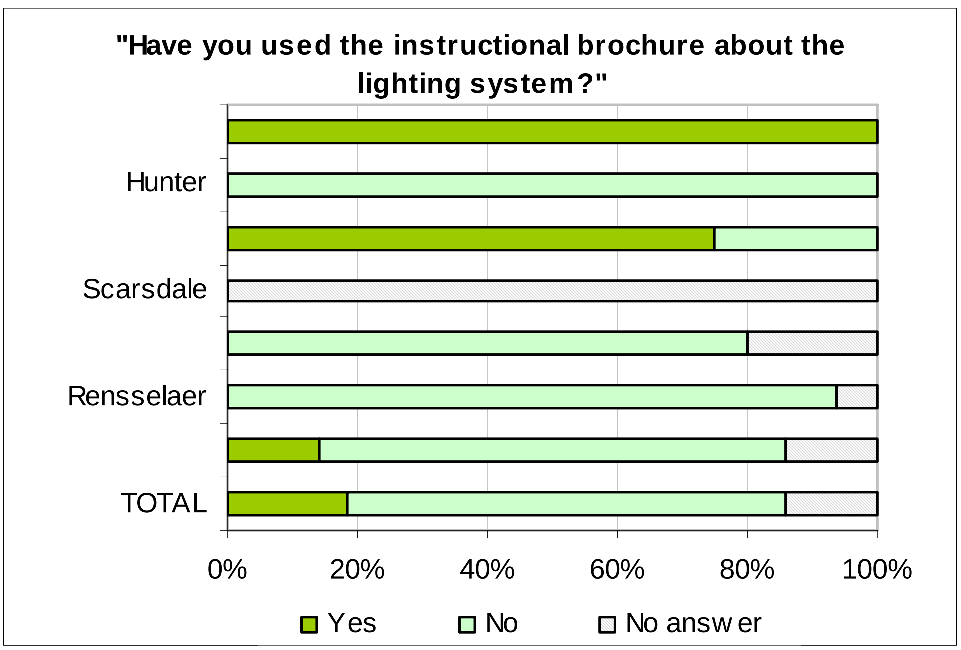

"I notice the delay in starting the light bulbs when changing between "General" and "AV" lighting modes."
BallstonSpa
Hunter
Ray
Scarsdale
New School
Rensselaer
Syracuse
TOTAL
0%
20%
40%
60%
80%
100%
Yes
No
Not anymore
no answer


"I find this delay..."
BallstonSpa
Hunter
Ray
Scarsdale
New School
Rensselaer
Syracuse
TOTAL
0%
20%
40%
60%
80%
100%
Acceptable
Somewhat Acceptable
Neutral
Somewhat Unacceptable
Unacceptable
no answer


"What type of computers do your students use in the class?"
100%
80%
60%
40%
20%
0%
Laptops
Desktops
None
Syracuse
Rensselaer
New School
Scarsdale
Ray
Hunter
BallstonSpa


"What mode of lighting do you typically use when students use computers?"
100%
80%
60%
40%
20%
0%
1-(both)
1-"no cmptr use"
1-N/A
General
AV
Other
no answer
Syracuse
Rensselaer
New School
Scarsdale
Ray
Hunter
BallstonSpa


"What type of instruction did you receive about the lighting system in your classroom?"
100%
80%
60%
40%
20%
0%
Rep Training
Brochure
Website
No Training
Syracuse
Rensselaer
New School
Scarsdale
Ray
Hunter
BallstonSpa


"Have you used the instructional brochure about the lighting system?"
Hunter
Scarsdale
Rensselaer
TOTAL
0%
20%
40%
60%
80%
100%
Yes
No
No answ er

Appendix A – Human Factor Analysis Report

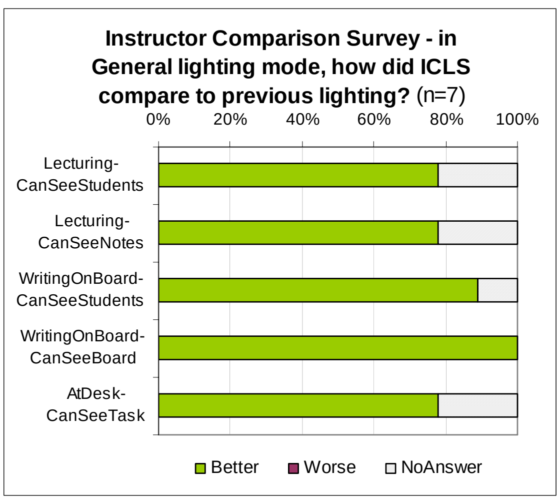
Instructor Comparison Survey – After ICLS

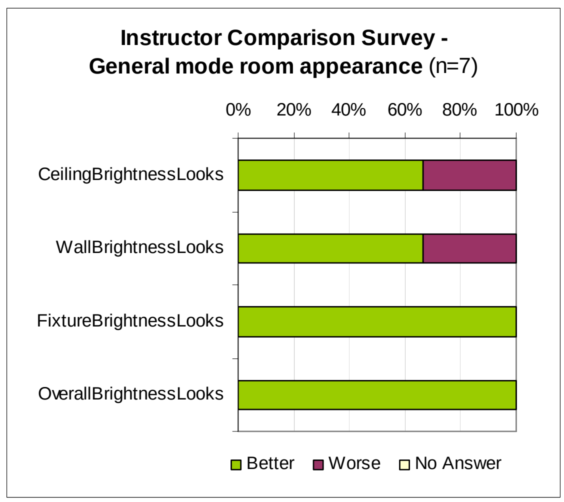
LRC asked instructors who participated in the original study to complete a survey comparing their previous lighting to the ICLS. Because most of the original teacher participants were no longer in the rooms that have ICLS, LRC was only able to obtain responses from seven instructors.

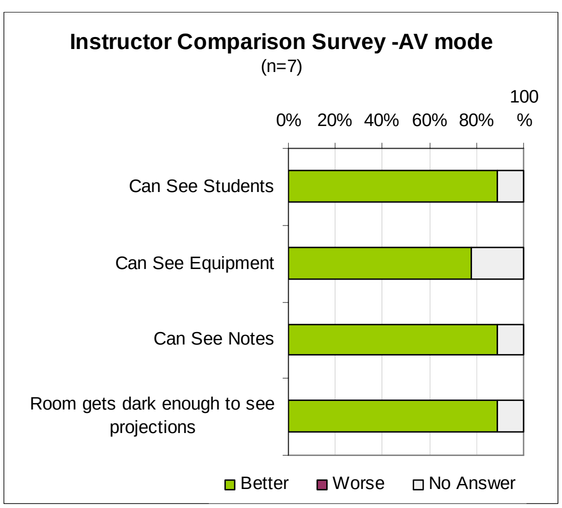
All seven participants were teaching at the middle/high school level. Two were from Scarsdale, three were from Ballston Spa, and four were from Ray Middle School.

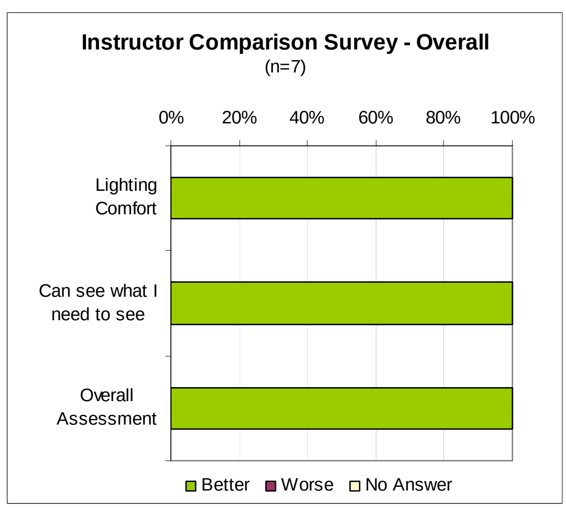
Questions were asked about visibility under General mode and AV mode.
Teachers indicated that the ICLS was "better" than the old lighting for seeing students, seeing notes, seeing writing on the board, seeing tasks at their desk, and seeing projections.

Questions were also asked about the appearance of the room under the General lighting mode. The only exception to the positive feedback was that a few instructors thought that ceiling brightness and wall brightness looked "worse" under the ICLS than the old lighting. Overall, though, instructors clearly preferred comfort and visibility under with the ICLS.









Student Survey Summary – After ICLS

LRC asked the teachers to distribute surveys to their students. The table below summarizes the quantities of surveys and associated room numbers.

Ballston Spa	106	108	110	112
n=	19	22	20	24
Hunter	N/A			
Ray	130	179	181	284
n=	20	25	22	25
Scarsdale	N/A			
New School	N/A			
RPI	Carnegie 201	Ricketts212	Sage2707	Sage2715
n=	13	34	14	6
Syracuse	Carn100	Carn114	Carn208	Carn219
n=	0	3	6	5

Although the instructor responses showed a disparity between the universities and the middle/high schools, the student reactions to ICLS were more similar regardless of location.

Students at all levels have enough light to see writing on the board and their notes. They have no major complaints about veiling reflections. They have the impression that their instructor uses the General mode more than the AV mode. They report that their instructor does not often turn all the lights off.

Students at the middle/high school level report more use of the dimmer, compared to university students.

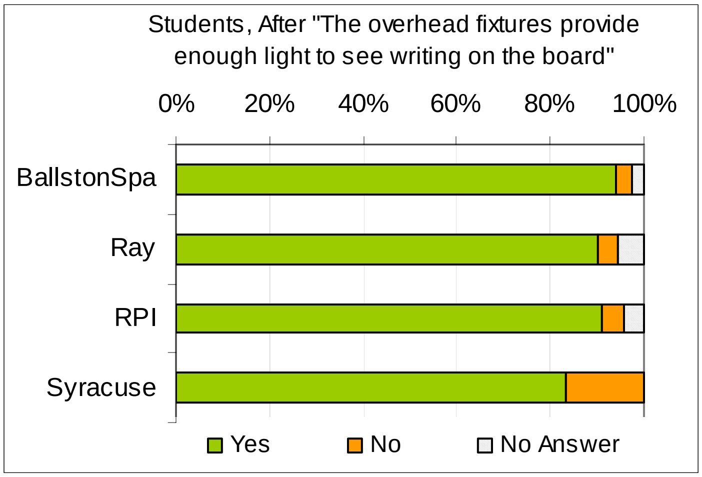
With the exception of RPI students, all the students report frequent use of the Whiteboard light.

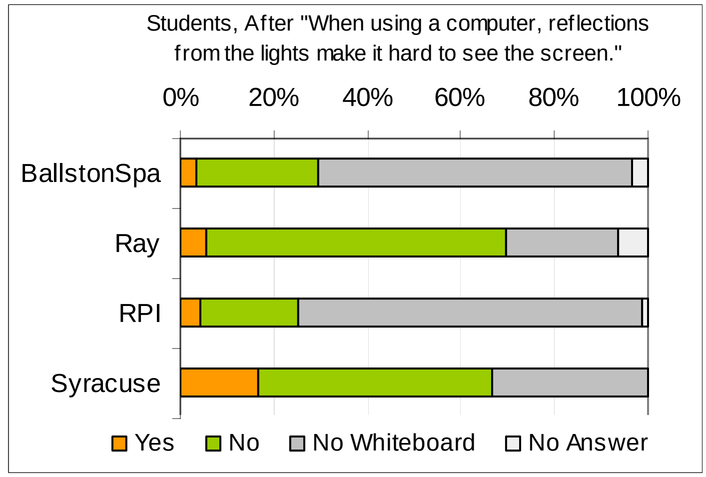
Students consider room brightnesses to be “just right.” They think the room gets dark enough to see projections, while providing enough light to take notes.

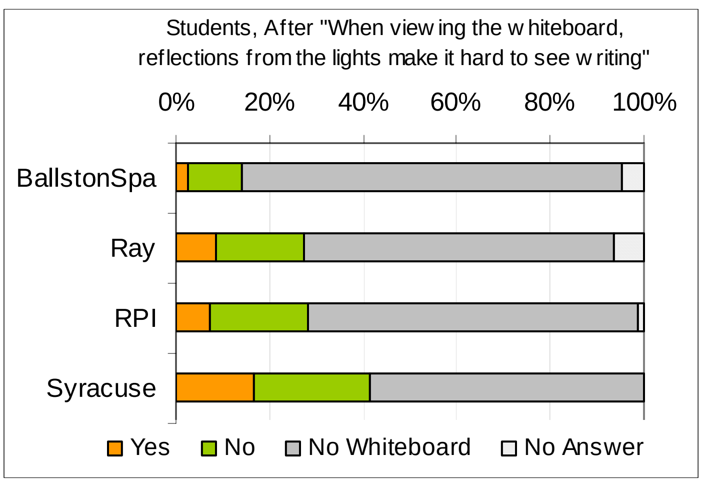
Overall, they find the lighting from the ICLS to be comfortable. Overall, they find it easy to see what they need to see in their classrooms.

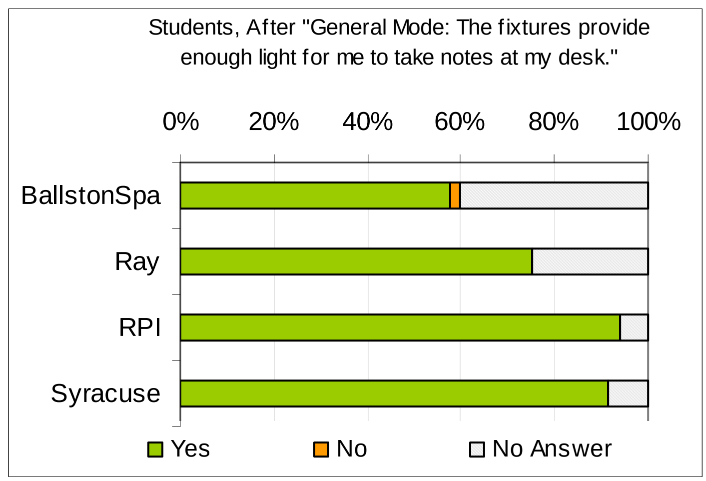
Student Survey Graphs, After Retrofit

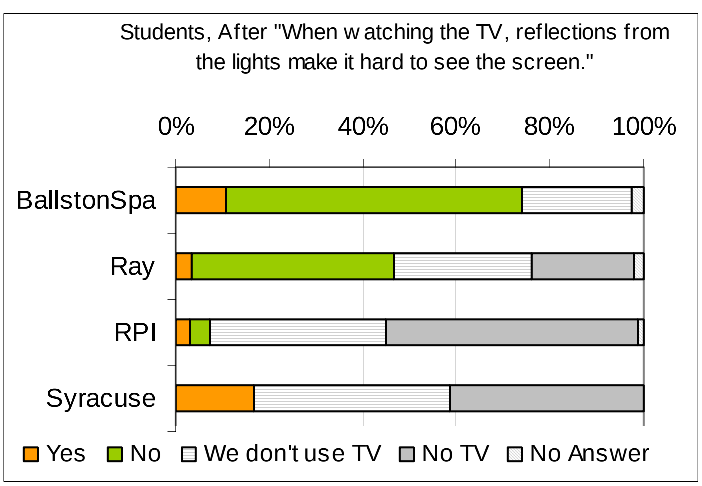
School:	**n-value**
Ballston Spa	85
Ray MS	92
RPI	67
Syracuse	14

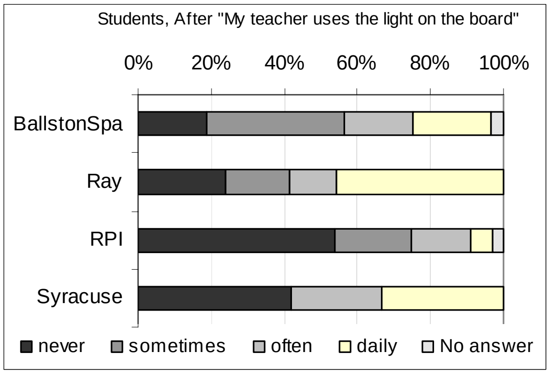


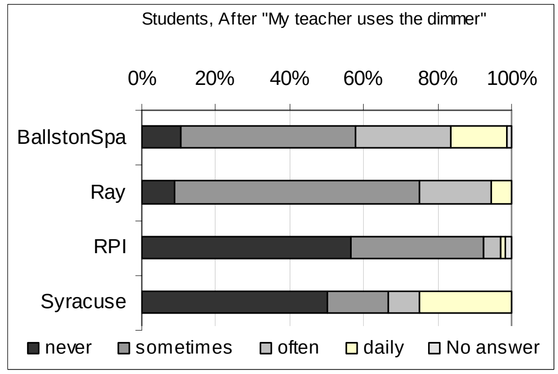


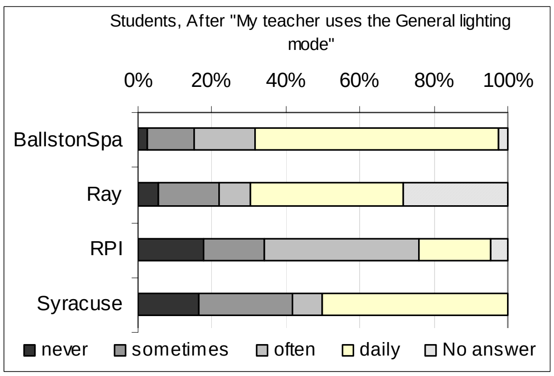


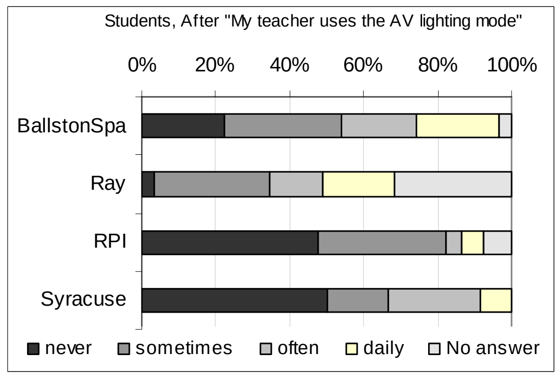


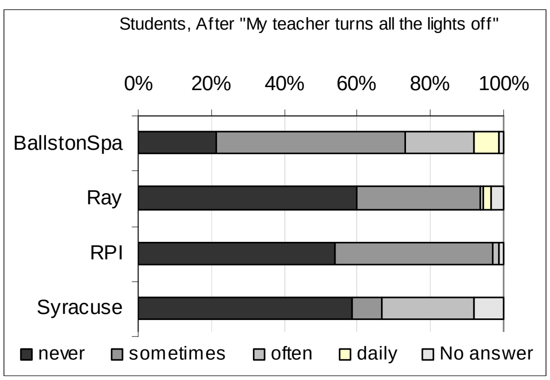



Students, After "My teacher uses the light on the board"
0%
20%
40%
60%
80%
100%
BallstonSpa
Ray
RPI
Syracuse
never
sometimes
often
daily
No answer

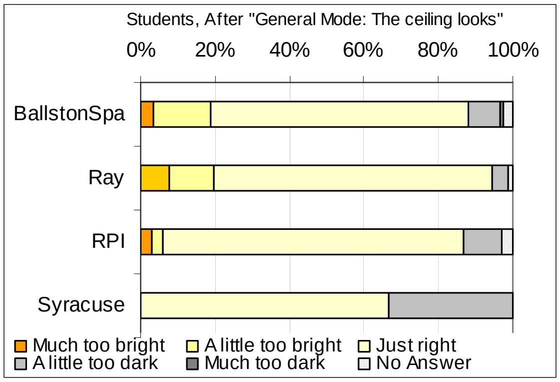

Students, After "My teacher uses the dimmer"
0%
20%
40%
60%
80%
100%
BallstonSpa
Ray
RPI
Syracuse
never
sometimes
often
daily
No answer

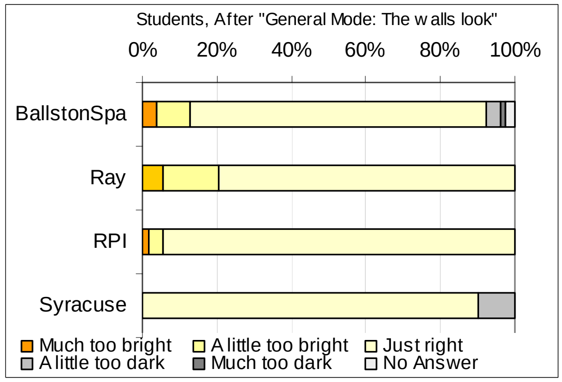

Students, After "My teacher uses the General lighting mode"
0%
20%
40%
60%
80%
100%
BallstonSpa
Ray
RPI
Syracuse
never
sometimes
often
daily
No answer

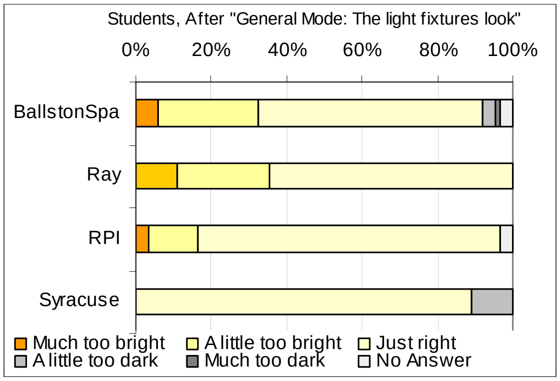

Students, After "My teacher uses the AV lighting mode"
0%
20%
40%
60%
80%
100%
BallstonSpa
Ray
RPI
Syracuse
never
sometimes
often
daily
No answer

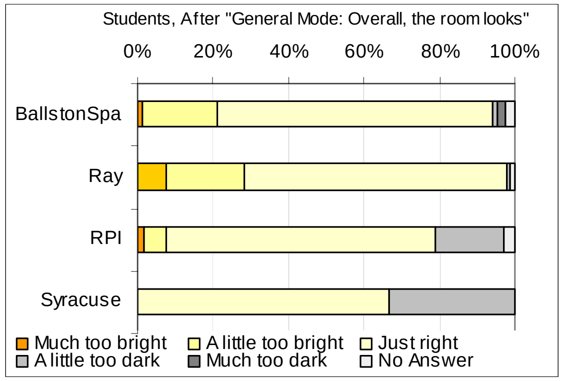

Students, After "My teacher turns all the lights off"
0%
20%
40%
60%
80%
100%
BallstonSpa
Ray
RPI
Syracuse
never
sometimes
often
daily
No answer

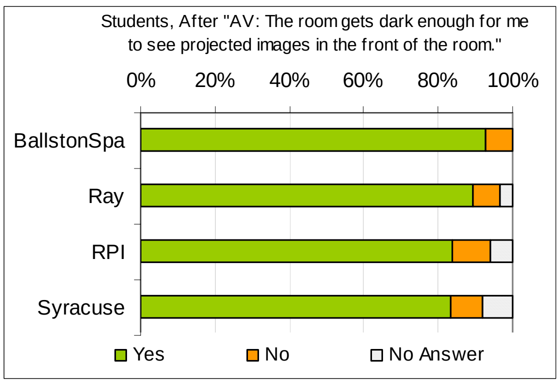
Appendix A – Human Factor Analysis Report

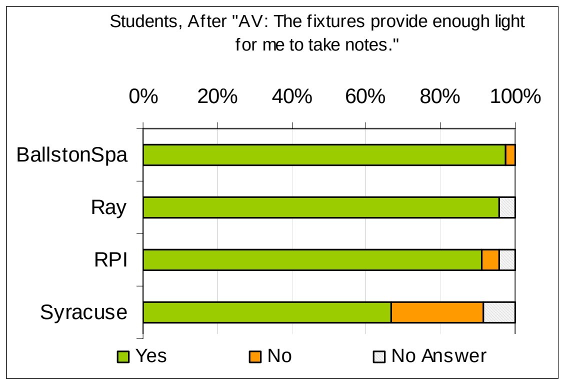


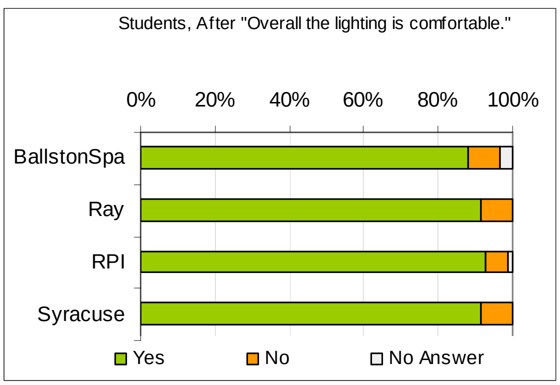


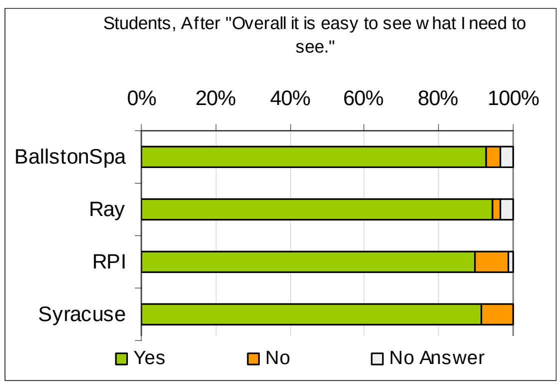


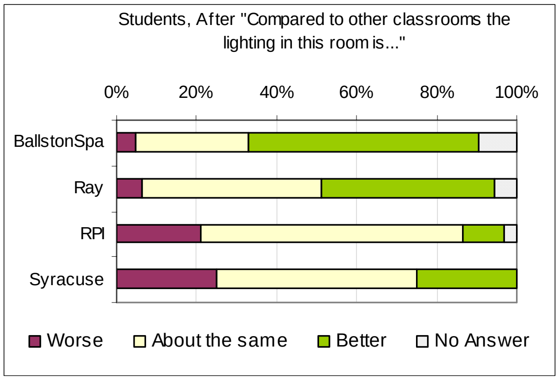


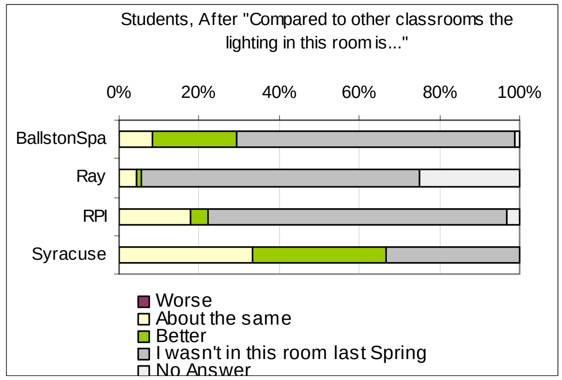









Students, After "Compared to other classrooms the lighting in this room is..."
0%
20%
40%
60%
80%
100%
BallstonSpa
Ray
RPI
Syracuse
Worse
About the same
Better
No Answer


Students, After "Compared to other classrooms the lighting in this room is..."
0%
20%
40%
60%
80%
100%
BallstonSpa
Ray
RPI
Syracuse
Worse
About the same
Better
I wasn't in this room last Spring
No Answer

Additional Comments from Students about lighting after ICLS retrofit:

Middle/High School Student Comments:

Note: A few[6] comments that were clearly sarcastic have been removed.

- “Glare on the smart board not bright enough”
- “Hang more lights similar to this system over summer break”
- “I don’t like the AV lights when its not dimmed. The light also give me a headache”
- “I don’t like the new lighting”
- “I don’t pay attention to the lights so my answers aren’t the best”
- “I have contacts and the general lighting hurts my eyes and makes it hard to read the smart board and sometimes the whiteboard too”
- “I like it very much”
- “I like that the lights come down off the ceiling”
- “I like the dark”
- “I like the fact that the lights hang from the ceiling making less glare”
- “I like the lighting. You should put them in all of the rooms”
- “I like the lights”
- “I really like the dimmer”
- “I think it is a great way to keep us alert- awake- and focused on the stuff being taught. All classes should have the lights. Sometimes it’s bright but most it’s not”
- “I think the lights are fantastic.”
- “It has a little bit of glare on the smart board when on general mode.”
- “It is ok although I never usually notice the lights.”
- “It is pretty.”
- “It is way too bright it hurts my eyes to look around and see. It glares off of everything and is distracting and annoying.”
- “It reflects off my desk because it is too bright and distracts me. It creates a glare that make it hard to see the smart board. I sit directly under the light. I like it more when the lights are completely dim.”
- “It would be more comfortable if the lights were dimmed a little bit”
- “Its pretty cool”
- “Its too bright in general mode”
- “Light is good”
- “Little bright”
- “Nice Lights”
- “Overall nice selection of lighting styles”
- “The AV lights shine on my desk”
- “The dimmer is better”
- “The dimming is nice”
- “The light is too bright. It makes my eyes hurt when its on the general light. I like the AV light setting”
- “The lighting in this room is just right but there is a glare right under the light”
- “The lighting is a good idea”
- “The lights are fantastic. Old lights are rubbish”
- “The lights are nice. It helps to see really well”
- “The smartboard projector glares on it”
- “There is some glare on my desk””

[6] Sarcastic comments that were removed included: 10 from middle/high school students, and (none) from university students.

- "This is a very good lighted room"
- "To me overall I think this class is much too bright. I like it much better with dimmed lights"
- "Too bright needs to be darker. I concentrate more when it is darker."
- "When the lights are off for a minute and you turn them back on they irritate your eyes."

University Student Comments:

- "Green Lighting would help us learn better"
- "I have had about 3 classes in this room so far, and the lighting is fine. We don't use any audio-visual aids, and she NEVER writes on the board. So, for many of these questions if there was an 'I dont know' answer- that would have been my answer."
- "Light should be on the projector or board only. Makes it easier to pay attention and see"
- "Non about the lighting, but this classroom has horrible ventilation. It is difficult to concentrate because the air makes people get very tired."
- "The light fixture for the blackboard is in the way of the projector screen so I often have a hard time seeing the overheads."
- "The light fixtures for the chalkboard area make viewing the top of the overhead projector screen impossible to read unless you sit far enough forward that you can see under the lighting 'tube.'"
- "This room is very stuffy and uncomfortable due to bad ventilation. That feeling of discomfort makes it more difficult to judge the quality of the lighting."
- "We don't watch any videos or use powerpoints in this class. So the lighting is always set at general."
- "When optimized for viewing the chalkboard, the lighting lets me see the chalkboard well, but not the projections. When optimized for the projections, the situation is reversed. This is sort of sensible, but it is often the case that notes on the" (cutoff)
- "Works well with the projector"

Electrician Comments

Ray Middle School
"It went in pretty quick. It came with a wiring diagram. Control box was premade. Because of the monitoring they had to make some connections in the field but it was pretty easy. It was layed out pretty nice. It was pretty much a plug and play system."

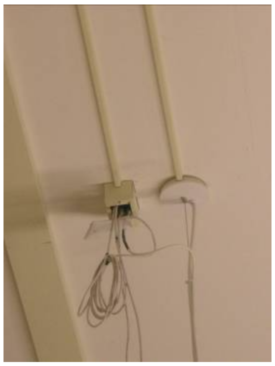
Scarsdale High School
"It was a fairly simple installation. It's a good quality product. Finelite had a lot of technical support the few times we needed help. There were some callbacks on their equipment that failed. But they got the parts in a reasonable amount of time. They're a good company to work with. It's a good product and a well-made fixture."

Ballston Spa Middle School
"The system was actually very simple to install. Fixtures came with cat5 cabling that went back to controller. Drawings couldn't have been any easier. They (Finelite) made the magic happen. We just brought our cabling back to controller. The owner ran cable from controller back to the data rack. They (Finelite) came out with a drawing in each of the room locations, with part numbers and everything. When fixtures got delivered it was all prelabeled per room. It really couldn't have been any easier."

Syracuse University
"As far as installation, it was a good installation. We can't complain. We'd like to do it again."

Syracuse University, other comments

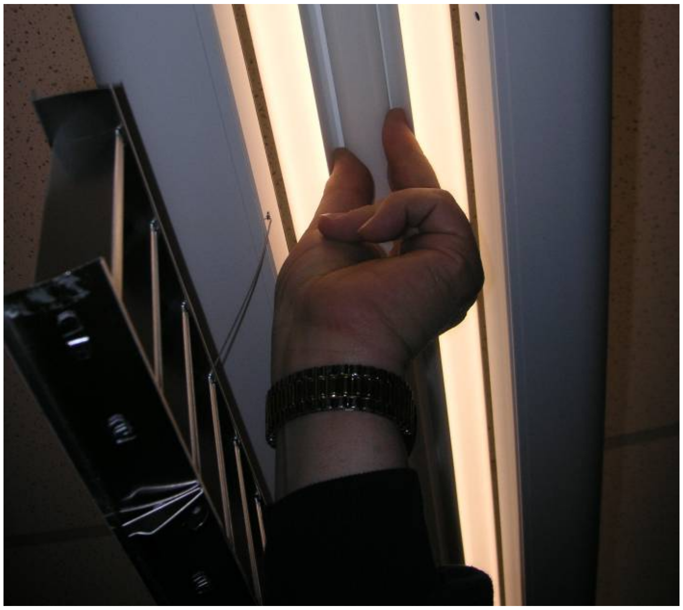
- Project manager at the site reports that the electrician disliked the control box. The contact at SU itself mentioned to LRC many reasons why he didn't care for the construction of the Control. He finds it messy. He is worried about how the power supply is cantilevering in the air. He prefers electrical connections not with wire nuts. He thinks they should use a terminal strip. He's worried about mixing line voltage and low voltage in the same control box. He doesn't find this control box to be "solidly" built.
- Since the monitoring wire is modular, it can't be shortened in the field, so it is looped in a messy fashion. (See photos below.) Note: monitoring would only be done for these demonstration sites, not for typical sites.




Maintenance Comments:

Ray Middle School:

- It is difficult to fit fingers between the reflector and the lamp to change lamps. (See photo below.) This could cause lamps to be seated improperly in the sockets, which can cause premature failure when used with dimming ballasts, as in the AV mode.[7]
- "What is the intended cleaning procedure? Are there some recommendations?"



Ballston Spa Middle School

- LRC noted that there were non-operational lamps in one room. It is unclear whether this is caused by a dimming ballast in the AV mode, or failed lamps, or both.
- LRC noted that there were crushed baffles in fixture, in the same fixture. This may relate to the problem above. (See photos below.)

[7] For more information about the importance of lamp seating with dimming ballasts, see NLPIP Lighting Diagnostics "Dimming T8 Fluorescent System Problems." This publication is available online at: http://www.lrc.rpi.edu/programs/NLPIP/publications.asp

Appendix A – Human Factor Analysis Report

Rensselaer Polytechnic Institute
"We have not received any repair requests that I know of. Things seem to be operating smoothly thus far. We had a couple of dimming ballasts fail in Carnegie 201 early on, but those were replaced quickly."

New School
"Everything is functioning well. No reports of any problems."

Syracuse University

- Some controllers did fail, and were replaced. It may be difficult to determine what loads the relays control, because the relays are crowded together in the control box. (Note: Labels are visible once disassembled)
- Aside from the wiring in the control box (described above), the people at this site are happy with how the system functions in the rooms.
- The contact at SU told LRC that he thinks the ICLS provides good lighting quality and good power density. He thinks ICLS should be made a state standard. He also thinks the Catholic schools need a lot of help with their lighting, and would benefit from a system such as this.
- LRC observed that in one room (Carnegie 219), the master on switch was TAPED in "on" position, as per photo below. However, the lights didn't come on when LRC entered the room. After several minutes of flicking on and off the master switch, the lights did come on. The tape is evidence that LRC was not the first to experience problems with this switch. It is unclear what caused this intermittent problem.
- LRC noted that the labeling on several of the switches has worn off such that it is difficult to read. This may be due to cleaning of accumulated chalk dust. (See photos at below.)
- LRC noted that the whiteboard light flashes and flickers when being turned OFF, even when warmed up. It is unclear what would cause this strange operation. No teachers commented about this experience.

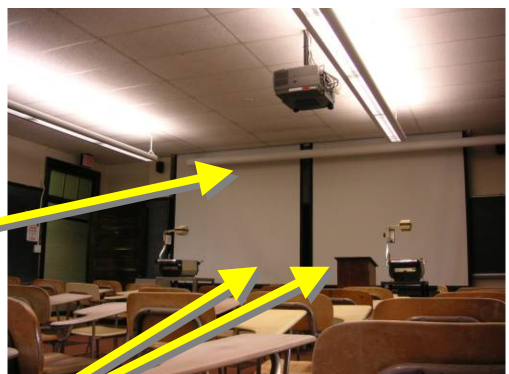
Room Integration

There are wide variations in furniture orientation, partly due to architectural variety, and partly based on individual teaching preference and course material. But most classrooms do still use a “front” of the room around which instructors focus their AV presentations.

When only one projector is used in a classroom, it can easily be positioned between the two rows of ICLS luminaires. However, universities sometimes use side-by-side projections which require extra coordination with projectors, screens, and luminaires. When two screens are used, and when the LCD projector is mounted on the ceiling, placement may conflict with the lighting, thus may need to be mounted on an extended stem. (See photos below.)

One instructor at RPI commented that he likes to use an overhead projector on one side and the blackboard on the other side, at the same time. If he uses the Whiteboard light in this instance, it would wash out projected images.

Also, the photos below show how the whiteboard light hangs below the screen, thus blocking part of the projected image. One RPI instructor commented that he found this was quite annoying, and dislikes teaching in this room as a result. Most sites mount the screen on the wall, rather than recessing above the ceiling, thus they do not extend above the Whiteboard light.



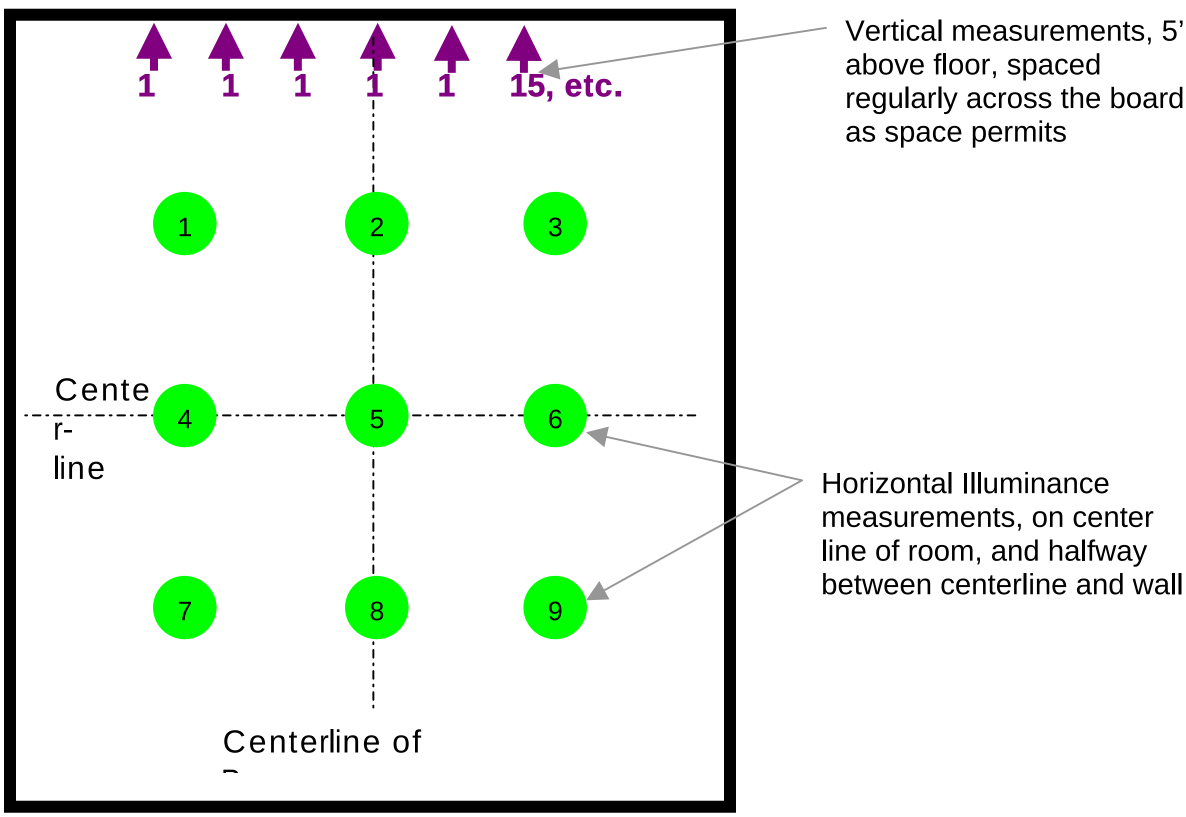
LCD projector now requires an extended mounting stem to be below pendant ICLS

Whiteboard light blocks projection screens

Two screens for use with overhead transparencies and LCD projectors

Illuminance Measurements

This was a study about lighting *quality*, rather than *quantity*. Nonetheless, LRC verified that the amount of light was sufficient for the classroom environment. LRC compared illuminance across all schools despite wide variations in room geometries. LRC devised a plan to measure illuminance in a standardized manner across all schools. As shown in Figure 6, nine horizontal measurement points were positioned at desktop level. Points were located along the lateral and transverse centerlines of the room, and halfway between the centerline and the wall. Vertical illuminance measurements took place at regular intervals across the primary board surface in the “front” of the room.



LRC visited the seven schools with the ICLS. Appendix 2 shows the average horizontal illuminances across these nine points at the desk level, and the various vertical illuminance points. Figures 7 and 8 summarize the illuminance data graphically. Average horizontal illuminances were typically 30-50 fc before the retrofit. After the retrofit, illuminances were slightly higher with the general mode (typically averaging 40-50 fc), and slightly lower in the AV mode (typically averaging 25-40 fc).

Before the retrofit, average vertical illuminances on the front board typically ranged 15-25 fc. After the retrofit, vertical illuminances on the board were higher with the whiteboard light (typically 20-35 fc) and lower with just the general lighting (typically 15-20 fc).

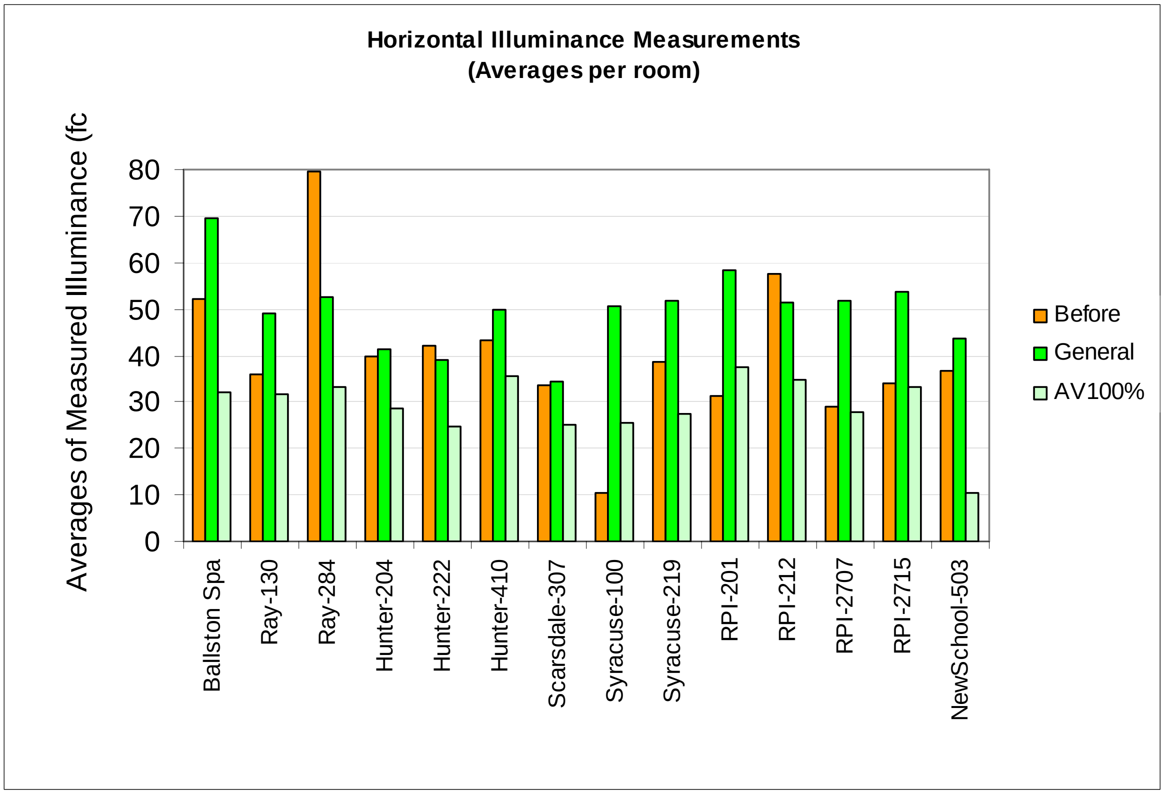


Figure 7: Horizontal Illuminances, averages of nine points in each room

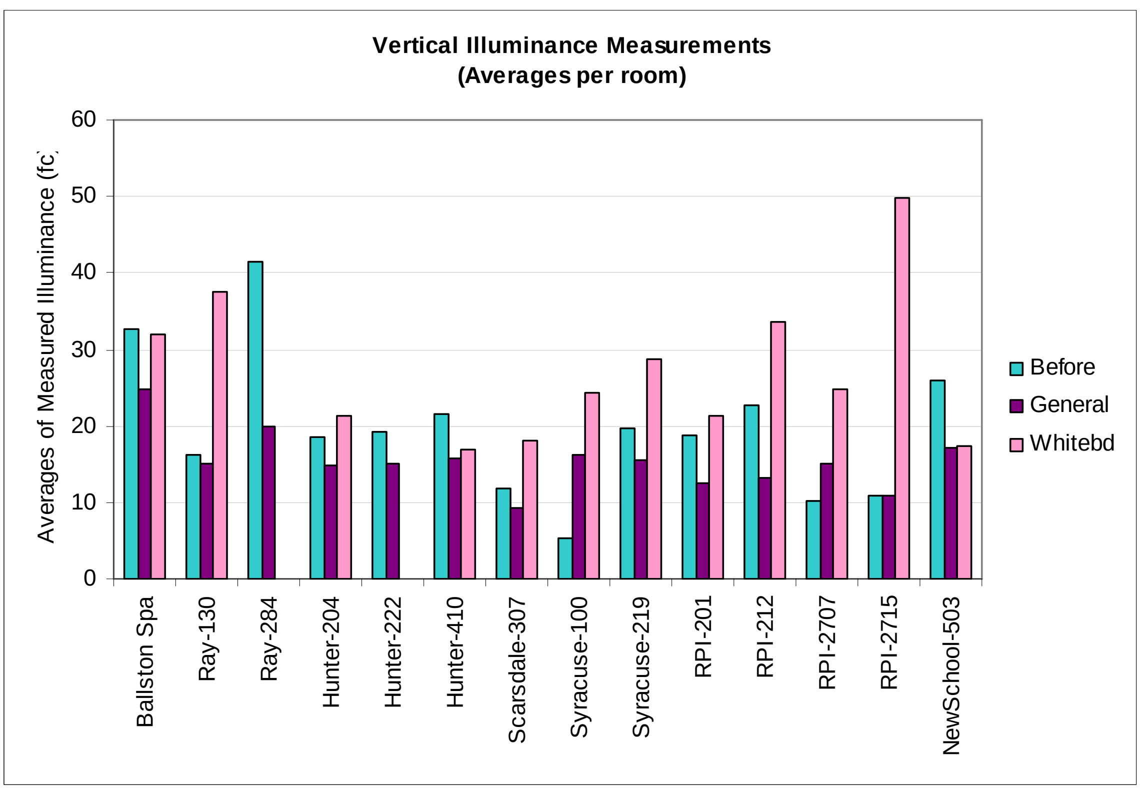


Figure 8: Vertical Illuminances on the front board, averages of 4-7 points in each room

Spot-checking of Monitoring and Energy Use

Finelite collected monitoring data for both the 7 control rooms and the 28 classrooms retrofitted with the ICLS. LRC reviewed these data and found it to be reasonable given the reductions in lighting power density. Figure 9 shows the power densities at all the sites before and after retrofit.

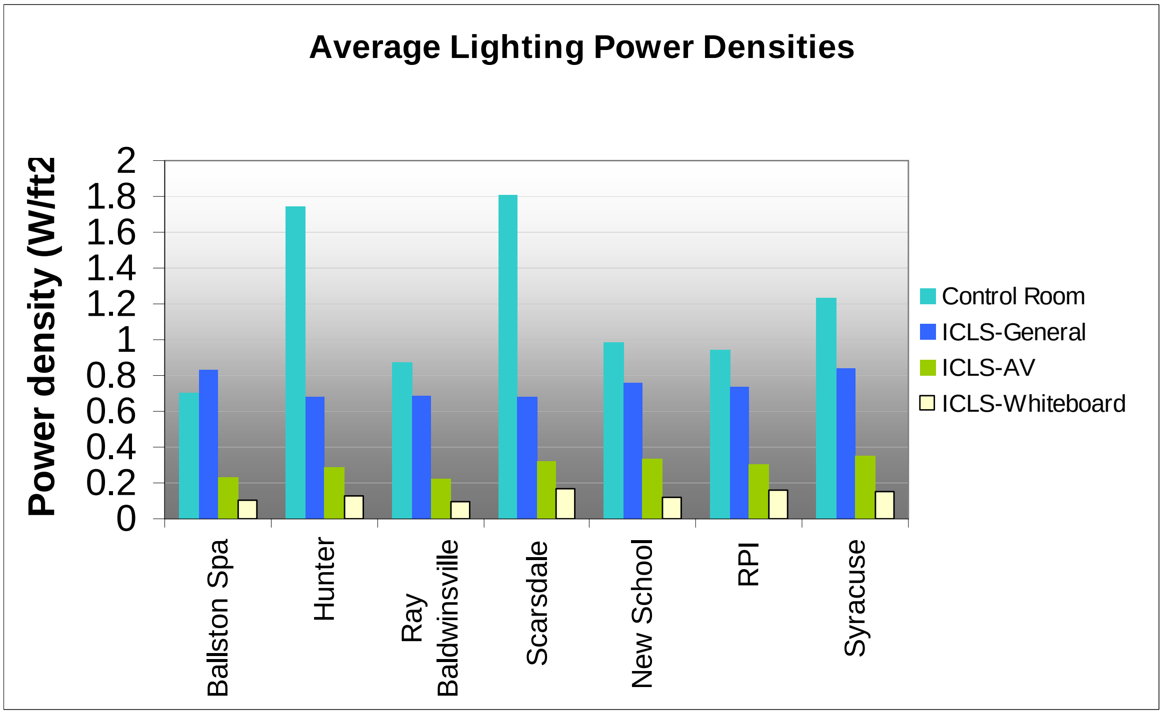


Figure 9: Lighting power densities before and after retrofit

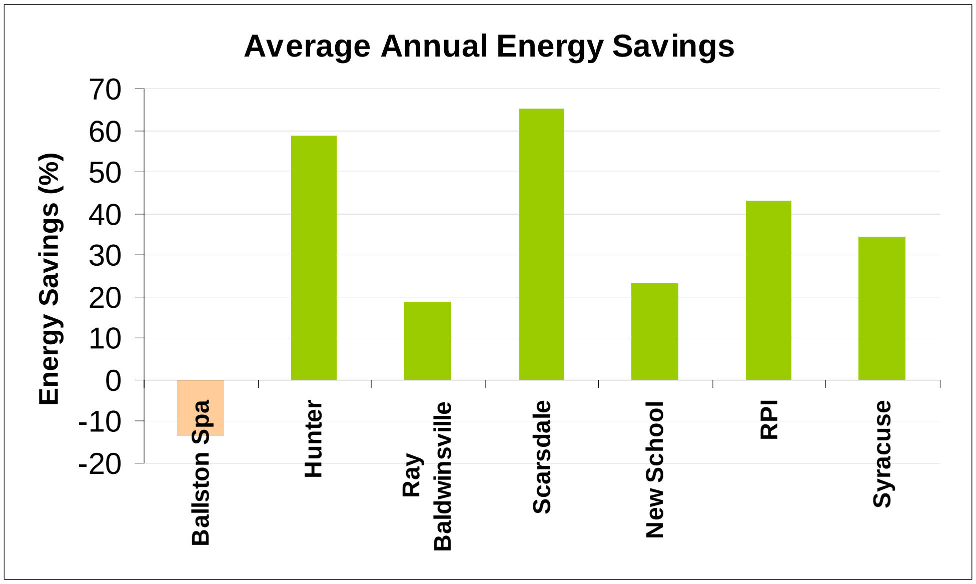


Figure 10: Average annual energy savings for the 7 schools in the demonstration

LRC performed a spot check of energy data at all the sites. As shown in Figure 10, energy savings varied primarily depending on the difference between power density of the Control condition, compared to that of the ICLS General lighting mode. As shown in Figure 11, classrooms with ICLS used an average of 38% less energy per square foot, compared to the control classrooms.

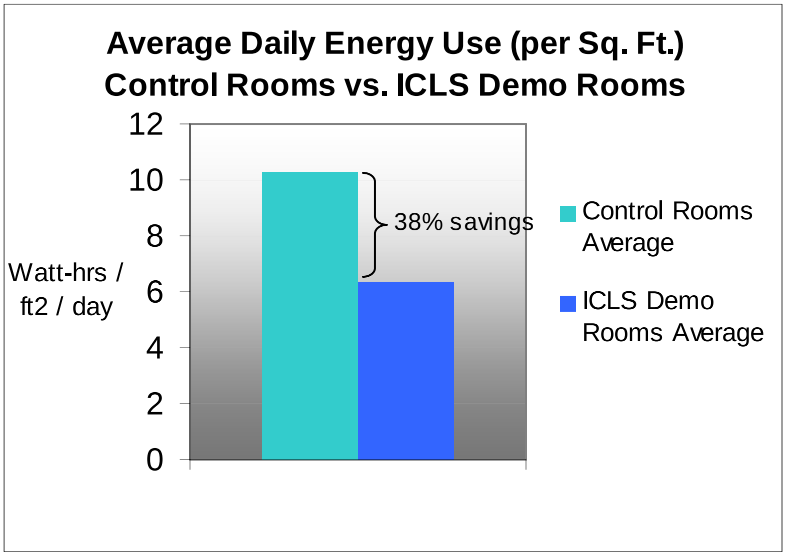


Figure 11: Average Daily Energy Use: Control Rooms vs. ICLS Demo Rooms

Only Ballston Spa Middle School exhibited increased energy use after converting its rooms to the ICLS (+14%, as per Figure 10). It should be noted that they had very low power density before the change. Ballston Spa also increased average general lighting levels by +30%. (See Appendix 2, page 55.)

The other primary source of reduced energy use was the lower power density of the A/V mode. Teachers no longer need to leave the lighting at full or partial output to allow students to take notes during audio-visual presentations. They can switch to the A/V mode and dramatically reduce lighting power density while maintaining visibility.

Appendix 1: Blank Survey Questions

Teacher Survey, Before

A research study is being performed about the **lighting** at Ray Middle School, rooms 113, 130, 179, 181, and 284. Because you teach in one of these classrooms, please take a moment to give your opinions about the **lighting** in this classroom. Your answers will be kept in the strictest confidence, and will not be viewed by any department administration. If you have any questions, please contact Jennifer Brons at (518) 687-7136 or bronsj@rpi.edu.

Name: ______ Subject/Course: ______ Period: ______

In which room(s) do you teach?: . . . . ☐ Room 113 ☐ Room 130 ☐ Room 179 ☐ Room 181 ☐ Room 284

Your Age: ○ 20-29 ○ 30-39 ○ 40-49 ○ 50-59 ○ 60+ How long have you been teaching in this room? (Yrs) ______

DURING NORMAL CLASS TIME:

When I'm **lecturing/reading out loud,** I have enough light to see the students: . . . . ○ *Yes* ○ *No* ○ *N/A*

When I'm lecturing/reading out loud, I have enough light to see **my printed notes**: . . . ○ *Yes* ○ *No* ○ *N/A*

When I'm **writing on the board**, I have enough light to see what I am writing: . . . . ○ *Yes* ○ *No* ○ *N/A*

When I'm **working at my desk,** I have enough light to see my task: . . . . ○ *Yes* ○ *No* ○ *N/A*

When viewing the following spaces:

The **ceiling** looks:	○ *Much too bright*	○ *A little too bright*	○ *Just right*	○ *A little too dark*	○ *Much too dark*
The **walls** look:	○ *Much too bright*	○ *A little too bright*	○ *Just right*	○ *A little too dark*	○ *Much too dark*
The **light fixtures** look:	○ *Much too bright*	○ *A little too bright*	○ *Just right*	○ *A little too dark*	○ *Much too dark*
Overall, the room looks:	○ *Much too bright*	○ *A little too bright*	○ *Just right*	○ *A little too dark*	○ *Much too dark*

WHEN USING PROJECTED IMAGES:

During audiovisual presentations, I have enough light to see **the students**: . . . . ○ *Yes* ○ *No* ○ *N/A*

During audiovisual presentations, I have enough light to see **my teaching equipment**: ○ *Yes* ○ *No* ○ *N/A*

During audiovisual presentations, I have enough light to see **my printed notes**: . . . . . ○ *Yes* ○ *No* ○ *N/A*

The room gets **dark enough** to see projected images at the front of the room: . . . . ○ *Yes* ○ *No* ○ *N/A*

I use the following audiovisual tools in this classroom: (indicate all that apply)

- ☐ *LCD Projector*
- ☐ *TV*
- ☐ *Overhead transparency projector*
- ☐ *Slide projector*
- ☐ *There are no audiovisual tools in this room.*

Do you use the lights to change the behavior of students in this classroom? . . . . ○ *Yes* ○ *No*

If "yes", for what reason? (indicate any that apply)

- ☐ *To calm down students*
- ☐ *To make students more alert*
- ☐ *To direct their attention to something*
- ☐ *Other (Explain):* ______

Just a few more questions >>>>>>>>

Sometimes the lights turn off automatically when I'm in the room: . . . . ◯ *Yes* ◯ *No*

If "yes", for when does this occur?

- ☐ *When I work alone in the room after class is dismissed*
- ☐ *When I am administering a test*
- ☐ *Other (Explain):* [ ]

The location of the switches for the lighting is:

◯ *Very convenient* ◯ *Somewhat convenient* ◯ *Neutral* ◯ *Somewhat inconvenient* ◯ *Very inconvenient*

Do you ever need to make this classroom **totally dark**? . . . . ◯ *Yes* ◯ *No*

If "yes", for what reason?

- ☐ *Audiovisual presentations*
- ☐ *Other (Explain):* [ ]

How do you darken the room? (indicate any that apply)

- ☐ *Close the window shades*
- ☐ *Turn off all lights*
- ☐ *Other (Explain):* [ ]

OVERALL:

The room looks: . . . . ◯ *Spacious* ◯ *Neutral* ◯ *Confining*

The lighting is comfortable: . . . . ◯ *Yes* ◯ *No*

It is easy to see what I need to see: . . . . ◯ *Yes* ◯ *No*

Compared to other classrooms the lighting in this room is: ◯ *Worse* ◯ *About the same* ◯ *Better*

If you could change the lighting in this classroom, what changes would you make? ☐ None [ ]

If you could change the lighting controls, what changes would you make? ☐ None [ ]

Other comments about the lighting in the classroom: [ ]

Thank you for completing this survey! - Lighting Research Center, Rensselaer Polytechnic Institute

Teacher Survey, After

Researchers are evaluating a lighting system that was installed last summer. Your opinions regarding this lighting system are very important and will assist researchers to understand which attributes of lighting are important for providing quality education.

Name: ____________ Subject/Class Name: ____________

School and Room:

Age: 20-29 30-39 40-49 50-59 60+

How long have you been teaching in this classroom? ______yrs

The lighting system has different modes of operation labeled "**General", "A/V Mode", "A/V Mode Dimming", "Whiteboard" and Quiet Time"** on switches. The following questions refer to these modes.

1a) For what activities do you use the **"General"** lighting mode? (Choose all that apply)

Lecture *Discussion* *Homework* *Test* *A/V Presentations*

While teaching from white/black board *Other:________________________* *I don't use this mode*

1b) Do you find the "General Mode" to be **helpful** in your teaching?

Very helpful *Somewhat helpful* *Neutral* *Somewhat unhelpful* *Very unhelpful*

2a) For what activities do you use the **"A/V"** lighting mode? (Choose all that apply)

Lecture *Discussion* *Homework* *Test* *A/V Presentations*

While teaching from white/black board *Other:________________________* *I don't use this mode*

2b) Do you find the "A/V" mode to be **helpful** in your teaching?

Very helpful *Somewhat helpful* *Neutral* *Somewhat unhelpful* *Very unhelpful*

3a) For what activities do you use the **"Quiet Time"** button? (Choose all that apply)

Lecture *Discussion* *Homework* *Test* *A/V Presentations*

While teaching from white/black board *Other:________________________* *I don't use this mode*

3b) Do you find the "Quiet Time" feature to be **helpful** in your teaching?

Very helpful *Somewhat helpful* *Neutral* *Somewhat unhelpful* *Very unhelpful*

4a) For what activities do you use the **whiteboard light**? (Choose all that apply)

Lecture *Discussion* *Homework* *Test* *A/V Presentation*

While teaching from white/black board *Other:________________________* *I don't use this mode*

4b) Do you find the whiteboard light to be **helpful** in your teaching?

Very helpful *Somewhat helpful* *Neutral* *Somewhat unhelpful* *Very unhelpful*

5a) How often do you adjust the **dimmer** in the A/V mode?

Every time I teach here *Often* *Sometimes* *Rarely* *Never*

5b) Do you find the dimmer to be **helpful** in your teaching?

Very *Somewhat* *Neutral* *Somewhat* *Very* *helpful* *helpful* *helpful* *helpful*

6a) Do you use the lights to change the behavior of students in this classroom? …………………… *Yes* *No*

6b) If "yes", for what reason? (Indicate any that apply)

____*To calm down students*

____*To make students more alert*

____*To direct their attention to something*

____*Other:* ________________________________

7a) Sometimes the lights turn off automatically when I'm in the room…………………………………… *Yes* *No*

7b) If "yes", for when does this occur?

____*When I work alone in the room after class is dismissed*

____*When I am administering a test*

____*Others:* __________________________

8) The location of the switches for the lighting is:

Very convenient *Somewhat convenient* *Neutral* *Somewhat inconvenient* *Very inconvenient*

9a) Do you clearly understand the labels on the switches? *Clear* *Unclear*

9b) If "unclear", which labels? *"Whiteboard"* *"A/V Dimming"* *"General Mode"* *"A/V Mode"* *"Quiet Time"*

10a) I **notice** the delay in starting the light bulbs when changing between "General" and "A/V" lighting modes:

Agree *Disagree* *Noticed at first, but not anymore*

10b) I find this delay……*Acceptable* *Somewhat Acceptable* *Neutral* *Somewhat Unacceptable* *Unacceptable*

11) What type of **instruction** did you receive about operating this lighting system? (circle any that apply)

Training with representatives *Product brochure* *Manufacturer website* *I received no training*

12a) What type of computers do your students use in class? *Laptops* *Desktop computers* *N/A*

12b) What mode of lighting do you typically use when students use computers? *General* *A/V*

13) This room looks ____________. *Spacious* *Neutral* *Confining*

14) If you could change the lighting in this classroom, what would you change? ____________________________________

15) If you could change the lighting controls in this classroom, what would you change? ___________________________

16) Any other comments about the lighting in this classroom?

Thank you! Lighting Research Center, Rensselaer Polytechnic Institute

Student Survey, Before

I have a class in the following room . . . . . ☐ Room 113 ☐ Room 130 ☐ Room 179 ☐ Room 181 ☐ Room 284

Instructor: ____ Date: ____ Period: ____ Subject: ____

Please answer these questions about the LIGHTING in this classroom.

DURING NORMAL CLASS TIME:

The light fixtures provide enough light for me to see **writing on the board**: . . . . ○ *Yes* ○ *No*

When viewing the whiteboard, **reflections from the lights** make it hard to see writing: . ○ *Yes* ○ *No* ○ *No whiteboard in this room*

The fixtures provide enough light for me to **take notes at my desk**: . . . . ○ *Yes* ○ *No*

When viewing the following spaces:

The **ceiling** looks:	○ *Much too bright*	○ *A little too bright*	○ *Just right*	○ *A little too dark*	○ *Much too dark*
The **walls** look:	○ *Much too bright*	○ *A little too bright*	○ *Just right*	○ *A little too dark*	○ *Much too dark*
The **light fixtures** look: .	○ *Much too bright*	○ *A little too bright*	○ *Just right*	○ *A little too dark*	○ *Much too dark*
Overall, the room looks:	○ *Much too bright*	○ *A little too bright*	○ *Just right*	○ *A little too dark*	○ *Much too dark*

WHEN VIEWING PROJECTED IMAGES:

When projecting images in the front of the classroom, my instructor turns off . . ○ ***all of** the lights* ○ ***some** of the lights* ○ ***none** of the lights*

The room gets **dark enough** for me to see projected images at the front of the room: ○ *Yes* ○ *No*

The overhead fixtures provide enough light for me to **take notes**: . . . . ○ *Yes* ○ *No*

When watching the **TV**, reflections from the lights make it hard to see the screen: . . ○ *Yes* ○ *No* ○ *We don't use the TV* ○ *No TV in this room*

OVERALL:

The lighting is comfortable: . . . . ○ *Yes* ○ *No*

It is easy to see what I need to see: . . . . ○ *Yes* ○ *No*

Compared to other classrooms, the lighting in this room is: . ○ *Worse* ○ *About the same* ○ *Better*

Other comments about the lighting in this classroom:

Thank you for completing this survey! - Lighting Research Center, Rensselaer Polytechnic Institute

Please return this survey to your teacher.

Student Survey, After

Room # _____ Teacher: ______________ Date: ____________ Period: _________ Subject: ____________________

Below are questions about the LIGHTING in this classroom. Please circle whichever answer you agree with.

My teacher uses the **light on the board**…………………………………………………… *Never Sometimes Often Daily*

My teacher uses the **dimmer** ………………………………………………………………… *Never Sometimes Often Daily*

My teacher turns all the lights **off** ………………………………………………………… *Never Sometimes Often Daily*

My teacher uses the **"General"** lighting mode …………………………………………… *Never Sometimes Often Daily*
(Light over the desks is directed both up and down)

My teacher uses the **"Audio Visual"** lighting mode ……………………………………… *Never Sometimes Often Daily*
(Light over the desks is directed down only)

The light fixtures provide enough light for me to see **writing on the board** ………………………………………… *Yes No*

When viewing the **whiteboard**, reflections from the lights make it hard to see writing: …………*Yes No No whiteboard*

When watching the **TV**, reflections from the lights make it hard to see the screen:

Yes No We don't use the TV No TV in this room

When using a **computer**, reflections from the lights make it hard to see the screen:

Yes No We don't use the computer(s) No Computers in this room

DURING NORMAL CLASS TIME (lighting set to "General" mode):

The fixtures provide enough light for me to **take notes at my desk**………………………………………………… *Yes No*

When viewing the following spaces in "General" lighting mode:

The **ceiling** looks: ……………	*Much too bright*	*A little too bright*	*Just right*	*A little too dark*	*Much too dark*
The **walls** look: ………………	*Much too bright*	*A little too bright*	*Just right*	*A little too dark*	*Much too dark*
The **light fixtures** look:……..	*Much too bright*	*A little too bright*	*Just right*	*A little too dark*	*Much too dark*
Overall, the room looks: ……	*Much too bright*	*A little too bright*	*Just right*	*A little too dark*	*Much too dark*

WHEN VIEWING PROJECTED IMAGES (lighting set to "A/V" mode):

The room gets **dark enough** for me to see projected images at the front of the room: ……………………………. *Yes No*

The fixtures provide enough light for me to **take notes**: ………………………………………………………………… *Yes No*

OVERALL:

The lighting is comfortable……………………………………………………………………………………………. *Yes No*

It is easy to see what I need to see ……………………………………………………………………………………. *Yes No*

Compared to other classrooms the lighting in this room is: …………………………….. *Worse About the same Better*

Compared to the old lighting in this room last year, the new lighting is:

Worse About the same Better I wasn't in this room last year

Any other comments about the lighting in this classroom?

Thank you for completing this survey! **Lighting Research Center, Rensselaer Polytechnic Institute**

Appendix 2: Illuminance Measurements, Before and After ICLS Installation

Ballston Spa - Room 110

Horizontal Illuminance (lux) @ 30" above finished floor (a.f.f.)

	Measurement Pt	Average	1	2	3	4	5	6	7	8	9
Before	Electric		514	567	542	571	636	625	535	575	533
			516	561	537	570	632	626	523	571	522
			520	561	535	567	636	624	526	565	522
		563	**517**	**563**	**538**	**569**	**635**	**625**	**528**	**570**	**526**
After	General Only		877	486	858	792	520	792	863	524	973
			883	490	879	799	523	799	867	526	980
			883	493	883	797	528	795	868	528	979
		748	**881**	**490**	**873**	**796**	**524**	**795**	**866**	**526**	**977**
	A/V 100%		402	237	395	337	226	337	458	269	453
			402	238	393	338	225	338	458	269	453
		346	**402**	**238**	**394**	**338**	**226**	**338**	**458**	**269**	**453**
	A/V @min		20	12	19	18	10	16	26	14	22
			19	11	19	17	11	17	26	14	22
		17	**20**	**12**	**19**	**18**	**11**	**17**	**26**	**14**	**22**

Vertical Illuminance across chalkboard

		Average	10	11	12	13	14	15	16	17
Before	Electric		345	360	364	360	357	352	343	325
			341	358	365	364	361	358	347	326
			342	358	362	361	359	355	345	323
		351	**343**	**359**	**364**	**362**	**359**	**355**	**345**	**325**
After	General		255	269	275	277	277	275	263	242
			254	267	275	276	277	273	266	243
			258	269	276	277	276	274	265	245
		267	**256**	**268**	**275**	**277**	**277**	**274**	**265**	**243**
	Whiteboard Light (AV @min)		330	387	412	399	383	350	309	208
			322	383	399	392	381	352	309	203
			325	382	401	392	376	349	312	209
		344	**326**	**384**	**404**	**394**	**380**	**350**	**310**	**207**

RayMS-130

Horizontal Illuminance (lux) @ 28" above finished floor (a.f.f.)

	Measurement Pts	Average	1	2	3	4	5	6	7	8	9
Before	Electric + daylight		449	430	437	308	321	305	431	419	428
	Daylight only		2.5	2.4	6.3	4.4	2.3	2.3	1.9	2.1	6.3
	Electric only	389	447	428	431	304	319	303	429	417	422
After	General + whiteboard		499	583	381	606	706	453	508	601	392
			495	585	382	609	714	451	510	599	389
			497	585	381	608	713	451	515	603	392
		526	497	584	381	608	711	452	511	601	391
	A/V 100%		298	321	244	401	469	334	322	398	287
			298	323	236	401	466	336	323	400	287
			300	322	243	397	467	335	320	396	286
		341	299	322	241	400	467	335	322	398	287

Vertical Illuminance across chalkboard

		Average	10	11	12	13	14
Before	Electric + daylight		172	177	175	180	175
	Daylight only		1.7	2	2.2	2.4	3.3
	Electric only	173	170	175	173	178	172
After	General + whiteboard		547	603	610	570	490
			547	606	611	583	490
			547	606	609	585	487
		566	547	605	610	579	489
	General only	161	160	162	167	158	161
	Whiteboard Light (AV @min)		385	442	444	420	324
			387	443	442	421	331
			388	444	444	424	330
		405	387	443	443	422	328
	A/V 100%		30	30	40	41	33
			30	30	40	41	33
		35	30	30	40	41	33

RayMS-284

Horizontal Illuminance (lux) @ 29" above finished floor (a.f.f.)

	Measurement Pts	Average	1	2	3	4	5	6	7	8	9	
Before	**Electric + daylight**		838	858	810	916	919	876	866	857	846	
	Daylight only		4.6	5.7	4.2	6	7.1	10.8	11	11.5	23	
	Electric only	**856**	**833**	**852**	**806**	**910**	**912**	**865**	**855**	**846**	**823**	
After	Little bit of spill around shades		3	3	2	4	3	3	7	3	6	
	General + whiteboard		449	683	442	529	872	553	421	695	467	
			445	686	446	529	872	567	421	695	465	
			445	688	444	530	870	565	421	694	469	
			446	686	444	529	871	562	421	695	467	Average
		565	444	683	443	526	868	558	414	691	462	Subtract daylight spill
	A/V 100%		253	415	271	345	573	366	277	469	295	
			257	415	272	341	573	365	276	467	294	
			256	415	273	343	574	365	275	467	294	
			255	415	272	343	573	365	276	468	294	Average
		359	253	412	271	339	570	362	269	464	289	Subtract daylight spill

Vertical Illuminance across chalkboard

		Average	10	11	12	13	14	
Before	**Electric + daylight**		466	455	422	479	426	
	Daylight only		2.3	2.7	2.9	2.5	1.6	
	Electric only	**447**	**464**	**452**	**419**	**477**	**424**	
After	Little bit of spill around shades		2.7	2.4	1.8	1.6	1.3	
	General + whiteboard		530	633	558	341	251	
			520	629	551	338	248	
			516	626	553	339	245	
			522	629	554	339	248	
		N/A	519	627	552	338	247	
	General only	213	200	214	220	222	210	
	Whiteboard Light (AV @min)		Bulletin Bd	Whitebd				Smart board, not whiteboard; not illuminated
			322	415	336	120	39	
			322	415	333	117	37	
			322	415	333	116	37	
			322	415	334	118	38	
		N/A	319	413	332	116	36	
	A/V 100%		55	69	76	74	60	
			57	69	77	75	63	
			57	69	76	74	62	
			56.3	69	76.3	74.3	61.7	
		66	53.6	66.6	74.5	72.7	60.4	

Appendix A – Human Factor Analysis Report

Syr-100 (=114)

Horizontal Illuminance (lux) @ 27" above finished floor (a.f.f.)

		Average	1	2	3	4	5	6	7	8	9	
Before	Electric + daylight		144	147	100	140	150	127	222	195	155	
Before	Daylight only		37	38	24	47	44	32	48	51	55	
Before	Electric only	**112**	**107**	**109**	**76**	**93**	**106**	**95**	**174**	**144**	**100**	
After	*Daylight spill*		*12.2*	*13.8*	*10.7*	*14.7*	*14.7*	*15*	*14.3*	*17.2*	*20.7*	*Daylight spill*
After	General + whiteboard		611	401	547	622	446	592	684	457	694	
			606	401	547	623	442	589	684	453	688	
			603	399	546	622	433	594	684	455	689	
			607	400	547	622	440	592	684	455	690	Average
		545	594	387	536	608	426	577	670	438	670	Subtract daylight spill
After	A/V 100%		310	248	266	301	256	280	363	278	331	
			308	243	260	300	254	277	361	280	323	
			306	242	265	300	252	277	361	280	331	
			308	244	264	300	254	278	362	279	328	Average
		276	296	231	253	286	239	263	347	262	308	Subtract daylight spill

Vertical Illuminance across Board (3' apart, 5' height)

		Average	10	11	12	13	14	15	
Before	Electric + daylight		113	127	132	100	63	42	
Before	Daylight only		40	51	52	42	26	21	
Before	Electric only	**58**	**73**	**76**	**80**	**58**	**37**	**21**	
After	*Daylight spill*		*9*	*10.5*	*11*	*11.5*	*9*	*6.9*	*Daylight spill*
After	General + whiteboard		318	508	555	549	467	282	
			318	510	556	547	468	287	
			317	510	556	548	464	293	
			318	509	556	548	466	287	Average
		438	309	499	545	537	457	280	Subtract daylight spill
After	General only	174	178	192	177	177	169	152	Subtract whiteboard
After	Whiteboard Light (AV @min)		131	317	378	371	298	137	
			130	318	377	371	297	133	
			130	316	381	371	298	136	
			130	317	379	371	298	135	Average
		262	121	307	368	360	289	128	Subtract daylight spill
After	A/V 100%		51	53	42	47	47	35	
			52	53	42	48	47	38	
			53	54	44	49	48	39	
			53	54	43	49	48	39	Average
		38	43.5	43	32	37	38.5	31.6	Subtract daylight spill

Appendix A – Human Factor Analysis Report

Syr-219 (=208)

Horizontal Illuminance (lux) @ 28" above finished floor (a.f.f.)

Room	Condition	Average	1	2	3	4	5	6	7	8	9	
208 B4	Electric + daylight		395	481	397	433	520	425	388	476	384	
	Daylight only		11.1	8.2	6.8	21.6	14.2	8.3	14.8	18	9	
	Electric only	**421**	**384**	**473**	**390**	**411**	**506**	**417**	**373**	**458**	**375**	
219 B4	Electric + daylight		410	431	418	443	451	420	404	401	370	
	Daylight only		0.7	0.5	0.5	1.2	0.6	0.95	0.8	2.4	0.6	
	Electric only	**416**	**409**	**431**	**418**	**442**	**450**	**419**	**403**	**399**	**369.4**	
	General + whiteboard		567	403	576	618	446	617	658	437	680	
			567	402	573	620	445	618	658	437	681	
			569	402	572	621	446	619	658	437	683	
		556	568	402	574	620	446	618	658	437	681	Average
	A/V 100%		287	231	248	314	273	294	360	302	360	
			287	231	249	313	273	296	360	301	358	
		297	287	231	249	314	273	295	360	302	359	Average

Vertical Illuminance across Board (3' apart, 5' height)

Room	Condition	Average	10	11	12	13	14	15
208 B4	Electric + daylight		202	245	253	243	215	150
	Daylight only		15	15.3	14	30.3	28.3	12
	Electric only	**199**	**187**	**230**	**239**	**213**	**187**	**138**

Room	Condition	Average	10	11	12	13	14	
219 B4	Electric + daylight		205	211	213	218	218	
	Daylight only		0.82	2.4	1.8	0.93	0.6	
	Electric only	**212**	**204**	**209**	**211**	**217**	**217**	
After - 219 (=208)	General + whiteboard		371	526	563	537	392	
			373	523	563	533	390	
			371	528	559	535	390	
			372	526	562	535	391	
	General only	167	136	159	170	181	192	Subtract whiteboard
	Whiteboard Light (AV @min)		236	371	390	355	198	
			236	365	396	356	201	
			235	365	390	351	198	
		310	236	367	392	354	199	
	A/V 100%		32	38	40	37	41	
			32	38	41	38	41	
			33	39	40	38	41	
		38	33	39	41	38	41	

RPI-201

Horizontal Illuminance (lux) @ 29" above finished floor (a.f.f.)

		Average	1	2	3	4	5	6	7	8	9
Before	Electric + daylight		347	453	393	295	333	308	427	386	332
			348	452	393	299	335	314	422	387	332
			347	453	392	300	332	309	430	390	333
			347	453	393	298	333	310	426	388	332.33
	Daylight only		7.4	17.3	9.9	32	26.3	10	112	26	8
	Electric only	**337**	**340**	**435**	**383**	**266**	**307**	**300**	**314**	**362**	**324.33**
After	General		623	396	526	878	522	707	837	492	682
			621	393	502	875	522	696	831	491	691
			627	389	521	876	524	702	816	482	691
		626	**624**	**393**	**516**	**876**	**523**	**702**	**828**	**488**	**688**
	A/V 100%		387	266	324	532	361	453	507	355	445
			384	266	326	532	364	453	507	353	443
			380	266	324	532	364	452	505	352	446
		403	**384**	**266**	**325**	**532**	**363**	**453**	**506**	**353**	**445**

Vertical Illuminance across Board (2' apart, 5' height)

		Average	10	11	12	13	14	15	16	17	18	19	20
Before	Electric + daylight		205	205	206	243	267	255	236	229	227	193	138
			199	209	211	241	269	254	238	232	226	192	139
			203	207	214	240	268	258	236	230	223	191	136
			202	207	210	241	268	256	237	230	225.33	192	137.67
	Daylight only		8.6	9.9	8.7	8.4	9.7	17.7	26	26	21.8	19.6	17.4
	Electric only	**203**	**194**	**197**	**202**	**233**	**258**	**238**	**211**	**204**	**204**	**172**	**120**
After	General		144	151	152	155	154	143	143	132	119	100	82
			148	151	156	156	154	149	144	133	118	100	82
			148	151	156	156	154	149	144	133	117	99	82
		135	**147**	**151**	**155**	**156**	**154**	**147**	**144**	**133**	**118**	**100**	**82**
	Whiteboard Light + General		319	383	410	415	407	408	401	387	358	297	202
			321	388	420	415	407	409	404	387	359	299	203
			320	388	411	415	412	407	402	389	358	299	201
		392	**320**	**386**	**414**	**415**	**409**	**408**	**402**	**388**	**358**	**298**	**202**
	Whiteboard only	**229**	**173**	**235**	**259**	**259**	**255**	**261**	**259**	**255**	**240**	**199**	**120**

Appendix A – Human Factor Analysis Report

RPI-212

Horizontal Illuminance (lux) @ 30" above finished floor (a.f.f.)

		Average	1	2	3	4	5	6	7	8	9	
Before	Electric + daylight		556	668	609	624	781	707	500	608	550	
			550	670	606	624	784	703	497	609	544	
			555	661	613	624	784	701	501	597	527	
			554	666	609	624	783	704	499	605	540.3	
	Daylight only		1	1.1	2.3	0.8	1	1.9	0.8	1	2.3	
	Electric only	**619**	**553**	**665**	**607**	**623**	**782**	**702**	**499**	**604**	**538**	
After	*Daylight spill*		*4*	*4*	*5.5*	*3*	*4*	*6*	*4.5*	*7*	*11*	*Daylight spill*
	General only		608	451	565	562	442	535	689	522	662	
			603	451	580	558	440	541	686	518	655	
			605	450	574	556	440	541	686	520	654	
			605	451	573	559	441	539	687	520	657	Average
		554	**601**	**447**	**568**	**556**	**437**	**533**	**683**	**513**	**646**	Subtract daylight spill
	A/V 100%		410	371	394	334	287	323	450	426	439	
			408	371	392	333	287	321	451	427	441	
			409	370	395	334	286	321	450	427	440	
			409	371	394	334	287	322	450	427	440	Average
		376	**405**	**367**	**388**	**331**	**283**	**316**	**446**	**420**	**429**	Subtract daylight spill
	AV @ min		22	20	21	20	17	22	26	27	30	
			21	20	21	20	17	22	26	27	30	
			22	20	21	20	17	22	26	27	30	Average
		17	18	16	16	17	13	16	22	20	19	Subtract daylight spill

Vertical Illuminance across Board (2' apart, 5' height)

		Average	10	11	12	13	14	15	16	17	18	19	
Before	Electric + daylight		112	176	256	305	311	307	303	297	240	166	
			109	179	254	306	304	301	301	301	249	167	
			111	182	255	301	306	306	310	294	249	167	
			111	179	255	304	307	305	305	297	246	167	Average
	Daylight only		1	1.3	1.5	1.8	2.3	2.6	2.9	3.4	2.9	2	Subtract daylight spill
	Electric only	**245**	**110**	**178**	**254**	**302**	**305**	**302**	**302**	**294**	**243**	**165**	
	Electric on at back of room only		27	34	40	44	46	47	48	42	38	32	
			27	34	40	45	47	48	47	43	37	31	
			27	34	41	45	48	49	48	45	39	33	
			27	34	40	45	47	48	48	43	38	32	Average
		38	**26**	**33**	**39**	**43**	**45**	**45**	**45**	**40**	**35**	**30**	Subtract daylight spill
After	General only		106	127	141	152	156	161	159	155	142	123	
			106	126	142	151	155	157	157	153	143	122	
			106	126	141	152	154	161	158	154	139	122	
		142	**106**	**126**	**141**	**152**	**155**	**160**	**158**	**154**	**141**	**122**	**Average**
	Whiteboard Light (AV @min)		212	321	343	402	405	408	403	403	379	336	
			212	325	377	404	404	405	400	401	380	335	
			209	323	362	400	404	405	400	396	383	334	
		362	**211**	**323**	**361**	**402**	**404**	**406**	**401**	**400**	**381**	**335**	**Average**

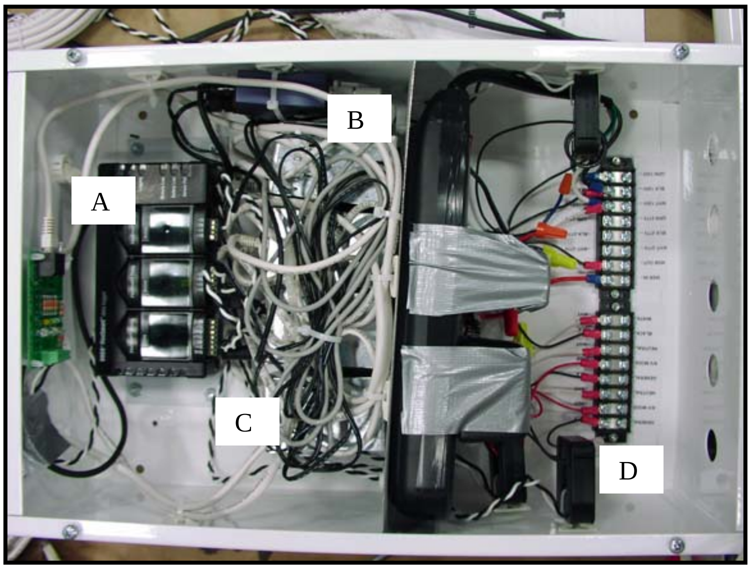
APPENDIX B - PROJECT METHODOLOGY

PROJECT METHODOLOGY

Data Collection Methodology – Data Retrieval Methodology and Technology

This section covers the equipment used for monitoring the ICLS systems installed in NYSERDA classrooms, the parameters monitored along with the preview of the equipment and some sample data.

The ICLS Monitoring Assembly (IMA) is a size 18” X 18” X 6” enclosure, which is comprised of the ICLS system components, data logger, current sensors and a networking device (Tibbo Device Server) for data transmission. Each classroom had one IMA which provided all the ICLS controls, electrical connections as well as data transmission for analysis. Shown below are the internal wiring and the components of the IMA.



A – Datalogger –

The Data logger records current readings from the current sensors for the General mode, A/V Mode and Whiteboard fixtures. It also records the Pulse Count which measures the Quiet Time count; and records the Occupancy sensor voltage at the pre-defined logging interval of every minute.

B - Networking Device

The Tibbo DS202 is a device server that links the Data Logger to the school network and allows data retrieval from the logger through the school network. A static IP address is assigned to each of these DS 202’s by the school network. This makes each classroom data accessible by using the assigned IP address. By using Virtual Private Network (VPN) or the privileged IP address access into the school network from Finelite, all the classroom data is retrieved remotely and archived at the Finelite Server.

C - ICLS Components

An assembly of relays functioning as Control Pack, Row Pack, Expansion Pack and Whiteboard Pack constitute the major ICLS components. These relays communicate over a Patented low voltage communication bus. The output of these Relays drives the General mode, A/V mode and Whiteboard fixtures and gives the entire system occupancy control based on the output from the Occupancy Sensor.

D – Current Sensor

The Current Sensors are donut shaped devices (Current Transformers) that measure the current flowing through a conductor, when the conductor is passed through the Current Sensor. This reading is then converted from A to mA and then passed on to the modules of the Data logger, which then records them for each logging interval. Three of these Current Sensors were deployed in each IMA to read the General mode, A/V mode and Whiteboard current measurements respectively.

Monitoring and Data Retrieval Procedure:

- Table 1 details the parameters monitored along with the devices and logic used for getting these parameters into the logger's memory.
- Data Retrieval was done by accessing the logger's memory through the networking device in the IMA. This networking device was tied into each school's internal network.
- Finelite had a single port access to each of the school's network, which it connected to over the Internet.
- The Data downloads were scheduled for every week, using the *Auto Offload software* and manual downloads. This data was then reviewed and exported into .*csv* format for analysis.
- A sample .*csv* data file is shown in Table 2, it highlights the different occurrences based on the changes in readings.
- All data was then transferred into the Finelite Database, which allowed specific data analysis as well as archiving.

Datalogger Model : HOBO® H22 Energy Logger Pro Data Logger				
Measured Quantity	datalogger Signal	Measured Unit	Sensing Device	Datalogger Module
Occupancy Sensor	The datalogger logs the occupancy sensor voltage. If the occupancy sensor voltage is ~+24VDC then the sensor is ON (occupancy) and if the voltage is ~0VDC (no occupancy), the sensor turns OFF.	Voltage DC	The output of the occupancy sensor is ~+24VDC, which is stepped down to ~+3VDC and fed into the datalogger's analog input module	Analog Input Module
General Mode	The datalogger logs current used in the General mode by reading the current output of the relay (Row/Expansion pack) to the General mode of the fixture. The relay output is fed through a current transformer, which reads the current usage and transfers the readings to the datalogger's TRMS module.	Current A	Current Transformer reads the current passing through the general mode wire and converts it to mA, which is then fed into the datalogger's TRMS module.	TRMS Module
A/V Mode	The datalogger logs current used in the A/V mode by reading the current output of the relay (Row/Expansion pack) to the A/V mode of the fixture. The relay output is fed through a current transformer, which reads the current usage and transfers the readings to the datalogger's TRMS module.	Current A	Current Transformer reads the current passing through the A/V mode wire and converts it to mA, which is then fed into the datalogger's TRMS module.	TRMS Module
Whiteboard	The datalogger logs current used by the Whiteboard by reading the current output of the relay (Whiteboard pack) to the Whiteboard. The relay output is fed through a current transformer, which reads the current usage and transfers the readings to the datalogger's TRMS module.	Current A	Current Transformer reads the current passing through the Whiteboard wire and converts it to mA, which is then fed into the datalogger's TRMS module.	TRMS Module
Quiet Time	The datalogger logs the pulse that is generated when the Quiet Time Switch is pressed. This pulse is detected using an Electronic Pulse input adapter that sends the signal to the logger, which then gets recorded.	Counts	Electronic Pulse input Adapter reads the pulse that is generated when the Quiet Time switch is pressed. This pulse is then recorded in the datalogger memory.	The electronic Pulse Input Adapter plugs into the RJ11 jack of the datalogger

Chart 21– Datalogger Setup Explanation

Sample Test Data for 120V ICLS System

#	Time, GMT-07:00	Occ. Sensor, V	A/V Mode Current, A	WB Current, A	General Current, A	Counts, # (Q/T)	Comments
1	9/21/2006 16:01	2.7633	0.937911	0.73094	0	0	A/V on, Occ. On, WB on
2	9/21/2006 16:02	2.7633	0.937974	0.73078	0	0	
3	9/21/2006 16:03	2.7583	0.938302	0.73047	0	0	
4	9/21/2006 16:04	2.7381	0.93788	0.73047	0	0	
5	9/21/2006 16:05	2.7431	0.938145	0.73032	0	0	
6	9/21/2006 16:06	2.7431	0.938145	0.73032	0	0	
7	9/21/2006 16:07	2.7633	0.937895	0.73032	0	0	
8	9/21/2006 16:08	2.7482	0.947755	0.73094	0	0	
9	9/21/2006 16:09	2.7431	0.937849	0.73032	0	0	
10	9/21/2006 16:10	2.7532	0.937692	0.73094	0	0	
11	9/21/2006 16:11	2.7431	0.92788	0.73	0	0	
12	9/21/2006 16:12	2.7482	0.937911	0.72063	0	0	
13	9/21/2006 16:13	3.2578	0	0	1.672846	0	Occ.&Gen. On. Others Off
14	9/21/2006 16:14	3.2982	0	0	1.677315	0	
15	9/21/2006 16:15	3.2982	0	0	1.680049	0	
16	9/21/2006 16:16	3.2931	0	0	1.680784	0	
17	9/21/2006 16:17	3.2931	0	0	1.681502	0	
18	9/21/2006 16:18	3.2931	0	0	1.681127	0	
19	9/21/2006 16:19	3.2931	0	0	1.681377	0	
20	9/21/2006 16:20	3.2982	0	0	1.68119	0	
21	9/21/2006 16:21	3.2982	0	0	1.681252	0	
22	9/21/2006 16:22	3.2931	0	0	1.681127	0	
23	9/21/2006 16:23	3.2931	0	0	1.680956	0	
24	9/21/2006 16:24	-0.0018	0	0	0	0	Occ. goes OFF, everything shuts down
25	9/21/2006 16:25	-0.0018	0	0	0	0	
26	9/21/2006 16:26	-0.0018	0	0	0	0	
27	9/21/2006 16:27	-0.0018	0	0	0	0	
28	9/21/2006 16:28	-0.0018	0	0	0	0	
29	9/21/2006 16:29	-0.0018	0	0	0	0	
30	9/21/2006 16:30	-0.0018	0	0	0	0	
31	9/21/2006 16:31	-0.0018	0	0	0	0	
32	9/21/2006 16:32	-0.0018	0	0	0	0	
33	9/21/2006 16:33	3.2729	0	0	0	0	Sensor detects motion
34	9/21/2006 16:34	2.733	0.93327	0.73516	0	1	Q/T on, A/V on, WB on, others OFF
35	9/21/2006 16:35	2.7381	0.936849	0.73422	0	0	
36	9/21/2006 16:36	2.7179	0.937724	0.73407	0	0	
37	9/21/2006 16:37	2.7482	0.94752	0.72375	0	0	
38	9/21/2006 16:38	2.7229	0.937567	0.73329	0	0	
39	9/21/2006 16:39	2.728	0.937349	0.73282	0	0	
40	9/21/2006 16:40	2.7885	0	0	0	0	MSB OFF
41	9/21/2006 16:41	2.7583	0	0	0	0	
42	9/21/2006 16:42	2.7532	0.934489	0.73375	0	0	MSB ON
43	9/21/2006 16:43	2.7583	0.936802	0.73329	0	0	
44	9/21/2006 16:44	2.733	0.937505	0.71297	0	0	
45	9/21/2006 16:45	2.7583	0.93763	0.73282	0	0	

Chart 22 – Sample Data from Datalogger

APPENDIX B - PROJECT METHODOLOGY

Data Collection Methodology – Database Structure and Custom Software

The NYSERDA data was stored in a Microsoft SQL Server database. The database consisted of two main data tables. One table contains the detailed data; one record taken each minute snapshot from each of the loggers. The other data table contains the daily summary data for each classroom. There also are a few ancillary data tables that are contain the daily totals of the number of periods of General Mode lighting, Audiovisual (AV) Mode lighting, and Settle Mode lighting. In addition to the data tables there are reference tables for the categories of General, AV, and Settle Mode period lengths.

Data points are recorded at one-minute intervals on each of the HOBO data loggers. The data collected includes the time when the recording is made, the current on the general mode, AV mode and white board circuits, and the voltage on the occupancy sensor and the quiet time circuits. The data is stored on the logger's memory for later download to the NYSERDA server. The data is downloaded weekly to the NYSERDA server via an Internet connection to each of the loggers. The downloaded data file is converted from the logger software, HOBOWare Pro proprietary format to a comma delimited text file.

Microsoft Access and SQL Server stored procedures were used to import, process, and analyze the data. The following section describes an automated process that was created in Access to import and process the data.

The first step is importing the text file into a local Access table. Both header and line item data is imported into this table. In the second step only the line item data is then transferred to a linked SQL Server table. The school and classroom identity information is associated with each record at this step. This SQL Server table is used for temporary storage of the data for processing and transfer to the permanent data storage table. The processing is done in a stored procedure on SQL Server.

As a validation check the data in the temporary storage table is first checked against the permanent database to prevent importation of duplicate records. Iterating through the records one at a time processes the new records. The timestamp, General current, AV current and whiteboard current are recorded directly. The Occupancy sensor voltage value is recorded and the occupancy status is recorded as one (on) or zero (off) depending on the voltage reading for the occupancy sensor. Quiet time data is also captured as one or zero. Values of one to 10 pulses is considered on and values of zero or greater than 10 pulses is assigned a value of zero.

Each time the general or AV mode lighting is switched on a number is entered in the relevant column (Gen_period or AV period, respectively) for each record during that period of time that the lights are on in that mode. This information is used to determine the lighting distributions that are described in more detail below. The number increments by one starting at the number one for the first period of each type each day. Each occurrence of a switch between the two lighting modes is also recorded. This is accomplished by assigning the status of the main lighting to a variable (“G” for general and “A” for AV mode). During the iteration through the day’s records the value of this variable is checked. If it has changed from the prior records value then a switch has occurred and is recorded.

Settle mode (both AV mode and the white board lights are on) status is recorded in a manner similar to the AV and general lighting periods. Each record of each period of settle mode lighting is assigned a number starting at one and incrementing for each subsequent period.

Each time the lights are shut off manually or by the occupancy sensor is recorded. When all the lights are turned off at the same time the occupancy sensor shuts off it is recorded as a occupancy sensor shutoff. If the occupancy sensor is on when the lights are turned off then it is entered as a manual shut off.

AV Dimming levels are determined by comparing the AV current for that minutes reading against the predetermined maximum AV current.

Daily Totals

In addition to capturing the detailed data for each minute the daily totals for each classroom are also captured for improving summary reporting performance. The following daily totals values are calculated and recorded in the daily totals table: general mode minutes, AV mode minutes, white board minutes, white board only minutes, settle mode minutes, quiet time pulses count, manual turn offs count, occupancy sensor turn offs count, lights on total minutes, the time of day when the lights are first turned on, the time of day when all the lights are turned off, the length of time from when the lights are turned on to when the lights are turned off, total watts consumed, a count of the AV periods and a count of the white board periods.

Distributions

Daily totals of the general periods, AV periods and settle mode periods of each length category were calculated. As described above each minute’s record of each General, AV or Settle Mode period was assigned a number. The day’s records are grouped by the period number and the records for each period number are summed to determine the length of each period. The number of each length category of period is then determined by summing the number of periods that qualify based on their length for each category. These totals are recorded for each day in the general, AV and settle mode distribution tables.

The distribution of AV dimming levels was also tracked. The number of minutes each day that dimming falls within specified ranges was determined by counting those records where the dimming level was between the minimum and maximum dimming for that range. The totals were entered in the AV dimming distribution table.

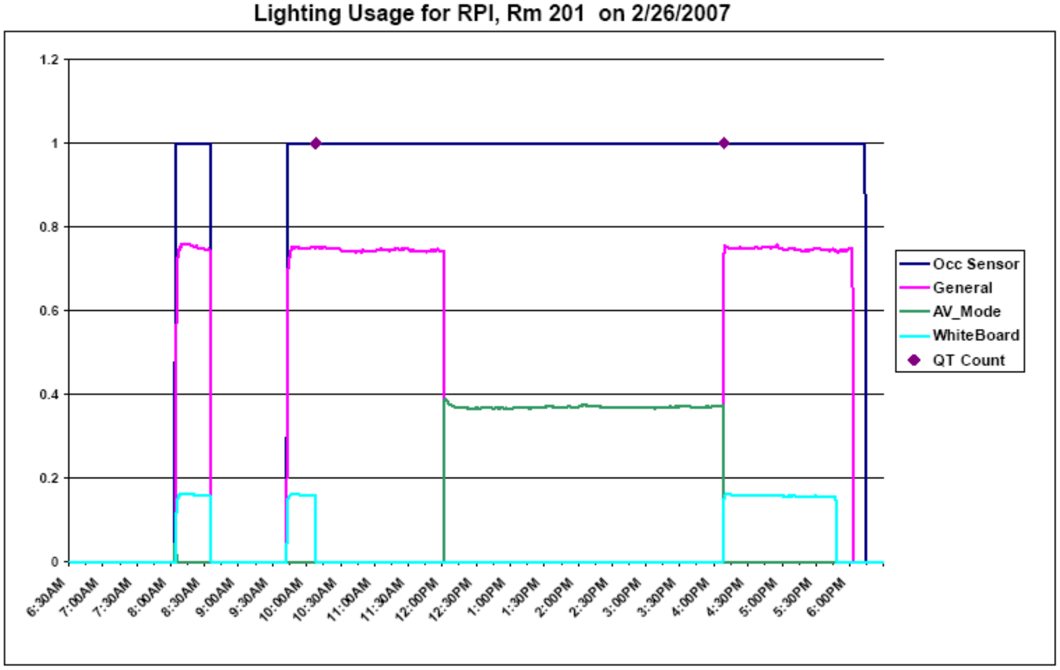
<u>Custom Reports Generated</u>

The proprietary software enables us to generate several reports useful to tracking system usage and monitoring energy consumption. An explanation of each report follows.

Daily Usage Charts

The daily usage charts take the minute-by-minute data and presents it graphically to show how the teacher used the system. The chart shows the different modes the teacher used during the day and the corresponding energy consumed (in watts per square foot along the X-axis) while in that mode. The chart also shows when the occupancy sensor detects occupancy, and when it turns off lights.

Lighting Usage for RPI, Rm 201 on 2/26/2007



Daily Usage Chart

Data Summary Chart

The Data Summary Chart incorporates all the data stored in the database to give a day-by-day review of the system usage for the ICLS test classrooms as well as the “Control” to map out the differences. The report details usage of each of the components as detailed below. Days presented are restricted to periods where the system was used for more than 70 minutes, which helps exclude days of inactivity from the averages.

Data Summary

Ballston Spa Middle School

Classroom	Date	AV Gen Switches	AV Use (#/Day)	WB Use (#/Day)	General Total Min	White Board Total Min	AV Total Min	Settle Time	Settle Count	Quiet Count	Occ Sensor Shut Off	Manual Shut Off	Lights On Total	Watts/ sq ft	kWh
110	5/14/07	10	5	6	217	243	203	46	1	0	0	4	420	0.60	3.11
	5/15/07	10	6	5	325	310	94	18	1	0	0	3	420	0.77	3.96
	5/16/07	12	6	10	195	287	222	93	1	0	0	4	417	0.59	3.04
	5/17/07	8	4	10	337	337	33	0		1	0	6	370	0.88	3.98
	5/18/07	0	0	3	478	478	0	0		0	0	3	478	0.93	5.47
	5/21/07	0	0	4	442	442	0	0		0	0	4	442	0.93	5.03
	5/22/07	2	1	4	461	461	6	0		0	0	3	467	0.92	5.28
	5/23/07	4	3	5	237	427	207	190	2	0	0	4	444	0.69	3.79
	5/24/07	2	2	4	281	541	260	260	2	0	0	4	541	0.67	4.47
	5/25/07	4	2	4	107	188	273	94	3	0	0	3	380	0.50	2.33
	5/29/07	0	0	0	519	0	0	0		0	0	4	519	0.74	4.71
	5/30/07	0	0	2	447	245	0	0		0	0	2	447	0.82	4.53
	5/31/07	1	3	5	179	421	242	242	3	1	0	5	421	0.66	3.40
112	10/2/06	2	4	0	204	0	127	0		0	0	8	331	0.64	2.61
	10/3/06	2	1	0	266	0	137	0		2	0	4	403	0.61	3.01
	10/4/06	0	0	0	335	0	0	0		0	1	5	335	0.84	3.47
	10/5/06	1	4	4	254	153	153	153	4	1	0	5	407	0.71	3.54
	10/6/06	3	3	4	210	164	88	86	2	0	1	8	298	0.78	2.86
	10/10/06	0	0	0	408	0	0	0		0	1	2	408	0.85	4.26
	10/11/06	0	0	0	497	0	0	0		0	0	3	497	0.84	5.17
	10/12/06	0	0	1	422	7	0	0		0	0	4	422	0.85	4.40
	10/13/06	2	1	1	250	213	213	213	1	0	0	3	463	0.63	3.60
	10/16/06	0	0	1	438	106	0	0		1	1	3	438	0.89	4.79

Data Summary Chart

AV Gen Switches: The count of the number of times the teacher switched between General and AV Mode.

AV Use (#/Day): The count of the number of times the teacher used AV Mode

WB Use (#/Day): The count of the number of times the teacher turned on the whiteboard.

General Total Min: The total minutes spent using the General Mode.

Whiteboard Total Min: The total minutes spent using the Whiteboard luminaire.

AV Total Min: The total minutes spent using the Audiovisual Mode.

Settle Time: The total minutes spent in the Settle Mode (AV Mode with the Whiteboard luminaire on).

Settle Count: The number of times the Settle Mode was used.

Quiet Count: The number of times the Quiet Time switch was used. The Quiet Time switch bypasses the occupancy sensor for 60 minutes.

Occ Sensor Shut Off: The number of times the occupancy sensor shut off the lights.

Manual Shut Off: The number of times the teacher used the Main Switch Bank to turn off the lights.

Lights On Total: The total amount of time the lights were on during the day.

Watts/Sq.ft.: This is a calculated result showing the watts per square footage consumed.

kWh: This is a calculated result showing the energy consumed in kWh.

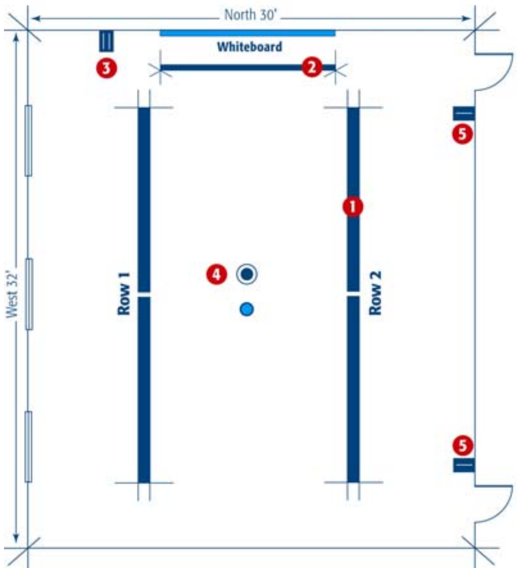
Average Daily Lighting Usage Chart

The data can be summarized for any period of time using the Average Daily Lighting Usage Chart. This shows the daily usage of each system element used over the defined period of time. Section 1 in the chart below shows the average usage for the particular classroom for the time period of 9/1/06 through 5/31/07. For example, the AV Mode was used 91.2 minutes on average per day and the average energy consumption was 0.63 w/ft^2. Section 2 in the chart shows the average time spent in each of the modes plus the percent of dimming used when the system was in AV Dimming. For example, the AV Mode chart demonstrates this teacher was most likely to spend up to 15 minutes in AV mode whenever they would use this mode. The teacher would tend to use the Settle Mode (lower right corner chart) for more than 5 hours at a time.

APPENDIX C – CLASSROOM TEMPLATES

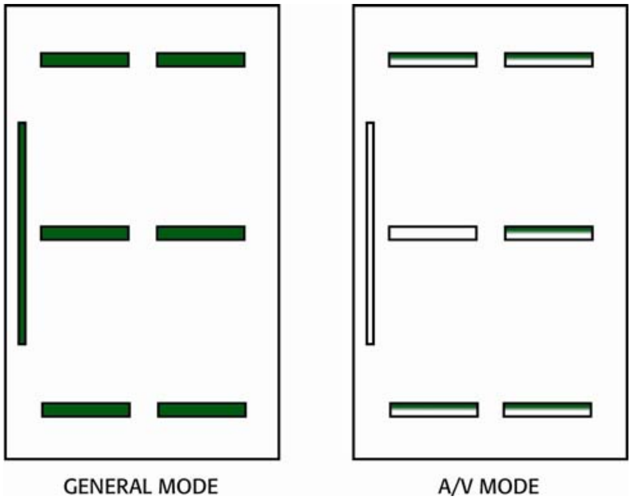
The Integrated Classroom Lighting System Template – 3rd Generation

The Integrated Classroom Lighting System installed in the NYSERDA demonstration classrooms represents years of research into high performance classroom design. This 3rd generation lighting system was developed using the Collaborative for High Performance Classrooms (CHPS) best practices as a base and two California Energy Commission sponsored research projects to prove and further develop the system. The template is flexible enough to accommodate a wide variety of classroom designs including:



- Low Ceiling Classrooms and Portables
- Classrooms with Sloped Ceilings
- Various Classroom Shapes and sizes
- Toplighting with Daylight Dimming
- Toplighting with Daylight Switching
- Sidelighting with Daylight Dimming
- Sidelighting with Daylight Switching

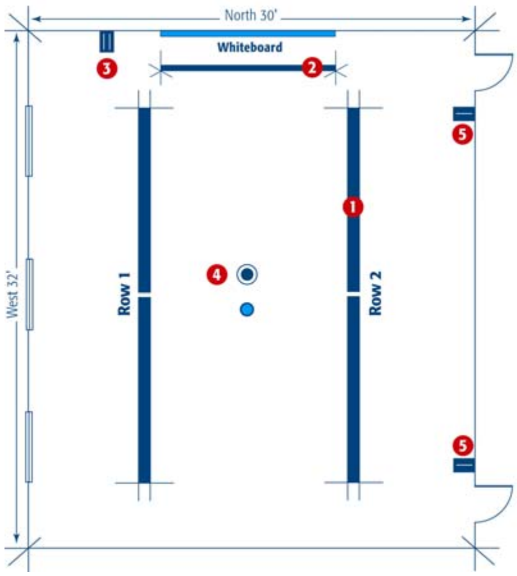
				
Indirect/Direct Luminaires:	Whiteboard Luminaire:	Teacher Controls:	Sensors:	Master Switch:
1) Two rows of two-scene indirect/direct luminaires mounted perpendicular to the main teaching wall (parallel to the window wall) and spaced 14-15' apart.	2) A dedicated luminaire is used to illuminate the whiteboard on the main teaching wall.	3) Teacher control is placed at the front of the classroom. Place teacher controls within 6" of the whiteboard for easy access.	4) Sensors are placed in the center of the classroom. Sensors always include occupancy and daylight harvesting is added where appropriate.	5) A master on/off switch is by every door to the classroom.



Classrooms with Low Ceilings (8'3" – 9'6")
The Collaborative for High Performance Schools (CHPS-NY) has recently put out The Best Practice Manual for Relocatable Classrooms that easily accommodates classroom with low ceilings. The following guideline should be used for classrooms with low ceilings. The room presented is 24' x 40'.

This template should be used as a general guideline. Specific site requirements shall be factored into the design for each project.

  **NEW**		 **NEW**		
Low Ceiling indirect/direct Luminaires	Whiteboard Luminaire:	Teacher Controls:	Sensors:	Master Switch:
Suspend luminaire as close as 3" from the ceiling. Luminaires should be 2T8 in cross-section wired to provide General and AV modes. The design uses (6) independent 8' luminaires spaced X' apart. Suspension: 8' AFF. General Mode- All lights on. AV Mode- Luminaire row perpendicular to whiteboard is off. The rest of luminaires have one lamp turned off.	A dedicated 1T8 cross-section luminaire is used to illuminate the whiteboard on the main teaching wall. Length: Match the length of the whiteboard. Lamps: 3100 lumen T8 lamp.	The controls at the front of the classroom. The Teacher Control Center will control the General and AV Mode, the whiteboard luminaire, and provide a quiet time control over the occupancy sensor.	Occupancy and sensors are placed in the center of the classroom.	A master on/off switch is by every door to the classroom.

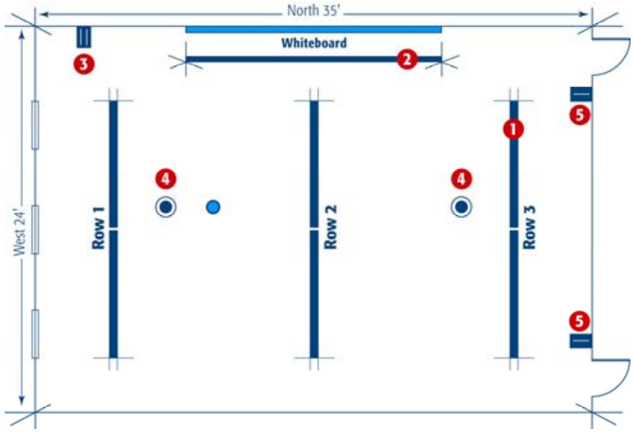


Classrooms with Sloped Ceilings

In general, sloped ceilings do not adversely affect the illuminance level or energy consumption. Ballast factors may need to be increased for ceilings in the 14-15' range, depending on room size and energy target.

This template should be used as a general guideline. Specific site requirements shall be factored into the design for each project.

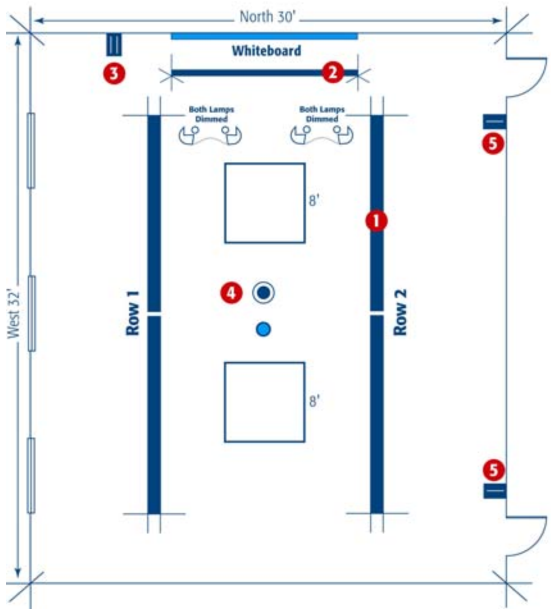
				
Indirect/Direct Luminaires:	Whiteboard Luminaire:	Teacher Controls:	Sensors:	Master Switch:
The pendant indirect/direct two-scene luminaires are a 2T8/1T8 cross-section. Luminaires shall be spaced 14-15' on center. General Mode will be wired to have the two outboard lamps turned. AV Mode will be wired to turn the center lamp on and the outboard lamps off. **NEW** Suspension: Suspension will vary depending on ceiling slope. Specify fully adjustable suspension cables and mount the luminaire 8'6" above finished floor.	A dedicated 1T8 cross-section luminaire is used to illuminate the whiteboard on the main teaching wall. Length: Match the length of the whiteboard. Lamps: 3100 lumen T8 lamp.	The controls at the front of the classroom. The Teacher Control Center will control the General and AV Mode, the whiteboard luminaire, and provide a quiet time control over the occupancy sensor.	Occupancy and sensors are placed in the center of the classroom.	A master on/off switch is by every door to the classroom.



Classrooms with various sizes

The Integrated Classroom Lighting System template is based on a nominal 30'x32' classroom, but the Classroom Lighting System can accommodate a wide variety of classroom shapes and sizes as demonstrated in the NYSERDA research. There were 28 classrooms studied in the research had 11 different classroom sizes ranging from: 21'x27' to 37'x24'. Detailed drawings and specifications can be found in Appendix F – L. The Integrated Classroom Lighting System was easily integrated into each of these classrooms.

				
Indirect/Direct Luminaires:	Whiteboard Luminaire:	Teacher Controls:	Sensors:	Master Switch:
The pendant indirect/direct two-scene luminaires are a 2T8/1T8 cross-section. Luminaires shall be spaced 14-15' on center. General Mode will be wired to have the two outboard lamps turned. AV Mode will be wired to turn the center lamp on and the outboard lamps off. **NEW** Row Lengths: row lengths can be adjusted to meet specific room sizes. A room of 24'x35' would require (3) 18' rows spaced 12' apart.	A dedicated 1T8 cross-section luminaire is used to illuminate the whiteboard on the main teaching wall. Length: Match the length of the whiteboard. Lamps: 3100 lumen T8 lamp.	The controls at the front of the classroom. The Teacher Control Center will control the General and AV Mode, the whiteboard luminaire, and provide a quiet time control over the occupancy sensor.	Occupancy and sensors are placed in the center of the classroom.	A master on/off switch is by every door to the classroom.



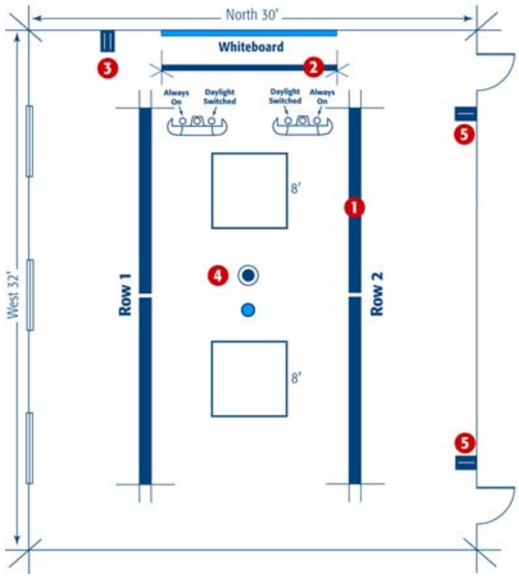
Toplighting with Automatic Daylight Dimming

This scenario accommodates top lighting designs for classrooms in the nominal range of 28'x28' to 30'x32', with skylights mounted in the center of the classroom. Larger size or different shape classrooms will require alterations to the luminaire layouts.

The design is flexible enough to accommodate skylights or tube lights in a variety of shapes.

This template should be used as a general guideline. Specific site requirements shall be factored into the design for each project.

 NEW		 NEW	 NEW	
Indirect/Direct Luminaires:	Whiteboard Luminaire:	Teacher Controls:	Sensors:	Master Switch:
The pendant indirect/direct luminaires are a 2T8 cross-section. All lamps are connected to dimming ballasts. Dimming the lamps provides the audiovisual mode.	A dedicated 1T8 cross-section luminaire is used to illuminate the whiteboard on the main teaching wall. Length: Match the length of the whiteboard. Lamps: 3100 lumen T8 lamp.	Controls at the front of the Classroom: The controls at the front of the classroom must also include a dimmer for control over the light level to achieve audiovisual mode. Additional controls should be included to control skylight baffles and other daylight sources not easily controlled manually.	Occupancy and Daylight Dimming sensor are placed in the center of the classroom. For optimal coverage install more than one occupancy sensor if the skylight placement does not permit sensor placement in the middle of the room.	A master on/off switch is by every door to the classroom.

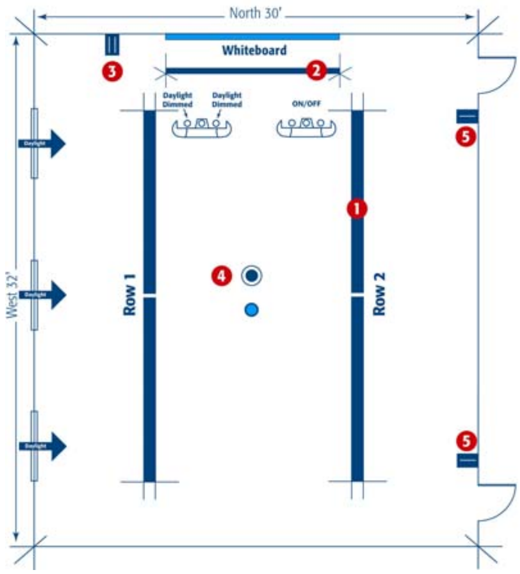


Toplighting with Automatic Daylight Switching.

This scenario accommodates top lighting designs for classrooms in the nominal range of 28'x28' to 30'x32', with skylights mounted in the center of the classroom. Larger size or different shape classrooms will require alterations to the luminaire layouts. The design is flexible enough to accommodate skylights or tube lights in a variety of shapes.

This template should be used as a general guideline. Specific site requirements shall be factored into the design for each project.

 		 **NEW**	 **NEW**	
Indirect/Direct Luminaires:	Whiteboard Luminaire:	Teacher Controls:	Sensors:	Master Switch:
The pendant indirect/direct two-scene luminaires are a 2T8/1T8 cross-section. **NEW** Wiring: As indicated above, the lamps nearest the daylight source are wired to the daylight switching control – automatic or manual.	A dedicated 1T8 cross-section luminaire is used to illuminate the whiteboard on the main teaching wall. Length: Match the length of the whiteboard. Lamps: 3100 lumen T8 lamp.	The controls at the front of the classroom. Manual daylight harvesting controls shall be incorporated into the teacher controls if automatic control is not desired. Additional controls should be included to control skylight baffles and other daylight sources not easily controlled manually.	Occupancy and Daylight switching sensors are placed in the center of the classroom. Install more than one occupancy sensor if the skylight design does not permit the sensor to be placed in the middle of the room.	A master on/off switch is by every door to the classroom.

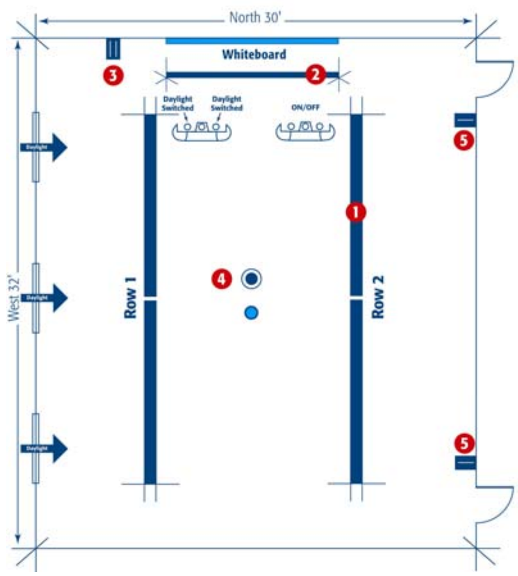


Sidelighting with Automatic Daylight Dimming

This scenario accommodates a variety of side lighting designs, including view windows, clerestory, and clerestory with lighting shelves or louvers. This layout is accommodates classrooms in the nominal range of 28'x28' to 30'x32'. Larger size or different shape classrooms may require alterations to the luminaire layouts.

This template should be used as a general guideline. Specific site requirements shall be factored into the design for each project.

 			  **NEW**	
Indirect/Direct Luminaires:	Whiteboard Luminaire:	Teacher Controls:	Sensors:	Master Switch:
The pendant indirect/direct two-scene luminaires are a 2T8/1T8 cross-section. **NEW** Wiring: The row nearest the window wall is controlled by the automatic daylight dimming sensor. The row opposite the window remains on/off.	A dedicated 1T8 cross-section luminaire is used to illuminate the whiteboard on the main teaching wall. Length: Match the length of the whiteboard. Lamps: 3100 lumen T8 lamp.	Place controls at the front of the classroom. Automatic or accessible manual controls shall be available for all daylight sources.	Occupancy and Daylight dimming sensors are placed in the center of the classroom.	A master on/off switch is by every door to the classroom.



Sidelighting with Automatic Daylight Switching

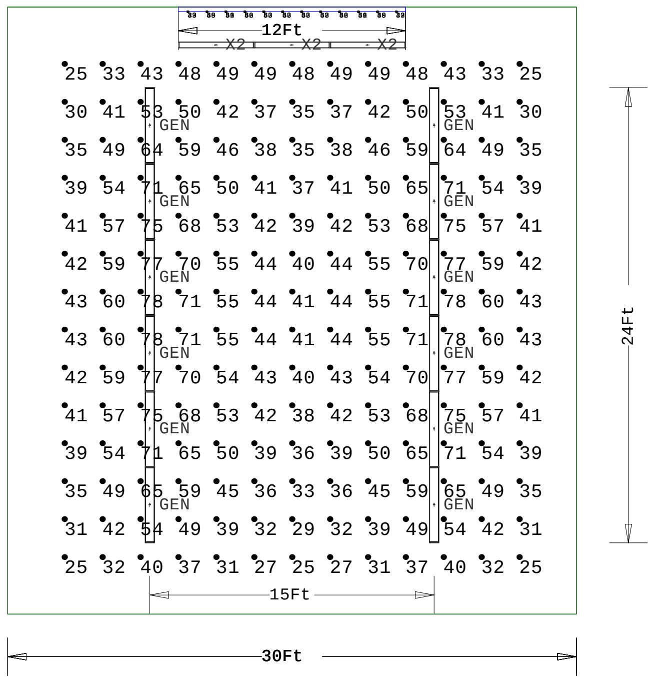
This scenario accommodates a variety of side lighting designs, including view windows, clerestory, and clerestory with lighting shelves or louvers. This layout is accommodates classrooms in the nominal range of 28’x28’ to 30’x32’. Larger size or different shaped classrooms may require alterations to the luminaire layouts.

This template should be used as a general guideline. Specific site requirements shall be factored into the design for each project.

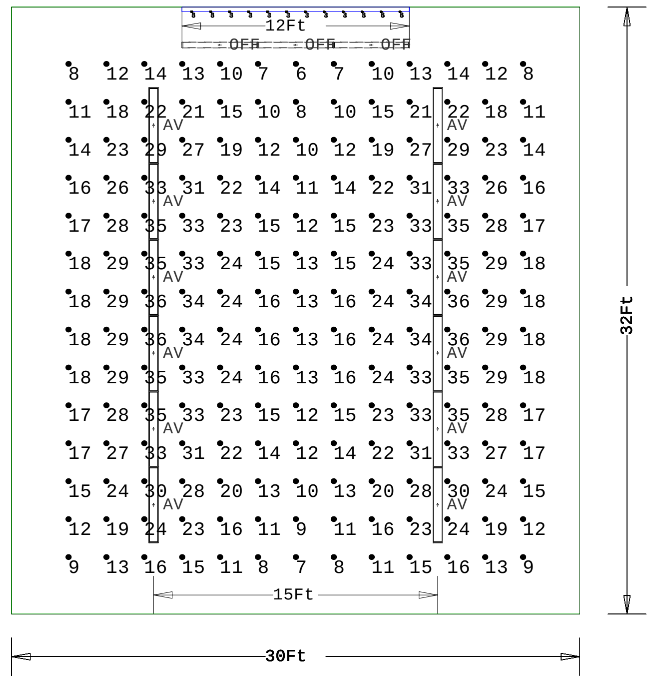
 		 	 NEW	
Indirect/Direct Luminaires:	Whiteboard Luminaire:	Teacher Controls:	Sensors:	Master Switch:
The pendant indirect/direct two-scene luminaires are a 2T8/1T8 cross-section. NEW Wiring: The row nearest the window wall is wired to the automatic daylight switching sensor. Both lamps in the general mode are turned off when the daylight reaches the design level. The sensor does not control the row opposite the window wall.	A dedicated 1T8 cross-section luminaire is used to illuminate the whiteboard on the main teaching wall. Length: Match the length of the whiteboard. Lamps: 3100 lumen T8 lamp.	Place controls at the front of the classroom. Automatic or accessible manual controls shall be available for all daylight sources.	Occupancy and Daylight switching sensors are placed in the center of the classroom.	A master on/off switch is by every door to the classroom.

Finelite ICLS Template - 30'-0" x 32'-0" x 10'-0"

GENERAL MODE



AV MODE



Luminaire Schedule									
Symbol	Qty	Label	Description	Lumens	Watts	BF	LDD	LLD	LLF
	12	GEN	S10-PLV-CCO-2T8-EP (3T8-center lamp off)	3100	55	0.88	0.9	0.95	0.752
	12	AV	S10-PLV-CCO-1T8-EP (3T8-outboard lamps off)	3100	25	0.78	0.9	0.95	0.667
	3	X2	SX2-WCB-1T8-96W	3100	28	0.88	0.9	0.95	0.752
	3	OFF	SX2-WCB-1T8-96W (SX2 OFF in AV mode)	3100	28	0.88	0.9	0.95	0.752

Numeric Summary							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
General Mode, Workplane	Illuminance	Fc	49.25	78	25	1.97	3.12
AV Mode, Workplane	Illuminance	Fc	20.63	36	6	3.44	6.00
Whiteboard, GEN Mode	Illuminance	Fc	46.06	60	32	1.44	1.88
Whiteboard, AV Mode	Illuminance	Fc	3.83	6	3	1.28	2.00

LPD Area Summary			
Label	Area	Total Watts	LPD
General Mode	960	744	0.775
AV Mode	960	300	0.313

NOTES:
- Ceiling Height 10'-0"
- Luminaires suspended 8'-0" AFF
- Input watts based on Osram QHE Instant Start Ballasts
- Lamp lumens based on Sylvania XPS 835 T8 lamps

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

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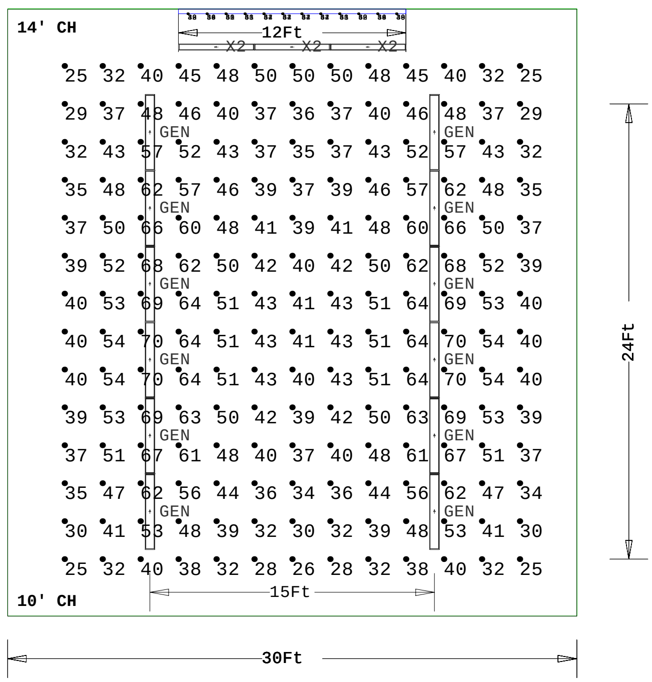
HORIZONTAL WORKPLANE VALUES SHOWN ARE MAINTAINED FOOTCANDLES AT 30" ABOVE FINISHED FLOOR.

AGI32 VERSION 1.94

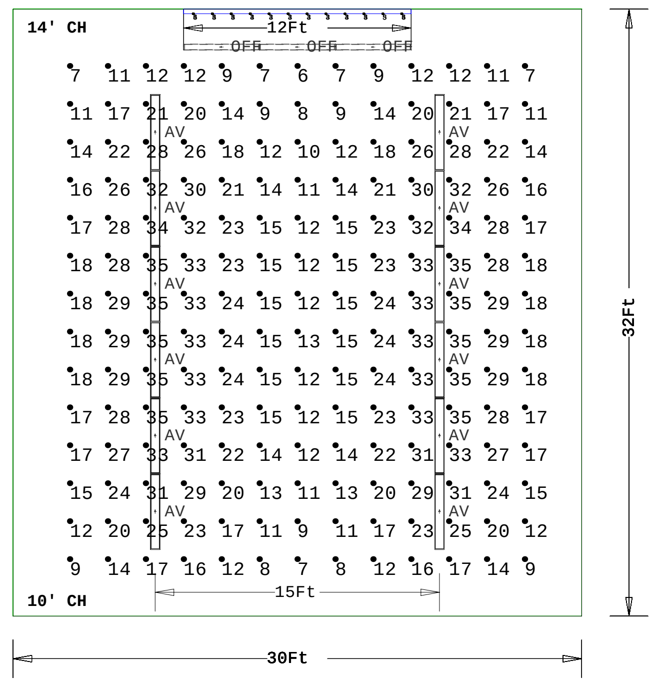
Calculations performed August, 2007, By Vickie Lauck, Finelite Inc.

Finelite ICLS Template - 30'-0" x 32'-0" x Sloped Ceiling 10' to 14'

GENERAL MODE



AV MODE



Luminaire Schedule									
Symbol	Qty	Label	Description	Lumens	Watts	BF	LDD	LLD	LLF
	12	GEN	S10-PLV-CCO-2T8-EP (3T8-center lamp off)	3100	55	0.88	0.9	0.95	0.752
	12	AV	S10-PLV-CCO-1T8-EP (3T8-outboard lamps off)	3100	25	0.78	0.9	0.95	0.667
	3	X2	SX2-WCB-1T8-96W	3100	28	0.88	0.9	0.95	0.752
	3	OFF	SX2-WCB-1T8-96W (SX2 OFF in AV mode)	3100	28	0.88	0.9	0.95	0.752

Numeric Summary							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
General Mode, Workplane	Illuminance	Fc	46.23	70	25	1.85	2.80
AV Mode, Workplane	Illuminance	Fc	20.40	35	6	3.40	5.83
Whiteboard, GEN Mode	Illuminance	Fc	46.31	62	30	1.54	2.07
Whiteboard, AV Mode	Illuminance	Fc	3.69	6	3	1.23	2.00

LPD Area Summary			
Label	Area	Total Watts	LPD
General Mode	960	744	0.775
AV Mode	960	300	0.313

NOTES:
- Ceiling Height - sloped 10'-0" to 14'-0"
- Luminaires suspended 8'-0" AFF
- Input watts based on Osram QHE Instant Start Ballasts
- Lamp lumens based on Sylvania XPS 835 T8 lamps

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

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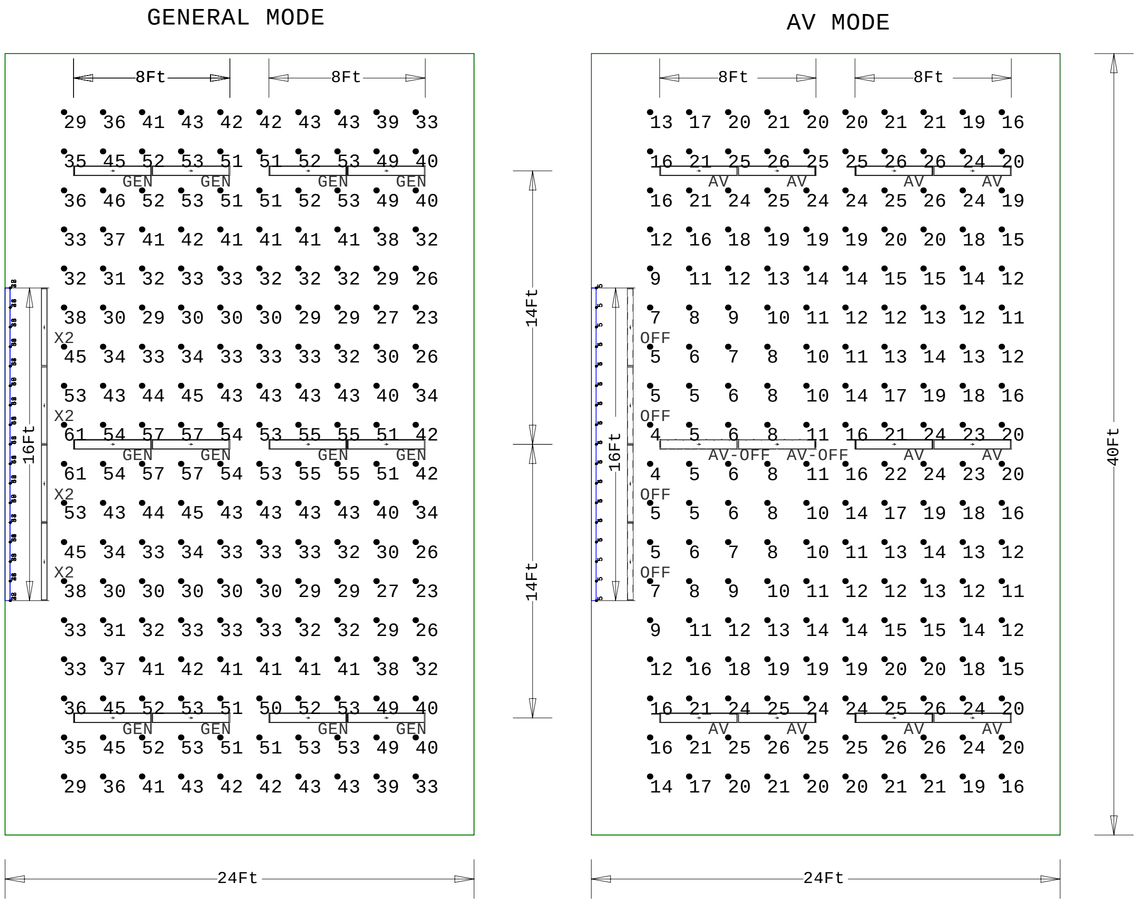
AGI32 VERSION 1.94

Calculations performed August, 2007, By Vickie Lauck, Finelite Inc.



Luminaire Schedule									
Symbol	Qty	Label	Description	Lumens	Watts	BF	LDD	LLD	LLF
	12	GEN	S15-2T8	3100	63	0.99	0.9	0.95	0.846
	10	AV	S15-1T8 (2T8 - one lamp turned off)	3100	34	0.99	0.9	0.95	0.846
	2	AV-OFF	S15-1T8 (2T8 - both lamps turned off)	3100	34	0.99	0.9	0.95	0.846
	4	X2	SX2-WCB-1T8-96W	3100	28	0.88	0.9	0.95	0.752
	4	OFF	SX2-WCB-1T8-96W (SX2 off in AV mode)	3100	28	0.88	0.9	0.95	0.752

Numeric Summary							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
General Mode, Workplane	Illuminance	Fc	40.59	61	23	1.76	2.65
AV Mode, Workplane	Illuminance	Fc	15.74	26	4	3.94	6.50
Whiteboard, GEN Mode	Illuminance	Fc	43.91	66	25	1.76	2.64
Whiteboard, AV Mode	Illuminance	Fc	4.76	5	4	1.19	1.25

LPD Area Summary			
Label	Area	Total Watts	LPD
General Mode	960	868	0.904
AV Mode	960	340	0.354

NOTES:
- Ceiling Height 8'-6"
- S15 Luminaires suspended 8'-0" AFF
- SX2 Ceiling surface mounted
- Input watts based on Osram QHE Instant Start Ballasts
- Lamp lumens based on Sylvania XPS 835 T8 lamps

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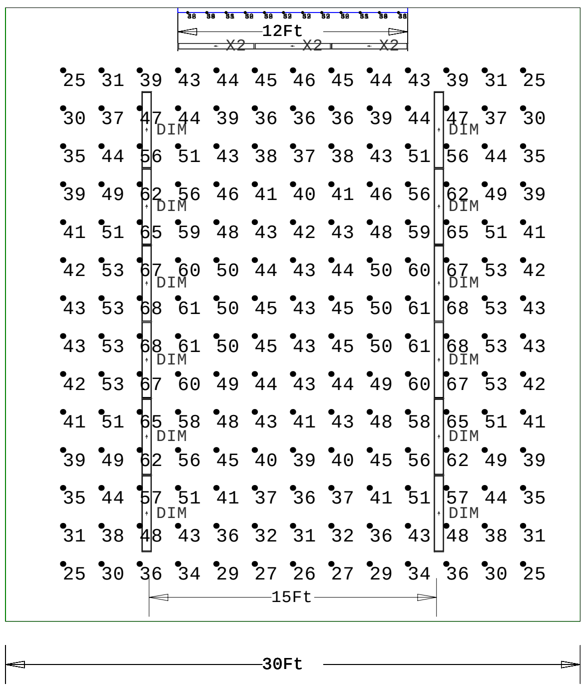
AGI32 VERSION 1.94

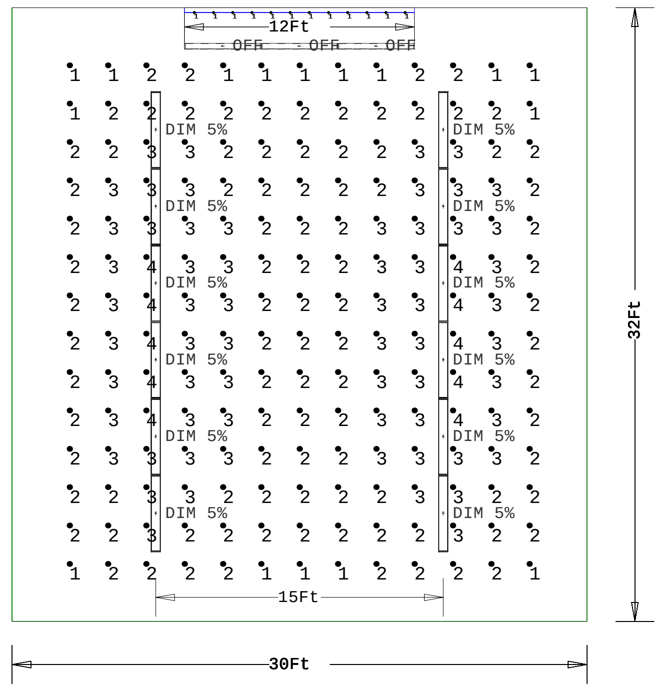
Calculations performed August, 2007, By Vickie Lauck, Finelite Inc.

Finelite ICLS Template - 30'-0" x 32'-0" x 10'-0" - DIMMING

GENERAL MODE



AV MODE (Dimmed to 5%)



Luminaire Schedule									
Symbol	Qty	Label	Description	Lumens	Watts	BF	LDD	LLD	LLF
	12	DIM	S10-PLV-2T8- OPEN	3100	60	0.88	0.9	0.95	0.752
	3	X2	SX2-WCB-1T8-96W	3100	28	0.88	0.9	0.95	0.752
	3	OFF	SX2-WCB-1T8-96W (SX2 OFF in AV mode)	3100	28	0.88	0.9	0.95	0.752
	12	DIM 5%	S10-PLV-2T8- OPEN (Dimmed to 5%)	3100	15	0.05	0.9	0.95	0.043

Numeric Summary							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
General Mode, Workplane	Illuminance	Fc	45.52	68	25	1.82	2.72
AV Mode, Workplane	Illuminance	Fc	2.36	4	1	2.36	4.00
Whiteboard, GEN Mode	Illuminance	Fc	45.42	59	31	1.47	1.90
Whiteboard, AV Mode	Illuminance	Fc	1.00	1	1	1.00	1.00

LPD Area Summary			
Label	Area	Total Watts	LPD
General Mode	960	804	0.838
AV Mode	960	180	0.188

NOTES:
- Ceiling Height 10'-0"
- Luminaires suspended 8'-0" AFF
- Input watts based on Osram Powersense 0-10 V Dimming Ballasts
- Lamp lumens based on Sylvania XPS 835 T8 lamps

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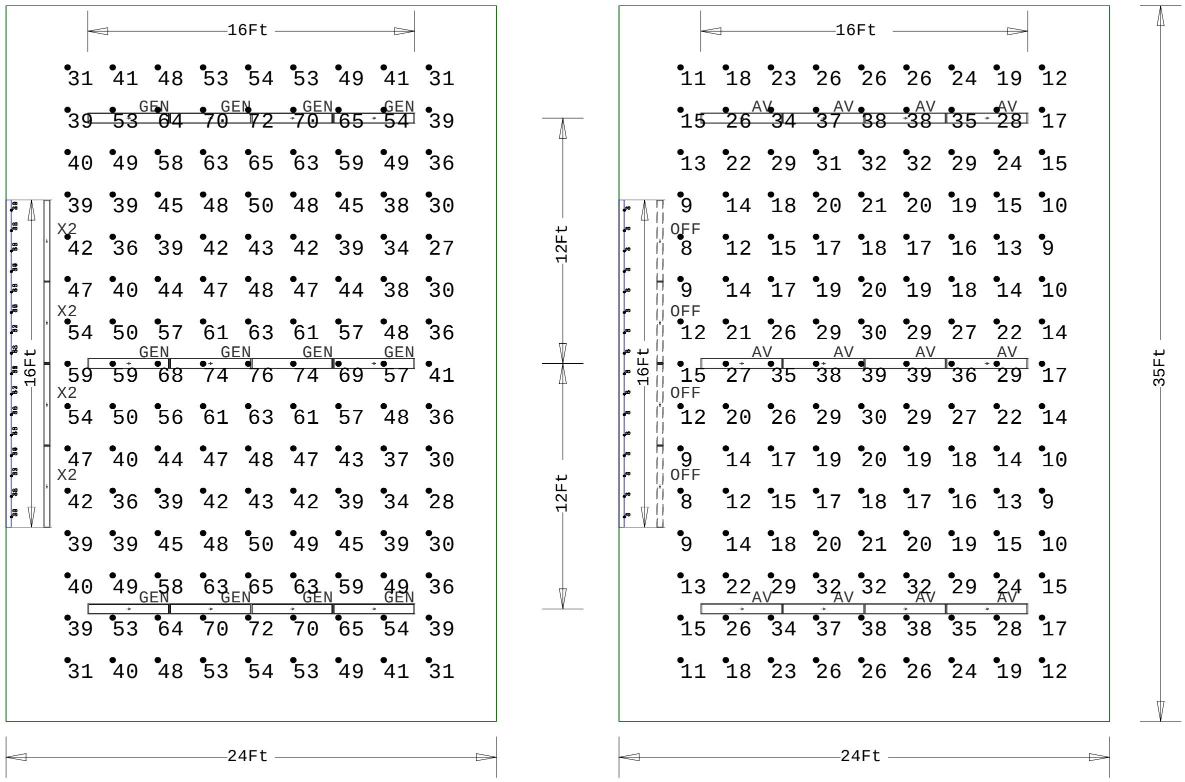
AGI32   VERSION 1.94

Calculations performed August, 2007, By Vickie Lauck, Finelite Inc.

Finelite ICLS Template - 24'-0" x 35'-0" x 10'-0"

GENERAL MODE

AV MODE



Luminaire Schedule									
Symbol	Qty	Label	Description	Lumens	Watts	BF	LDD	LLD	LLF
	12	GEN	SX1-PLV-CCO-2T8-EP (3T8 - center lamp off)	3100	48	0.78	0.9	0.95	0.667
	12	AV	SX1-PLV-COO-1T8-EP (3T8 - outboard lamps off)	3100	25	0.78	0.9	0.95	0.667
	4	X2	SX2-WCB-1T8-96W	3100	28	0.88	0.9	0.95	0.752
	4	OFF	SX2-WCB-1T8-96W (SX2 off in AV mode)	3100	28	0.88	0.9	0.95	0.752

Numeric Summary								
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
General Mode, Workplane	Illuminance	Fc	48.81	76	27	1.81	2.81
AV Mode, Workplane	Illuminance	Fc	21.31	39	8	2.66	4.88
Whiteboard, GEN Mode	Illuminance	Fc	43.09	58	29	1.49	2.00
Whiteboard, AV Mode	Illuminance	Fc	3.83	6	3	1.28	2.00

LPD Area Summary			
Label	Area	Total Watts	LPD
General Mode	840	688	0.819
AV Mode	840	300	0.357

NOTES:
- Ceiling Height 10'-0"
- SX1 Luminaires suspended 8'-0" AFF
- SX2 mounted 8'-6" AFF
- Input watts based on Osram QHE Instant Start Ballasts
- Lamp lumens based on Sylvania XPS 835 T8 lamps

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AGI32 VERSION 1.94

Calculations performed August, 2007, By Vickie Lauck, Finelite Inc.

APPENDIX D – CHPS AND LEED INFORMATION

Collaborative for High Performance Schools.

" The Collaborative for High Performance Schools (CHPS) began in November 1999, when the California Energy Commission called together Pacific Gas and Electric Company, San Diego Gas and Electric, and Southern California Edison to discuss the best way to improve the Performance of California's schools. Out of this partnership, CHPS grew to include a diverse range of government, utility, and non-profit organizations with a unifying goal to improve the quality of education for California's children. With the successful launch of the Best Practices Manual in 2001, interest in high performance design grew, and CHPS expanded its focus beyond California, developing a national version of the manuals as well as other state-specific versions. In early 2002, CHPS incorporated as a non-profit organization, further solidifying its commitment to environmentally sound design that enhances the educational environment."

CHPS Best Practice Manual Design, 2006 CHPS, Inc

More information on CHPS, including how to acquire the manuals can be found at www.chps.net. The attached information is reproduced from CHPS Design Criteria Manual.

LEED® for Schools

The LEED for Schools Rating System recognizes the unique nature of the design and construction of K-12 schools. Based on LEED for New Construction, it addresses issues such as classroom acoustics, master planning, mold prevention, and environmental site assessment. By addressing the uniqueness of school spaces and children's health issues, LEED for Schools provides a unique, comprehensive tool for schools that wish to build green, with measurable results. LEED for Schools is the recognized third-party standard for high performance schools that are healthy for students, comfortable for teachers, and cost-effective. The LEED for Schools Rating System is most applicable to new construction and major renovation projects in K-12 educational spaces. Other projects, such as university educational buildings, K-12 athletic facilities, or interpretive centers, may choose to use LEED for Schools if they wish."

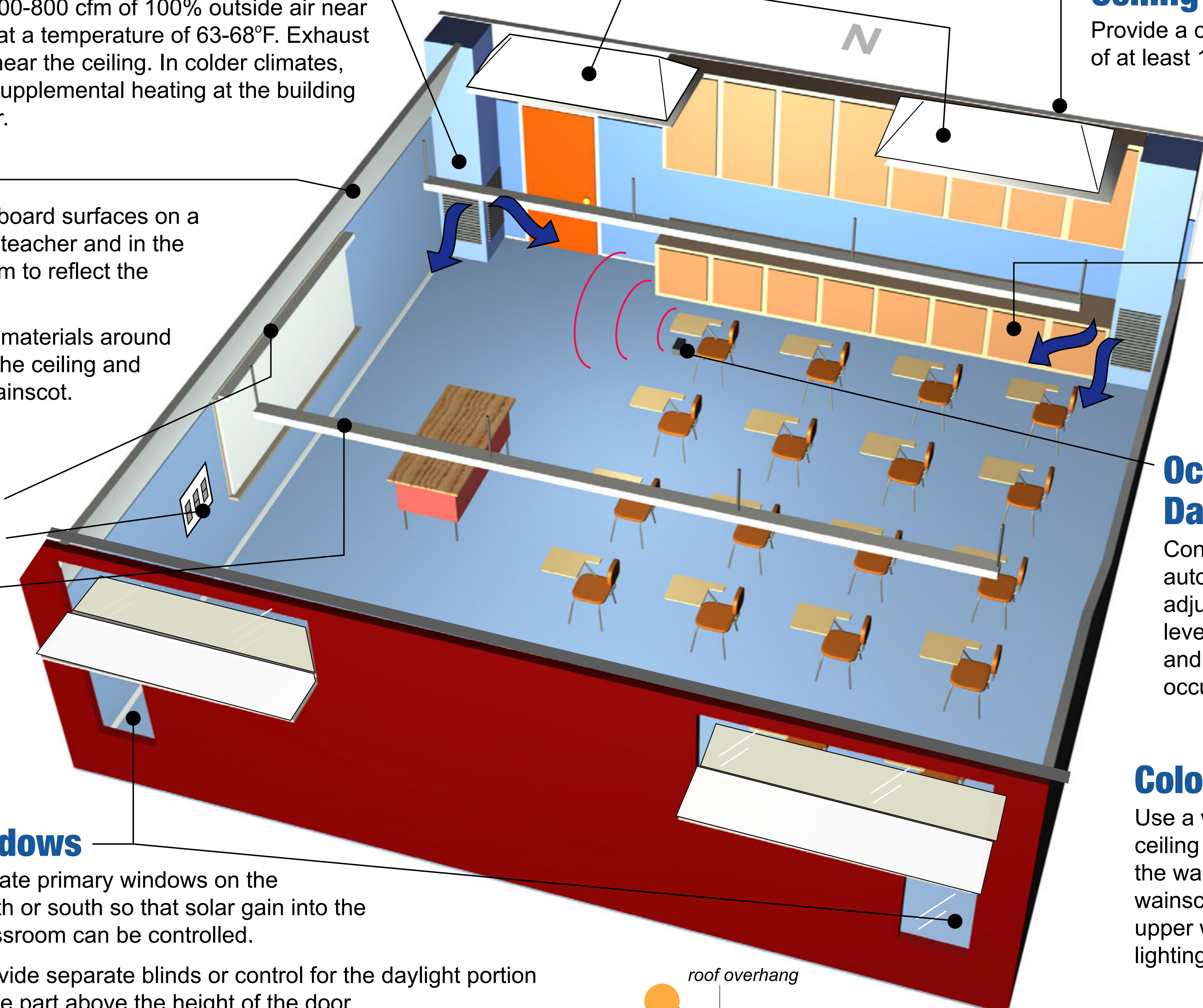
LEED for Schools for New Construction and Major Renovations
Approved 2007 Version – April 2007

More information on LEED can be found at www.usgbc.org.

The following information was reproduced from the LEED for Schools for New Construction and Major Renovations – 2007 Version.

The CHPS Classroom

the collaborative for high performance schools



Displacement Ventilation

Deliver 400-800 cfm of 100% outside air near the floor at a temperature of 63-68°F. Exhaust air at or near the ceiling. In colder climates, provide supplemental heating at the building perimeter.

Acoustics

- Provide gypsum board surfaces on a slope behind the teacher and in the middle of the room to reflect the teachers voice.
- Provide acoustic materials around the perimeter of the ceiling and above the 6'8" wainscot.

Whiteboard Luminaire

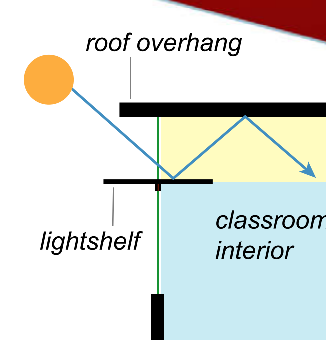
Teacher Control Center

Electric Lighting

Provide multi-scene indirect/direct lighting with two rows of pendant luminaires that use T8 lamps and electronic ballasts. Provide the teacher with controls at the teaching wall to operate the two lighting modes, general illumination and A/V. Incorporate a separately-switched whiteboard luminaire. Provide manual or automatic controls to reduce electric lighting when daylight is sufficient or the room is not occupied.

Windows

- Locate primary windows on the north or south so that solar gain into the classroom can be controlled.
- Provide separate blinds or control for the daylight portion – the part above the height of the door.
- If windows are not continuous, locate them in the corners to more effectively daylight the teaching surfaces.
- Select fenestration that reduces heat loss and improves comfort, while providing adequate for daylighting.
- Provide light shelves, overhangs for south facing windows.



Skylights

For classrooms that are one-story and have windows on just one side, locate two 4x8 diffusing skylights near the back wall to balance daylighting.

Ceiling Height

Provide a ceiling height of at least 10 ft.

Furnishings and Finishes

Select furnishings, casework, materials, and finishes that are non-toxic, durable, resource efficient and which provide a good acoustic environment.

Occupancy and/or Daylight Sensors

Consider installing automatic controls that adjust electric lighting to the level of daylight available and the presence of occupants in the space.

Colors

Use a white finish for the ceiling and the portion of the wall above the 6'8" wainscot. The ceiling and upper walls are part of the lighting system.

Classroom Layout

Provide an interior space layout that positions the principal visual tasks to reduce glare and provide good vertical illuminance on the teaching wall.

Goal: Improve student productivity through quality daylighting and electric lighting design. Provide a connection between indoor spaces and the outdoor environment through the introduction of sunlight and views into the occupied areas of the building.

EQ1.3: Electric Lighting

Intent: Provide high quality and flexible classroom lighting.

Progressive learning institutions are rapidly moving to better prepare students for today's high-tech, postindustrial world. Many new forms of learning have gained acceptance, as emerging technologies enhance the quality and efficiency of information delivery. These varied media including video, large-screen interactive presentations, and networked computer access to images and data, place new demands on the physical space. K-12 classrooms must be adaptable to support widely varying media and learning activities.

Requirement

1 point	EQ1.3.1	Provide multi-scene indirect/direct lighting systems for all classrooms, with the exception of chemistry laboratories, art rooms, shops, music rooms, and dance/exercise studios.
	EQ1.3.2	The lighting system shall operate in two modes: general illumination and A/V.
	EQ1.3.3	Provide a separately switched lighting system for the teaching wall that provides white board vertical illumination of at least 30 footcandles average with maximum uniformity of 8:1 or better.
	EQ1.3.4	In general illumination mode, achieve an average illumination at the desk level of 35 to 50 footcandles with a minimum of 25 footcandles at any point more than 3 ft from any wall.
	EQ1.3.5	In A/V mode, not including contribution from the teaching wall light, achieve an average illumination at the desk level of between 10 and 20 footcandles for any point in the room greater than 3 ft from the side walls, 10 ft from the front wall and 6 ft from the back wall, while limiting vertical illumination on the projection screen to no more than 7 footcandles at any point on the screen.
	EQ1.3.6	In indirect mode, controls shall provide at least two levels of uniform lighting both at night and when daylight is available.

Verification

A lighting computer program shall be used to determine the performance characteristics of the electric lighting system in typical classrooms. Minimum required calculations shall include point-by-point analysis of horizontal illumination levels at desk height in both modes, vertical illumination levels of the teaching wall in general lighting mode, and vertical ambient illumination on the projection screen in A/V mode. Calculations must be carefully set up to analyze only the specific tasks or zones as defined in the requirement. Use of a lighting analysis program employing radiosity and/or ray tracing is necessary. Some acceptable software packages include Lumen Micro 2000, Lumen Designer, AGI32, Radiance, Desktop Radiance, LightPro, Luxicon and Visual. CHPS may pre-approve typical lighting solutions as meeting the requirements.

Applicability

This credit applies to all new classrooms and can also be earned in modernization projects when classroom lighting is included in the scope of work. Many modernization projects include the installation of new lighting systems, providing an excellent opportunity to install energy efficient, high quality electric lighting that is integrated with the available daylight.

EQ Credit 6.1: Lighting System Design and Controllability
1 Point

Intent

Provide a high level of lighting system control by individual occupants or by specific groups in multi-occupant spaces (i.e. classrooms or conference areas) to promote the productivity, comfort and well-being of building occupants.

Requirements

FOR ADMINISTRATIVE OFFICES AND OTHER REGULARLY OCCUPIED SPACES:

Provide individual lighting controls for 90% (minimum) of the building occupants in workspaces to enable adjustments to suit individual task needs and preferences.

AND

FOR CLASSROOMS AND CORE LEARNING SPACES, with the exception of chemistry laboratories, art rooms, shops, music rooms, and dance/exercise studios,

Provide a classroom lighting system that operates in two modes: general illumination and A/V.

- In general illumination mode, achieve an average illumination at the desk level of 35 to 50 footcandles with a minimum of 25 footcandles at any point more than 3 ft from any wall.
- In A/V mode, not including contribution from the teaching wall light, achieve an average illumination at the desk level of between 10 and 20 footcandles for any point in the room greater than 3 ft from the side walls, 10 ft from the front wall and 6 ft from the back wall, while limiting vertical illumination on the projection screen to no more than 7 footcandles at any point on the screen.

Potential Technologies & Strategies

Design the building with occupant controls for lighting. Strategies to consider include lighting controls and task lighting. Integrate lighting systems controllability into the overall lighting design, providing ambient and task lighting while managing the overall energy use of the building.

Appendix E – Educational Materials

- DELTA Snapshot Draft
- Estimator & Contractor Guide

Field Test DELTA Snapshots

CLASSROOM LIGHTING

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

From grade schools to universities, the classroom environment is changing, with teachers increasingly using audio-visual projections to communicate with their students. Traditional instructional technology (chalkboards) required only one mode of general lighting. New instructional technologies require a second lighting mode — darker in the front of the room, and brighter in the student seating areas.

The Integrated Classroom Lighting System (ICLS) provides these two lighting modes with controls technology to facilitate switching between modes.[1]

Application profile

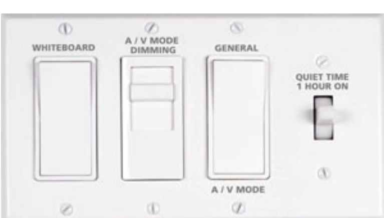
Seven schools in New York State participated in a demonstration of the ICLS.[2] At each of the seven schools, DELTA evaluated the lighting before and after retrofit of the ICLS in four classrooms.[3]

Lighting objectives

- Provide lighting for both audiovisual presentations and general teaching conditions
- Provide task lighting on the main teaching board
- Integrate the lighting and controls technologies into an easy-to-use system for teachers

Lighting system

The ICLS typically includes two rows of pendant direct/indirect luminaires and a separate wallwash luminaire for the main teaching board. The teacher control center (TCC) allows the teacher to change the lighting distribution from General mode (both uplight and downlight) to A/V mode (downlight only). The A/V mode, intended to be used during audio-visual presentations, includes an adjustable dimmer (optional). The Whiteboard switch allows the teacher to direct light towards the main teaching board. A Quiet Time switch overrides the occupancy sensor for one hour, keeping the lighting on during long periods of occupied non-movement such as standardized testing. The TCC is located near the main teaching board. Other controls in the ICLS include a hybrid ultrasonic/infrared occupancy sensor and a master on/off switch at the door.



Teacher control center

General mode (uplight and downlight) and Whiteboard light

Ballston Spa MS before and after ICLS retrofit

A/V mode (downlight only)

[1] See case study, "Integrated Energy Lighting System," accessed October 16, 2007 at http://www.archenergy.com/lrp/products/brochures/deliverable_6.2.5_CaseStudy_4.5.pdf.

[2] Middle and high schools included: Ballston Spa Middle School, Hunter College Campus (High) School, Ray Middle School, and Scarsdale High School. Universities included: New School, Rensselaer Polytechnic Institute, and Syracuse University.

[3] Detailed results of the full lighting demonstration are available from the Lighting Research Center.

Teacher survey

The teachers at the middle and high schools rated the ICLS favorably. They use the General mode for many teaching functions and the A/V mode for the intended presentations. They enjoy the added light for the main teaching board, as well as the dimmer for the A/V mode. However, they did not rate the Quiet Time mode as particularly helpful. Overall, these teachers considered the ICLS better than their previous lighting system. Feedback from university instructors was more mixed, perhaps due to less familiarity with the ICLS' features.

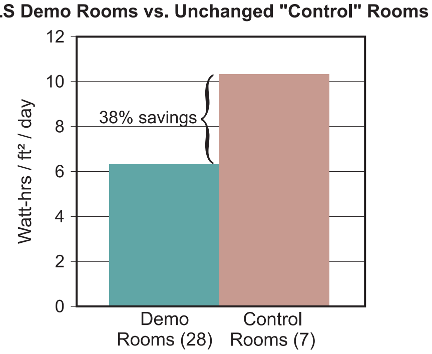
Installation and maintenance feedback

Electricians at the schools in this study characterized the ICLS as "easy to install." After one year of operation, there have been no major complaints about maintenance of the ICLS at the demonstration sites.

Energy savings

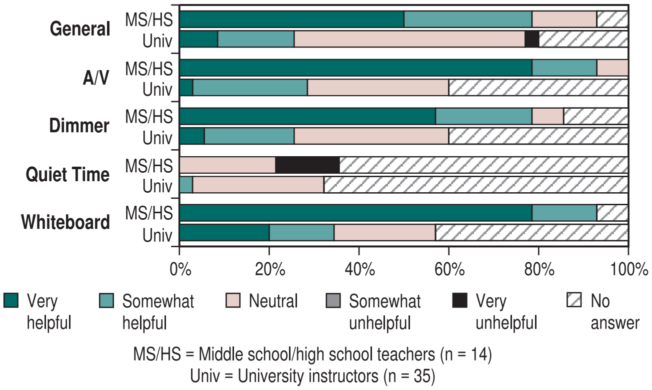
DELTA researchers performed a spot check of energy use with and without retrofit with ICLS.[4] Six schools reduced their lighting power density relative to previous lighting. However, illuminances and lighting power density at one school were slightly higher after retrofit; this school did not show energy savings. Energy savings from all seven schools together averaged 38%. The graph (right) shows projected savings compared to other power densities.

Average Daily Energy Use[4]
ICLS Demo Rooms vs. Unchanged "Control" Rooms



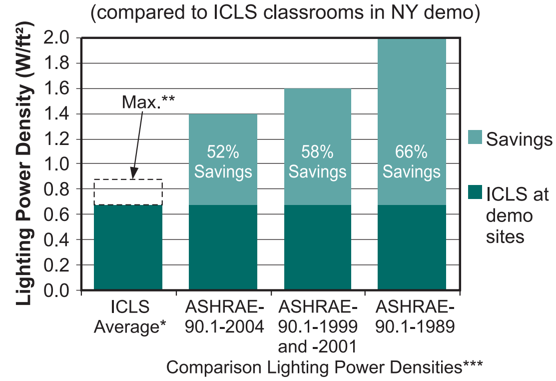
[4] Room sizes, lighting configurations, and lighting use patterns varied across the schools. Researchers sampled lighting use in 28 ICLS rooms and 7 control rooms over a typical week in the fall, winter, and spring. To compare across all schools in equivalent terms, energy use data (in watt-hours) were averaged over the 15 sampled days and over the square footage of the rooms.

"Do you find ______ mode helpful in your teaching?"



> *"It is much better than the lighting in my former room. [There is] less glare and the students really like them now!"*
> *– Middle school teacher*
>
> *"It really couldn't have been any easier." – Electrician*

Lighting Power Densities and Projected Savings
(compared to ICLS classrooms in NY demo)



* Average based on observed patterns of ICLS mode use at all demo classrooms.

** Maximum power density, averaged across all the schools (0.88 W/ft²); this includes both General and Whiteboard light modes.

*** Lighting power density limits for classrooms (space-by-space method) as outlined in ASHRAE-IESNA 90.1 standards. At press time, New York State Energy Conservation Construction Code references ASHRAE-IESNA 90.1-2001.

Note: More information about lighting for classrooms is available from New York Collaborative for High Performance Schools (NY-CHPS) and Leadership in Energy and Environmental Design (LEED) for Schools.

Field Test DELTA Snapshots
Issue 3, January 2008
Classroom Lighting

Sponsor: New York State Energy Research and Development Authority (NYSERDA)

ICLS Manufacturer: Finelite, Inc.

DELTA Program Director and Author: Jennifer Brons
Principal Investigator: Peter Morante
Technical Assistance: Yukio Akashi, Jennifer Brons, Peter Morante
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Field Test DELTA evaluates new energy-efficient lighting products to independently verify field performance claims and to suggest improvements. A primary goal of the Field Test DELTA program is to facilitate rapid market acceptance of innovative energy-efficient technologies.

Rensselaer

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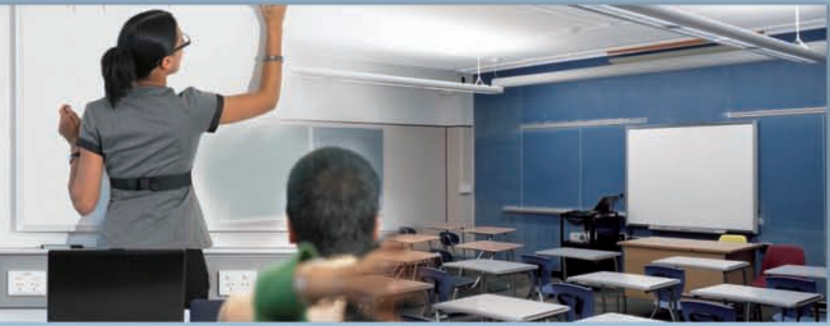
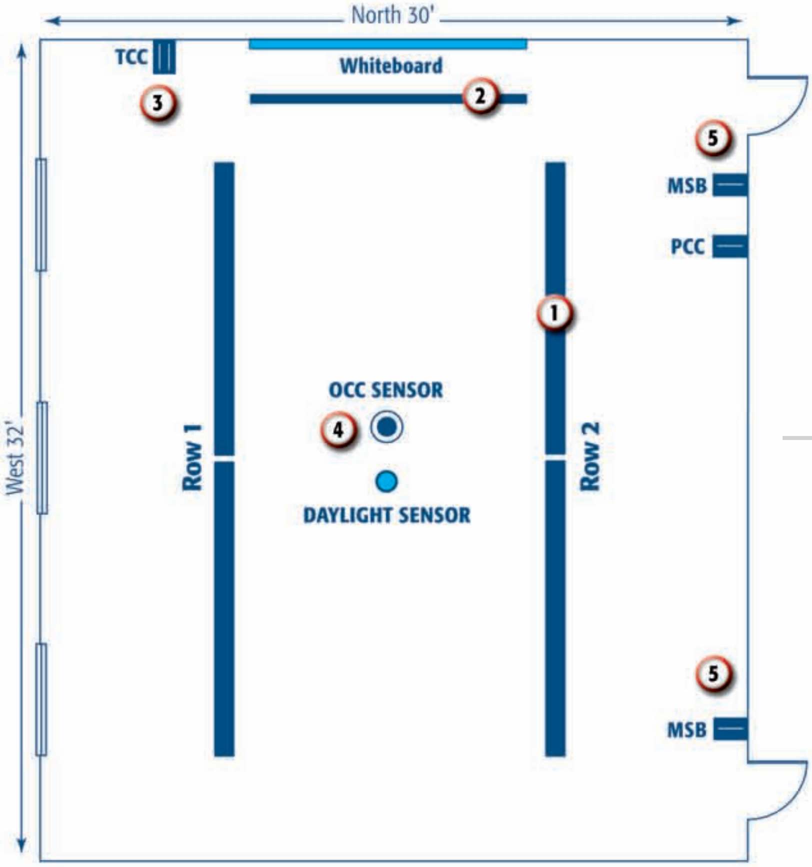
FINELITE
Better Lighting

ICLS
Integrated Classroom
Lighting System

Integrated Classroom Lighting System



Estimator & Contractor Guide



ICLS Template

High performance schools focus on construction elements that provide maximum benefit for the learning environment, while delivering superior energy performance.

The Integrated Classroom Lighting System (ICLS) meets the needs of the high performance classroom, requires just 5 integrated components to complete the system, and is backed by a 5-year single source warranty from Finelite – the company that sets the standard for service in the lighting industry.

ICLS Integrated Classroom Lighting System

1

Indirect/Direct Luminaires

Two rows of two-scene indirect/direct luminaires are mounted perpendicular to the main teaching wall (parallel to the window wall) and spaced 14-15′ apart.

2

Whiteboard Luminaire

A dedicated luminaire is used to illuminate the whiteboard on the main teaching wall.

3

Teacher Control Center

The Teacher Control Center (TCC) is placed at the front of the classroom. Place teacher controls within 6″ of the whiteboard for easy access.

4

Sensors

Sensors are placed in the center of the classroom and always include occupancy and daylight harvesting, *(added where appropriate)*.

5

Master On/Off Switch

Master On/Off Switches are installed by every door of the classroom.

ICLS - **Single Source** Solution

Installing ICLS takes just 10 man hours!

Finelite products install faster and easier than traditional lighting products. Our luminaires arrive at the jobsite fully assembled with all the necessary hanging hardware, and the ICLS system uses robust plug and play wiring components with patented technology to reduce the number of electrical connections required. The times listed below are conservative estimates that can be used to estimate your next ICLS project.

Start Up — 1 HOUR 15 MINUTES

Every project is different. This labor estimate factors in these differences for a more realistic approach.

Assess unique site conditions — 45 min.
Identify and organize parts — 30 min.

Rough-In — 5 HOURS 35 MINUTES

The rough-in phase of the project involves installing junction boxes, ceiling supports, and running electrical conduit.

Rough-in Power Control Center — 120 min.
Rough-in Teacher Control Center — 45 min.
Rough-in Main Switch Bank — 60 min.
Rough-in Occupancy Sensor — 30 min.
Rough-in Luminaire Supports — 80 min.

Luminaire Installation — 2 HOURS 15 MINUTES

Finelite has a rich history of developing easy-to-install products and you will see that our luminaires install faster than traditional lighting products.

Hang and level indirect/direct luminaires — 72 min.
Hang and level whiteboard luminaires — 18 min.
Make electrical connections — 45 min.

Controls Installation — 35 MINUTES

Plug and play wiring reduces labor and makes your job easier.

Install Teacher Control Center — 10 min.
Install Main Switch Bank — 10 min.
Install Occupancy Sensor — 15 min.

Clean-up and Finish Work — 35 MINUTES

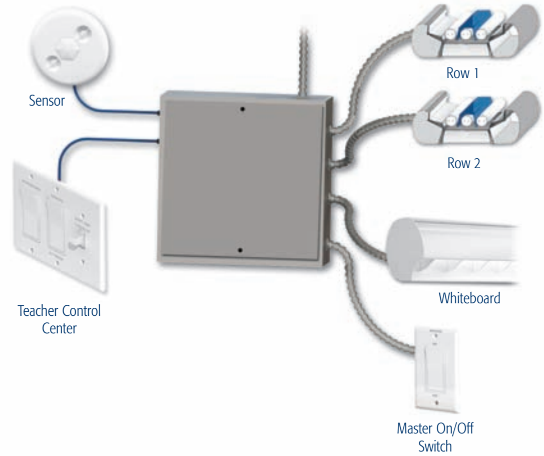
Finelite makes clean up and finish work easy. Our luminaires are shipped in protective plastic bags that can remain on until all the trades are off the job.

Remove Luminaire Bags — 10 min.
Install Faceplates — 10 min.
Test System — 10 min.

Total Installation Time — 10 HOURS 15 MIN.

Power Control Center

The Power Control Center (PCC) takes line voltage from building power and then carries power to, and communicates with ICLS system components. This robust unit is constructed of heavy duty 16-gauge steel, is easy to install and maintain, and is built to last the life of the installation.



Product Features that Reduce Installation Time

Plug & Play

Plenum rated plug and play wiring is used to connect the PCC to the TCC and sensors. Plug and play wiring is provided by Finelite for each job.

QUICK & EASY Installation

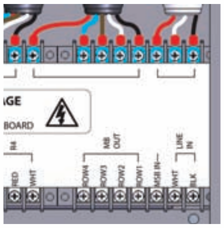
The PCC comes pre-wired and ready to be installed. Installation is easy – just mount the PCC, connecting building and fixture power as indicated, and run low voltage plug and play wiring to the TCC and sensors.

Terminal Strips

Terminal strips are used to speed installation and ensure the electrical connections are secure.

Knockouts

Heavy duty knockouts accommodate 1/2" to 1" conduit. The Box is constructed of 16-gauge steel.

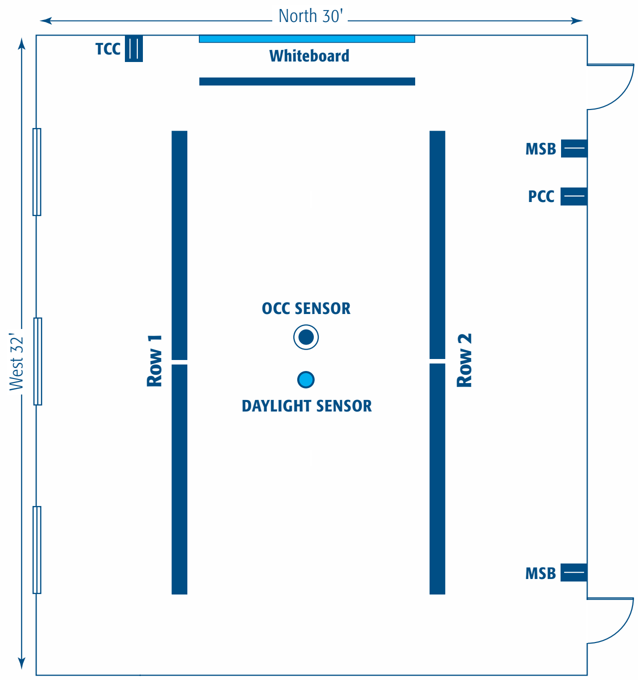


Wiring Label Panel

The wiring label panel clearly identifies every wiring connection for ease of installation and maintenance.

Diagnostic Tools

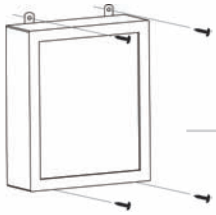
Diagnostic LED's show installers and maintenance teams when the unit is receiving power and when power is reaching the whiteboard luminaire, indirect luminaires, and occupancy sensor.



Power Control Center Rough-In Steps

Installing the PCC is quick and requires four easy steps.

Installation Time Labor Estimate



1) Place and Install PCC ---------- 30 MINUTES

The PCC is generally installed above ceiling by the Main Switch Bank at the classroom entrance. Four mounting tabs make it easy to attach to the wall. Simply screw it in.

2) Connect Building Wiring ---------- 30 MINUTES

Building wire is brought into the PCC and connected via terminal strips. The PCC features heavy duty knockouts.

3) Connect Fixture Wiring ---------- 45 MINUTES

Connect flex to the PCC for each of the luminaire rows. Three would be needed for the layout above

4) Connect Plug and Play Wiring ---------- 15 MINUTES

Plenum rated plug and play low voltage wiring is used to connect the Teacher Control Center and any sensors to the system, reducing the labor.

Total Installation Time: ---------- 2 HOURS

Component Rough-In

Teacher Control Center

- Run plug and play cables from PCC.
- Install junction box or low voltage network bracket at desired location.

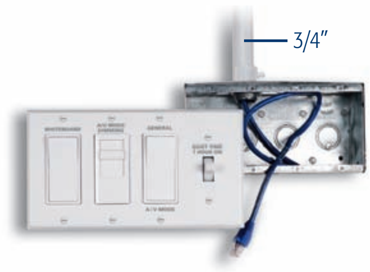
  In most cases, plug and play cabling can be run through the wall without conduit. (Check local regulations.)

Low Voltage Bracket

Installation Time: 30 minutes

J-box with Conduit

Installation Time: 60 minutes



Main Switch Bank

- Run power from PCC line voltage
- Install junction box or low voltage network bracket at desired location. (*Refer to specifications for junction box size.)*
- Install main switch bank.

J-box with Conduit

Installation Time: 60 minutes

Occupancy Sensor

- Run plug and play cables from PCC.
- Cut hole in ceiling tile (*if present*) or place junction box.

Occupancy Sensor Installed without J-box

Installation Time: 30 minutes

Occupancy Sensor Installed with J-box

Installation Time: 45 minutes

Non-Feed Locations

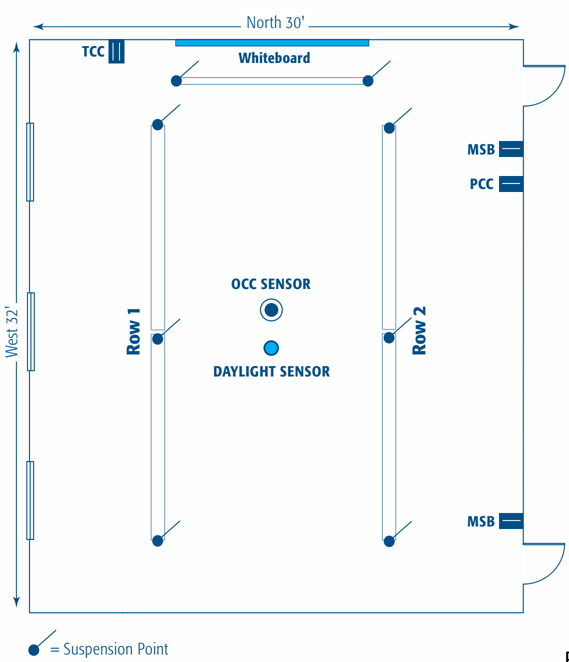
Screw ceiling support wires into upper structure. Attach the caddy clip to the T-Bar and secure aircraft cable and canopy.

Installation Time: 10 Min. per support

Feed Locations

Finelite's exclusive GridBox™ is the first electrical box that enables indirect lighting to be mounted On-Grid™ and meet all national codes. Attach the GridBox to the T-bar, connect the flex and ceiling support wire, and secure aircraft cable and canopy in place. Pre-level the bottom nut for faster luminaire installation.

Installation Time: 10 Min. per support



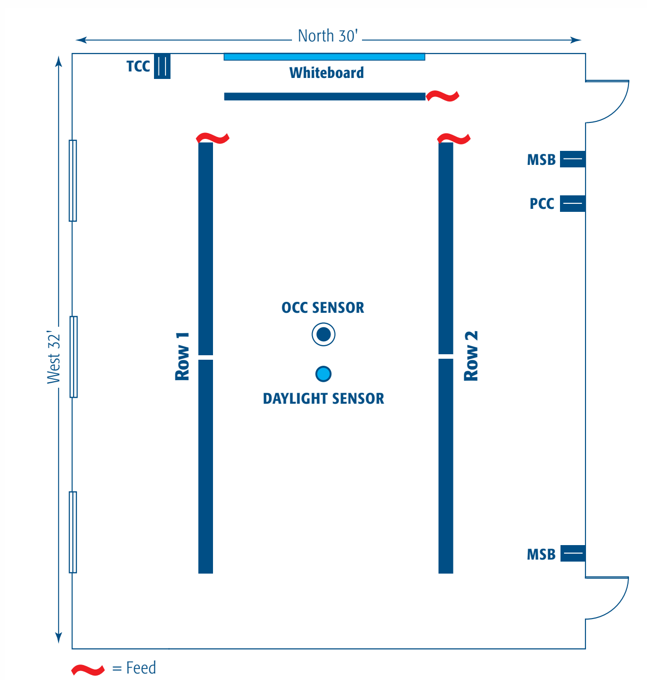
Template Totals / Rough-In

	Qty	Time Per	Total
Power Control Center	1	120 min.	120 min.
Teacher Control Center	1	45 min.	45 min.
Main Switch Bank	1	60 min.	60 min.
Occupancy Sensors	1	30 min.	30 min.
Non-Feed Supports	5	10 min.	50 min.
Feed Supports	3	10 min.	30 min.
			335 min.

Total Rough-In Installation Time:
5 HOURS 35 MINUTES

Finelite Luminaires install FASTER & EASIER than traditional lighting systems.

ICLS luminaires arrive on site fully assembled and pre-wired. They incorporate many labor saving elements, including On-Grid™ mounting, plug together wiring, and our exclusive Gridbox™. Follow these simple steps for a successful installation.



Template Totals / Luminaire Installation

	Qty	Time
# of Luminaire Feet	60	90 min.
# of Electrical Feeds	3	45 min.

Total Luminaire Installation Time:
2 HOURS 15 MINUTES

Hang & Level Luminaires

1.5 MINUTES PER FOOT

Hang Starter Fixture

Install the starter unit by lowering the bottom kep nut to the desired location and secure to the balancer cable attached to luminaire, repeating at joining end.

Whiteboard Installation

Position Luminaire

Locate the adjustable mounting brackets in the proper position and secure them in place for easy installation.

Connect Wiring and Join Fixtures

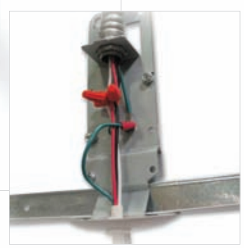
Hang the far end of joiner fixture while supporting both ends. Connect plug together wiring and join fixtures using two screws (*provided*).

Hang & Level Fixture

Attach the hanging hardware to the mounting bracket, level the luminaire, and secure the hardware in place.

Make Electrical Connections

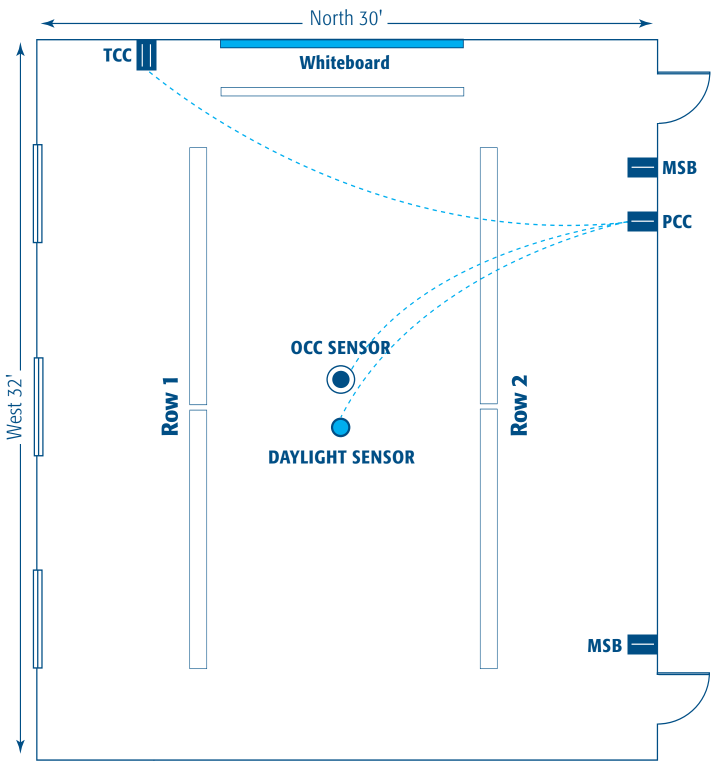
15 MINUTES PER FEED



For Indirect/Direct & Whiteboard Installation

Finelite's exclusive Gridbox is the first electrical box that enables indirect lighting to be mounted On-Grid and meet all national codes. Pull flex into the GridBox, thread through the strain relief and make the electrical connection.

Plug & Play makes installing ICLS controls and sensors EASY!



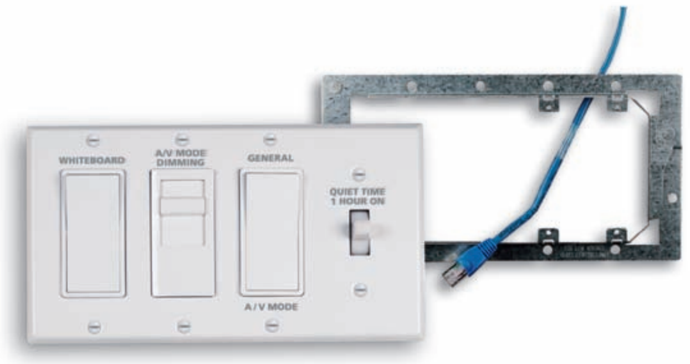
ICLS is an integrated system with luminaires and controls connected together using patented technology. Low voltage wire or plug and play cables connect the controls to the system, reducing labor, materials, and ensuring connections are right every time.

Quiet Time Occupancy Sensor

Install the occupancy sensor in the middle of the room with or without a junction box (*depending on local codes*). Plug and play wiring connects the sensor to the system.

Some room configurations require additional sensors, which can easily be daisy chained with the supplied Cat5 cable.

Installation Time: 15 Minutes



Teacher Control Center (TCC)

Install the TCC with its unique Quiet Time switch on the teaching wall next to the whiteboard.

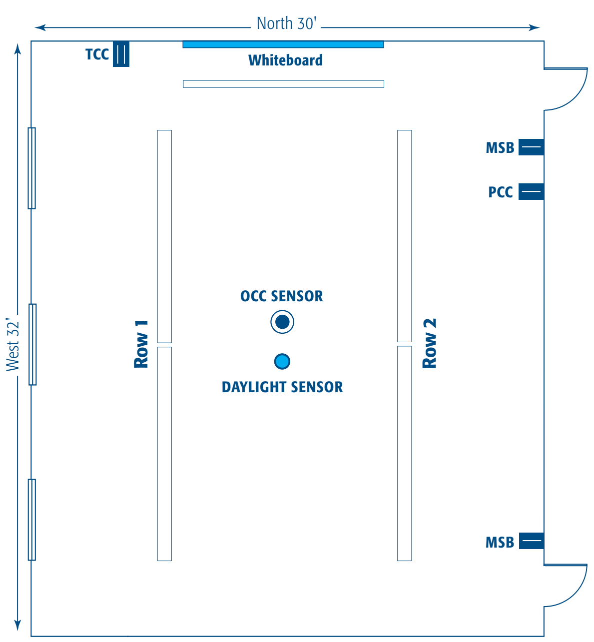
The low voltage TCC is shipped fully assembled, requiring only one plug and play connection, thus reducing labor costs.

Installation Time: 10 Minutes

Main Switch Bank (MSB)

Install the main on/off switches by each door using line voltage with the power coming from the Power Control Center (PCC).

Installation Time: 10 Minutes



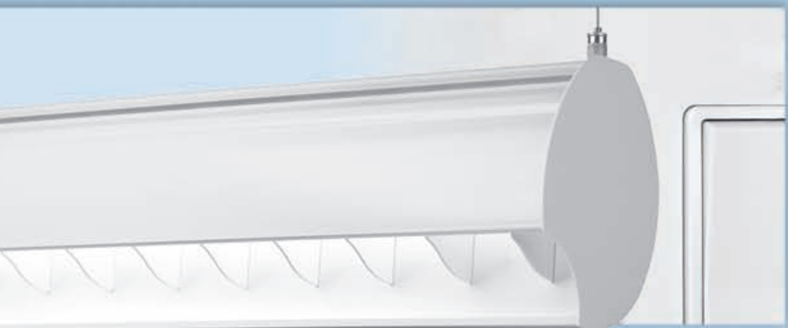
Template Totals / Installing Controls

	Qty	Time Per	Total
Teacher Control Center	1	10	10 min.
Main Switch Bank	1	10	10 min.
Occupancy Sensor	1	15	15 min.
			35 Min.

Total Controls Installation Time:
35 MINUTES

ICLS Integrated Classroom Lighting System

Best Practices



FINELITE
Better Lighting

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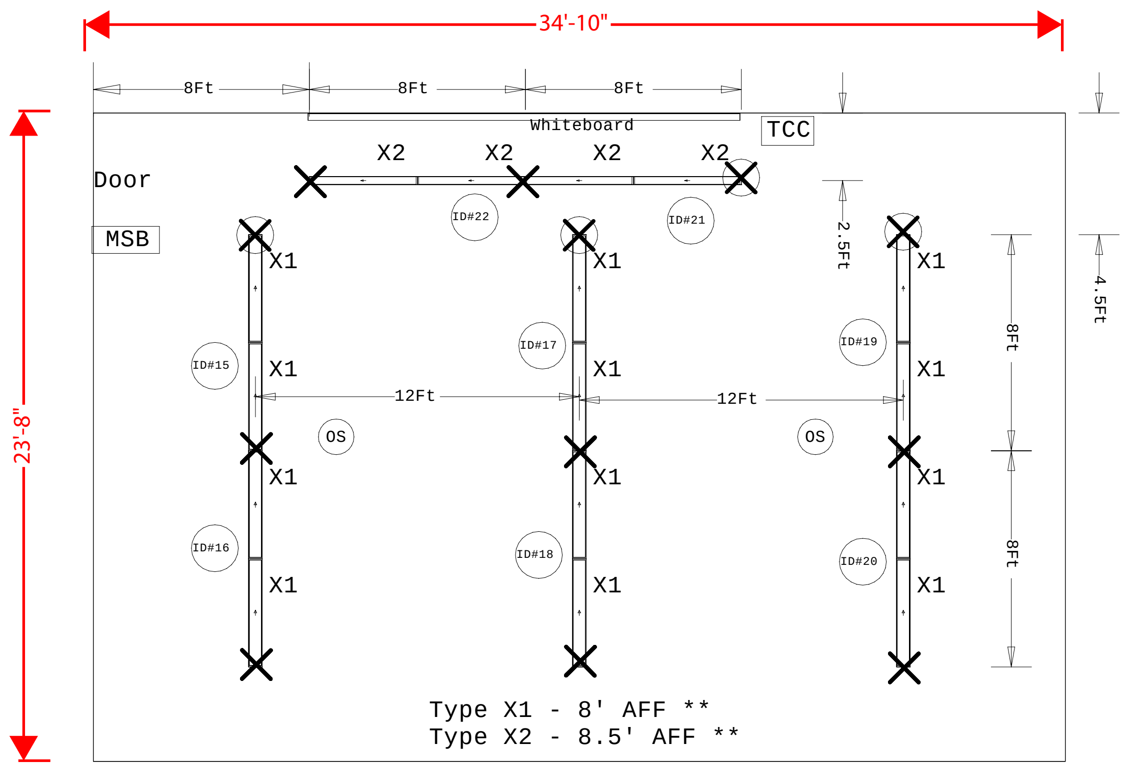
www.finelite.com

Form No. CBR0071

Appendix F – Baldwinsville Public Schools Information

- Room Dimension and Fixture Layout
- Lighting Layouts and calculations
- Energy Consumption Chart
- Data Summary Table
- Average Daily Lighting Usage Report

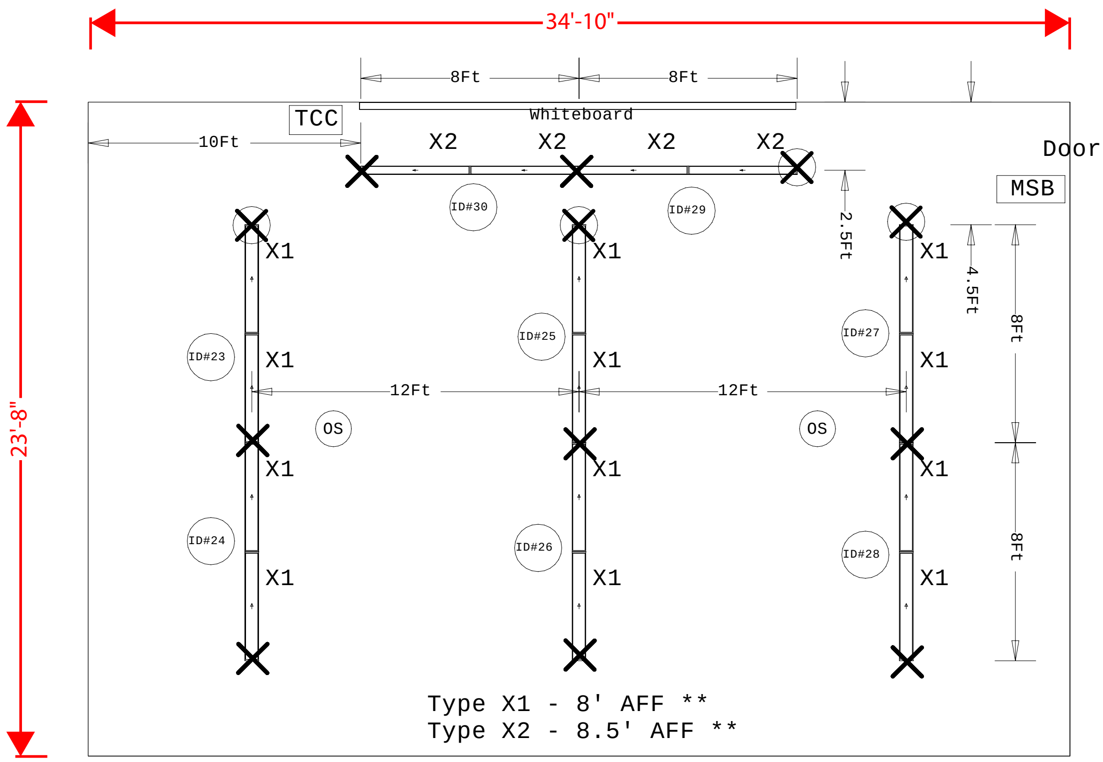
Baldwinsville Room 130
Installation Dimensions **



LEGEND	
TCC	Teacher Control Center mounting location: 4'-0" AFF (to top of box). Install on the left side of whiteboard/chalkboard
OS	Occupancy Sensor(s)
X	Suspension Point
⊗	Power Feed & Suspension Point (Pre-existing power feed points could affect changes to feed points)
ID# 1	Fixture ID#. Each fixture section will have a label with a unique ID# which can be found on the outside of the box and on the fixture itself.
MSB	Master Switch Bank -- Locate MSB on wall at entrance(s) to room. Exact location to be determined on-site.

** Site conditions could influence fixture placement and suspension. All fixtures to be mounted "on-grid" (if ceiling is grid type) therefore the attached dimensional information is approximate. The spacing between rows is the most important dimension to maintain.

Baldwinsville Room 179
Installation Dimensions **



LEGEND	
TCC	Teacher Control Center mounting location: 4'-0" AFF (to top of box). Install on the left side of whiteboard/chalkboard
OS	Occupancy Sensor(s)
X	Suspension Point
⊗	Power Feed & Suspension Point (Pre-existing power feed points could affect changes to feed points)
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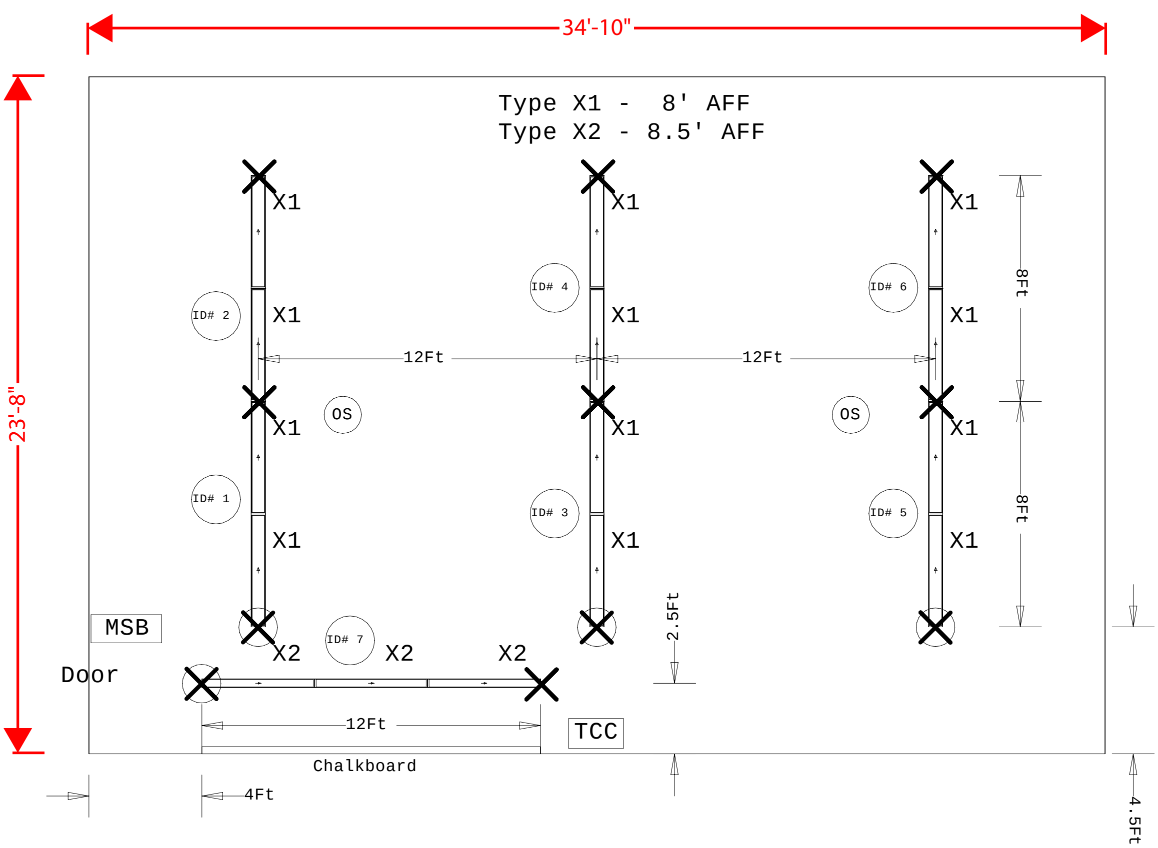
MSB	Master Switch Bank -- Locate MSB on wall at entrance(s) to room. Exact location to be determined on-site.

** Site conditions could influence fixture placement and suspension. All fixtures to be mounted "on-grid" (if ceiling is grid type) therefore the attached dimensional information is approximate. The spacing between rows is the most important dimension to maintain.

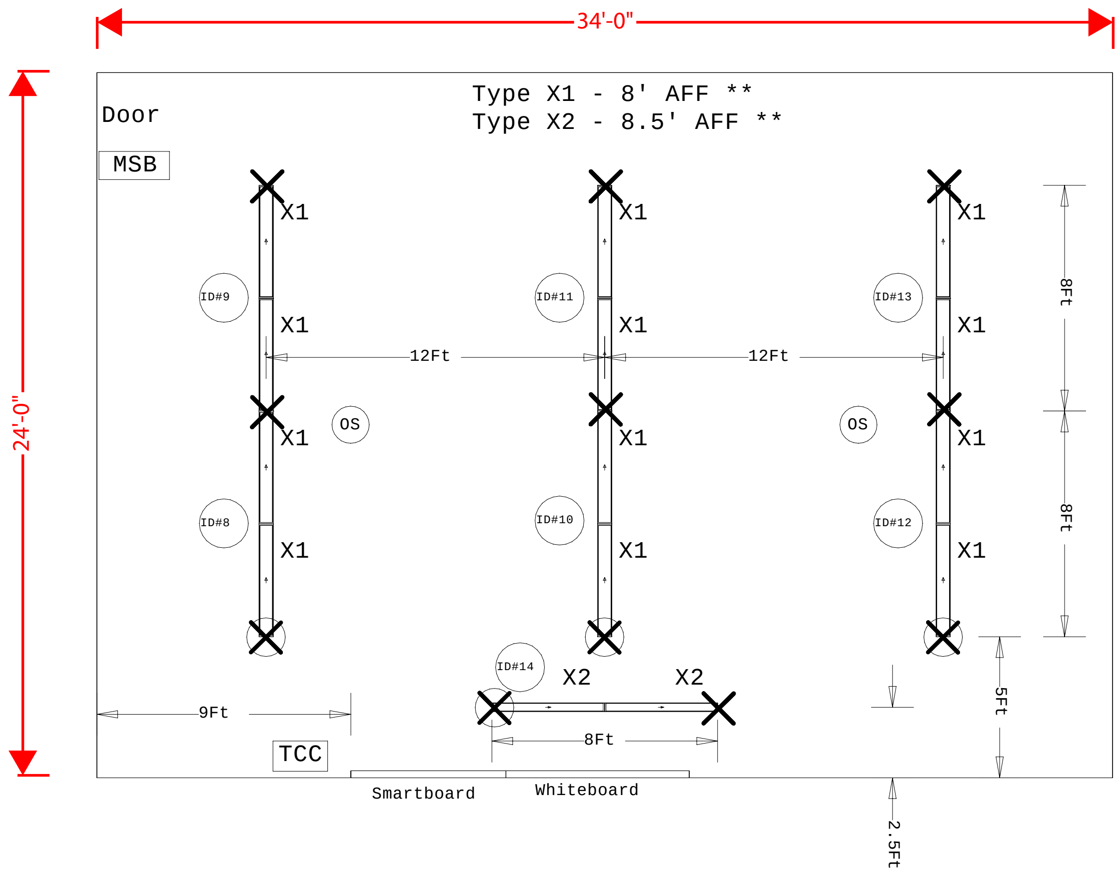
Baldwinsville Room 181
Installation Dimensions **



LEGEND	
TCC	Teacher Control Center mounting location: 4'-0" AFF (to top of box). Install on the left side of whiteboard/chalkboard
OS	Occupancy Sensor(s)
X	Suspension Point
⊗	Power Feed & Suspension Point (Pre-existing power feed points could affect changes to feed points)
ID# 1	Fixture ID#. Each fixture section will have a label with a unique ID# which can be found on the outside of the box and on the fixture itself.
MSB	Master Switch Bank -- Locate MSB on wall at entrance(s) to room. Exact location to be determined on-site.

** Site conditions could influence fixture placement and suspension. All fixtures to be mounted "on-grid" (if ceiling is grid type) therefore the attached dimensional information is approximate. The spacing between rows is the most important dimension to maintain.

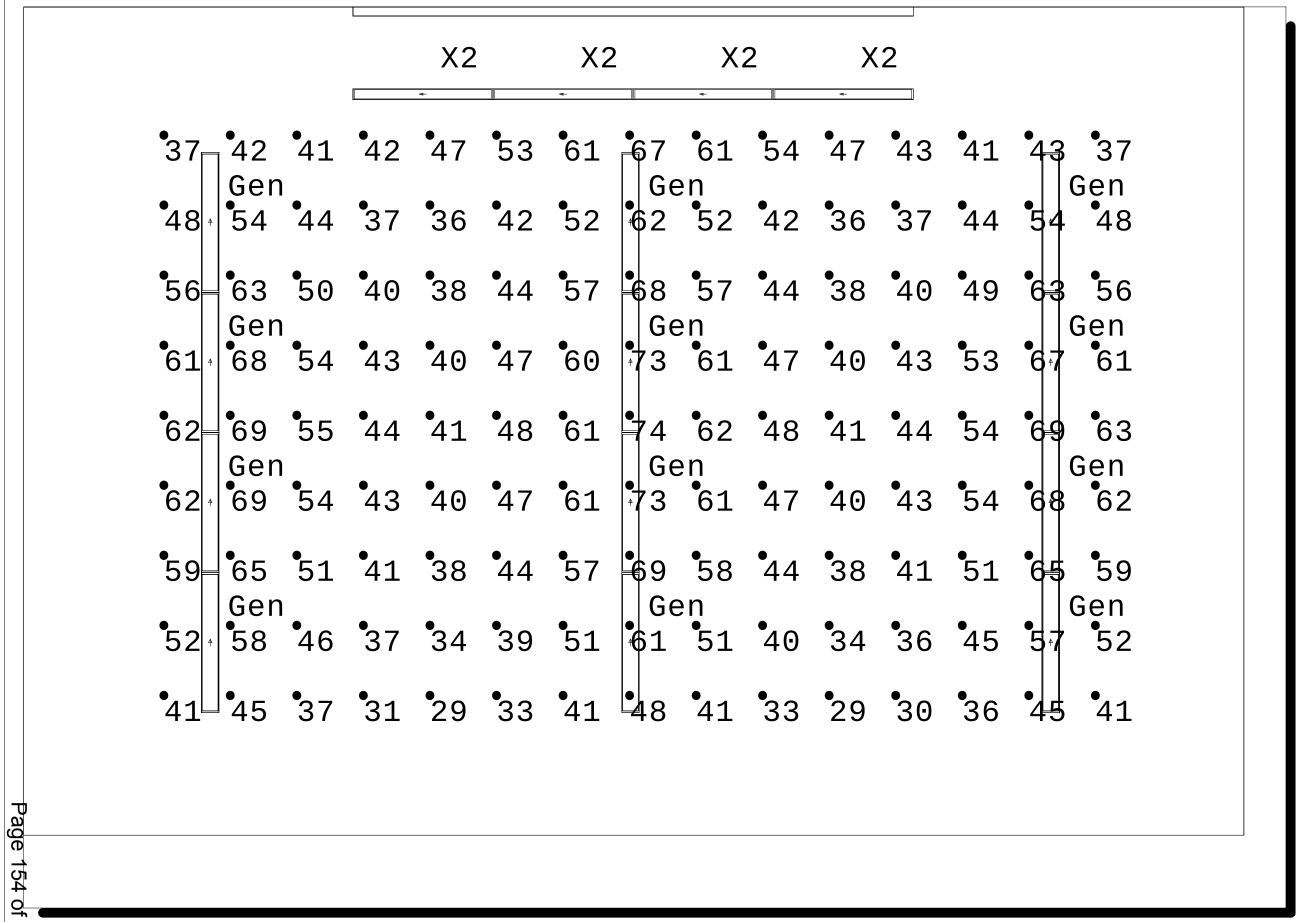
Baldwinsville Room 284
Installation Dimensions **



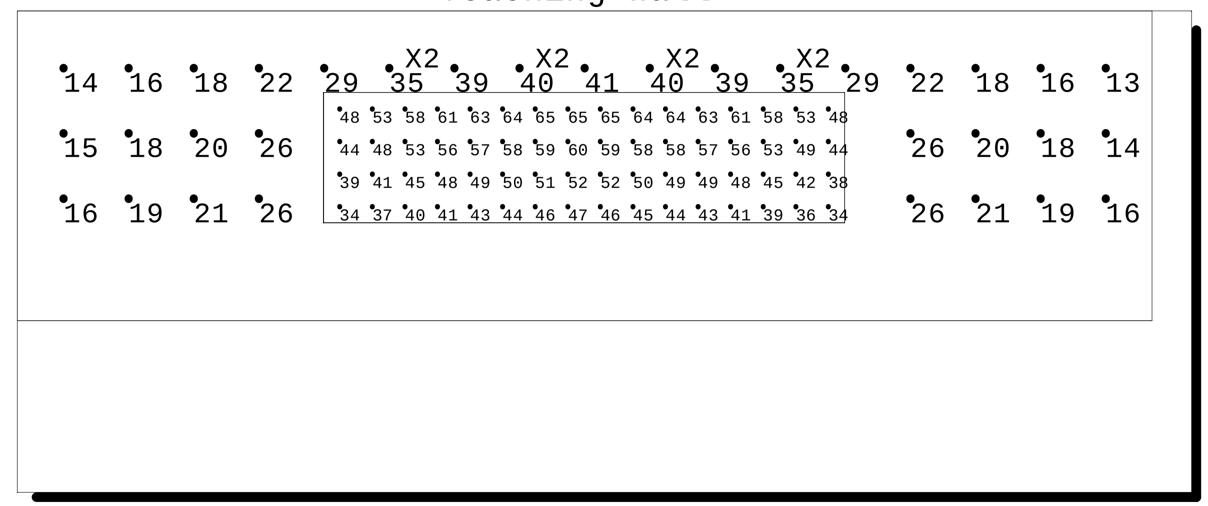
LEGEND	
TCC	Teacher Control Center mounting location: 4'-0" AFF (to top of box). Install on the left side of whiteboard/chalkboard
OS	Occupancy Sensor(s)
	Suspension Point
	Power Feed & Suspension Point (Pre-existing power feed points could affect changes to feed points)
ID# 1	Fixture ID#. Each fixture section will have a label with a unique ID# which can be found on the outside of the box and on the fixture itself.
MSB	Master Switch Bank -- Locate MSB on wall at entrance(s) to room. Exact location to be determined on-site.

** Site conditions could influence fixture placement and suspension. All fixtures to be mounted "on-grid" (if ceiling is grid type) therefore the attached dimensional information is approximate. The spacing between rows is the most important dimension to maintain.

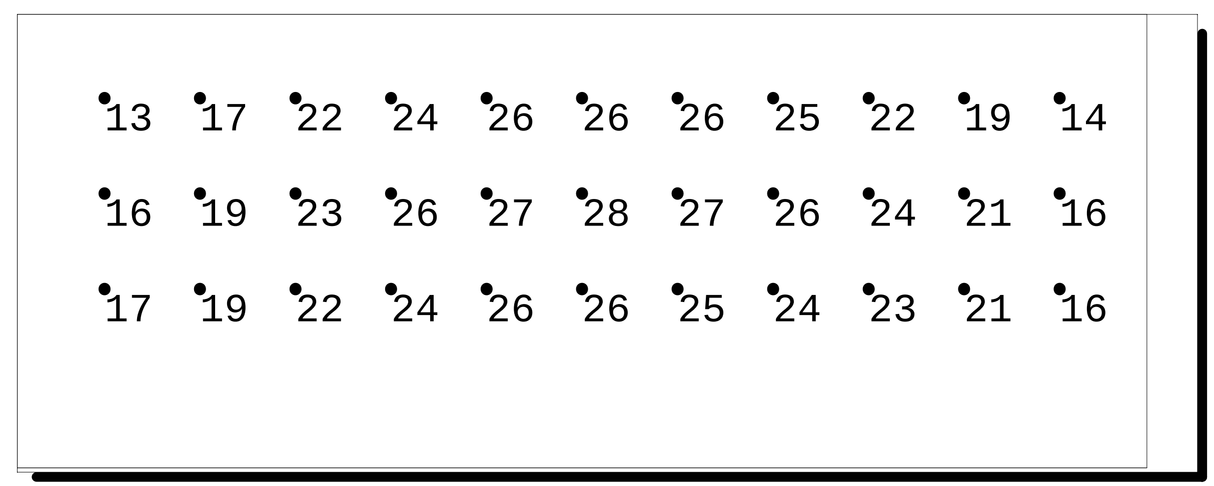
GENERAL MODE



Teaching Wall



East Wall



Luminaire Schedule									
Project: Baldwinsville, Ray Middle, Room 130 & 179									
Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	12	Gen	3100	0.667	X1 PLV CCO 2T8 EP	0.78	48	0.9	0.95
	4	X2	3100	1.026	SX2 WCB 1T8 96W	1.2	38	0.9	0.95

Numeric Summary							
Project: Baldwinsville, Ray Middle, Room 130 & 179							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Teaching Wall	Illuminance	Fc	23.85	41	13	1.83	3.15
Chalkboard	Illuminance	Fc	50.47	65	34	1.48	1.91
East Wall	Illuminance	Fc	22.12	28	13	1.70	2.15
Horizontal WP	Illuminance	Fc	49.46	74	29	1.71	2.55

Room Summary		
Project: Baldwinsville, Ray Middle, Room 130 & 179		
Label	Wall Ht.	Description
Room 130 & 179	9.5	34'-10" x 23'-8" Refl. 80/50/20

LPD Area Summary			
Project: Baldwinsville, Ray Middle, Room 130 & 179			
Label	Area	Total Watts	LPD
Room 130 & 179	823.91	728	0.884

SX1 luminaires 8' AFF; X2 luminaire is 8.5' AFF.
Calculations are based on Osram QHE .78 Instant
Start Ballasts on outboard lamps and Osram Powersense
Dimming Ballasts on the center lamps.
X2 ballasts are QHE 1.2 ballasts.

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

PHOTOMETRIC DATA USED AS INPUT FOR THESE CALCULATIONS IS BASED ON ESTABLISHED IES PROCEDURES AND PUBLISHED LAMP & BALLAST RATINGS. FIELD PERFORMANCE WILL DEPEND ON ACTUAL LAMP, BALLAST, ELECTRICAL AND SITE CHARACTERISTICS.

VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT 30" ABOVE FINISHED FLOOR.

AGI32 VERSION 1.8

FINELITE
Better Lighting for a Better Workplace

Comments	Date	#

Revisions

Drawn By: V Lauck
Date: April, 2006

Project: NYSERDA
Baldwnsvl, Ray Mdl, Rm 130&179

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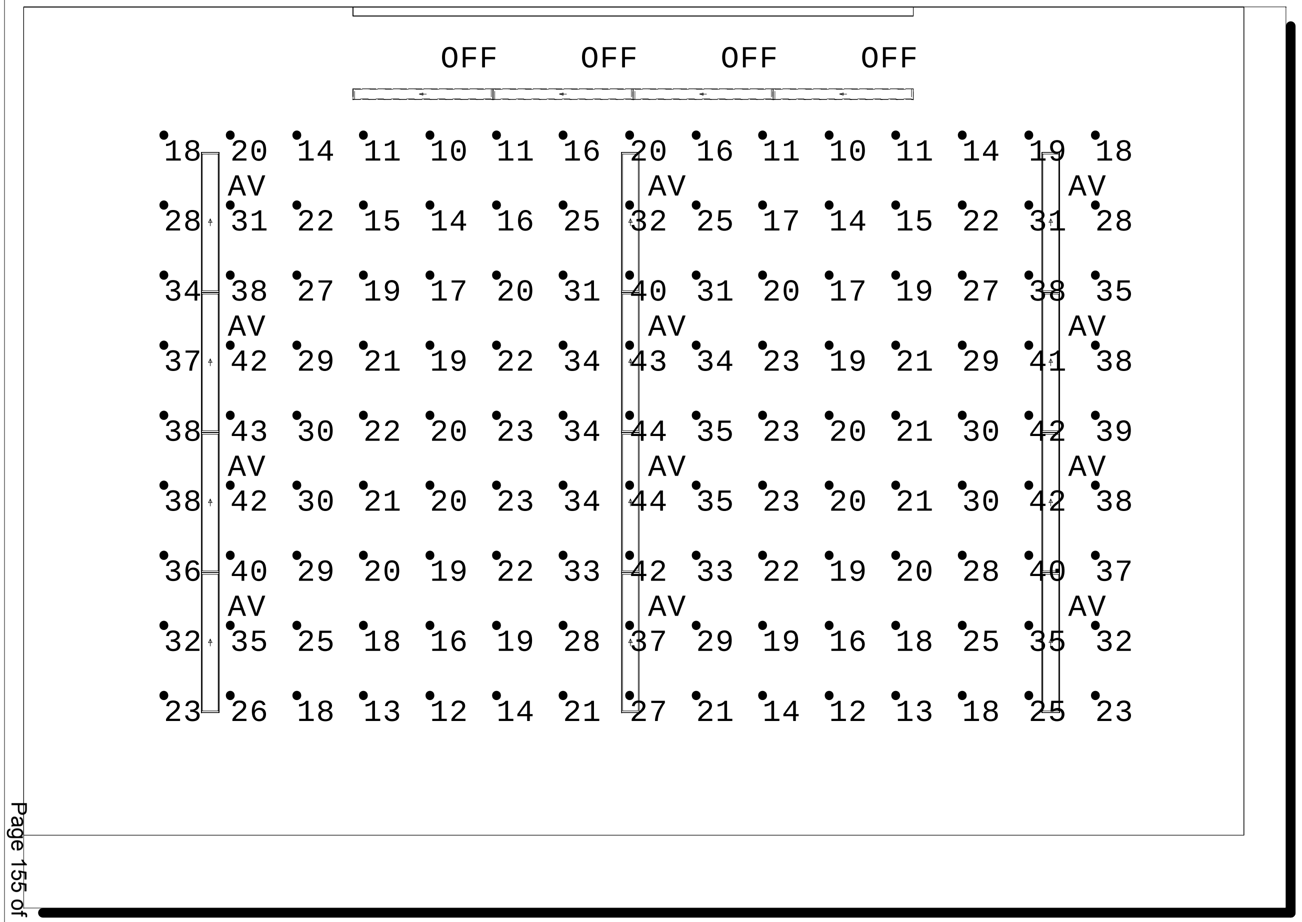
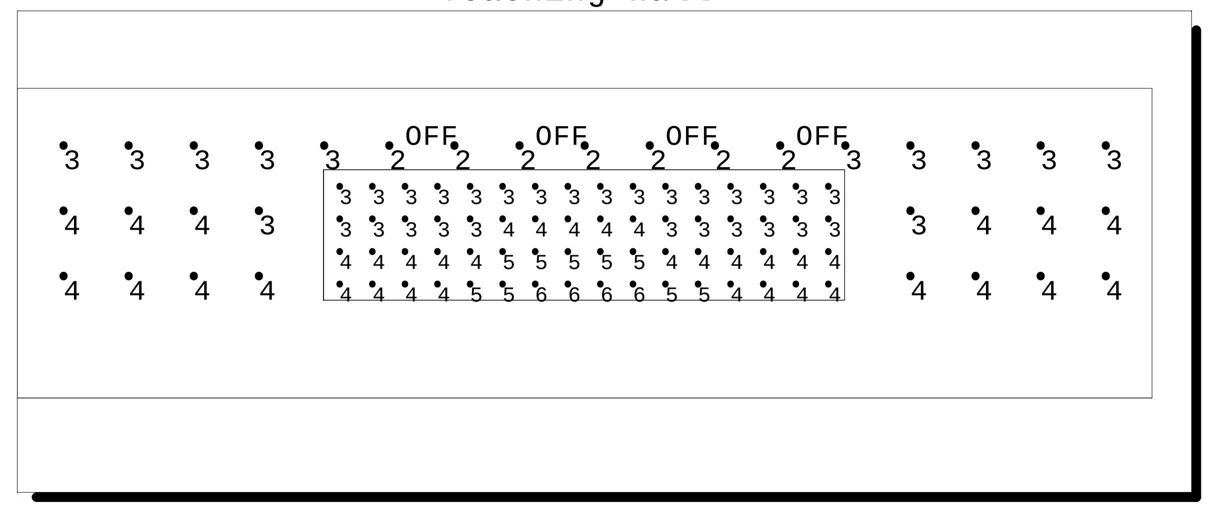
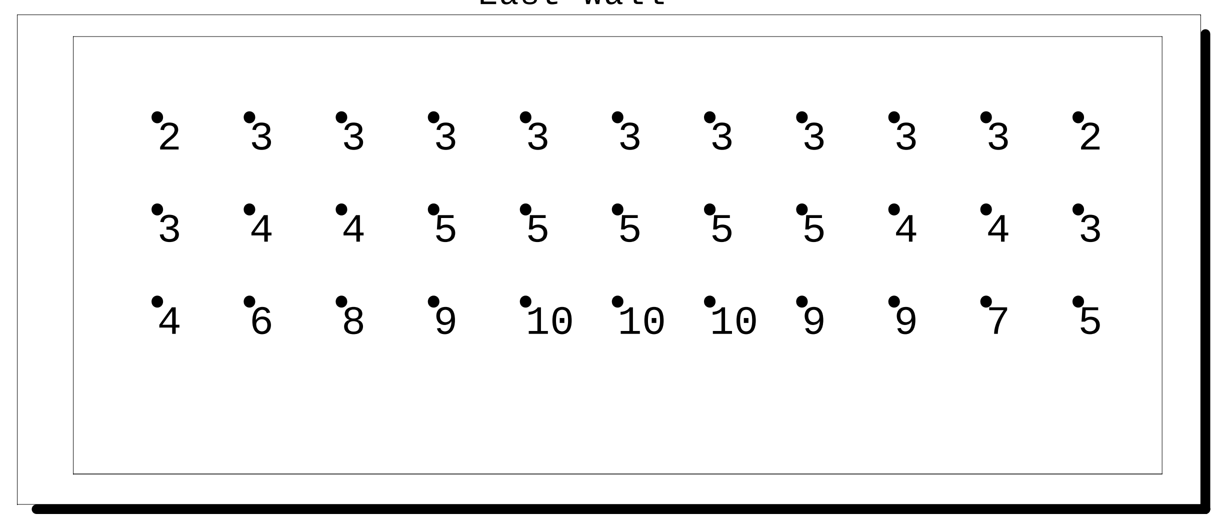
AV MODE



Teaching Wall



East Wall



Luminaire Schedule									
Project: Baldwinsville, Ray Middle, Room 130 & 179									
Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	12	AV	3100	0.752	X1 PLV COO 1T8 EP	0.88	30	0.9	0.95
	4	OFF	3100	1.026	SX2 WCB 1T8 96W	1.2	38	0.9	0.95

Numeric Summary							
Project: Baldwinsville, Ray Middle, Room 130 & 179							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Horizontal WP	Illuminance	Fc	25.54	44	10	2.55	4.40
Teaching Wall	Illuminance	Fc	3.21	4	2	1.61	2.00
East Wall	Illuminance	Fc	5.00	10	2	2.50	5.00
Chalkboard	Illuminance	Fc	3.84	6	3	1.28	2.00

Room Summary		
Project: Baldwinsville, Ray Middle, Room 130 & 179		
Label	Wall Ht.	Description
Room 130 & 179	9.5	34'-10" x 23'-8" Refl. 80/50/20

LPD Area Summary			
Project: Baldwinsville, Ray Middle, Room 130 & 179			
Label	Area	Total Watts	LPD
Room 130 & 179	823.91	360	0.437

SX1 luminaires 8' AFF; X2 luminaire is 8.5' AFF.
Calculations are based on Osram QHE .78 Instant
Start Ballasts on outboard lamps and Osram Powersense
Dimming Ballasts on the center lamps.
Type X2 is turned OFF.

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

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VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT 30" ABOVE FINISHED FLOOR.
AGI32 VERSION 1.8

FINELITE
Better Lighting for a Better Workplace

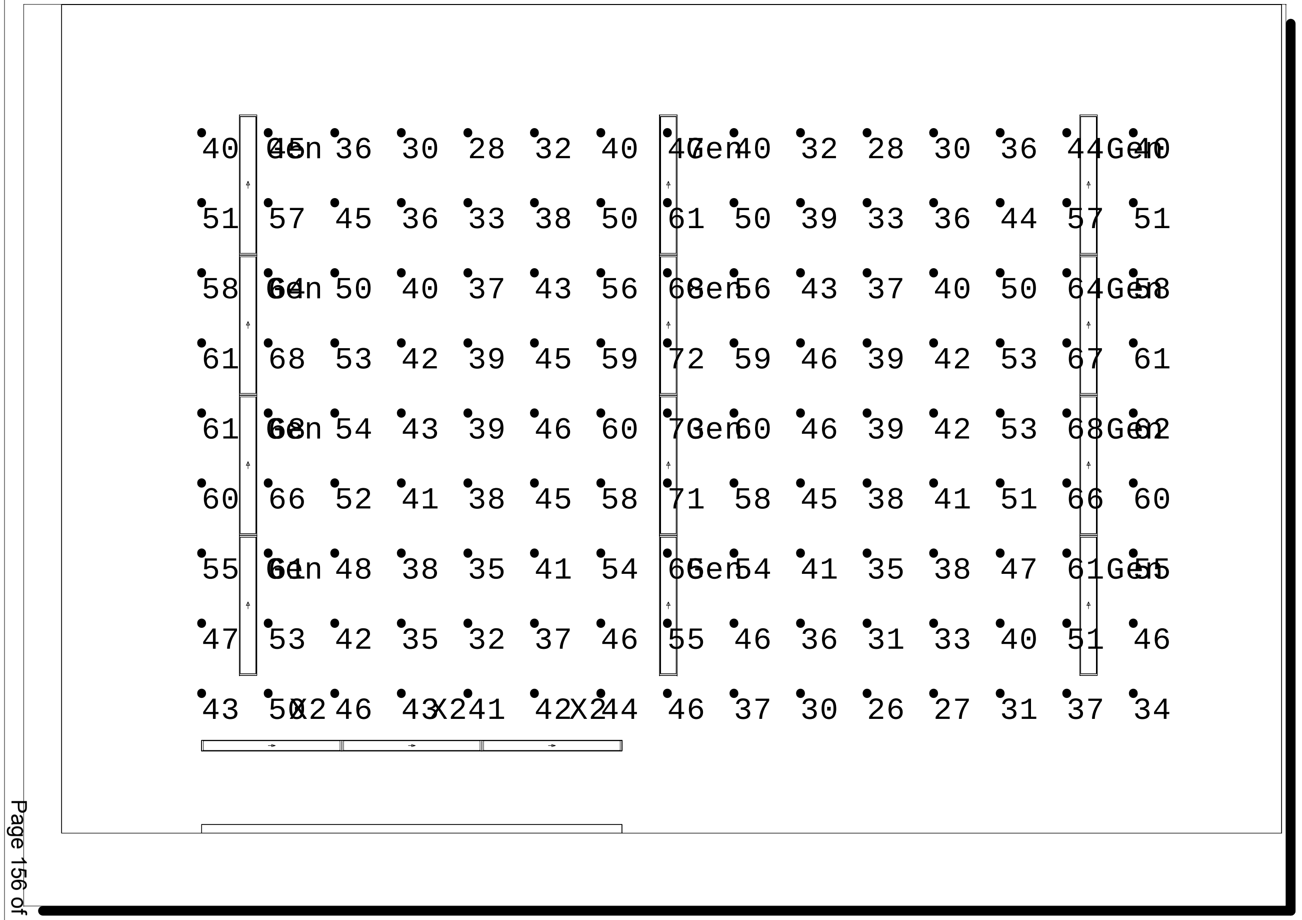
#	Date	Comments
Revisions		

Drawn By: V Lauck
Date: April, 2006

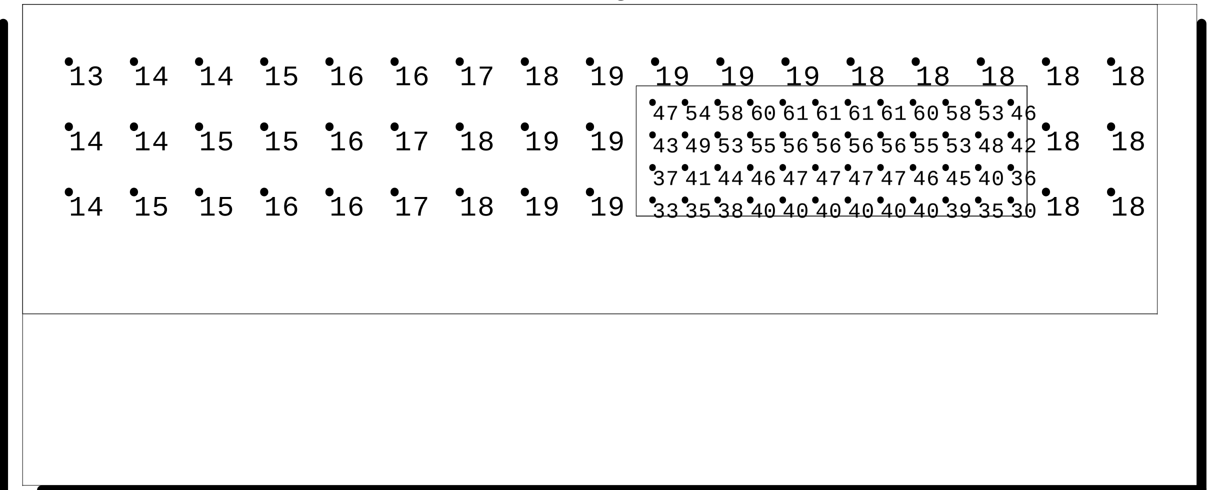
Project: NYSERDA
Baldwnsvl, Ray Mdl, Rm 130&179

Page 1 of 1

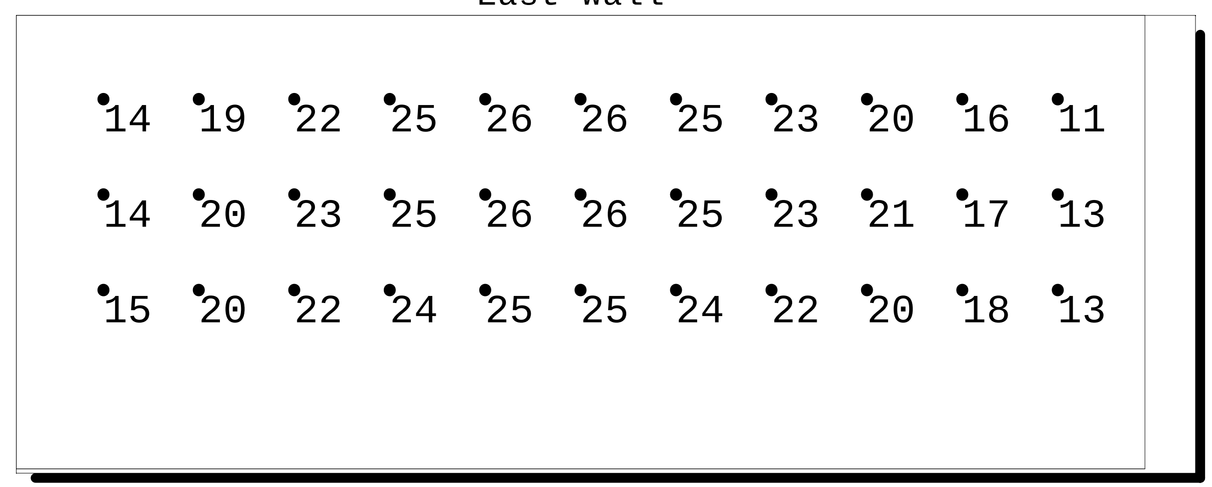
GENERAL MODE



Teaching Wall



East Wall



Luminaire Schedule									
Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	12	Gen	3100	0.667	X1 PLV CCO 2T8 EP	0.78	48	0.9	0.95
	3	X2	3100	1.026	SX2 WCB 1T8 96W	1.2	38	0.9	0.95

Numeric Summary							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Teaching Wall	Illuminance	Fc	16.85	19	13	1.30	1.46
Chalkboard	Illuminance	Fc	47.40	61	30	1.58	2.03
East Wall	Illuminance	Fc	20.85	26	11	1.90	2.36
Horizontal WP	Illuminance	Fc	46.95	73	26	1.81	2.81

Room Summary		
Label	Wall Ht.	Description
Room 181	9.5	34'-10" x 23'-8" Refl. 80/50/20

LPD Area Summary			
Label	Area	Total Watts	LPD
Room 181	823.91	690	0.837

SX1 luminaires 8' AFF; X2 luminaire is 8.5' AFF.
Calculations are based on Osram QHE .78 Instant Start Ballasts on outboard lamps and Osram Powersense Dimming Ballasts on the center lamps.
X2 ballasts are QHE 1.2 ballasts.

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

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VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT 30" ABOVE FINISHED FLOOR.
AGI32 VERSION 1.8

FINELITE
Better Lighting for a Better Workplace

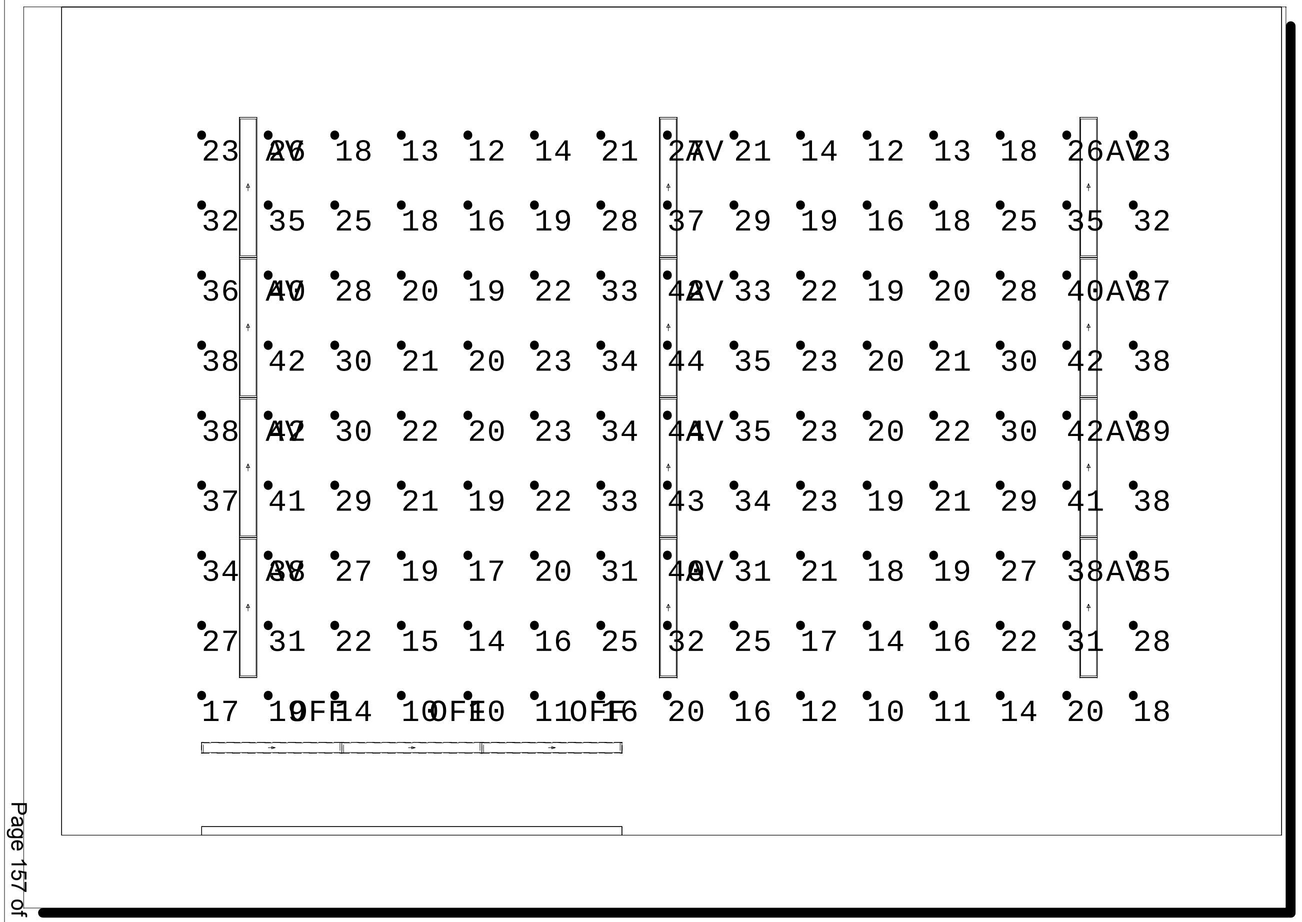
Revisions		
#	Date	Comments

Drawn By: V Lauck
Date: April, 2006

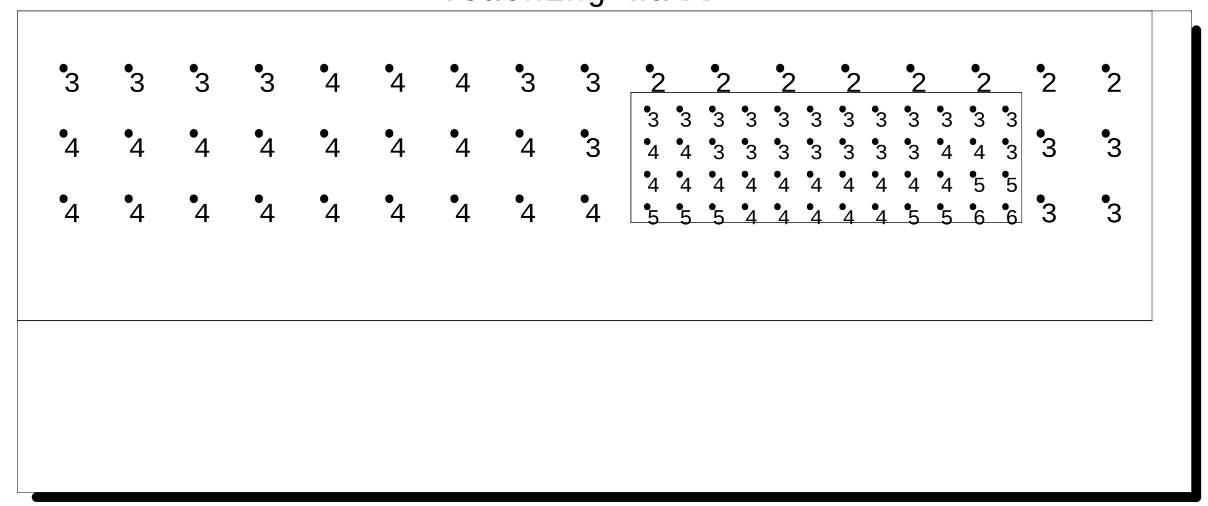
Project: NYSERDA
Baldwnsvl, Ray Mdl, Room 181

Page 1 of 1

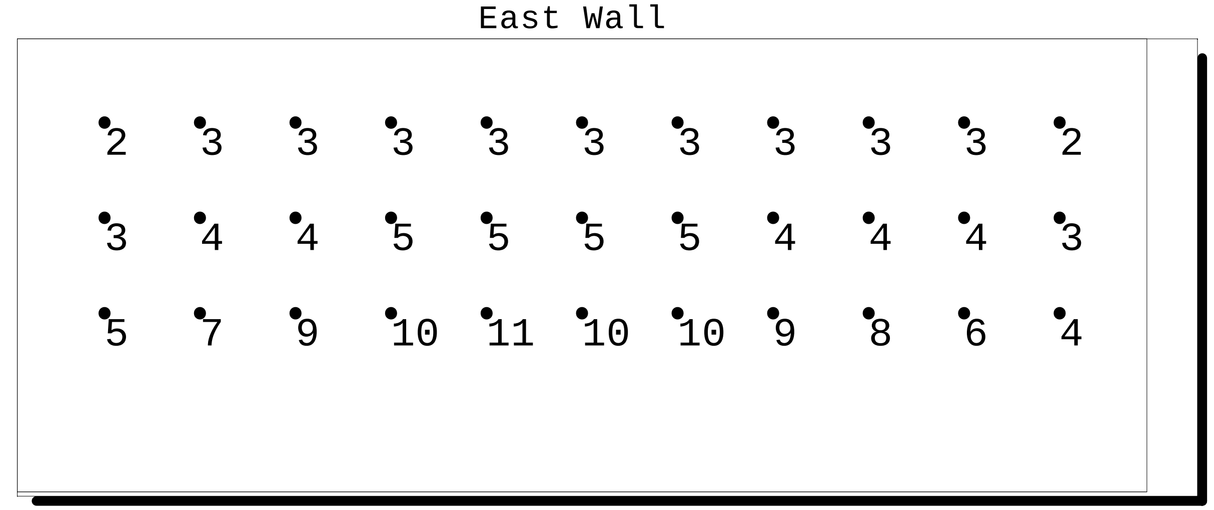
AV MODE



Teaching Wall



East Wall



Luminaire Schedule									
Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	12	AV	3100	0.752	X1 PLV COO 1T8 EP	0.88	30	0.9	0.95
	3	OFF	3100	1.026	SX2 WCB 1T8 96W	1.2	38	0.9	0.95

Numeric Summary							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Teaching Wall	Illuminance	Fc	3.31	4	2	1.66	2.00
Chalkboard	Illuminance	Fc	3.81	6	3	1.27	2.00
East Wall	Illuminance	Fc	5.03	11	2	2.52	5.50
Horizontal WP	Illuminance	Fc	25.53	44	10	2.55	4.40

Room Summary		
Label	Wall Ht.	Description
Room 181	9.5	34'-10" x 23'-8" Refl. 80/50/20

LPD Area Summary			
Label	Area	Total Watts	LPD
Room 181	823.91	360	0.437

SX1 luminaires 8' AFF; X2 luminaire is 8.5' AFF.
Calculations are based on Osram QHE .78 Instant
Start Ballasts on outboard lamps and Osram Powersense
Dimming Ballasts on the center lamps.
Type X2 is turned OFF.

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

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VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT 30" ABOVE FINISHED FLOOR.
AGI32 VERSION 1.8

FINELITE
Better Lighting for a Better Workplace

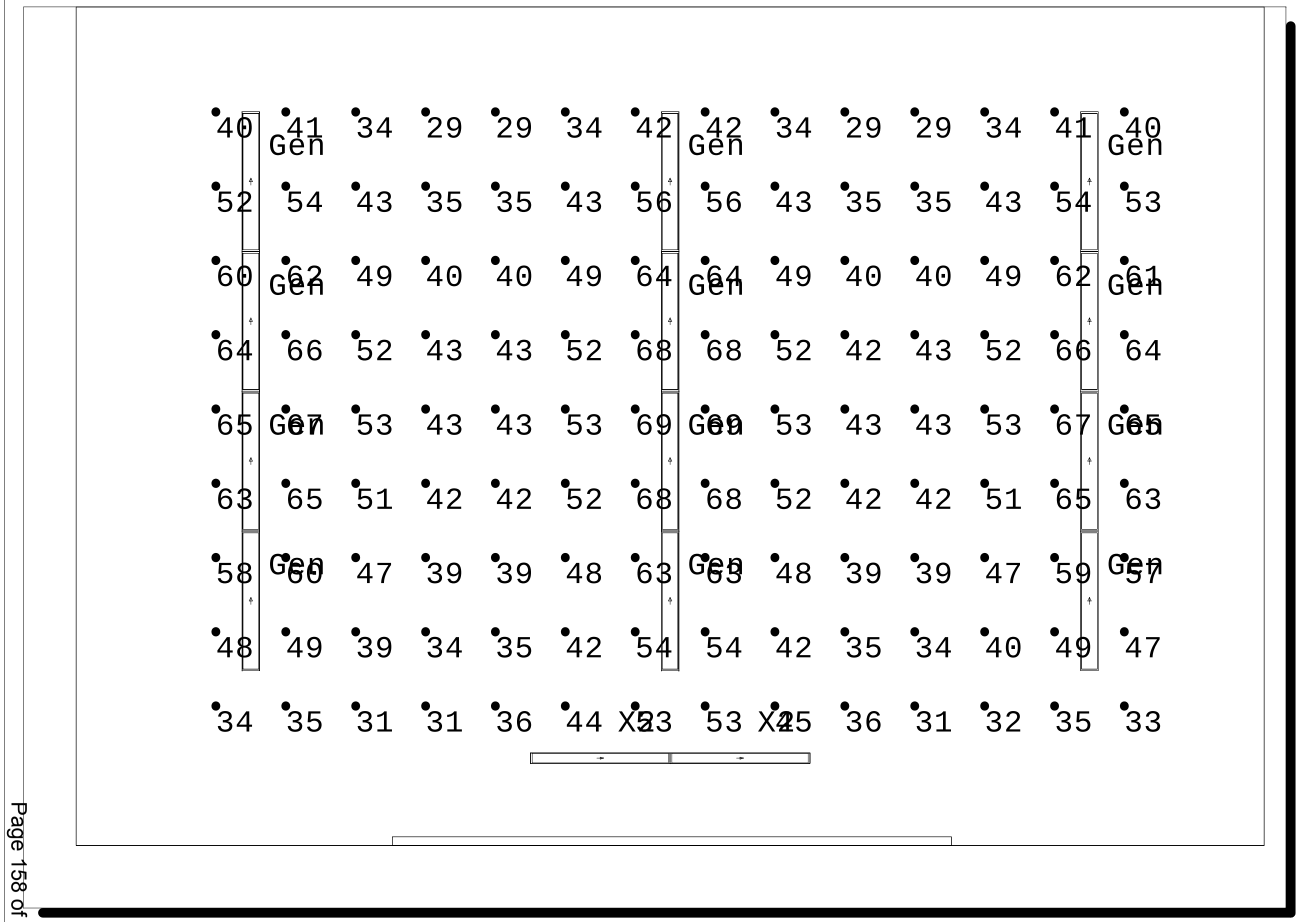
#	Date	Comments

Revisions

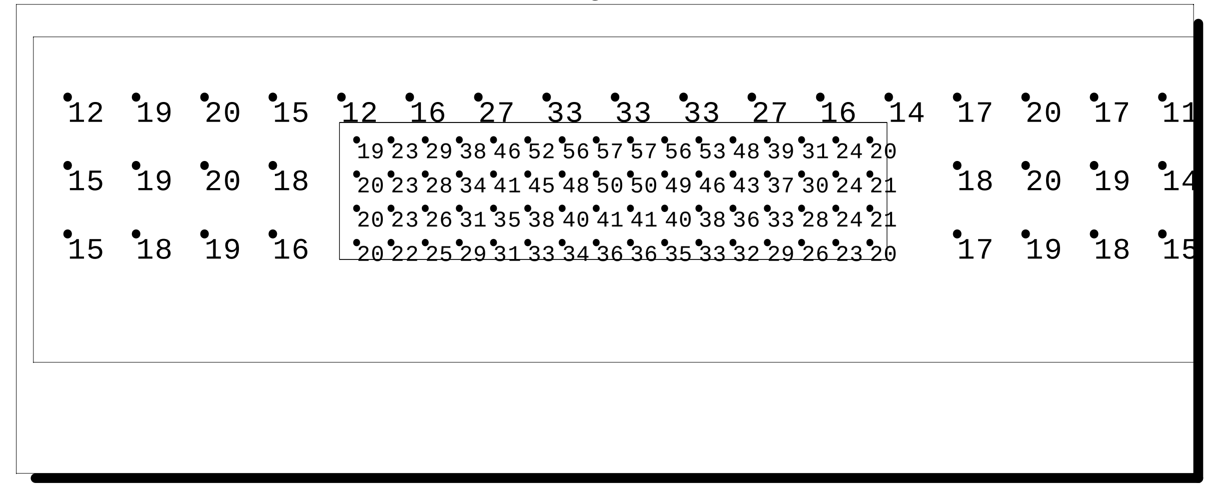
Drawn By: V Lauck
Date: April, 2006

Project: NYSERDA
Baldwnsvl, Ray Mdl, Room 181

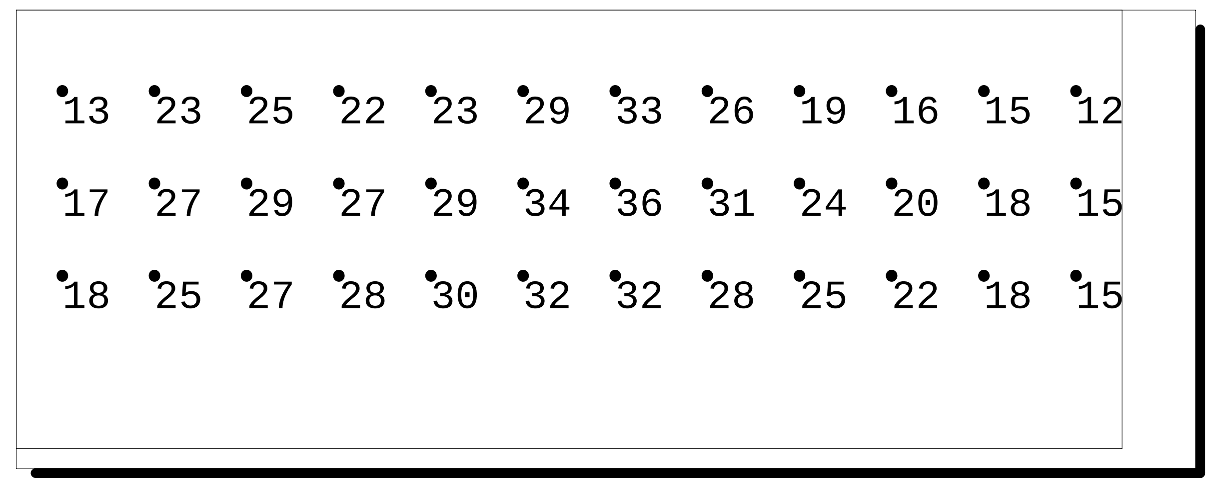
GENERAL MODE



Teaching Wall



East Wall



Luminaire Schedule									
Project: Baldwinsville, Ray Middle, Room 284									
Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	12	Gen	3100	0.667	X1 PLV CCO 2T8 EP	0.78	48	0.9	0.95
	2	X2	3100	1.026	SX2 WCB 1T8 96W	1.2	38	0.9	0.95

Numeric Summary							
Project: Baldwinsville, Ray Middle, Room 284							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Teaching Wall	Illuminance	Fc	18.85	33	11	1.71	3.00
Whiteboard	Illuminance	Fc	34.63	57	19	1.82	3.00
East Wall	Illuminance	Fc	23.97	36	12	2.00	3.00
Horizontal	Illuminance	Fc	47.84	69	29	1.65	2.38

Room Summary		
Project: Baldwinsville, Ray Middle, Room 284		
Label	Wall Ht.	Description
Room 284	9.5	34' x 24' Refl. 80/50/20

LPD Area Summary			
Project: Baldwinsville, Ray Middle, Room 284			
Label	Area	Total Watts	LPD
Room 284	816	652	0.799

SX1 luminaires 8' AFF; X2 luminaire is 8.5' AFF.
Calculations are based on Osram QHE .78 Instant
Start Ballasts on outboard lamps and Osram Powersense
Dimming Ballasts on the center lamps.
QHE 1.2 IS ballasts on Type X2.

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

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AGI32 VERSION 1.8

FINELITE
Better Lighting for a Better Workplace

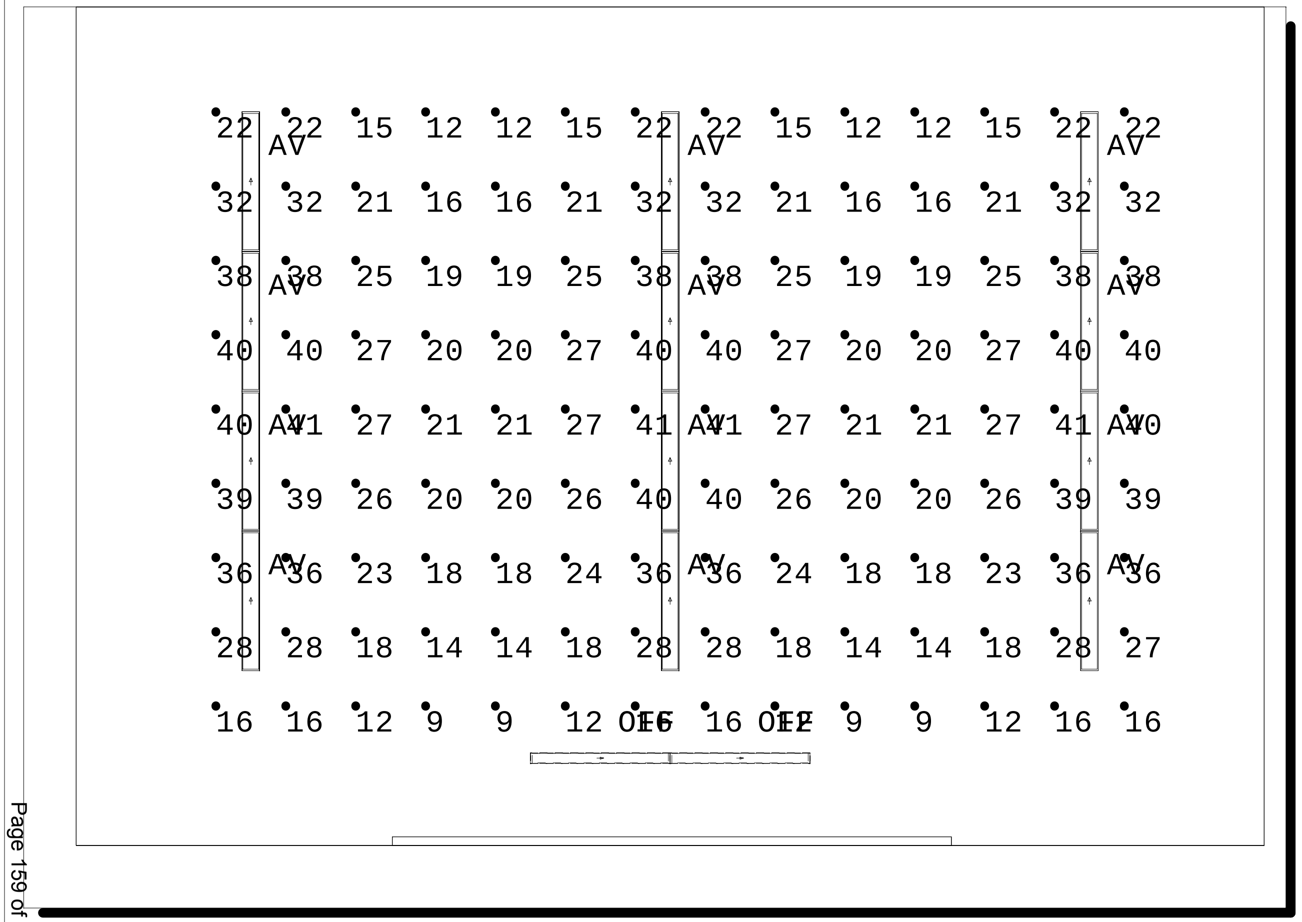
#	Date	Comments

Revisions

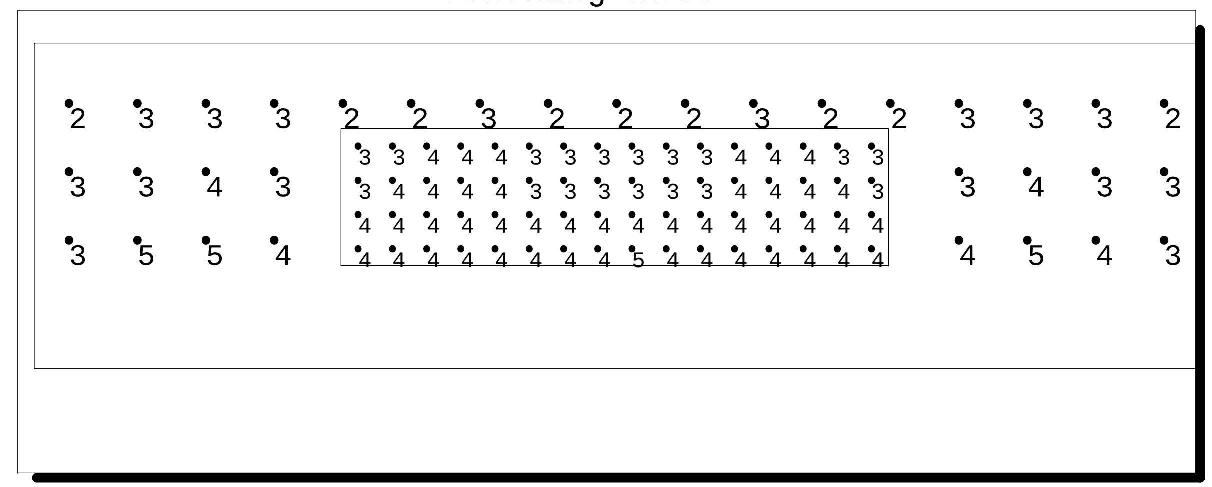
Drawn By: V Lauck
Date: April, 2006

Project: NYSERDA
Baldwnsvl, Ray Middle, Rm 284

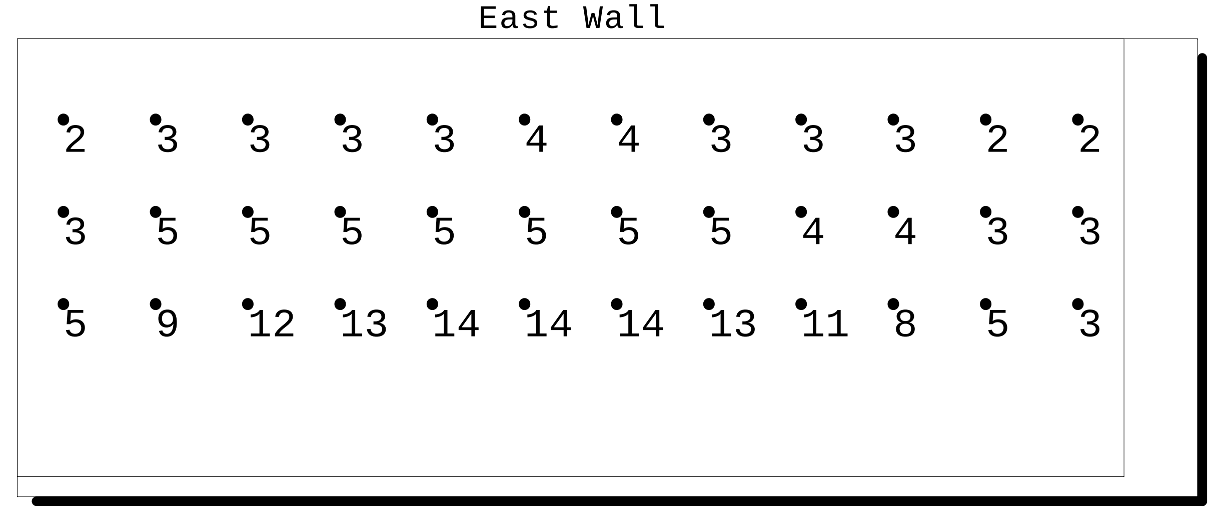
AV MODE



Teaching Wall



East Wall



Luminaire Schedule									
Project: Baldwinsville, Ray Middle, Room 284									
Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	12	AV	3100	0.752	X1 PLV COO 1T8 EP	0.88	30	0.9	0.95
	2	OFF	3100	1.026	SX2 WCB 1T8 96W	1.2	38	0.9	0.95

Numeric Summary							
Project: Baldwinsville, Ray Middle, Room 284							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Teaching Wall	Illuminance	Fc	3.06	5	2	1.53	2.50
Whiteboard	Illuminance	Fc	3.73	5	3	1.24	1.67
East Wall	Illuminance	Fc	5.78	14	2	2.89	7.00
Horizontal WP	Illuminance	Fc	24.80	41	9	2.76	4.56

Room Summary		
Project: Baldwinsville, Ray Middle, Room 284		
Label	Wall Ht.	Description
Room 284	9.5	34' x 24' Refl. 80/50/20

LPD Area Summary			
Project: Baldwinsville, Ray Middle, Room 284			
Label	Area	Total Watts	LPD
Room 284	816	360	0.441

SX1 luminaires 8' AFF; X2 luminaire is 8.5' AFF.
Calculations are based on Osram QHE .78 Instant
Start Ballasts on outboard lamps and Osram Powersense
Dimming Ballasts on the center lamps.
Type X2 is turned OFF.

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AGI32 VERSION 1.8

FINELITE
Better Lighting for a Better Workplace

Revisions		
#	Date	Comments

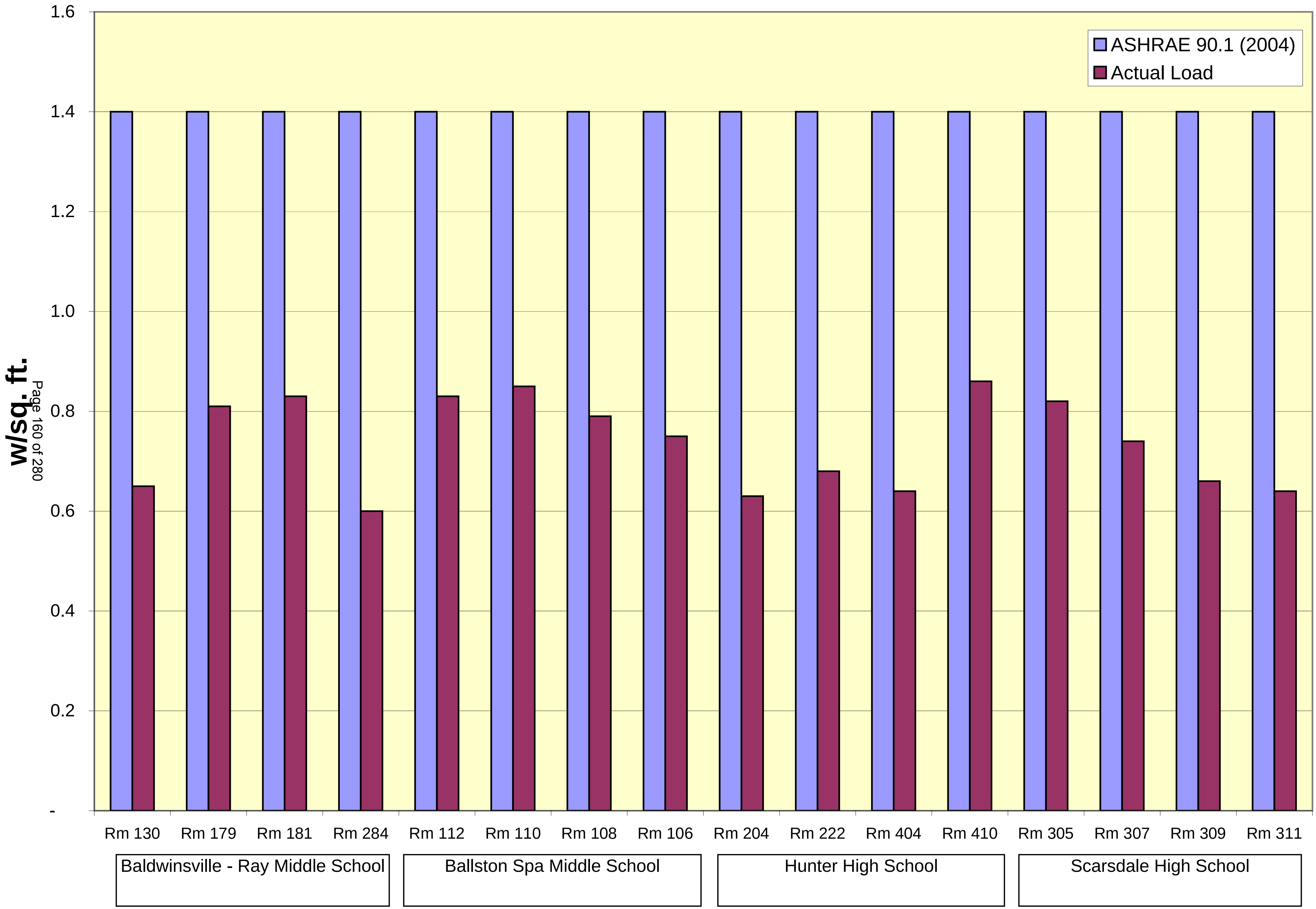
Drawn By: V Lauck
Date: April, 2006

Project: NYSERDA
Baldwnsvl, Ray Middle, Rm 284

Energy Consumption by Classroom - K12

NYSERDA Classroom Lighting System

Sep 2006 - May 2007



Data Summary

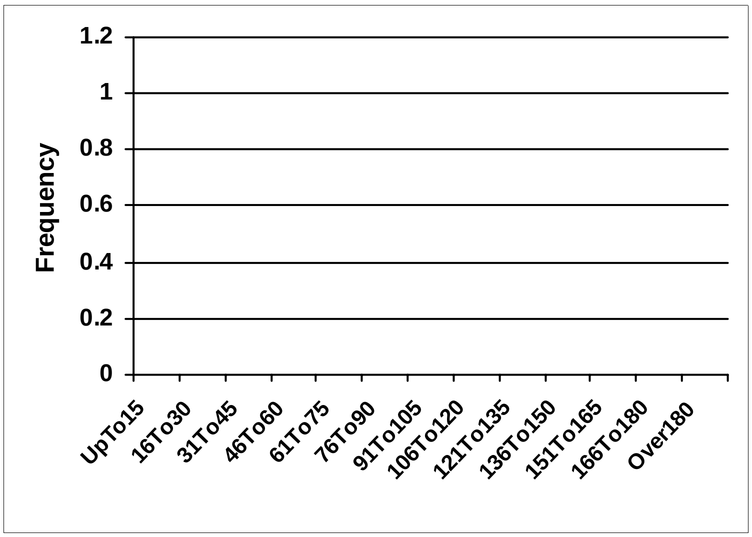
Baldwinsville Public Schools

Classroom	Date	AV Gen Switches	AV Use (#/Day)	WB Use (#/Day)	General Total Min	White Board Total Min	AV Total Min	Settle Time	Settle Count	Quiet Count	Occ Sensor Shut Off	Manual Shut Off	Lights On Total	Watts/ sq ft	kWh
130	10/2/06	2	1	0	255	0	1	0		0	0	10	256	0.70	2.45
	10/3/06	2	1	0	457	0	36	0		0	0	11	493	0.67	4.55
	10/4/06	0	0	0	418	0	0	0		0	0	5	418	0.70	4.04
	10/5/06	1	5	0	283	0	285	0		0	3	4	568	0.55	4.28
	10/6/06	1	1	0	359	0	83	0		0	2	5	442	0.65	3.94
	10/10/06	0	0	0	19	0	0	0		0	0	5	19	0.68	0.18
	10/11/06	0	0	0	505	0	0	0		0	0	4	505	0.70	4.88
	10/12/06	0	0	0	535	0	0	0		0	2	5	535	0.70	5.16
	10/13/06	0	0	0	478	0	0	0		0	2	4	478	0.70	4.59
	10/16/06	2	1	0	816	0	15	0		0	1	6	831	0.69	7.93
	10/17/06	2	1	1	465	41	41	41	1	0	0	4	506	0.67	4.62
	10/18/06	0	0	0	450	0	0	0		0	4	6	450	0.70	4.33
	10/19/06	0	0	0	549	0	0	0		0	3	3	549	0.70	5.31
	10/20/06	0	0	0	608	0	0	0		0	0	3	608	0.70	5.83
	10/23/06	8	6	0	520	0	224	0		0	1	6	744	0.60	6.15
	10/24/06	0	0	0	503	0	0	0		0	3	1	503	0.70	4.84
	10/25/06	1	2	1	141	43	425	0		0	0	3	566	0.51	3.93
	10/26/06	1	1	2	359	299	188	160	1	1	4	4	547	0.66	4.97
	10/27/06	2	1	0	349	0	40	0		0	2	5	389	0.67	3.58
	10/30/06	6	8	0	445	0	342	0		0	2	5	787	0.58	6.29
	10/31/06	0	0	0	513	0	0	0		0	2	3	513	0.70	4.95
179	10/2/06	10	5	11	378	362	137	55	6	1	1	4	515	0.67	4.77
	10/3/06	8	6	12	208	325	143	116	5	1	2	9	352	0.63	3.06
	10/4/06	21	13	15	333	307	384	9	3	1	2	7	717	0.51	5.05
	10/5/06	8	5	9	211	273	218	76	2	1	1	6	429	0.52	3.05
	10/6/06	13	14	11	255	332	133	108	6	1	1	11	388	0.66	3.51
	10/10/06	1	3	0	167	0	188	0		0	2	3	355	0.54	2.65
	10/11/06	10	8	10	383	340	63	4	2	1	2	5	446	0.75	4.60
	10/12/06	1	4	13	296	310	62	62	4	0	1	14	358	0.80	3.94
	10/13/06	1	1	6	491	526	35	35	1	0	3	3	526	0.85	6.16
	10/14/06	0	0	3	45	45	0	0		0	2	1	45	0.87	0.54
	10/16/06	0	0	4	512	512	0	0		0	1	3	512	0.87	6.09
	10/17/06	4	3	5	432	422	22	0		0	2	3	454	0.84	5.26
	10/18/06	6	3	8	453	447	27	17	2	1	2	7	480	0.83	5.45
	10/19/06	8	4	8	304	485	190	181	3	0	2	5	494	0.70	4.75
	10/20/06	4	2	1	253	225	21	20	1	0	1	4	274	0.80	3.00
	10/23/06	14	7	6	381	267	104	10	2	2	2	3	485	0.68	4.55
	10/24/06	7	7	9	221	304	161	109	5	2	0	9	382	0.60	3.14

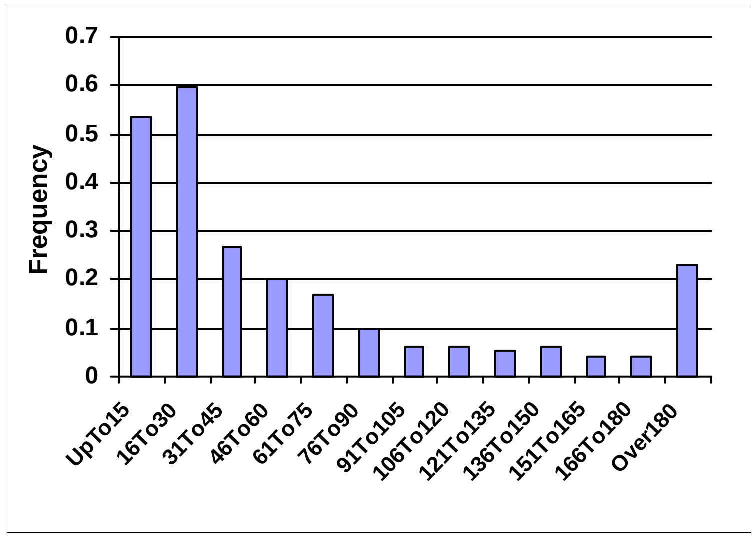
Average Daily Lighting Usage for Baldwinsville Public Schools, Rm 113 (Control) From 9/1/06 To 5/31/07

General AV mode Switches:	**2.1**	**Quiet Time Usage:**	**0.0**
General Mode Time:	**488.5**	**Occupancy Sensor Shutoff Frequency:**	**0.0**
AV mode Time:	**39.0**	**Manual Shutoff Frequency:**	**0.0**
White Board Time:	**.0**	**Lights On:**	**527.6**
Settle Mode Time:	**.0**	**Watts/ sq ft:**	**0.81**
Settle Mode Counts:	**0.0**	**School Days:**	**164**

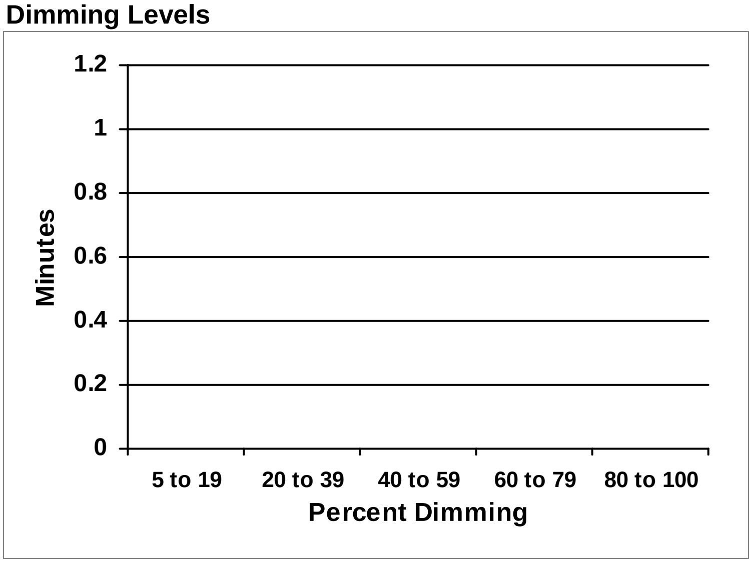
AV Mode



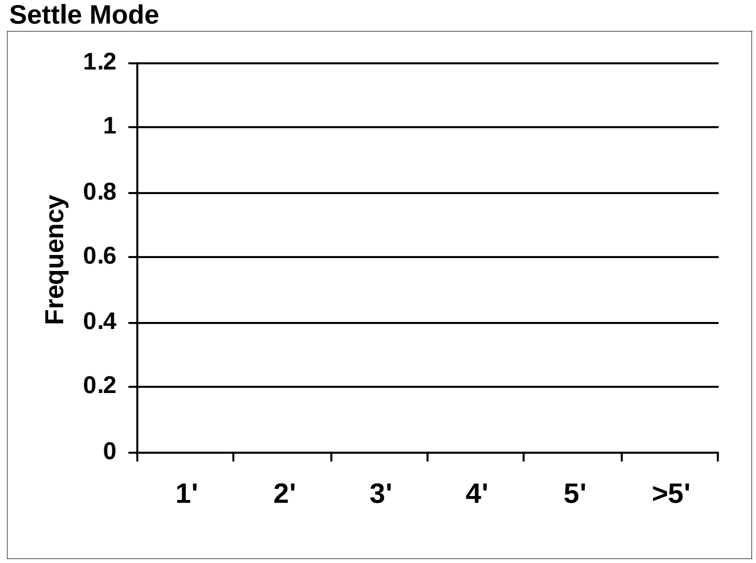
General Mode



Dimming Levels



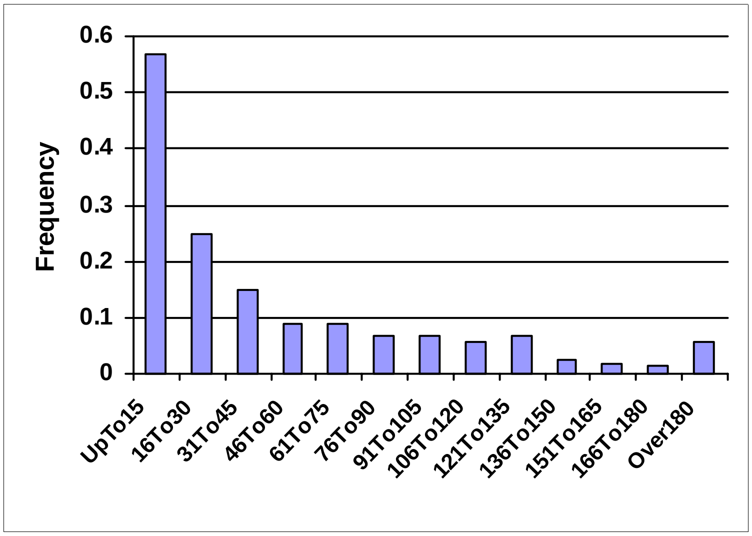
Settle Mode



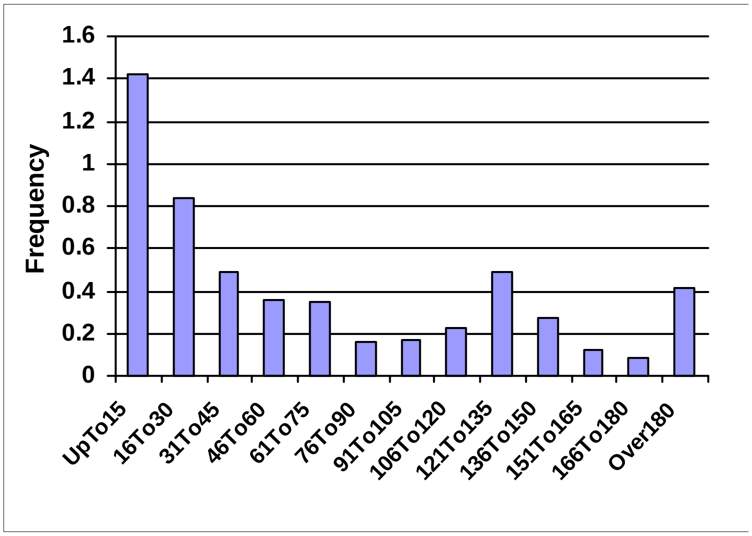
Average Daily Lighting Usage for Baldwinsville Public Schools, Rm 130
From 9/1/06 To 5/31/07

General AV mode Switches:	**1.5**	**Quiet Time Usage:**	**0.1**
General Mode Time:	**406.7**	**Occupancy Sensor Shutoff Frequency:**	**1.5**
AV mode Time:	**74.3**	**Manual Shutoff Frequency:**	**4.4**
White Board Time:	**11.3**	**Lights On:**	**481.1**
Settle Mode Time:	**3.3**	**Watts/ sq ft:**	**0.64**
Settle Mode Counts:	**0.2**	**School Days:**	**160**

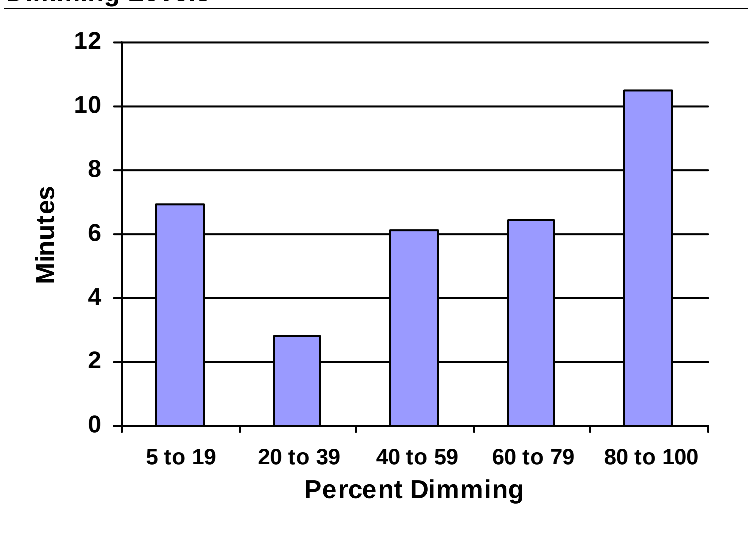
AV Mode



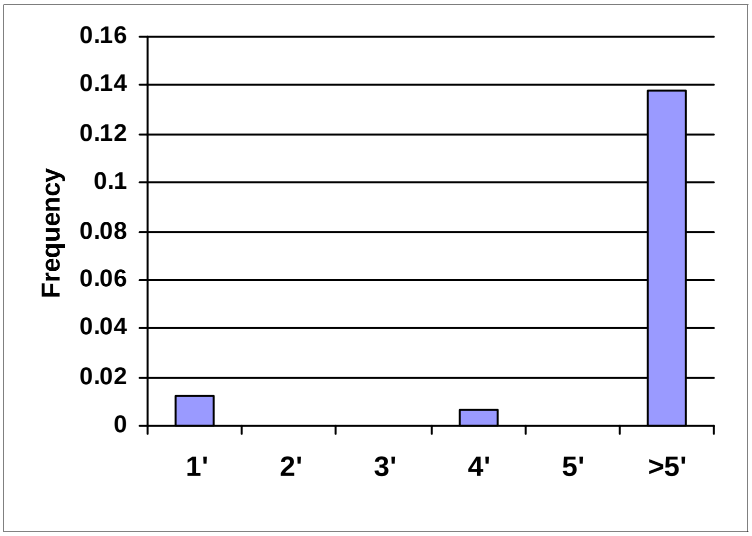
General Mode



Dimming Levels



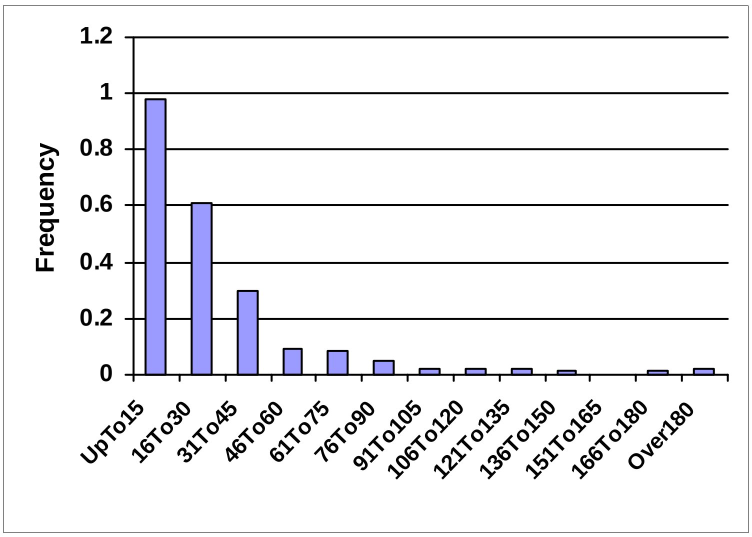
Settle Mode



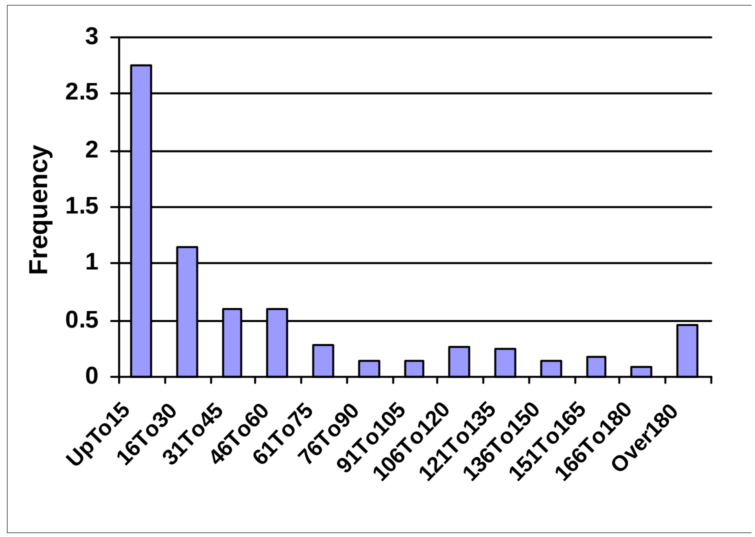
Average Daily Lighting Usage for Baldwinsville Public Schools, Rm 179 From 9/1/06 To 5/31/07

General AV mode Switches:	3.4	Quiet Time Usage:	0.3
General Mode Time:	385.2	Occupancy Sensor Shutoff Frequency:	1.6
AV mode Time:	59.0	Manual Shutoff Frequency:	5.0
White Board Time:	386.7	Lights On:	444.2
Settle Mode Time:	26.8	Watts/ sq ft:	0.8
Settle Mode Counts:	1.0	School Days:	164

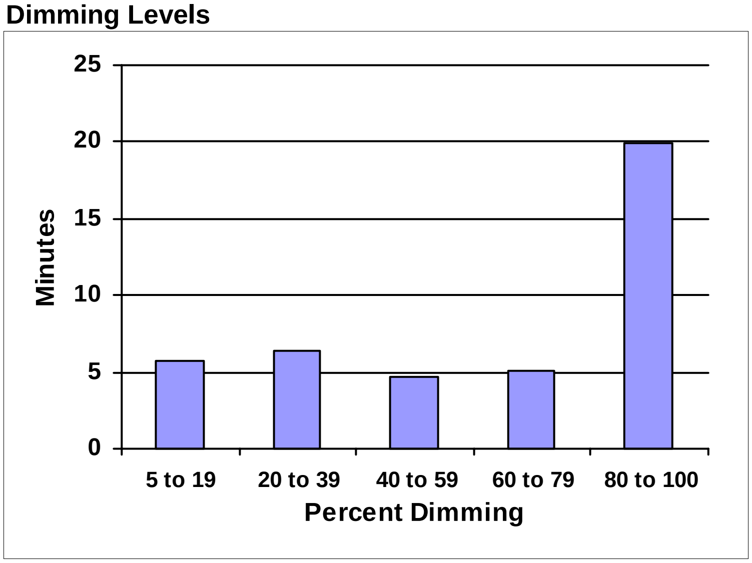
AV Mode



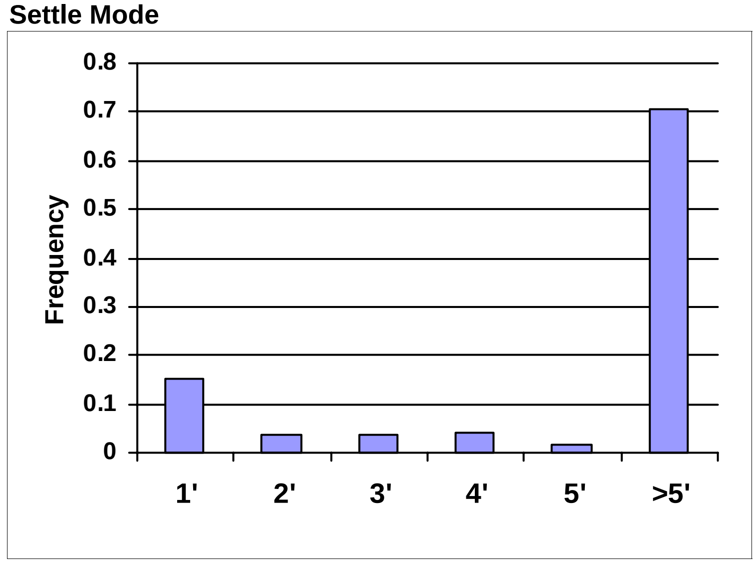
General Mode



Dimming Levels



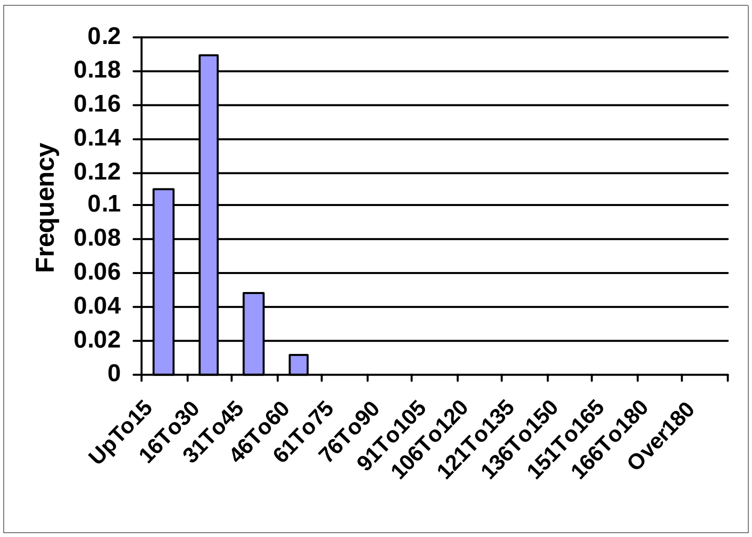
Settle Mode



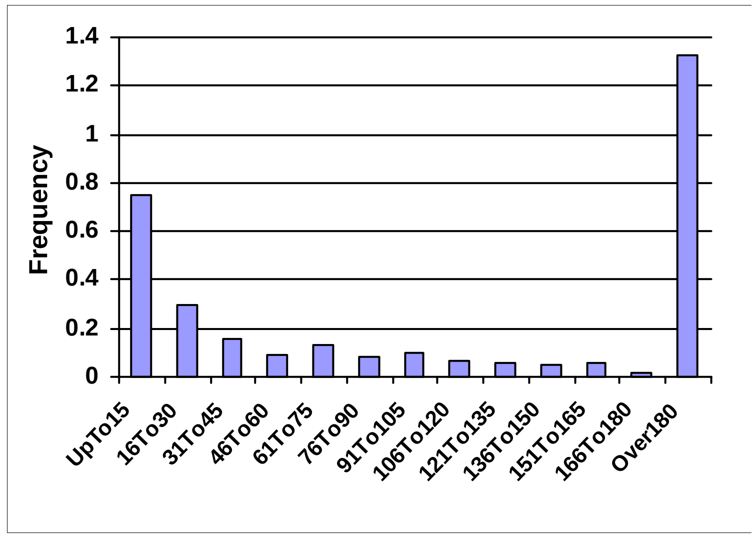
Average Daily Lighting Usage for Baldwinsville Public Schools, Rm 181 From 9/1/06 To 5/31/07

General AV mode Switches:	.7	Quiet Time Usage:	0.1
General Mode Time:	627.1	Occupancy Sensor Shutoff Frequency:	0.6
AV mode Time:	7.4	Manual Shutoff Frequency:	2.5
White Board Time:	622.5	Lights On:	641.1
Settle Mode Time:	1.3	Watts/ sq ft:	0.82
Settle Mode Counts:	0.1	School Days:	164

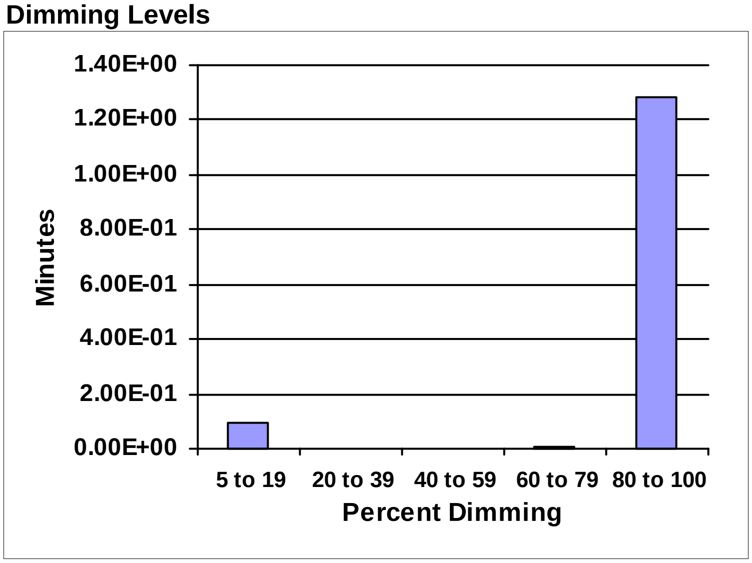
AV Mode



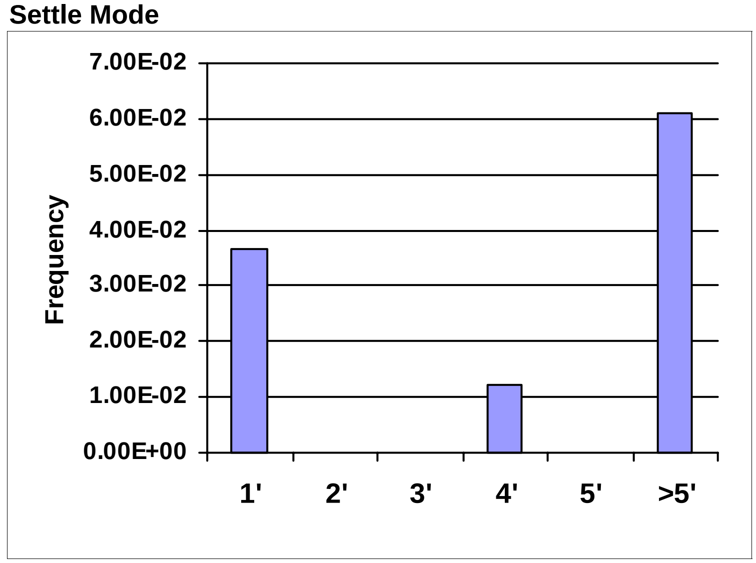
General Mode



Dimming Levels



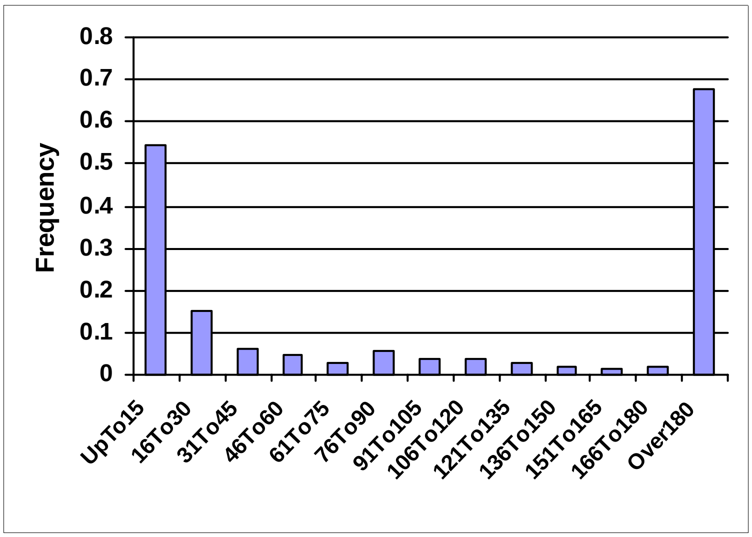
Settle Mode



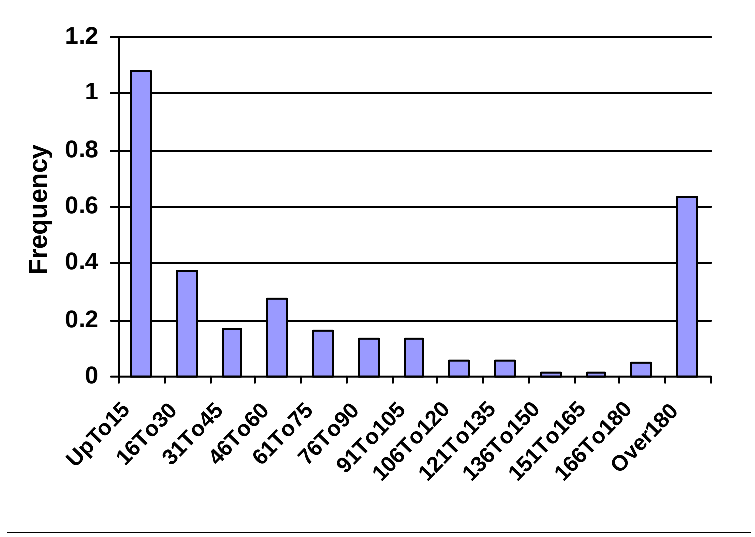
Average Daily Lighting Usage for Baldwinsville Public Schools, Rm 284 From 9/1/06 To 5/31/07

General AV mode Switches:	2.0	Quiet Time Usage:	0.3
General Mode Time:	330.0	Occupancy Sensor Shutoff Frequency:	0.8
AV mode Time:	303.0	Manual Shutoff Frequency:	2.5
White Board Time:	101.8	Lights On:	626.3
Settle Mode Time:	14.5	Watts/ sq ft:	0.59
Settle Mode Counts:	0.3	School Days:	163

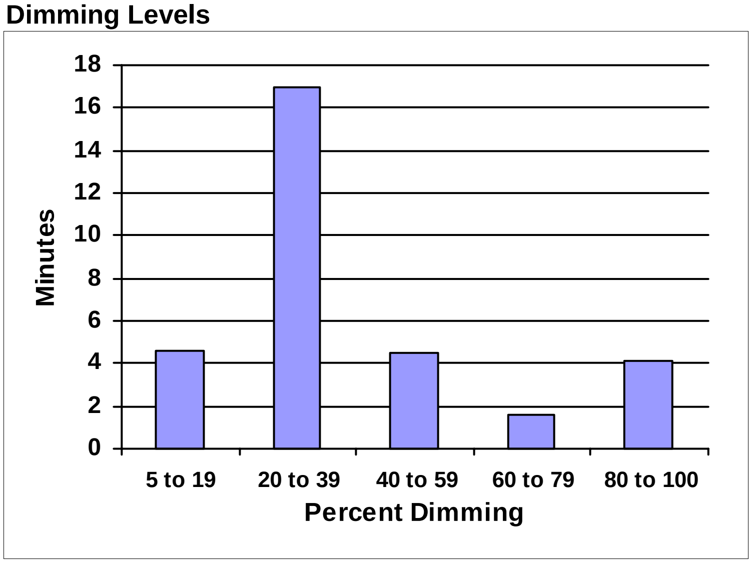
AV Mode



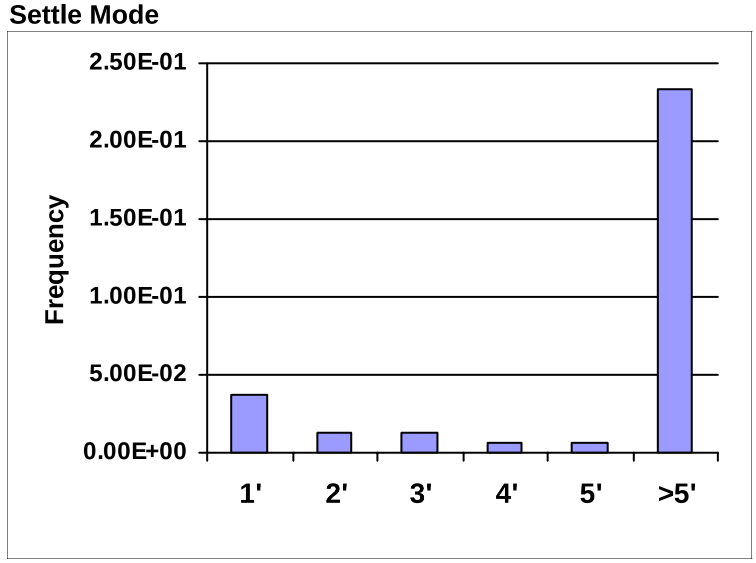
General Mode



Dimming Levels



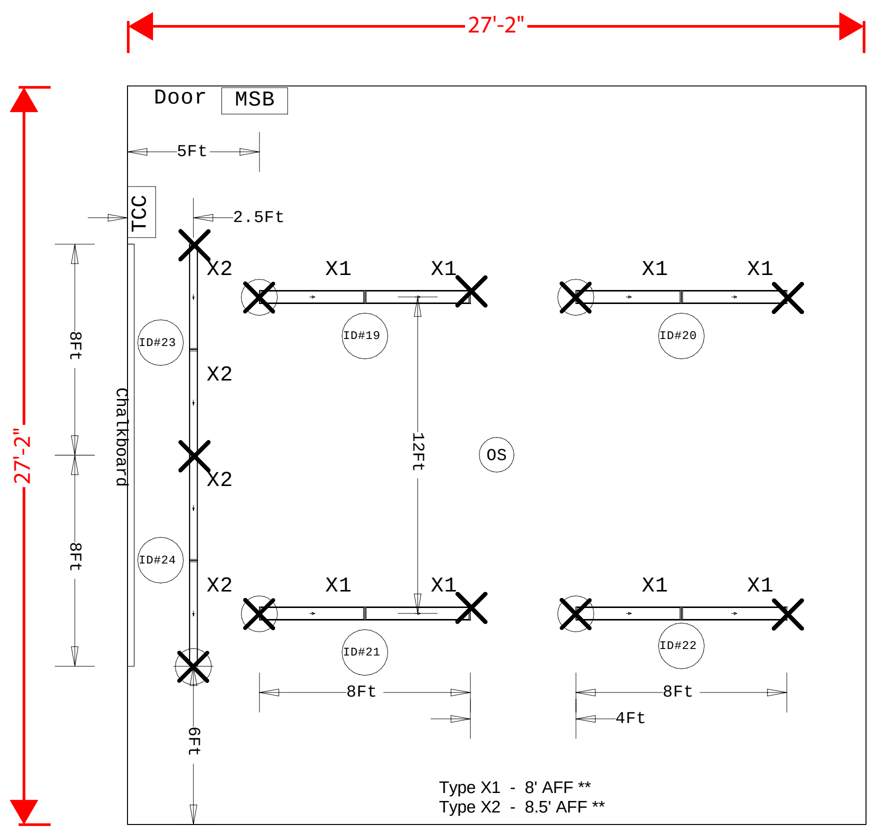
Settle Mode



Appendix G – Ballston Spa Middle School Information

- Room Dimension and Fixture Layout
- Lighting Layouts and calculations
- Energy Consumption Chart
- Data Summary Table
- Average Daily Lighting Usage Report

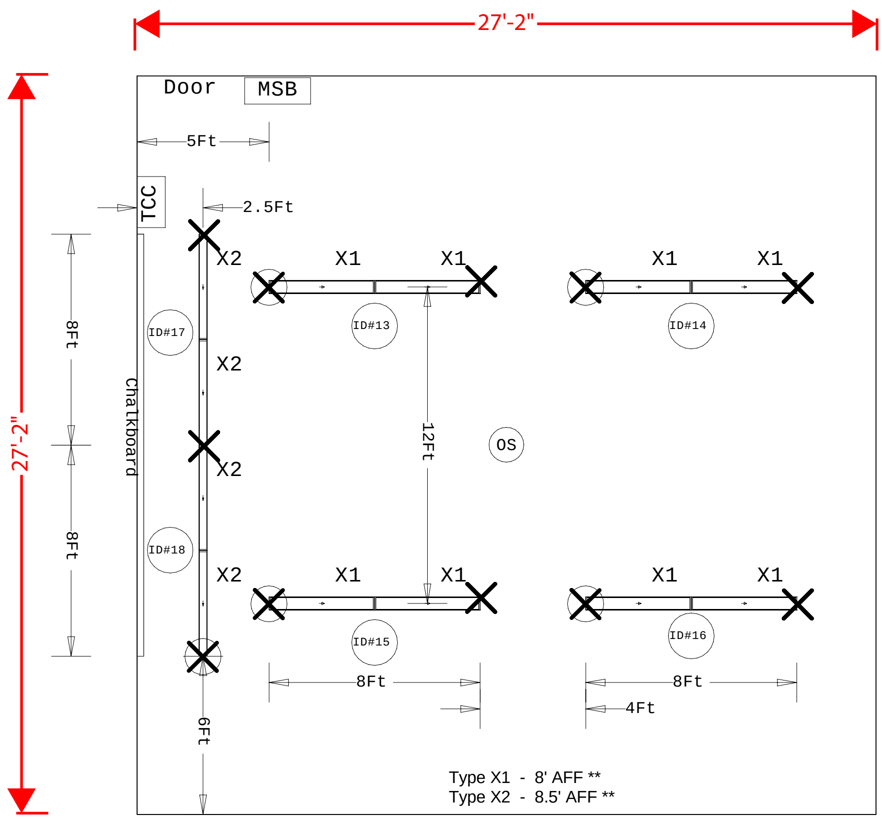
Ballston Spa, Room 106
Installation Dimensions



LEGEND	
TCC	Teacher Control Center mounting location: 4'-0" AFF (to top of box). Install on the left side of whiteboard/chalkboard
OS	Occupancy Sensor(s)
X	Suspension Point
(X)	Power Feed & Suspension Point (Pre-existing power feed points could affect changes to feed points)
ID# 1	Fixture ID#. Each fixture section will have a label with a unique ID# which can be found on the outside of the box and on the fixture itself.
MSB	Master Switch Bank -- Locate MSB on wall at entrance(s) to room. Exact location to be determined on-site.

** Site conditions could influence fixture placement and suspension. All fixtures to be mounted "on-grid" (if ceiling is grid type) therefore the attached dimensional information is approximate. The spacing between rows is the most important dimension to maintain.

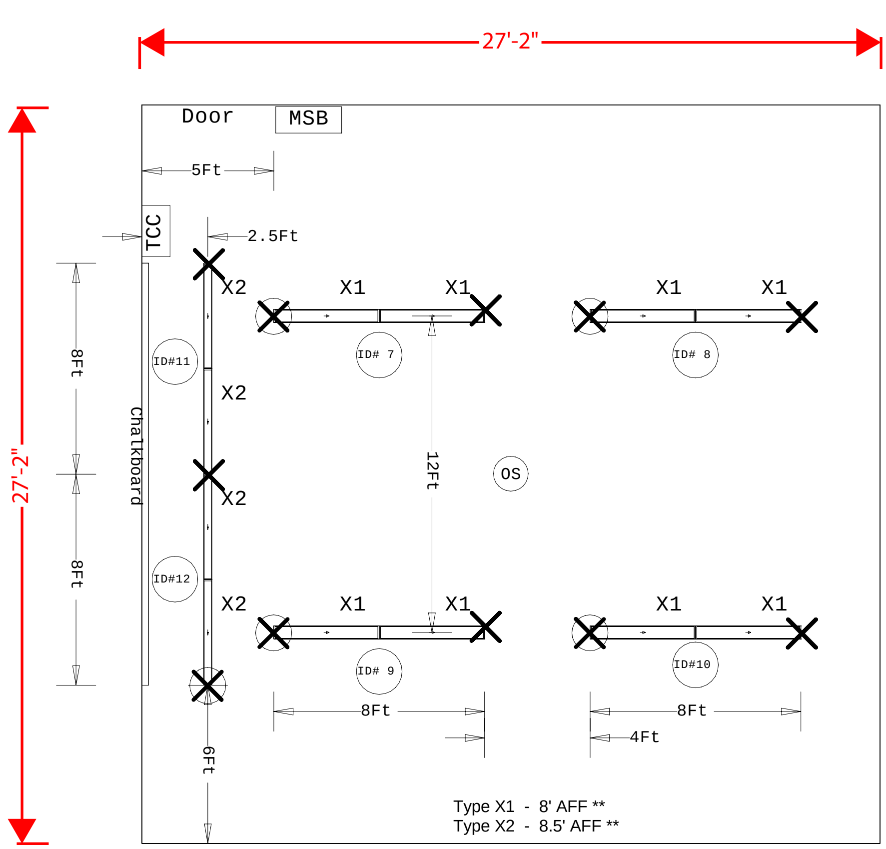
Ballston Spa, Room 108
Installation Dimensions



LEGEND	
TCC	Teacher Control Center mounting location: 4'-0" AFF (to top of box). Install on the left side of whiteboard/chalkboard
OS	Occupancy Sensor(s)
	Suspension Point
	Power Feed & Suspension Point (Pre-existing power feed points could affect changes to feed points)
ID# 1	Fixture ID#. Each fixture section will have a label with a unique ID# which can be found on the outside of the box and on the fixture itself.
MSB	Master Switch Bank -- Locate MSB on wall at entrance(s) to room. Exact location to be determined on-site.

** Site conditions could influence fixture placement and suspension. All fixtures to be mounted "on-grid" (if ceiling is grid type) therefore the attached dimensional information is approximate. The spacing between rows is the most important dimension to maintain.

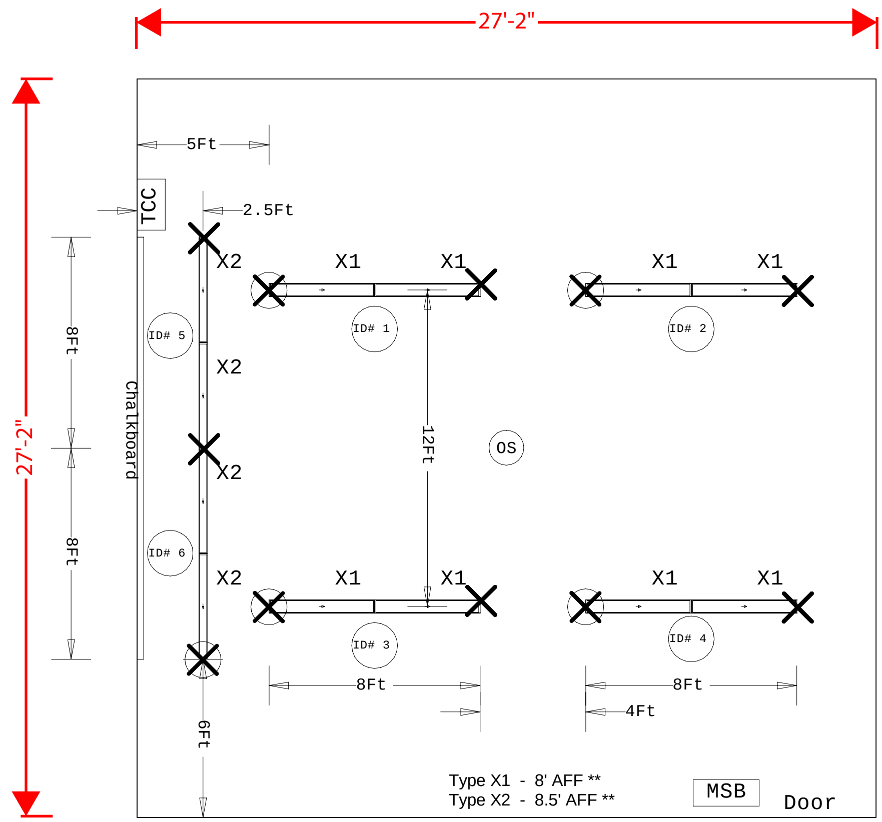
Ballston Spa, Room 110
Installation Dimensions



LEGEND	
TCC	Teacher Control Center mounting location: 4'-0" AFF (to top of box). Install on the left side of whiteboard/chalkboard
OS	Occupancy Sensor(s)
	Suspension Point
	Power Feed & Suspension Point (Pre-existing power feed points could affect changes to feed points)
ID# 1	Fixture ID#. Each fixture section will have a label with a unique ID# which can be found on the outside of the box and on the fixture itself.
MSB	Master Switch Bank -- Locate MSB on wall at entrance(s) to room. Exact location to be determined on-site.

** Site conditions could influence fixture placement and suspension. All fixtures to be mounted "on-grid" (if ceiling is grid type) therefore the attached dimensional information is approximate. The spacing between rows is the most important dimension to maintain.

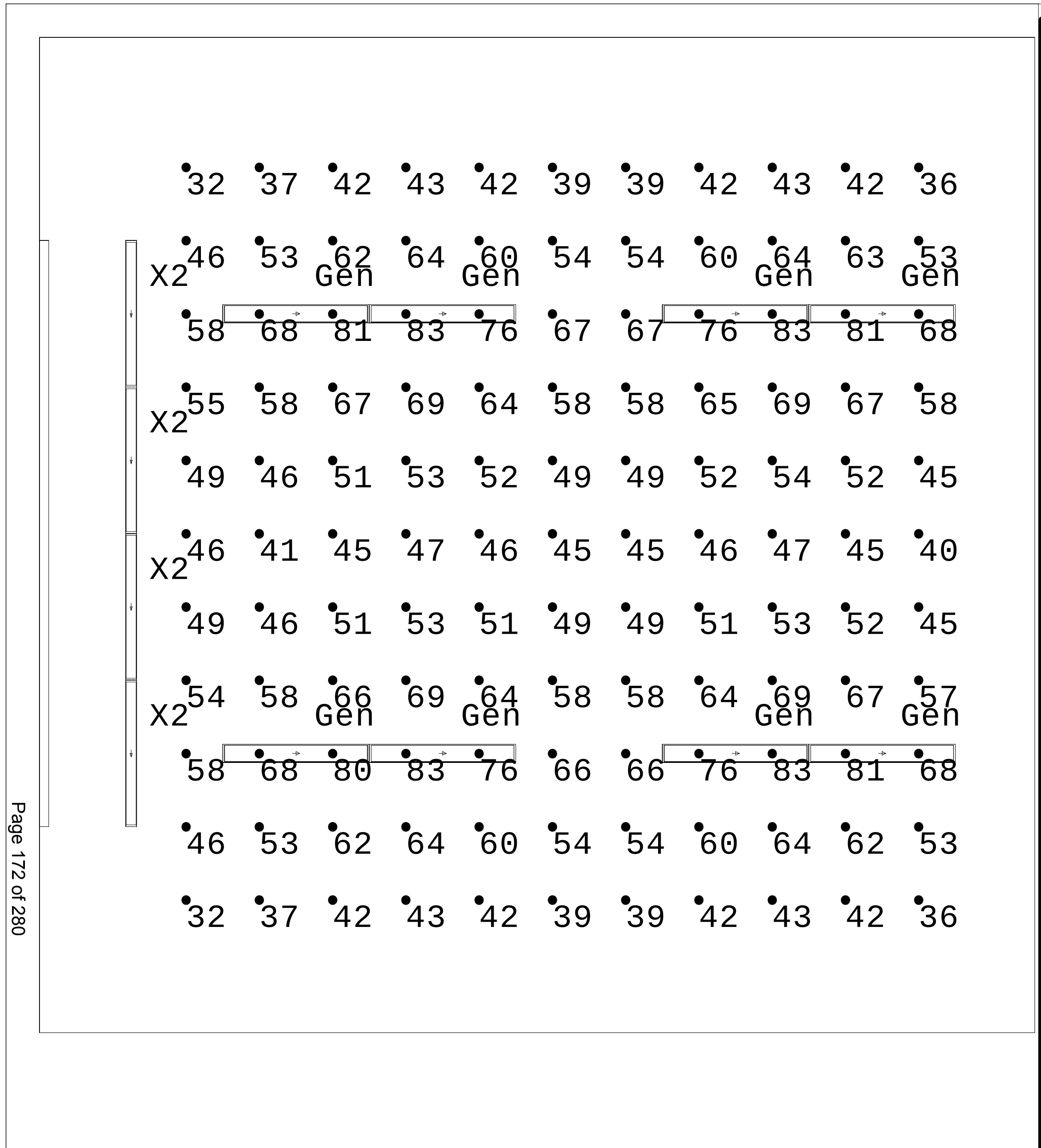
Ballston Spa, Room 112
Installation Dimensions



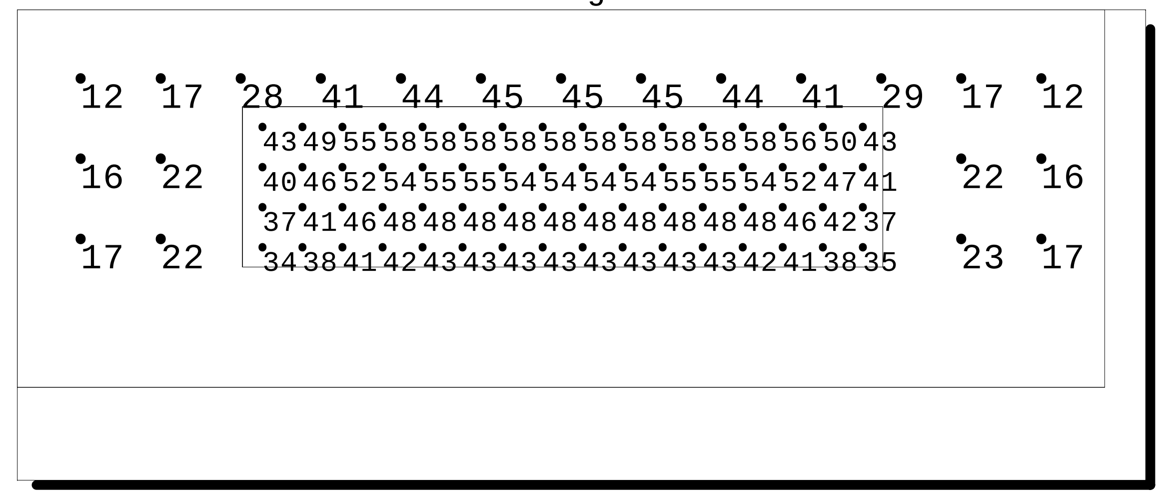
LEGEND	
TCC	Teacher Control Center mounting location: 4'-0" AFF (to top of box). Install on the left side of whiteboard/chalkboard
OS	Occupancy Sensor(s)
X	Suspension Point
⊗	Power Feed & Suspension Point (Pre-existing power feed points could affect changes to feed points)
ID# 1	Fixture ID#. Each fixture section will have a label with a unique ID# which can be found on the outside of the box and on the fixture itself.
MSB	Master Switch Bank -- Locate MSB on wall at entrance(s) to room. Exact location to be determined on-site.

** Site conditions could influence fixture placement and suspension. All fixtures to be mounted "on-grid" (if ceiling is grid type) therefore the attached dimensional information is approximate. The spacing between rows is the most important dimension to maintain.

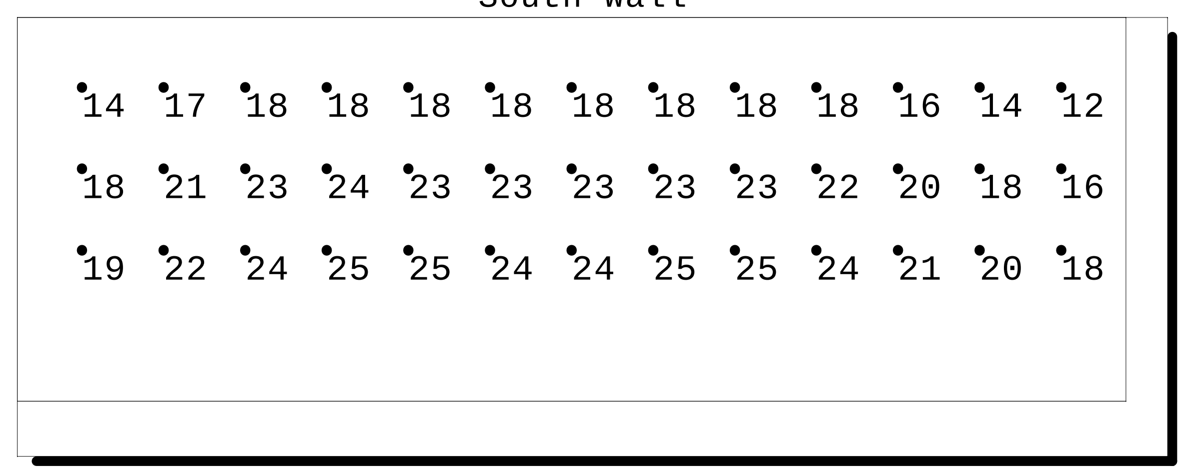
GENERAL MODE



Teaching Wall



South Wall



Luminaire Schedule									
Project: Ballston Spa, Middle School, Room 112 TYPICAL									
Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	8	Gen	3100	1.026	X1 PLV CCO 2T8 EP	1.2	74	0.9	0.95
	4	X2	3100	0.846	SX2 WCB 1T8 96W	0.99	34	0.9	0.95

Numeric Summary							
Project: Ballston Spa, Middle School, Room 112 TYPICAL							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Chalkboard	Illuminance	Fc	48.16	58	34	1.42	1.71
Teaching Wall	Illuminance	Fc	27.38	45	12	2.28	3.75
South Wall	Illuminance	Fc	20.26	25	12	1.69	2.08
Horizontal	Illuminance	Fc	55.52	83	32	1.74	2.59

Room Summary		
Project: Ballston Spa, Middle School, Room 112 TYPICAL		
Label	Wall Ht.	Description
Room 112 Typ	9.42	27'-2" x 27'-2" Refl. 80/50/20

LPD Area Summary			
Project: Ballston Spa, Middle School, Room 112 TYPICAL			
Label	Area	Total Watts	LPD
Room 112, Typical	738.1	728	0.986

SX1 luminaires 8'AFF; X2 luminaire is 8.5' AFF. Calculations based on Osram 1.2 QHE Instant Start Ballasts on outboard lamps and Osram Powersense Dimming Ballasts on the center lamps. QHE .99 BF IS ballast on Type X2 (3-lamp ballast on 2-lamps).

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

PHOTOMETRIC DATA USED AS INPUT FOR THESE CALCULATIONS IS BASED ON ESTABLISHED IES PROCEDURES AND PUBLISHED LAMP & BALLAST RATINGS. FIELD PERFORMANCE WILL DEPEND ON ACTUAL LAMP, BALLAST, ELECTRICAL AND SITE CHARACTERISTICS.

VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT 30" ABOVE FINISHED FLOOR.
AGI32 VERSION 1.8

FINELITE
Better Lighting for a Better Workplace

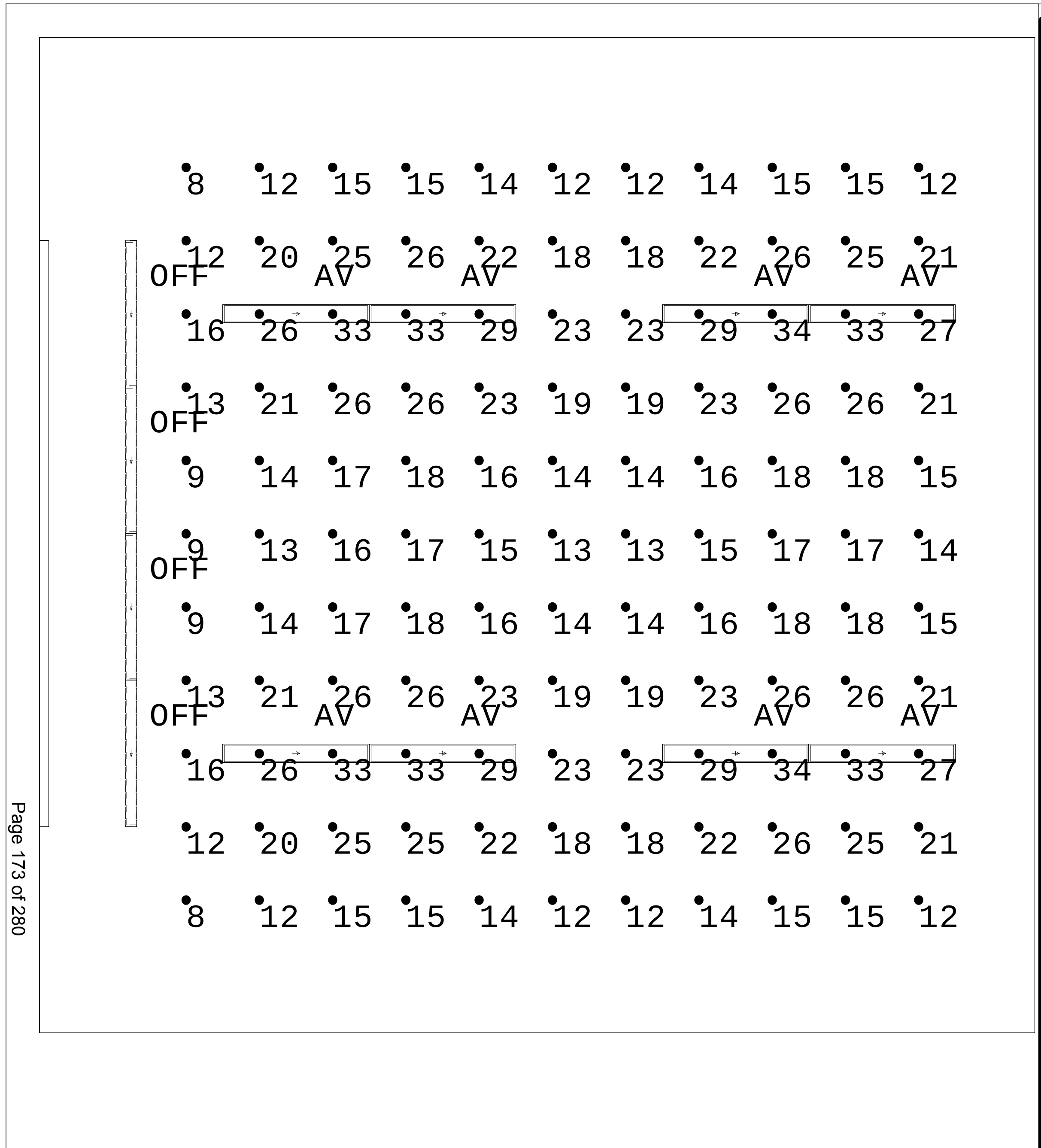
#	Date	Comments

Revisions

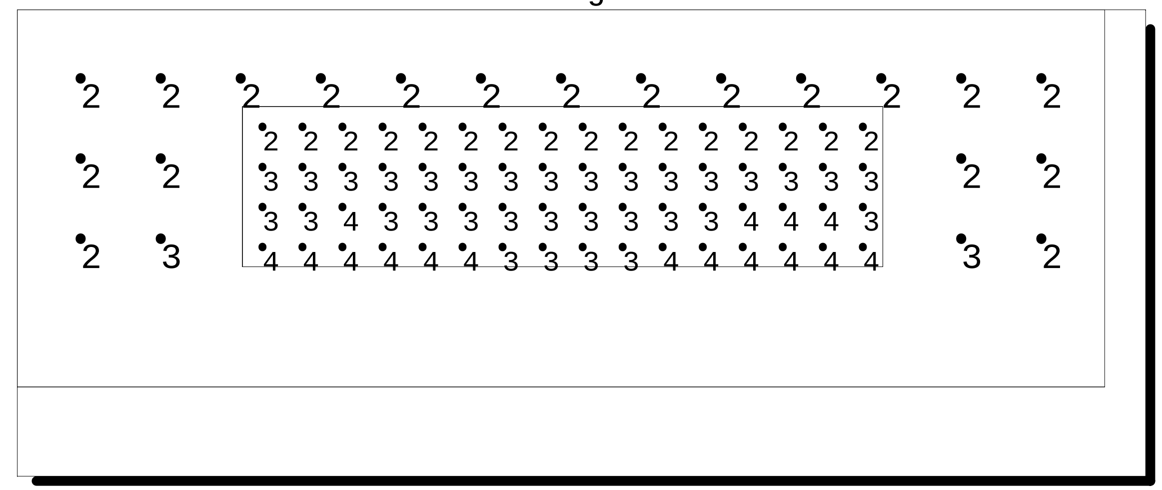
Drawn By: V Lauck
Date: April, 2006

Project: NYSERDA - Ballston Spa, MS, Rm 112, TYPICAL

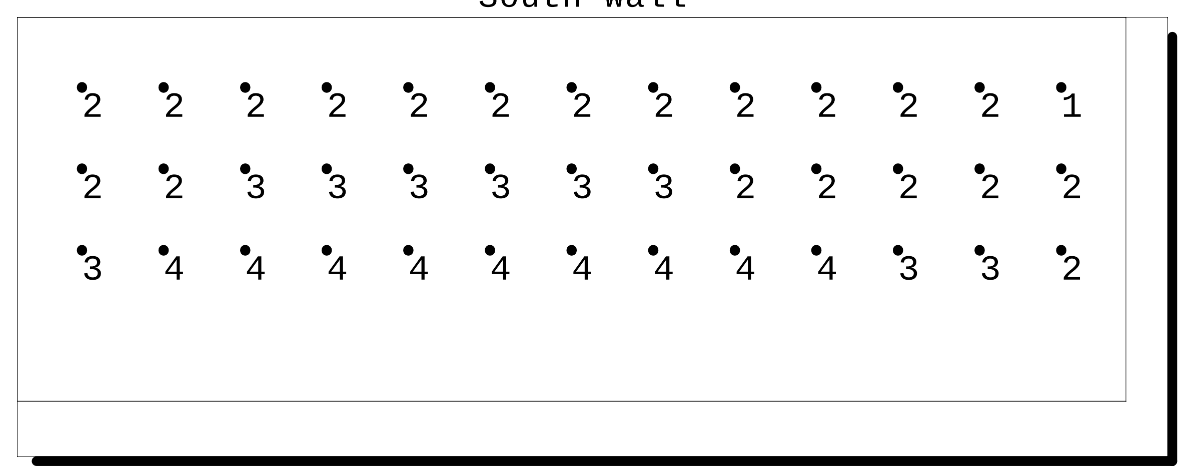
AV MODE



Teaching Wall



South Wall



Luminaire Schedule									
Project: Ballston Spa, Middle School, Room 112 TYPICAL									
Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	8	AV	3100	0.752	X1 PLV COO 1T8 EP	0.88	30	0.9	0.95
	4	OFF	3100	0.846	SX2 WCB 1T8 96W	0.99	34	0.9	0.95

Numeric Summary							
Project: Ballston Spa, Middle School, Room 112 TYPICAL							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Chalkboard	Illuminance	Fc	3.00	4	2	1.50	2.00
Teaching Wall	Illuminance	Fc	2.10	3	2	1.05	1.50
South Wall	Illuminance	Fc	2.67	4	1	2.67	4.00
Horizontal WP	Illuminance	Fc	19.44	34	8	2.43	4.25

Room Summary		
Project: Ballston Spa, Middle School, Room 112 TYPICAL		
Label	Wall Ht.	Description
Room 112	9.42	27'-2" x 27'-2" Refl. 80/50/20

LPD Area Summary			
Project: Ballston Spa, Middle School, Room 112 TYPICAL			
Label	Area	Total Watts	LPD
Room 112	738.1	240	0.325

SX1 luminaires 8'AFF; X2 luminaire is 8.5' AFF. Calculations based on Osram 1.2 QHE Instant Start Ballasts on outboard lamps and Osram Powersense Dimming Ballasts on the center lamps. Type X2 fixture is turned OFF.

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

PHOTOMETRIC DATA USED AS INPUT FOR THESE CALCULATIONS IS BASED ON ESTABLISHED IES PROCEDURES AND PUBLISHED LAMP & BALLAST RATINGS. FIELD PERFORMANCE WILL DEPEND ON ACTUAL LAMP, BALLAST, ELECTRICAL AND SITE CHARACTERISTICS.

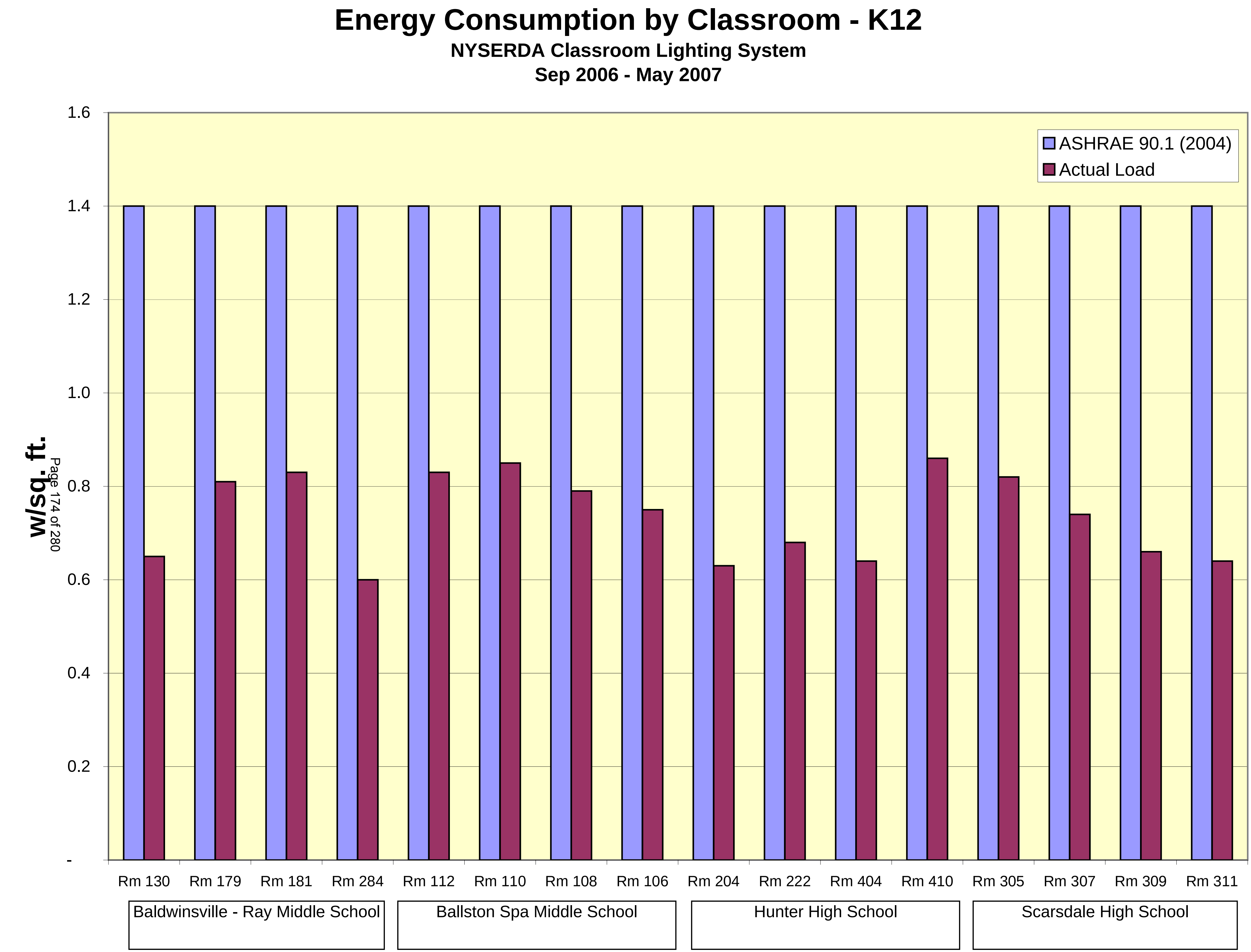
VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT 30" ABOVE FINISHED FLOOR.
AGI32 VERSION 1.8

FINELITE
Better Lighting for a Better Workplace

Revisions		
#	Date	Comments

Drawn By: V Lauck
Date: April, 2006

Project: NYSERDA - Ballston Spa, MS, Rm 112, TYPICAL


Energy Consumption by Classroom - K12
NYSERDA Classroom Lighting System
Sep 2006 - May 2007
w/sq. ft.
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
-
ASHRAE 90.1 (2004)
Actual Load
Rm 130
Rm 179
Rm 181
Rm 284
Rm 112
Rm 110
Rm 108
Rm 106
Rm 204
Rm 222
Rm 404
Rm 410
Rm 305
Rm 307
Rm 309
Rm 311
Baldwinsville - Ray Middle School
Ballston Spa Middle School
Hunter High School
Scarsdale High School

Data Summary

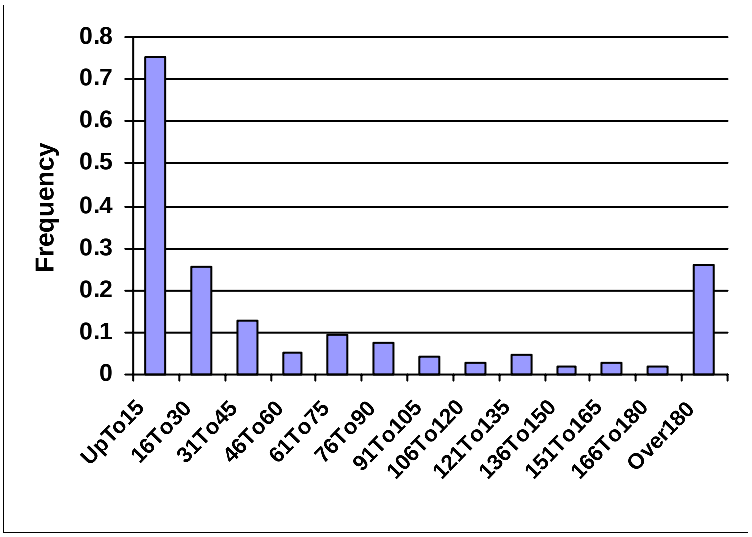
Ballston Spa Middle School

Classroom	Date	AV Gen Switches	AV Use (#/Day)	WB Use (#/Day)	General Total Min	White Board Total Min	AV Total Min	Settle Time	Settle Count	Quiet Count	Occ Sensor Shut Off	Manual Shut Off	Lights On Total	Watts/ sq ft	kWh
110	5/14/07	10	5	6	217	243	203	46	1	0	0	4	420	0.60	3.11
	5/15/07	10	6	5	325	310	94	18	1	0	0	3	420	0.77	3.96
	5/16/07	12	6	10	195	287	222	93	1	0	0	4	417	0.59	3.04
	5/17/07	8	4	10	337	337	33	0		1	0	6	370	0.88	3.98
	5/18/07	0	0	3	478	478	0	0		0	0	3	478	0.93	5.47
	5/21/07	0	0	4	442	442	0	0		0	0	4	442	0.93	5.03
	5/22/07	2	1	4	461	461	6	0		0	0	3	467	0.92	5.28
	5/23/07	4	3	5	237	427	207	190	2	0	0	4	444	0.69	3.79
	5/24/07	2	2	4	281	541	260	260	2	0	0	4	541	0.67	4.47
	5/25/07	4	2	4	107	188	273	94	3	0	0	3	380	0.50	2.33
	5/29/07	0	0	0	519	0	0	0		0	0	4	519	0.74	4.71
	5/30/07	0	0	2	447	245	0	0		0	0	2	447	0.82	4.53
	5/31/07	1	3	5	179	421	242	242	3	1	0	5	421	0.66	3.40
112	10/2/06	2	4	0	204	0	127	0		0	0	8	331	0.64	2.61
	10/3/06	2	1	0	266	0	137	0		2	0	4	403	0.61	3.01
	10/4/06	0	0	0	335	0	0	0		0	1	5	335	0.84	3.47
	10/5/06	1	4	4	254	153	153	153	4	1	0	5	407	0.71	3.54
	10/6/06	3	3	4	210	164	88	86	2	0	1	8	298	0.78	2.86
	10/10/06	0	0	0	408	0	0	0		0	1	2	408	0.85	4.26
	10/11/06	0	0	0	497	0	0	0		0	0	3	497	0.84	5.17
	10/12/06	0	0	1	422	7	0	0		0	0	4	422	0.85	4.40
	10/13/06	2	1	1	250	213	213	213	1	0	0	3	463	0.63	3.60
	10/16/06	0	0	1	438	106	0	0		1	1	3	438	0.89	4.79
	10/17/06	0	0	0	436	0	0	0		0	1	4	436	0.85	4.56
	10/18/06	0	0	0	434	0	0	0		0	0	3	434	0.85	4.52
	10/19/06	0	0	0	413	0	0	0		0	0	6	413	0.85	4.30
	10/20/06	0	0	0	444	0	0	0		0	0	3	444	0.85	4.64
	10/23/06	0	0	0	473	0	0	0		1	0	3	473	0.85	4.96
	10/24/06	0	0	0	506	0	0	0		1	0	3	506	0.85	5.29
	10/25/06	0	0	0	448	0	0	0		0	0	3	448	0.85	4.68
	10/26/06	4	2	1	511	1	50	1	1	2	3	3	561	0.78	5.39
	10/27/06	4	3	0	225	0	39	0		1	0	5	264	0.75	2.45
	10/30/06	0	0	0	435	0	0	0		0	0	4	435	0.85	4.53
	10/31/06	1	2	0	237	0	85	0		1	0	2	322	0.66	2.61
	11/1/06	2	2	0	166	0	145	0		0	0	6	311	0.55	2.10
	11/2/06	4	2	2	274	27	67	7	1	0	0	9	341	0.72	3.03
	11/3/06	2	1	0	298	0	4	0		0	0	6	302	0.84	3.11
	11/6/06	0	0	0	489	0	0	0		0	0	4	489	0.85	5.09

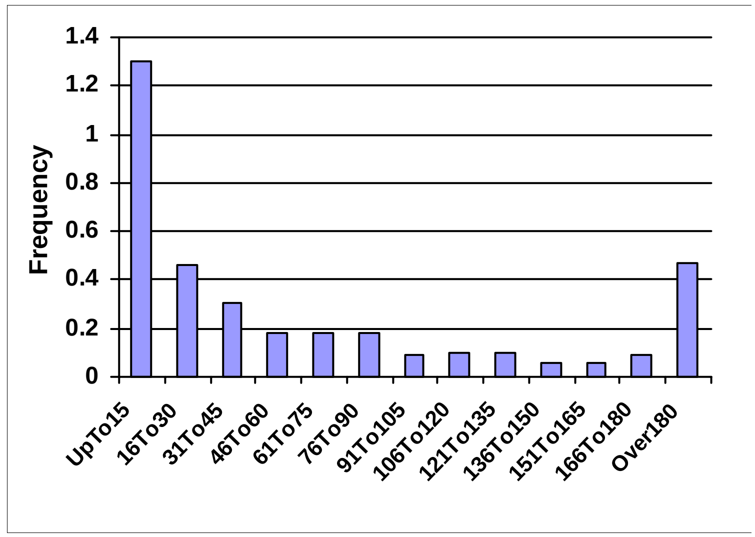
Average Daily Lighting Usage for Ballston Spa Middle School, Rm 106 From 9/1/06 To 5/31/07

General AV mode Switches:	1.3	Quiet Time Usage:	0.4
General Mode Time:	288.5	Occupancy Sensor Shutoff Frequency:	0.7
AV mode Time:	149.5	Manual Shutoff Frequency:	3.9
White Board Time:	207.0	Lights On:	438.0
Settle Mode Time:	92.8	Watts/ sq ft:	0.74
Settle Mode Counts:	1.2	School Days:	169

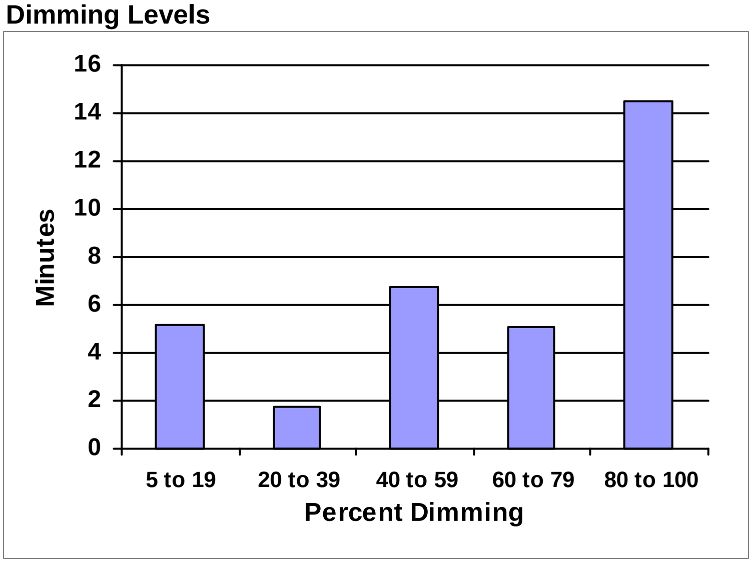
AV Mode



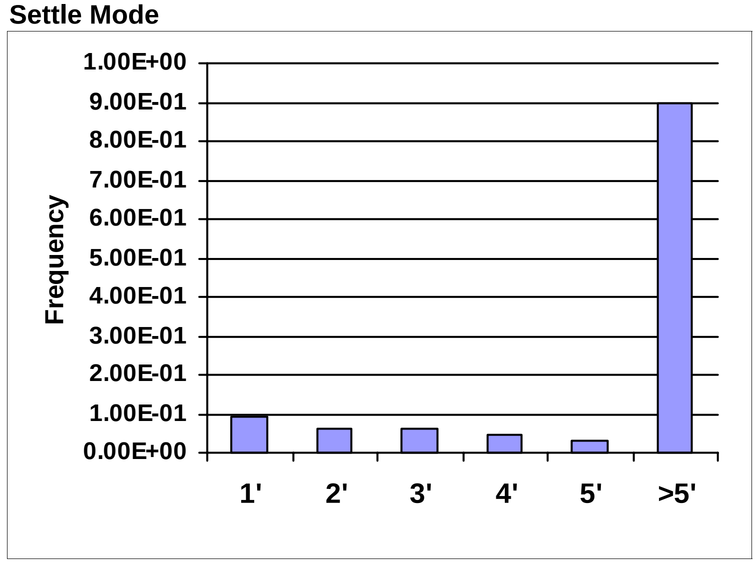
General Mode



Dimming Levels



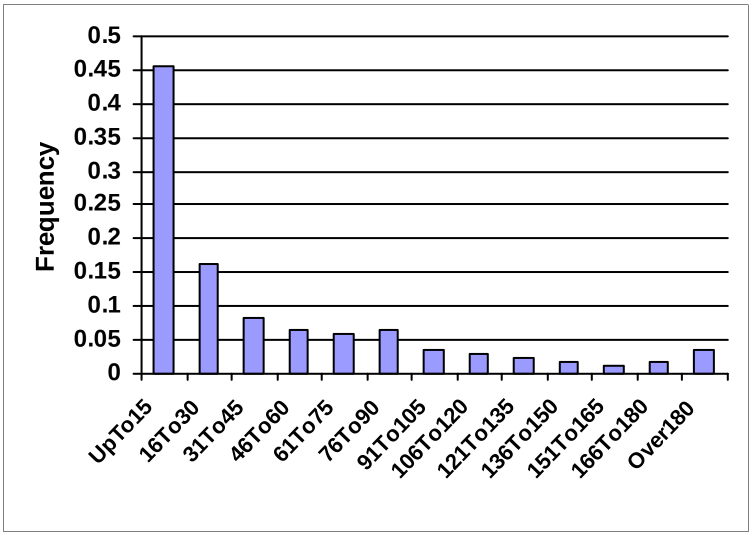
Settle Mode



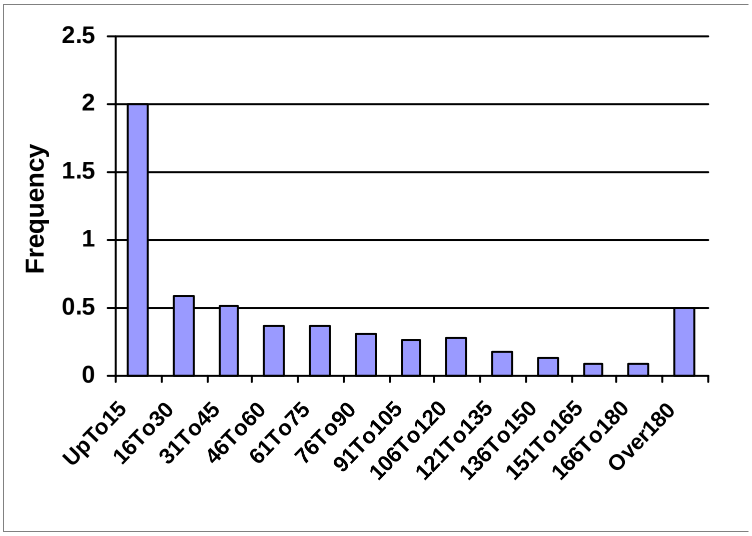
Average Daily Lighting Usage for Ballston Spa Middle School, Rm 108 From 9/1/06 To 5/31/07

General AV mode Switches:	**.8**	**Quiet Time Usage:**	**0.2**
General Mode Time:	**399.6**	**Occupancy Sensor Shutoff Frequency:**	**0.3**
AV mode Time:	**47.5**	**Manual Shutoff Frequency:**	**6.0**
White Board Time:	**30.0**	**Lights On:**	**447.2**
Settle Mode Time:	**14.6**	**Watts/ sq ft:**	**0.8**
Settle Mode Counts:	**0.6**	**School Days:**	**171**

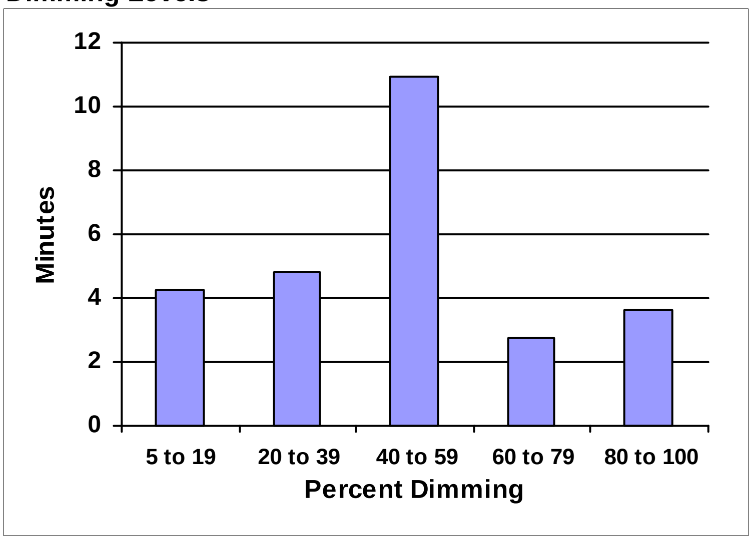
AV Mode



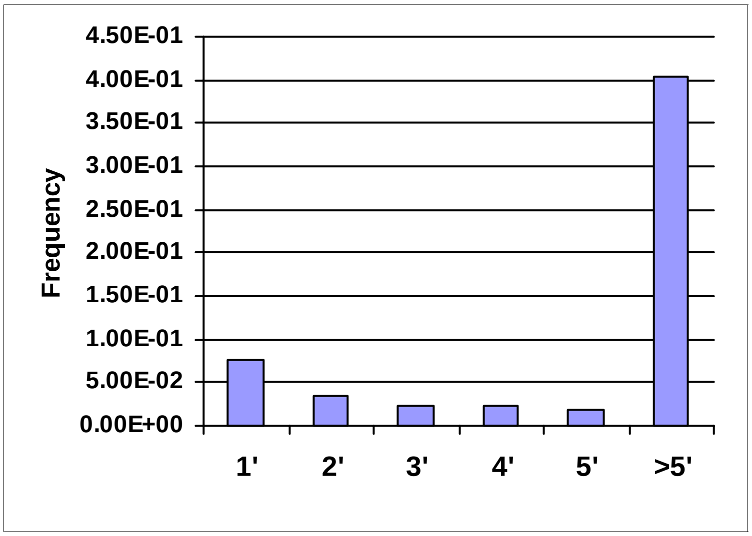
General Mode



Dimming Levels



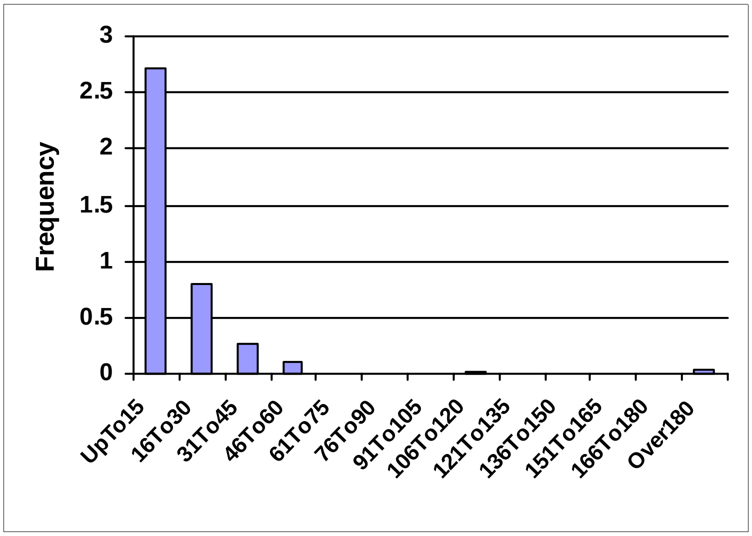
Settle Mode



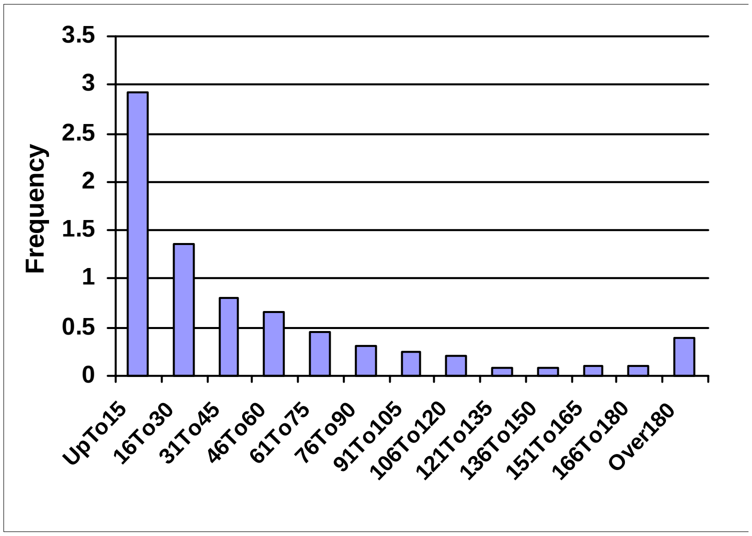
Average Daily Lighting Usage for Ballston Spa Middle School, Rm 110 From 9/1/06 To 5/31/07

General AV mode Switches:	7.9	Quiet Time Usage:	0.8
General Mode Time:	390.9	Occupancy Sensor Shutoff Frequency:	0.1
AV mode Time:	63.9	Manual Shutoff Frequency:	4.2
White Board Time:	371.7	Lights On:	454.7
Settle Mode Time:	9.2	Watts/ sq ft:	0.85
Settle Mode Counts:	0.5	School Days:	169

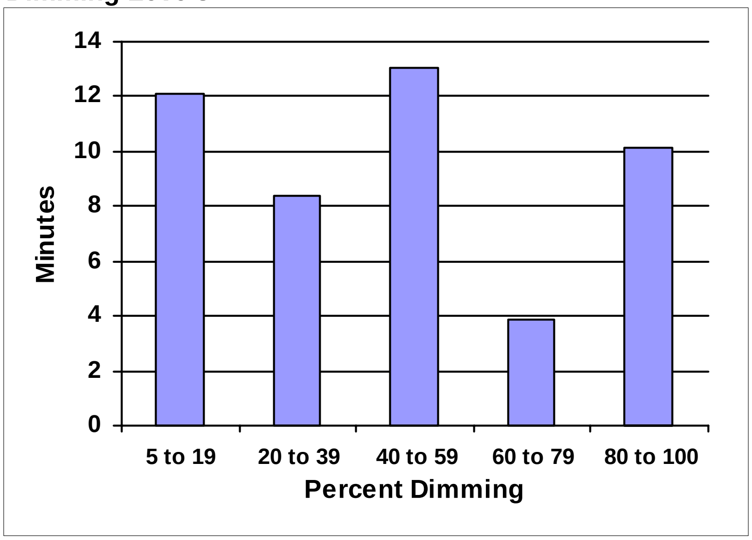
AV Mode



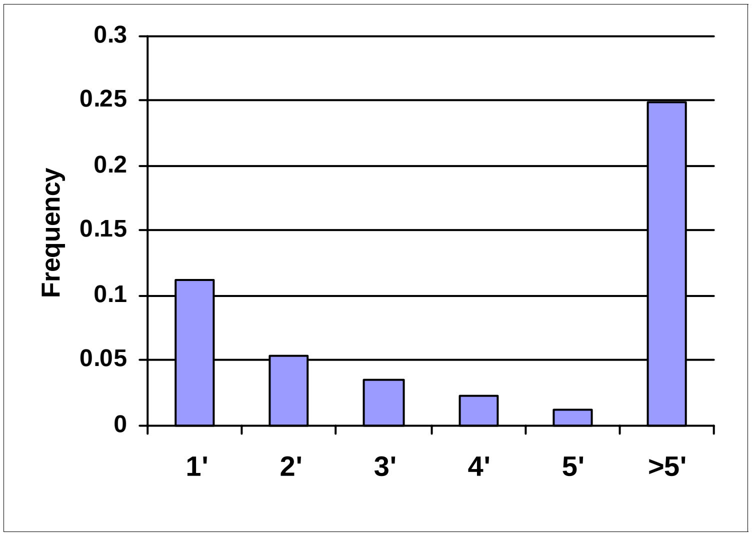
General Mode



Dimming Levels



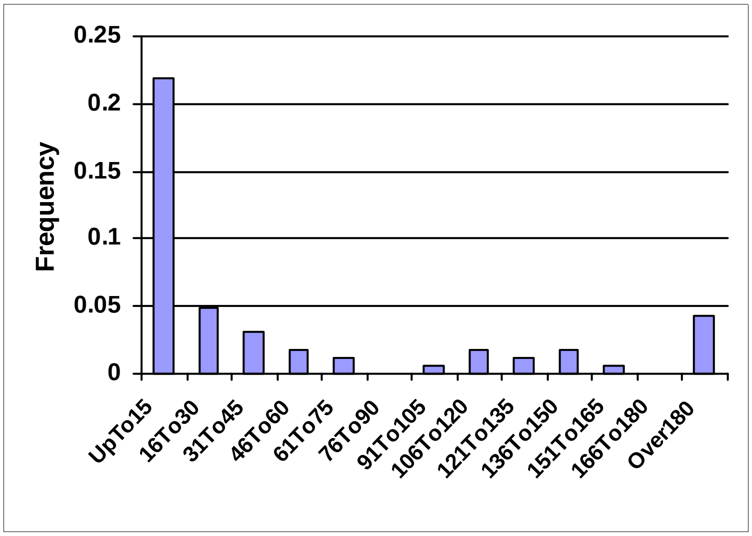
Settle Mode



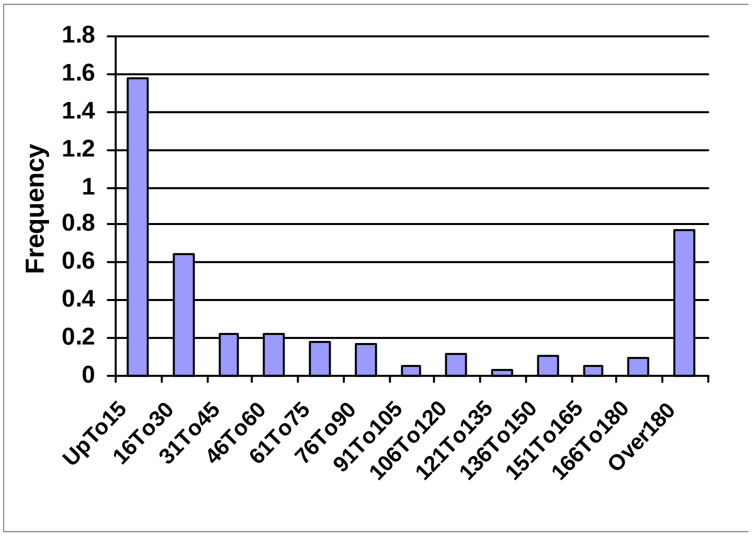
Average Daily Lighting Usage for Ballston Spa Middle School, Rm 112 From 9/1/06 To 5/31/07

General AV mode Switches:	.5	Quiet Time Usage:	0.5
General Mode Time:	396.0	Occupancy Sensor Shutoff Frequency:	0.6
AV mode Time:	24.1	Manual Shutoff Frequency:	3.9
White Board Time:	71.5	Lights On:	420.1
Settle Mode Time:	4.8	Watts/ sq ft:	0.83
Settle Mode Counts:	0.1	School Days:	164

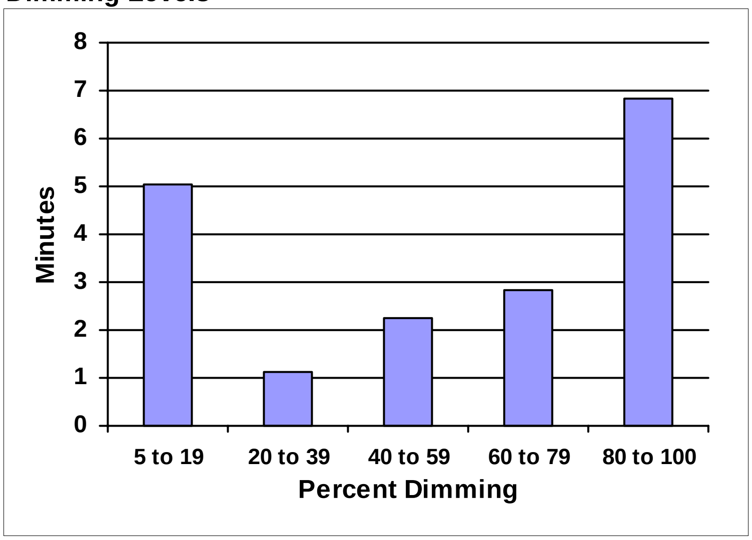
AV Mode



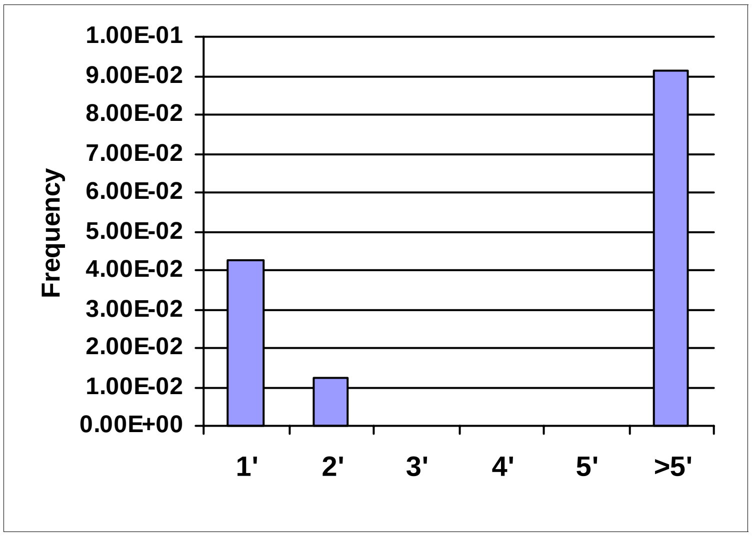
General Mode



Dimming Levels



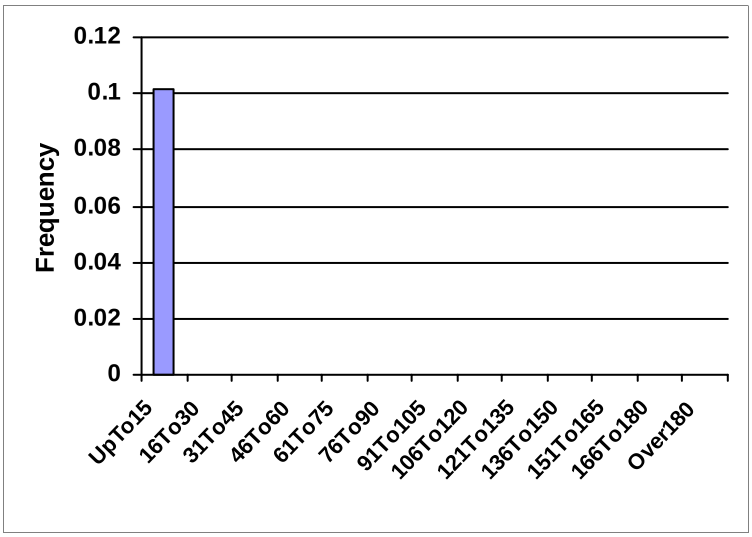
Settle Mode



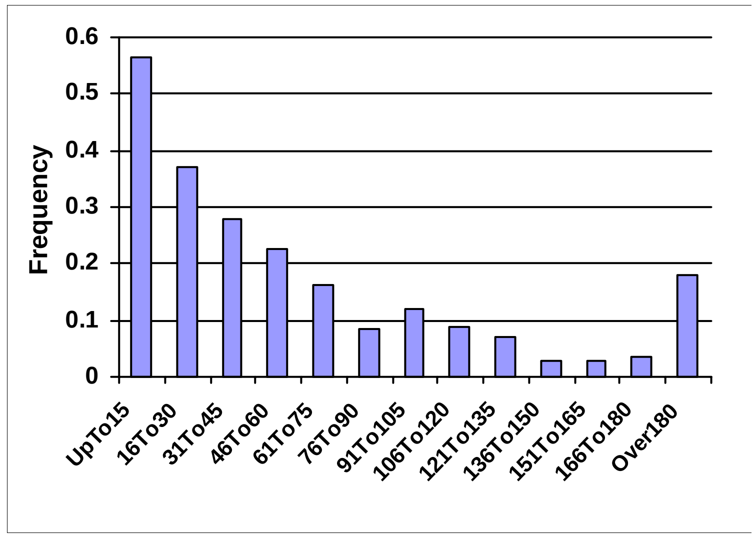
Average Daily Lighting Usage for Ballston Spa Middle School, Rm 104 (Control) From 9/1/06 To 5/31/07

General AV mode Switches:	.5	**Quiet Time Usage:**	0.0
General Mode Time:	418.2	**Occupancy Sensor Shutoff Frequency:**	0.0
AV mode Time:	11.3	**Manual Shutoff Frequency:**	0.0
White Board Time:	.0	**Lights On:**	429.6
Settle Mode Time:	.0	**Watts/ sq ft:**	0.68
Settle Mode Counts:	0.0	**School Days:**	168

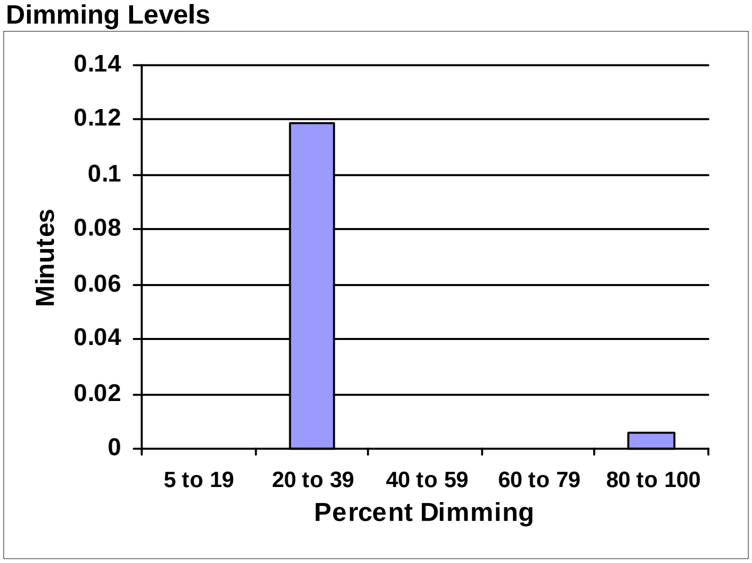
AV Mode



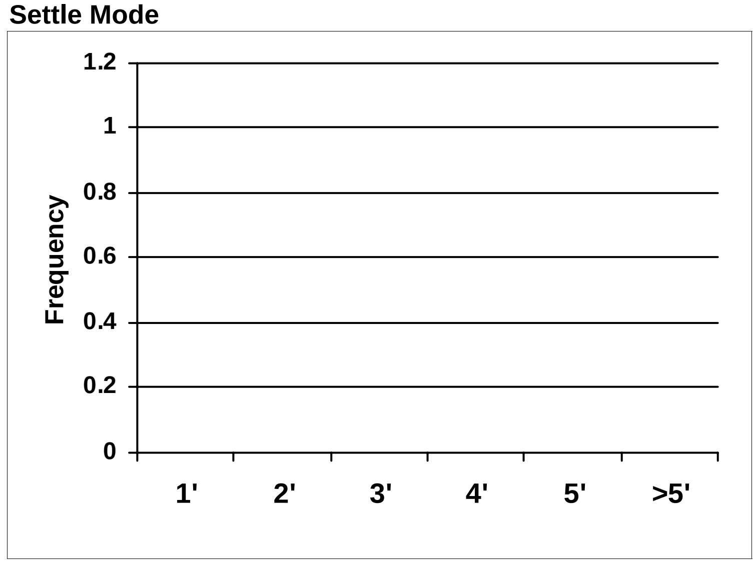
General Mode



Dimming Levels



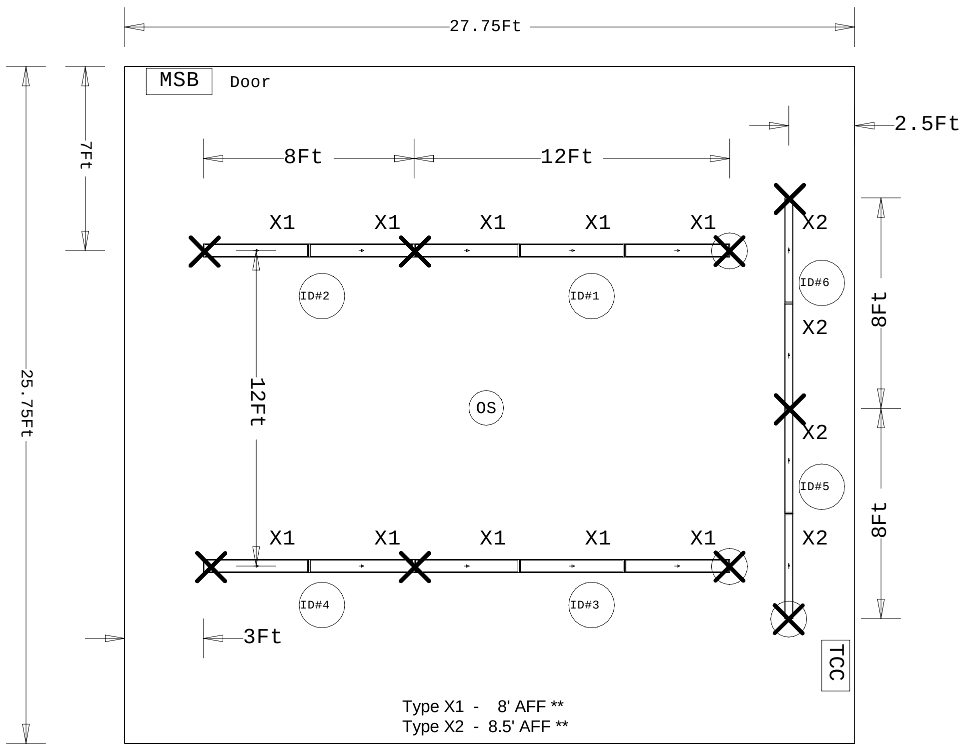
Settle Mode



Appendix G – Hunter High School Information

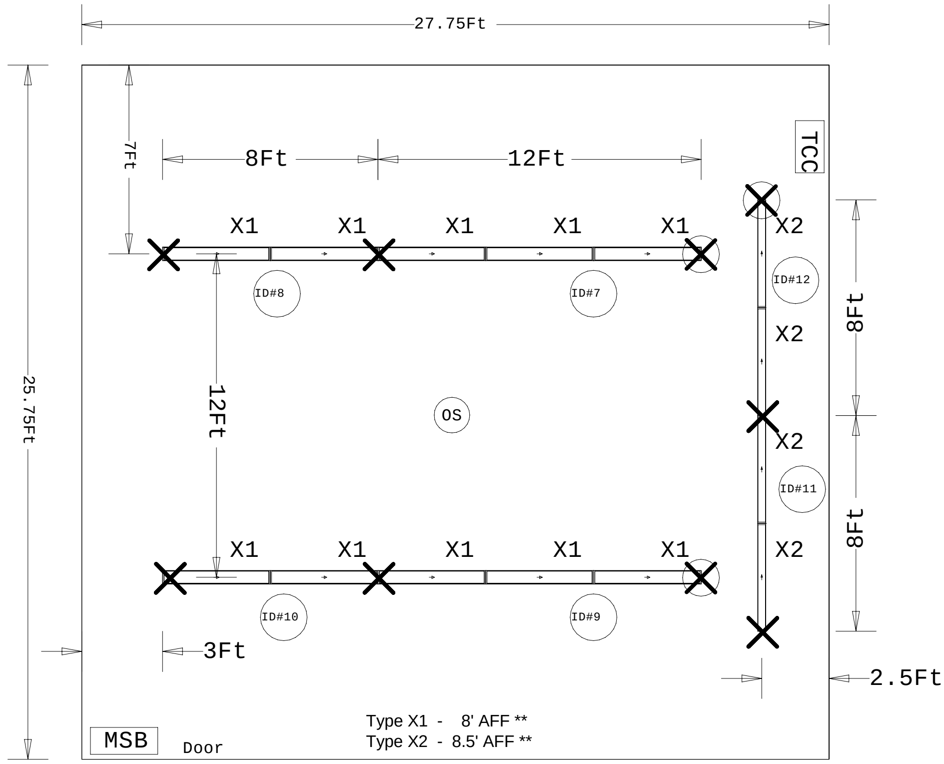
- Room Dimension and Fixture Layout
- Lighting Layouts and calculations
- Energy Consumption Chart
- Data Summary Table
- Average Daily Lighting Usage Report

Hunter HS, Room 204
Installation Dimensions



LEGEND	
TCC	Teacher Control Center mounting location: 4'-0" AFF (to top of box). Install on the left side of whiteboard/chalkboard
OS	Occupancy Sensor(s)
X	Suspension Point
⊗	Power Feed & Suspension Point (Pre-existing power feed points could affect changes to feed points)
ID# 1	Fixture ID#. Each fixture section will have a label with a unique ID# which can be found on the outside of the box and on the fixture itself.
MSB	Master Switch Bank -- Locate MSB on wall at entrance(s) to room. Exact location to be determined on-site.
** Site conditions could influence fixture placement and suspension. All fixtures to be mounted "on-grid" (if ceiling is grid type) therefore the attached dimensional information is approximate. The spacing between rows is the most important dimension to maintain.	

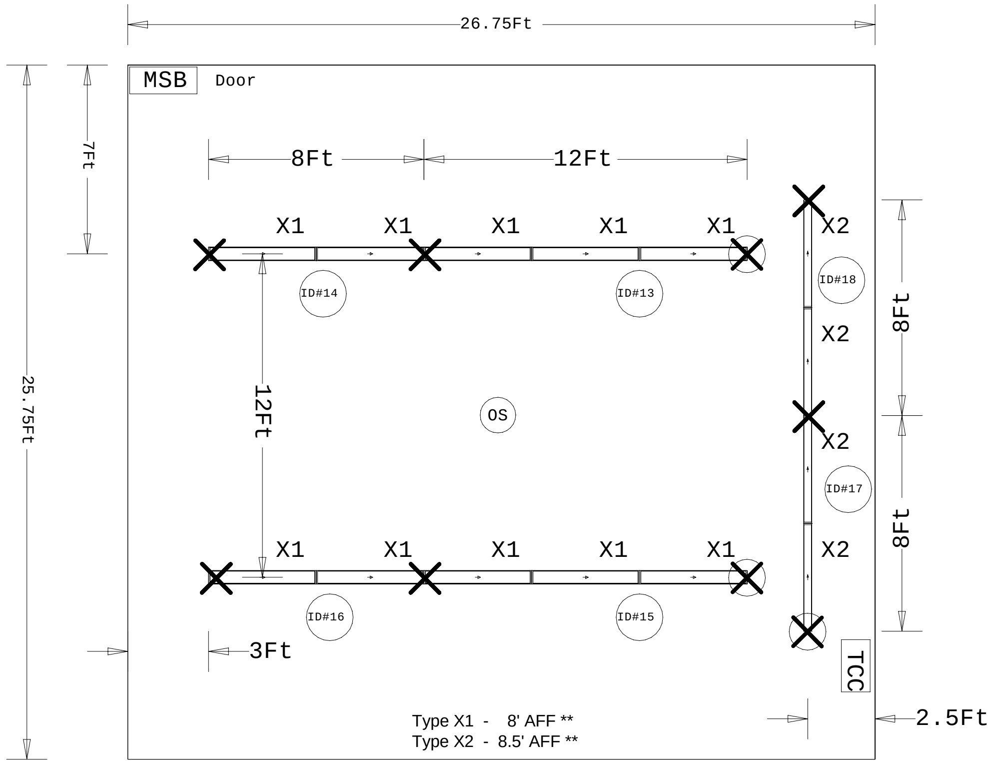
Hunter HS, Room 222
Installation Dimensions



LEGEND	
TCC	Teacher Control Center mounting location: 4'-0" AFF (to top of box). Install on the left side of whiteboard/chalkboard
OS	Occupancy Sensor(s)
X	Suspension Point
(X)	Power Feed & Suspension Point (Pre-existing power feed points could affect changes to feed points)
ID# 1	Fixture ID#. Each fixture section will have a label with a unique ID# which can be found on the outside of the box and on the fixture itself.
MSB	Master Switch Bank -- Locate MSB on wall at entrance(s) to room. Exact location to be determined on-site.

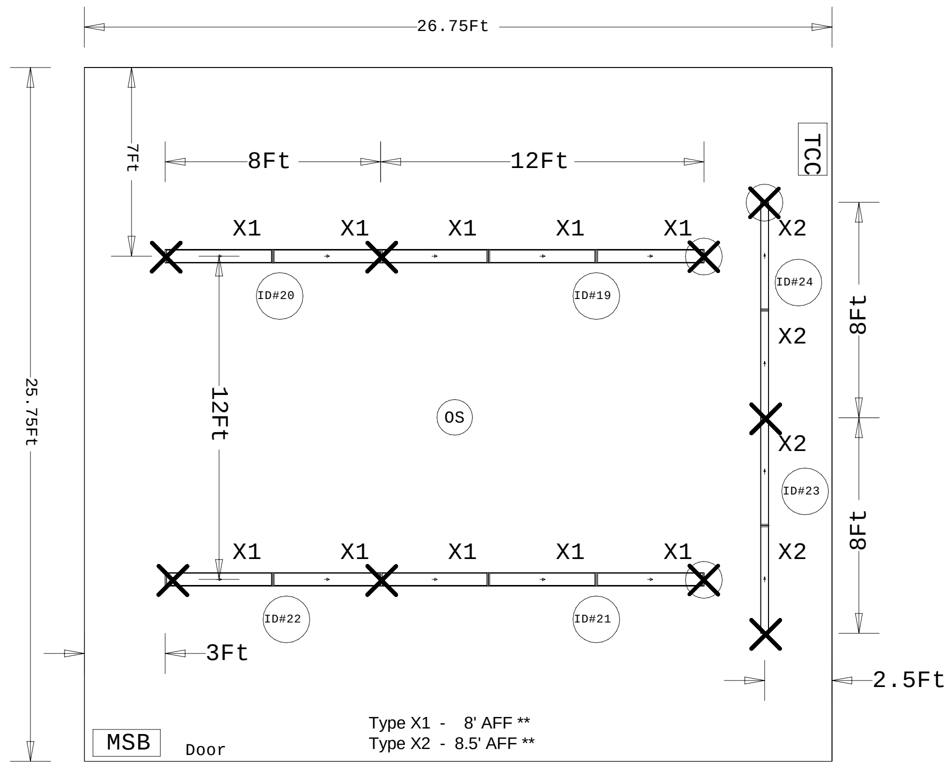
** Site conditions could influence fixture placement and suspension. All fixtures to be mounted "on-grid" (if ceiling is grid type) therefore the attached dimensional information is approximate. The spacing between rows is the most important dimension to maintain.

Hunter HS, Room 404
Installation Dimensions



LEGEND	
TCC	Teacher Control Center mounting location: 4'-0" AFF (to top of box). Install on the left side of whiteboard/chalkboard
OS	Occupancy Sensor(s)
X	Suspension Point
⊗	Power Feed & Suspension Point (Pre-existing power feed points could affect changes to feed points)
ID# 1	Fixture ID#. Each fixture section will have a label with a unique ID# which can be found on the outside of the box and on the fixture itself.
MSB	Master Switch Bank -- Locate MSB on wall at entrance(s) to room. Exact location to be determined on-site.
** Site conditions could influence fixture placement and suspension. All fixtures to be mounted "on-grid" (if ceiling is grid type) therefore the attached dimensional information is approximate. The spacing between rows is the most important dimension to maintain.	

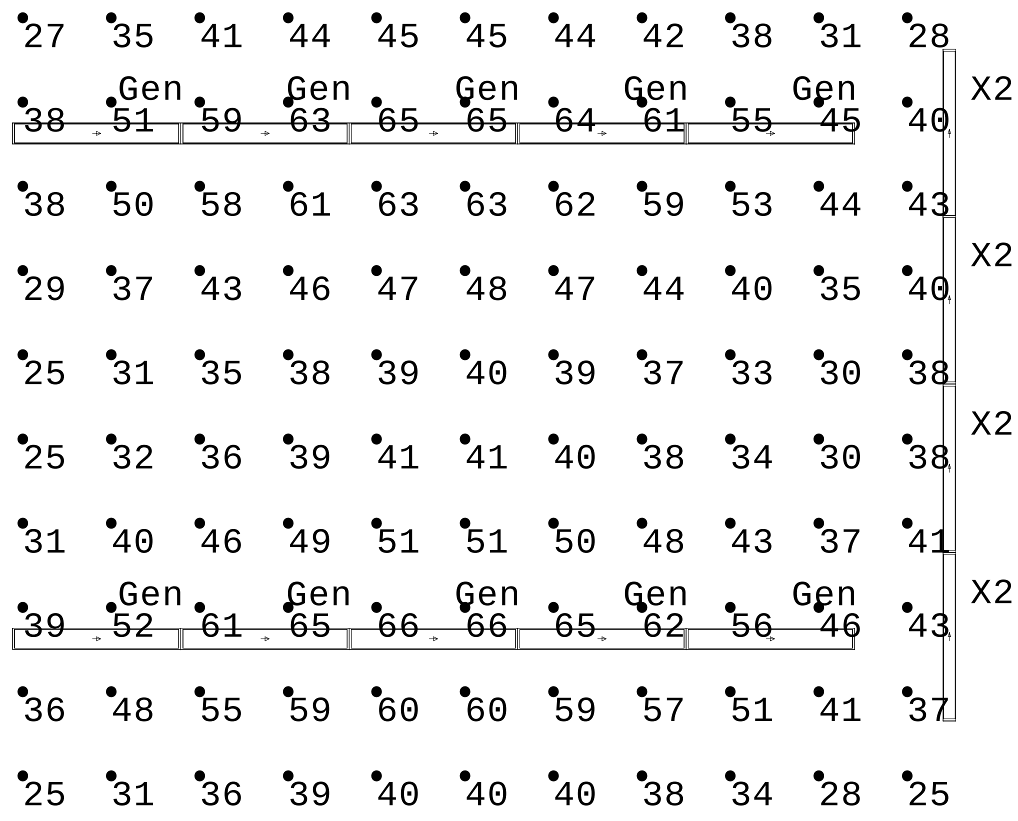
Hunter HS, Room 410
Installation Dimensions



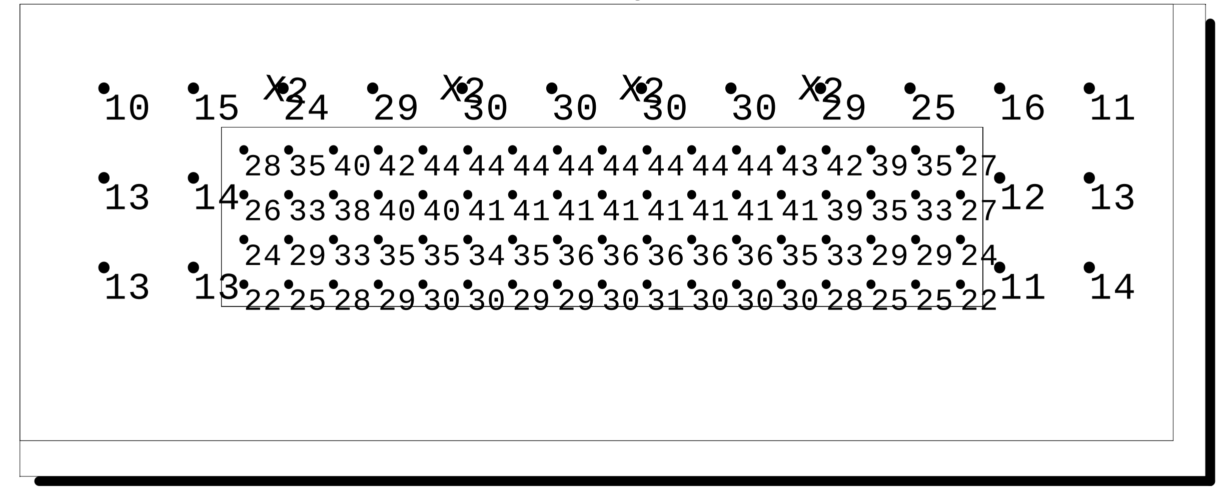
LEGEND	
TCC	Teacher Control Center mounting location: 4'-0" AFF (to top of box). Install on the left side of whiteboard/chalkboard
OS	Occupancy Sensor(s)
	Suspension Point
	Power Feed & Suspension Point (Pre-existing power feed points could affect changes to feed points)
ID# 1	Fixture ID#. Each fixture section will have a label with a unique ID# which can be found on the outside of the box and on the fixture itself.
MSB	Master Switch Bank -- Locate MSB on wall at entrance(s) to room. Exact location to be determined on-site.

** Site conditions could influence fixture placement and suspension. All fixtures to be mounted "on-grid" (if ceiling is grid type) therefore the attached dimensional information is approximate. The spacing between rows is the most important dimension to maintain.

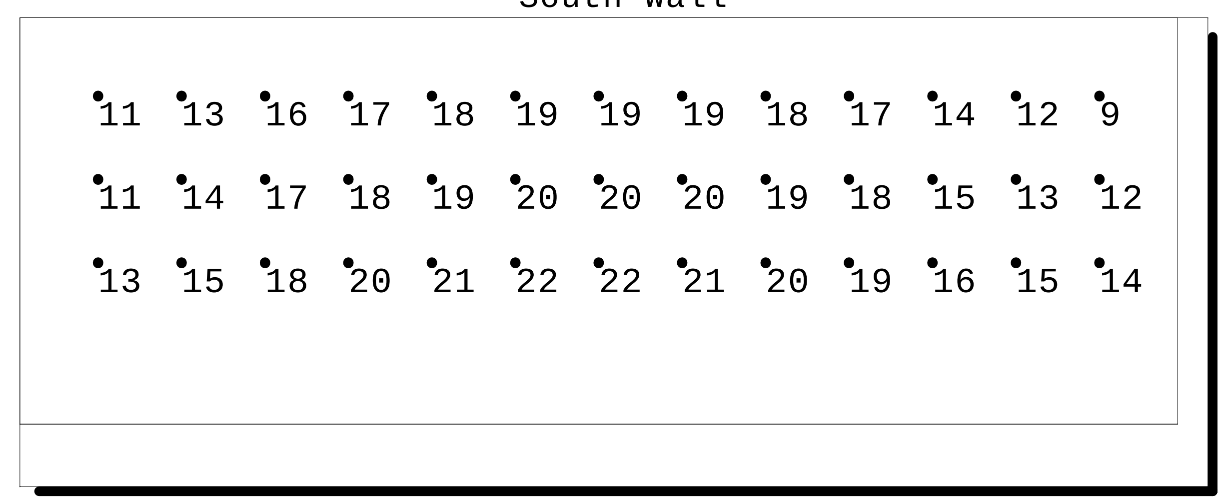
GENERAL MODE



Teaching Wall



South Wall



Luminaire Schedule									
Project: Hunter HS Room 204 & 222									
Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	10	Gen	3100	0.667	X1 PLV CCO 2T8 EP	0.78	48	0.9	0.95
	4	X2	3100	0.667	SX2 WCB 1T8 96W	0.78	25	0.9	0.95

Numeric Summary							
Project: Hunter HS Room 204 & 222							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Chalkboard	Illuminance	Fc	34.56	44	22	1.57	2.00
Teaching Wall	Illuminance	Fc	19.10	30	10	1.91	3.00
North Wall	Illuminance	Fc	16.77	22	9	1.86	2.44
Horizontal WP	Illuminance	Fc	44.56	66	25	1.78	2.64

Room Summary		
Project: Hunter HS Room 204 & 222		
Label	Wall Ht.	Description
Room 204 & 222	9.75	27.75' x 25.75'; Refl: 80/30/20

LPD Area Summary			
Project: Hunter HS Room 204 & 222			
Label	Area	Total Watts	LPD
Room 204 & 222	714.56	580	0.812

SX1 luminaires 8' AFF; X2 luminaire is 8.5' AFF. Calculations based on Osram QHE .78 Instant Start Ballasts operating outboard lamps and Osram Powersense Dimming Ballasts on the center lamps. QHE .78 BF IS ballasts on Type X2.

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

PHOTOMETRIC DATA USED AS INPUT FOR THESE CALCULATIONS IS BASED ON ESTABLISHED IES PROCEDURES AND PUBLISHED LAMP & BALLAST RATINGS. FIELD PERFORMANCE WILL DEPEND ON ACTUAL LAMP, BALLAST, ELECTRICAL AND SITE CHARACTERISTICS.

VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT 30" ABOVE FINISHED FLOOR.
AGI32 VERSION 1.8

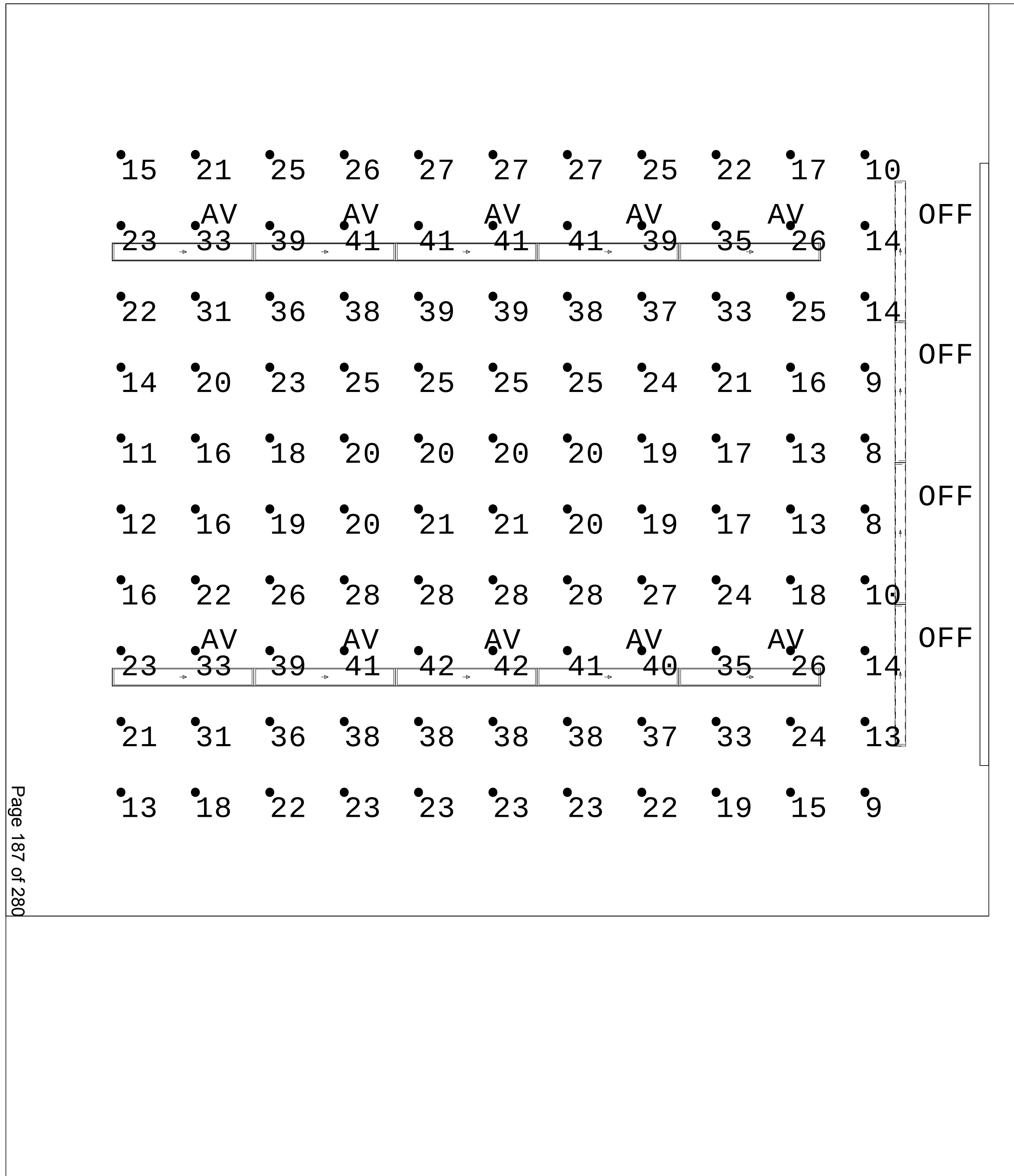
FINELITE
Better Lighting for a Better Workplace

#	Date	Comments
Revisions		

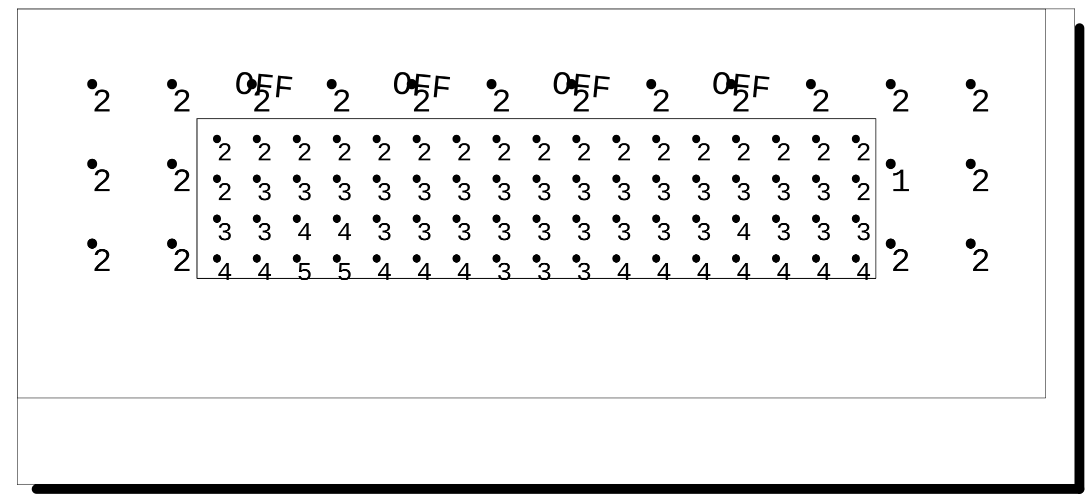
Drawn By: V Lauck
Date: April, 2006

Project: NYSERDA
Hunter HS, Room 204 & 222

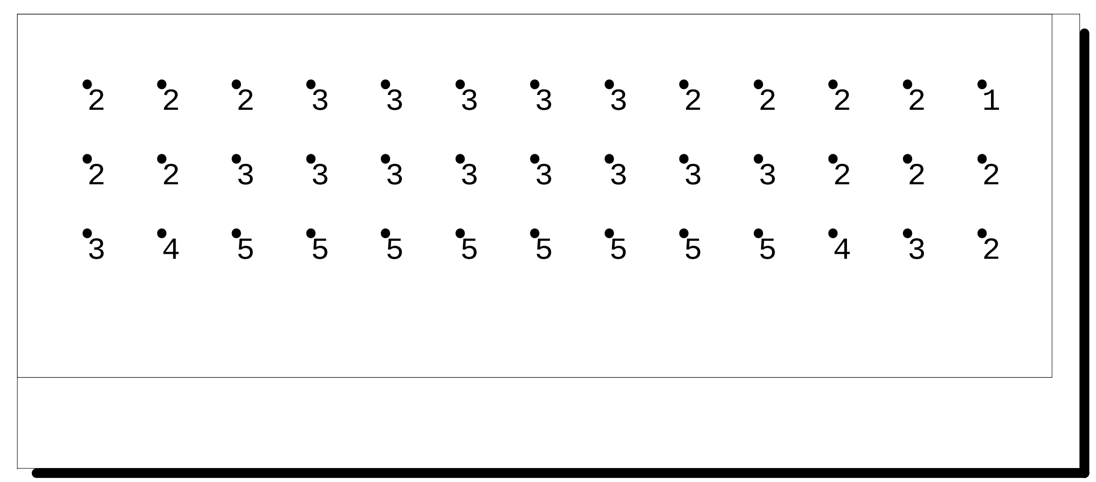
AV MODE



Teaching Wall



South Wall



Luminaire Schedule									
Project: Hunter HS Room 204 & 222									
Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	10	AV	3100	0.752	X1 PLV COO 1T8 EP	0.88	30	0.9	0.95
	4	OFF	3100	0.667	SX2 WCB 1T8 96W	0.78	25	0.9	0.95

Numeric Summary							
Project: Hunter HS Room 204 & 222							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Chalkboard	Illuminance	Fc	3.00	5	2	1.50	2.50
Teaching Wall	Illuminance	Fc	1.95	2	1	1.95	2.00
North Wall	Illuminance	Fc	3.08	5	1	3.08	5.00
Horizontal WP	Illuminance	Fc	25.00	42	8	3.13	5.25

Room Summary		
Project: Hunter HS Room 204 & 222		
Label	Wall Ht.	Description
Room 204 & 222	9.75	27.75' x 25.75'; Refl: 80/30/20

LPD Area Summary			
Project: Hunter HS Room 204 & 222			
Label	Area	Total Watts	LPD
Room 204 & 222	714.56	300	0.420

SX1 luminaires 8' AFF; X2 luminaire is 8.5' AFF. Calculations based on Osram QHE .78 Instant Start Ballasts operating outboard lamps and Osram Powersense Dimming Ballasts on the center lamps. Type X2 fixture is turned OFF.

VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT 30" ABOVE FINISHED FLOOR.
AGI32 VERSION 1.8

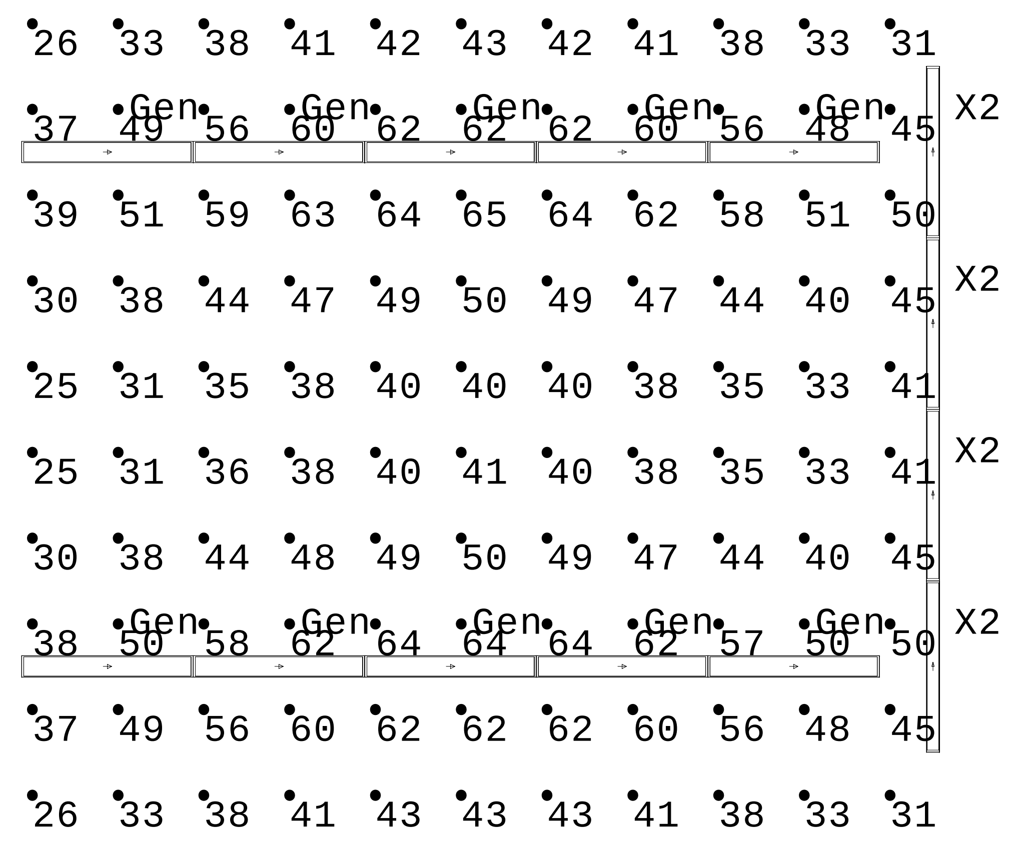
FINELITE
Better Lighting for a Better Workplace

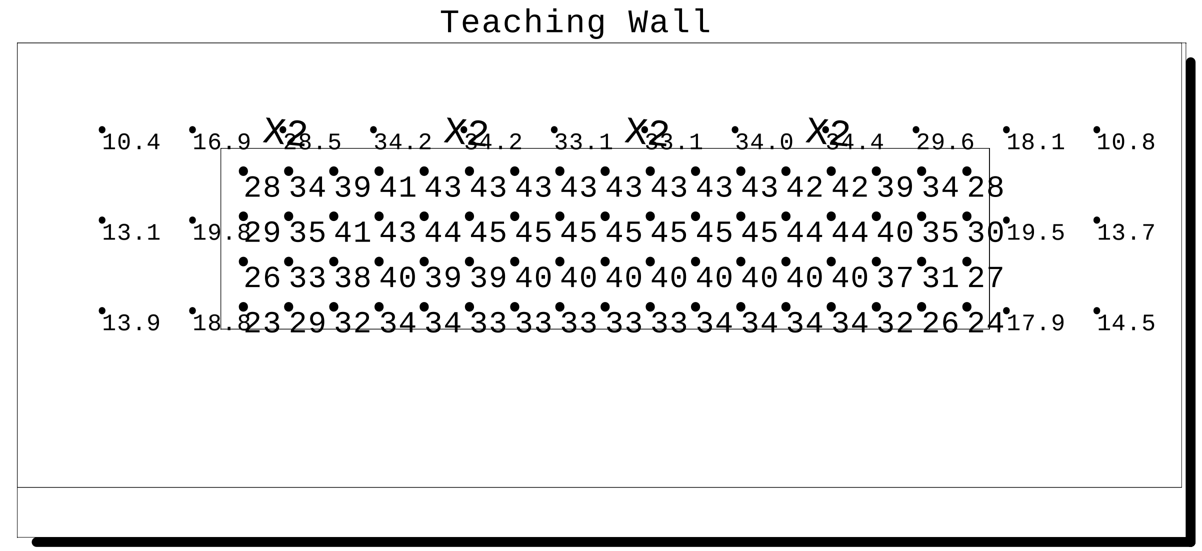
Revisions		
#	Date	Comments

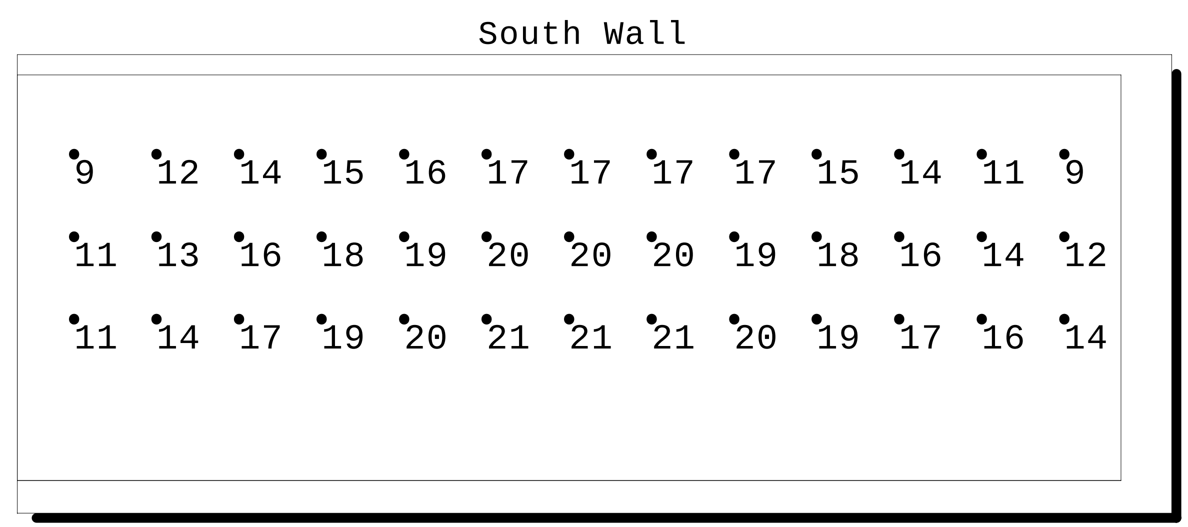
Drawn By: V Lauck
Date: April, 2006

Project: NYSERDA
Hunter HS, Room 204 & 222

GENERAL MODE







Luminaire Schedule									
Project: Hunter HS Room 404 & 410									
Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	4	X2	3100	0.667	SX2 WCB 1T8 96W	0.78	25	0.9	0.95
	10	Gen	3100	0.667	X1 PLV CCO 2T8 EP	0.78	48	0.9	0.95

Numeric Summary								
Project: Hunter HS Room 404 & 410								
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Teaching Wall	Illuminance	Fc	22.43	34.4	10.4	2.16	3.31
Chalkboard	Illuminance	Fc	37.29	45	23	1.62	1.96
North Wall	Illuminance	Fc	16.13	21	9	1.79	2.33
Horizontal WP	Illuminance	Fc	45.62	65	25	1.82	2.60

Room Summary		
Project: Hunter HS Room 404 & 410		
Label	Wall Ht.	Description
Room 404 & 410	9.83	26.75' x 25.75' 80/30/20 Reflectances

LPD Area Summary			
Project: Hunter HS Room 404 & 410			
Label	Area	Total Watts	LPD
Room 404 & 410	688.81	580	0.842

SX1 luminaires 8' AFF; X2 luminaire is 8.5' AFF. Calculations based on Osram QHE .78 Instant Start Ballasts operating outboard lamps and Osram Powersense Dimming Ballasts on the center lamps. QHE .78 BF IS ballasts on Type X2.

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

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VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT 30" ABOVE FINISHED FLOOR.

AGI32 VERSION 1.8

FINELITE
Better Lighting for a Better Workplace

#	Date	Comments

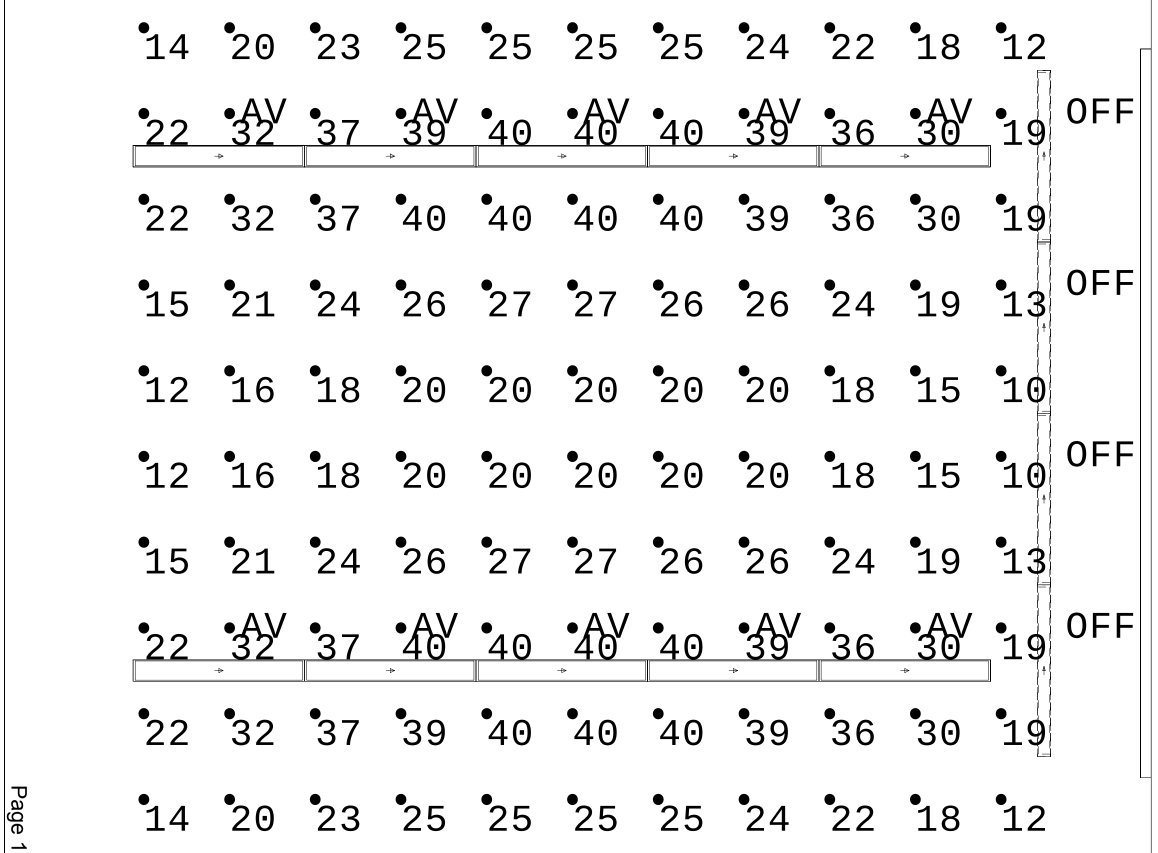
Revisions

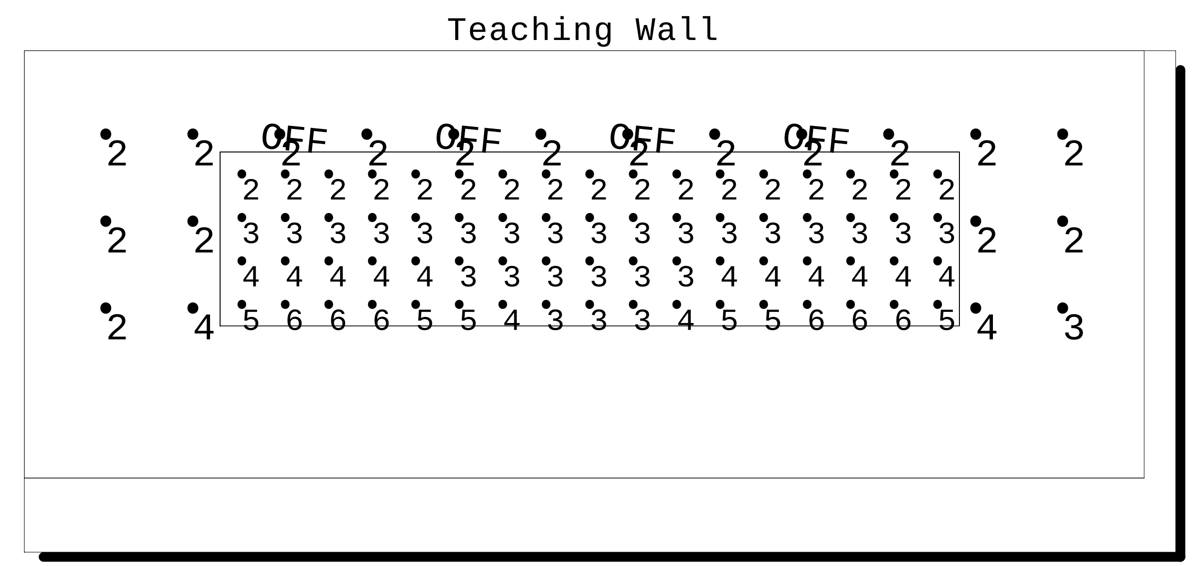
Drawn By: V Lauck
Date: April, 2006

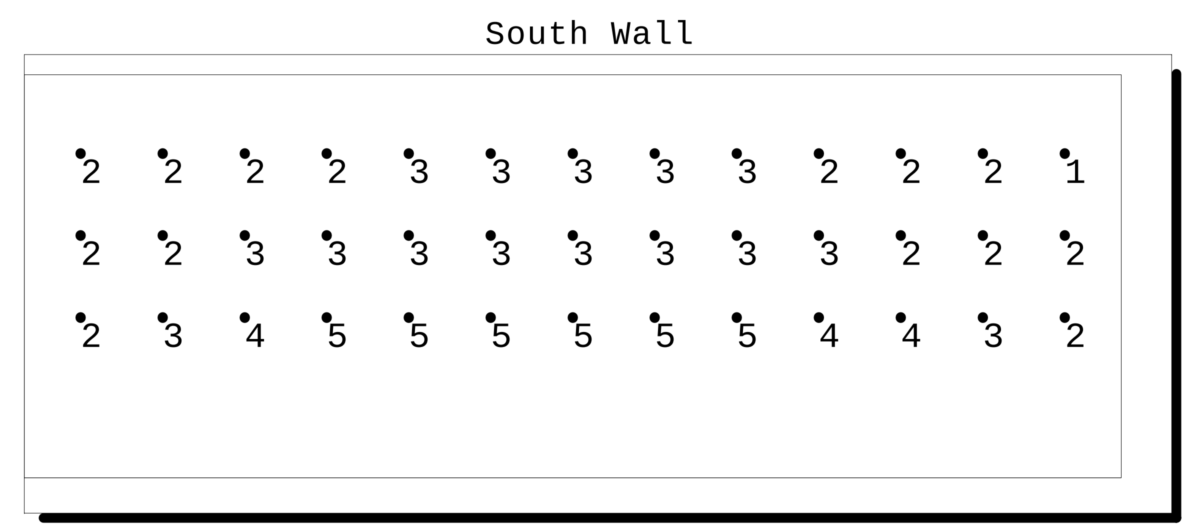
Project: NYSERDA
Hunter HS, Room 404 & 410

Page 1 of 1

AV MODE







Luminaire Schedule									
Project: Hunter HS Room 404 & 410									
Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	10	AV	3100	0.752	X1 PLV COO 1T8 EP	0.88	30	0.9	0.95
	4	OFF	3100	0.667	SX2 WCB 1T8 96W	0.78	25	0.9	0.95

Numeric Summary								
Project: Hunter HS Room 404 & 410								
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Chalkboard	Illuminance	Fc	3.38	6	2	1.69	3.00
Teaching Wall	Illuminance	Fc	2.25	4	2	1.13	2.00
North Wall	Illuminance	Fc	2.97	5	1	2.97	5.00
Horizontal WP	Illuminance	Fc	25.80	40	10	2.58	4.00

Room Summary		
Project: Hunter HS Room 404 & 410		
Label	Wall Ht.	Description
Room 404 & 410	9.83	26.75' x 25.75' 80/30/20 Reflectances

LPD Area Summary			
Project: Hunter HS Room 404 & 410			
Label	Area	Total Watts	LPD
Room 404 & 410	688.81	300	0.436

SX1 luminaires 8' AFF; X2 luminaire is 8.5' AFF. Calculations based on Osram QHE .78 Instant Start Ballasts operating outboard lamps and Osram Powersense Dimming Ballasts on the center lamps. Type X2 fixture is turned OFF.

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VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT 30" ABOVE FINISHED FLOOR.

AGI32 VERSION 1.8

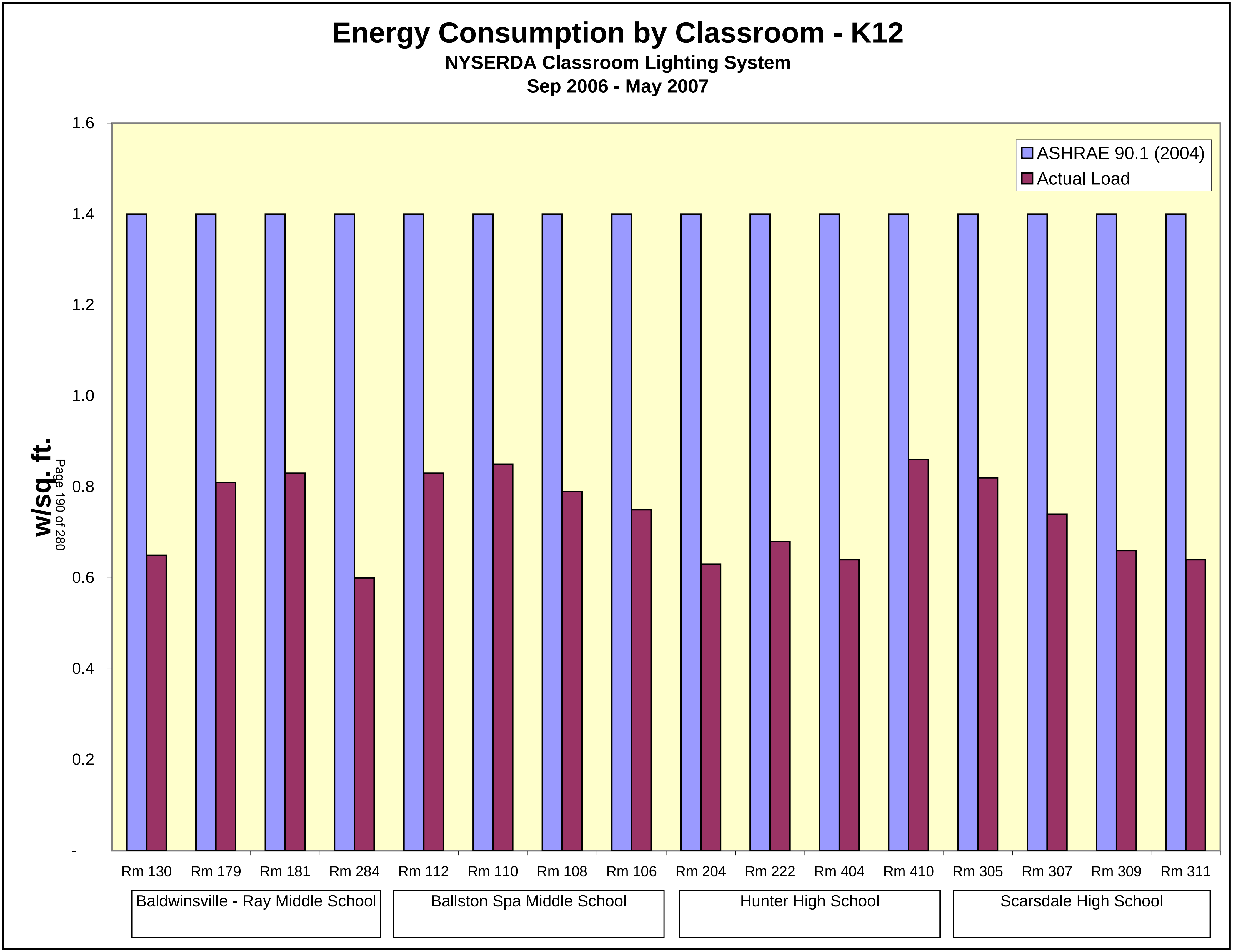
FINELITE
Better Lighting for a Better Workplace

#	Date	Comments

Revisions

Drawn By: V Lauck
Date: April, 2006

Project: NYSERDA
Hunter HS, Room 404 & 410



Energy Consumption by Classroom - K12
NYSERDA Classroom Lighting System
Sep 2006 - May 2007
w/sq. ft.
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
-
ASHRAE 90.1 (2004)
Actual Load
Rm 130
Rm 179
Rm 181
Rm 284
Rm 112
Rm 110
Rm 108
Rm 106
Rm 204
Rm 222
Rm 404
Rm 410
Rm 305
Rm 307
Rm 309
Rm 311
Baldwinsville - Ray Middle School
Ballston Spa Middle School
Hunter High School
Scarsdale High School

Data Summary

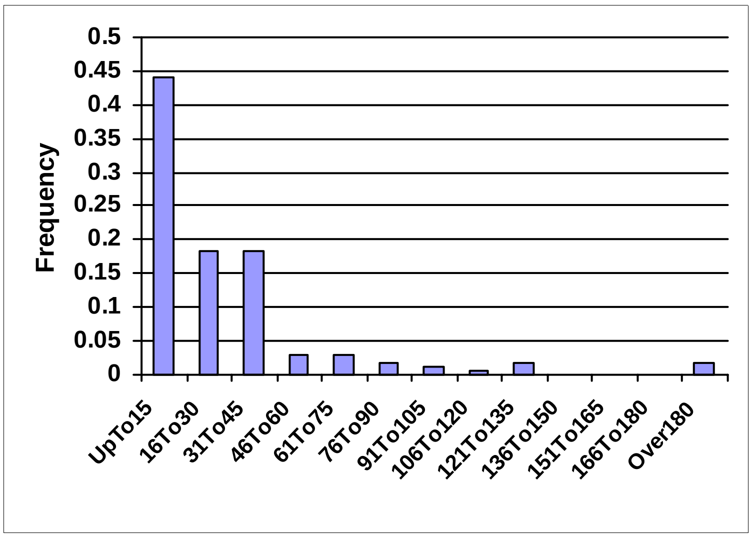
Hunter High School

Classroom	Date	AV Gen Switches	AV Use (#/Day)	WB Use (#/Day)	General Total Min	White Board Total Min	AV Total Min	Settle Time	Settle Count	Quiet Count	Occ Sensor Shut Off	Manual Shut Off	Lights On Total	Watts/ sq ft	kWh
222	5/23/07	6	3	5	280	105	96	42	2	1	1	4	376	0.56	2.52
	5/24/07	0	0	0	372	0	0	0		0	1	3	372	0.67	2.96
	5/25/07	2	1	0	363	0	21	0		0	0	5	384	0.65	2.96
	5/26/07	1	1	0	15	0	1	0		2	0	1	16	0.62	0.12
	5/29/07	0	0	0	376	0	0	0		0	0	4	376	0.68	3.04
	5/30/07	0	0	1	361	3	0	0		1	2	3	361	0.68	2.91
	5/31/07	0	0	0	156	0	0	0		0	0	4	156	0.67	1.25
404	10/2/06	0	0	2	0	4	0	0		0	0	2	4	0.13	0.01
	10/3/06	4	3	1	194	758	313	313	3	0	0	1	758	0.45	3.96
	10/4/06	0	2	4	0	423	107	107	2	0	0	4	423	0.21	1.04
	10/5/06	0	6	6	0	505	138	138	6	0	2	4	505	0.17	0.97
	10/6/06	0	0	5	112	462	0	0		0	0	5	462	0.31	1.63
	10/10/06	0	3	3	0	699	699	699	3	0	1	2	699	0.44	3.56
	10/11/06	0	2	2	0	418	418	418	2	1	0	2	418	0.26	1.24
	10/12/06	0	4	6	0	603	597	597	4	0	0	6	603	0.23	1.62
	10/13/06	0	6	6	0	56	56	56	6	0	0	6	56	0.23	0.15
	10/14/06	0	1	1	0	105	105	105	1	0	0	1	105	0.23	0.28
	10/16/06	0	4	4	0	715	715	715	4	1	0	4	715	0.23	1.92
	10/17/06	0	2	2	0	645	608	608	2	0	1	1	645	0.23	1.69
	10/18/06	0	1	4	0	598	38	38	1	0	0	4	598	0.14	0.98
	10/19/06	0	3	4	0	728	103	81	2	0	0	3	750	0.15	1.28
	10/20/06	0	5	4	0	491	62	62	5	0	0	4	491	0.16	0.91
	10/23/06	0	3	2	0	599	108	108	3	0	0	2	599	0.16	1.13
	10/24/06	0	2	1	0	652	72	72	2	0	0	1	652	0.15	1.11
	10/25/06	0	2	4	0	377	121	121	2	2	0	4	377	0.19	0.82
	10/26/06	0	2	3	0	224	25	25	2	1	0	3	224	0.15	0.38
	10/27/06	0	1	1	0	468	422	422	1	0	0	1	468	0.51	2.76
	10/30/06	0	3	5	0	770	156	156	3	1	3	2	770	0.21	1.82
	10/31/06	0	0	8	0	423	0	0		0	4	4	423	0.14	0.67
	11/1/06	0	1	4	0	775	140	140	1	0	1	3	775	0.21	1.88
	11/2/06	0	1	8	0	583	41	41	1	0	6	1	583	0.14	0.97
	11/3/06	0	4	3	0	435	161	161	4	0	0	3	435	0.28	1.41
	11/4/06	0	1	1	0	330	330	330	1	0	0	1	330	0.55	2.08
	11/6/06	0	5	5	0	705	181	178	4	1	2	3	708	0.24	1.93
	11/7/06	0	3	6	0	345	206	166	3	1	1	4	385	0.32	1.42
	11/8/06	0	0	3	0	562	0	0		4	0	3	562	0.14	0.88
	11/9/06	0	0	6	0	611	0	0		1	0	6	611	0.14	0.96
	11/10/06	0	2	5	0	142	3	2	2	1	1	3	143	0.14	0.23

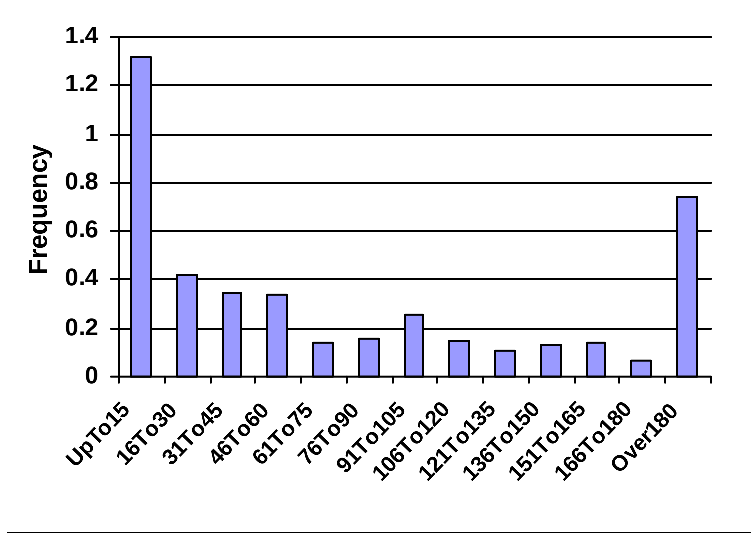
Average Daily Lighting Usage for Hunter High School, Rm 204
From 9/1/06 To 5/31/07

General AV mode Switches:	1.6	Quiet Time Usage:	0.1
General Mode Time:	372.8	Occupancy Sensor Shutoff Frequency:	0.8
AV mode Time:	24.4	Manual Shutoff Frequency:	3.1
White Board Time:	40.0	Lights On:	397.2
Settle Mode Time:	3.0	Watts/ sq ft:	0.63
Settle Mode Counts:	0.1	School Days:	175

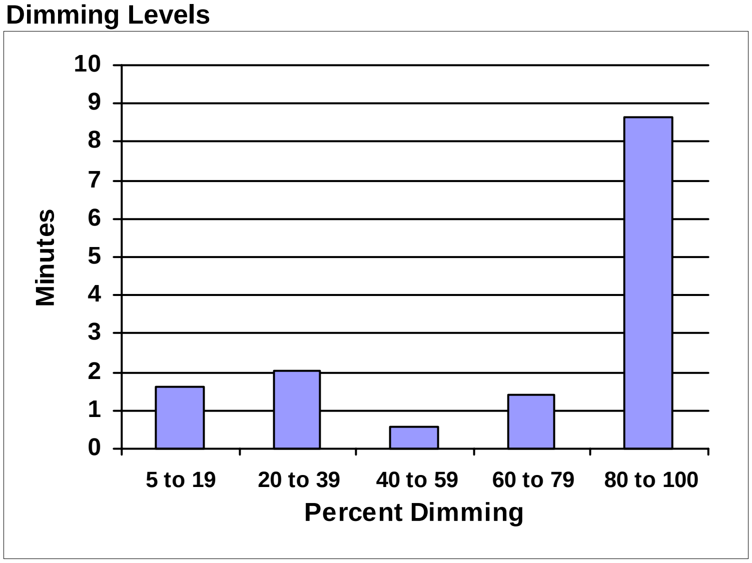
AV Mode



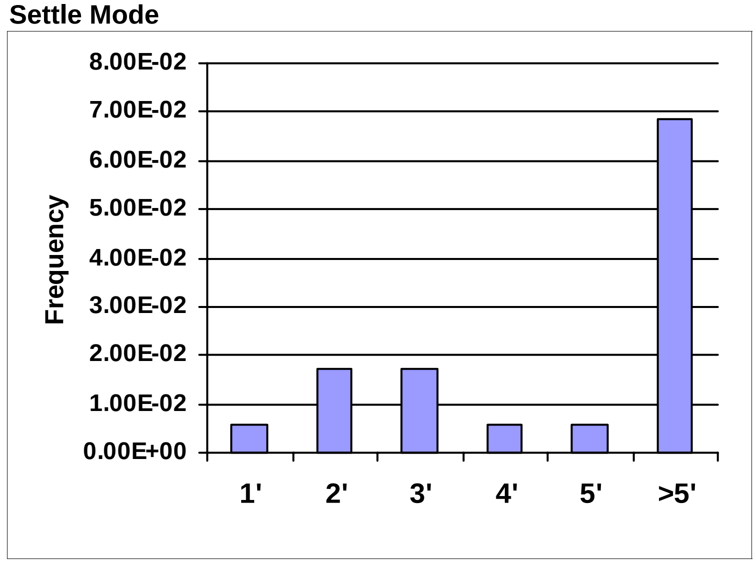
General Mode



Dimming Levels



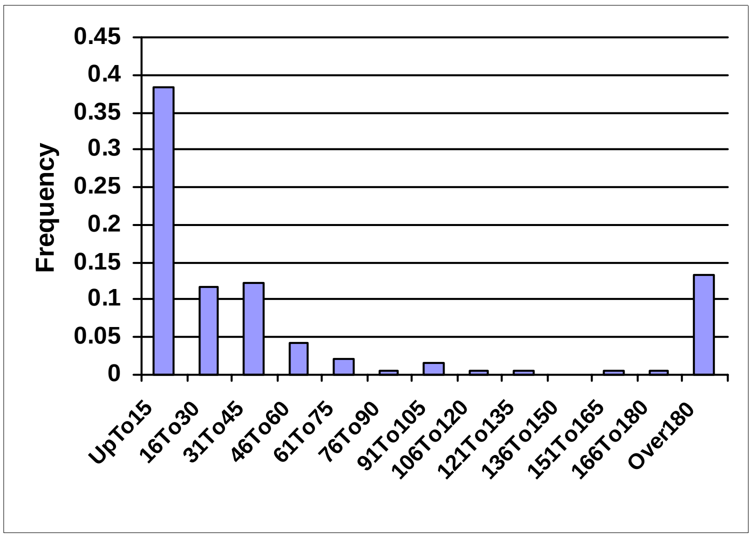
Settle Mode



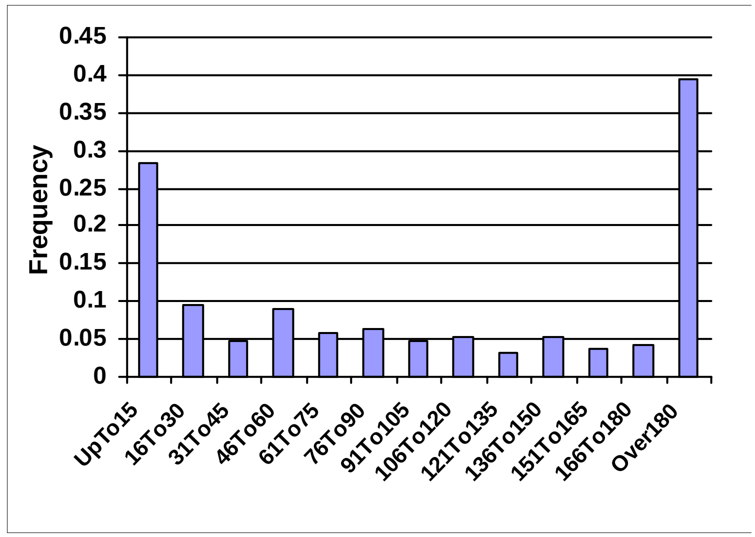
Average Daily Lighting Usage for Hunter High School, Rm 220 (Control) From 9/1/06 To 5/31/07

General AV mode Switches:	2.8	Quiet Time Usage:	0.0
General Mode Time:	538.3	Occupancy Sensor Shutoff Frequency:	0.0
AV mode Time:	29.6	Manual Shutoff Frequency:	0.0
White Board Time:	.0	Lights On:	567.9
Settle Mode Time:	.0	Watts/ sq ft:	1.68
Settle Mode Counts:	0.0	School Days:	188

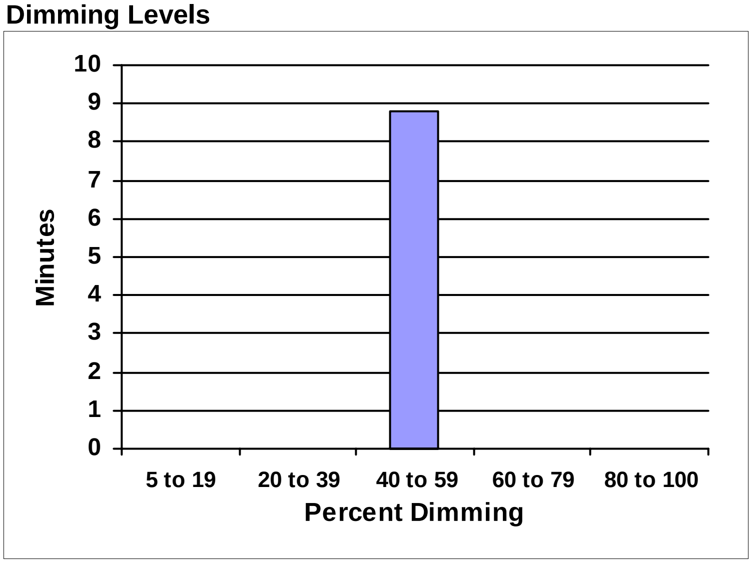
AV Mode



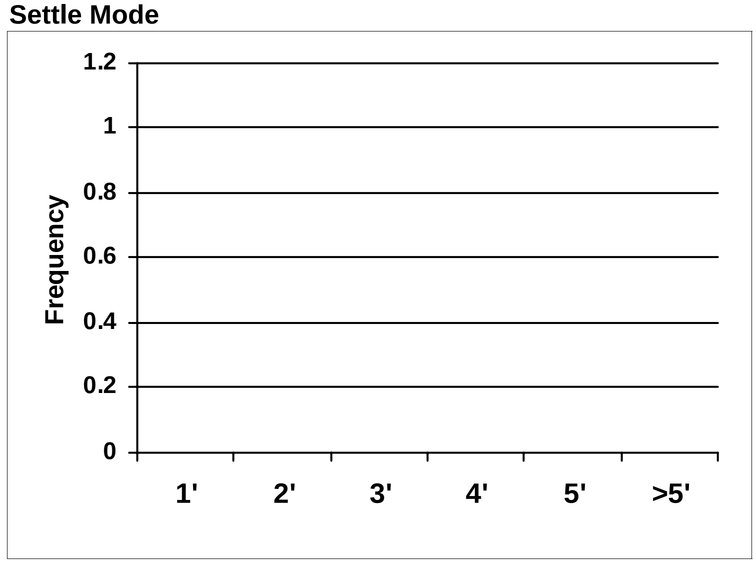
General Mode



Dimming Levels



Settle Mode

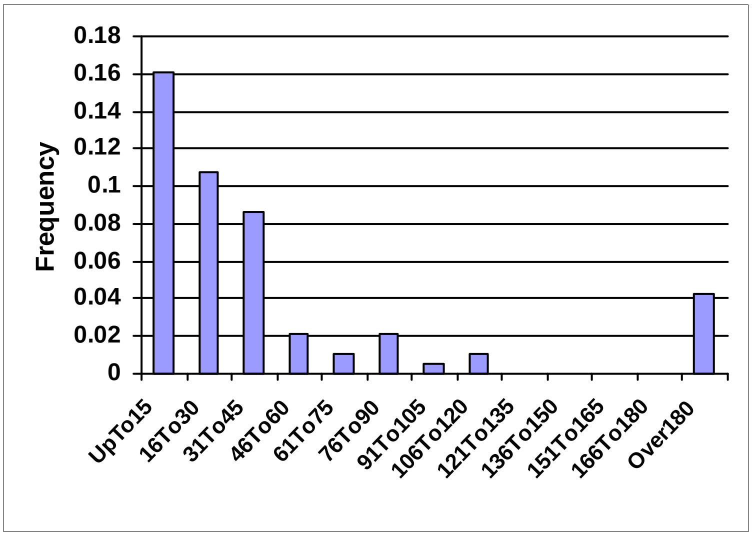


Average Daily Lighting Usage for Hunter High School, Rm 222
From 9/1/06 To 5/31/07

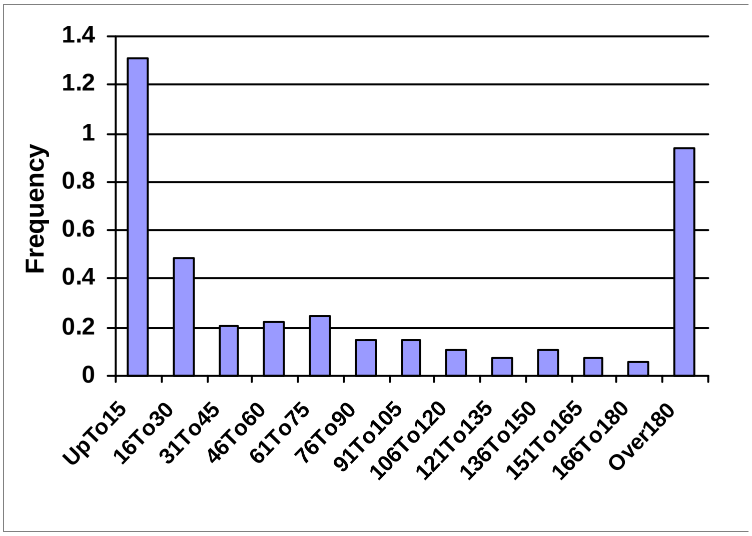
General AV mode Switches: .7
General Mode Time: 462.0
AV mode Time: 32.6
White Board Time: 160.9
Settle Mode Time: 5.7
Settle Mode Counts: 0.2

Quiet Time Usage: 0.1
Occupancy Sensor Shutoff Frequency: 1.4
Manual Shutoff Frequency: 2.8
Lights On: 494.7
Watts/ sq ft: 0.68
School Days: 186

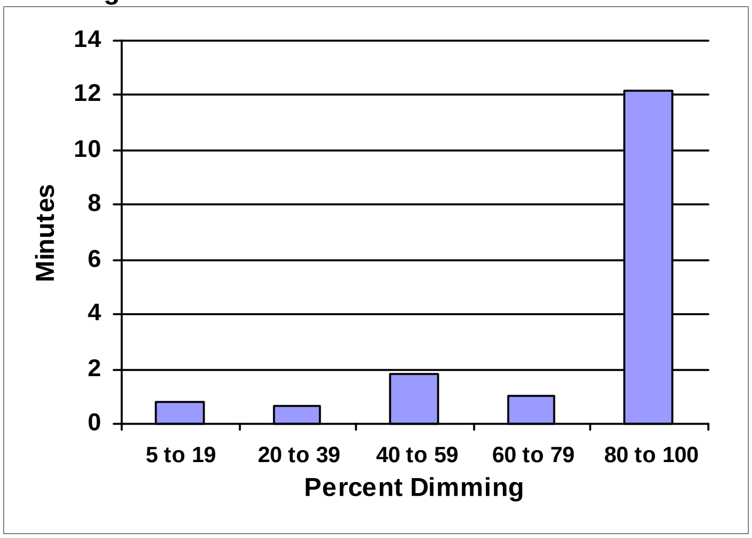
AV Mode



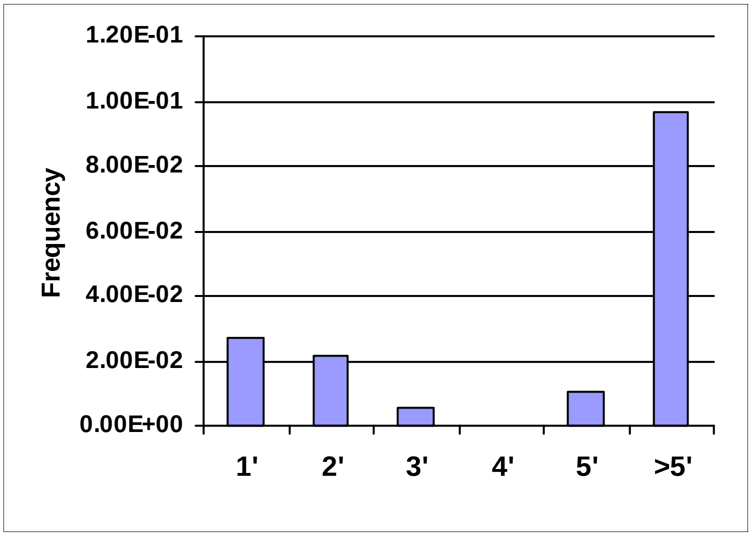
General Mode



Dimming Levels



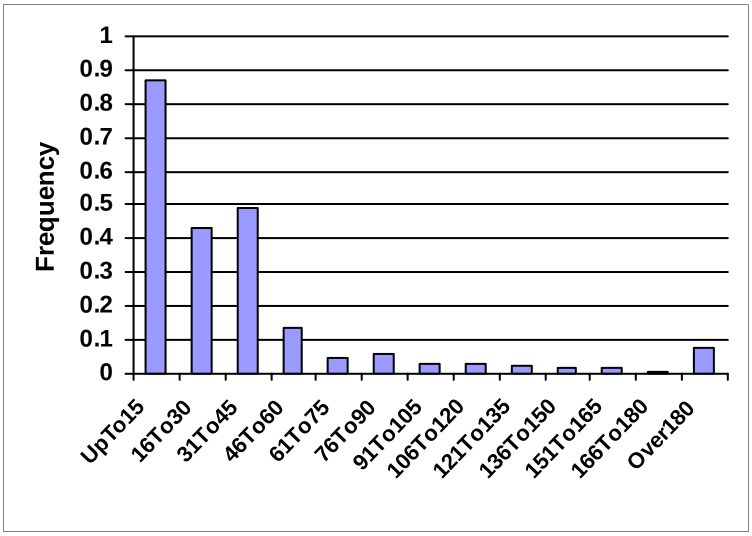
Settle Mode



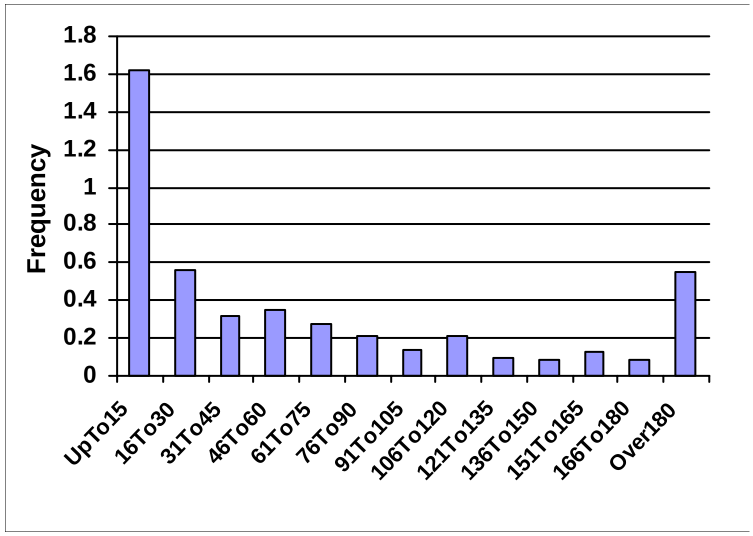
Average Daily Lighting Usage for Hunter High School, Rm 404
From 9/1/06 To 5/31/07

General AV mode Switches:	**2.7**	**Quiet Time Usage:**	**0.3**
General Mode Time:	**364.7**	**Occupancy Sensor Shutoff Frequency:**	**1.5**
AV mode Time:	**91.2**	**Manual Shutoff Frequency:**	**3.1**
White Board Time:	**475.4**	**Lights On:**	**539.2**
Settle Mode Time:	**72.7**	**Watts/ sq ft:**	**0.63**
Settle Mode Counts:	**1.7**	**School Days:**	**180**

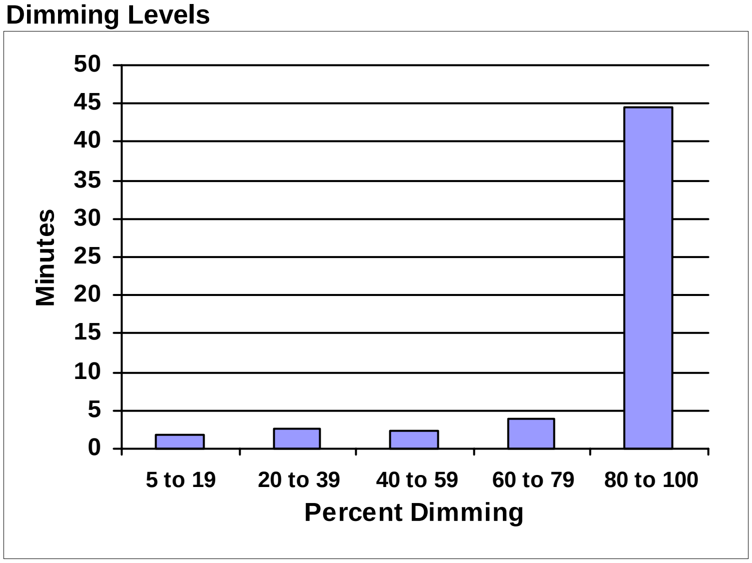
AV Mode



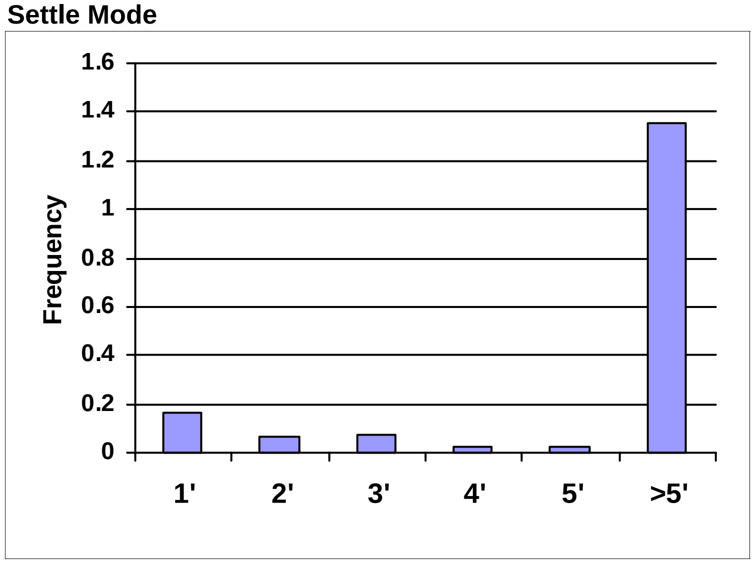
General Mode



Dimming Levels



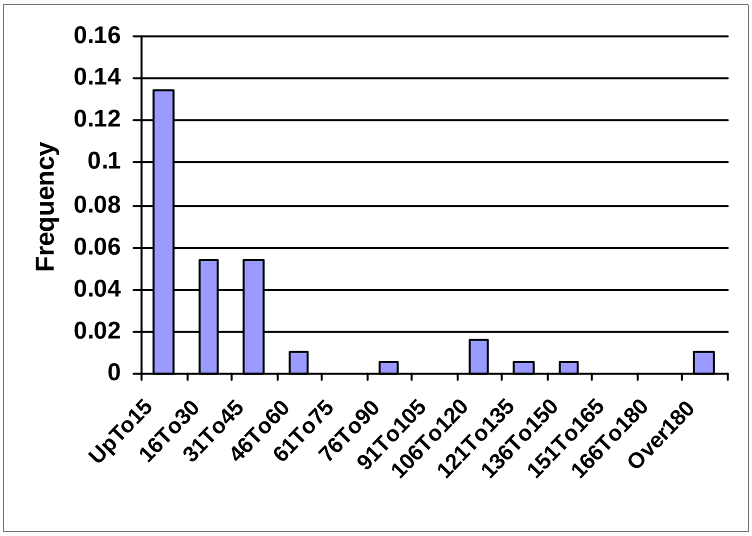
Settle Mode



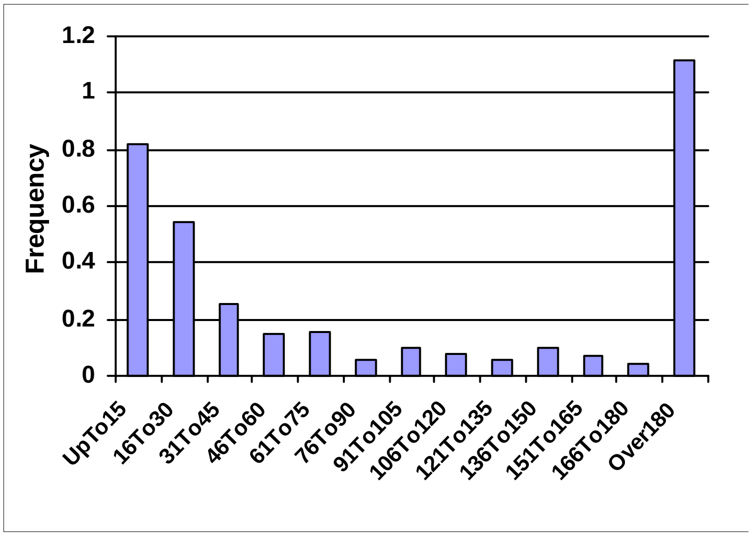
Average Daily Lighting Usage for Hunter High School, Rm 410
From 9/1/06 To 5/31/07

General AV mode Switches:	**.4**	**Quiet Time Usage:**	**0.1**
General Mode Time:	**543.5**	**Occupancy Sensor Shutoff Frequency:**	**2.1**
AV mode Time:	**4.9**	**Manual Shutoff Frequency:**	**1.5**
White Board Time:	**521.1**	**Lights On:**	**548.4**
Settle Mode Time:	**2.3**	**Watts/ sq ft:**	**0.86**
Settle Mode Counts:	**0.1**	**School Days:**	**186**

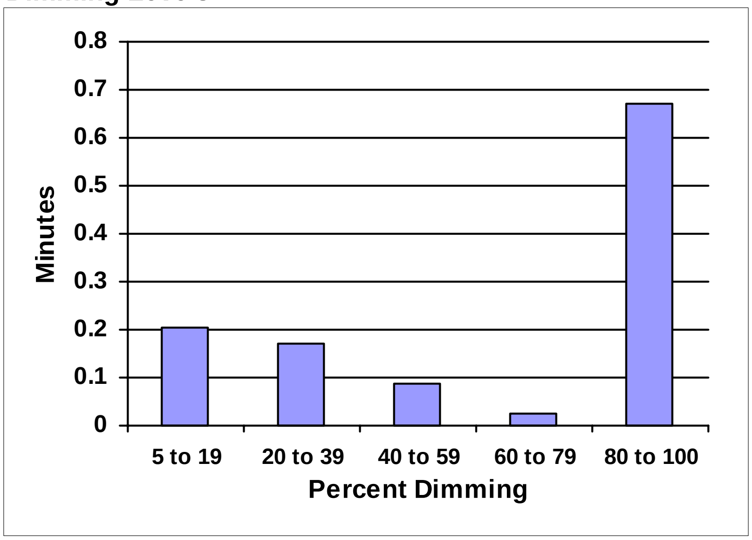
AV Mode



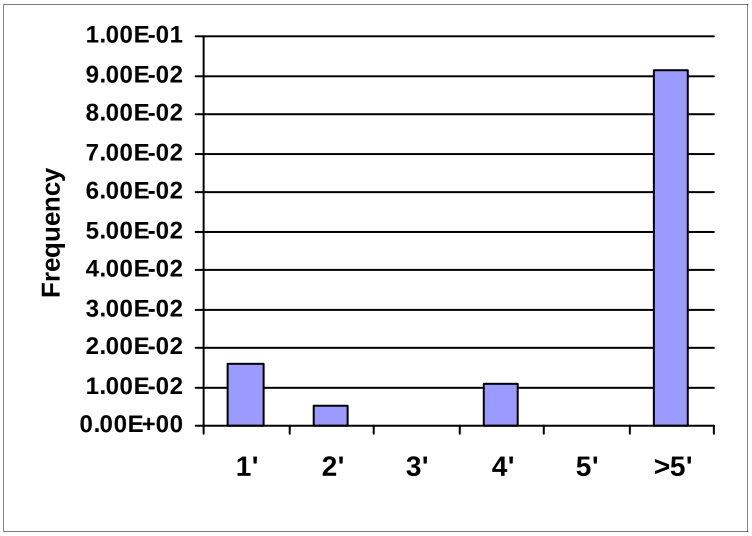
General Mode



Dimming Levels



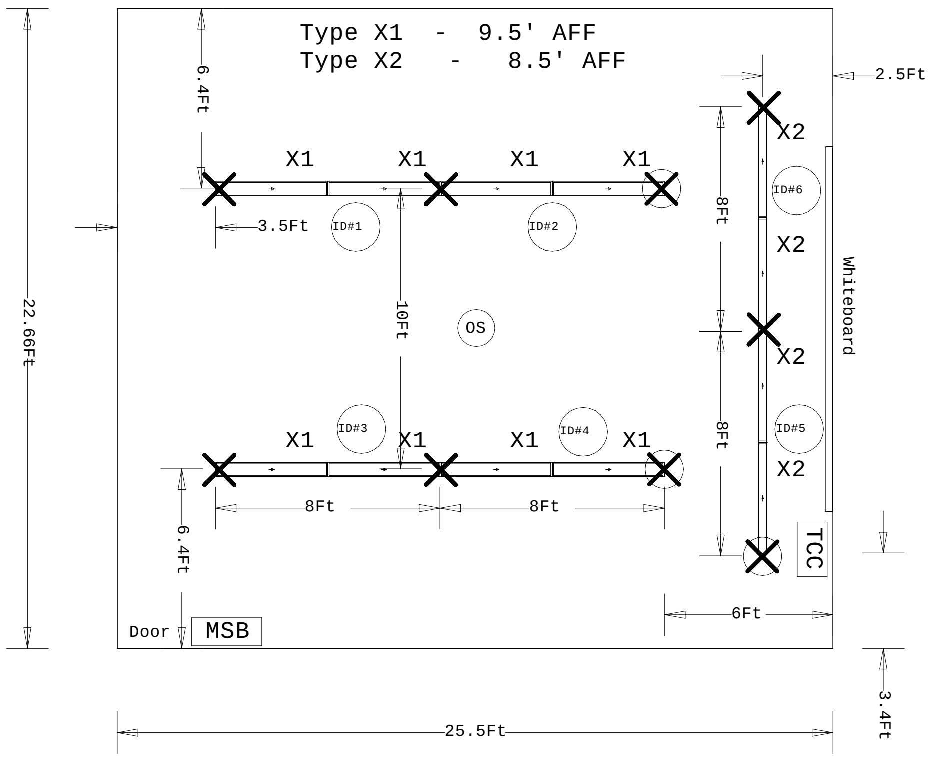
Settle Mode



Appendix I – Scarsdale Public School Information

- Room Dimension and Fixture Layout
- Lighting Layouts and calculations
- Energy Consumption Chart
- Data Summary Table
- Average Daily Lighting Usage Report

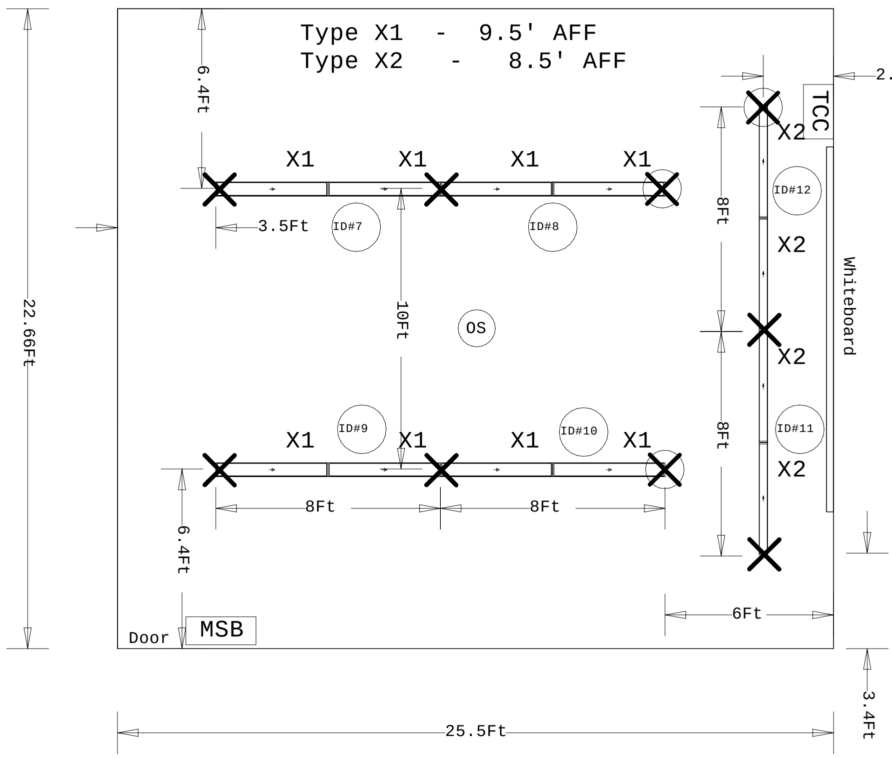
Scarsdale Room 305
Installation Dimensions **



LEGEND	
TCC	Teacher Control Center mounting location: 4'-0" AFF (to top of box). Install on the left side of whiteboard/chalkboard
OS	Occupancy Sensor(s)
X	Suspension Point
⊗	Power Feed & Suspension Point (Pre-existing power feed points could affect changes to feed points)
ID# 1	Fixture ID#. Each fixture section will have a label with a unique ID# which can be found on the outside of the box and on the fixture itself.
MSB	Master Switch Bank -- Locate MSB on wall at entrance(s) to room. Exact location to be determined on-site.

** Site conditions could influence fixture placement and suspension. All fixtures to be mounted "on-grid" (if ceiling is grid type) therefore the attached dimensional information is approximate. The spacing between rows is the most important dimension to maintain.

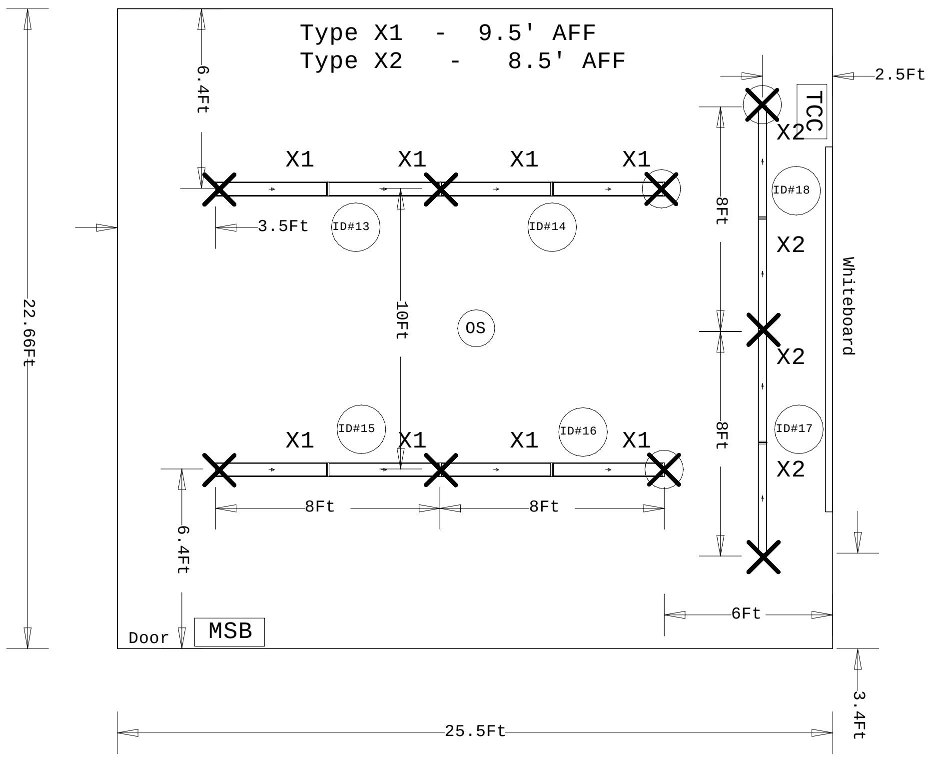
Scarsdale Room 307
Installation Dimensions **



LEGEND	
TCC	Teacher Control Center mounting location: 4'-0" AFF (to top of box). Install on the left side of whiteboard/chalkboard
OS	Occupancy Sensor(s)
	Suspension Point
	Power Feed & Suspension Point (Pre-existing power feed points could affect changes to feed points)
ID# 1	Fixture ID#. Each fixture section will have a label with a unique ID# which can be found on the outside of the box and on the fixture itself.
MSB	Master Switch Bank -- Locate MSB on wall at entrance(s) to room. Exact location to be determined on-site.

** Site conditions could influence fixture placement and suspension. All fixtures to be mounted "on-grid" (if ceiling is grid type) therefore the attached dimensional information is approximate. The spacing between rows is the most important dimension to maintain.

Scarsdale Room 309
Installation Dimensions **

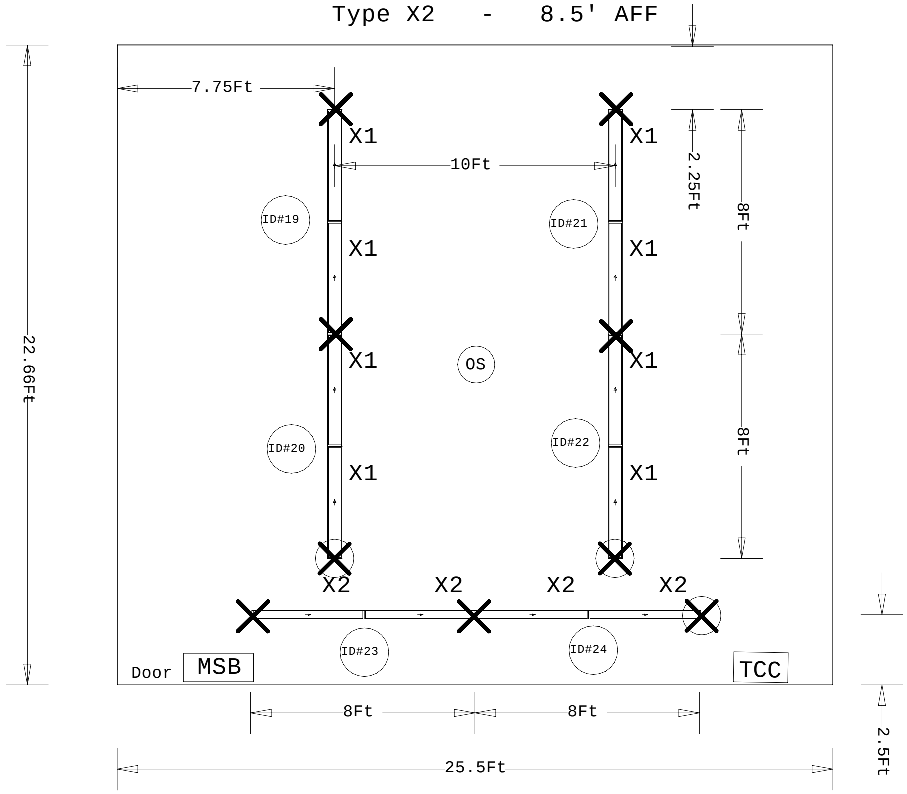


LEGEND	
TCC	Teacher Control Center mounting location: 4'-0" AFF (to top of box). Install on the left side of whiteboard/chalkboard
OS	Occupancy Sensor(s)
	Suspension Point
	Power Feed & Suspension Point (Pre-existing power feed points could affect changes to feed points)
ID# 1	Fixture ID#. Each fixture section will have a label with a unique ID# which can be found on the outside of the box and on the fixture itself.
MSB	Master Switch Bank -- Locate MSB on wall at entrance(s) to room. Exact location to be determined on-site.

** Site conditions could influence fixture placement and suspension. All fixtures to be mounted "on-grid" (if ceiling is grid type) therefore the attached dimensional information is approximate. The spacing between rows is the most important dimension to maintain.

Scarsdale Room 311
Installation Dimensions **

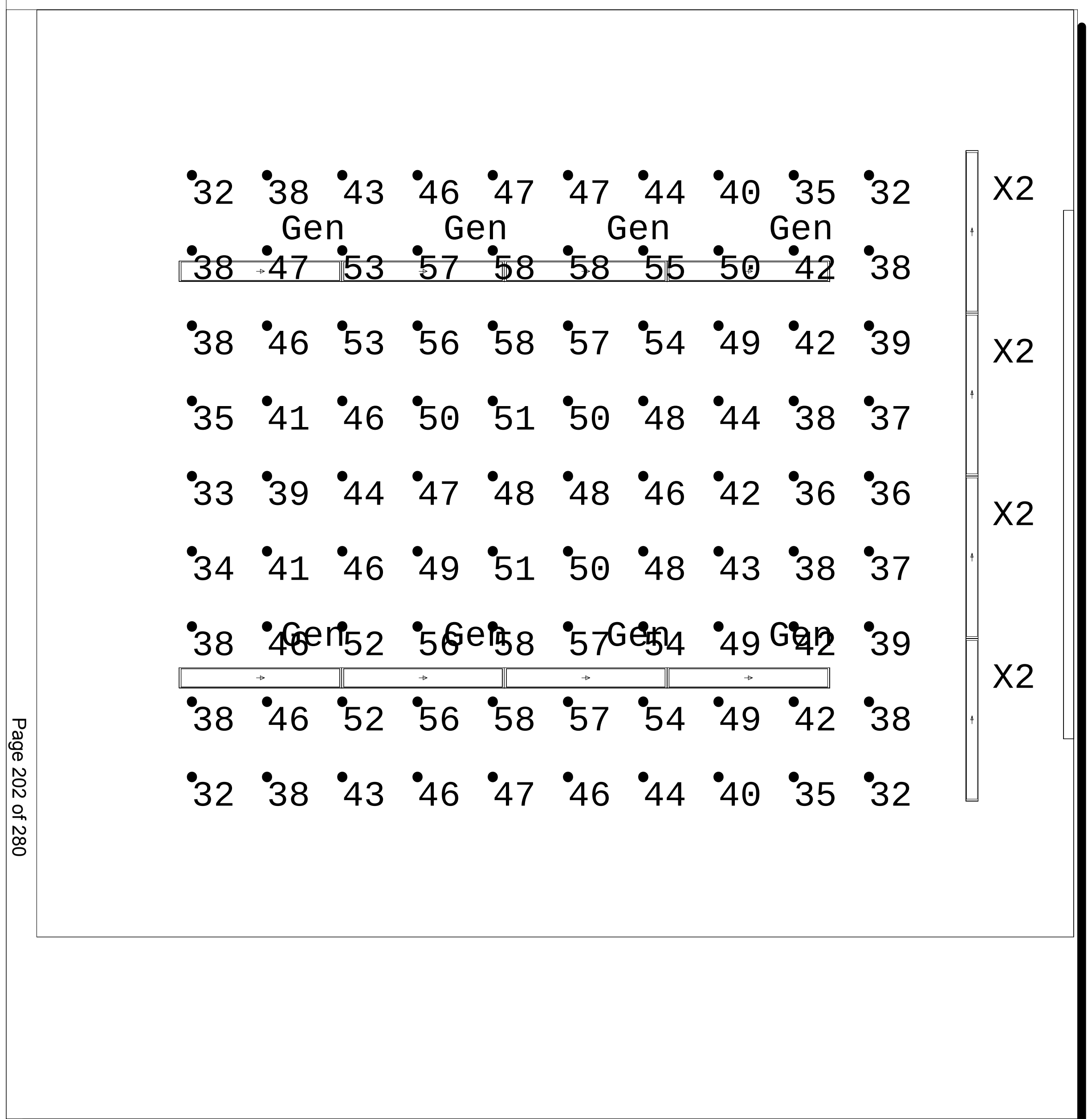
Type X1 - 9.5' AFF
Type X2 - 8.5' AFF



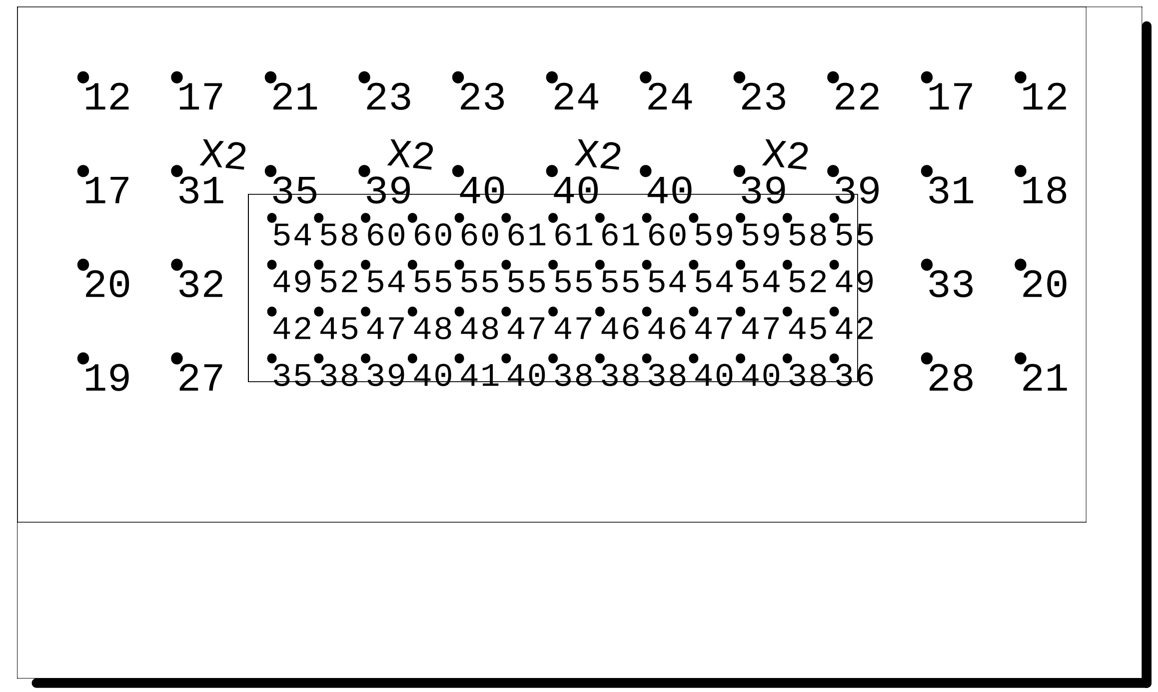
LEGEND	
TCC	Teacher Control Center mounting location: 4'-0" AFF (to top of box). Install on the left side of whiteboard/chalkboard
OS	Occupancy Sensor(s)
X	Suspension Point
(X)	Power Feed & Suspension Point (Pre-existing power feed points could affect changes to feed points)
ID# 1	Fixture ID#. Each fixture section will have a label with a unique ID# which can be found on the outside of the box and on the fixture itself.
MSB	Master Switch Bank -- Locate MSB on wall at entrance(s) to room. Exact location to be determined on-site.

** Site conditions could influence fixture placement and suspension. All fixtures to be mounted "on-grid" (if ceiling is grid type) therefore the attached dimensional information is approximate. The spacing between rows is the most important dimension to maintain.

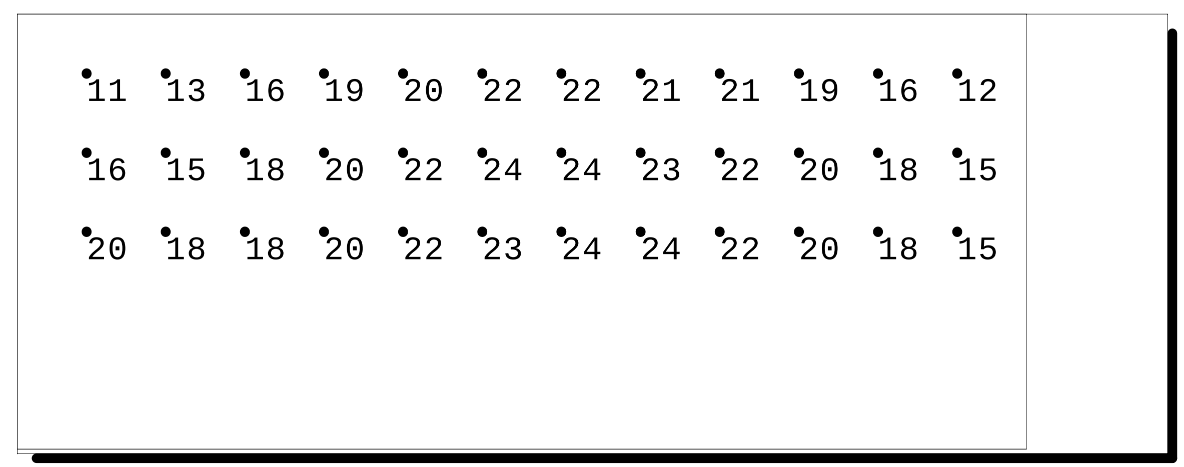
GENERAL MODE



Teaching Wall



South Wall



Luminaire Schedule									
Project: Scarsdale, Senior High, Room 305 TYPICAL									
Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	4	X2	3100	1.026	SX2 WCB 1T8 96W	1.2	38	0.9	0.95
	8	Gen	3100	0.667	X1 PLV CCO 2T8 EP	0.78	48	0.9	0.95

Numeric Summary							
Project: Scarsdale, Senior High, Room 305 TYPICAL							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Chalkboard	Illuminance	Fc	49.17	61	35	1.40	1.74
Teaching Wall	Illuminance	Fc	26.23	40	12	2.19	3.33
South Wall	Illuminance	Fc	19.25	24	11	1.75	2.18
Horizontal WP	Illuminance	Fc	45.24	58	32	1.41	1.81

Room Summary		
Project: Scarsdale, Senior High, Room 305 TYPICAL		
Label	Wall Ht.	Description
Room 305 Typical	11	25.5' x 22.8', 80/50/20 Reflect.

LPD Area Summary			
Project: Scarsdale, Senior High, Room 305 TYPICAL			
Label	Area	Total Watts	LPD
Room 305, Typical	581.53	536	0.922

SX1 luminaires 9.5' AFF; X2 luminaire is 8.5' AFF. Calculations based on Osram .78 QHE Instant Start Ballasts on outboard lamps and Osram Powersense Dimming Ballasts on the center lamps. QHE 1.2 BF IS ballast on Type X2.

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

PHOTOMETRIC DATA USED AS INPUT FOR THESE CALCULATIONS IS BASED ON ESTABLISHED IES PROCEDURES AND PUBLISHED LAMP & BALLAST RATINGS. FIELD PERFORMANCE WILL DEPEND ON ACTUAL LAMP, BALLAST, ELECTRICAL AND SITE CHARACTERISTICS.

VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT 30" ABOVE FINISHED FLOOR.
AGI32 VERSION 1.8

FINELITE
Better Lighting for a Better Workplace

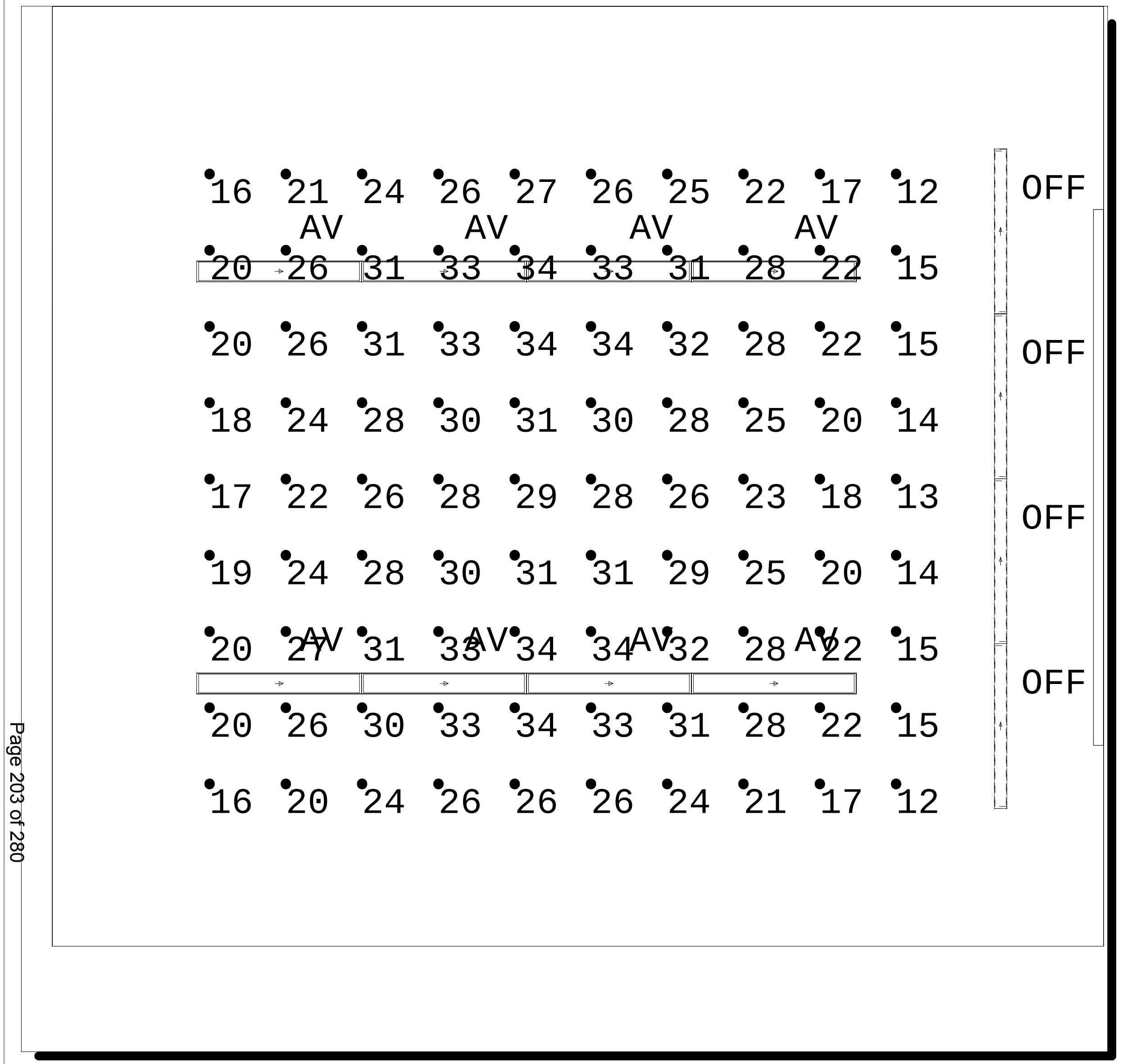
Revisions		
#	Date	Comments

Drawn By: V Lauck
Date: April, 2006

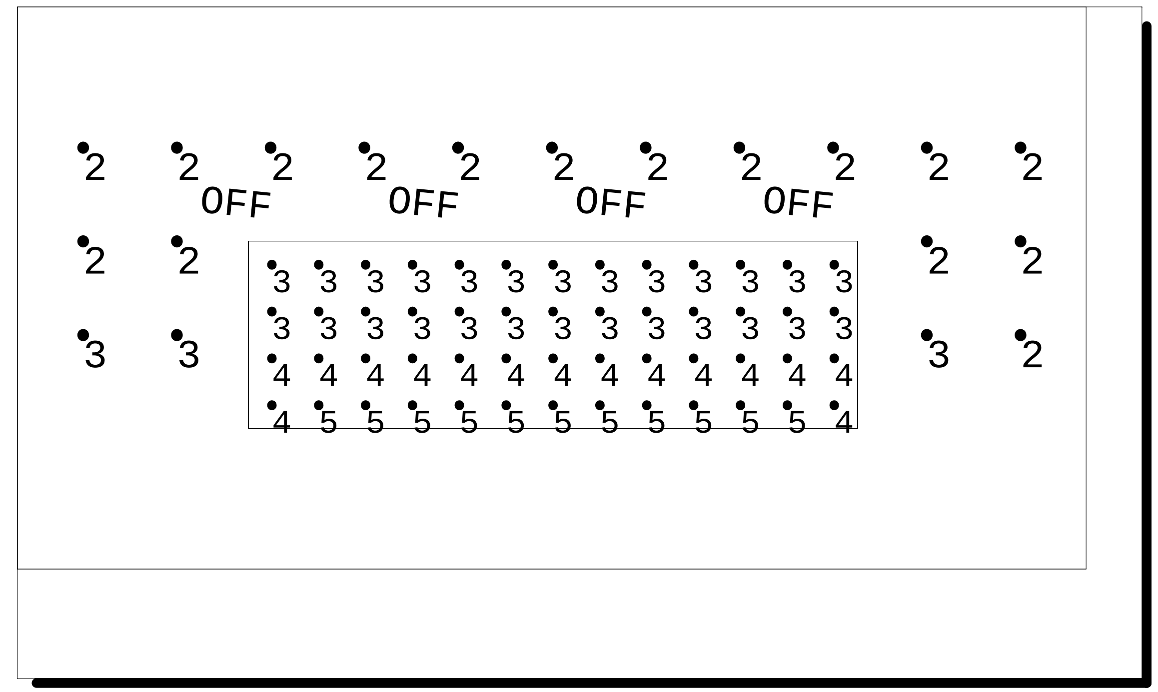
Project: NYSERDA
Scarsdale, SH, Rm 305, TYPICAL

Page 1 of 1

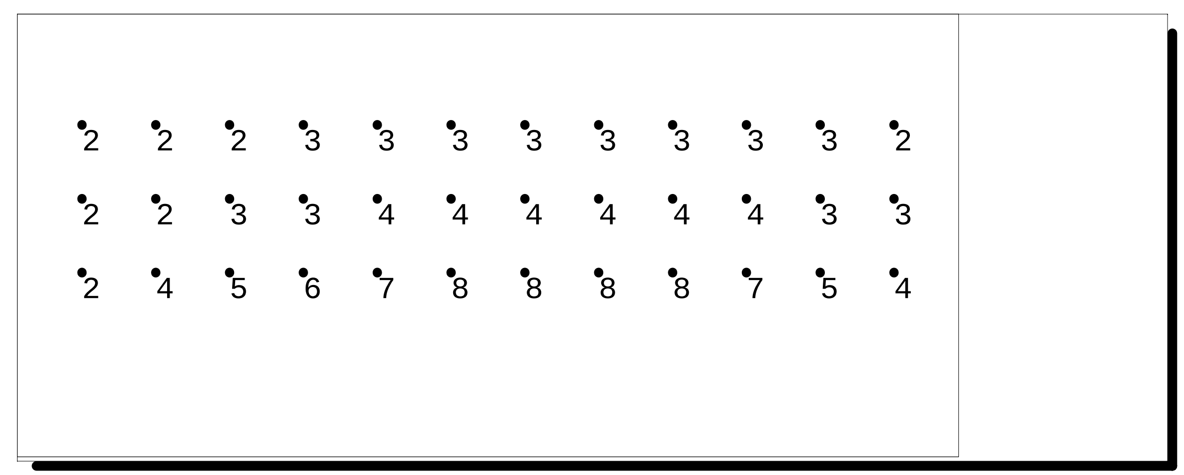
AV MODE



Teaching Wall



South Wall



Luminaire Schedule									
Project: Scarsdale, Senior High, Room 205 TYPICAL									
Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	8	AV	3100	0.752	X1 PLV COO 1T8 EP	0.88	30	0.9	0.95
	4	OFF	3100	1.026	SX2 WCB 1T8 96W	1.2	38	0.9	0.95

Numeric Summary							
Project: Scarsdale, Senior High, Room 205 TYPICAL							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Chalkboard	Illuminance	Fc	3.71	5	3	1.24	1.67
Teaching Wall	Illuminance	Fc	2.16	3	2	1.08	1.50
South Wall	Illuminance	Fc	4.00	8	2	2.00	4.00
Horizontal WP	Illuminance	Fc	25.03	34	12	2.09	2.83

Room Summary		
Project: Scarsdale, Senior High, Room 205 TYPICAL		
Label	Wall Ht.	Description
Room 205, Typical	12	25.5' x 22.8', 80/50/20 Reflect.

LPD Area Summary			
Project: Scarsdale, Senior High, Room 205 TYPICAL			
Label	Area	Total Watts	LPD
Room 205, Typical	581.53	240	0.413

SX1 luminaires 9.5' AFF; X2 luminaire is 8.5' AFF. Calculations based on Osram .78 QHE Instant Start Ballasts on outboard lamps and Osram Powersense Dimming Ballasts on the center lamps.

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

PHOTOMETRIC DATA USED AS INPUT FOR THESE CALCULATIONS IS BASED ON ESTABLISHED IES PROCEDURES AND PUBLISHED LAMP & BALLAST RATINGS. FIELD PERFORMANCE WILL DEPEND ON ACTUAL LAMP, BALLAST, ELECTRICAL AND SITE CHARACTERISTICS.

VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT 30" ABOVE FINISHED FLOOR.
AGI32 VERSION 1.8

FINELITE
Better Lighting for a Better Workplace

Revisions		
#	Date	Comments

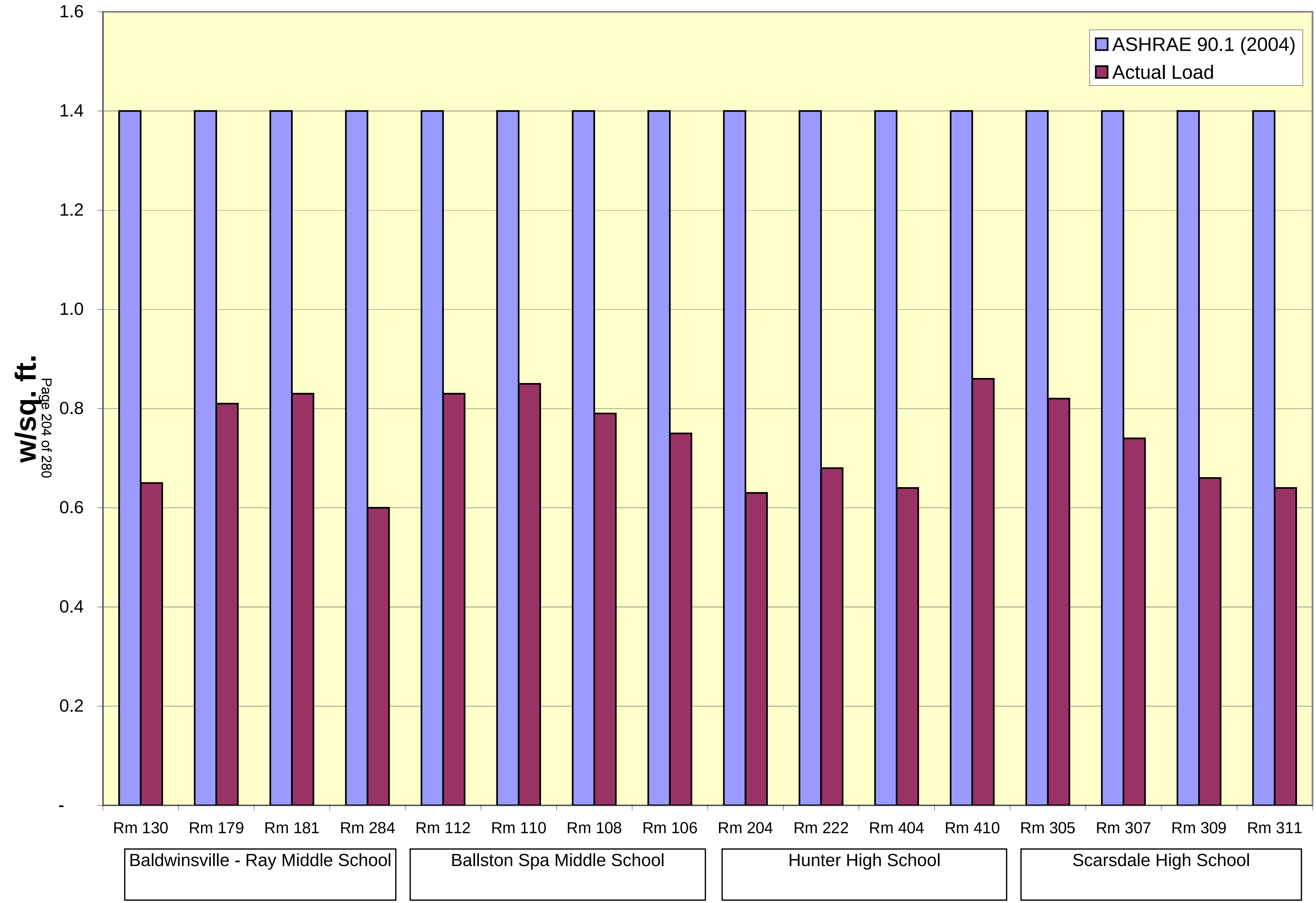
Drawn By: V Lauck
Date: April, 2006

Project: NYSERDA
Scarsdale, SH, Rm 305 TYPICAL

Energy Consumption by Classroom - K12

NYSERDA Classroom Lighting System

Sep 2006 - May 2007



Data Summary

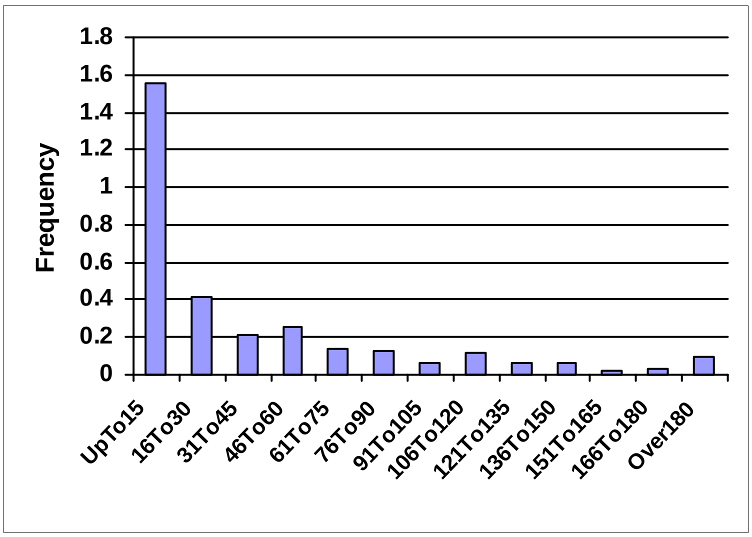
Scarsdale Public Schools

Classroom	Date	AV Gen Switches	AV Use (#/Day)	WB Use (#/Day)	General Total Min	White Board Total Min	AV Total Min	Settle Time	Settle Count	Quiet Count	Occ Sensor Shut Off	Manual Shut Off	Lights On Total	Watts/ sq ft	kWh
311	5/5/07	0	0	3	408	408	0	0		0	1	2	408	0.92	3.60
	5/7/07	3	2	4	213	213	68	0		0	1	2	281	0.73	1.98
	5/8/07	8	5	7	170	180	134	10	1	0	0	4	304	0.57	1.67
	5/9/07	6	3	6	165	173	19	8	1	1	0	4	184	0.87	1.54
	5/10/07	8	4	7	240	240	39	0		0	0	3	279	0.83	2.23
	5/11/07	4	3	3	264	145	27	0		0	3	4	291	0.76	2.13
	5/14/07	1	1		273	0	11	0		0	2	1	284	0.65	1.79
	5/15/07	5	3	5	137	137	87	0		0	0	3	224	0.62	1.33
	5/16/07	1	2	4	169	173	20	4	1	0	1	4	189	0.86	1.57
	5/17/07	1	1	4	495	549	55	54	1	1	1	2	550	0.88	4.67
	5/18/07	0	0	4	140	140	0	0		0	0	4	140	0.95	1.28
	5/21/07	8	4	6	267	248	86	0		1	1	2	353	0.73	2.47
	5/22/07	2	1	3	318	161	13	0		0	1	2	331	0.78	2.50
	5/23/07	7	4	3	91	92	42	5	1	0	1	2	133	0.68	0.88
	5/24/07	10	7	8	147	163	210	16	3	0	0	3	357	0.46	1.58
	5/25/07	0	2		0	0	70	0		1	0	2	70	0.09	0.06
	5/26/07	0	1		0	0	6	0		0	0	1	6	0.09	0.01
	5/29/07	7	4	6	183	183	79	0		0	0	3	262	0.69	1.73
	5/30/07	3	2	4	162	172	20	10	1	0	0	3	182	0.87	1.53
	5/31/07	2	1	1	112	97	69	0		0	0	3	181	0.60	1.04
(Control) 405	10/3/06	0	0		403	0	0	0		0	0	0	403	1.80	7.00
	10/4/06	0	0		372	0	0	0		0	0	0	372	1.80	6.44
	10/5/06	0	0		439	0	0	0		0	0	0	439	1.80	7.61
	10/6/06	0	0		309	0	0	0		0	0	0	309	1.82	5.40
	10/10/06	0	0		399	0	0	0		0	0	0	399	1.80	6.93
	10/11/06	0	0		778	0	0	0		0	0	0	778	1.81	13.58
	10/12/06	0	0		462	0	0	0		0	0	0	462	1.81	8.06
	10/13/06	0	0		541	0	0	0		0	0	0	541	1.80	9.40
	10/16/06	0	0		410	0	0	0		0	0	0	410	1.79	7.08
	10/17/06	0	0		453	0	0	0		0	0	0	453	1.81	7.89
	10/18/06	0	0		925	0	0	0		0	0	0	925	1.79	15.99
	10/19/06	0	0		1295	0	0	0		0	0	0	1295	1.80	22.48
	10/20/06	0	0		238	0	0	0		0	0	0	238	1.81	4.15
	10/23/06	0	0		489	0	0	0		0	0	0	489	1.81	8.51
	10/24/06	0	0		304	0	0	0		0	0	0	304	1.81	5.30
	10/25/06	0	0		399	0	0	0		0	0	0	399	1.80	6.93
	10/26/06	0	0		490	0	0	0		0	0	0	490	1.80	8.50
	10/27/06	0	0		266	0	0	0		0	0	0	266	1.80	4.60

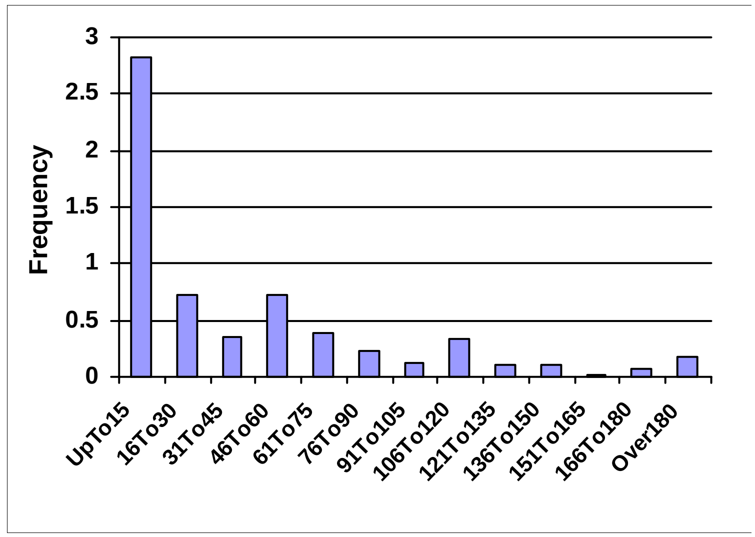
Average Daily Lighting Usage for Scarsdale Public Schools, Rm 305 From 9/1/06 To 5/31/07

General AV mode Switches:	3.3	Quiet Time Usage:	0.2
General Mode Time:	271.1	Occupancy Sensor Shutoff Frequency:	0.6
AV mode Time:	133.9	Manual Shutoff Frequency:	5.8
White Board Time:	1.5	Lights On:	271.5
Settle Mode Time:	.4	Watts/ sq ft:	0.84
Settle Mode Counts:	0.0	School Days:	167

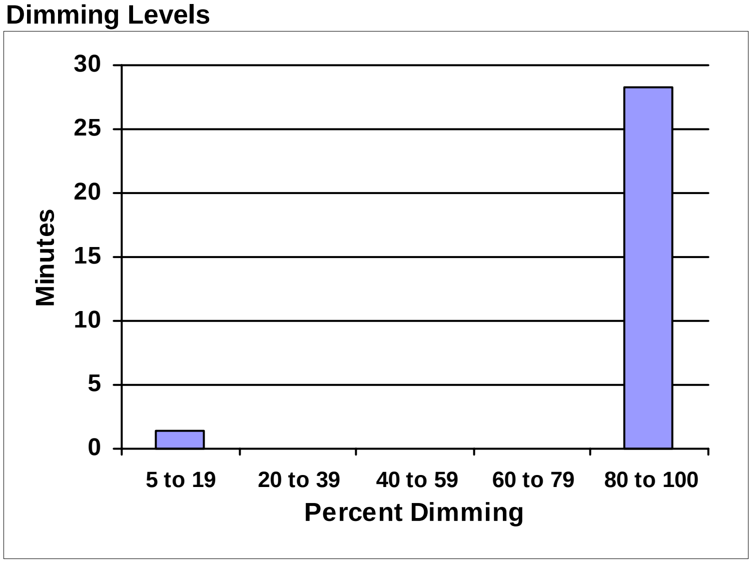
AV Mode



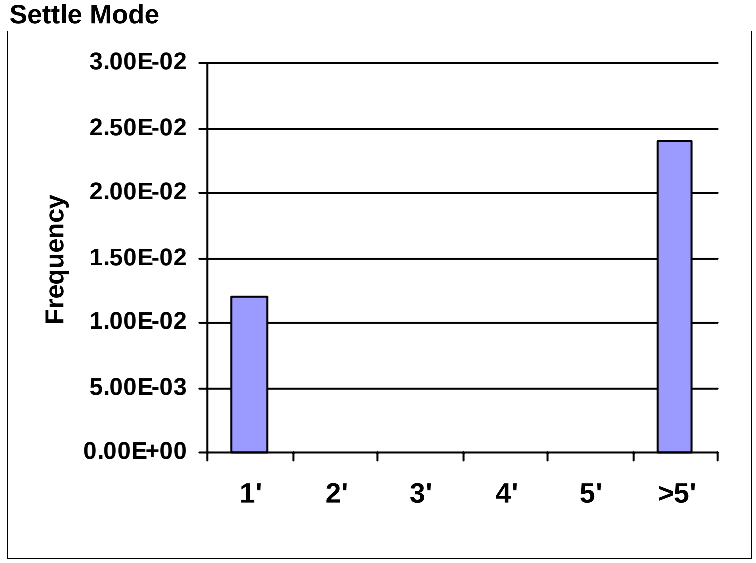
General Mode



Dimming Levels



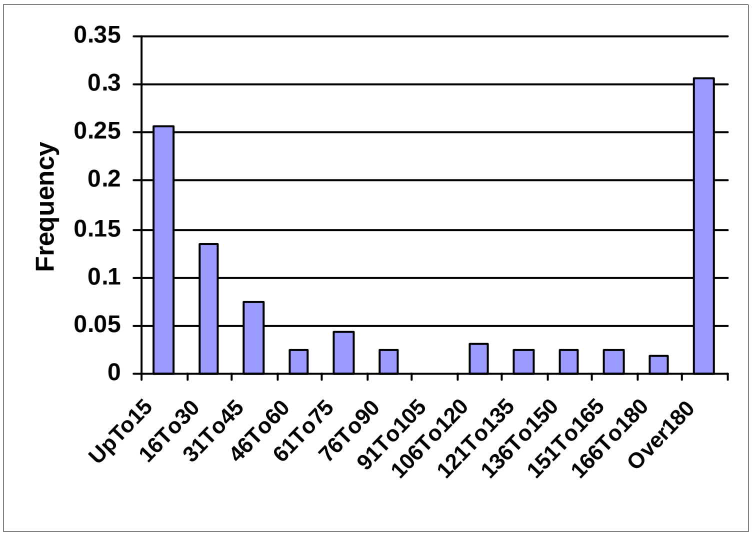
Settle Mode



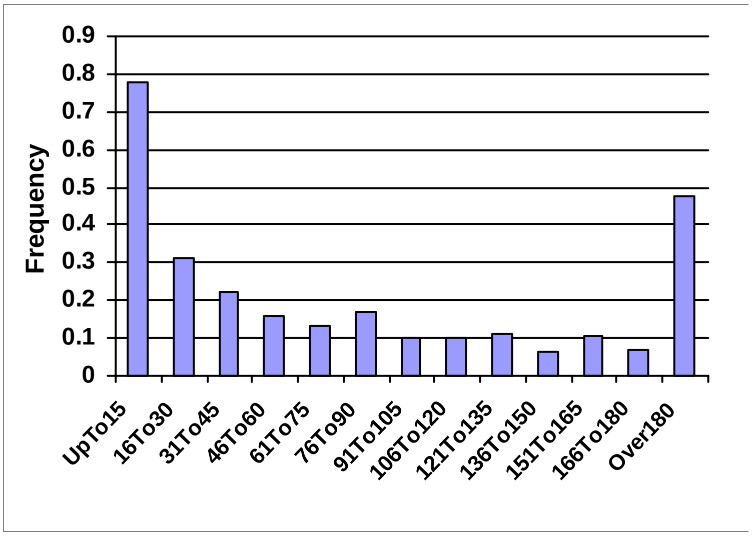
Average Daily Lighting Usage for Scarsdale Public Schools, Rm 307 From 9/1/06 To 5/31/07

General AV mode Switches:	**.7**	**Quiet Time Usage:**	**0.1**
General Mode Time:	**302.9**	**Occupancy Sensor Shutoff Frequency:**	**1.1**
AV mode Time:	**168.5**	**Manual Shutoff Frequency:**	**2.1**
White Board Time:	**276.9**	**Lights On:**	**471.4**
Settle Mode Time:	**71.5**	**Watts/ sq ft:**	**0.73**
Settle Mode Counts:	**0.5**	**School Days:**	**163**

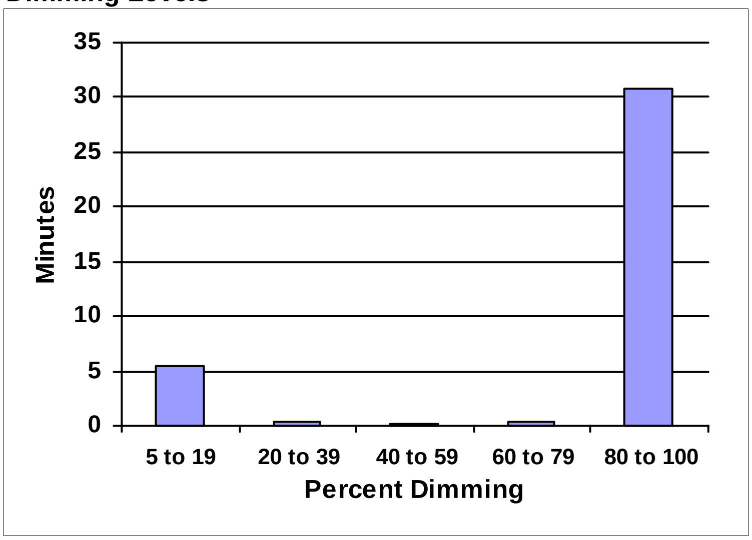
AV Mode



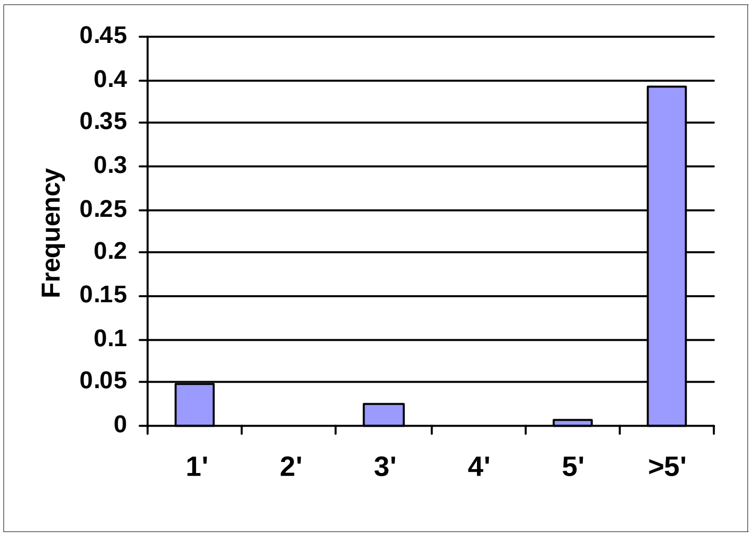
General Mode



Dimming Levels



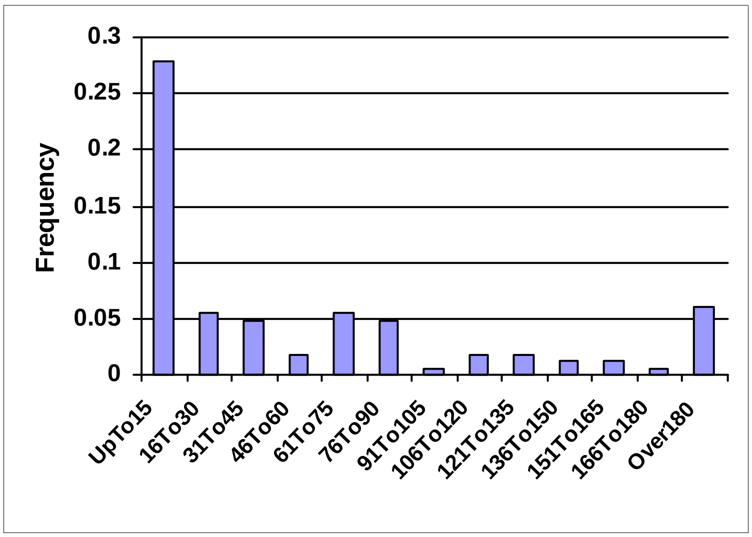
Settle Mode



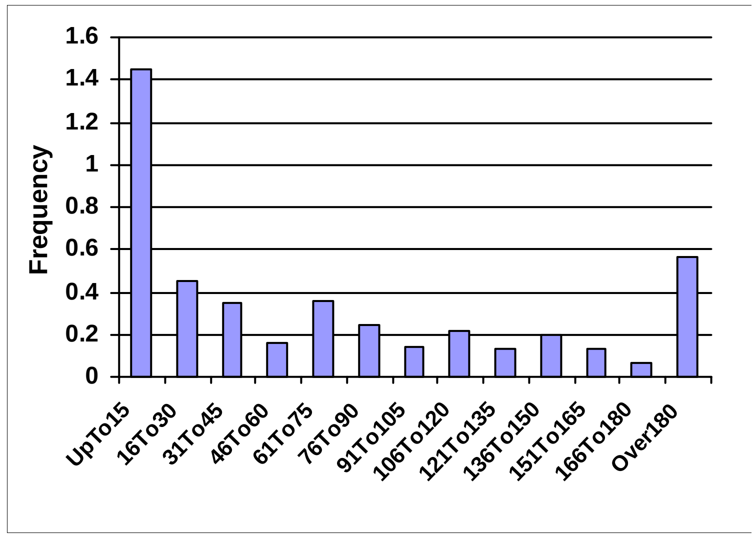
Average Daily Lighting Usage for Scarsdale Public Schools, Rm 309 From 9/1/06 To 5/31/07

General AV mode Switches:	.5	Quiet Time Usage:	0.4
General Mode Time:	343.0	Occupancy Sensor Shutoff Frequency:	2.2
AV mode Time:	37.7	Manual Shutoff Frequency:	2.6
White Board Time:	15.9	Lights On:	380.7
Settle Mode Time:	3.0	Watts/ sq ft:	0.67
Settle Mode Counts:	0.1	School Days:	165

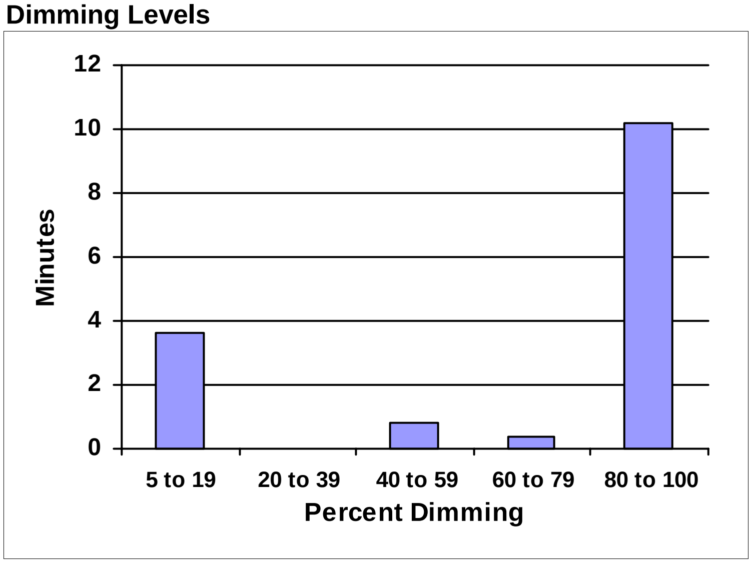
AV Mode



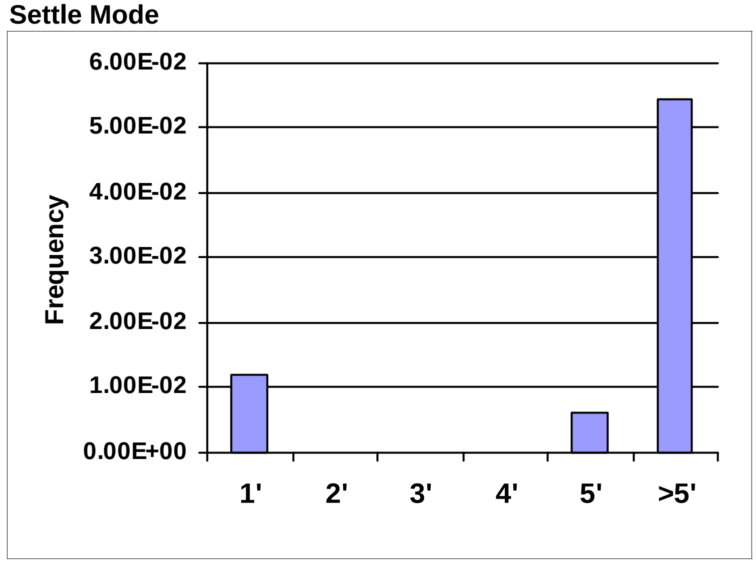
General Mode



Dimming Levels



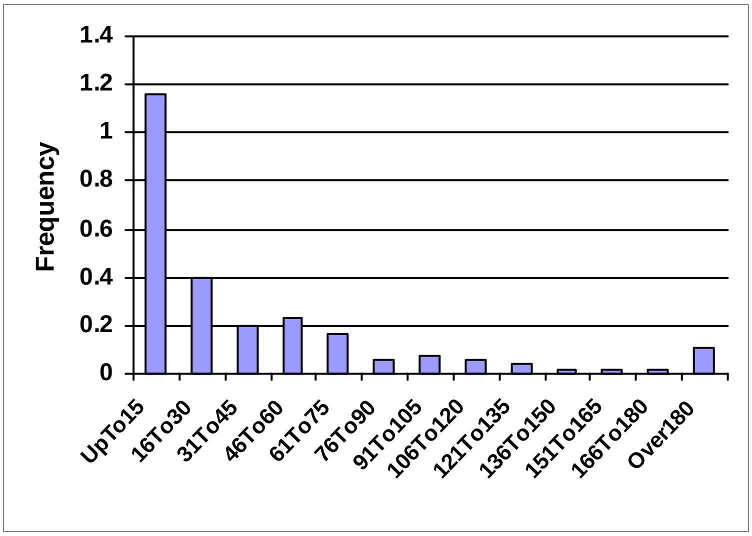
Settle Mode



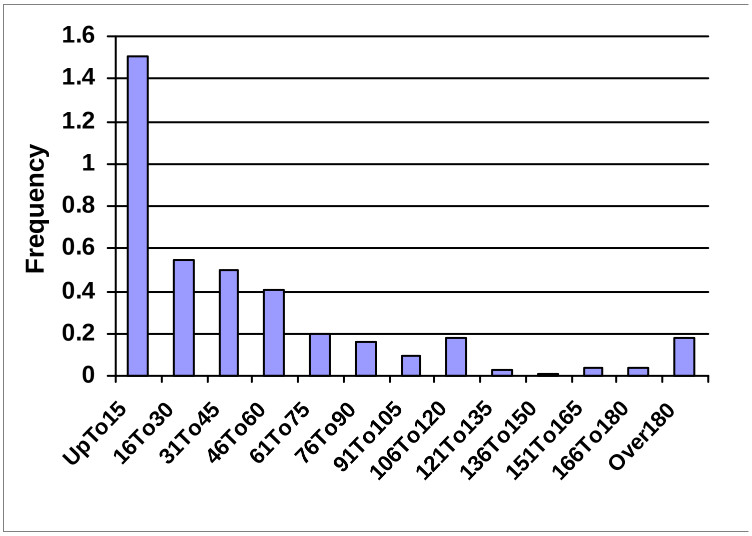
Average Daily Lighting Usage for Scarsdale Public Schools, Rm 311
From 9/1/06 To 5/31/07

General AV mode Switches:	3.0	Quiet Time Usage:	0.6
General Mode Time:	190.3	Occupancy Sensor Shutoff Frequency:	0.6
AV mode Time:	113.5	Manual Shutoff Frequency:	3.5
White Board Time:	108.4	Lights On:	303.7
Settle Mode Time:	20.9	Watts/ sq ft:	0.63
Settle Mode Counts:	0.8	School Days:	165

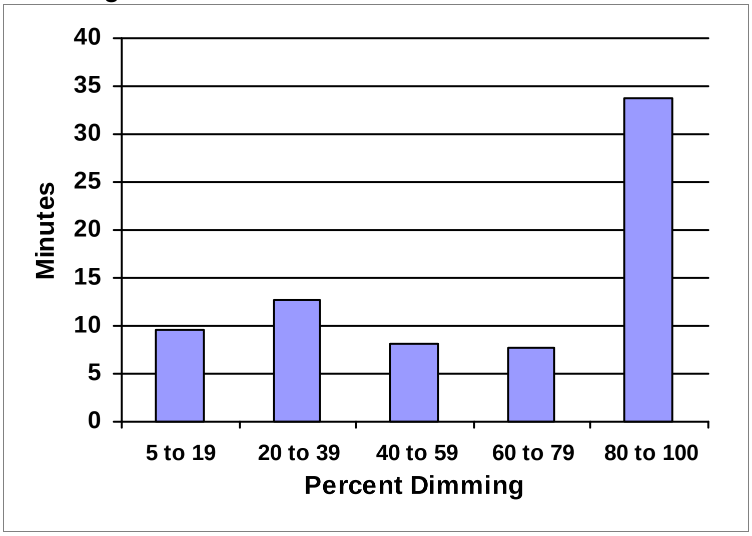
AV Mode



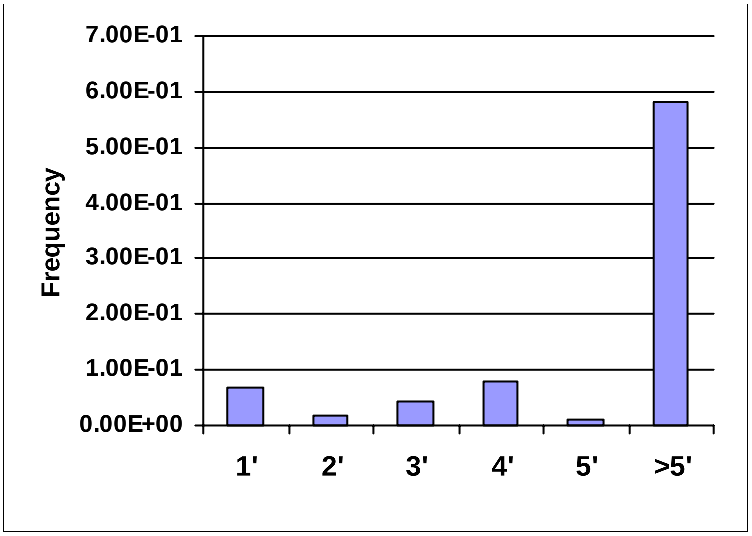
General Mode



Dimming Levels



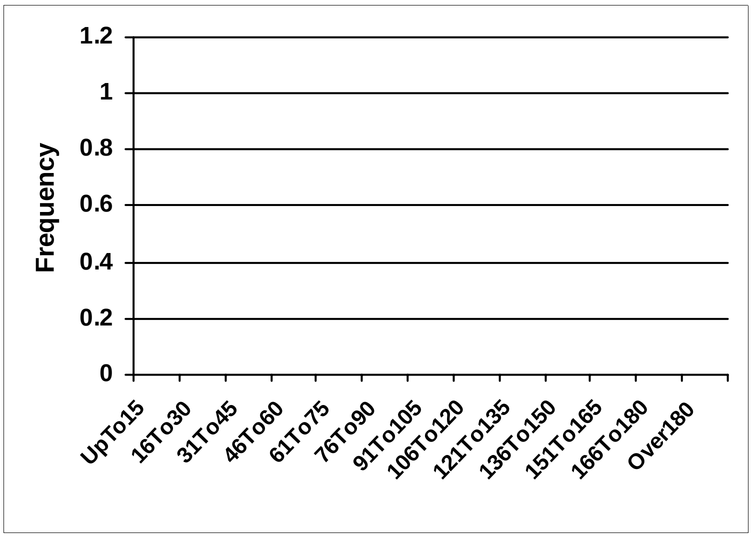
Settle Mode



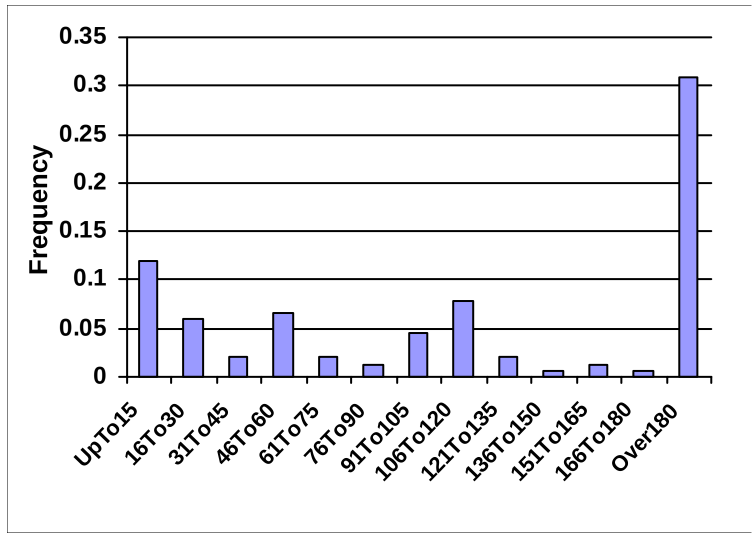
Average Daily Lighting Usage for Scarsdale Public Schools, Rm 405 (Control) From 9/1/06 To 5/31/07

General AV mode Switches:	.0	**Quiet Time Usage:**	0.0
General Mode Time:	340.6	**Occupancy Sensor Shutoff Frequency:**	0.0
AV mode Time:	.0	**Manual Shutoff Frequency:**	0.0
White Board Time:	.0	**Lights On:**	340.6
Settle Mode Time:	.0	**Watts/ sq ft:**	1.81
Settle Mode Counts:	0.0	**School Days:**	152

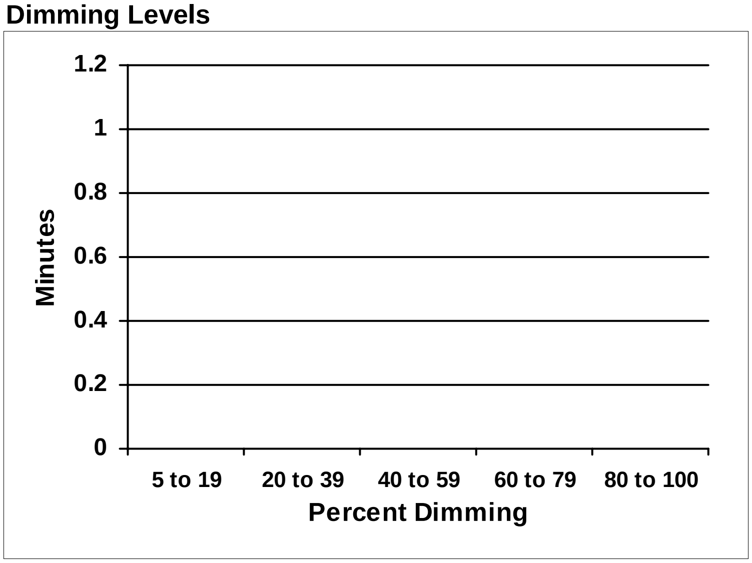
AV Mode



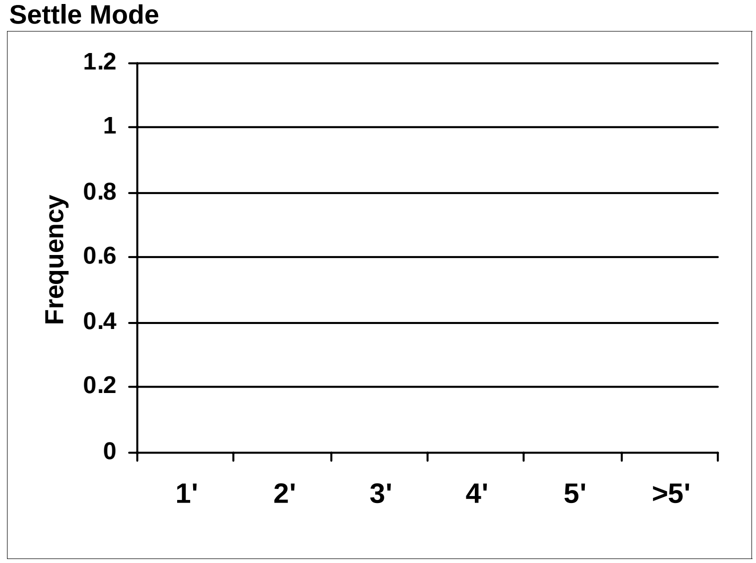
General Mode



Dimming Levels



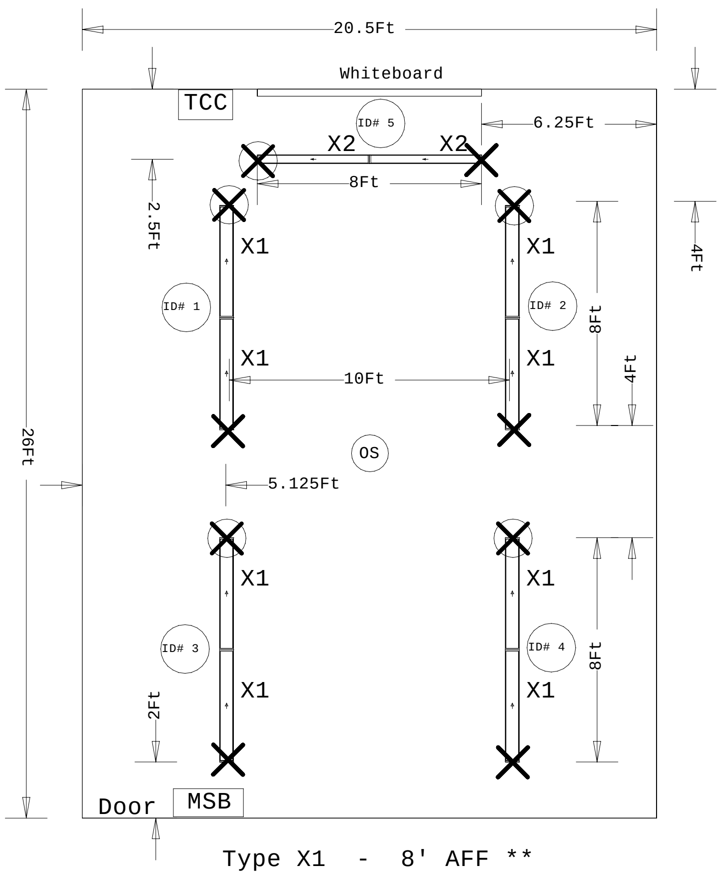
Settle Mode



Appendix J – New School University Information

- Room Dimension and Fixture Layout
- Lighting Layouts and calculations
- Energy Consumption Chart
- Data Summary Table
- Average Daily Lighting Usage Report

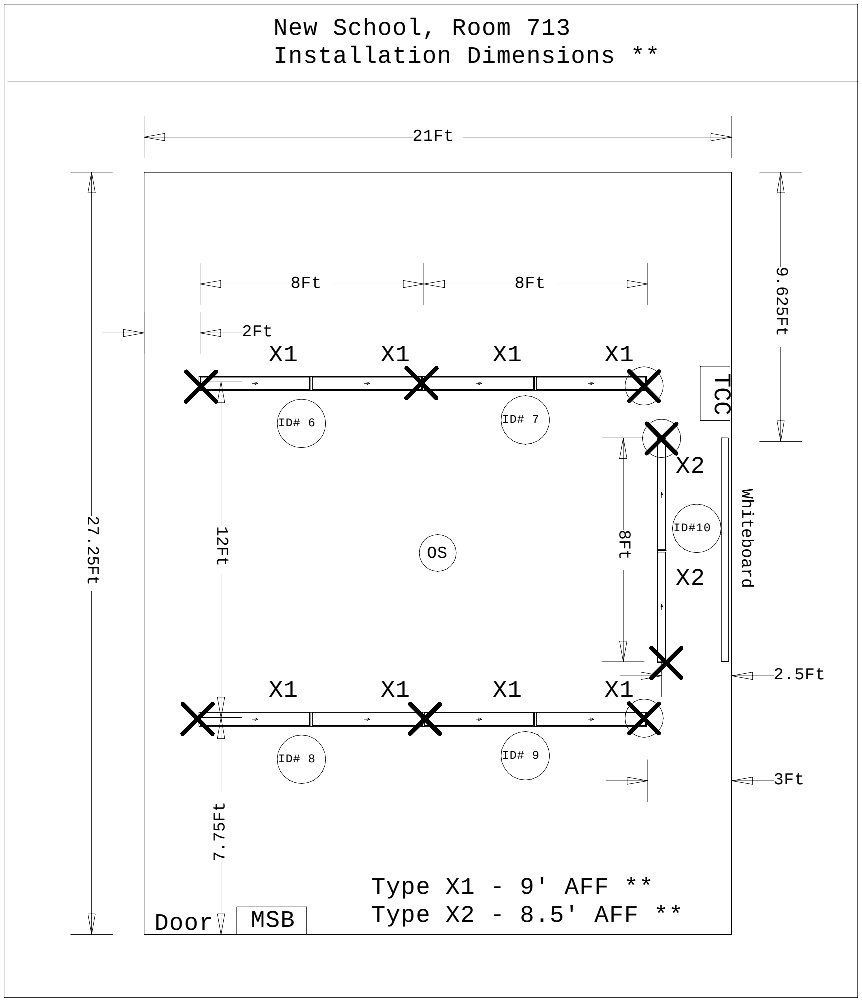
New School, Room 503
Installation Dimensions **



Type X1 - 8' AFF **
Type X2 - 8.5' AFF **

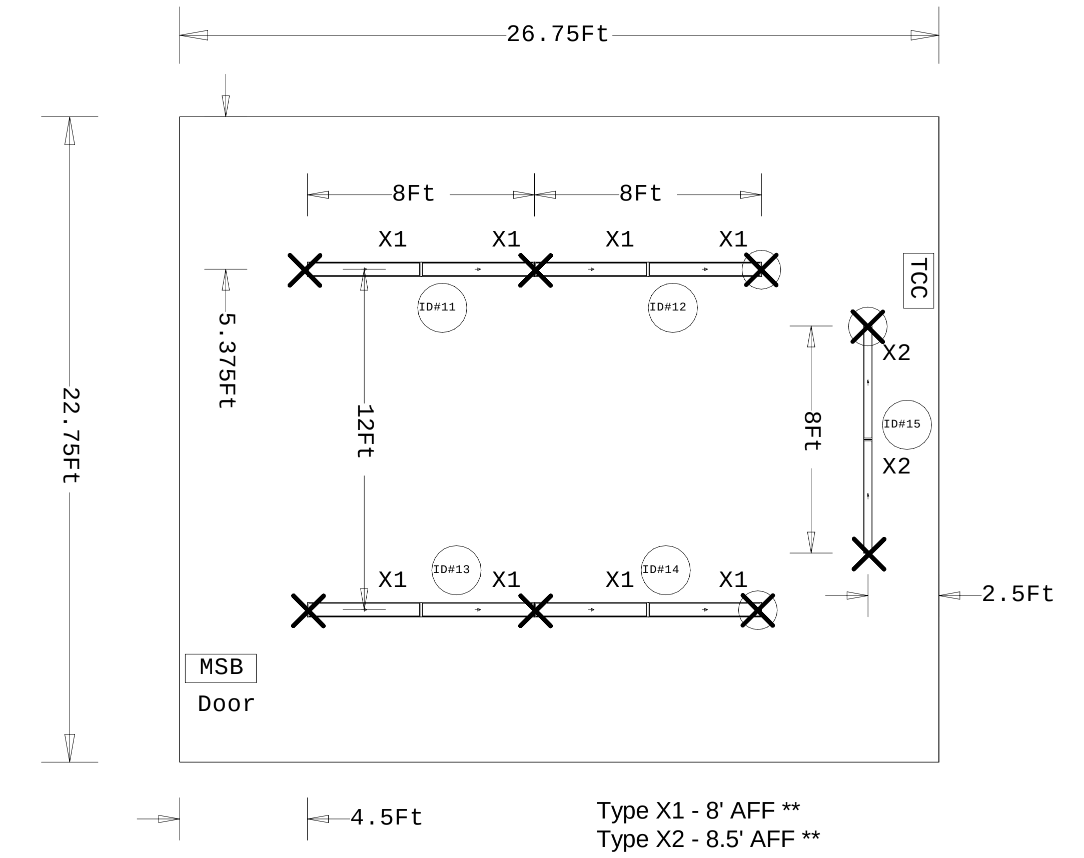
LEGEND	
TCC	Teacher Control Center mounting location: 4'-0" AFF (to top of box). Install on the left side of whiteboard/chalkboard
OS	Occupancy Sensor(s)
X	Suspension Point
(X)	Power Feed & Suspension Point (Pre-existing power feed points could affect changes to feed points)
ID# 1	Fixture ID#. Each fixture section will have a label with a unique ID# which can be found on the outside of the box and on the fixture itself.
MSB	Master Switch Bank -- Locate MSB on wall at entrance(s) to room. Exact location to be determined on-site.

** Site conditions could influence fixture placement and suspension. All fixtures to be mounted "on-grid" (if ceiling is grid type) therefore the attached dimensional information is approximate. The spacing between rows is the most important dimension to maintain.



LEGEND	
TCC	Teacher Control Center mounting location: 4'-0" AFF (to top of box). Install on the left side of whiteboard/chalkboard
OS	Occupancy Sensor(s)
X	Suspension Point
⊗	Power Feed & Suspension Point (Pre-existing power feed points could affect changes to feed points)
ID# 1	Fixture ID#. Each fixture section will have a label with a unique ID# which can be found on the outside of the box and on the fixture itself.
MSB	Master Switch Bank -- Locate MSB on wall at entrance(s) to room. Exact location to be determined on-site.
** Site conditions could influence fixture placement and suspension. All fixtures to be mounted "on-grid" (if ceiling is grid type) therefore the attached dimensional information is approximate. The spacing between rows is the most important dimension to maintain.	

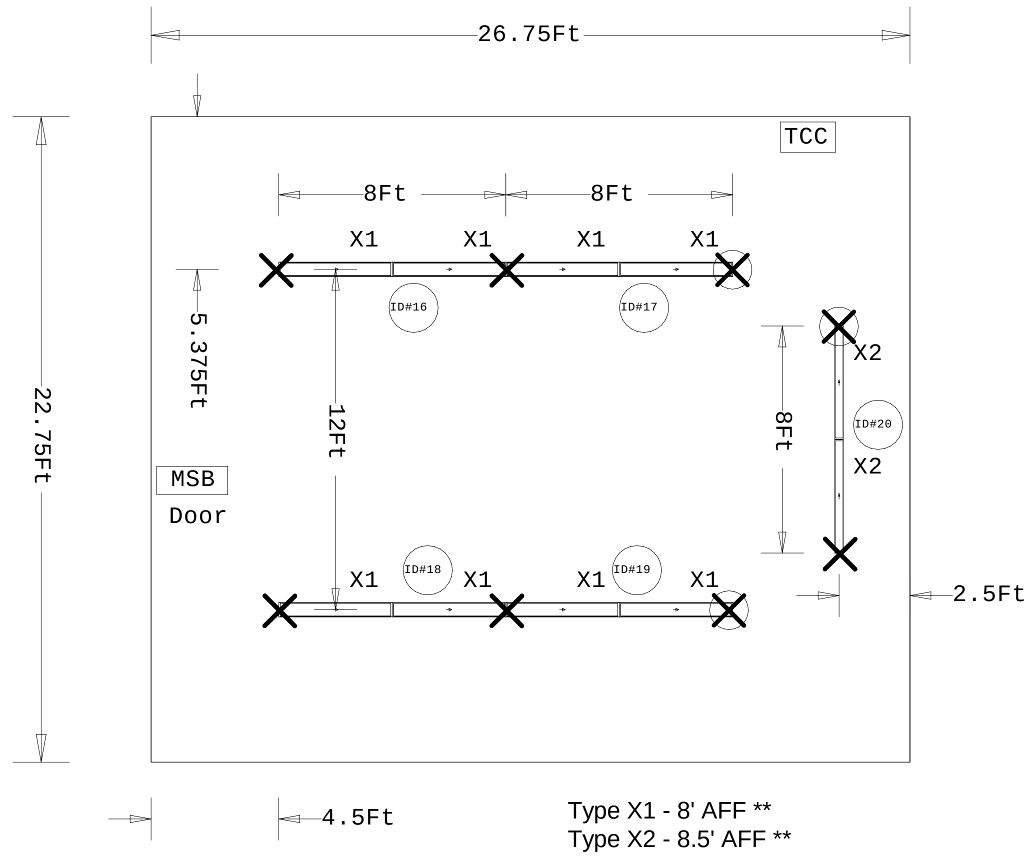
New School, Room 1013
Installation Dimensions **



LEGEND	
TCC	Teacher Control Center mounting location: 4'-0" AFF (to top of box). Install on the left side of whiteboard/chalkboard
OS	Occupancy Sensor(s)
	Suspension Point
	Power Feed & Suspension Point (Pre-existing power feed points could affect changes to feed points)
ID# 1	Fixture ID#. Each fixture section will have a label with a unique ID# which can be found on the outside of the box and on the fixture itself.
MSB	Master Switch Bank -- Locate MSB on wall at entrance(s) to room. Exact location to be determined on-site.

** Site conditions could influence fixture placement and suspension. All fixtures to be mounted "on-grid" (if ceiling is grid type) therefore the attached dimensional information is approximate. The spacing between rows is the most important dimension to maintain.

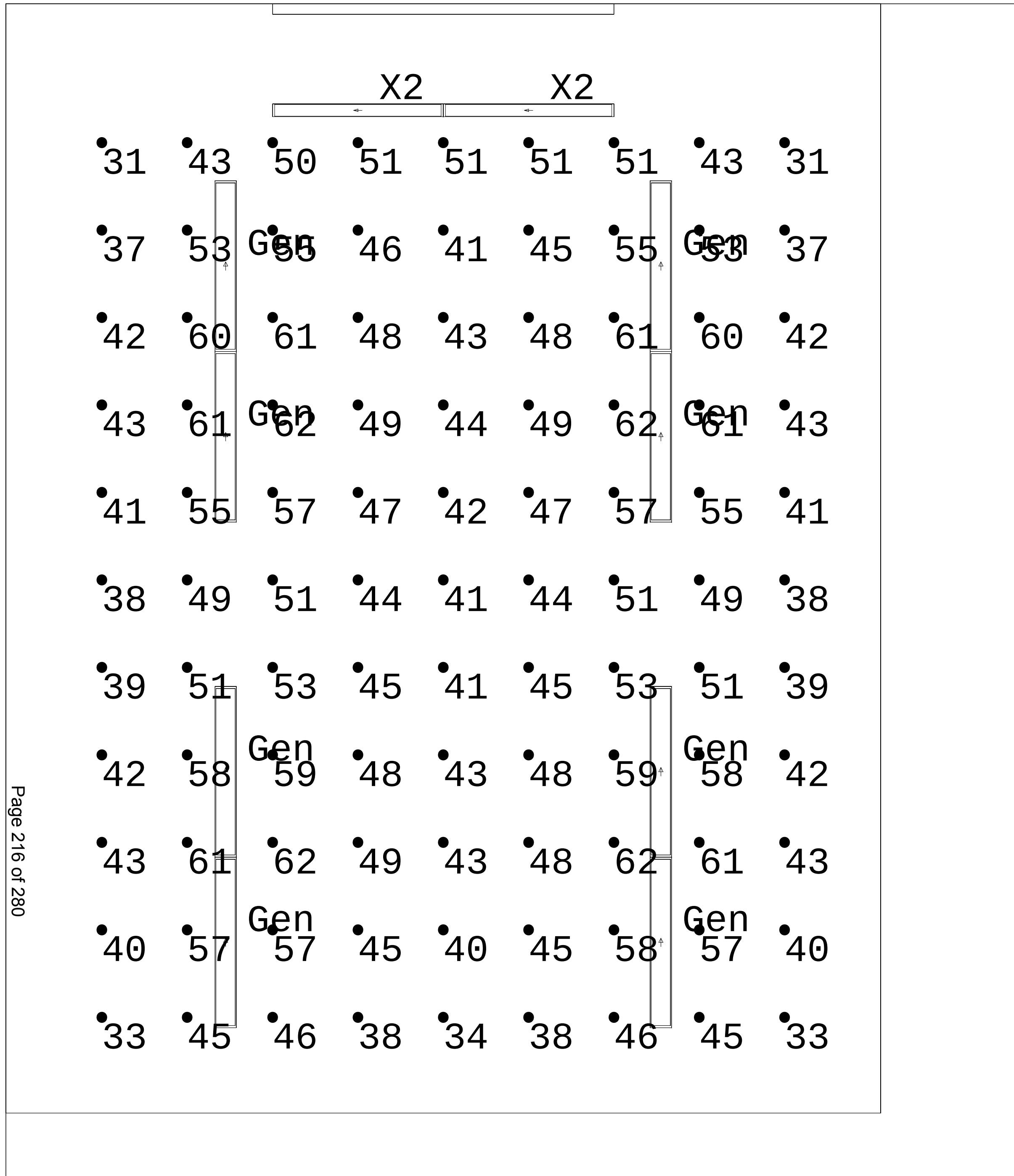
New School, Room 1111
Installation Dimensions **



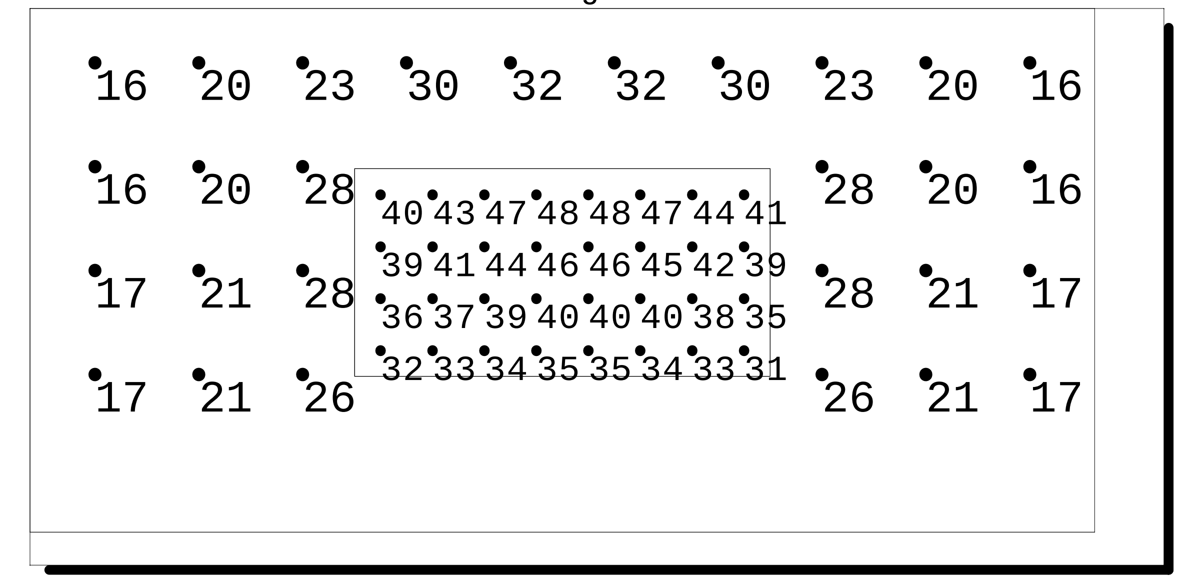
LEGEND	
TCC	Teacher Control Center mounting location: 4'-0" AFF (to top of box). Install on the left side of whiteboard/chalkboard
OS	Occupancy Sensor(s)
	Suspension Point
	Power Feed & Suspension Point (Pre-existing power feed points could affect changes to feed points)
ID# 1	Fixture ID#. Each fixture section will have a label with a unique ID# which can be found on the outside of the box and on the fixture itself.
MSB	Master Switch Bank -- Locate MSB on wall at entrance(s) to room. Exact location to be determined on-site.

** Site conditions could influence fixture placement and suspension. All fixtures to be mounted "on-grid" (if ceiling is grid type) therefore the attached dimensional information is approximate. The spacing between rows is the most important dimension to maintain.

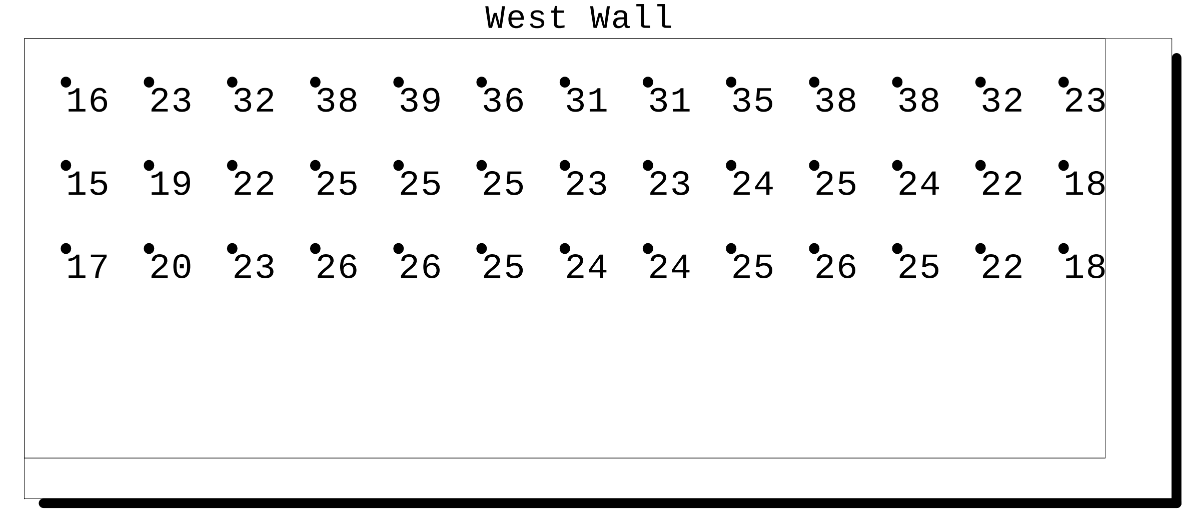
GENERAL MODE



Teaching Wall



West Wall



Luminaire Schedule

Project: New School, 25E 13th, Room 503

Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	8	Gen	3100	0.752	X1 PLV CCO 2T8 EP	0.88	55	0.9	0.95
	2	X2	3100	0.752	SX2 WCB 1T8 96W	0.88	28	0.9	0.95

Numeric Summary

Project: New School, 25E 13th, Room 503

Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Whiteboard	Illuminance	Fc	39.75	48	31	1.28	1.55
Teaching Wall	Illuminance	Fc	22.50	32	16	1.41	2.00
East Wall	Illuminance	Fc	25.72	39	15	1.71	2.60
Horizontal WP	Illuminance	Fc	48.01	62	31	1.55	2.00

Room Summary

Project: New School, 25E 13th, Room 503

Label	Wall Ht.	Description
Room 503	10.083	20.5' x 26' - Refl. 80/50/20

LPD Area Summary

Project: New School, 25E 13th, Room 503

Label	Area	Total Watts	LPD
Room 503	533	496	0.931

SX1 luminaires 8' AFF; X2 luminaire is 8.5' AFF.
Calculations are based on Osram QHE .88 Instant Start
Ballasts on outboard lamps and Osram Powersense Dimming
Ballasts on the center lamps of Type GEN.
QHE IS .88 ballasts on Type X2.

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

PHOTOMETRIC DATA USED AS INPUT FOR THESE CALCULATIONS IS BASED ON ESTABLISHED IES PROCEDURES AND PUBLISHED LAMP & BALLAST RATINGS. FIELD PERFORMANCE WILL DEPEND ON ACTUAL LAMP, BALLAST, ELECTRICAL AND SITE CHARACTERISTICS.

VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT 30" ABOVE FINISHED FLOOR.
AGI32 VERSION 1.8

FINELITE
Better Lighting for a Better Workplace

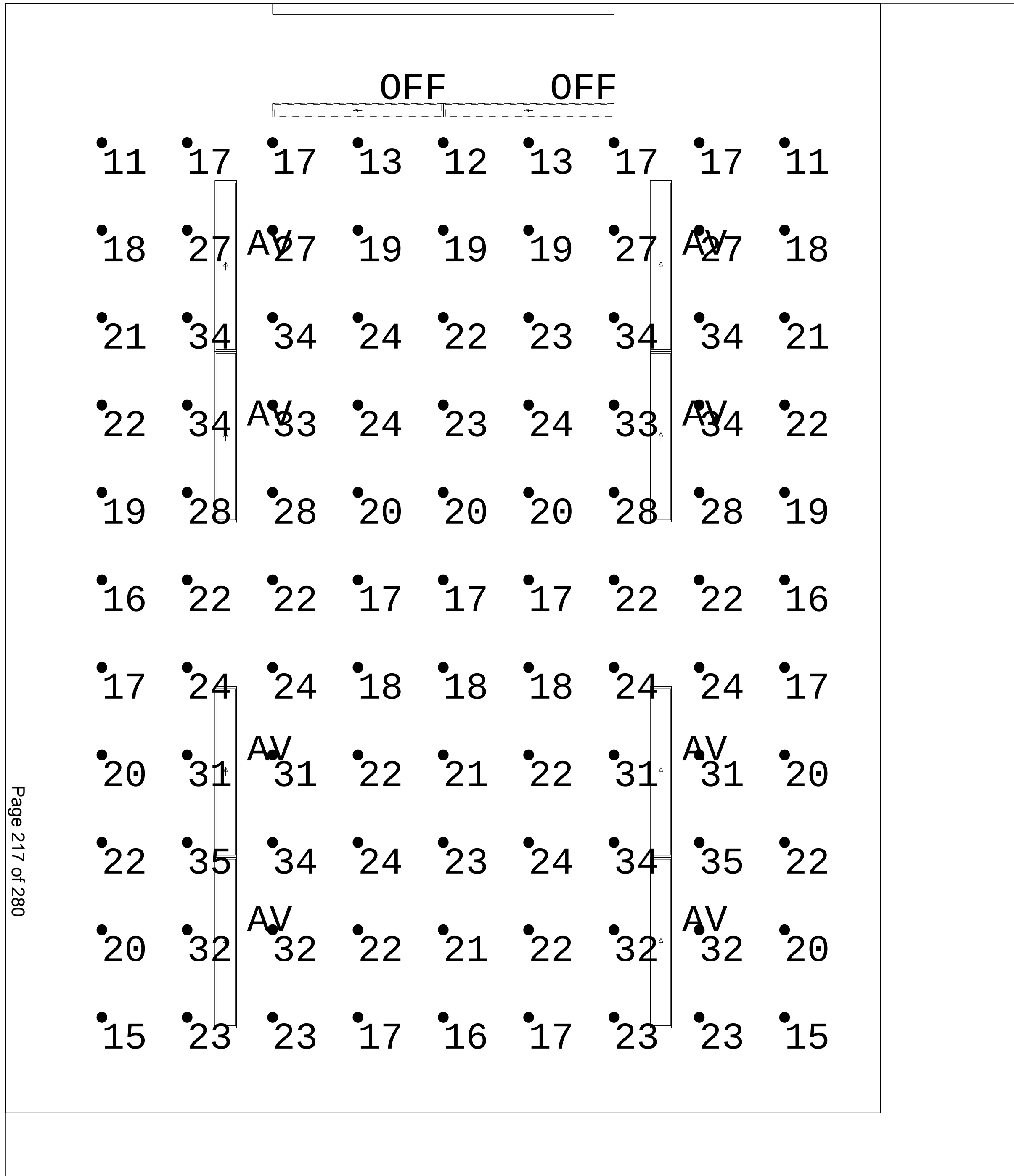
#	Date	Comments
1		

Revisions

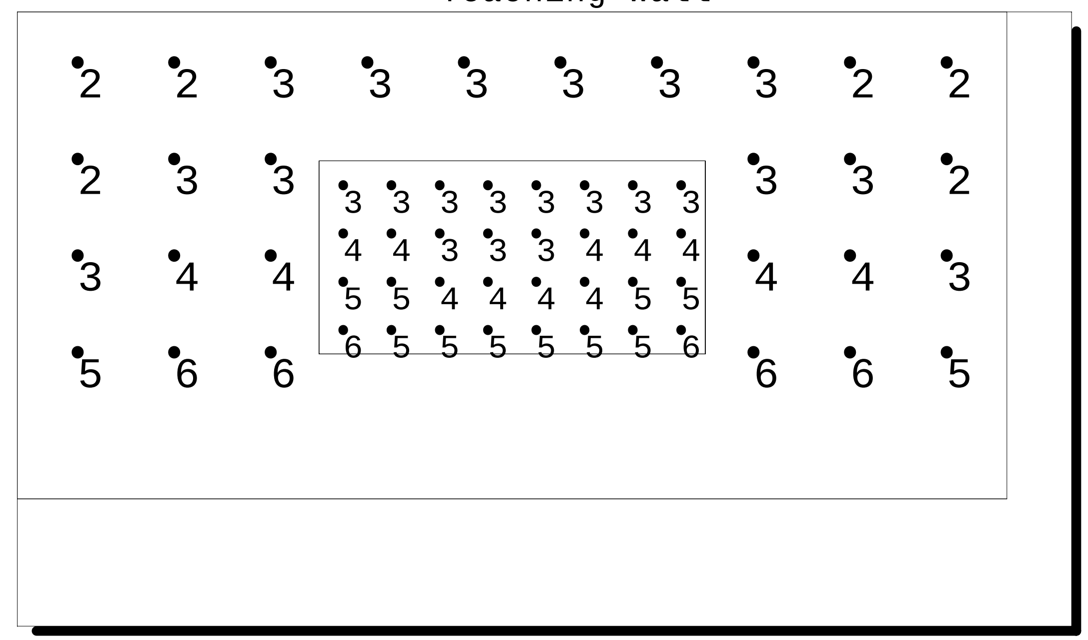
Drawn By: V Lauck
Date: April, 2006

Project: NYSERDA New School,
25 E 13th, Room 503

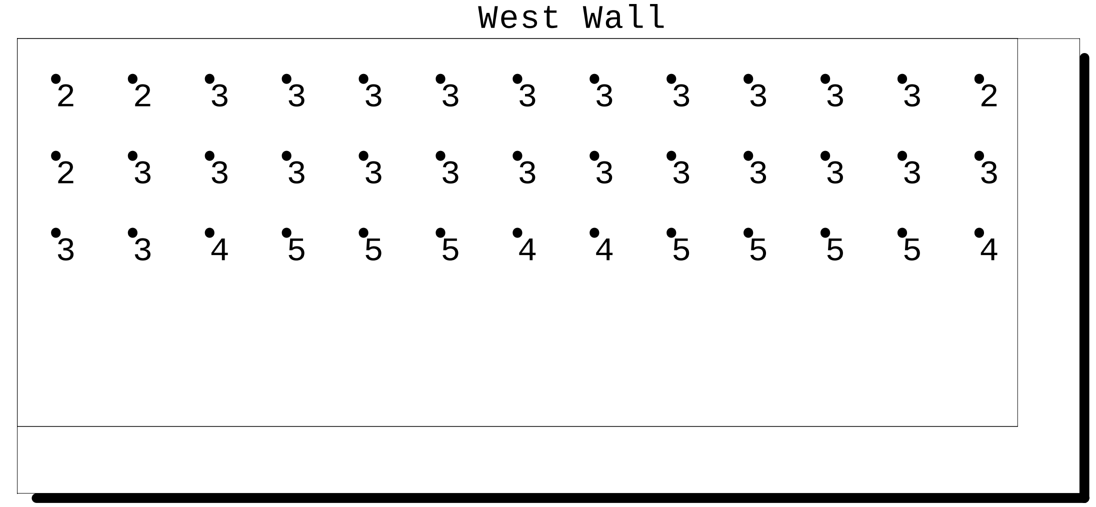
AV MODE



Teaching Wall



West Wall



Luminaire Schedule									
Project: New School, 25E 13th, Room 503									
Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	8	AV	3100	0.752	X1 PLV COO 1T8 EP	0.88	30	0.9	0.95
	2	OFF	3100	0.752	SX2 WCB 1T8 96W	0.88	28	0.9	0.95

Numeric Summary							
Project: New School, 25E 13th, Room 503							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Whiteboard	Illuminance	Fc	4.09	6	3	1.36	2.00
Teaching Wall	Illuminance	Fc	3.50	6	2	1.75	3.00
East Wall	Illuminance	Fc	3.36	5	2	1.68	2.50
Horizontal WP	Illuminance	Fc	23.00	35	11	2.09	3.18

Room Summary		
Project: New School, 25E 13th, Room 503		
Label	Wall Ht.	Description
Room 503	10.083	20.5' x 26' - Refl. 80/50/20

LPD Area Summary			
Project: New School, 25E 13th, Room 503			
Label	Area	Total Watts	LPD
Room 503	533	240	0.450

SX1 luminaires 8' AFF; X2 luminaire is 8.5' AFF.
Calculations are based on Osram QHE .88 Instant Start
Ballasts on outboard lamps and Osram Powersense Dimming
Ballasts on the center lamps of Type GEN.
Type X2 is OFF.

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

PHOTOMETRIC DATA USED AS INPUT FOR THESE CALCULATIONS IS BASED ON ESTABLISHED IES PROCEDURES AND PUBLISHED LAMP & BALLAST RATINGS. FIELD PERFORMANCE WILL DEPEND ON ACTUAL LAMP, BALLAST, ELECTRICAL AND SITE CHARACTERISTICS.

VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT 30" ABOVE FINISHED FLOOR.
AGI32 VERSION 1.8

FINELITE
Better Lighting for a Better Workplace

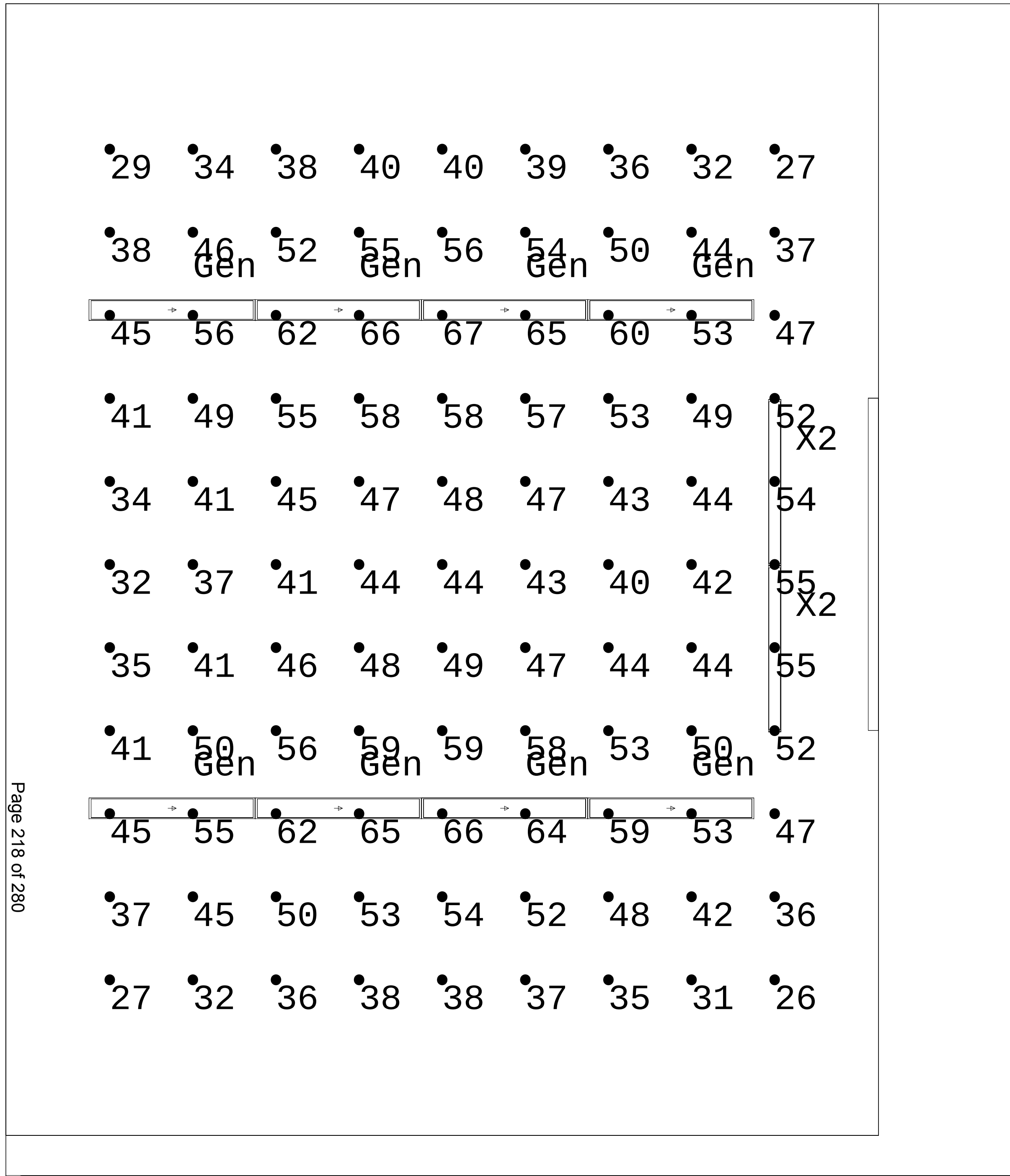
#	Date	Comments

Revisions

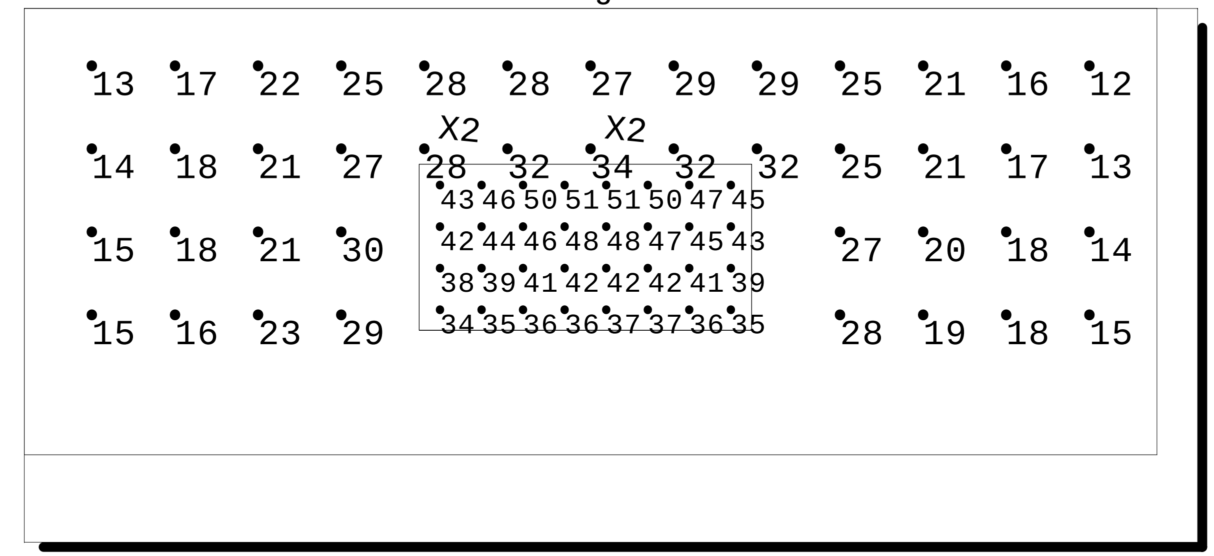
Drawn By: V Lauck
Date: April, 2006

Project: NYSERDA New School,
25 E 13th, Room 503

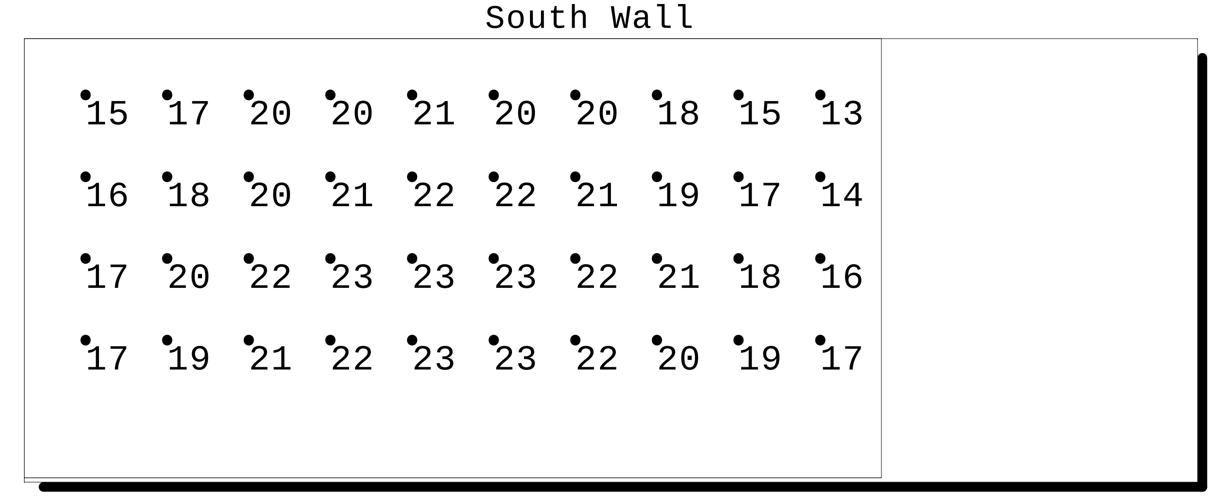
GENERAL MODE



Teaching Wall



South Wall



Luminaire Schedule									
Project: New School, 66W 12th, Room 713									
Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	8	Gen	3100	0.752	X1 PLV CCO 2T8 EP	0.88	55	0.9	0.95
	2	X2	3100	0.846	SX2 WCB 1T8 96W	0.99	34	0.9	0.95

Numeric Summary							
Project: New School, 66W 12th, Room 713							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Chalkboard	Illuminance	Fc	42.38	51	34	1.25	1.50
Teaching Wall	Illuminance	Fc	22.19	34	12	1.85	2.83
North Wall	Illuminance	Fc	19.43	23	13	1.49	1.77
Horizontal WP	Illuminance	Fc	46.88	67	26	1.80	2.58

Room Summary		
Project: New School, 66W 12th, Room 713		
Label	Wall Ht.	Description
Room 713	10.75	21' x 27.25' - Refl 80/50/20

LPD Area Summary			
Project: New School, 66W 12th, Room 713			
Label	Area	Total Watts	LPD
Room 713	572.25	508	0.888

SX1 luminaires 9' AFF; X2 luminaire is 8.5' AFF. Calculations based on Osram .88 QHE Instant Start Ballasts on outboard lamps and Osram Powersense Dimming Ballasts on the center lamps. Osram .99 QHE Instant Start ballast (3-lamp ballast on 2 lamps) on Type X2.

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

PHOTOMETRIC DATA USED AS INPUT FOR THESE CALCULATIONS IS BASED ON ESTABLISHED IES PROCEDURES AND PUBLISHED LAMP & BALLAST RATINGS. FIELD PERFORMANCE WILL DEPEND ON ACTUAL LAMP, BALLAST, ELECTRICAL AND SITE CHARACTERISTICS.

VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT 30" ABOVE FINISHED FLOOR.
AGI32 VERSION 1.8

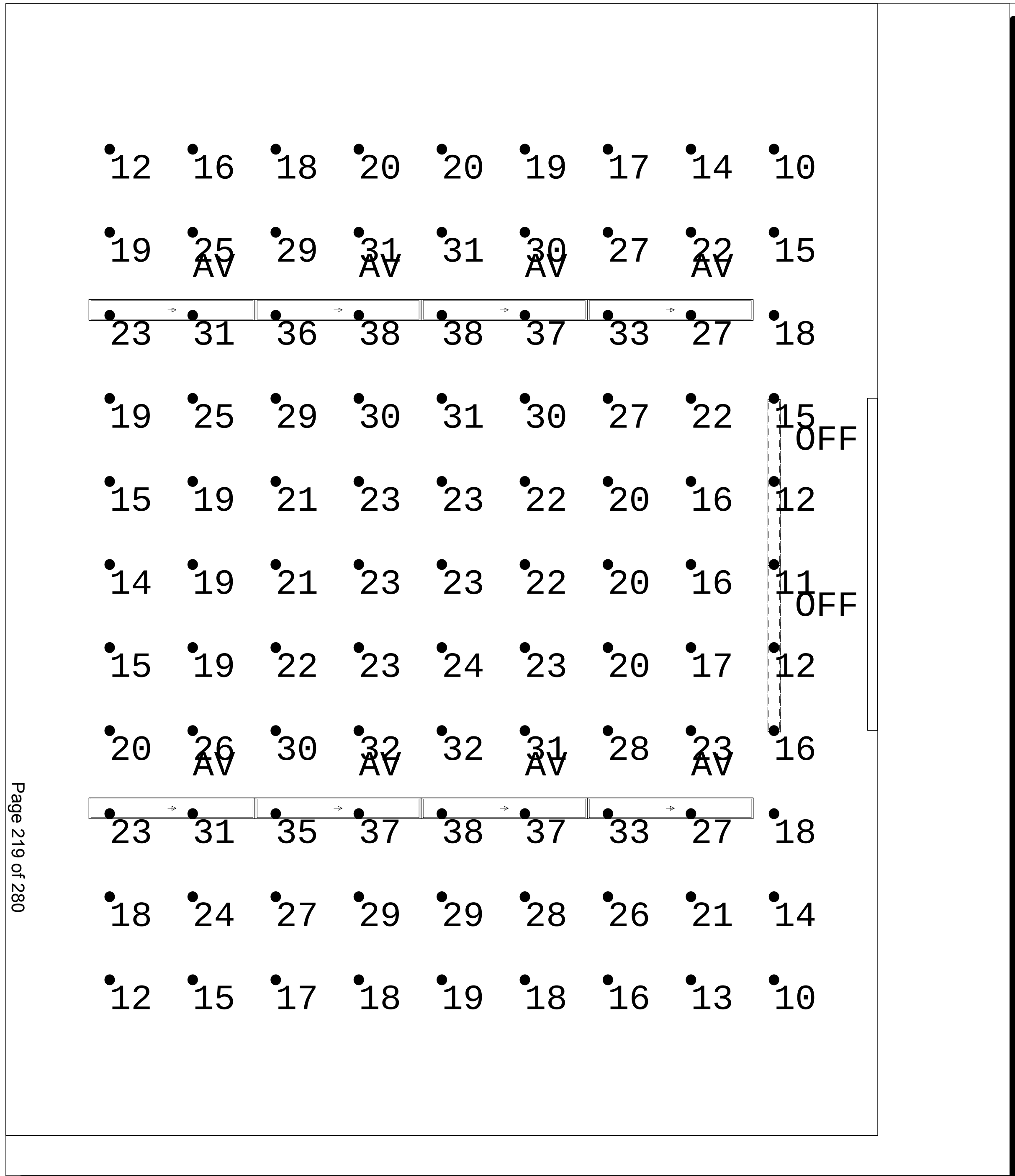
FINELITE
Better Lighting for a Better Workplace

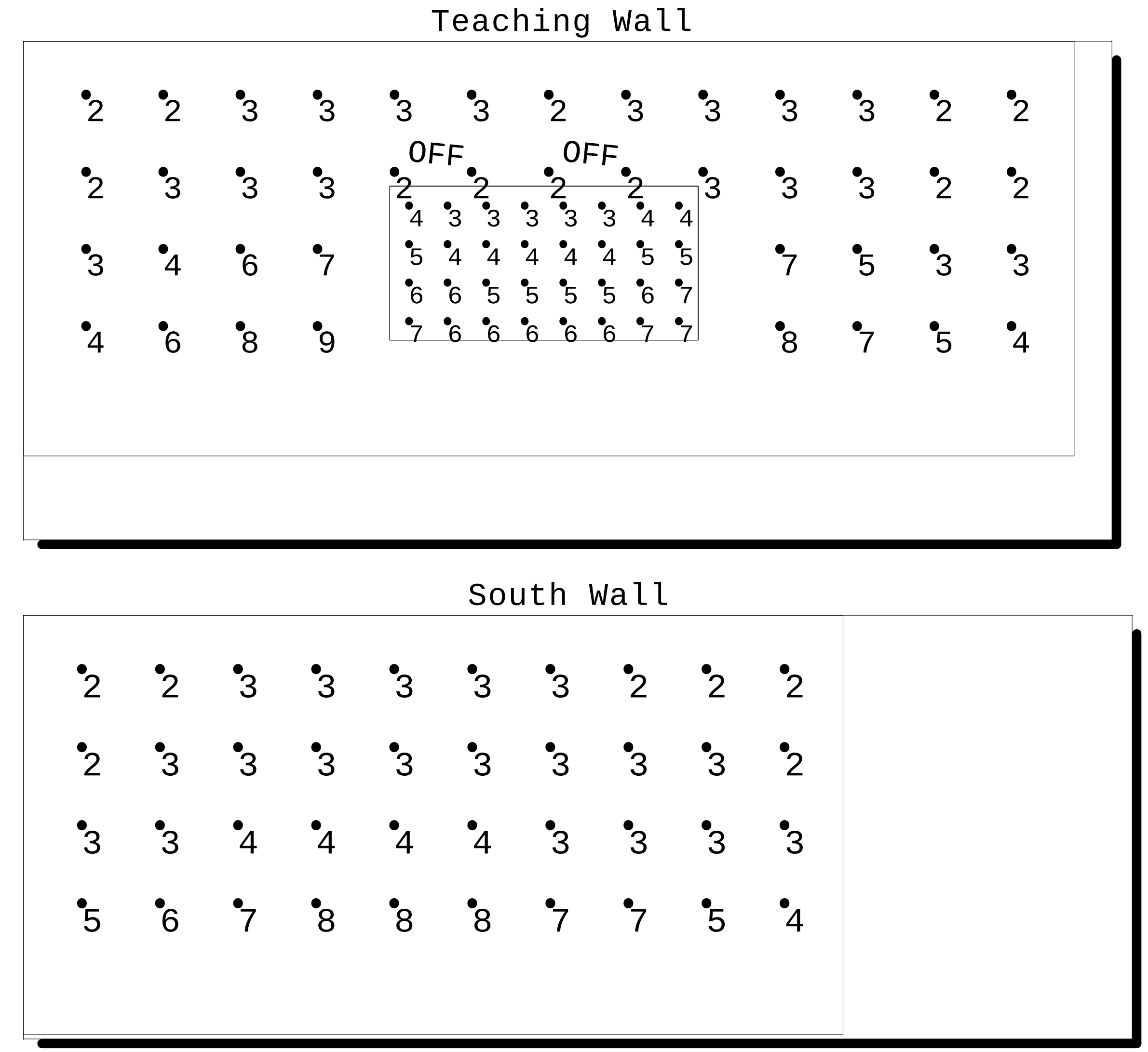
#	Revisions

Drawn By: V Lauck
Date: April, 2006

Project: NYSERDA, New School
66 W 12th, Room 713

AV MODE





Luminaire Schedule									
Project: New School, 66W 12th, Room 713									
Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	8	AV	3100	0.752	X1 PLV COO 1T8 EP	0.88	30	0.9	0.95
	2	OFF	3100	0.846	SX2 WCB 1T8 96W	0.99	34	0.9	0.95

Numeric Summary							
Project: New School, 66W 12th, Room 713							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Chalkboard	Illuminance	Fc	4.94	7	3	1.65	2.33
Teaching Wall	Illuminance	Fc	3.69	9	2	1.85	4.50
North Wall	Illuminance	Fc	3.80	8	2	1.90	4.00
Horizontal WP	Illuminance	Fc	22.93	38	10	2.29	3.80

Room Summary		
Project: New School, 66W 12th, Room 713		
Label	Wall Ht.	Description
Room 713	10.75	21' x 27.25' - Refl 80/50/20

LPD Area Summary			
Project: New School, 66W 12th, Room 713			
Label	Area	Total Watts	LPD
Room 713	572.25	240	0.419

SX1 luminaires 9' AFF; X2 luminaire is 8.5' AFF. Calculations based on Osram .88 QHE Instant Start Ballasts on outboard lamps and Osram Powersense Dimming Ballasts on the center lamps. Type X2 is turned OFF.

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

PHOTOMETRIC DATA USED AS INPUT FOR THESE CALCULATIONS IS BASED ON ESTABLISHED IES PROCEDURES AND PUBLISHED LAMP & BALLAST RATINGS. FIELD PERFORMANCE WILL DEPEND ON ACTUAL LAMP, BALLAST, ELECTRICAL AND SITE CHARACTERISTICS.

VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT 30" ABOVE FINISHED FLOOR.
AGI32 VERSION 1.8

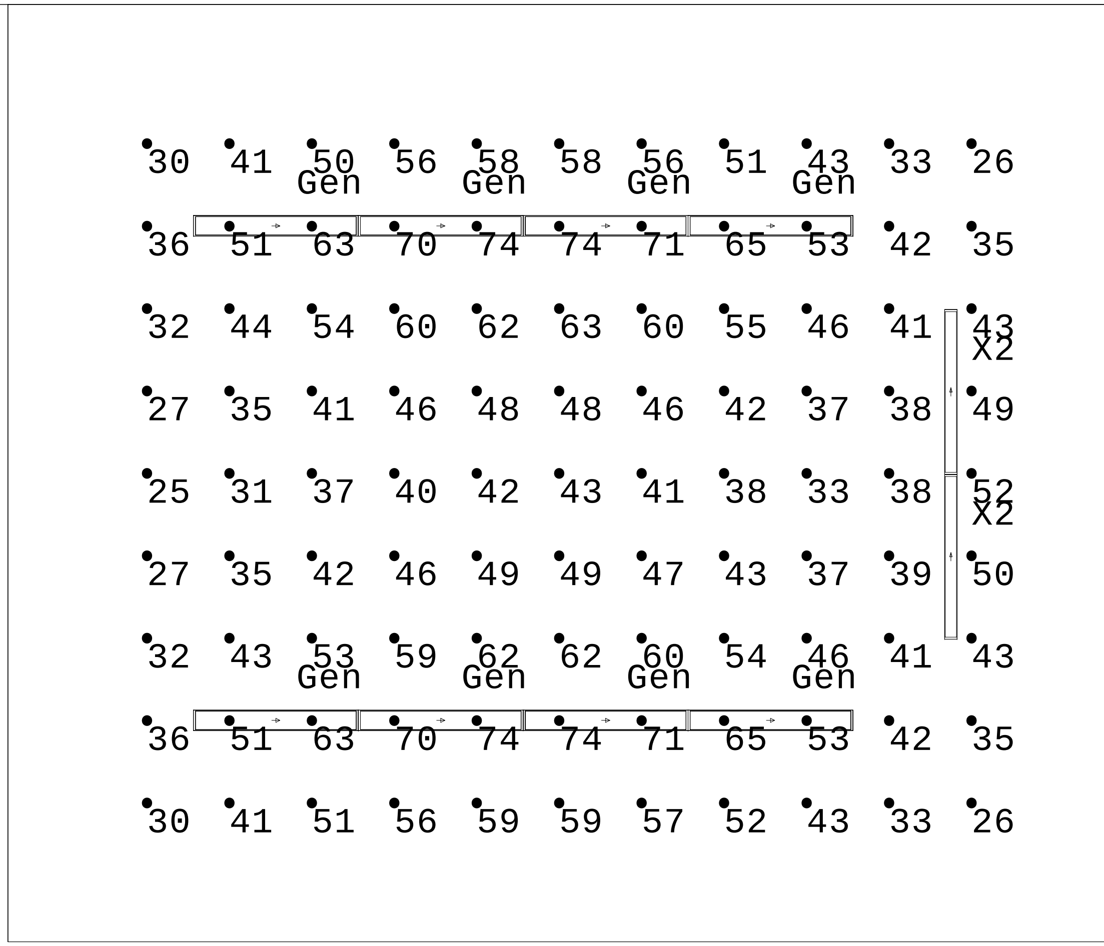
FINELITE
Better Lighting for a Better Workplace

#	Revisions

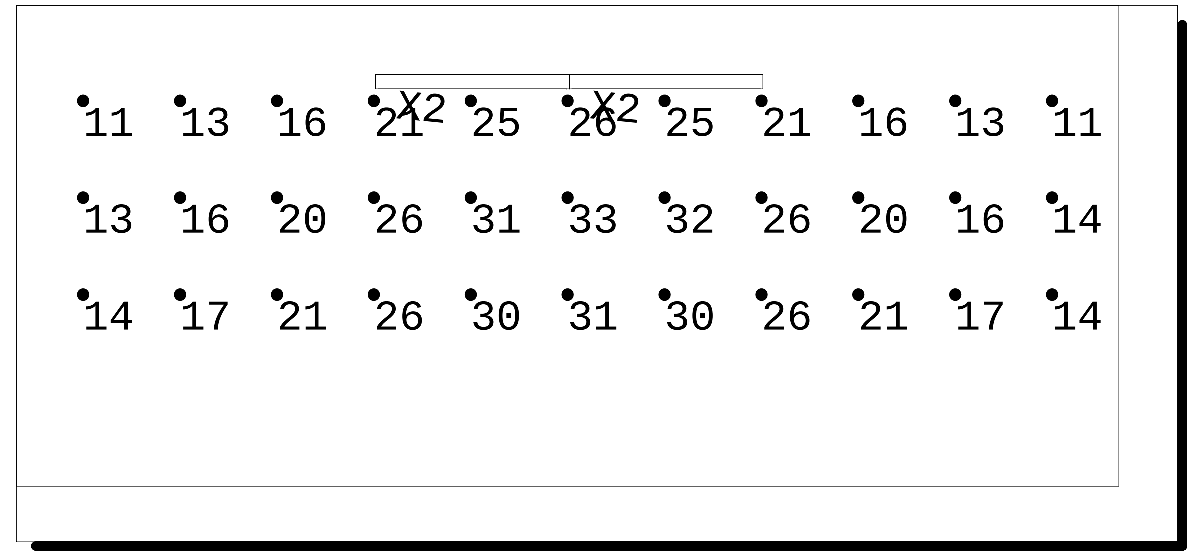
Drawn By: V Lauck
Date: April, 2006

Project: NYSERDA, New School
66 W 12th, Room 713

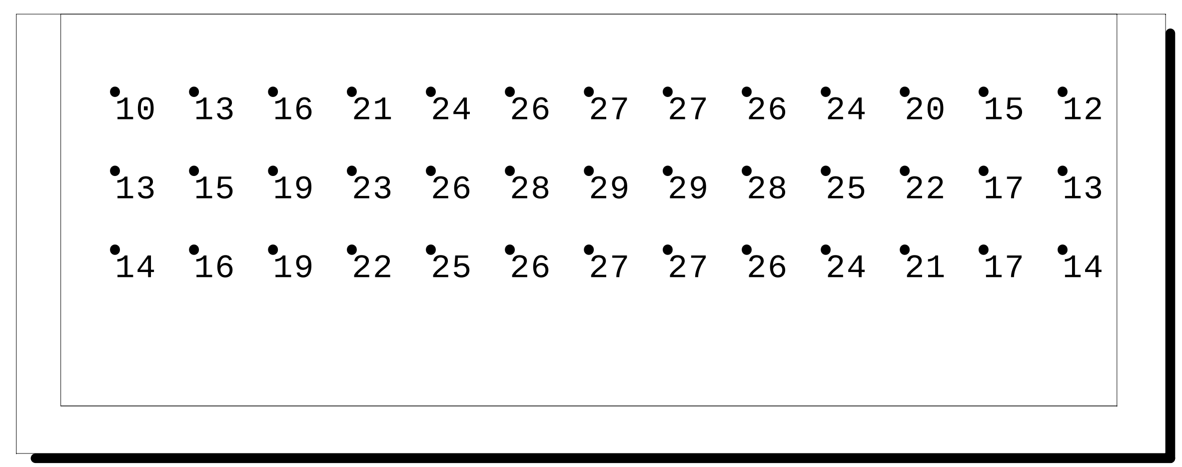
GENERAL MODE



Teaching Wall



South Wall



Luminaire Schedule
Project: New School, 2W 13th, Room 1111 & 1013

Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	8	Gen	3100	0.752	X1 PLV CCO 2T8 EP	0.88	55	0.9	0.95
	2	X2	3100	0.846	SX2 WCB 1T8 96W	0.99	34	0.9	0.95

Numeric Summary
Project: New School, 2W 13th, Room 1111 & 1013

Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Teaching Wall	Illuminance	Fc	20.97	33	11	1.91	3.00
South Wall	Illuminance	Fc	21.18	29	10	2.12	2.90
Horizontal WP	Illuminance	Fc	47.81	74	25	1.91	2.96

Room Summary
Project: New School, 2W 13th, Room 1111 & 1013

Label	Wall Ht.	Description
Room 1111 & 1013	9.92	26.75'x22.75' - Refl. 80/50/20

LPD Area Summary
Project: New School, 2W 13th, Room 1111 & 1013

Label	Area	Total Watts	LPD
Room 1111 & 1013	608.56	508	0.835

SX1 luminaires 8' AFF; X2 luminaire is 8.5' AFF. Calculations based on Osram .88 QHE Instant Start Ballasts on outboard lamps and Osram Powersense Dimming Ballasts on the center lamps. Osram .99 QHE Instant Start ballast (3-lamp ballast on 2 lamps) on Type X2.

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

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VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT 30" ABOVE FINISHED FLOOR.
AGI32 VERSION 1.8

FINELITE
Better Lighting for a Better Workplace

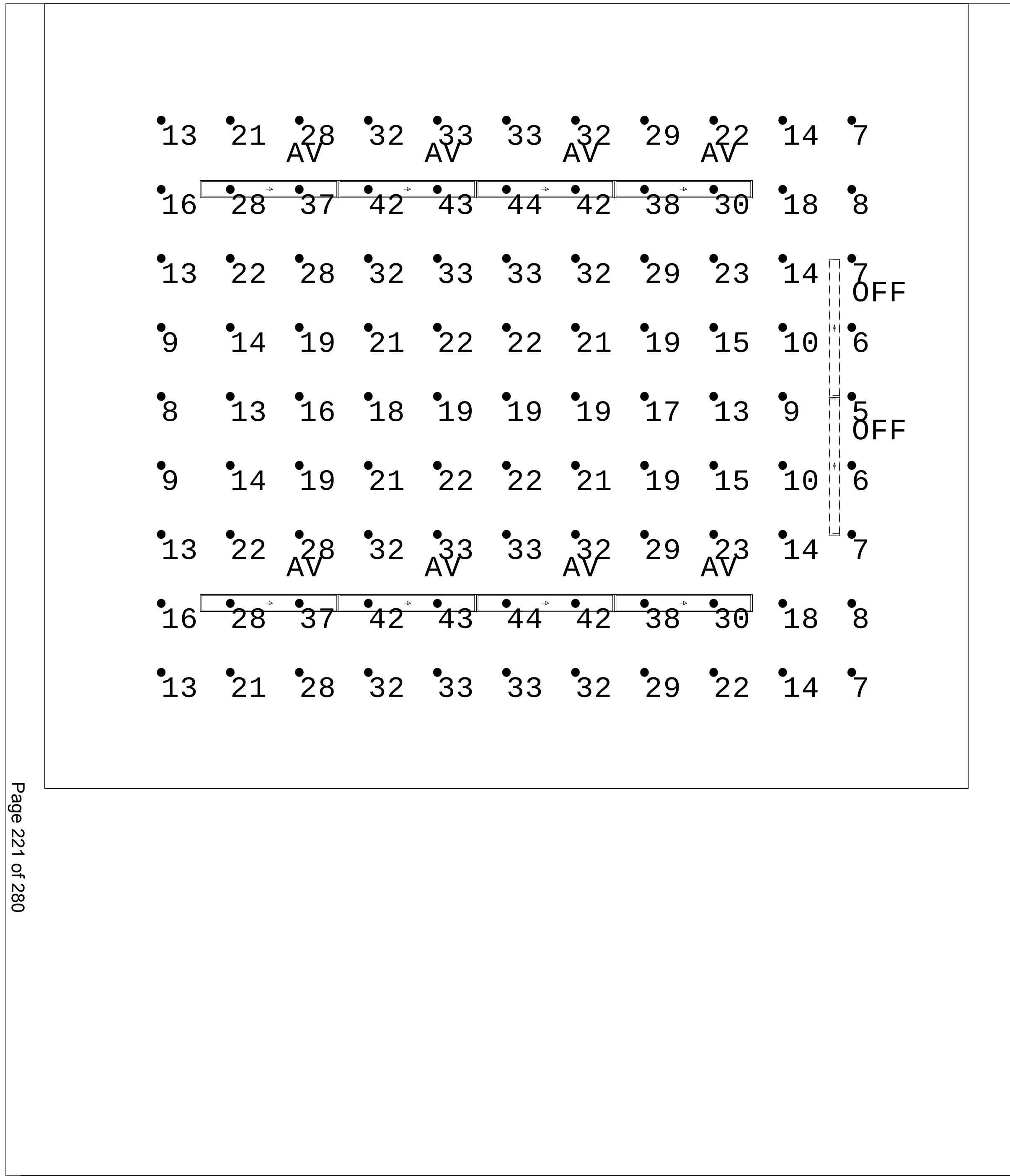
#	Date	Comments

Revisions

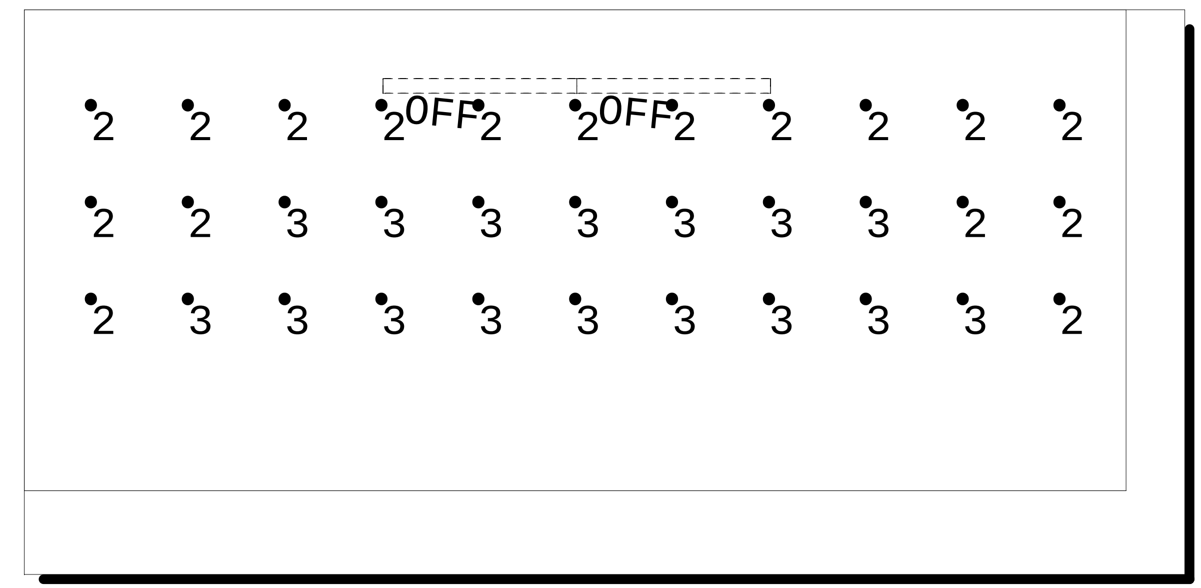
Drawn By: V Lauck
Date: April, 2006

Project: NYSERDA, New School
2 W 13th, Room 1111 & 1013

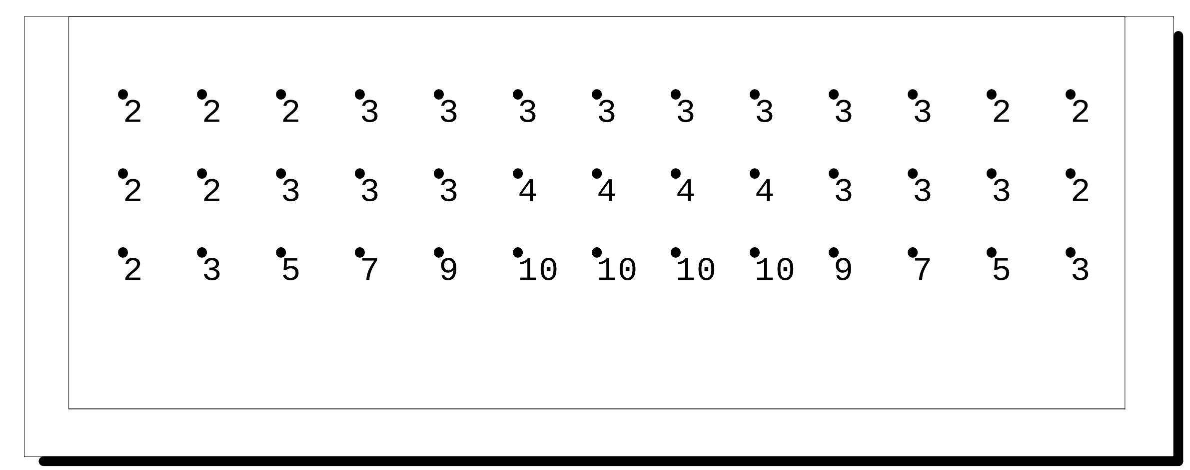
AV MODE



Teaching Wall



South Wall



Luminaire Schedule									
Project: New School, 2W 13th, Room 1111 & 1013									
Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	8	AV	3100	0.752	X1 PLV COO 1T8 EP	0.88	30	0.9	0.95
	2	OFF	3100	0.846	SX2 WCB 1T8 96W	0.99	34	0.9	0.95

Numeric Summary							
Project: New School, 2W 13th, Room 1111 & 1013							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Teaching Wall	Illuminance	Fc	2.48	3	2	1.24	1.50
South Wall	Illuminance	Fc	4.21	10	2	2.11	5.00
Horizontal WP	Illuminance	Fc	22.87	44	5	4.57	8.80

Room Summary		
Project: New School, 2W 13th, Room 1111 & 1013		
Label	Wall Ht.	Description
Room 1111 & 1013	9.92	26.75'x22.75' - Refl. 80/50/20

LPD Area Summary			
Project: New School, 2W 13th, Room 1111 & 1013			
Label	Area	Total Watts	LPD
Room 1111 & 1013	608.56	240	0.394

SX1 luminaires 8' AFF; X2 luminaire is 8.5' AFF. Calculations based on Osram .88 QHE Instant Start Ballasts on outboard lamps and Osram Powersense Dimming Ballasts on the center lamps. Type X2 is turned OFF.

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

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AGI32 VERSION 1.8

FINELITE
Better Lighting for a Better Workplace

#	Date	Comments
Revisions		

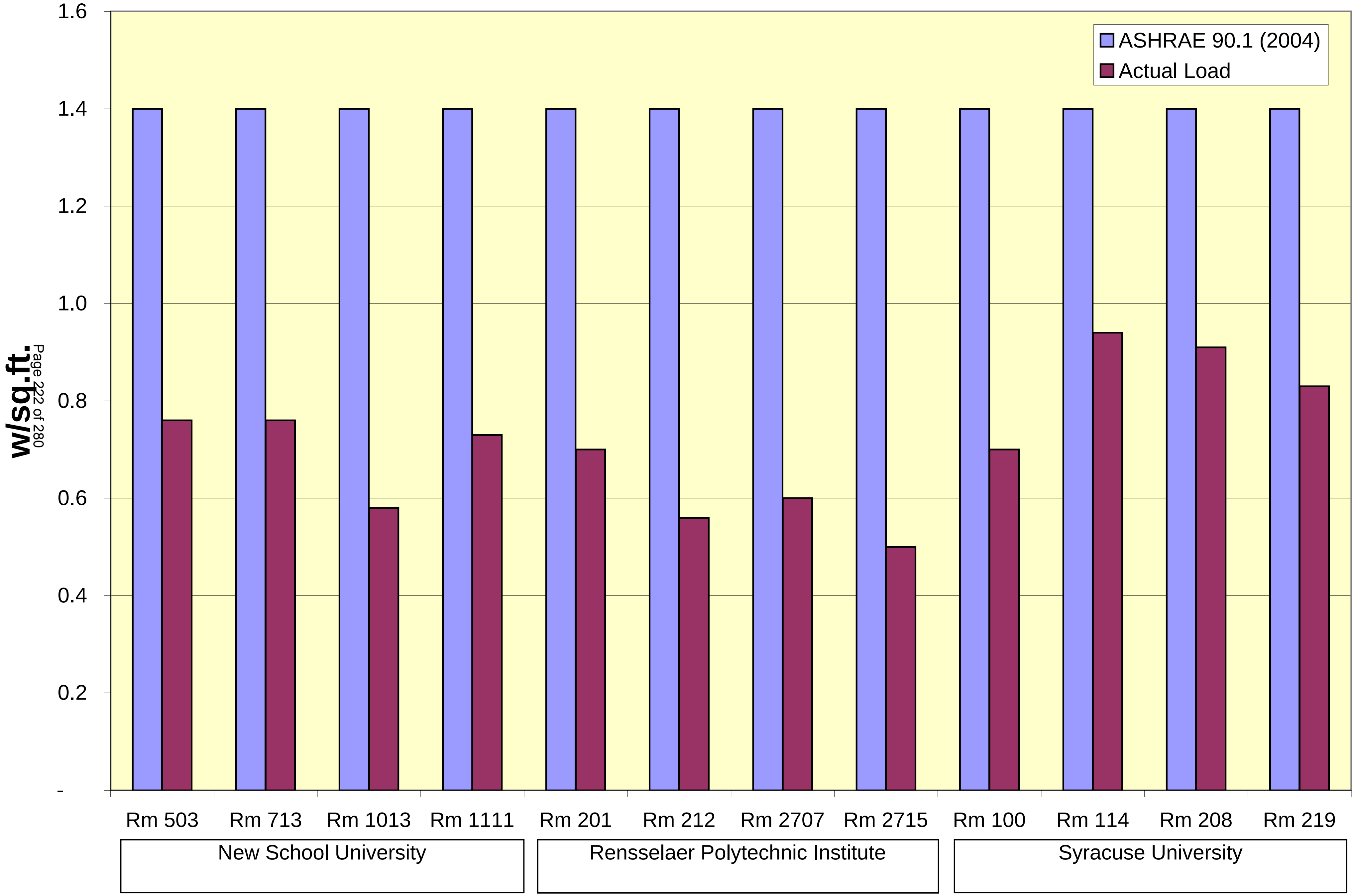
Drawn By: V Lauck
Date: April, 2006

Project: NYSERDA, New School
2 W 13th, Room 1111 & 1013

Energy Consumption by School - University

NYSERDA Classroom Lighting System

Sep 2006 - May 2007



Data Summary

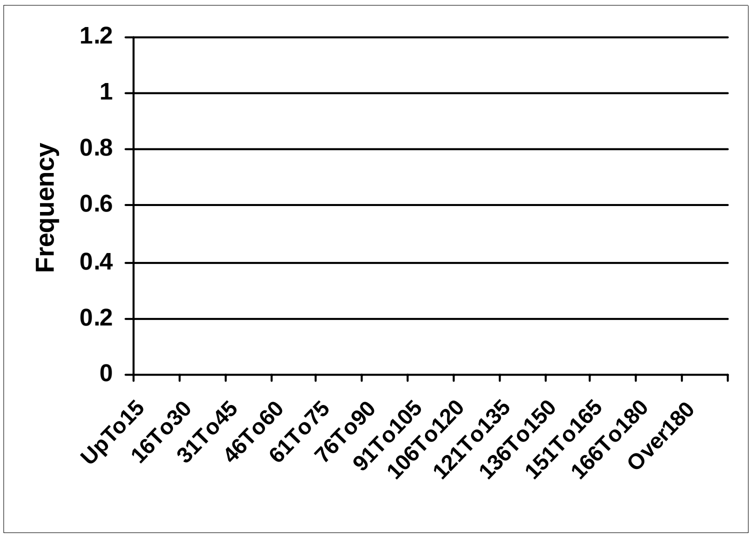
New School University

Classroom	Date	AV Gen Switches	AV Use (#/Day)	WB Use (#/Day)	General Total Min	White Board Total Min	AV Total Min	Settle Time	Settle Count	Quiet Count	Occ Sensor Shut Off	Manual Shut Off	Lights On Total	Watts/ sq ft	kWh
503	9/5/06	0	0		158	0	0	0		0	0	4	158	0.80	1.12
	9/6/06	1	1	0	564	30	190	30	1	1	0	4	754	0.71	4.74
	9/7/06	1	3		363	0	28	0		0	3	3	391	0.79	2.75
	9/8/06	0	0		219	0	0	0		0	0	2	219	0.84	1.63
	9/9/06	0	0		1	0	0	0		0	0	1	1	0.77	0.01
	9/11/06	0	0		439	0	0	0		0	1	6	439	0.83	3.23
	9/12/06	0	0	0	227	229	0	0		0	1	1	229	0.94	1.92
	9/13/06	1	1	0	431	467	70	70	1	1	1	3	501	0.87	3.85
	9/14/06	0	5	0	0	802	801	801	5	0	1	2	802	0.53	3.81
	9/15/06	0	2	0	0	69	69	69	2	1	0	2	69	0.52	0.32
	9/18/06	0	4	0	0	757	757	757	4	0	0	4	757	0.56	3.75
	9/19/06	0	4	0	0	876	875	875	4	0	0	4	876	0.56	4.35
	9/20/06	0	9	0	0	741	741	741	9	0	0	9	741	0.55	3.61
	9/21/06	0	7	0	0	336	336	336	7	3	4	5	336	0.55	1.63
	9/22/06	0	1	0	0	8	8	8	1	0	0	1	8	0.53	0.04
	9/25/06	0	6	0	0	588	588	588	6	0	0	6	588	0.54	2.81
	9/26/06	0	8	0	0	830	830	830	8	0	4	4	830	0.53	3.94
	9/27/06	0	3	0	0	577	742	577	3	0	0	3	742	0.49	3.24
	9/28/06	0	1		0	0	15	0		0	0	2	15	0.41	0.05
	9/29/06	0	8		0	0	508	0		0	6	2	508	0.42	1.89
	10/1/06	0	1		0	0	4	0		0	0	1	4	0.39	0.01
	10/2/06	0	2		0	0	6	0		0	0	2	6	0.40	0.02
	10/3/06	0	5		0	0	656	0		0	1	4	656	0.42	2.43
	10/4/06	1	3	0	486	486	308	0		0	1	3	794	0.74	5.19
	10/5/06	1	10	0	215	215	437	0		0	10	4	652	0.58	3.38
	10/6/06	0	14		0	0	529	0		0	8	6	529	0.42	1.97
	10/7/06	0	1		0	0	178	0		0	1	0	178	0.42	0.66
	10/8/06	0	8		0	0	104	0		0	6	3	104	0.42	0.39
	10/9/06	0	2		0	0	755	0		0	0	2	755	0.42	2.82
	10/10/06	1	2	0	615	615	233	0		0	1	3	848	0.78	5.90
	10/11/06	1	5	0	587	711	124	124	5	0	1	5	711	0.86	5.40
	10/12/06	0	9	0	0	678	677	677	9	0	5	5	678	0.46	2.74
	10/13/06	0	19	0	0	493	492	492	19	1	17	2	493	0.45	1.98
	10/14/06	0	2	0	0	17	17	17	2	0	1	1	17	0.46	0.07
	10/15/06	0	3	0	0	21	21	21	3	0	0	3	21	0.46	0.09
	10/16/06	0	13	0	0	498	498	498	13	0	8	5	498	0.45	2.01
	10/17/06	0	7	0	0	742	752	742	7	1	8	3	752	0.52	3.46
	10/18/06	1	4	0	570	570	35	0		2	3	4	605	0.91	4.87

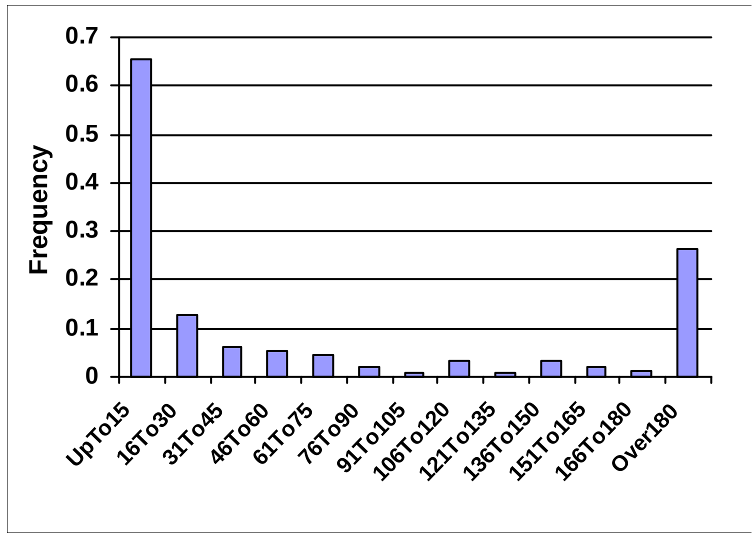
Average Daily Lighting Usage for New School University, Rm 502 (Control) From 9/1/06 To 5/31/07

General AV mode Switches:	.0	**Quiet Time Usage:**	0.0
General Mode Time:	533.5	**Occupancy Sensor Shutoff Frequency:**	0.0
AV mode Time:	.0	**Manual Shutoff Frequency:**	0.0
White Board Time:	.0	**Lights On:**	533.5
Settle Mode Time:	.0	**Watts/ sq ft:**	0.98
Settle Mode Counts:	0.0	**School Days:**	148

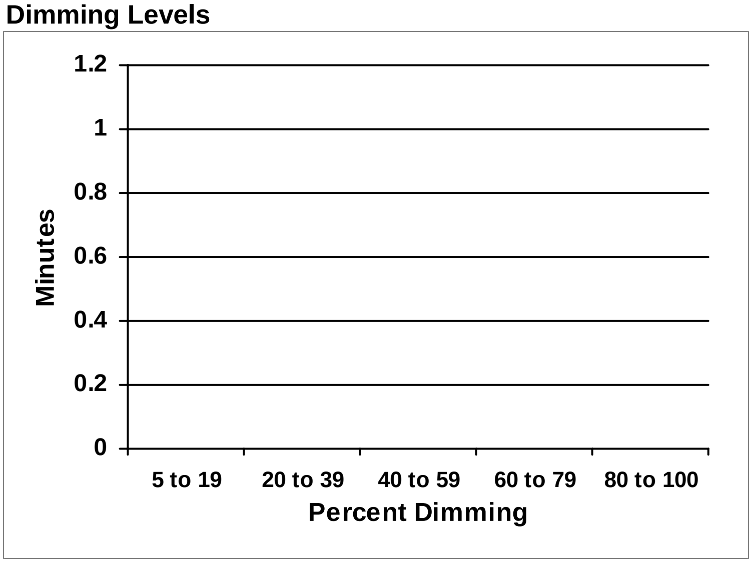
AV Mode



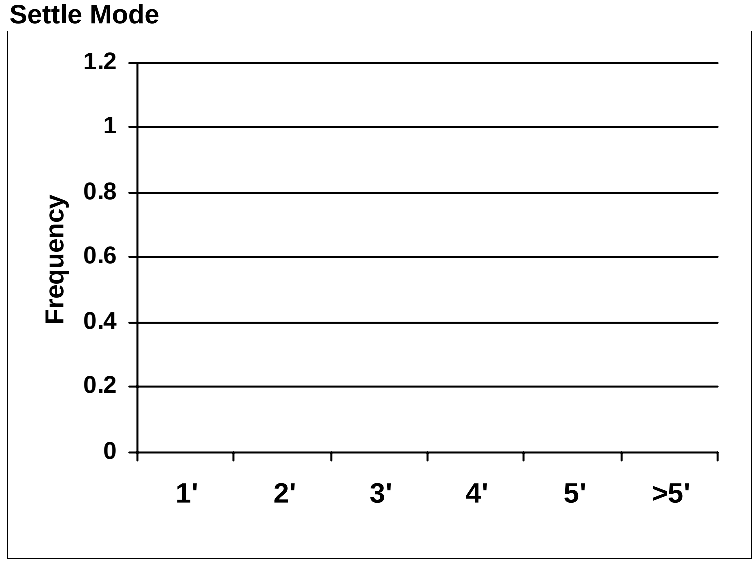
General Mode



Dimming Levels



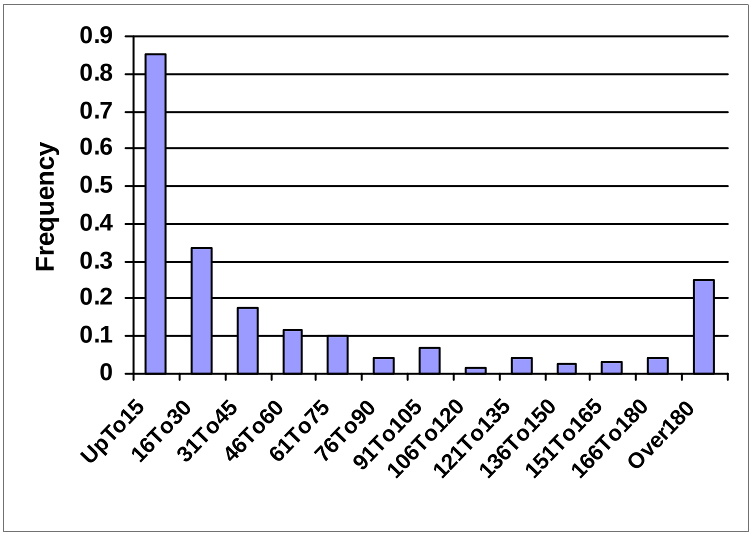
Settle Mode



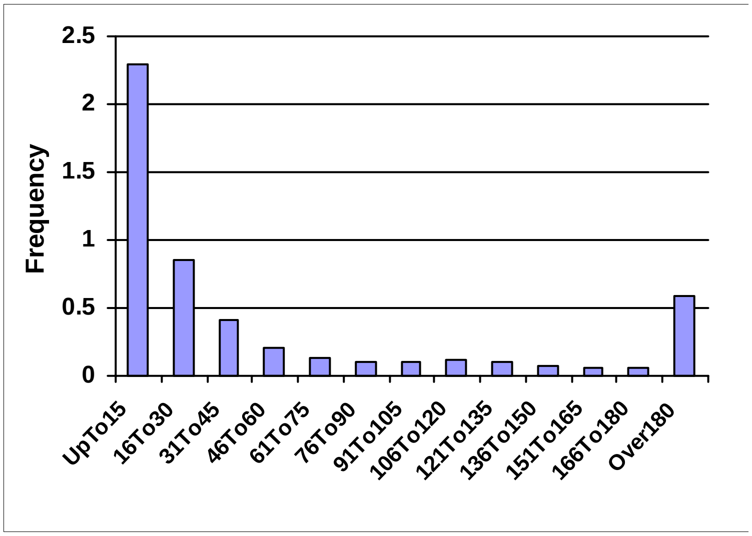
Average Daily Lighting Usage for New School University, Rm 503
From 9/1/06 To 5/31/07

General AV mode Switches:	**.4**	**Quiet Time Usage:**	**0.3**
General Mode Time:	**355.8**	**Occupancy Sensor Shutoff Frequency:**	**3.6**
AV mode Time:	**169.4**	**Manual Shutoff Frequency:**	**3.6**
White Board Time:	**388.6**	**Lights On:**	**525.2**
Settle Mode Time:	**129.1**	**Watts/ sq ft:**	**0.75**
Settle Mode Counts:	**1.6**	**School Days:**	**161**

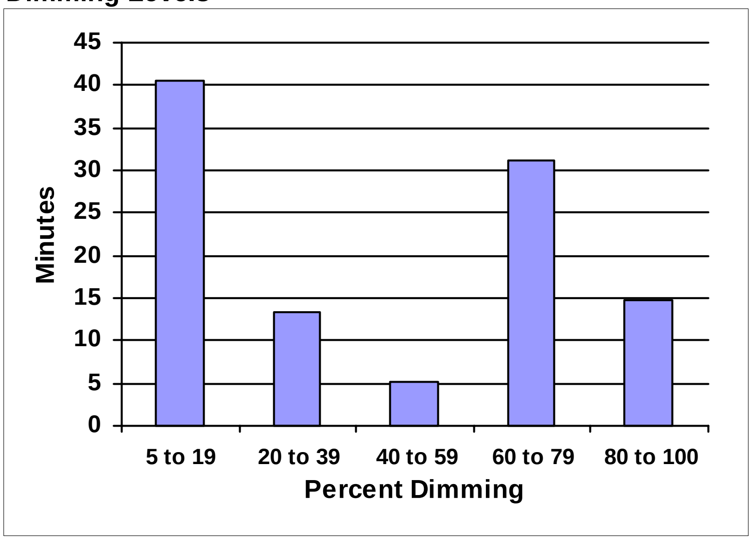
AV Mode



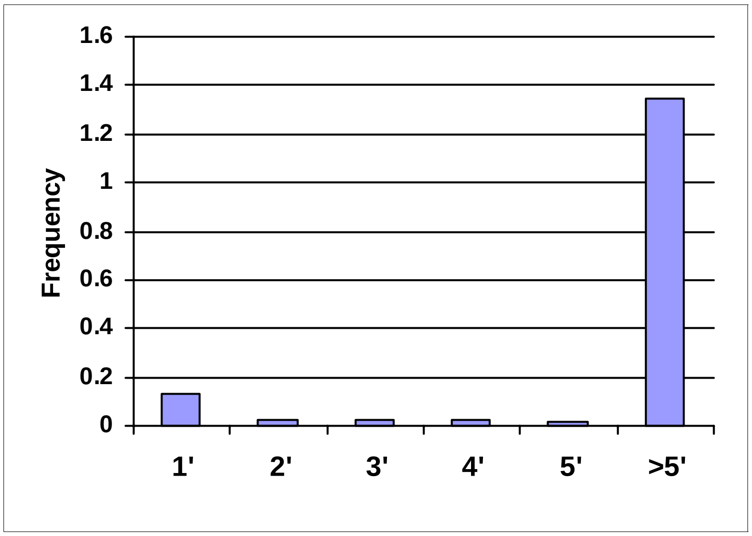
General Mode



Dimming Levels



Settle Mode

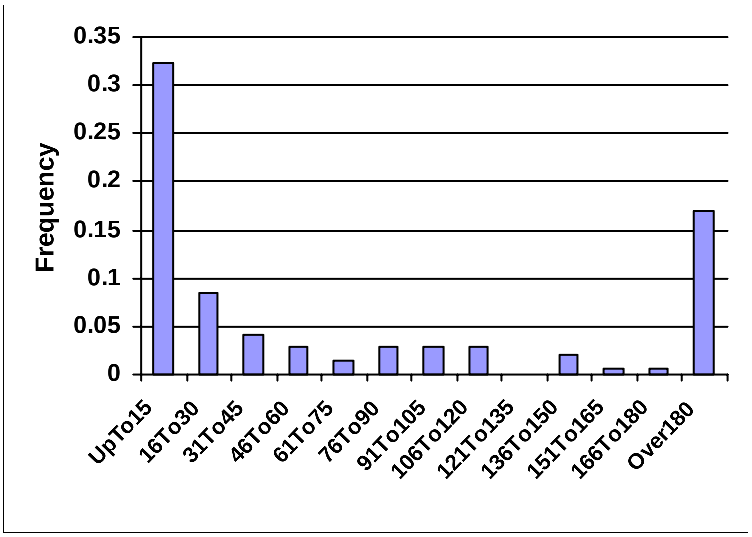


Average Daily Lighting Usage for New School University, Rm 713 From 9/1/06 To 5/31/07

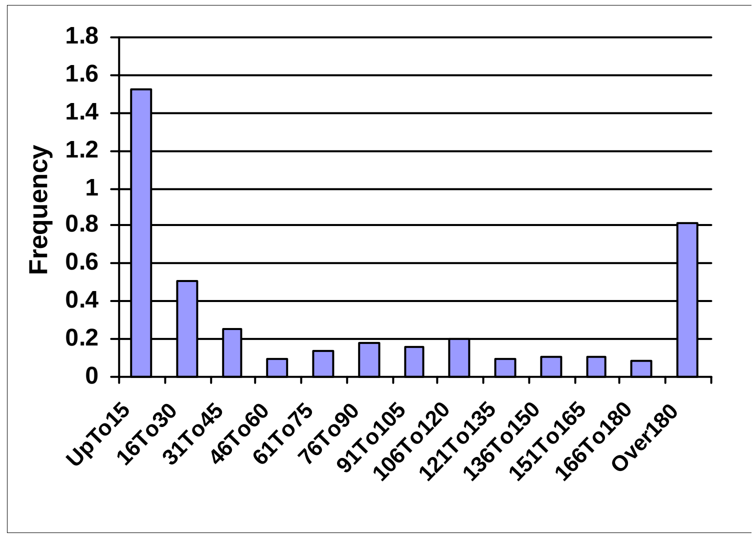
General AV mode Switches: .3
General Mode Time: 486.3
AV mode Time: 88.2
White Board Time: 345.3
Settle Mode Time: 52.9
Settle Mode Counts: 0.5

Quiet Time Usage: 0.2
Occupancy Sensor Shutoff Frequency: 1.7
Manual Shutoff Frequency: 3.3
Lights On: 574.5
Watts/ sq ft: 0.76
School Days: 142

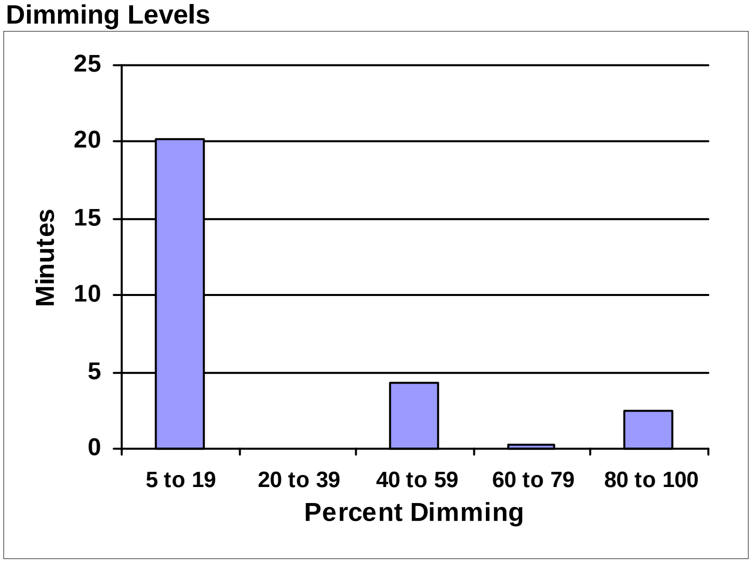
AV Mode



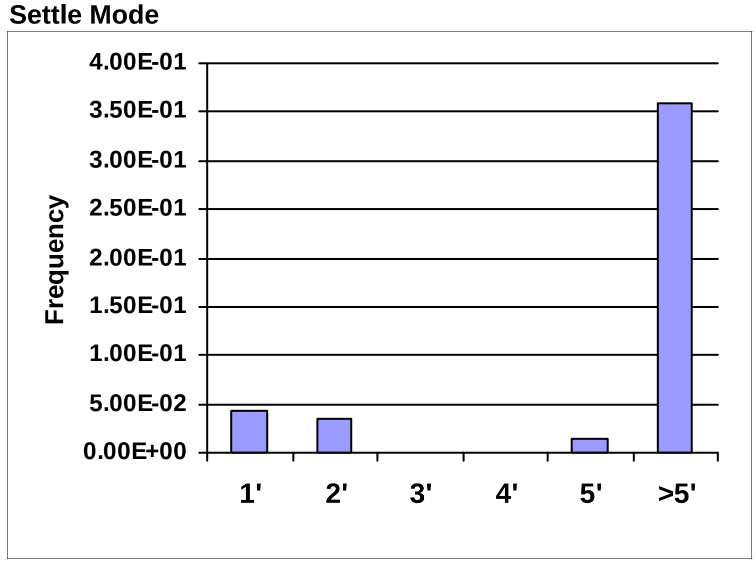
General Mode



Dimming Levels



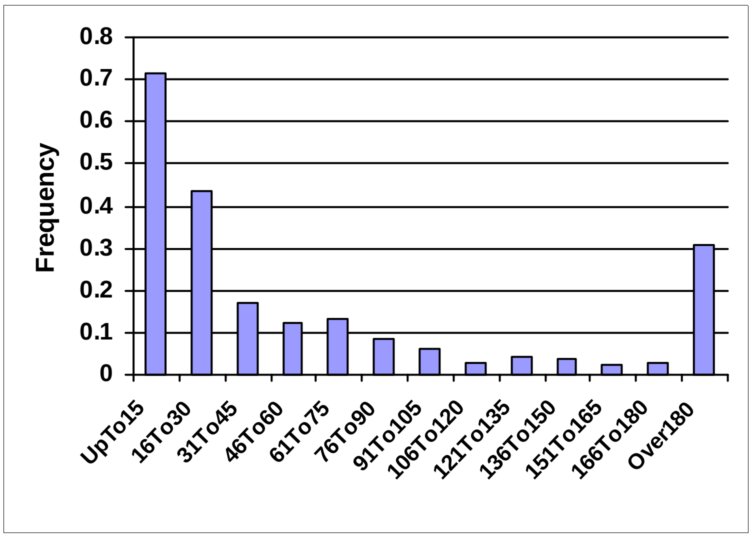
Settle Mode



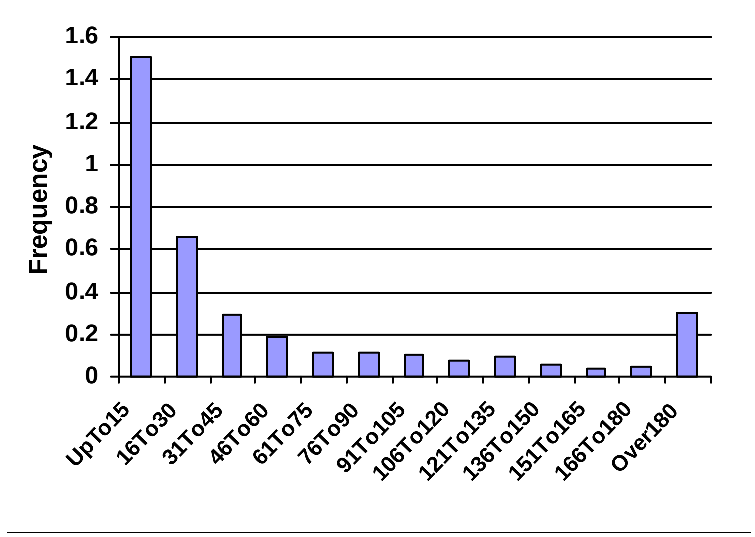
Average Daily Lighting Usage for New School University, Rm 1013
From 9/1/06 To 5/31/07

General AV mode Switches:	**.4**	**Quiet Time Usage:**	**0.3**
General Mode Time:	**212.2**	**Occupancy Sensor Shutoff Frequency:**	**2.0**
AV mode Time:	**163.4**	**Manual Shutoff Frequency:**	**3.7**
White Board Time:	**118.1**	**Lights On:**	**375.6**
Settle Mode Time:	**20.2**	**Watts/ sq ft:**	**0.56**
Settle Mode Counts:	**0.2**	**School Days:**	**165**

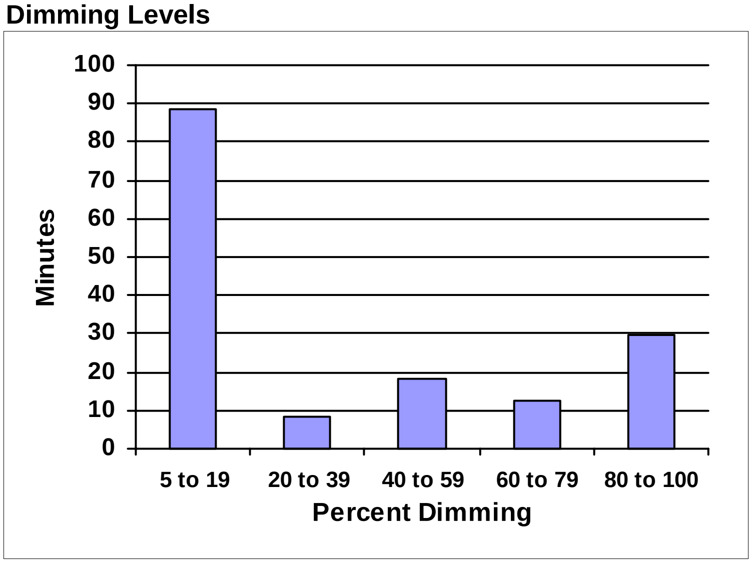
AV Mode



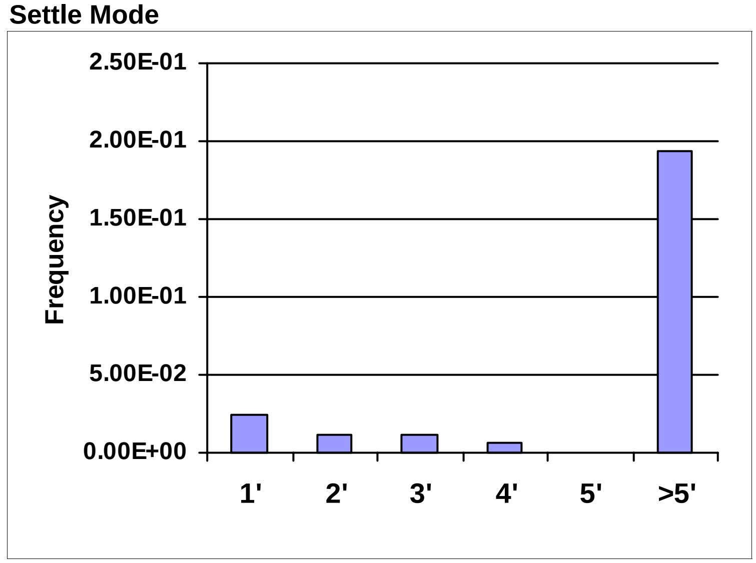
General Mode



Dimming Levels



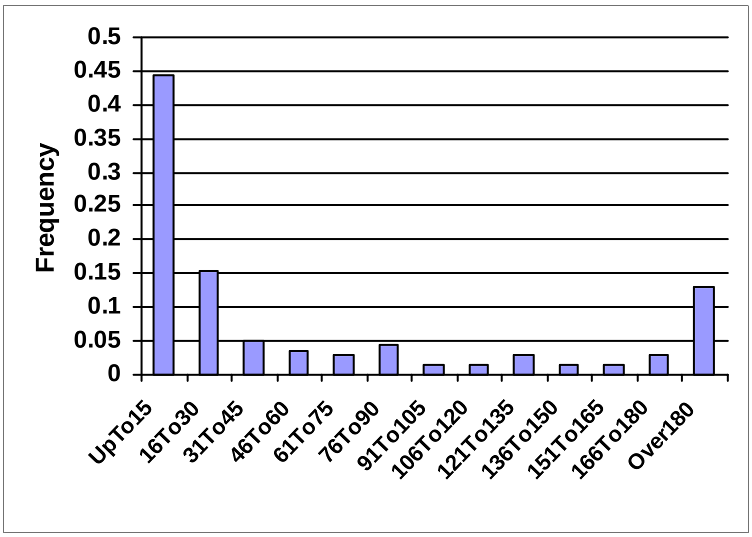
Settle Mode



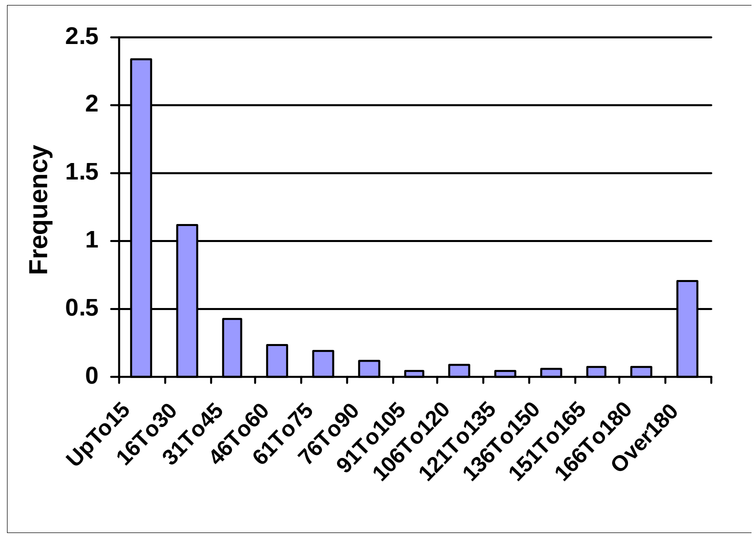
Average Daily Lighting Usage for New School University, Rm 1111
From 9/1/06 To 5/31/07

General AV mode Switches:	**.3**	**Quiet Time Usage:**	**0.5**
General Mode Time:	**385.9**	**Occupancy Sensor Shutoff Frequency:**	**3.2**
AV mode Time:	**81.6**	**Manual Shutoff Frequency:**	**3.6**
White Board Time:	**227.3**	**Lights On:**	**467.6**
Settle Mode Time:	**26.0**	**Watts/ sq ft:**	**0.72**
Settle Mode Counts:	**0.4**	**School Days:**	**137**

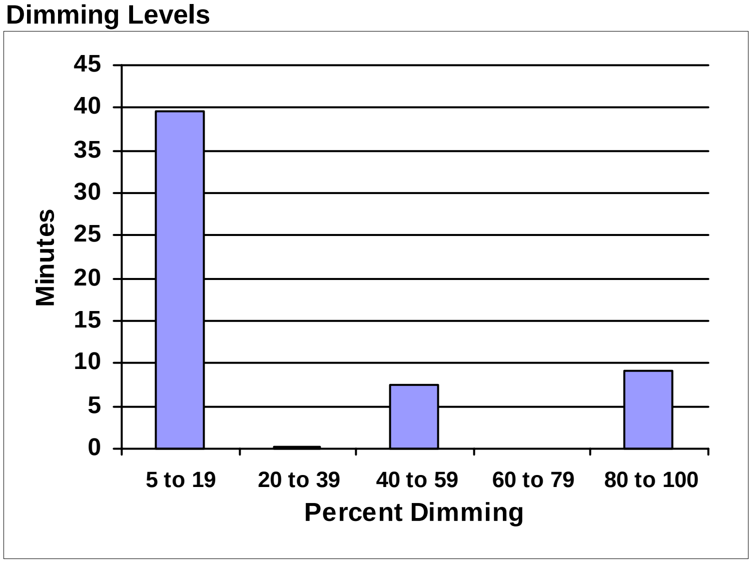
AV Mode



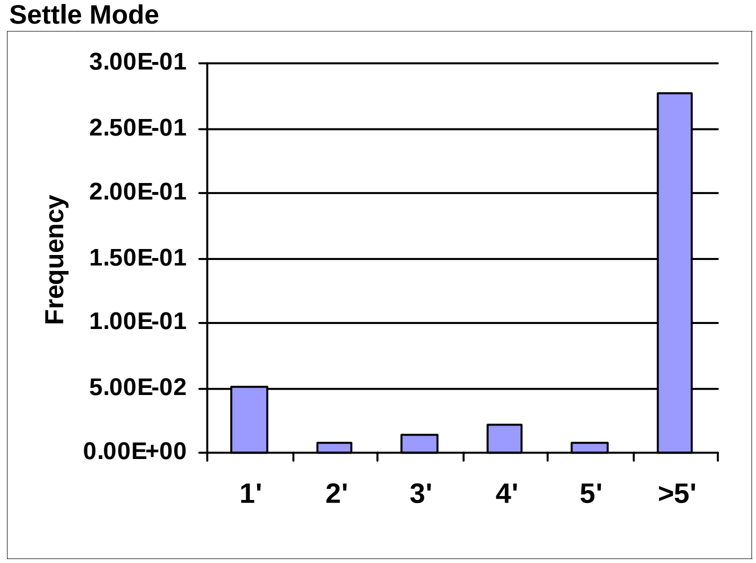
General Mode



Dimming Levels



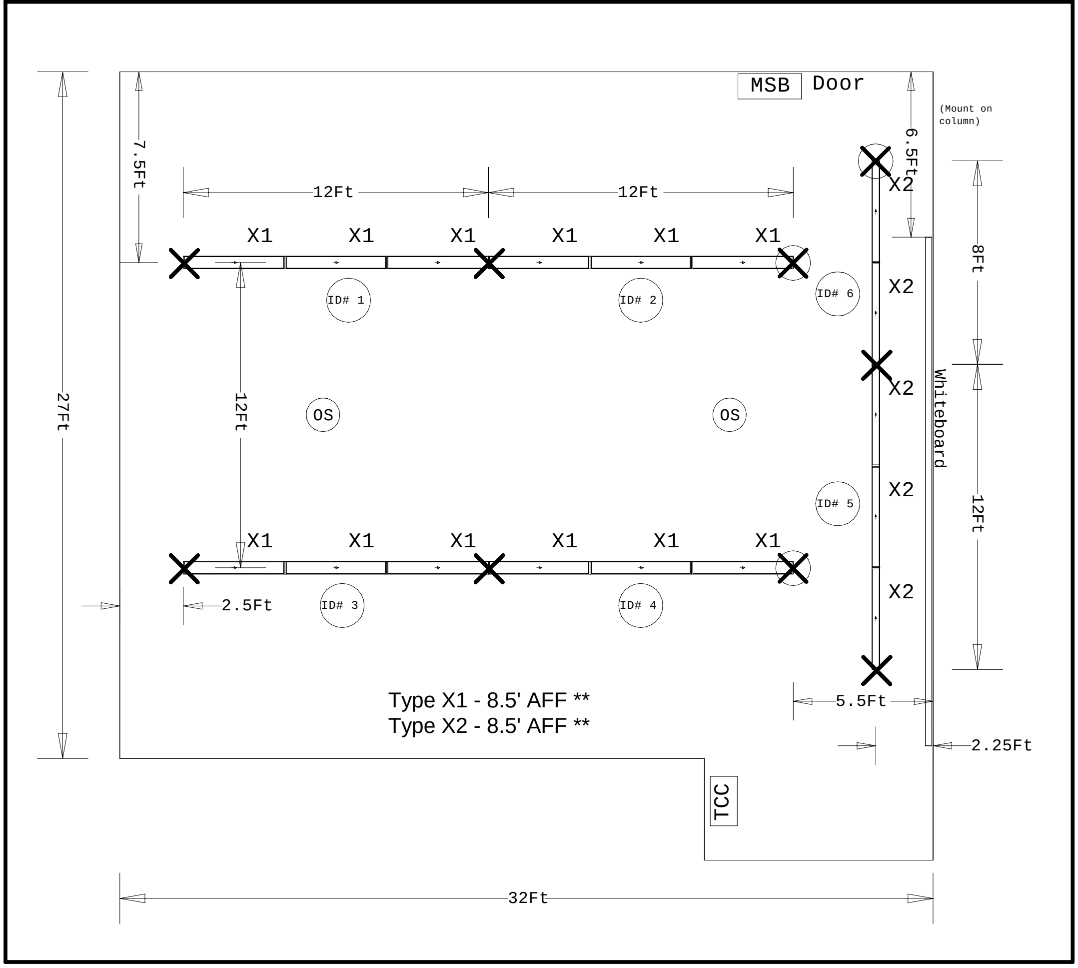
Settle Mode



Appendix K –Rensselaer Polytechnic Institute Information

- Room Dimension and Fixture Layout
- Lighting Layouts and calculations
- Energy Consumption Chart
- Data Summary Table
- Average Daily Lighting Usage Report

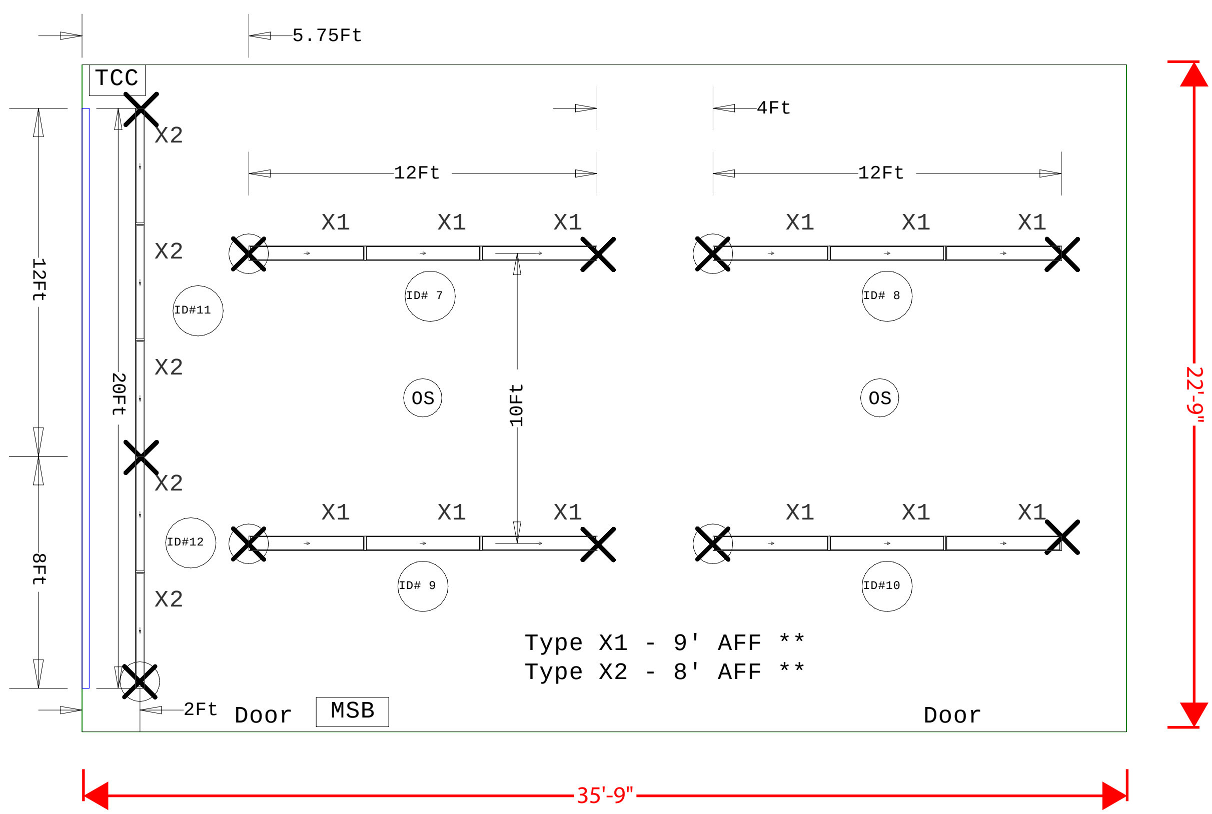
Carnegie, Room 201
Installation Dimensions **



LEGEND	
TCC	Teacher Control Center mounting location: 4'-0" AFF (to top of box). Install on the left side of whiteboard/chalkboard
OS	Occupancy Sensor(s)
	Suspension Point
	Power Feed & Suspension Point (Pre-existing power feed points could affect changes to feed points)
ID# 1	Fixture ID#. Each fixture section will have a label with a unique ID# which can be found on the outside of the box and on the fixture itself.
MSB	Master Switch Bank -- Locate MSB on wall at entrance(s) to room. Exact location to be determined on-site.

** Site conditions could influence fixture placement and suspension. All fixtures to be mounted "on-grid" (if ceiling is grid type) therefore the attached dimensional information is approximate. The spacing between rows is the most important dimension to maintain.

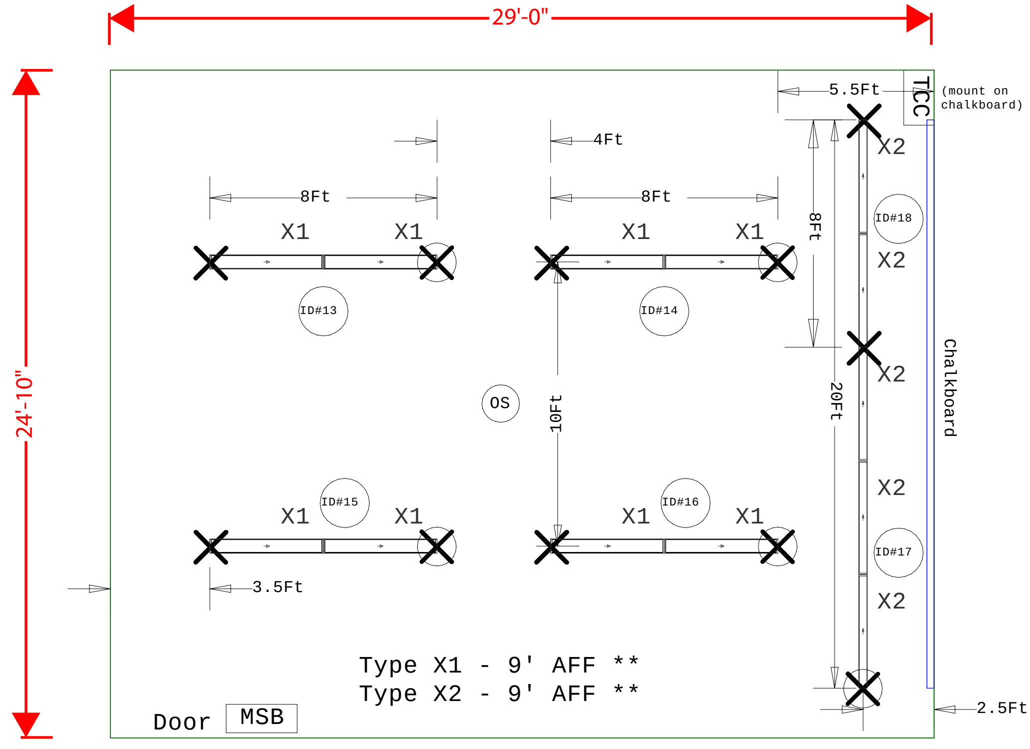
Ricketts, Room 212
Installation Dimensions



LEGEND	
TCC	Teacher Control Center mounting location: 4'-0" AFF (to top of box). Install on the left side of whiteboard/chalkboard
OS	Occupancy Sensor(s)
	Suspension Point
	Power Feed & Suspension Point (Pre-existing power feed points could affect changes to feed points)
ID# 1	Fixture ID#. Each fixture section will have a label with a unique ID# which can be found on the outside of the box and on the fixture itself.
MSB	Master Switch Bank -- Locate MSB on wall at entrance(s) to room. Exact location to be determined on-site.

** Site conditions could influence fixture placement and suspension. All fixtures to be mounted "on-grid" (if ceiling is grid type) therefore the attached dimensional information is approximate. The spacing between rows is the most important dimension to maintain.

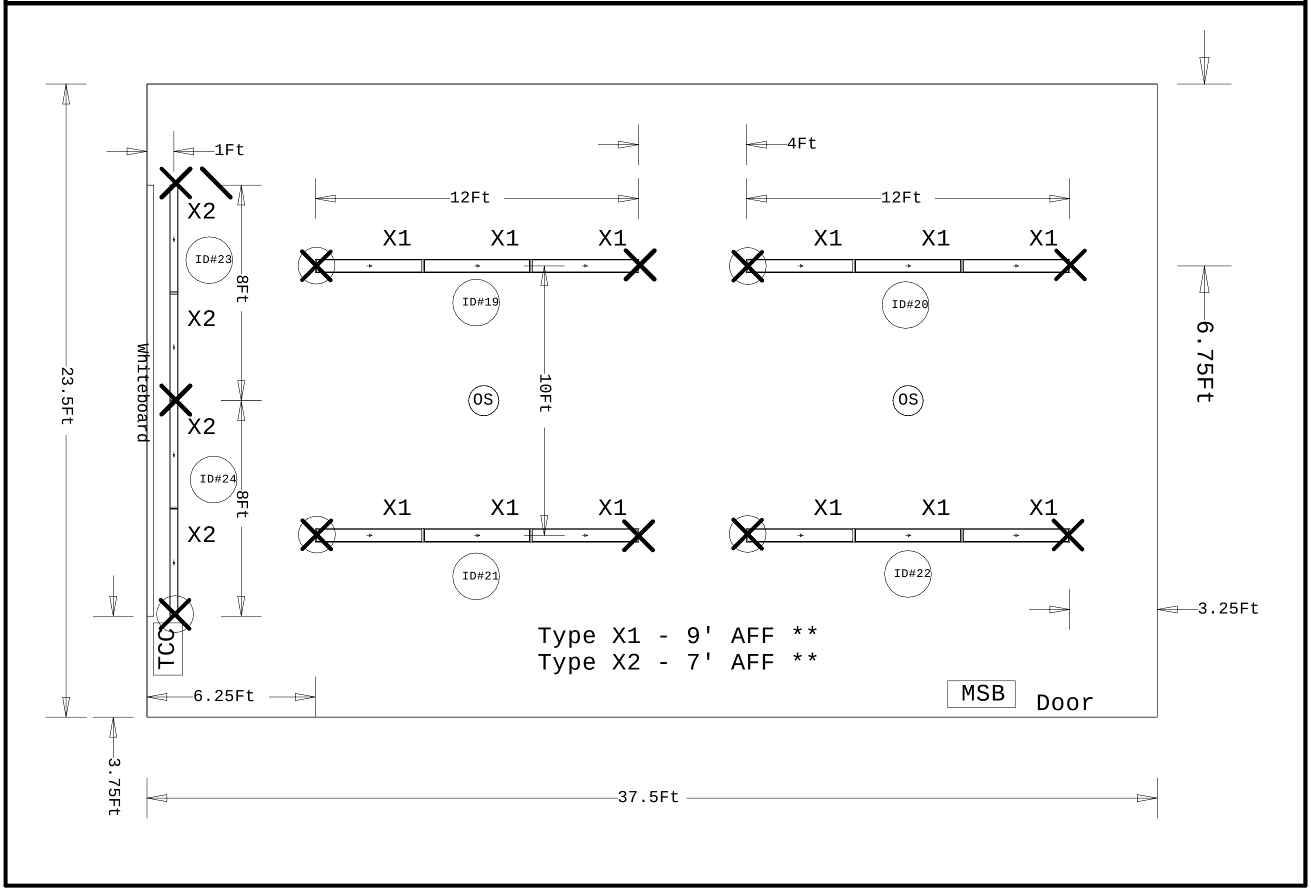
Sage Lab, Room 2707
Installation Dimensions



LEGEND	
TCC	Teacher Control Center mounting location: 4'-0" AFF (to top of box). Install on the left side of whiteboard/chalkboard
OS	Occupancy Sensor(s)
X	Suspension Point
⊗	Power Feed & Suspension Point (Pre-existing power feed points could affect changes to feed points)
ID# 1	Fixture ID#. Each fixture section will have a label with a unique ID# which can be found on the outside of the box and on the fixture itself.
MSB	Master Switch Bank -- Locate MSB on wall at entrance(s) to room. Exact location to be determined on-site.

** Site conditions could influence fixture placement and suspension. All fixtures to be mounted "on-grid" (if ceiling is grid type) therefore the attached dimensional information is approximate. The spacing between rows is the most important dimension to maintain.

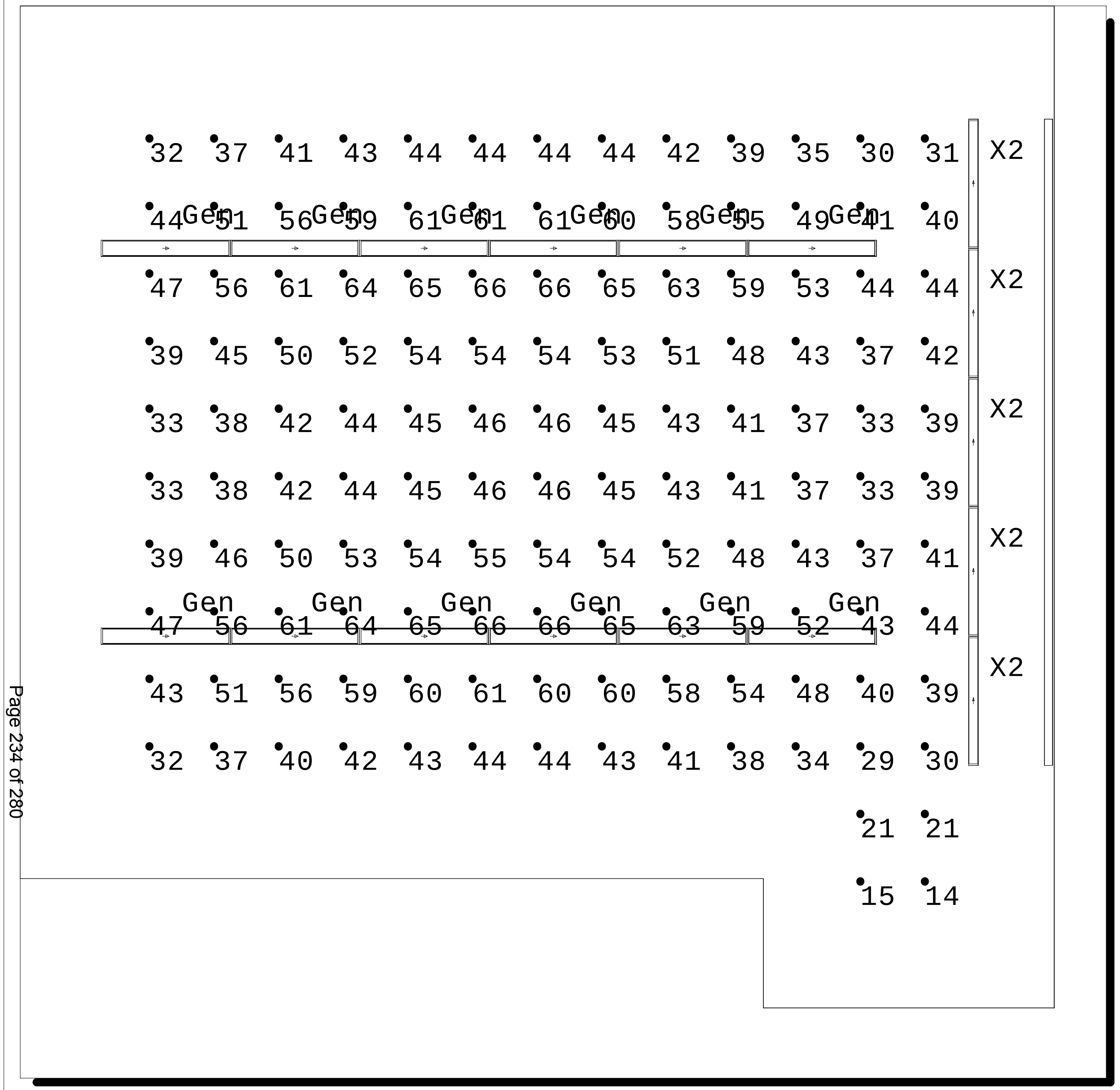
Sage Lab, Room 2715
Installation Dimensions **

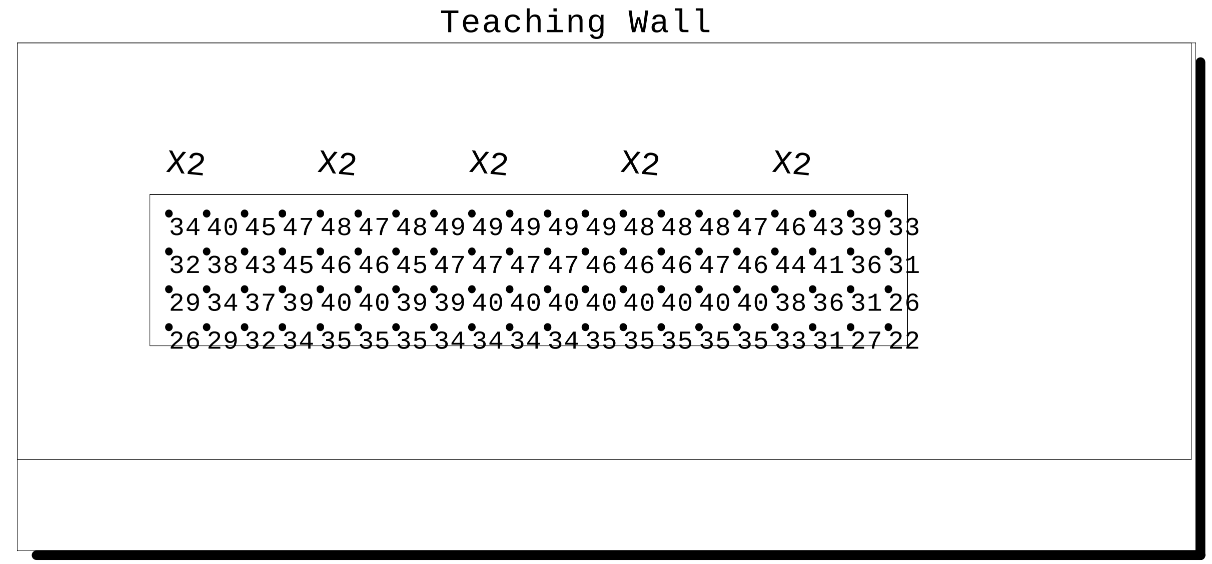


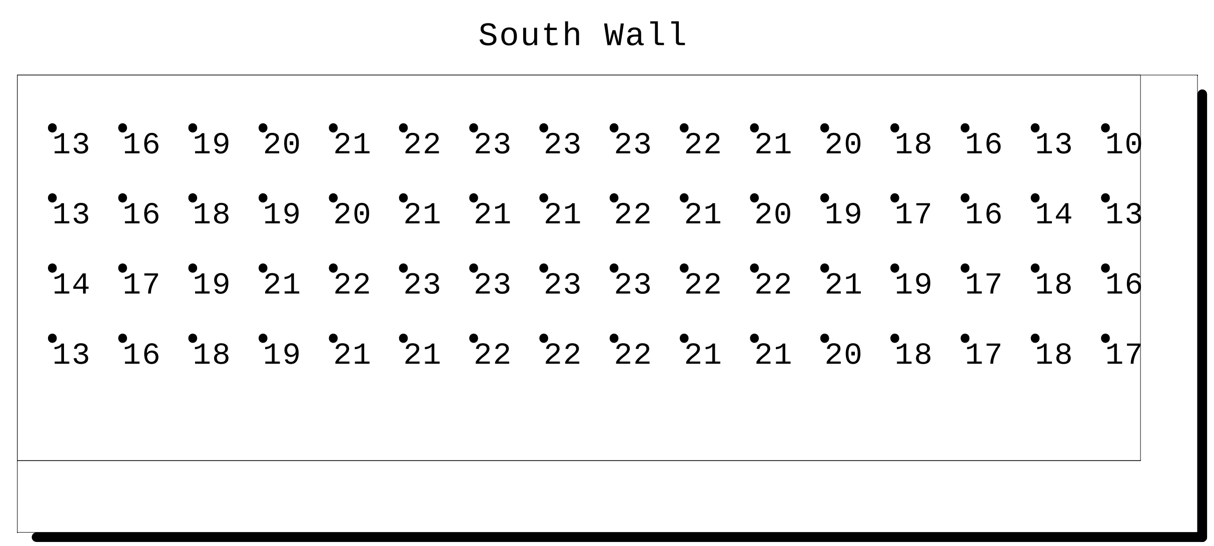
LEGEND	
TCC	Teacher Control Center mounting location: 4'-0" AFF (to top of box). Install on the left side of whiteboard/chalkboard
OS	Occupancy Sensor(s)
	Suspension Point
	Power Feed & Suspension Point (Pre-existing power feed points could affect changes to feed points)
ID# 1	Fixture ID#. Each fixture section will have a label with a unique ID# which can be found on the outside of the box and on the fixture itself.
MSB	Master Switch Bank -- Locate MSB on wall at entrance(s) to room. Exact location to be determined on-site.

** Site conditions could influence fixture placement and suspension. All fixtures to be mounted "on-grid" (if ceiling is grid type) therefore the attached dimensional information is approximate. The spacing between rows is the most important dimension to maintain.

GENERAL MODE







Luminaire Schedule									
Project: RPI, Carnegie, Room 201									
Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	5	X2	3100	0.752	SX2 WCB 1T8 96W	0.88	28	0.9	0.95
	12	Gen	3100	0.752	X1 PLV CCO 2T8 EP	0.88	55	0.9	0.95

Numeric Summary							
Project: RPI, Carnegie, Room 201							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Chalkboard	Illuminance	Fc	39.63	49	22	1.80	2.23
North Wall	Illuminance	Fc	19.02	23	10	1.90	2.30
Horizontal WP	Illuminance	Fc	46.83	66	14	3.35	4.71

Room Summary		
Project: RPI, Carnegie, Room 201		
Label	Wall Ht.	Description
Room 201	11	32' x 27' + alcove; Reflect. 70/50/20

LPD Area Summary			
Project: RPI, Carnegie, Room 201			
Label	Area	Total Watts	LPD
Room 201	900	800	0.889

SX1 luminaires 9' AFF; X2 luminaire is 8.5' AFF. Calculations based on Osram QHE .88 Instant Start Ballasts on outboard lamps and Osram Powersense Dimming Ballasts on the center lamps. QHE .88 IS ballasts on Type X2.

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

PHOTOMETRIC DATA USED AS INPUT FOR THESE CALCULATIONS IS BASED ON ESTABLISHED IES PROCEDURES AND PUBLISHED LAMP & BALLAST RATINGS. FIELD PERFORMANCE WILL DEPEND ON ACTUAL LAMP, BALLAST, ELECTRICAL AND SITE CHARACTERISTICS.

VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT 30" ABOVE FINISHED FLOOR.
AGI32 VERSION 1.8

FINELITE
Better Lighting for a Better Workplace

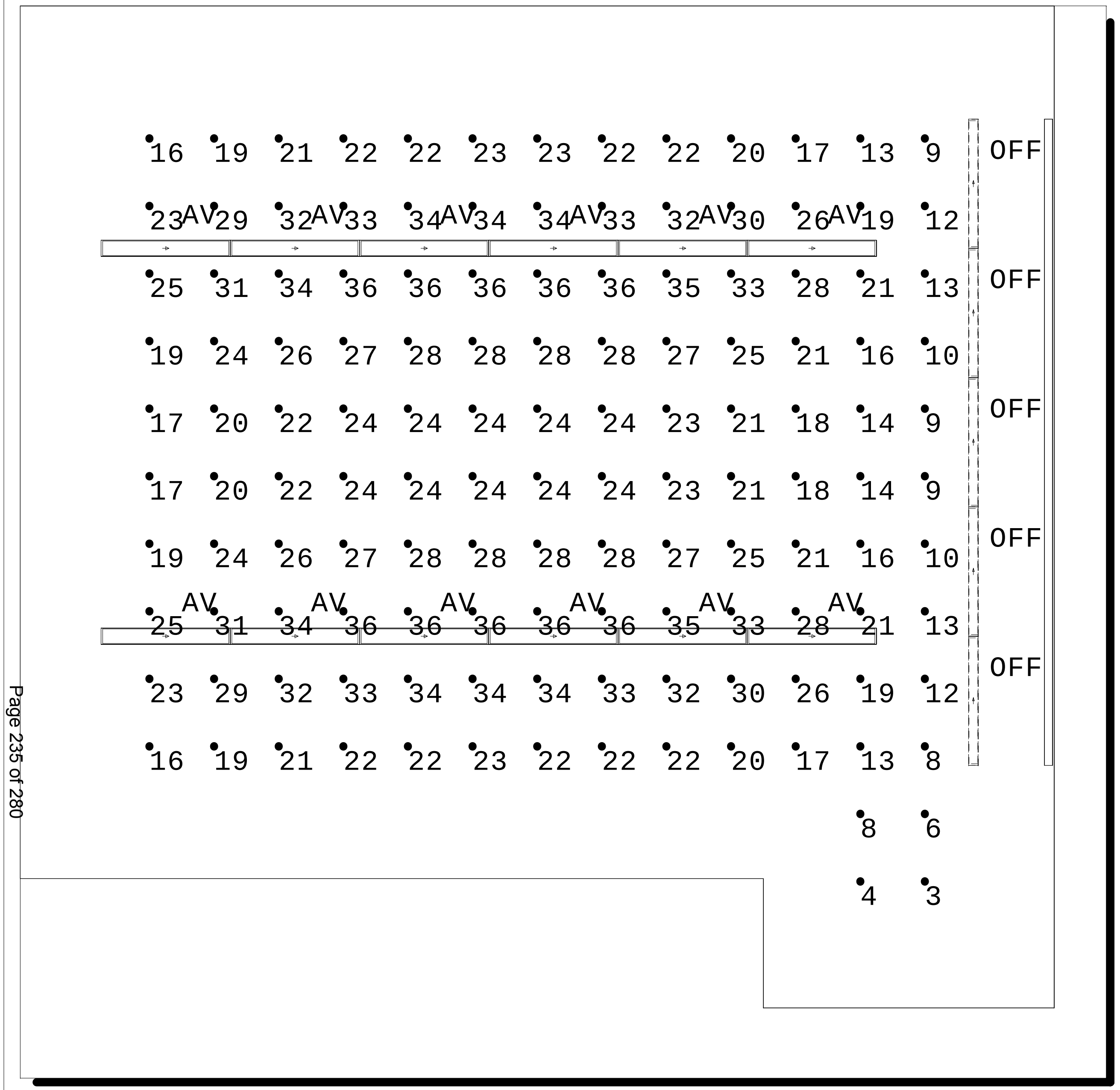
#	Date	Comments

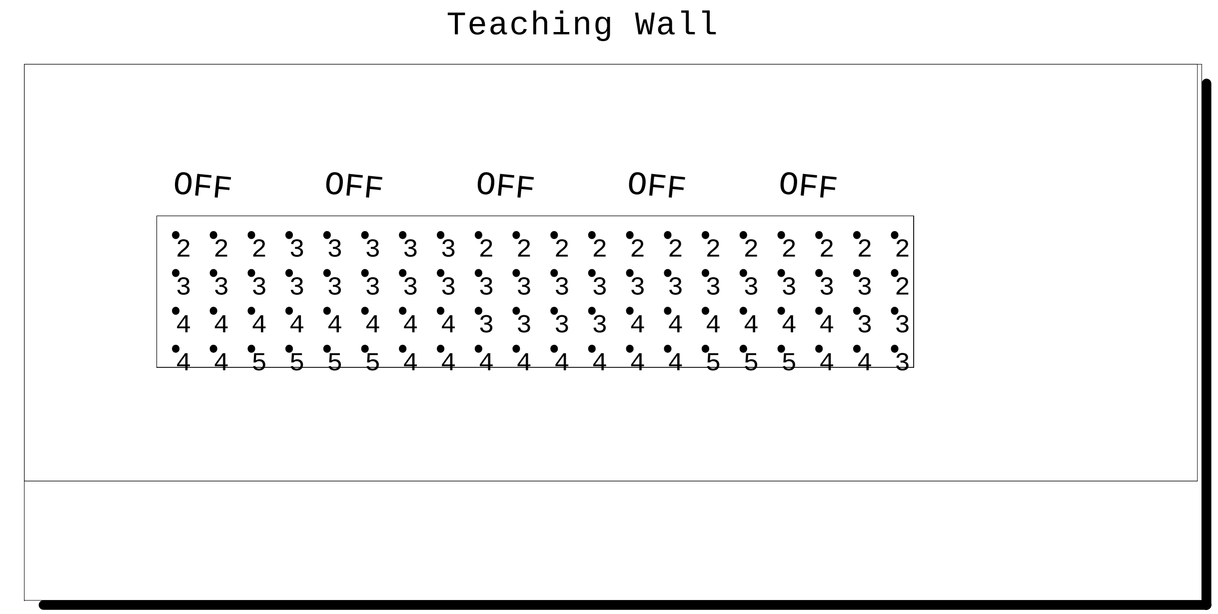
Revisions

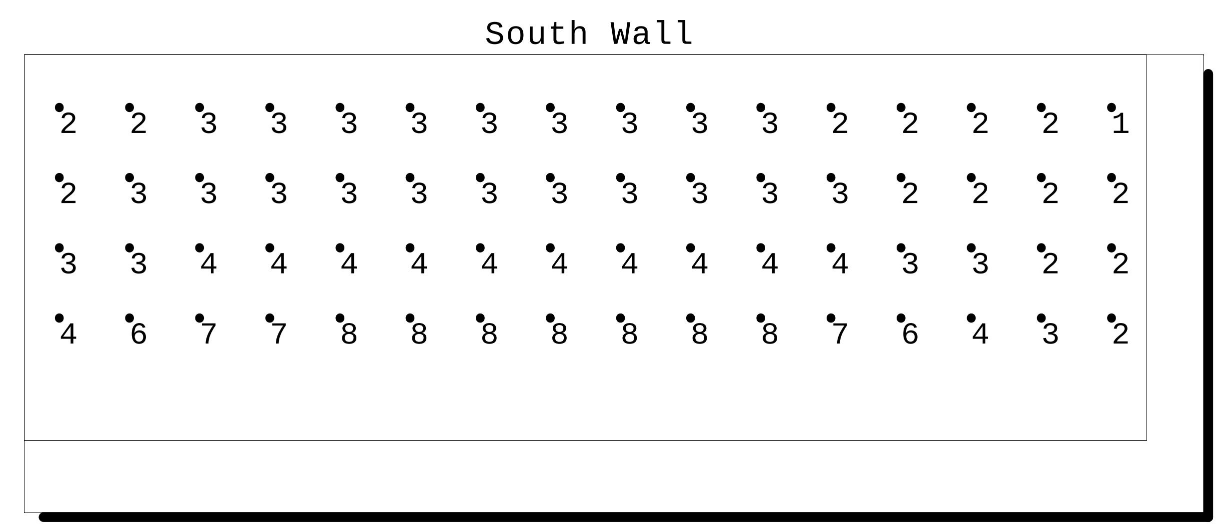
Drawn By: V Lauck
Date: April, 2006

Project: NYSERDA
RPI, Carnegie, Room 201

AVMODE







Luminaire Schedule									
Project: RPI, Carnegie, Room 201									
Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	12	AV	3100	0.752	X1 PLV COO 1T8 EP	0.88	30	0.9	0.95
	5	OFF	3100	0.752	SX2 WCB 1T8 96W	0.88	28	0.9	0.95

Numeric Summary							
Project: RPI, Carnegie, Room 201							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Chalkboard	Illuminance	Fc	3.30	5	2	1.65	2.50
North Wall	Illuminance	Fc	3.77	8	1	3.77	8.00
Horizontal WP	Illuminance	Fc	23.89	36	3	7.96	12.00

Room Summary		
Project: RPI, Carnegie, Room 201		
Label	Wall Ht.	Description
Room 201	11	32' x 27' + alcove; Reflect. 70/50/20

LPD Area Summary			
Project: RPI, Carnegie, Room 201			
Label	Area	Total Watts	LPD
Room 201	900	360	0.400

SX1 luminaires 9' AFF; X2 luminaire is 8.5' AFF
Calculations based on Osram QHE .88 Instant Start Ballasts on outboard lamps and Osram Powersense Dimming Ballasts on the center lamps.

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

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VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT 30" ABOVE FINISHED FLOOR.
AGI32 VERSION 1.8

FINELITE
Better Lighting for a Better Workplace

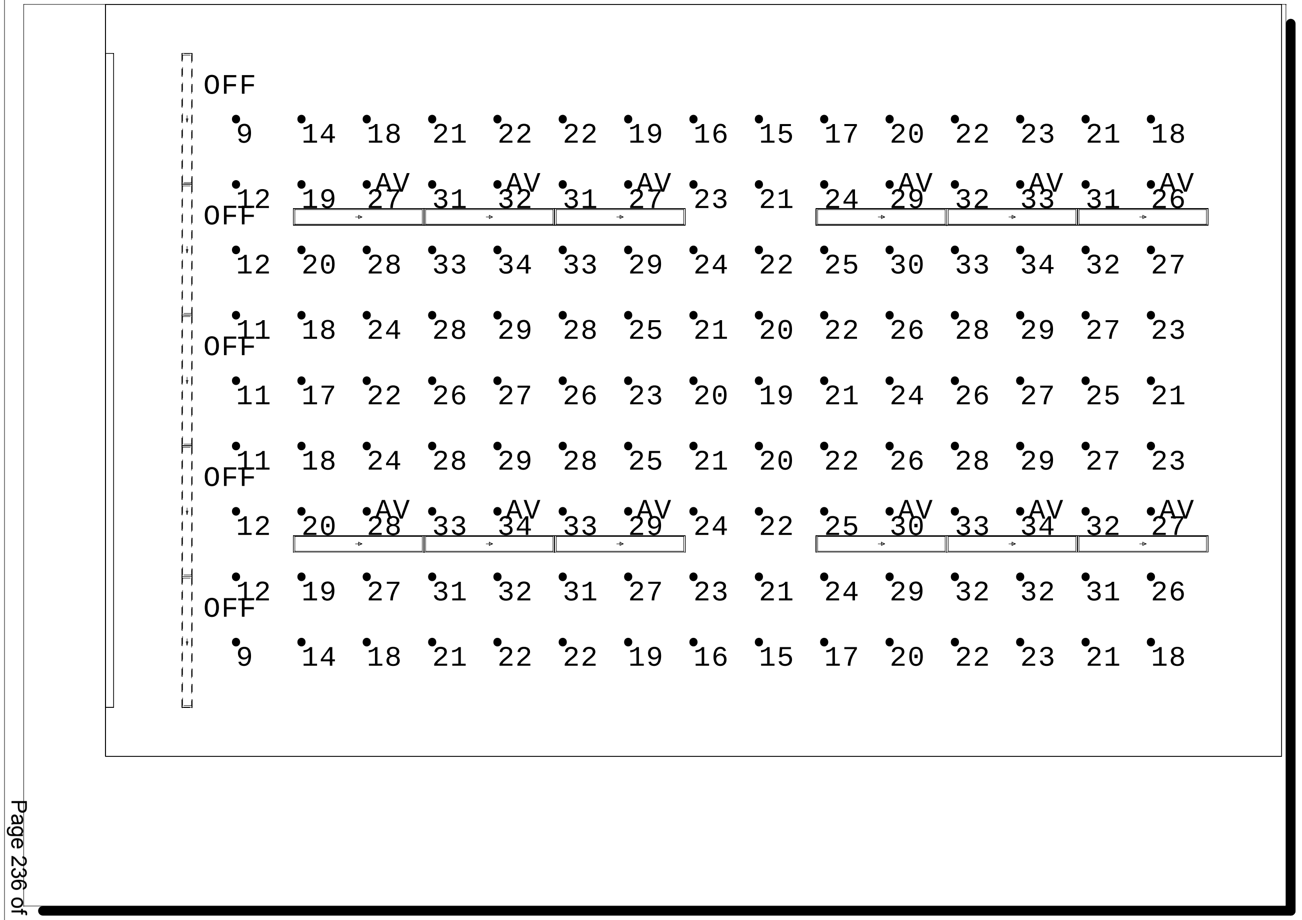
#	Date	Comments

Revisions

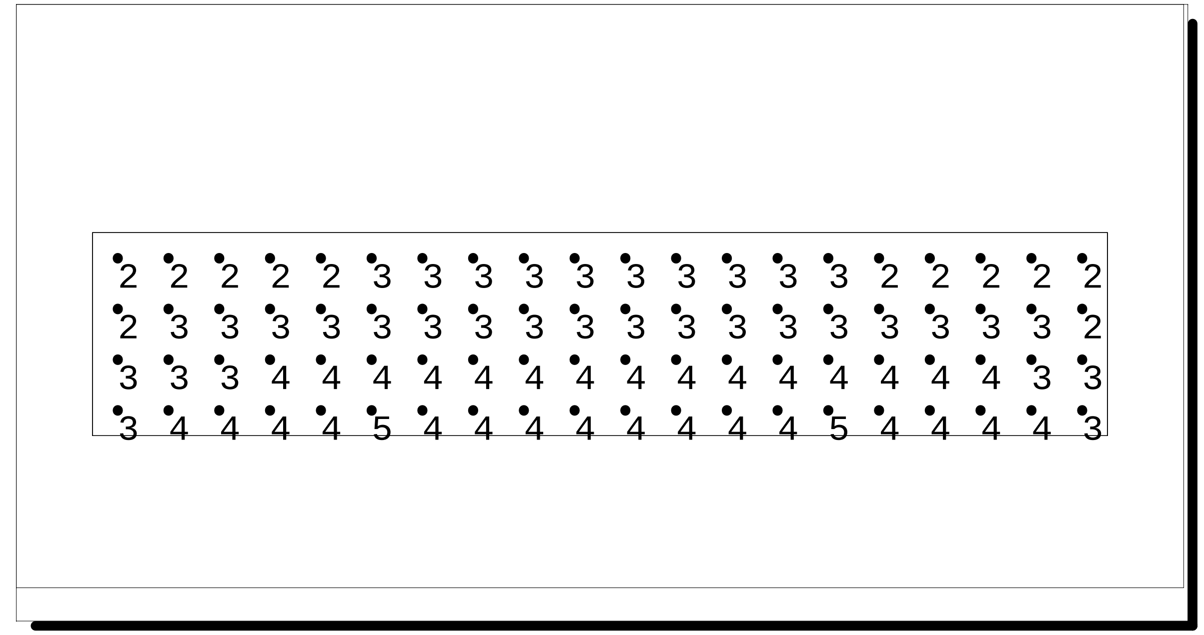
Drawn By: V Lauck
Date: April, 2006

Project: NYSERDA
RPI, Carnegie, Room 201

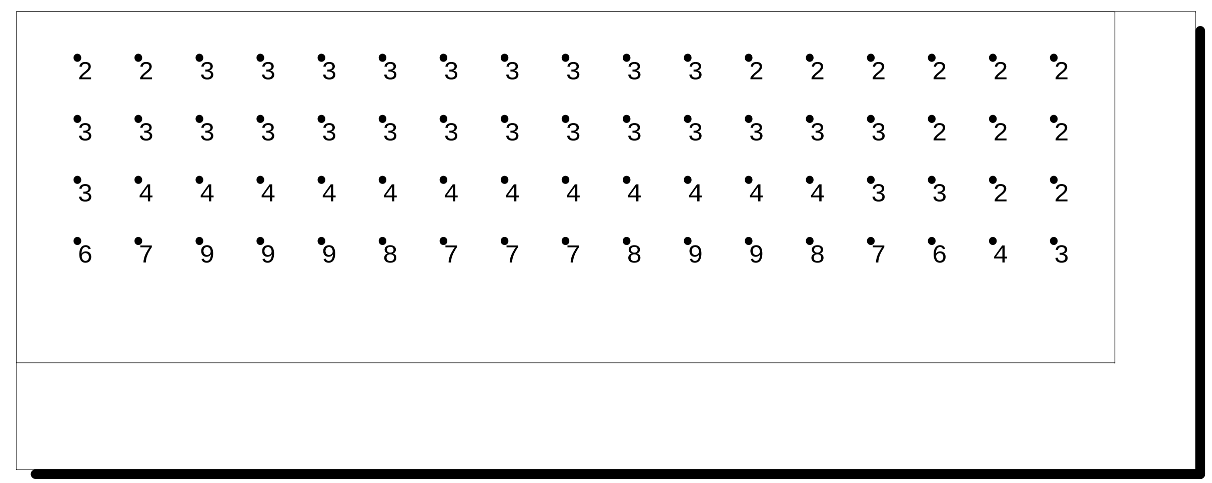
AV MODE



Teaching Wall



South Wall



Luminaire Schedule									
Project: RPI, Ricketts, Room 212									
Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	12	AV	3100	0.752	X1 PLV COO 1T8 EP	0.88	30	0.9	0.95
	5	OFF	3100	1.026	SX2 WCB 1T8 96W	1.2	38	0.9	0.95

Numeric Summary							
Project: RPI, Ricketts, Room 212							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Chalkboard	Illuminance	Fc	3.29	5	2	1.65	2.50
South Wall	Illuminance	Fc	4.04	9	2	2.02	4.50
Horizontal WP	Illuminance	Fc	23.96	34	9	2.66	3.78

Room Summary		
Project: RPI, Ricketts, Room 212		
Label	Wall Ht.	Description
Room 212	11.5	36' x 23' Refl 70/50/20 (west wall 25%)

LPD Area Summary			
Project: RPI, Ricketts, Room 212			
Label	Area	Total Watts	LPD
Room 212	828	360	0.435

SX1 luminaires 9' AFF; X2 luminaire is 8.5' AFF.
Calculations based on Osram .78 QHE Instant Start Ballasts on outboard lamps and Osram Powersense Dimming Ballasts on the center lamps.

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

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VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT 30" ABOVE FINISHED FLOOR.
AGI32 VERSION 1.8

FINELITE
Better Lighting for a Better Workplace

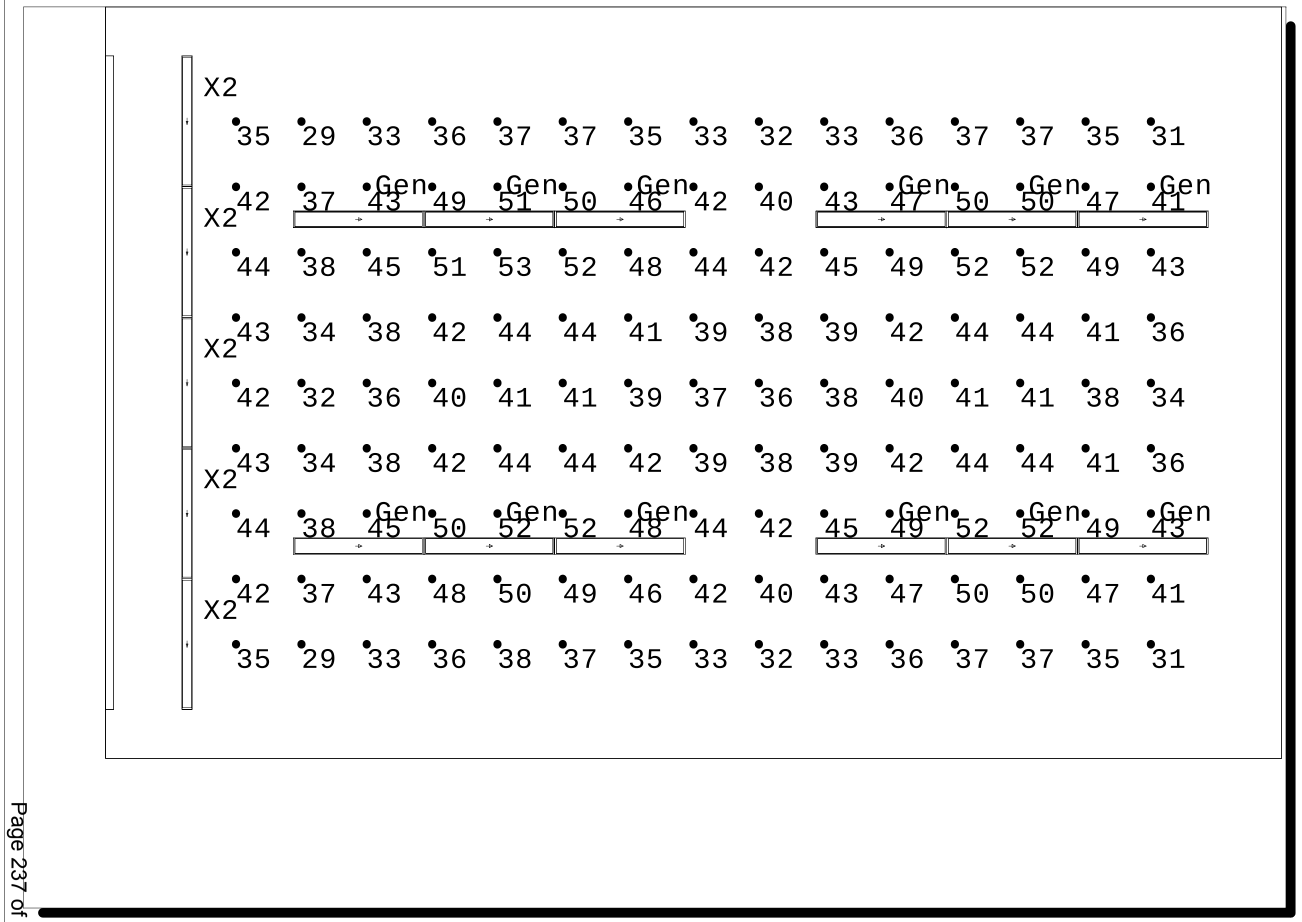
#	Date	Comments

Revisions

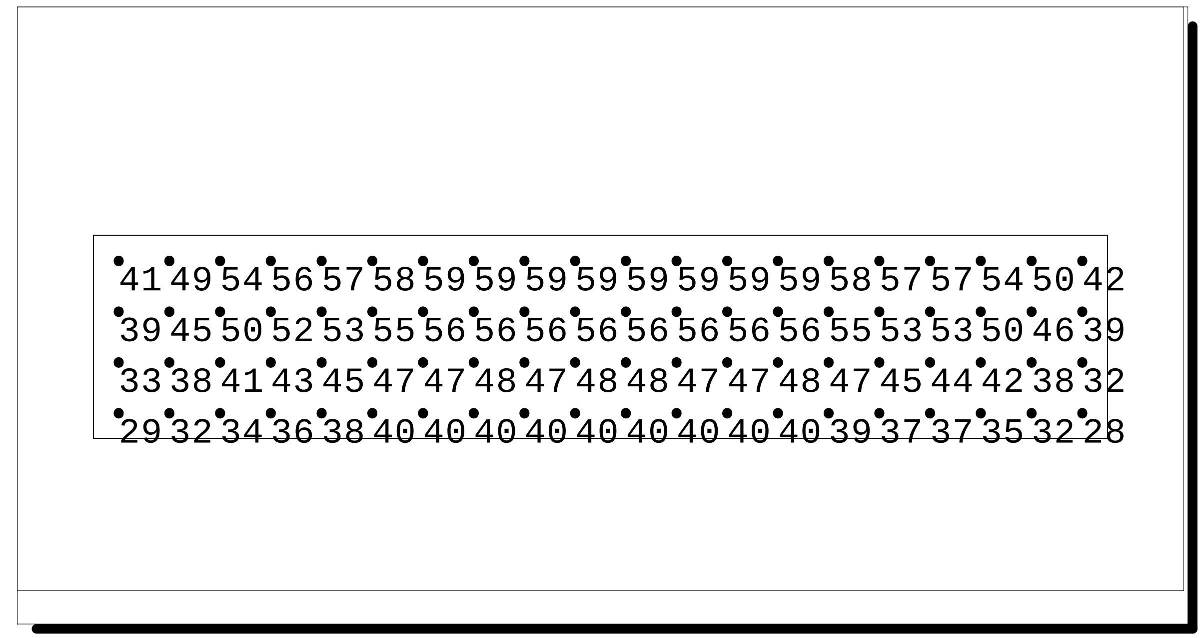
Drawn By: V Lauck
Date: April, 2006

Project: NYSERDA
RPI, Ricketts, Room 212

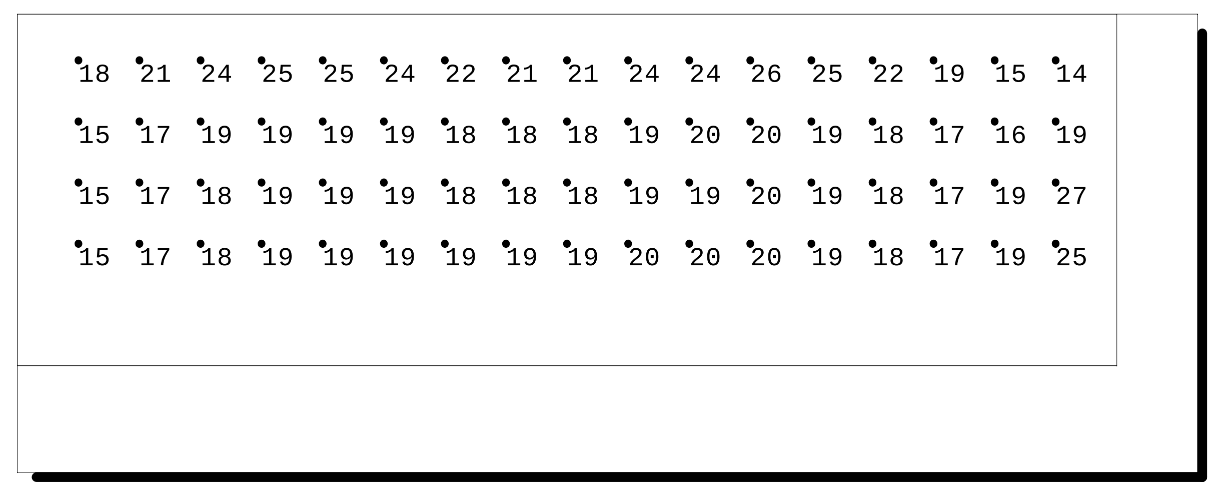
GENERAL MODE



Teaching Wall



South Wall



Luminaire Schedule
Project: RPI, Ricketts, Room 212

Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	12	Gen	3100	0.667	X1 PLV CCO 2T8 EP	0.78	48	0.9	0.95
	5	X2	3100	1.026	SX2 WCB 1T8 96W	1.2	38	0.9	0.95

Numeric Summary
Project: RPI, Ricketts, Room 212

Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Horizontal WP	Illuminance	Fc	41.43	53	29	1.43	1.83
South Wall	Illuminance	Fc	19.43	27	14	1.39	1.93
Chalkboard	Illuminance	Fc	46.94	59	28	1.68	2.11

Room Summary
Project: RPI, Ricketts, Room 212

Label	Wall Ht.	Description
Room 212	11.5	36' x 23' Refl 70/50/20 (west wall 25%)

LPD Area Summary
Project: RPI, Ricketts, Room 212

Label	Area	Total Watts	LPD
Room 212	828	766	0.925

SX1 luminaires 9' AFF; X2 luminaire is 8.5' AFF.
Calculations based on Osram QHE .78 Instant Start Ballasts on outboard lamps and Osram Powersense Dimming Ballasts on the center lamps. QHE 1.18 IS ballasts on Type X2.

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

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VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT 30" ABOVE FINISHED FLOOR.
AGI32 VERSION 1.8

FINELITE
Better Lighting for a Better Workplace

#	Date	Comments

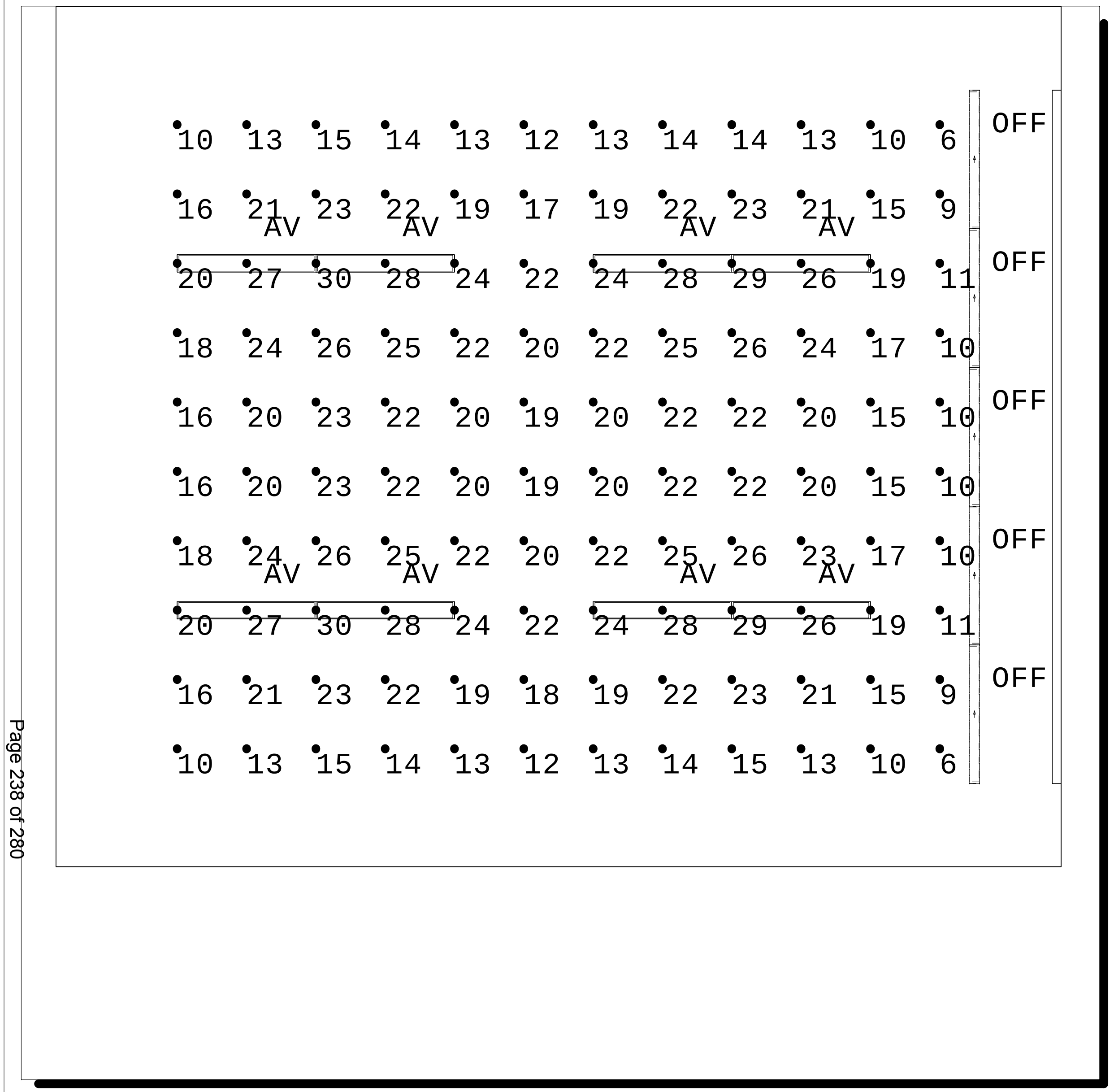
Revisions

Drawn By: V Lauck
Date: April, 2006

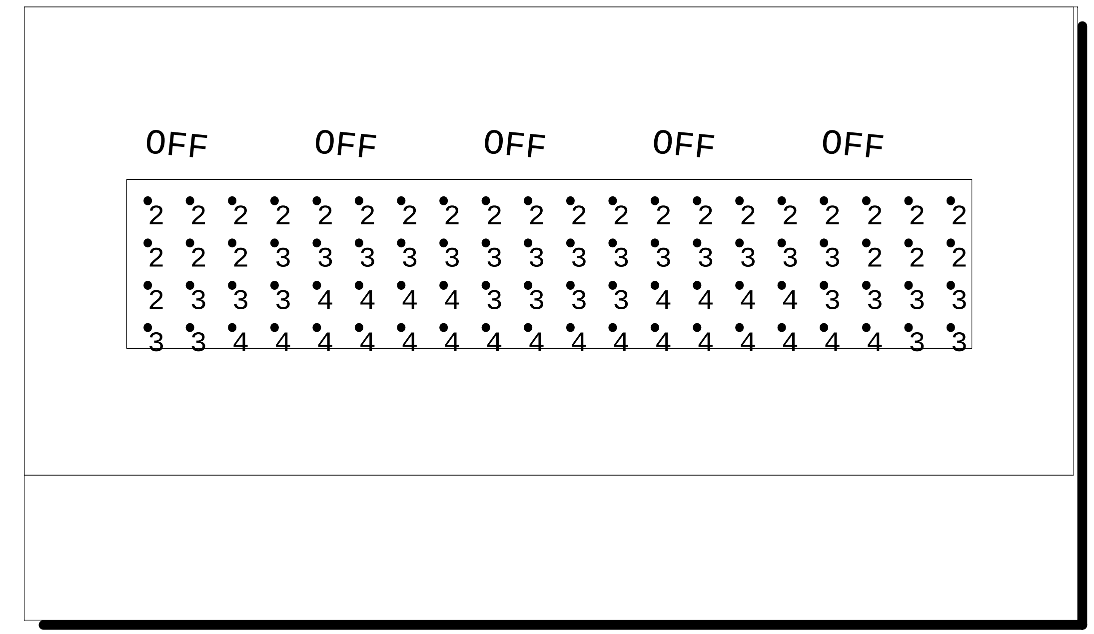
Project: NYSERDA
RPI, Ricketts, Room 212

Page 1 of 1

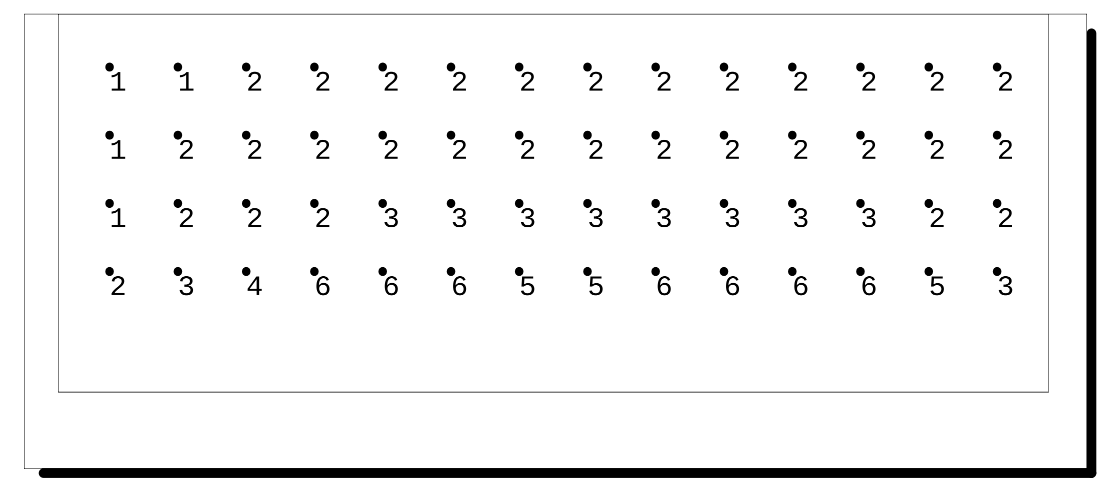
AV MODE



Teaching Wall



South Wall



Luminaire Schedule									
Project: RPI, Sage Lab, Room 2707									
Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	8	AV	3100	0.752	X1 PLV COO 1T8 EP	0.88	30	0.9	0.95
	5	OFF	3100	0.752	SX2 WCB 1T8 96W	0.88	28	0.9	0.95

Numeric Summary							
Project: RPI, Sage Lab, Room 2707							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Chalkboard	Illuminance	Fc	2.96	4	2	1.48	2.00
South Wall	Illuminance	Fc	2.80	6	1	2.80	6.00
Horizontal WP	Illuminance	Fc	19.18	30	6	3.20	5.00

Room Summary		
Project: RPI, Sage Lab, Room 2707		
Label	Wall Ht.	Description
Room 2707	11.083	29' x 24'-10"; Refl: 70/50/20 (25 East Wall)

LPD Area Summary			
Project: RPI, Sage Lab, Room 2707			
Label	Area	Total Watts	LPD
Room 2707	719.2	240	0.334

SX1 luminaires 9' AFF; X2 luminaire is 9' AFF. Calculations based on Osram QHE .88 Instant Start Ballasts (3-lamp ballast operating 2 lamps) on outboard lamps and Osram Powersense Dimming Ballasts on the center lamps. Type X2 is turned OFF.

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

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VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT 30" ABOVE FINISHED FLOOR.
AGI32 VERSION 1.8

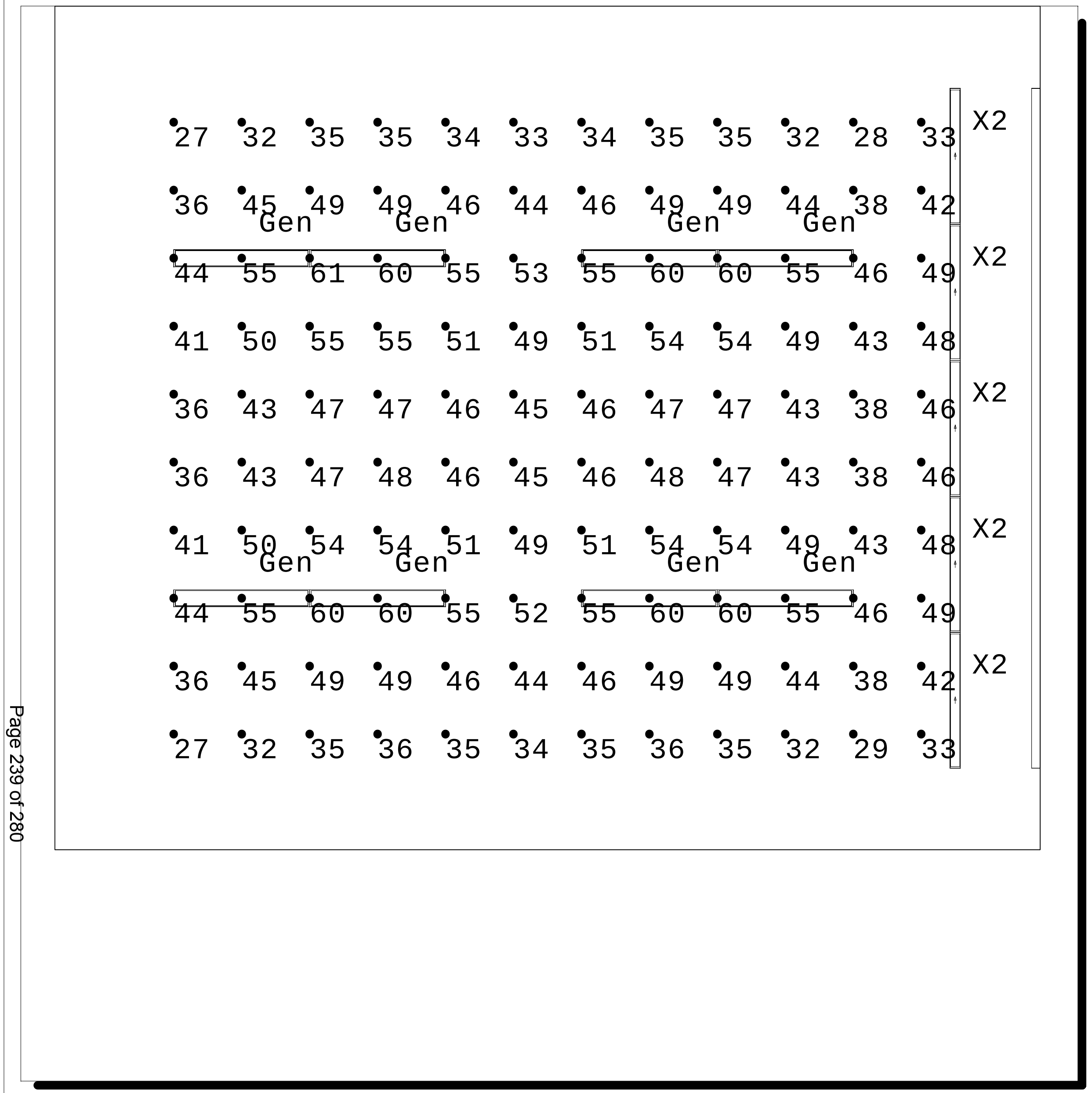
FINELITE
Better Lighting for a Better Workplace

Revisions		
#	Date	Comments

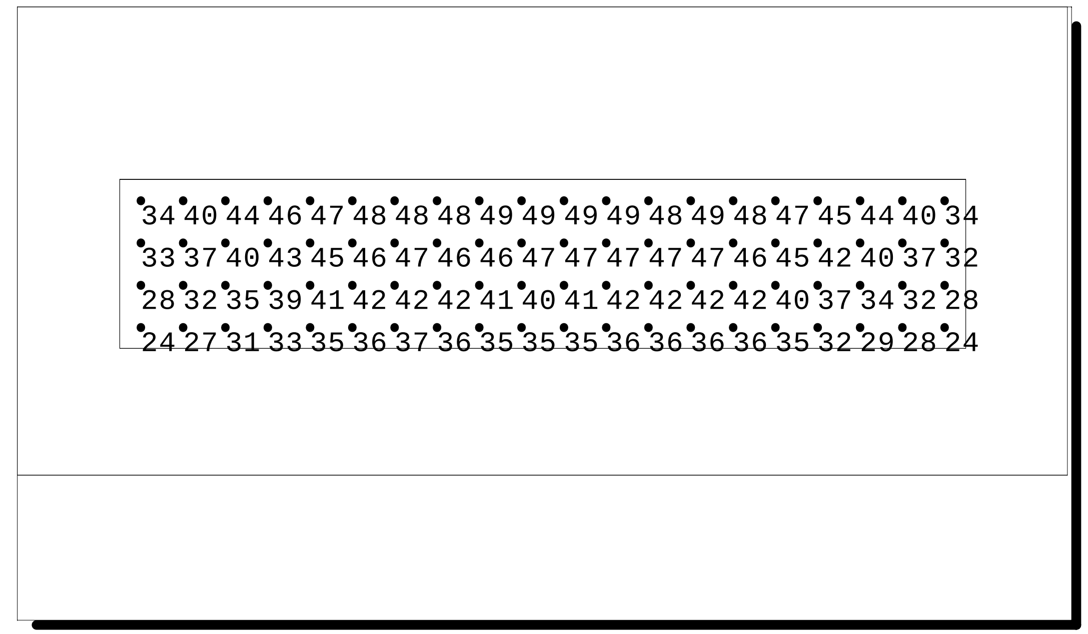
Drawn By: V Lauck
Date: April, 2006

Project: NYSERDA
RPI, Sage Lab, Room 2707

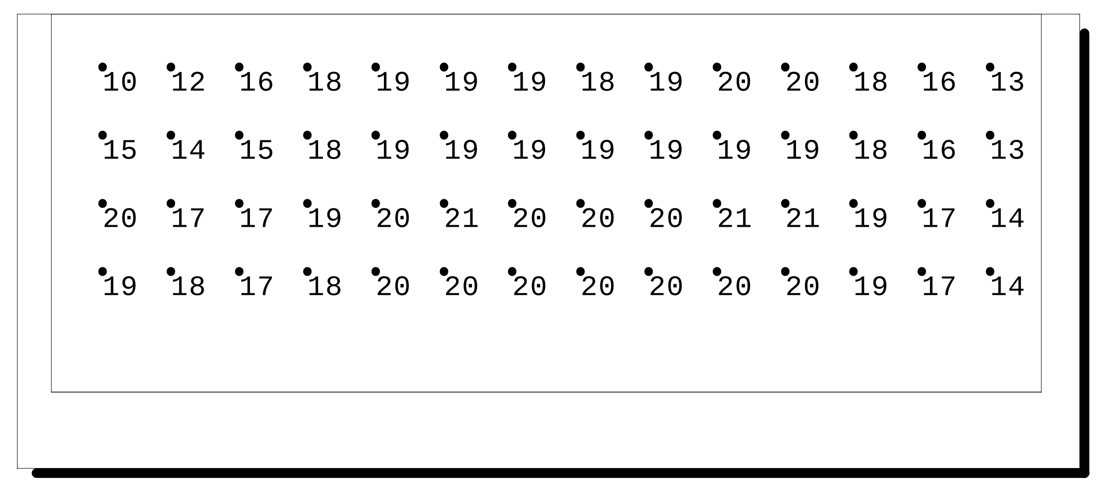
GENERAL MODE



Teaching Wall



South Wall



Luminaire Schedule									
Project: RPI, Sage Lab, Room 2707									
Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	5	X2	3100	0.752	SX2 WCB 1T8 96W	0.88	28	0.9	0.95
	8	Gen	3100	0.855	X1 PLV CCO 2T8 EP	1	63	0.9	0.95

Numeric Summary							
Project: RPI, Sage Lab, Room 2707							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Chalkboard	Illuminance	Fc	39.80	49	24	1.66	2.04
South Wall	Illuminance	Fc	17.98	21	10	1.80	2.10
Horizontal WP	Illuminance	Fc	45.27	61	27	1.68	2.26

Room Summary		
Project: RPI, Sage Lab, Room 2707		
Label	Wall Ht.	Description
Room 2707	11.083	29' x 24'-10"; Refl: 70/50/20 (25 East Wall)

LPD Area Summary			
Project: RPI, Sage Lab, Room 2707			
Label	Area	Total Watts	LPD
Room 2707	719.2	644	0.895

SX1 luminaires 9' AFF; X2 luminaire is 9' AFF. Calculations based on Osram QHE .88 Instant Start Ballasts (3-lamp ballast operating 2 lamps) on outboard lamps and Osram Powersense Dimming Ballasts on the center lamps. QHE .88 BF IS ballasts on Type X2.

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VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT 30" ABOVE FINISHED FLOOR.
AGI32 VERSION 1.8

FINELITE
Better Lighting for a Better Workplace

#	Date	Comments

Revisions

Drawn By: V Lauck
Date: April, 2006

Project: NYSERDA
RPI, Sage Lab, Room 2707

Page 1 of 1

GENERAL MODE

Horizontal WP

28	31	37	41	44	44	42	39	37	37	40	42	43	41	37	31
36	40	49	56	59	59	56	50	46	48	53	57	58	56	50	41
39	42	51	58	62	61	58	53	48	50	55	59	60	58	52	42
39	38	44	49	52	52	50	46	44	44	47	50	51	49	44	36
38	36	41	45	48	48	46	43	41	41	44	46	46	44	40	34
39	38	44	49	52	52	49	46	43	44	47	50	51	49	44	36
39	42	51	58	62	61	58	52	48	50	55	59	60	58	52	42
36	40	49	56	59	59	56	50	46	47	52	57	58	56	50	41
28	31	37	41	44	44	42	39	37	37	40	42	43	41	37	31

Teaching Wall

78	88	95	97	98	99	99	99	99	99	99	98	97	95	88	79
69	76	84	87	88	88	89	89	89	89	88	88	86	83	78	69
51	55	61	65	66	67	67	67	67	67	67	66	65	61	57	51
36	40	44	47	49	49	49	50	50	49	49	49	47	44	40	36

South Wall

14	17	20	22	22	23	20	20	19	21	23	23	25	22	21	17	13	10
14	16	19	20	20	21	19	19	19	21	21	22	23	21	20	18	15	12
15	18	20	21	22	22	21	21	21	22	23	23	23	23	21	20	18	15
16	18	20	22	23	23	22	22	22	23	24	24	24	23	22	20	19	18

Luminaire Schedule
Project: RPI, Sage Lab, Room 2715

Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	12	Gen	3100	0.752	X1 PLV CCO 2T8 EP	0.88	55	0.9	0.95
	4	X2	3100	1.026	SX2 WCB 1T8 96W	1.2	38	0.9	0.95

Numeric Summary
Project: RPI, Sage Lab, Room 2715

Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Whiteboard	Illuminance	Fc	71.48	99	36	1.99	2.75
South Wall	Illuminance	Fc	20.08	25	10	2.01	2.50
Horizontal WP	Illuminance	Fc	46.51	62	28	1.66	2.21

Room Summary
Project: RPI, Sage Lab, Room 2715

Label	Wall Ht.	Description
Room 2715	10.83	37.5' x 23.5'; Refl: 70/50/20 (West wall 25%)

LPD Area Summary
Project: RPI, Sage Lab, Room 2715

Label	Area	Total Watts	LPD
Room 2715	881.25	812	0.921

SX1 luminaires 9' AFF; X2 luminaire is 8.5' AFF. Calculations based on Osram .88 QHE Instant Start Ballasts on outboard lamps Osram Powersense Dimming Ballasts on the center lamps. QHE 1.2 BF IS ballasts on type X2.

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

PHOTOMETRIC DATA USED AS INPUT FOR THESE CALCULATIONS IS BASED ON ESTABLISHED IES PROCEDURES AND PUBLISHED LAMP & BALLAST RATINGS. FIELD PERFORMANCE WILL DEPEND ON ACTUAL LAMP, BALLAST, ELECTRICAL AND SITE CHARACTERISTICS.

VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT 30" ABOVE FINISHED FLOOR.
AGI32 VERSION 1.8

FINELITE
Better Lighting for a Better Workplace

#	Date	Comments

Revisions

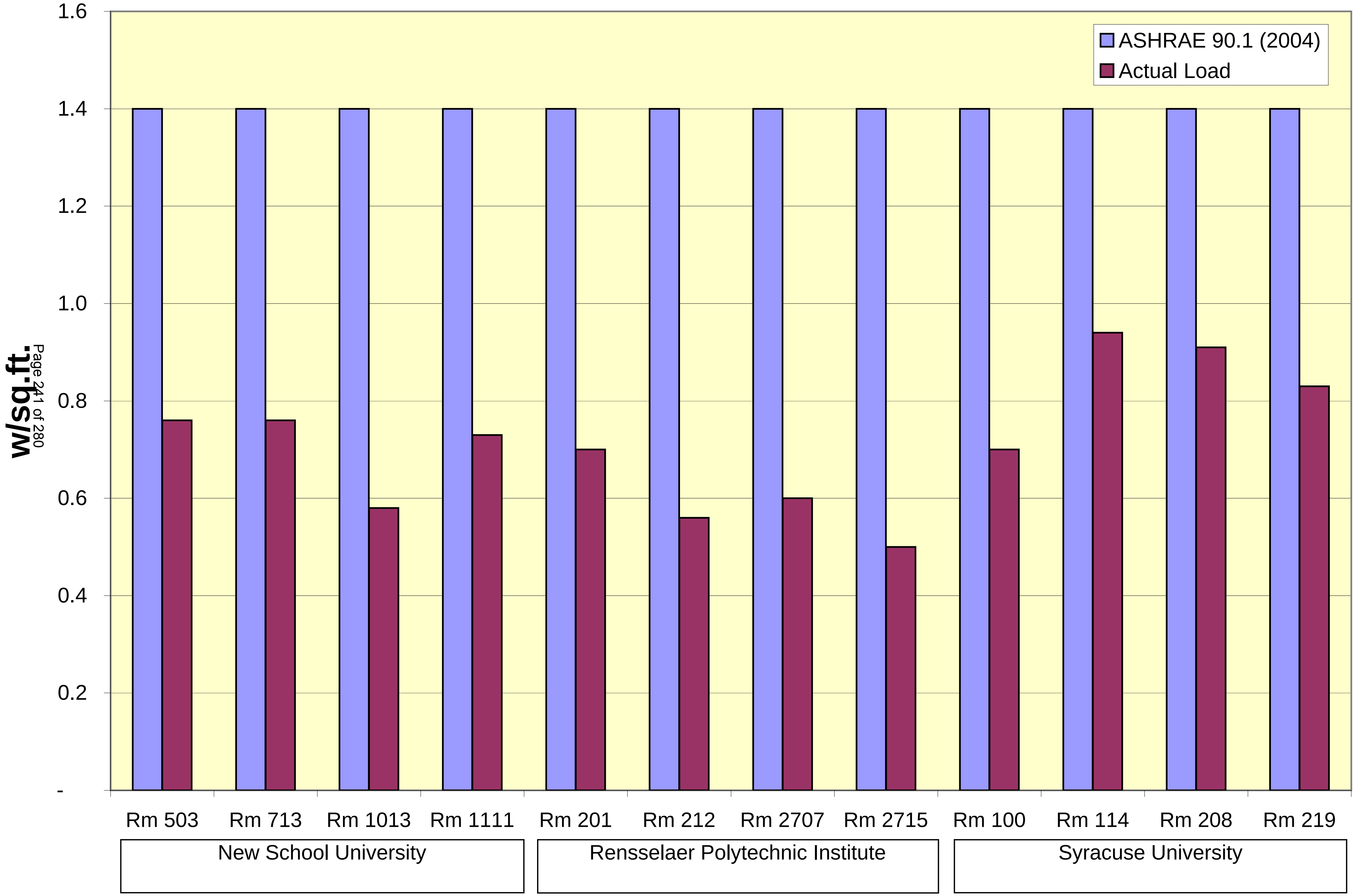
Drawn By: V Lauck
Date: April, 2006

Project: NYSERDA
RPI, Sage Lab, Room 2715

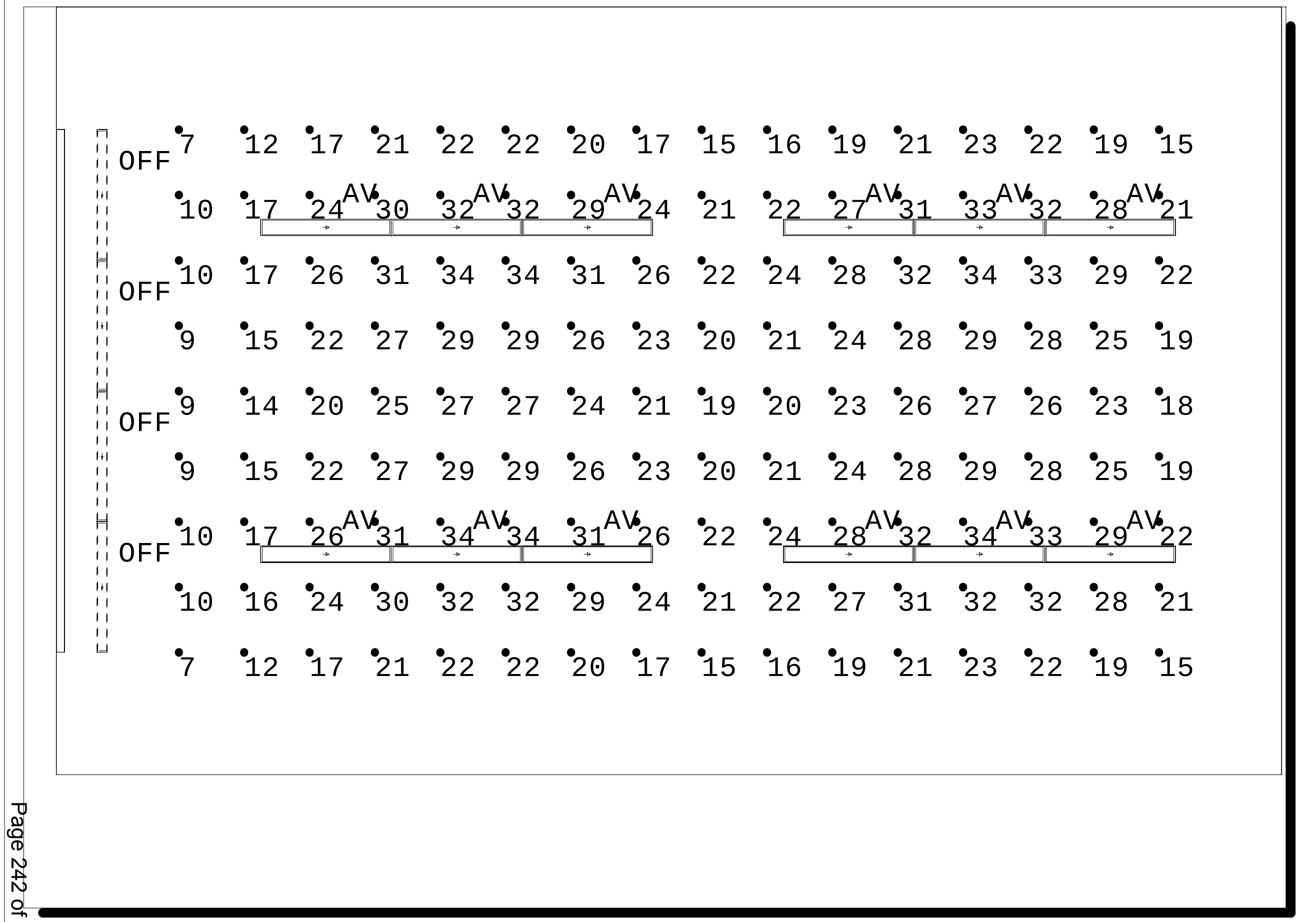
Energy Consumption by School - University

NYSERDA Classroom Lighting System

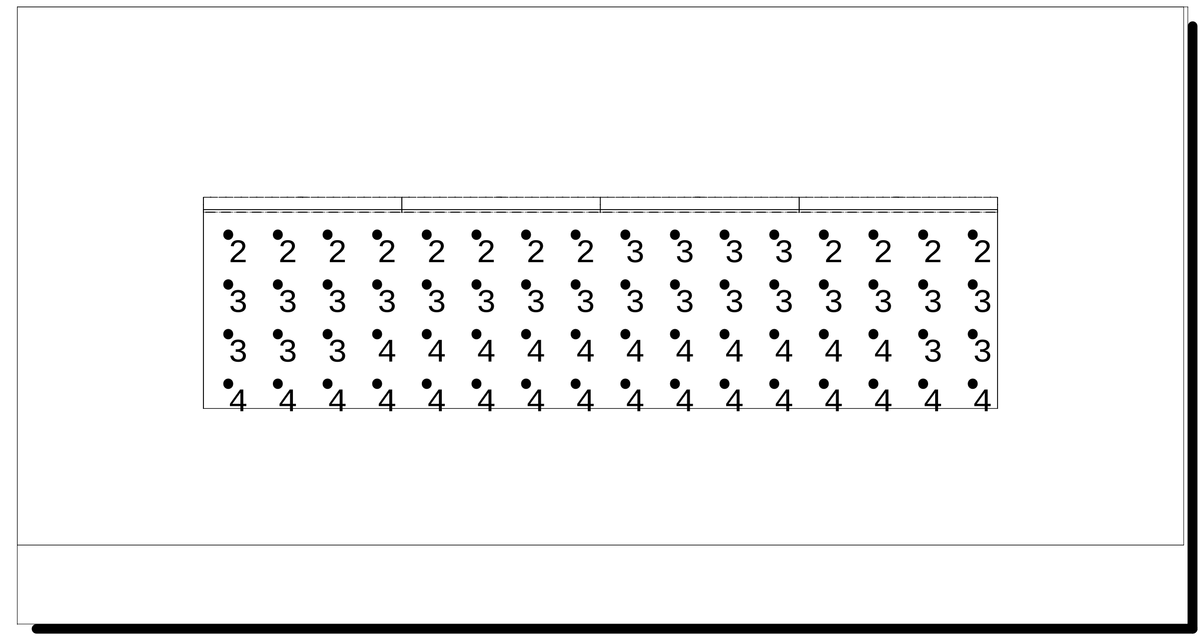
Sep 2006 - May 2007



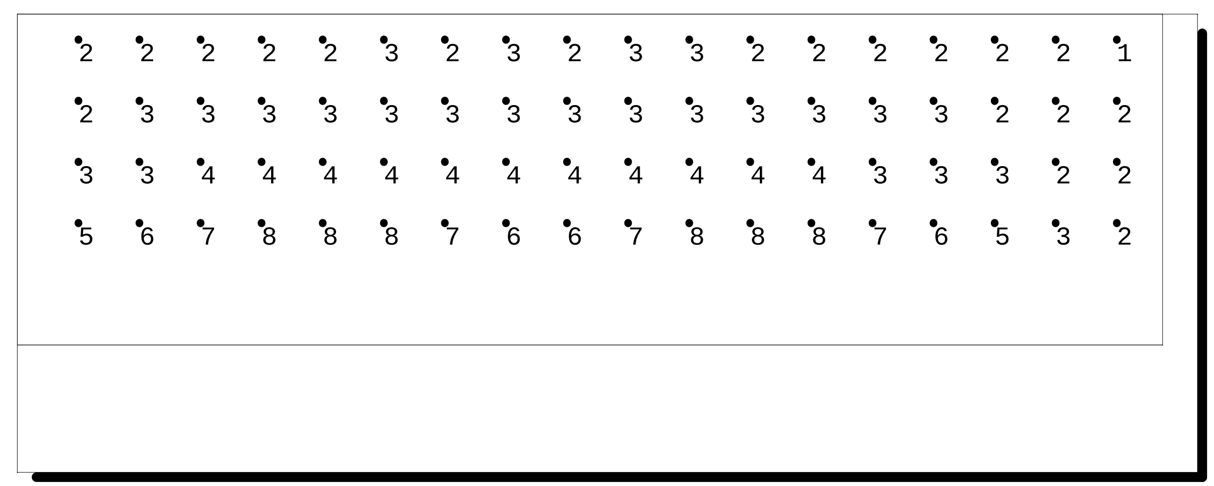
AV MODE



Teaching Wall



South Wall



Luminaire Schedule									
Project: RPI, Sage Lab, Room 2715									
Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	12	AV	3100	0.752	X1 PLV COO 1T8 EP	0.88	30	0.9	0.95
	4	OFF	3100	1.026	SX2 WCB 1T8 96W	1.2	38	0.9	0.95

Numeric Summary							
Project: RPI, Sage Lab, Room 2715							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Whiteboard	Illuminance	Fc	3.23	4	2	1.62	2.00
South Wall	Illuminance	Fc	3.71	8	1	3.71	8.00
Horizontal WP	Illuminance	Fc	23.35	34	7	3.34	4.86

Room Summary		
Project: RPI, Sage Lab, Room 2715		
Label	Wall Ht.	Description
Room 2715	10.83	37.5' x 23.5' ; Refl: 70/50/20 (West wall 25%)

LPD Area Summary			
Project: RPI, Sage Lab, Room 2715			
Label	Area	Total Watts	LPD
Room 2715	881.25	360	0.409

SX1 luminaires 9' AFF; X2 luminaire is 8.5' AFF. Calculations based on Osram .88 QHE Instant Start Ballasts on outboard lamps Osram Helios Dimming Ballasts on the center lamps.

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

PHOTOMETRIC DATA USED AS INPUT FOR THESE CALCULATIONS IS BASED ON ESTABLISHED IES PROCEDURES AND PUBLISHED LAMP & BALLAST RATINGS. FIELD PERFORMANCE WILL DEPEND ON ACTUAL LAMP, BALLAST, ELECTRICAL AND SITE CHARACTERISTICS.

VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT 30" ABOVE FINISHED FLOOR.
AGI32 VERSION 1.8

FINELITE
Better Lighting for a Better Workplace

#	Date	Comments

Revisions

Drawn By: V Lauck
Date: April, 2006

Project: NYSERDA
RPI, Sage Lab, Room 2715

Data Summary

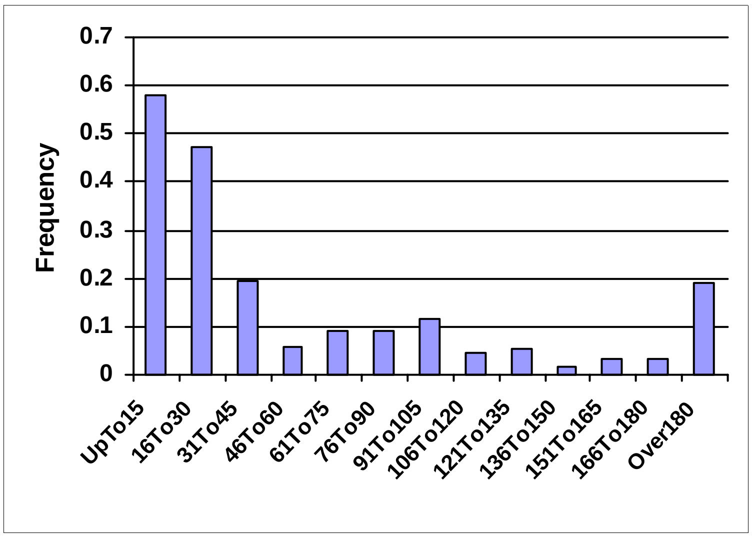
RPI

Classroom	Date	AV Gen Switches	AV Use (#/Day)	WB Use (#/Day)	General Total Min	White Board Total Min	AV Total Min	Settle Time	Settle Count	Quiet Count	Occ Sensor Shut Off	Manual Shut Off	Lights On Total	Watts/ sq ft	kWh
201	9/1/06	2	3	2	280	21	77	0		3	4	1	357	0.61	3.26
	9/5/06	0	0	3	517	302	0	0		2	5	1	517	0.84	6.51
	9/6/06	1	8	8	68	317	249	249	8	2	8	0	317	0.54	2.57
	9/7/06	2	5	5	120	257	585	146	4	1	3	1	705	0.42	4.40
	9/8/06	1	2	4	128	733	726	686	2	0	2	0	854	0.48	6.15
	9/9/06	2	11	10	1	1217	1216	1216	11	1	10	0	1217	0.44	7.99
	9/10/06	0	4	3	0	1386	1387	1386	4	0	3	0	1387	0.45	9.30
	9/11/06	1	10	11	372	940	0	506	10	3	3	2	372	0.75	4.21
	9/12/06	2	1	4	483	398	12	0		1	3	0	495	0.86	6.40
	9/13/06	6	5	10	330	191	68	68	5	1	5	7	399	0.64	3.84
	9/14/06	0	0	3	626	163	0	0		0	1	3	626	0.79	7.41
	9/15/06	0	0	1	590	402	0	0		0	4	2	590	0.85	7.53
	9/16/06	0	0	3	781	781	0	0		0	2	0	781	0.91	10.65
	9/17/06	0	0	3	407	407	0	0		0	3	1	407	0.91	5.56
	9/18/06	1	1	3	683	314	1	0		1	0	1	**683**	0.82	8.41
	9/19/06	4	2	7	526	430	2	1	1	0	2	2	528	0.87	6.88
	9/20/06	0	0	9	524	524	0	0		0	7	3	524	0.91	7.17
	9/21/06	0	0	4	568	334	0	0		1	0	3	568	0.84	7.17
	9/22/06	0	0	2	423	291	0	0		0	1	0	423	0.86	5.48
	9/25/06	2	1	4	520	573	157	131	1	0	1	2	678	0.76	7.76
	9/26/06	1	1	3	267	33	3	0		2	0	3	271	0.76	3.08
	9/27/06	0	0		540	0	0	0		0	0	1	540	0.75	6.04
	9/28/06	2	1	3	473	187	356	18	1	1	7	2	829	0.58	7.25
	9/29/06	0	0	3	430	194	0	0		1	1	1	430	0.83	5.33
	9/30/06	0	0	2	21	21	0	0		0	2	0	21	0.90	0.28
	10/1/06	0	0	5	61	61	0	0		0	5	0	61	0.91	0.83
	10/2/06	0	0	4	611	171	0	0		0	2	3	611	0.80	7.32
	10/3/06	0	0		512	0	0	0		0	2	1	512	0.75	5.77
	10/4/06	0	0		142	0	0	0		0	1	5	142	0.75	1.60
	10/5/06	0	0	2	666	272	0	0		0	1	2	666	0.82	8.16
	10/6/06	0	0	4	470	365	0	0		0	3	1	470	0.88	6.17
	10/8/06	0	0	2	84	84	0	0		0	2	0	84	0.91	1.14
	10/9/06	0	0	3	124	125	0	0		0	4	0	125	0.91	1.70
	10/10/06	2	1	5	498	330	5	0		0	2	3	503	0.85	6.40
	10/11/06	0	0	3	60	60	0	0		0	1	2	60	0.91	0.82
	10/12/06	1	3	4	121	79	490	0		0	3	3	611	0.40	3.63
	10/13/06	1	1	3	323	236	18	0		2	1	2	341	0.84	4.29
	10/16/06	0	0	3	575	37	0	0		0	2	3	575	0.76	6.58

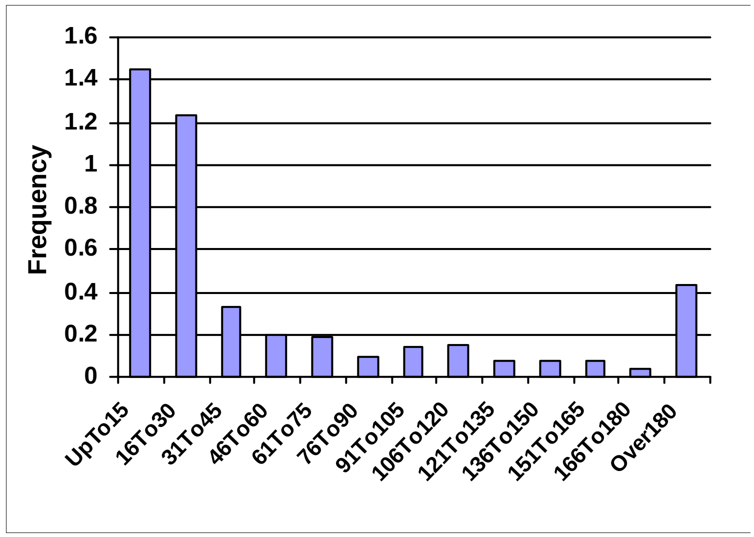
Average Daily Lighting Usage for RPI, Rm 201
From 9/1/06 To 5/31/07

General AV mode Switches:	1.0	Quiet Time Usage:	0.4
General Mode Time:	327.5	Occupancy Sensor Shutoff Frequency:	4.0
AV mode Time:	138.3	Manual Shutoff Frequency:	1.7
White Board Time:	196.6	Lights On:	465.8
Settle Mode Time:	33.8	Watts/ sq ft:	0.68
Settle Mode Counts:	0.5	School Days:	190

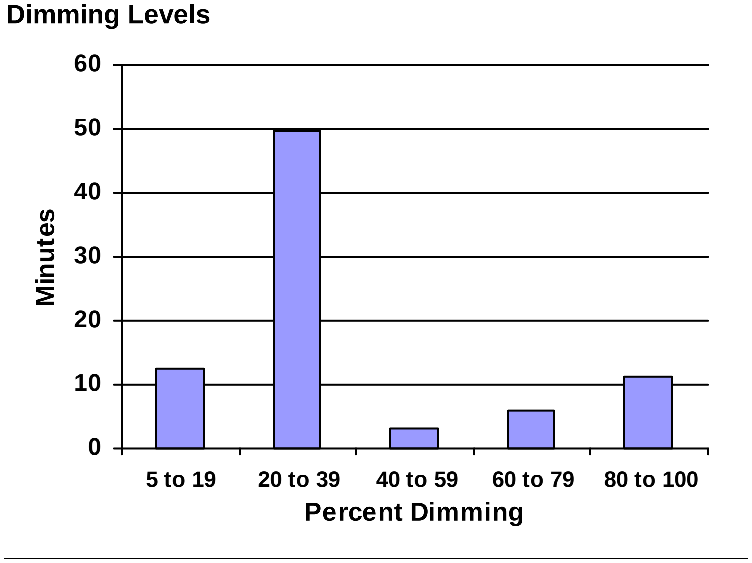
AV Mode



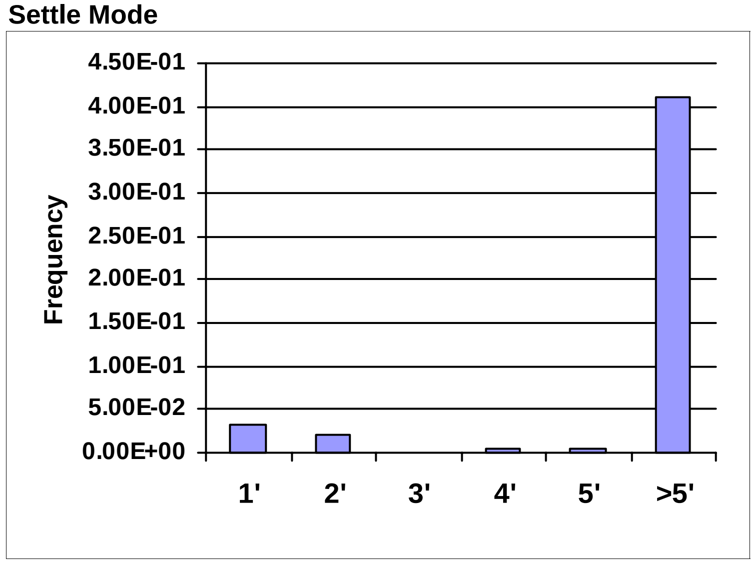
General Mode



Dimming Levels



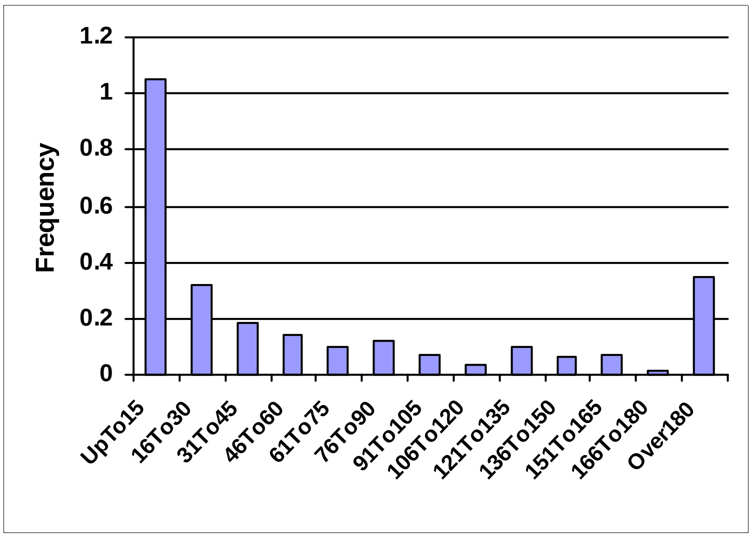
Settle Mode



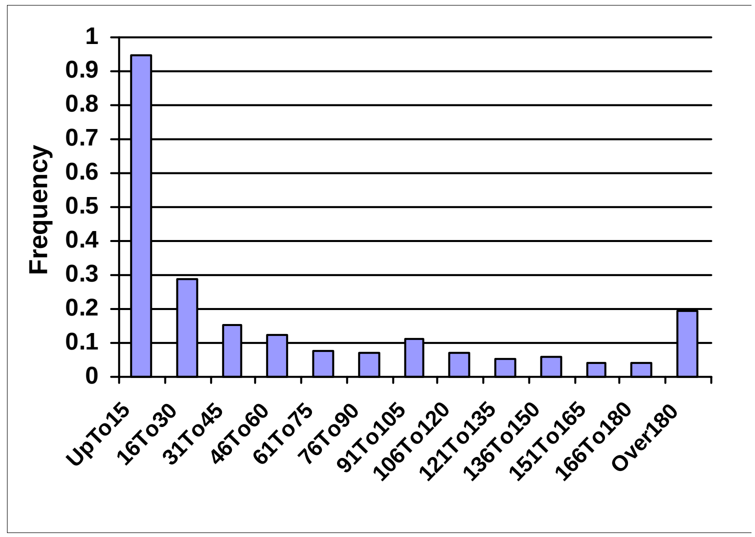
Average Daily Lighting Usage for RPI, Rm 212
From 9/1/06 To 5/31/07

General AV mode Switches:	**.8**	**Quiet Time Usage:**	**0.3**
General Mode Time:	**137.2**	**Occupancy Sensor Shutoff Frequency:**	**1.5**
AV mode Time:	**213.3**	**Manual Shutoff Frequency:**	**2.8**
White Board Time:	**53.8**	**Lights On:**	**350.6**
Settle Mode Time:	**25.9**	**Watts/ sq ft:**	**0.54**
Settle Mode Counts:	**0.5**	**School Days:**	**146**

AV Mode



General Mode



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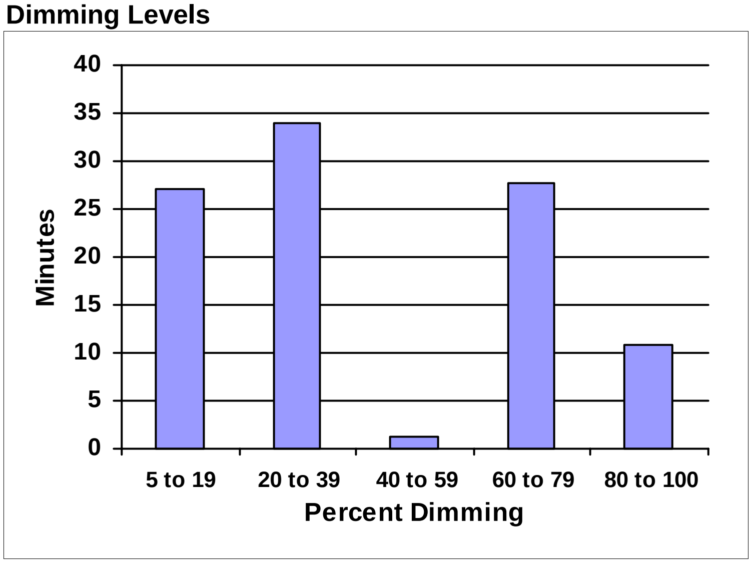
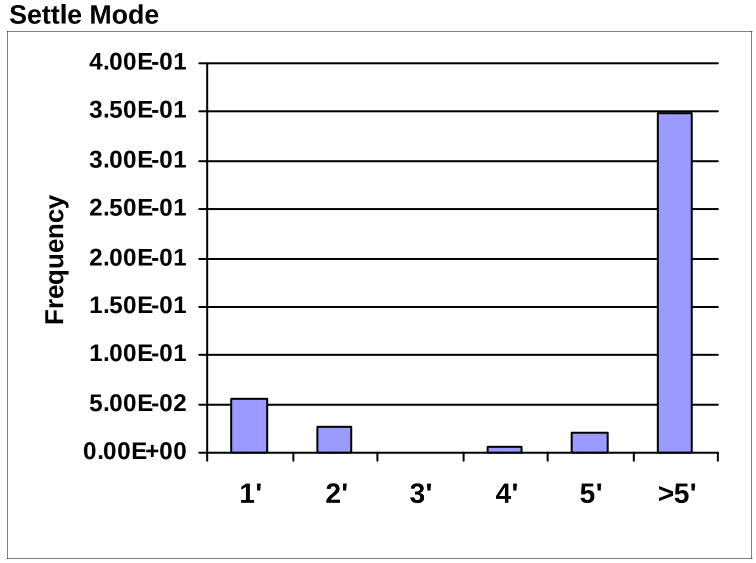


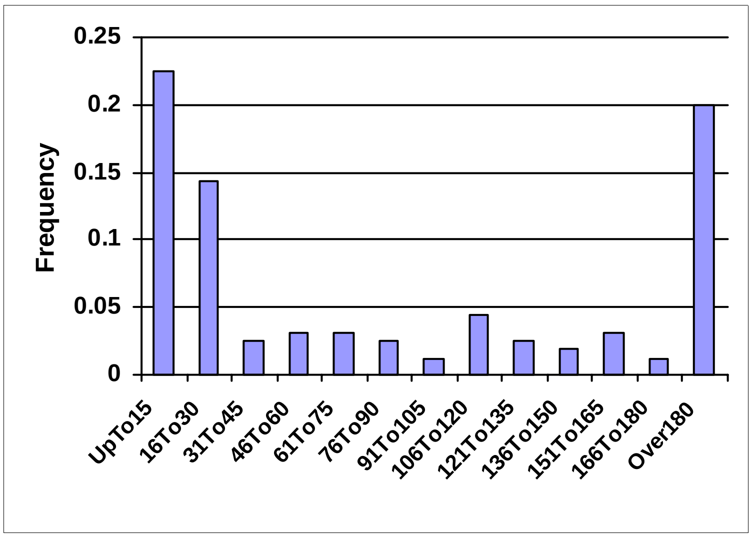
Settle Mode



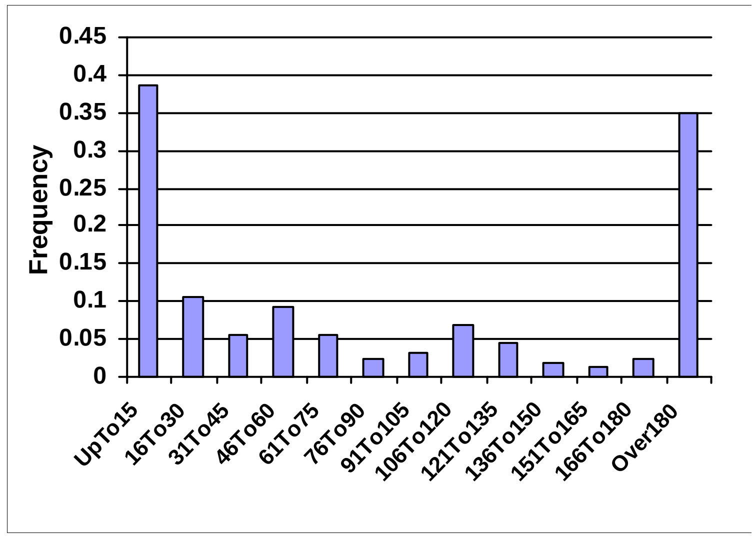
Average Daily Lighting Usage for RPI, Rm 2701 (Control)
From 9/1/06 To 5/31/07

General AV mode Switches:	**1.1**	**Quiet Time Usage:**	**0.0**
General Mode Time:	**519.6**	**Occupancy Sensor Shutoff Frequency:**	**0.0**
AV mode Time:	**109.0**	**Manual Shutoff Frequency:**	**0.0**
White Board Time:	**.0**	**Lights On:**	**628.6**
Settle Mode Time:	**.0**	**Watts/ sq ft:**	**0.85**
Settle Mode Counts:	**0.0**	**School Days:**	**160**

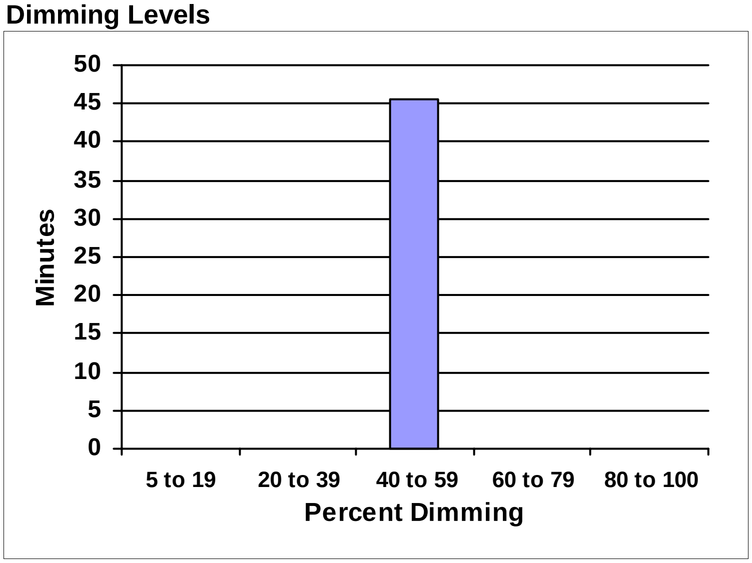
AV Mode



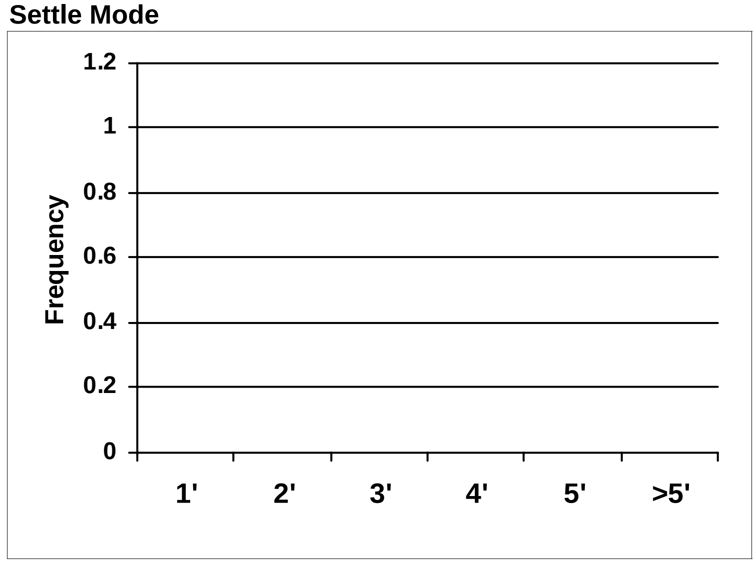
General Mode



Dimming Levels



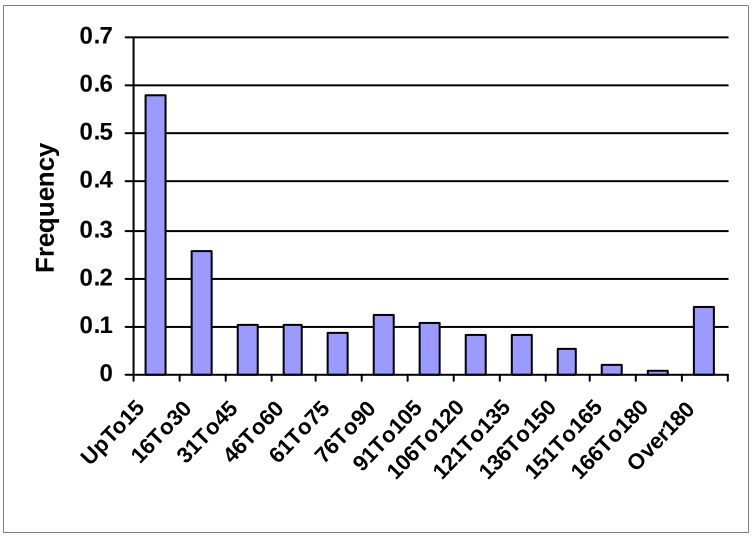
Settle Mode



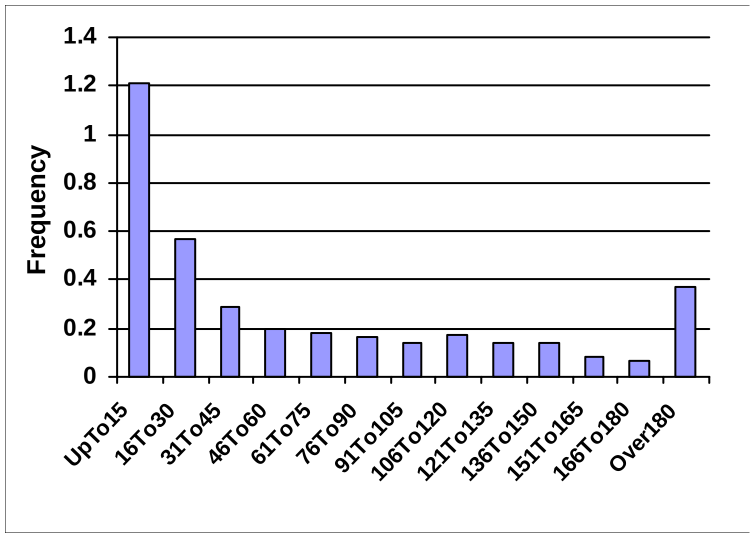
Average Daily Lighting Usage for RPI, Rm 2707
From 9/1/06 To 5/31/07

General AV mode Switches:	**.9**	**Quiet Time Usage:**	**0.4**
General Mode Time:	**263.6**	**Occupancy Sensor Shutoff Frequency:**	**1.9**
AV mode Time:	**123.9**	**Manual Shutoff Frequency:**	**2.9**
White Board Time:	**91.1**	**Lights On:**	**387.5**
Settle Mode Time:	**16.2**	**Watts/ sq ft:**	**0.6**
Settle Mode Counts:	**0.3**	**School Days:**	**147**

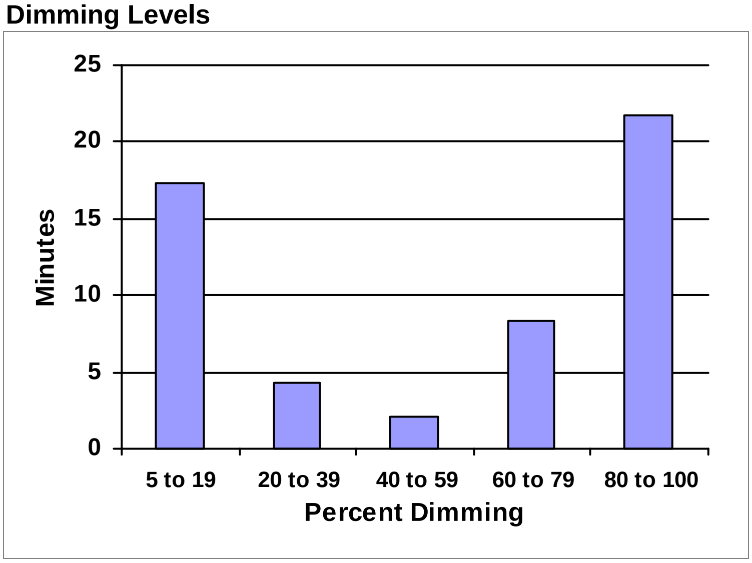
AV Mode



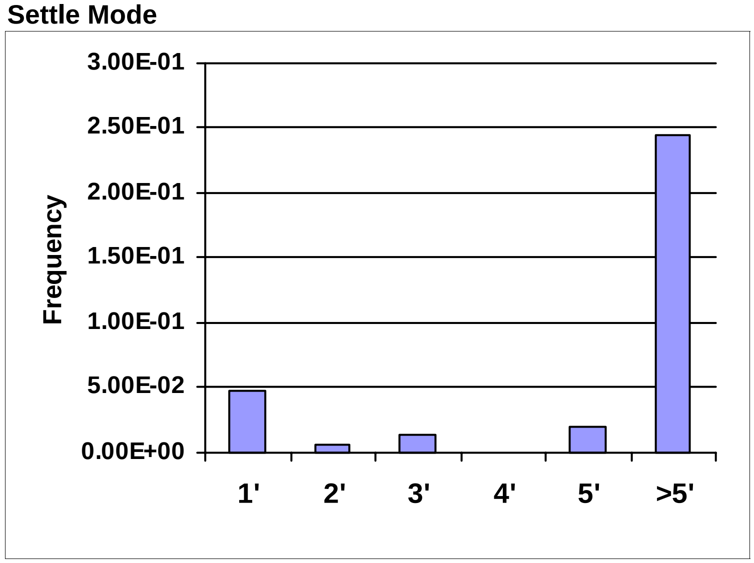
General Mode



Dimming Levels



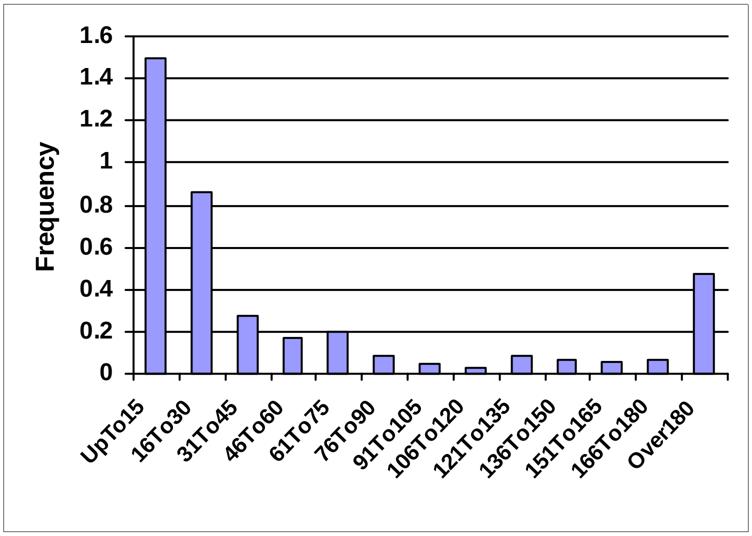
Settle Mode



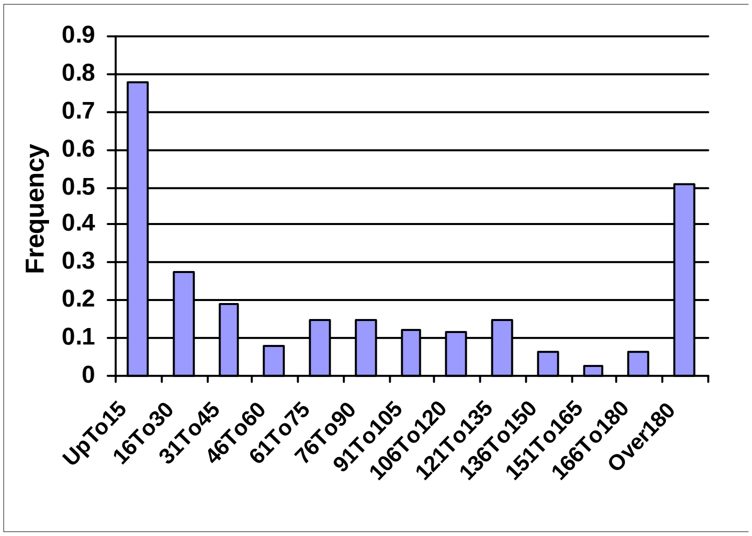
Average Daily Lighting Usage for RPI, Rm 2715
From 9/1/06 To 5/31/07

General AV mode Switches:	**1.6**	**Quiet Time Usage:**	**0.9**
General Mode Time:	**278.0**	**Occupancy Sensor Shutoff Frequency:**	**2.9**
AV mode Time:	**321.0**	**Manual Shutoff Frequency:**	**2.5**
White Board Time:	**85.6**	**Lights On:**	**598.9**
Settle Mode Time:	**15.5**	**Watts/ sq ft:**	**0.51**
Settle Mode Counts:	**0.3**	**School Days:**	**185**

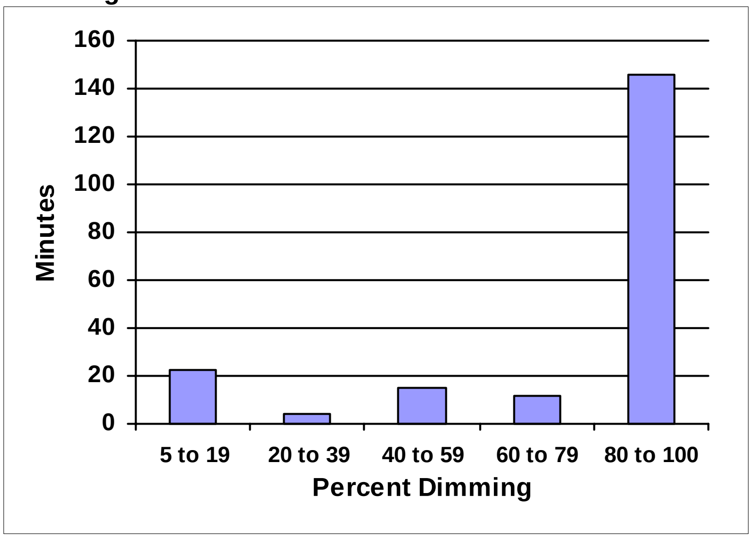
AV Mode



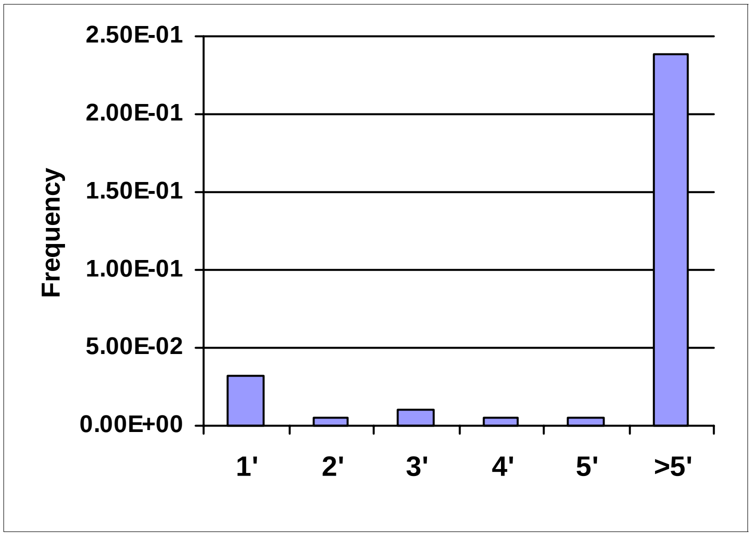
General Mode



Dimming Levels



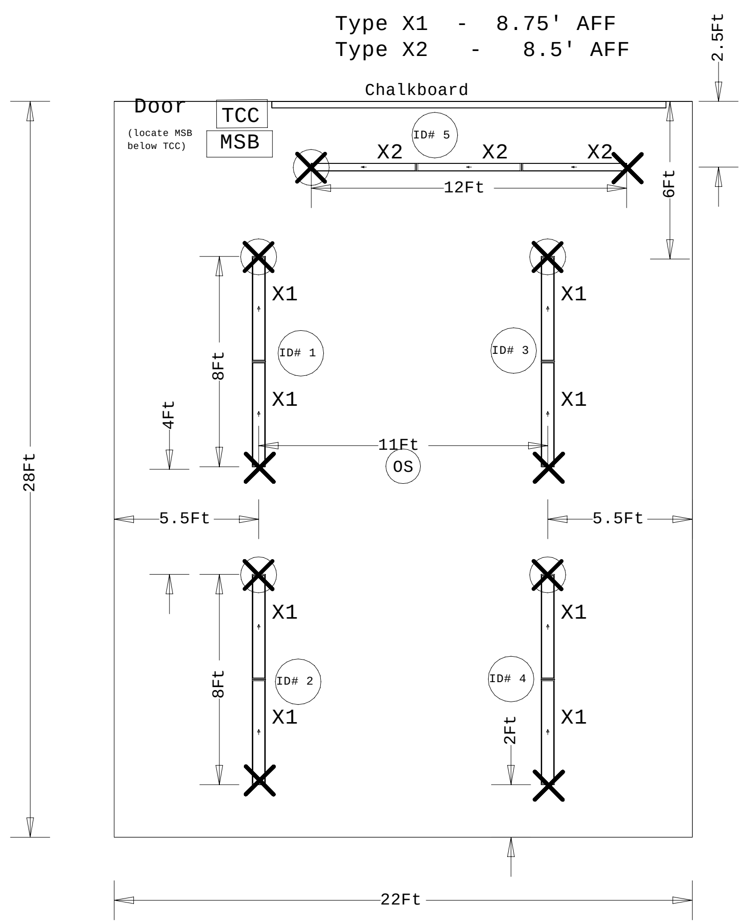
Settle Mode



Appendix L –Syracuse University Information

- Room Dimension and Fixture Layout
- Lighting Layouts and calculations
- Energy Consumption Chart
- Data Summary Table
- Average Daily Lighting Usage Report

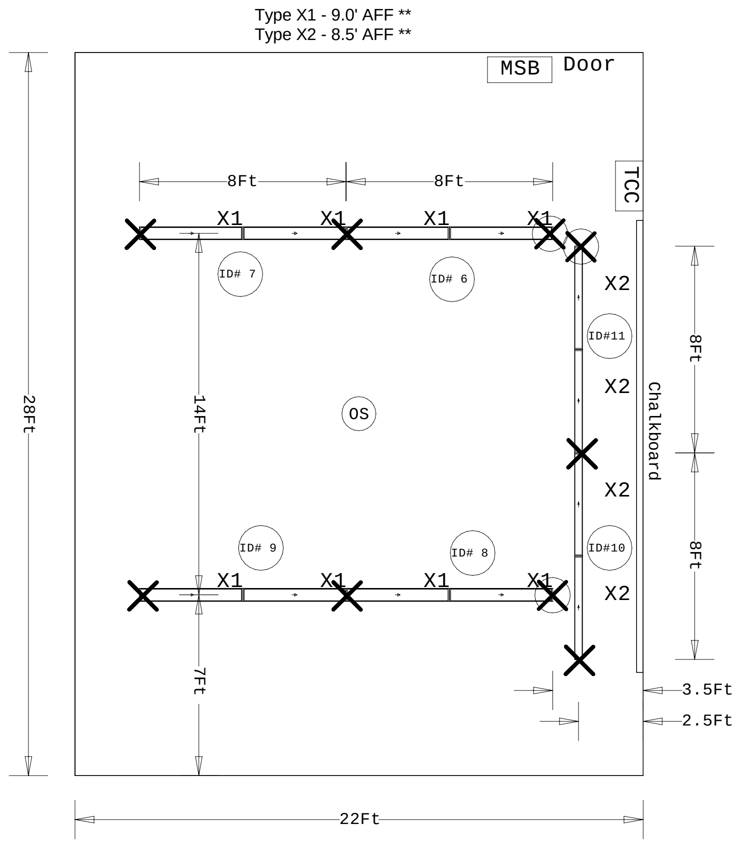
Syracuse U., Room 100
Installation Dimensions **



LEGEND	
TCC	Teacher Control Center mounting location: 4'-0" AFF (to top of box). Install on the left side of whiteboard/chalkboard
OS	Occupancy Sensor(s)
X	Suspension Point
⊗	Power Feed & Suspension Point (Pre-existing power feed points could affect changes to feed points)
ID# 1	Fixture ID#. Each fixture section will have a label with a unique ID# which can be found on the outside of the box and on the fixture itself.
MSB	Master Switch Bank -- Locate MSB on wall at entrance(s) to room. Exact location to be determined on-site.

** Site conditions could influence fixture placement and suspension. All fixtures to be mounted "on-grid" (if ceiling is grid type) therefore the attached dimensional information is approximate. The spacing between rows is the most important dimension to maintain.

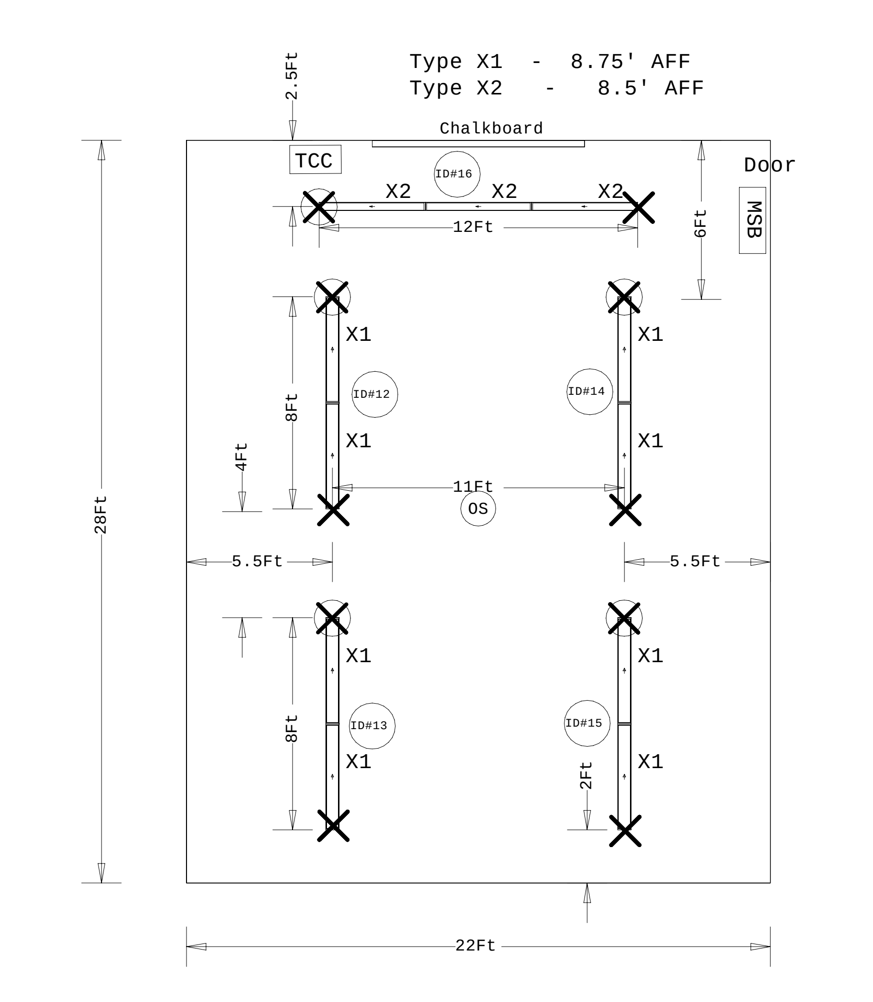
Syracuse U., Room 114
Installation Dimensions **



LEGEND	
TCC	Teacher Control Center mounting location: 4'-0" AFF (to top of box). Install on the left side of whiteboard/chalkboard
OS	Occupancy Sensor(s)
X	Suspension Point
⊗	Power Feed & Suspension Point (Pre-existing power feed points could affect changes to feed points)
ID# 1	Fixture ID#. Each fixture section will have a label with a unique ID# which can be found on the outside of the box and on the fixture itself.
MSB	Master Switch Bank -- Locate MSB on wall at entrance(s) to room. Exact location to be determined on-site.

** Site conditions could influence fixture placement and suspension. All fixtures to be mounted "on-grid" (if ceiling is grid type) therefore the attached dimensional information is approximate. The spacing between rows is the most important dimension to maintain.

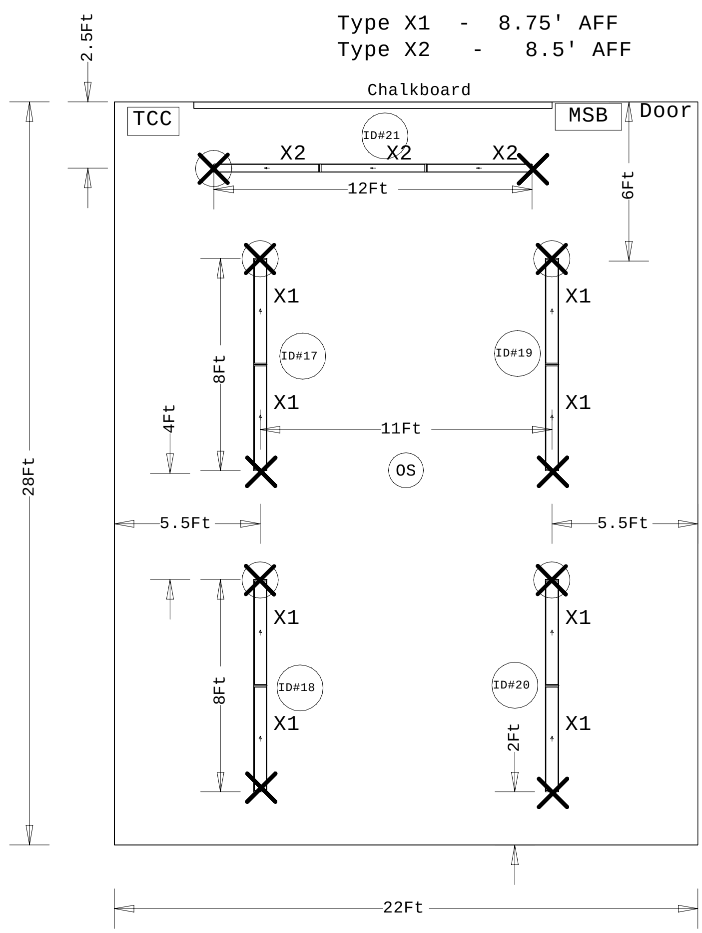
Syracuse U., Room 208
Installation Dimensions **



LEGEND	
TCC	Teacher Control Center mounting location: 4'-0" AFF (to top of box). Install on the left side of whiteboard/chalkboard
OS	Occupancy Sensor(s)
X	Suspension Point
⊗	Power Feed & Suspension Point (Pre-existing power feed points could affect changes to feed points)
ID# 1	Fixture ID#. Each fixture section will have a label with a unique ID# which can be found on the outside of the box and on the fixture itself.
MSB	Master Switch Bank -- Locate MSB on wall at entrance(s) to room. Exact location to be determined on-site.

** Site conditions could influence fixture placement and suspension. All fixtures to be mounted "on-grid" (if ceiling is grid type) therefore the attached dimensional information is approximate. The spacing between rows is the most important dimension to maintain.

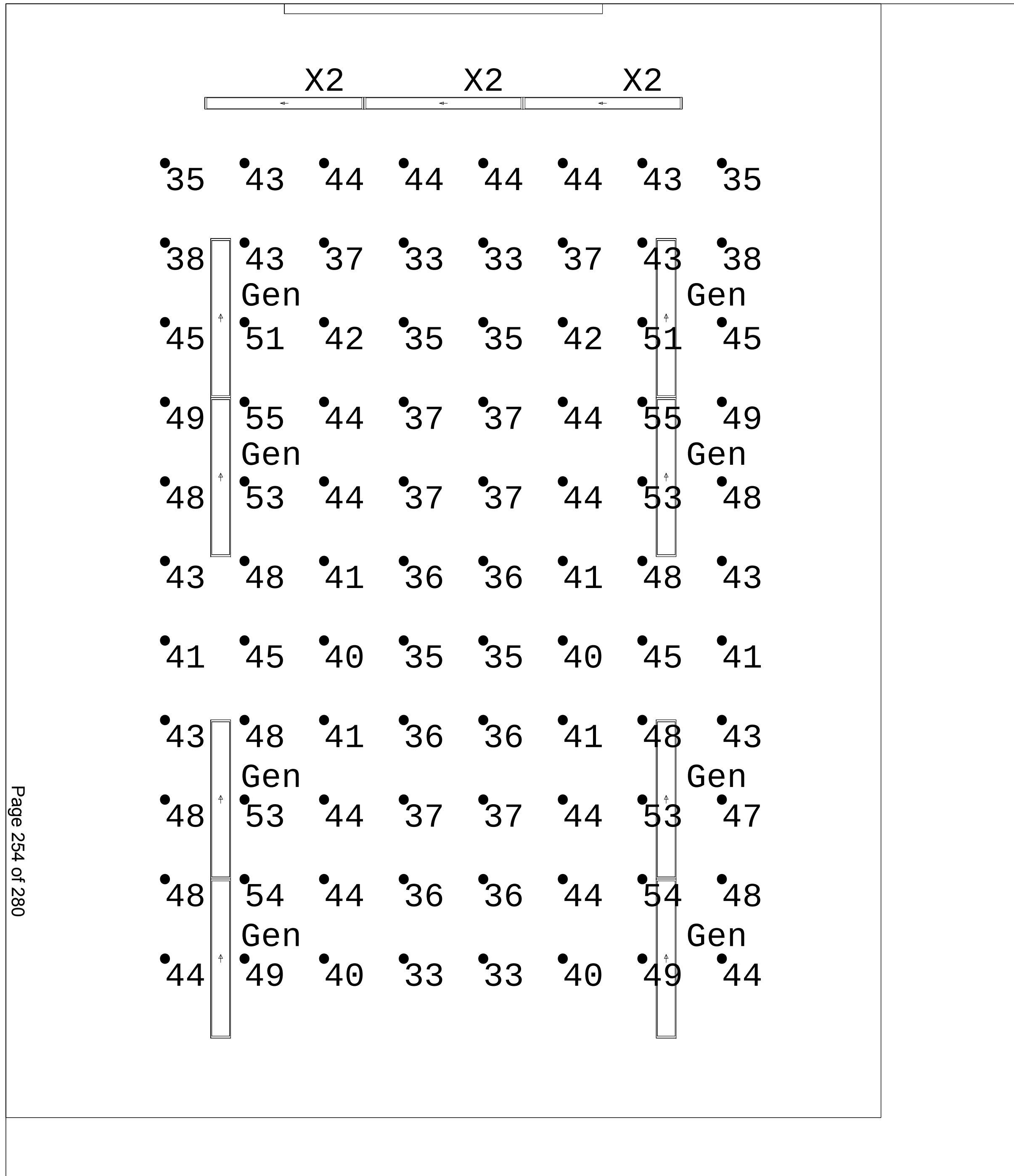
Syracuse U., Room 219
Installation Dimensions **

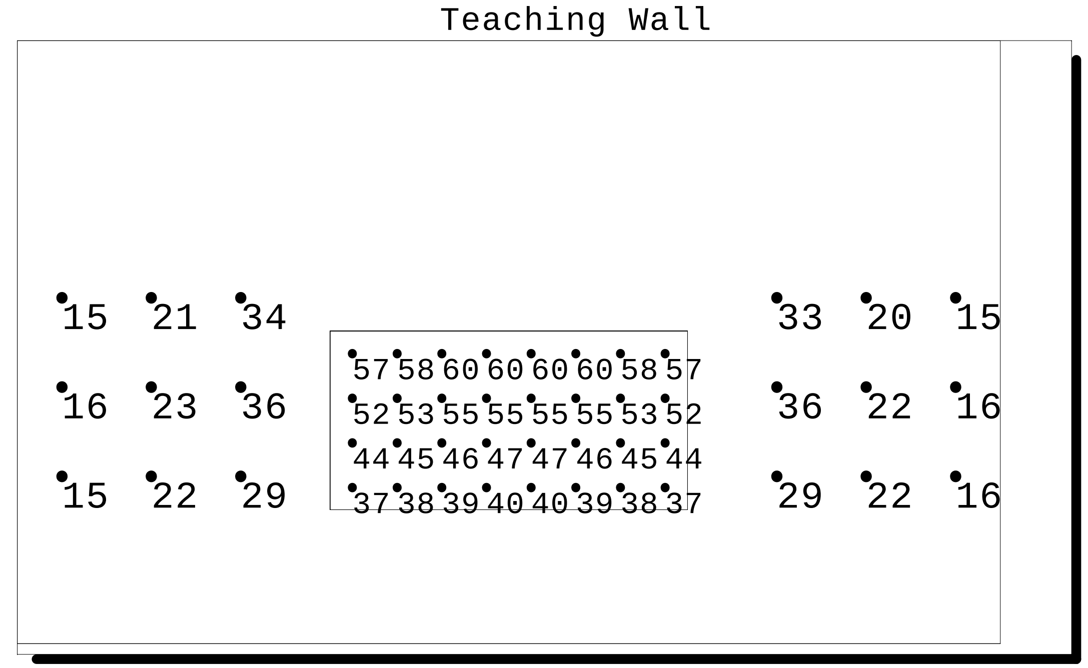


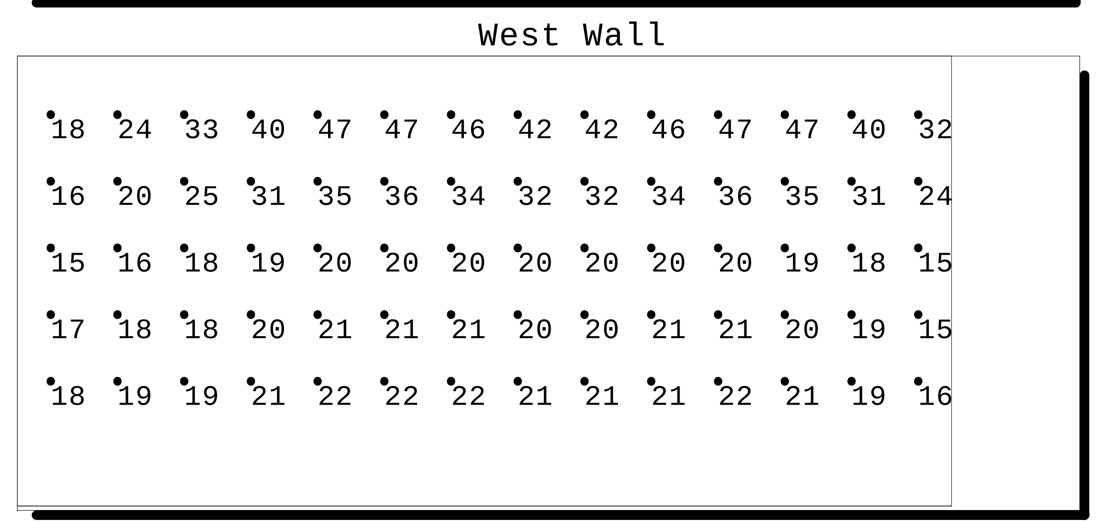
LEGEND	
TCC	Teacher Control Center mounting location: 4'-0" AFF (to top of box). Install on the left side of whiteboard/chalkboard
OS	Occupancy Sensor(s)
X	Suspension Point
⊗	Power Feed & Suspension Point (Pre-existing power feed points could affect changes to feed points)
ID# 1	Fixture ID#. Each fixture section will have a label with a unique ID# which can be found on the outside of the box and on the fixture itself.
MSB	Master Switch Bank -- Locate MSB on wall at entrance(s) to room. Exact location to be determined on-site.

** Site conditions could influence fixture placement and suspension. All fixtures to be mounted "on-grid" (if ceiling is grid type) therefore the attached dimensional information is approximate. The spacing between rows is the most important dimension to maintain.

GENERAL MODE







Luminaire Schedule									
Project: Syracuse U Carnegie Rm 100 208 219									
Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	3	X2	3100	1.026	SX2 WCB 1T8 96W	1.2	38	0.9	0.95
	8	Gen	3100	0.846	X1 PLV CCO 2T8 EP	0.99	63	0.9	0.95

Numeric Summary							
Project: Syracuse U Carnegie Rm 100 208 219							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Chalkboard	Illuminance	Fc	49.13	60	37	1.33	1.62
Teaching Wall	Illuminance	Fc	23.33	36	15	1.56	2.40
West Wall	Illuminance	Fc	25.54	47	15	1.70	3.13
Horizontal WP	Illuminance	Fc	42.81	55	33	1.30	1.67

Room Summary		
Project: Syracuse U Carnegie Rm 100 208 219		
Label	Wall Ht.	Description
Room 100, 208 & 219	13.5	22' x 28' - Refl .70, .50, .30

LPD Area Summary			
Project: Syracuse U Carnegie Rm 100 208 219			
Label	Area	Total Watts	LPD
Room 100, 208 & 219	616	618	1.003

SX1 luminaires 8.75' AFF; X2 luminaire is 8.5' AFF.
Calculations are based on Osram QHE .99 Instant Start Ballasts (3-lamp on 2 lamps) on outboard lamps and Osram Powersense Dimming Ballasts on the center lamps.
QHE IS 1.2 ballasts on Type X2.

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

PHOTOMETRIC DATA USED AS INPUT FOR THESE CALCULATIONS IS BASED ON ESTABLISHED IES PROCEDURES AND PUBLISHED LAMP & BALLAST RATINGS. FIELD PERFORMANCE WILL DEPEND ON ACTUAL LAMP, BALLAST, ELECTRICAL AND SITE CHARACTERISTICS.

VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT 30" ABOVE FINISHED FLOOR.

AGI32 VERSION 1.8

FINELITE
Better Lighting for a Better Workplace

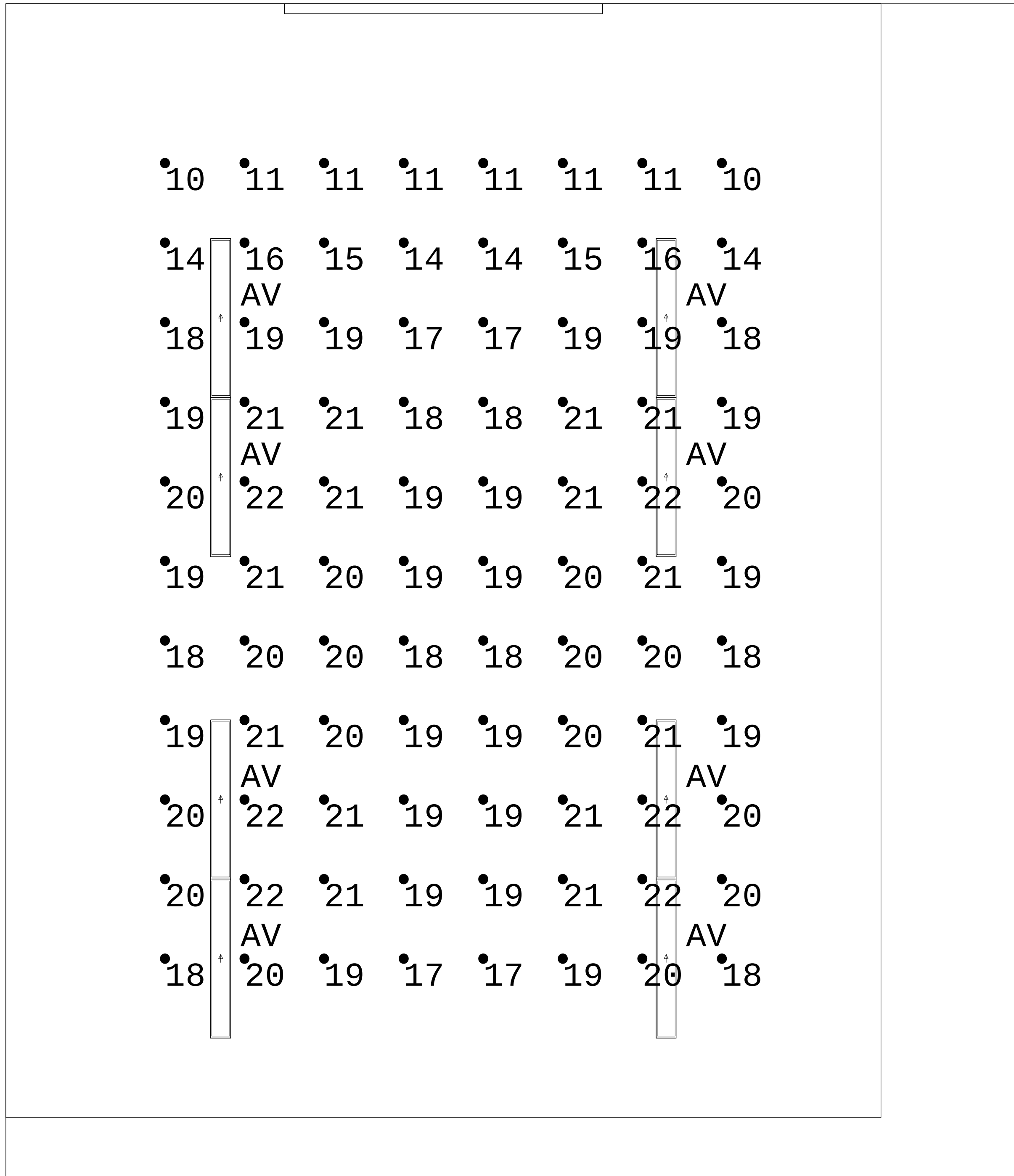
#	Date	Comments
1		

Revisions

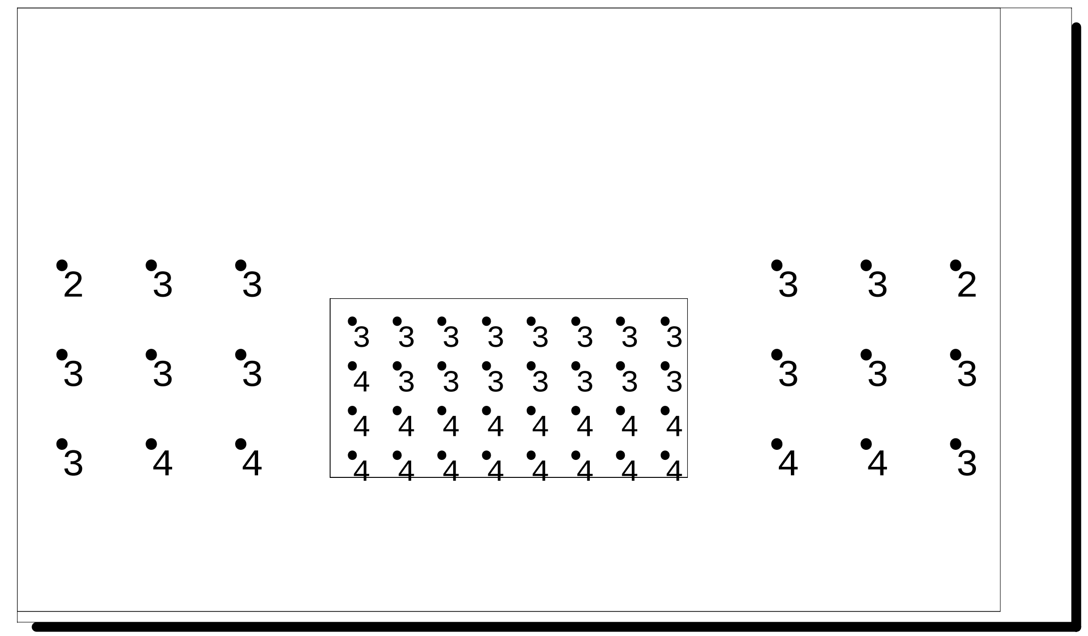
Drawn By: V Lauck
Date: April, 2006

Project: NYSERDA Syracuse U, Carnegie, Room 100, 208 & 219

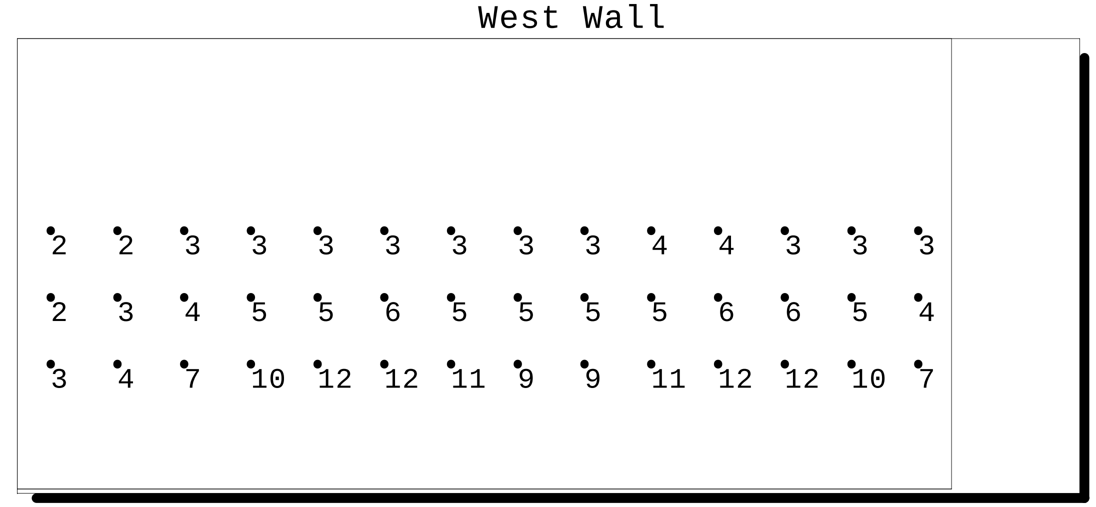
AV MODE



Teaching Wall



West Wall



Luminaire Schedule									
Project: Syracuse U Carnegie Rm 100 208 219									
Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	8	AV	3100	0.752	X1 PLV COO 1T8 EP	0.88	30	0.9	0.95

Numeric Summary							
Project: Syracuse U Carnegie Rm 100 208 219							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Chalkboard	Illuminance	Fc	3.53	4	3	1.18	1.33
Teaching Wall	Illuminance	Fc	3.11	4	2	1.56	2.00
Horizontal	Illuminance	Fc	18.36	22	10	1.84	2.20
West Wall	Illuminance	Fc	5.64	12	2	2.82	6.00

Room Summary		
Project: Syracuse U Carnegie Rm 100 208 219		
Label	Wall Ht.	Description
Rm 100, 208 & 219	13.5	22' x 28' - Refl .70, .50, .30

LPD Area Summary			
Project: Syracuse U Carnegie Rm 100 208 219			
Label	Area	Total Watts	LPD
Room 100, 208 & 219	616	240	0.390

SX1 luminaires 8.75' AFF; X2 luminaire is 8.5' AFF
Calculations based on Osram QHE .99 Instant Start
Ballasts (3-lamp on 2 lamps) on outboard lamps and
Osram Powersense Dimming Ballasts on the center lamps.
Type X2 is OFF.

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

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VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT 30" ABOVE FINISHED FLOOR.
AGI32 VERSION 1.8

Project: NYSERDA Syracuse U.,
Carnegie, Rm 100, 208 & 219

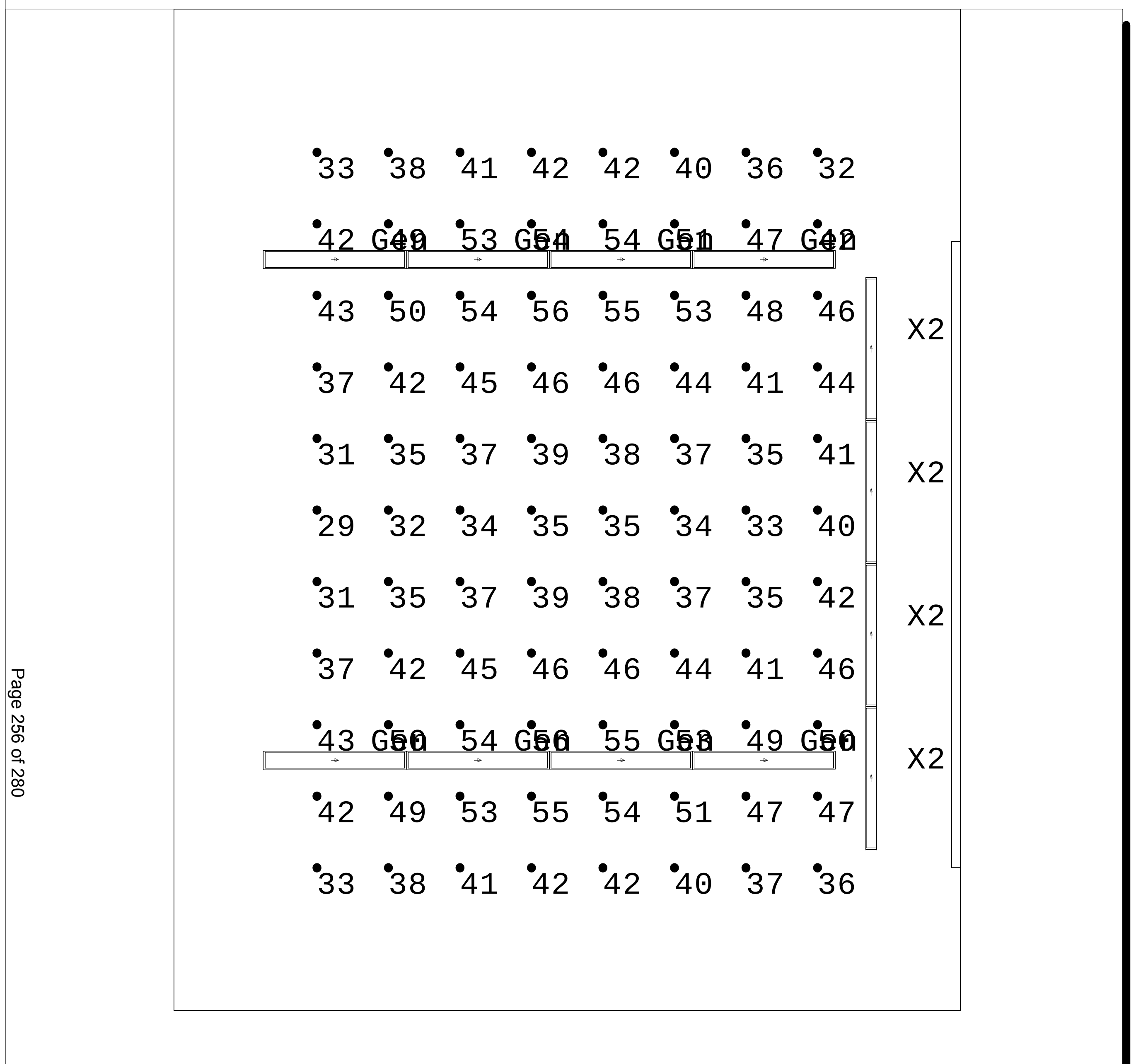
Drawn By: V Lauck

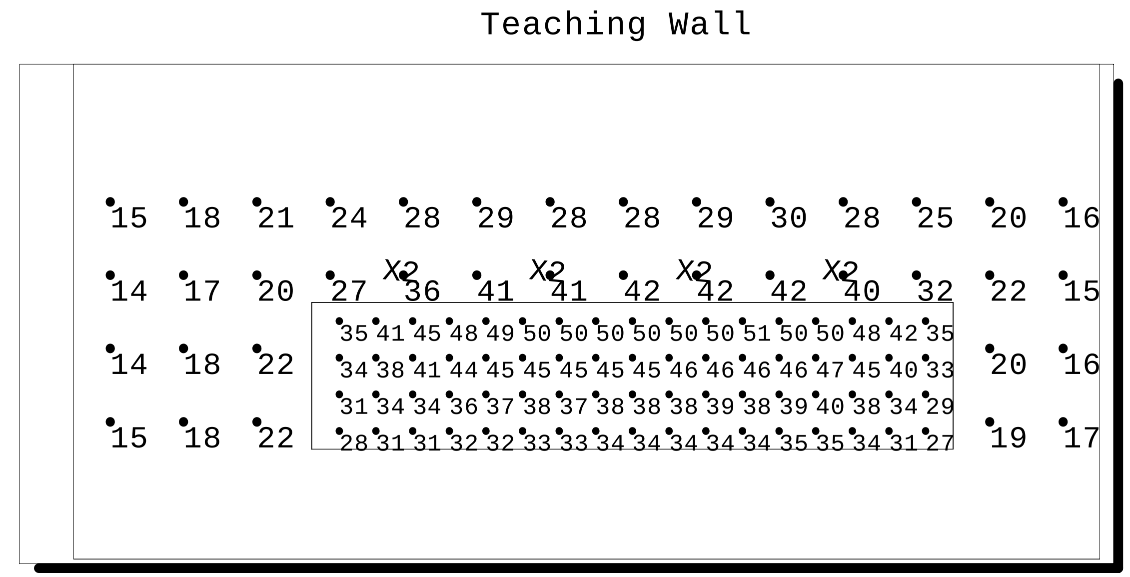
Date: April, 2006

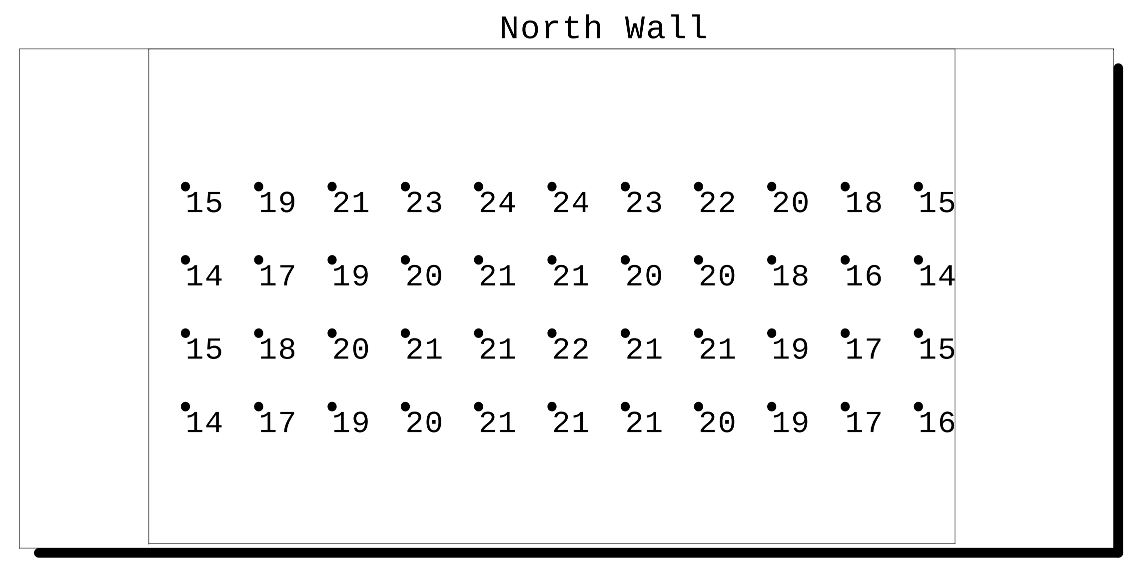
Revisions #	Date	Comments
1		

FINELITE
Better Lighting for a Better Workplace

GENERAL MODE







Luminaire Schedule									
Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	4	X2	3100	0.752	SX2 WCB 1T8 96W	0.88	28	0.9	0.95
	8	Gen	3100	0.846	X1 PLV CCO 2T8 EP	0.99	63	0.9	0.95

Numeric Summary							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
North Wall	Illuminance	Fc	19.07	24	14	1.36	1.71
Teaching Wall	Illuminance	Fc	25.03	42	14	1.79	3.00
Chalkboard	Illuminance	Fc	39.63	51	27	1.47	1.89
Horizontal WP	Illuminance	Fc	42.83	56	29	1.48	1.93

Room Summary	
Label	Description
Room 114	22' x 28' - Refl .70, .50, .30 -- 13' CH

LPD Area Summary			
Label	Area	Total Watts	LPD
Room 114	616	616	1.000

SX1 luminaires 9.0' AFF; X2 luminaire is 8.5' AFF. Calculations based on Osram .99 QHE Instant Start Ballasts on outboard lamps (3-lamp .88 ballast on two lamps). Osram Powersense Dimming Ballasts on the center lamps.
QHE .88 BF IS ballasts on type X2.

Calculations have been performed according to IES standards and good practice. Some differences between measured values and calculated results may occur due to tolerances in calculation methods, testing procedures, component performance, measurement techniques and field conditions such as voltage and temperature variations. Input data used to generate the attached calculations such as room dimensions, reflectances, furniture and architectural elements significantly affect the lighting calculations. If the real environment conditions do not match the input data, differences will occur between measured values and calculated values.

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VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT 30" ABOVE FINISHED FLOOR.
AGI32 VERSION 1.8

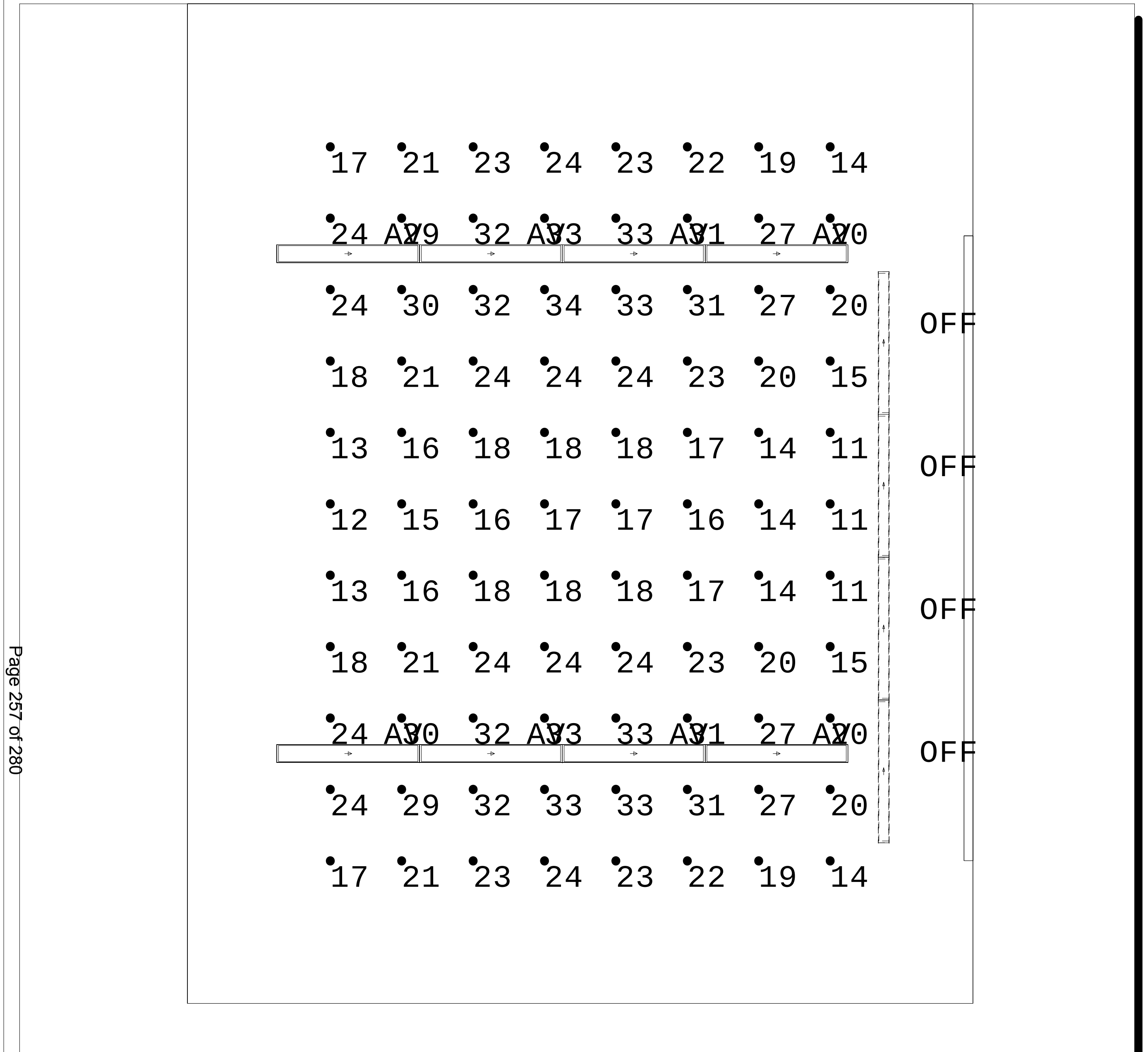
FINELITE
Better Lighting for a Better Workplace

Comments			Revisions

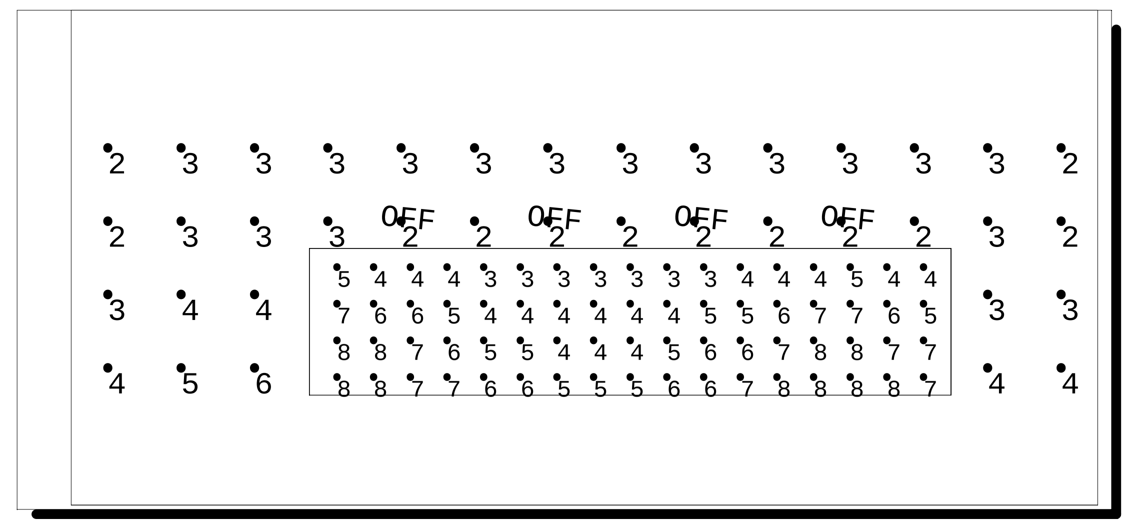
Drawn By: V Lauck
Date: April, 2006

Project: NYSERDA Syracuse U,
Room 114

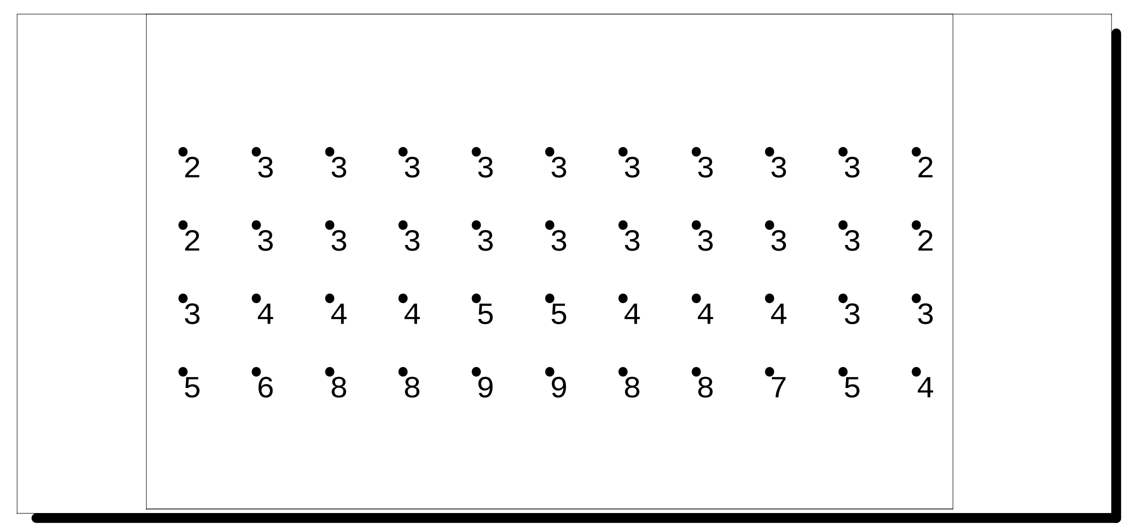
AV MODE



Teaching Wall



North Wall



Luminaire Schedule									
Symbol	Qty	Label	Lumens	LLF	Description	BF	Watts	LDD	LLD
	8	AV	3100	0.752	X1 PLV COO 1T8 EP	0.88	30	0.9	0.95
	4	OFF	3100	0.752	SX2 WCB 1T8 96W	0.88	28	0.9	0.95

Room Summary	
Label	Description
Room 114	22' x 28' - Refl .70, .50, .30 -- 13' CH

Numeric Summary							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Chalkboard	Illuminance	Fc	5.47	8	3	1.82	2.67
Horizontal WP	Illuminance	Fc	22.17	34	11	2.02	3.09
North Wall_	Illuminance	Fc	4.14	9	2	2.07	4.50
Teaching Wall_	Illuminance	Fc	2.95	6	2	1.48	3.00

LPD Area Summary			
Label	Area	Total Watts	LPD
Room 114	616	240	0.390

SX1 luminaires 8.75' AFF; X2 luminaire is 8.5' AFF. Calculations based on Osram .99 QHE Instant Start Ballasts on outboard lamps (3-lamp .88 ballast on two lamps). Osram Powersense Dimming Ballasts on the center lamps.
Type X2 luminaire is OFF.

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VALUES SHOWN ARE MAINTAINED HORIZONTAL FOOTCANDLES AT 30" ABOVE FINISHED FLOOR.
AGI32 VERSION 1.8

FINELITE
Better Lighting for a Better Workplace

#	Date	Comments

Revisions

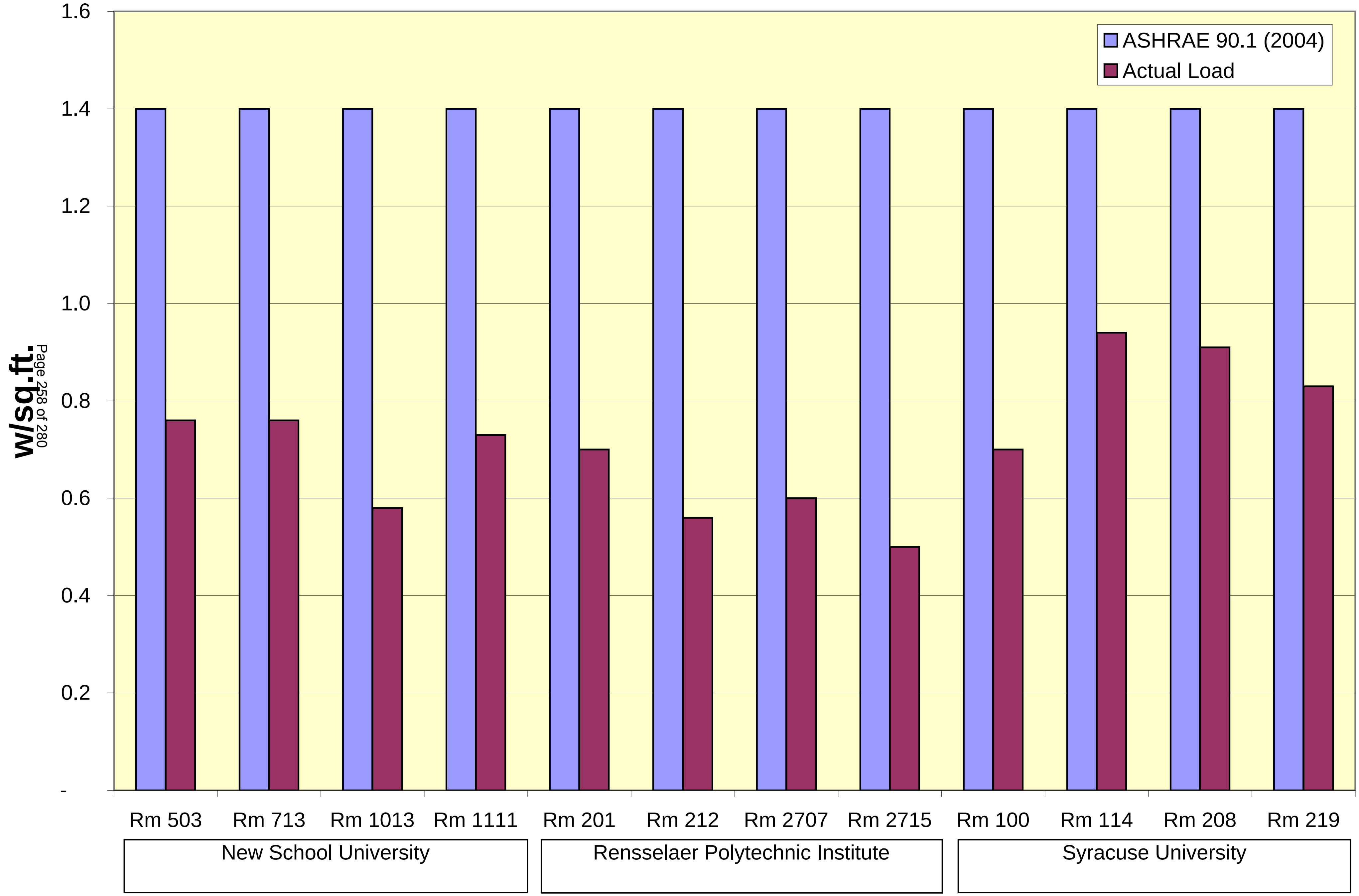
Drawn By: V Lauck
Date: April, 2006

Project: NYSERDA Syracuse U, Room 114

Energy Consumption by School - University

NYSERDA Classroom Lighting System

Sep 2006 - May 2007



Data Summary

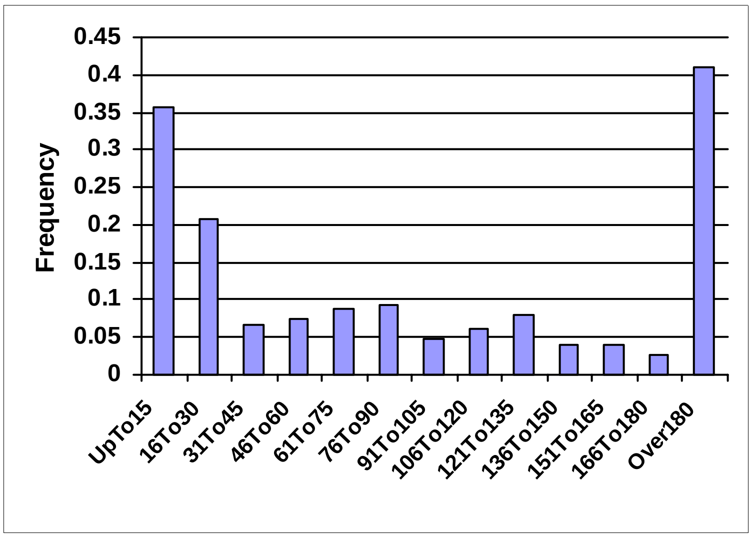
Syracuse University

Classroom	Date	AV Gen Switches	AV Use (#/Day)	WB Use (#/Day)	General Total Min	White Board Total Min	AV Total Min	Settle Time	Settle Count	Quiet Count	Occ Sensor Shut Off	Manual Shut Off	Lights On Total	Watts/ sq ft	kWh
219	2/15/07	0	0	0	625	625	0	0		0	2	1	625	1.02	6.57
	2/16/07	0	0	0	460	460	0	0		0	4	0	460	1.03	4.85
	2/17/07	1	1	0	1	43	43	42	1	3	0	1	44	0.48	0.22
	2/18/07	1	3	0	17	325	308	308	3	2	3	1	325	0.51	1.70
	2/19/07	2	4	0	436	457	218	27	1	2	3	2	654	0.79	5.28
	2/20/07	1	2	0	169	520	402	383	2	1	2	1	571	0.62	3.65
	2/21/07	1	1	0	126	583	457	457	1	2	1	2	583	0.60	3.58
	2/22/07	1	3	0	445	506	73	61	1	1	5	2	518	0.94	4.99
	2/23/07	1	2	0	347	347	83	0		2	5	0	430	0.84	3.71
	2/24/07	0	0	0	44	44	0	0		1	1	1	44	1.01	0.46
	2/25/07	0	0	0	130	130	0	0		0	3	0	130	1.02	1.36
	2/26/07	0	0	0	445	417	0	0		0	1	3	445	1.01	4.61
	2/27/07	0	0	0	506	506	0	0		0	3	1	506	1.02	5.31
	2/28/07	0	0	0	501	501	0	0		0	3	0	501	1.02	5.26
	3/1/07	0	0	0	556	556	0	0		0	1	1	556	1.02	5.83
	3/2/07	0	0	0	339	339	0	0		0	2	0	339	1.02	3.56
	3/3/07	0	0	0	87	87	0	0		0	3	0	87	1.02	0.91
	3/4/07	0	0	0	50	50	0	0		0	2	0	50	1.02	0.52
	3/5/07	0	0	0	481	481	0	0		1	2	1	481	1.02	5.05
	3/6/07	0	0	0	629	471	0	0		0	1	1	629	0.98	6.31
	3/7/07	1	3	0	558	640	82	82	3	0	4	1	640	0.95	6.26
	3/8/07	1	2	0	8	497	497	497	2	0	1	2	505	0.49	2.52
	3/9/07	1	1	0	424	424	1	0		0	2	1	425	1.03	4.47
	3/15/07	0	1	0	0	42	42	42	1	1	1	0	42	0.47	0.20
	3/16/07	0	2	0	0	18	18	18	2	2	2	0	18	0.48	0.09
	3/18/07	0	1	0	0	10	10	10	1	0	1	0	10	0.47	0.05
	3/19/07	0	4	0	0	325	325	325	4	0	4	0	325	0.48	1.60
	3/20/07	0	0	0	568	560	0	0		0	2	0	568	1.02	5.93
	3/21/07	1	1	0	331	460	129	129	1	0	2	0	460	0.87	4.11
	3/22/07	3	6	0	330	409	239	79	1	0	5	0	569	0.74	4.30
	3/23/07	1	1	0	239	372	140	133	1	0	4	0	379	0.82	3.17
	3/24/07	0	0	0	34	34	0	0		0	2	0	34	1.02	0.35
	3/25/07	0	0	0	86	86	0	0		0	4	0	86	1.02	0.90
	3/26/07	1	2	0	271	268	214	0		0	3	0	485	0.68	3.40
	3/27/07	0	2	0	0	408	537	408	2	0	3	0	537	0.41	2.28
	3/28/07	1	3	0	265	299	207	34	2	0	3	0	472	0.69	3.33
	3/29/07	1	3	0	14	522	519	508	3	0	4	0	533	0.48	2.63
	3/30/07	0	0	0	298	298	0	0		0	3	0	298	1.02	3.12

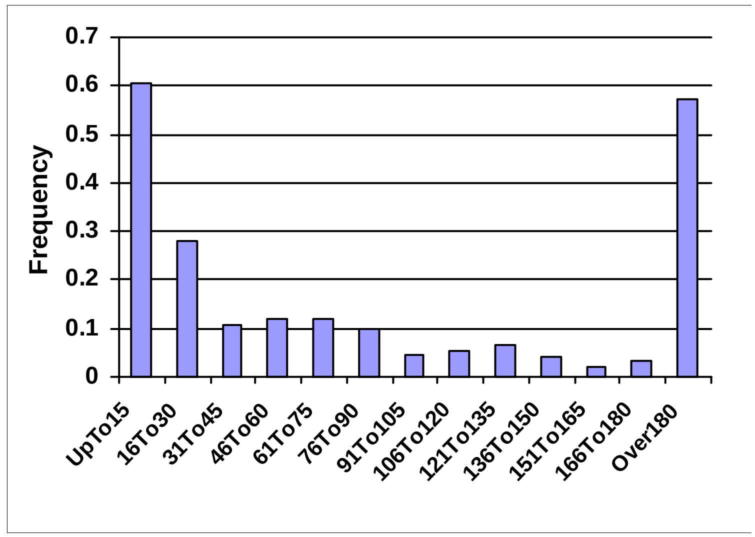
Average Daily Lighting Usage for Syracuse University, Rm 100
From 9/1/06 To 5/31/07

General AV mode Switches:	**.7**	**Quiet Time Usage:**	**1.4**
General Mode Time:	**341.4**	**Occupancy Sensor Shutoff Frequency:**	**2.0**
AV mode Time:	**285.8**	**Manual Shutoff Frequency:**	**1.2**
White Board Time:	**128.1**	**Lights On:**	**627.2**
Settle Mode Time:	**44.3**	**Watts/ sq ft:**	**0.64**
Settle Mode Counts:	**0.3**	**School Days:**	**149**

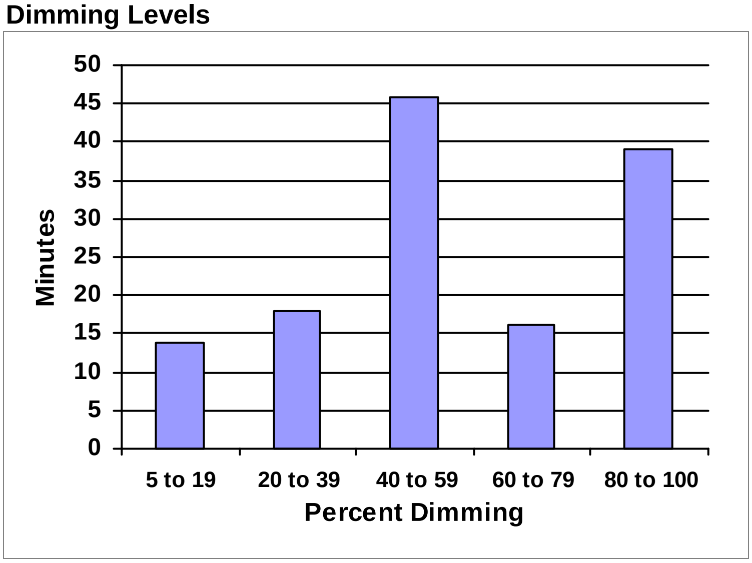
AV Mode



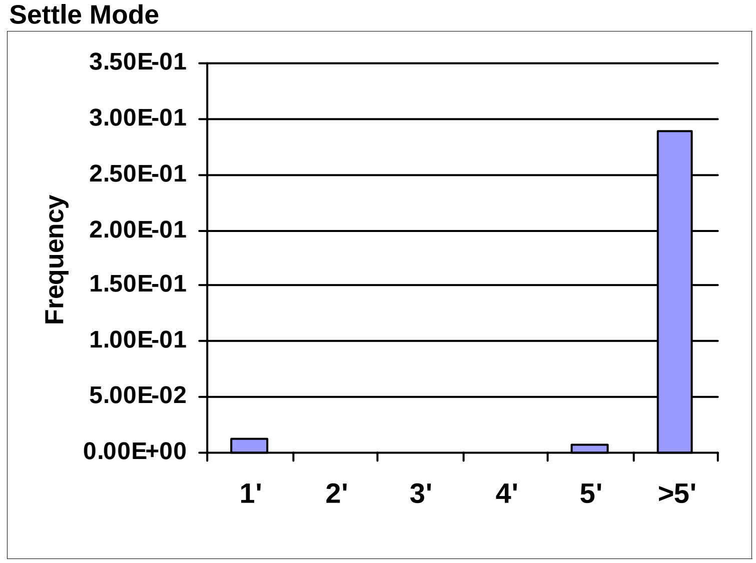
General Mode



Dimming Levels



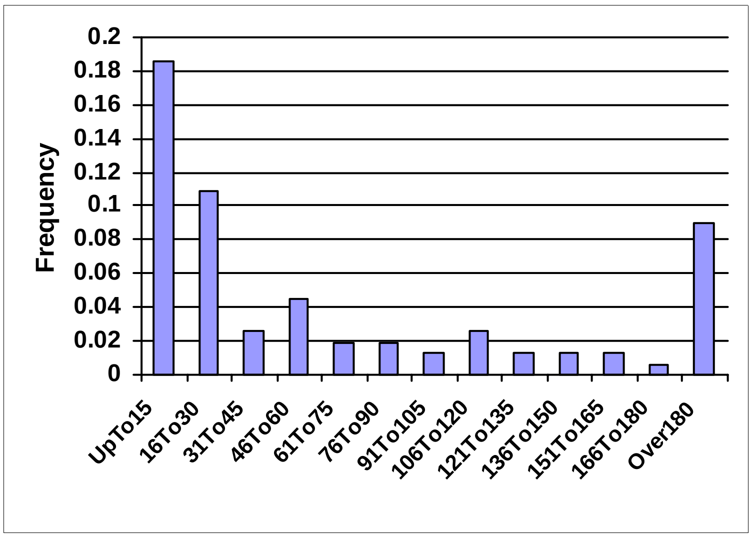
Settle Mode



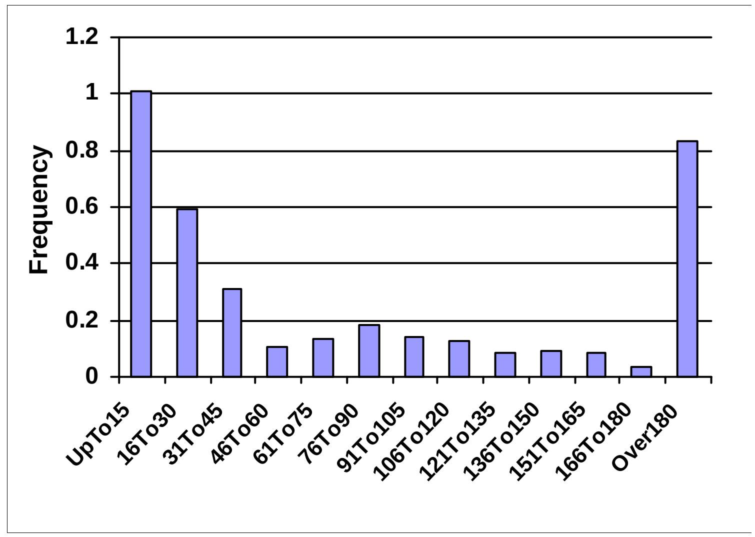
Average Daily Lighting Usage for Syracuse University, Rm 114
From 9/1/06 To 5/31/07

General AV mode Switches:	**.6**	**Quiet Time Usage:**	**0.5**
General Mode Time:	**434.4**	**Occupancy Sensor Shutoff Frequency:**	**2.5**
AV mode Time:	**56.3**	**Manual Shutoff Frequency:**	**1.3**
White Board Time:	**290.4**	**Lights On:**	**469.4**
Settle Mode Time:	**32.3**	**Watts/ sq ft:**	**0.95**
Settle Mode Counts:	**0.3**	**School Days:**	**156**

AV Mode



General Mode



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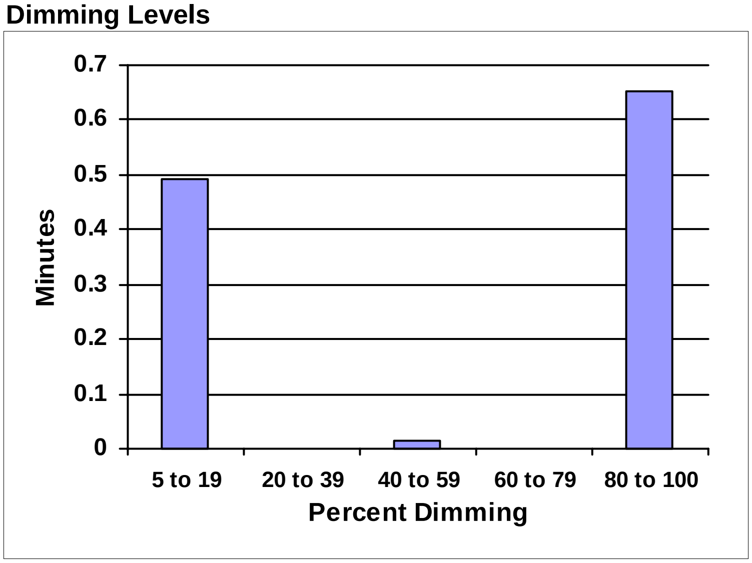
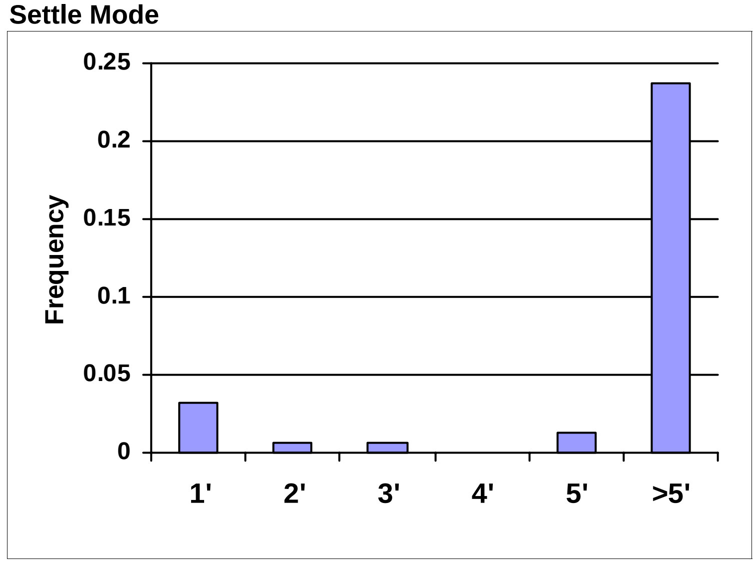


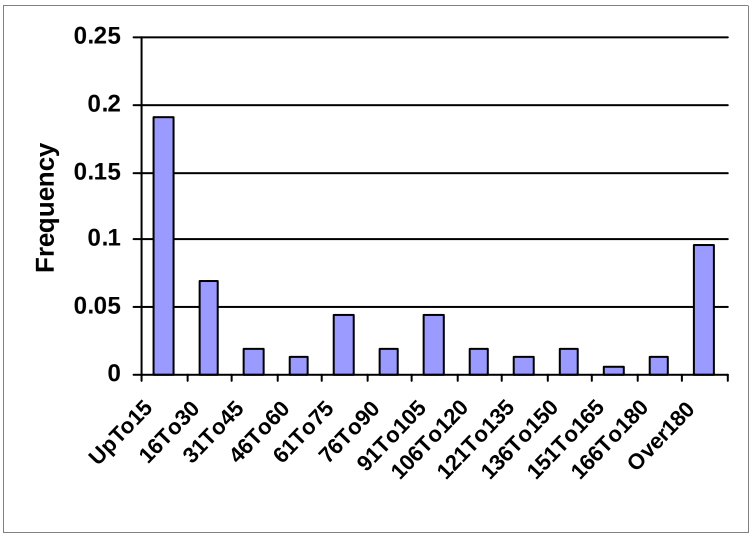
Settle Mode



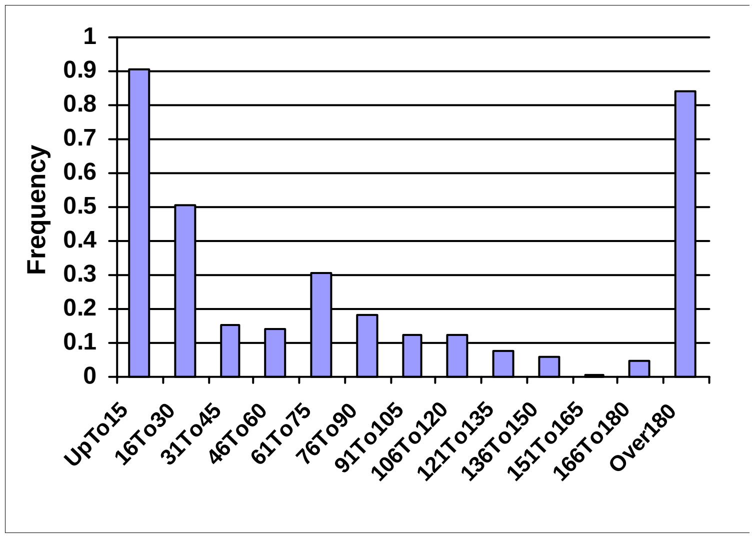
Average Daily Lighting Usage for Syracuse University, Rm 208
From 9/1/06 To 5/31/07

General AV mode Switches:	.2	**Quiet Time Usage:**	0.7
General Mode Time:	454.6	**Occupancy Sensor Shutoff Frequency:**	2.7
AV mode Time:	57.0	**Manual Shutoff Frequency:**	1.4
White Board Time:	463.4	**Lights On:**	511.6
Settle Mode Time:	51.1	**Watts/ sq ft:**	0.93
Settle Mode Counts:	0.6	**School Days:**	157

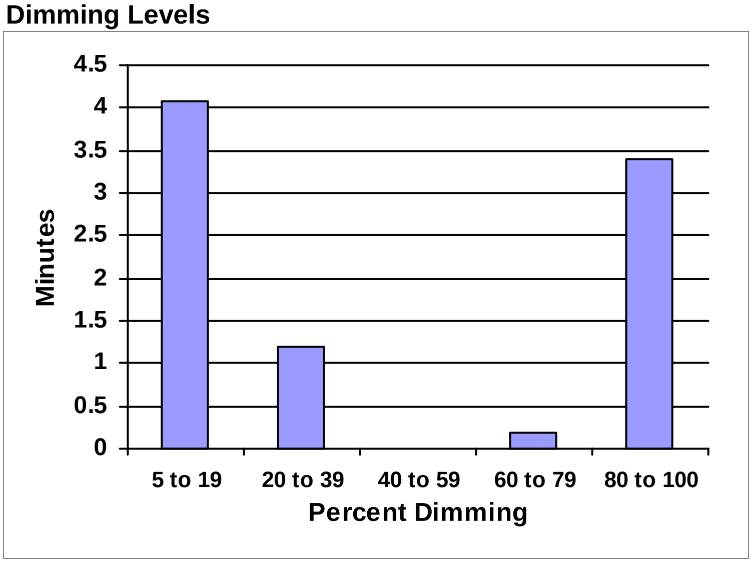
AV Mode



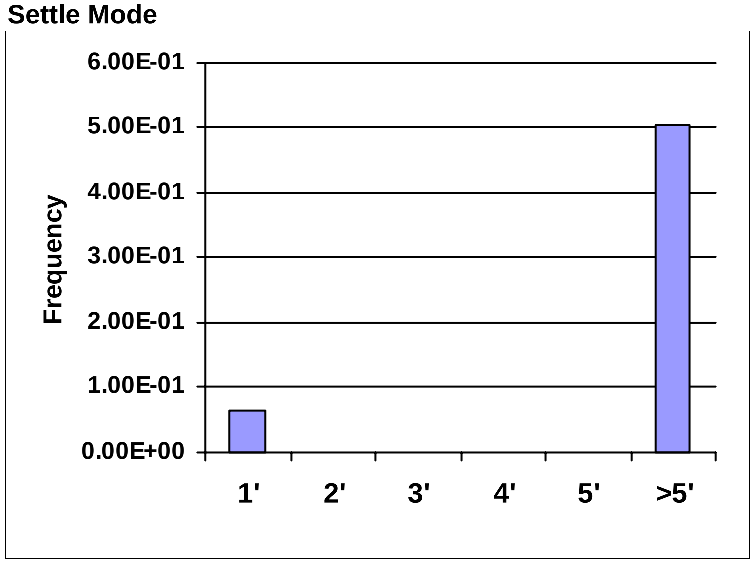
General Mode



Dimming Levels



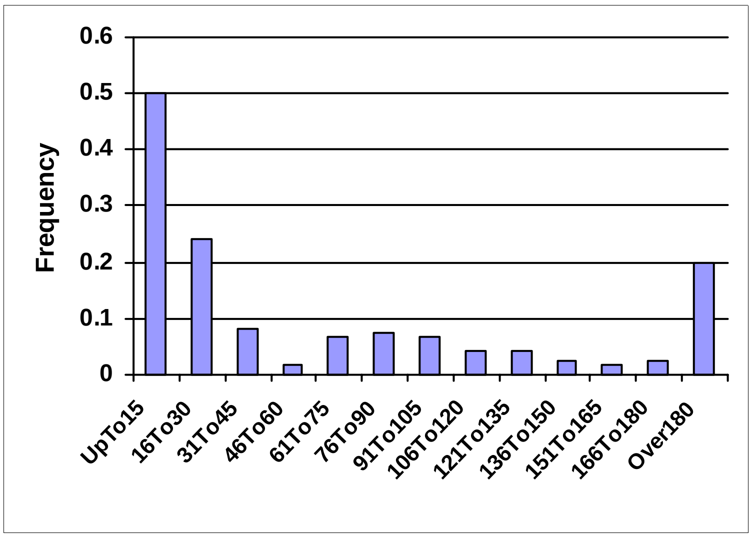
Settle Mode



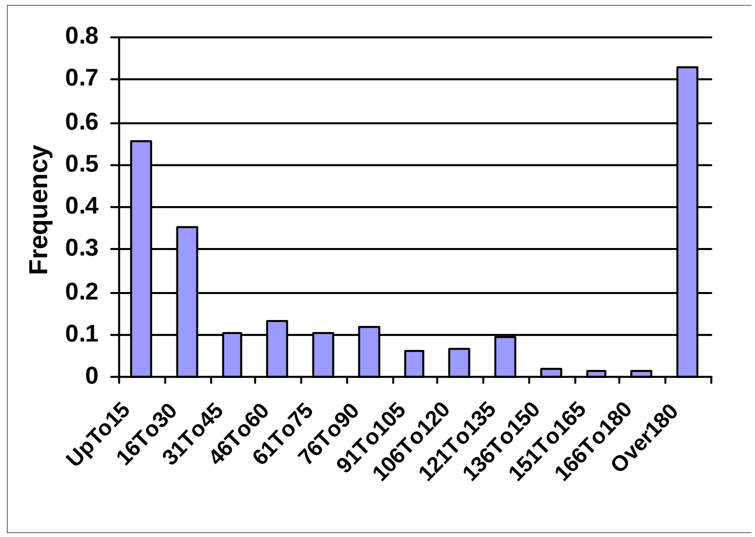
Average Daily Lighting Usage for Syracuse University, Rm 219
From 9/1/06 To 5/31/07

General AV mode Switches:	.7	Quiet Time Usage:	0.4
General Mode Time:	370.5	Occupancy Sensor Shutoff Frequency:	2.8
AV mode Time:	136.9	Manual Shutoff Frequency:	0.7
White Board Time:	415.1	Lights On:	507.4
Settle Mode Time:	99.5	Watts/ sq ft:	0.85
Settle Mode Counts:	0.8	School Days:	162

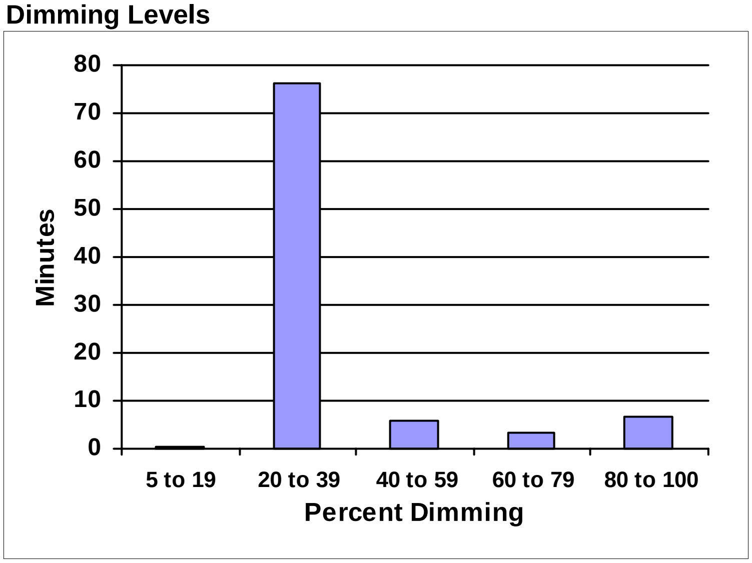
AV Mode



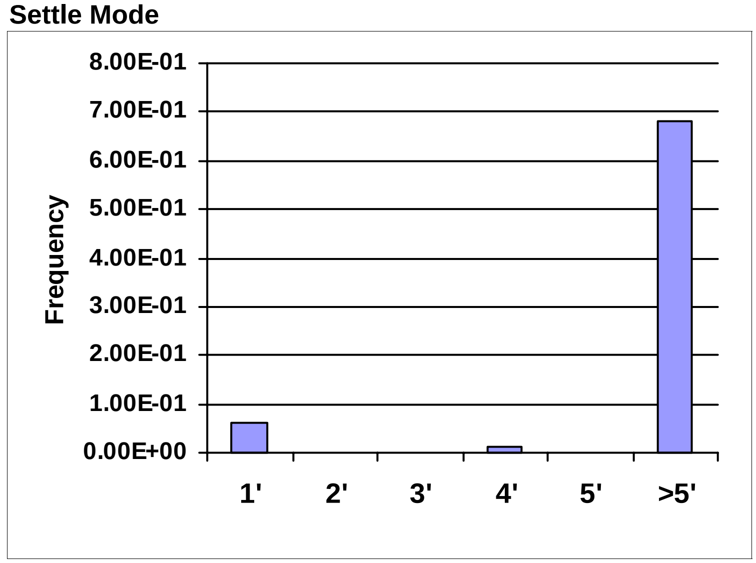
General Mode



Dimming Levels



Settle Mode

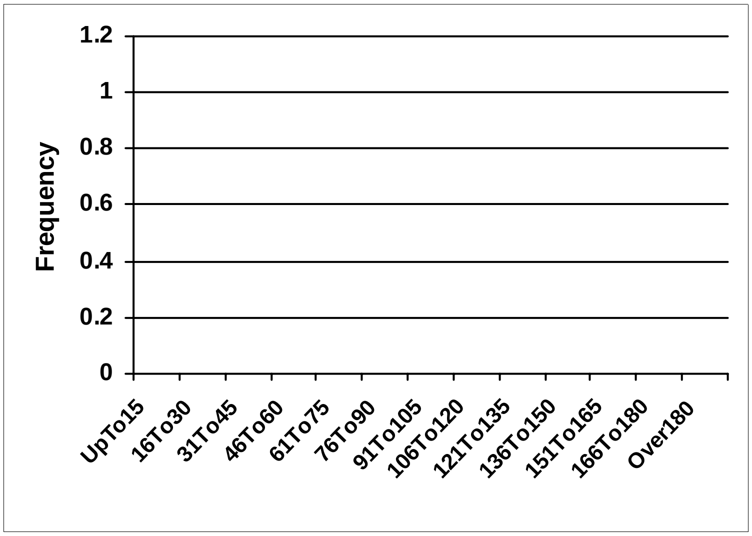


Average Daily Lighting Usage for Syracuse University, Rm 316 (Control)
From 9/1/06 To 5/31/07

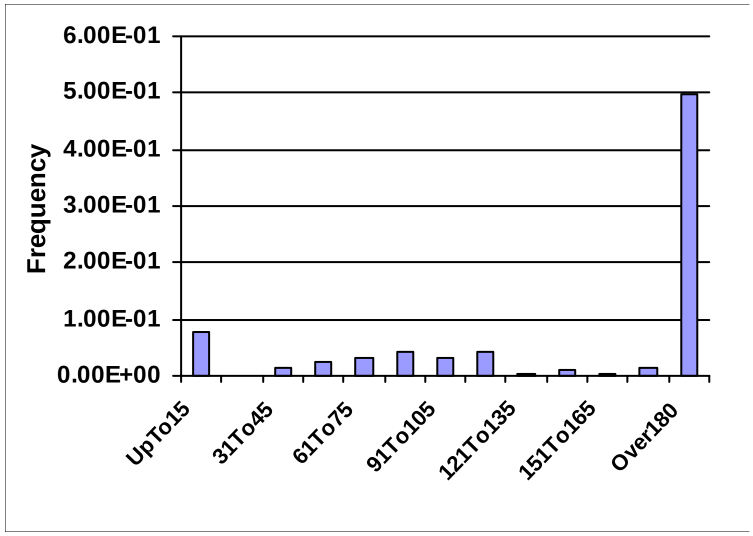
General AV mode Switches: .0
General Mode Time: 726.2
AV mode Time: .0
White Board Time: .0
Settle Mode Time: .0
Settle Mode Counts: 0.0

Quiet Time Usage: 0.0
Occupancy Sensor Shutoff Frequency: 0.0
Manual Shutoff Frequency: 0.0
Lights On: 727.7
Watts/ sq ft: 1.25
School Days: 189

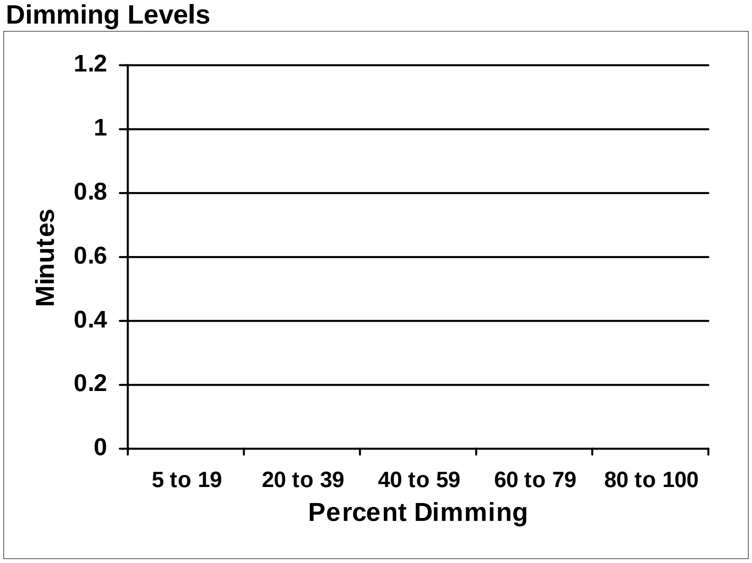
AV Mode



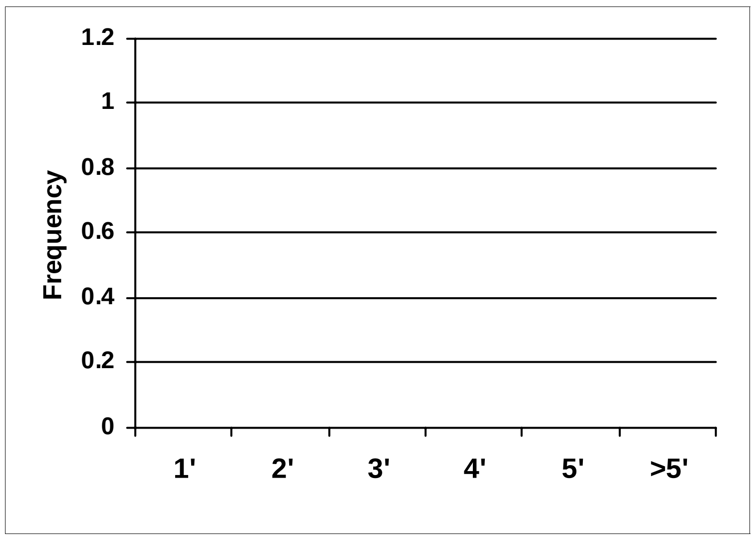
General Mode



Dimming Levels



Settle Mode



APPENDIX M – ICLS LAMP SELECTION

The two-scene luminaire uses 3100 Lumen T8 lamps, which deliver approximately 9% more light than the general 2850 lumen lamps. These 3100 lumen lamps are available from Osram-Sylvania, GE, and Philips. The incremental cost of these lamps is less than $\$0.05/ft^2$ making them a very affordable element of the entire system. See Appendix XX for an explanation why the system uses T8 lamps as opposed to T5HO lamps.

T8 & T5HO Lamps

T8 Lamps were selected over T5HO lamps in the classroom lighting system for a number of reasons, including:

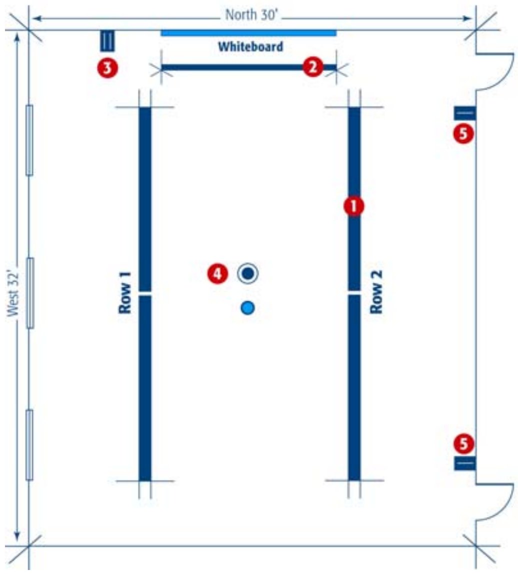
- Cost: T5HO lamps and ballast cost more than high output T8 products.

- Ballast Selection: There are a greater variety of ballasts available for T8 lamps. The variety in ballast factors improves the flexibility for designing classrooms. For instance, as demonstrated in this study the classrooms at the different sites required different ballast factors to achieve the recommended light level at the ideal energy level.

- Maintenance: T5HO ballasts are wired in series, which poses a problem for maintenance teams. When one lamp goes out all lamps wired to the same ballast go out.

- Lenses Required: T5HO lamps require a lens below the lamps to shield occupants from the intense bulb wall brightness. The lens in the fixture captures objects thrown up into the luminaire instead of allowing them to flow through, which adds to work for the maintenance teams.

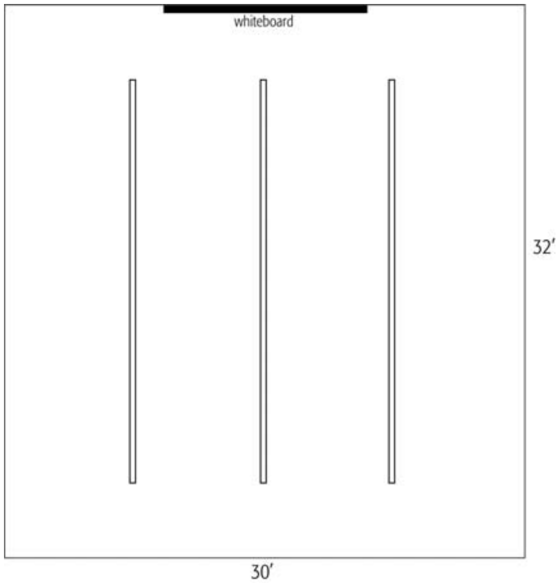
- Audiovisual: Providing excellent audiovisual lighting in a classroom is difficult with only one T5HO lamp in cross section. Using multiple T5HO lamps in cross-section yields higher energy consumption.

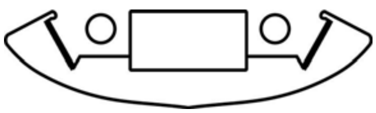


The Integrated Classroom Lighting System Template – 3rd Generation

The Integrated Classroom Lighting System installed in the NYSERDA demonstration classrooms represents years of research into high performance classroom design. This 3rd generation lighting system was developed using the Collaborative for High Performance Classrooms (CHPS) best practices as a base and two California Energy Commission sponsored research projects to prove and further develop the system. Following this template ensures the classroom design will meet or exceed the CHPS and LEED for Schools best practice standards. Following is the history of how the 3rd generation classroom came to exist in its present form.

				
Indirect/Direct Luminaires:	Whiteboard Luminaire:	Teacher Controls:	Sensors:	Master Switch:
1) Two rows of two-scene indirect/direct luminaires mounted perpendicular to the main teaching wall (parallel to the window wall) and spaced 14-15' apart.	2) A dedicated luminaire is used to illuminate the whiteboard on the main teaching wall.	3) Teacher control is placed at the front of the classroom. Place teacher controls within 6" of the whiteboard for easy access.	4) Sensors are placed in the center of the classroom. Sensors always include occupancy and daylight harvesting is added where appropriate.	5) A master on/off switch is by every door to the classroom.





1st Generation – CHPS

The 1st Generation system was based on CHPS best practices.

System Design:

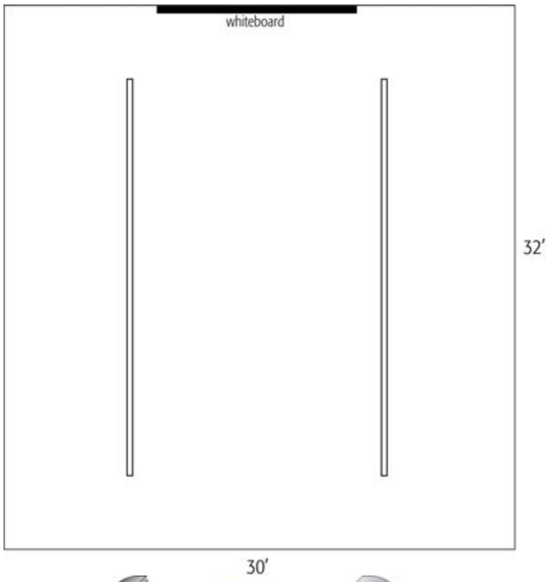
- Three rows of 2T8 indirect/direct luminaires.
- 2850 Lumen T8 Lamps
- 0.77 ballast factor Ballasts
- Two switches located by the door controlling the window row separately from the other two rows.

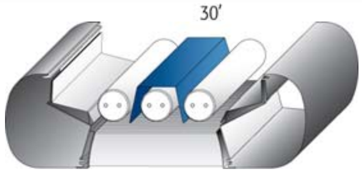
Benefits to Classroom:

- Beautiful and even illumination.
- Improved lighting quality, reduced glare, and evenly illuminated ceilings and walls.
- Reduced Energy Consumption: The design achieved 1.0 w/sq.ft.

Design Feedback

- A 3-row design is 50% more expensive than a 2-row design.
- The center row conflicted with common ceiling mounted audiovisual equipment.
- Teacher controls were placed at the back of the room and were not used as by teachers.
- Accommodating an audiovisual mode is more challenging in a 2T8 luminaire.





2nd Generation – PIER 4.5

The 2nd Generation Integrated Classroom Lighting System was developed through the California Energy Commission's PIER project.

System Design:

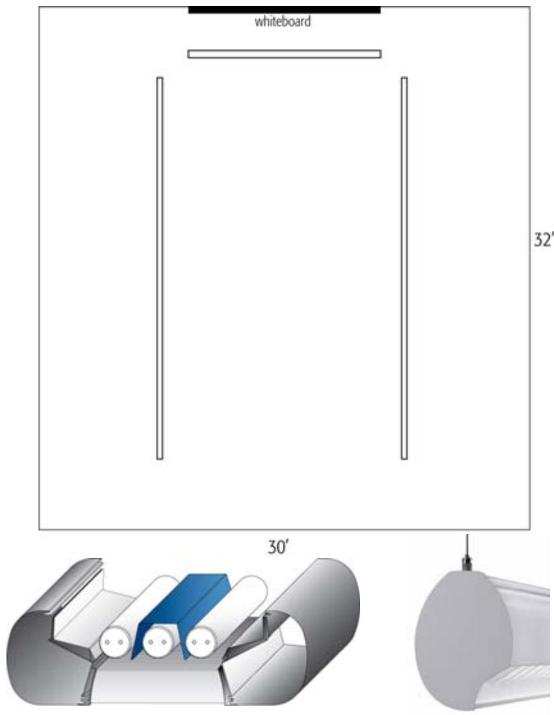
- Two Rows of indirect/direct two-scene luminaires spaced 14-15' on center.
- 3100 lumen "Super" T8 lamps
- 1.18 ballast factor ballasts
- 96% reflective optical materials
- Teacher control center placed at the front of the classroom.
- Ceiling mounted occupancy sensors mounted in the center of the room.
- Quiet Time occupancy sensor bypass controls at the front of the classroom.
- On/Off master controls by each door.
- Plug and play low voltage wiring connecting system.

Benefits to the classroom:

- Improved lighting quality, including reduced glare, and evenly illuminated ceilings and walls.
- Reduced energy consumption: <1 w/sq. ft. (0.9 w/sq. ft.)
- Two lighting modes: General Mode and Audiovisual Mode
- Optional Audiovisual Dimming
- Teacher controls at the front ensured teachers used the system every day.
- Master on/off controls were also placed at each entrance to the room.

Design Feedback

- Teachers preferred the Generation 2 9:1 to existing lighting.
- Teachers preferred having controls at the front of the classroom and used them daily.
- Dual technology occupancy sensors saved energy and the Quiet Time control improved teacher satisfaction.
- Even with illumination levels in the classroom between 40 and 70 footcandles (fc) some teachers still felt the space needed more light on the whiteboard.



3rd Generation – NYSERDA

The NYSERDA Integrated Classroom Lighting System is the culmination of all research projects conducted to date.

System Design:

- Adds a whiteboard luminaire to the 2nd Generation system.
- Ballast factor is changed from 1.18 to 0.88.

Benefit to Classroom

- Improved vertical illumination on the whiteboard.
- Reduced energy consumption: 0.69 – 0.73 w/ft^2
- Two lighting modes: General Mode and Audiovisual Mode
- Additional Lighting Mode: Settle Mode- A/V Mode + Whiteboard.
- Optional Audiovisual Dimming
- Teacher controls at the front ensured teachers used the system every day.
- Master on/off controls were also placed at each entrance to the room.

Design Feedback

- Teachers prefer ICLS to the previous system
- Students prefer ICLS to the previous system
- Teachers used the Settle/Focus mode to calm students.
- Teachers used the whiteboard to focus student attention.

APPENDIX O – INTEGRATED CLASSROOM LIGHTING SPECIFICATION

SECTION 16512 - CLASSROOM LIGHTING SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 OVERVIEW

A. This section specifies an integrated classroom lighting and control system that provides:

1. Single source responsibility by the manufacturer for the specified lighting fixtures, sensors, and lighting control devices in the classroom. The manufacture shall provide the following:

   Lighting fixtures, lamps, motion sensors, photo-sensors, dimmer controls, power packs and relays, switches and wall cover plates, with labels, as described herein and as noted on the drawings.

   Confirmation of lighting and power calculations based on the indicated design.

   Wiring diagrams.

   Control cables with pre-installed plug connectors.

   Control Devices as indicated with receptacles for Control cables.

   Installation and Owners Manuals.

   Factory training for installation of products.

   Single-source post-installation support for owner and their designated representatives.
   Pass through warranties apply for lamps, ballast, sensors and controls from the appropriate manufacturers.

B. This Section includes the following:

1. Interior lighting fixtures with lamps, ballasts and controls designed specifically for multi-functional classroom lighting.
2. Accessories: As noted on the plans, provide Teacher Control Center, Single Pole Switches, Low Voltage Switches, dimmer controls (optional), occupancy sensors, and/or light level photo-sensors.

C. Related Sections include the following:
1. Division 16 Section "Raceways and Boxes".
2. Division 16 Section "Conductors and Cables".

1.3 DEFINITIONS

A. BF: Ballast Factor. Ratio of light output of a given lamp(s) operated by the subject ballast to the light output of the same lamp(s) when operated on an ANSI reference circuit.

B. CRI: Color Rendering Index.

C. CU: Coefficient of Utilization.

D. LER: Luminaire Efficiency rating, which is calculated according to NEMA LE 5. This value can be estimated from photometric data using the following formula:

1. LER is equal to the product of total rated lamp lumens times BF times luminaire efficiency, divided by input watts.

E. RCR: Room Cavity Ratio.

1.4 PERFORMANCE REQUIREMENTS

A. The Classroom Lighting System shall consist of: pendant luminaires with specified ballast factor, lamps with specified lumen output and CRI, Teacher Control Center, Dimmer Control (if specified herein), faceplates with specified labels, motion control sensors, photo sensors (if specified herein), Relay Control Interface with Modular receptacles, Plenum-rated Low-Voltage Control cables with modular connectors, and control components.

B. The pendant luminaires shall contain two rows of 48-inch fluorescent lamps whose primary luminous distribution is upward and one center row of 48-inch fluorescent lamps whose primary luminous distribution is downward. These rows shall be dual switched per information to follow.

C. The control system shall consist of:

1. A Teacher Control Center (TCC) located near the teacher's primary teaching position. Teacher will select uplight on or down light on, but up light and down light cannot be on at the same time. The cover plate for the Teacher Control Switch will be labeled "GENERAL" and "A/V MODE". Wiring from the TCC shall be through factory wired receptacle and factory supplied low-voltage cable with pre-installed connectors as described.

2. "Quiet Time Switch". The instructor can use a toggle switch on the TCC to send a signal to the motion sensor. When the switched is toggled, the lighting in the classroom will stay on even in the absence of motion, for one hour. After one hour, the motion sensor will automatically restore to its previous state. The instructor can toggle the switch at any time to re-set "Quiet-Time" to a full 60 minute on period. While in "Quiet Time" mode the instructor will have full control of the classroom lighting. The label on the TCC will read "QUIET TIME 1 HOUR ON".

3. Motion Sensor shall be ceiling-mounted and connect to the lighting system through low-voltage wiring using factory-installed receptacles and factory supplied cable with pre-installed connectors as described. The sensor shall turn lights on when both PIR and ultrasonic sensors detect occupancy. Once on, detection by either sensor will keep the lights on. A field adjustable time-delay shall be factory preset to recommended NEMA standards. Sensitivity settings shall adjust automatically through integrated sensor technology.

4. (Optional) The downlight of each luminaire shall be dimmed to 5% of the initial light level. The TCC contains the dimmer control unit, which is labeled "A/V MODE DIMMING."

5. (Optional) Daylight Control sensor shall be ceiling-mounted facing the primary window wall and located approximately one-half way between the first row of luminaries and the wall. It shall provide for user-adjustable light level setting between 10 and 1000 footcandles. It shall provide for an adjustable dead band setting to prevent lighting system cycling. The Daylight Control sensor shall be connected to a set of relays by plug together low voltage cables. The relays will be used to turn off one-half of the up lights in each row when the sensor indicates that sufficient daylight is present. Sensor will be factory calibrated to reduce the field commissioning time to calibrate the units.

D. Performance of up-light (General Mode) portion of the luminaries:

1. In General Illumination mode, achieve an average illumination at the desk level of 35 to 50 footcandles with a minimum of 25 footcandles at any point more than 3ft from the wall. Lighting power density shall be equal to or less than 1 w/sq. ft.
2. Performance results will be calculated as follows: Horizontal light reading averages shall be taken from an area 3-feet in from each wall with readings every foot. Standard reflectances used should be 80/50/20.

3. Performance results will be calculated as follows: Horizontal light reading averages shall be taken from an area 3-feet in from each wall with readings every foot. Standard reflectances used should be 80/50/20.

E. Performance of downlight (Audiovisual Mode) portion of the luminaires:
   1. In Audiovisual Mode, not including contribution from the teaching wall light, achieve an average illumination at the desk level of between 10 and 20 footcandles for any point in the room greater than 3 feet from the side walls, 10 feet from the front wall and 6 feet from the back wall, while limiting vertical illumination on the projection screen to no more than 7 footcandles at any point on the screen.
   2. Performance results will be calculated as follows: Horizontal light reading averages shall be taken from an area 3 feet from the side walls, 10 feet from the front wall and 6 feet from the back wall, with readings every foot. Standard reflectances used should be 80/50/20.

F. Performance of Whiteboard luminaire
   1. Provide a separately switched lighting system for the teaching wall that provides whiteboard vertical illumination of at least 30 footcandles average with maximum uniformity of 8:1 or better.

G. The Classroom Lighting System shall be shipped from the luminaire manufacturer complete with luminare, ballasts, lamps, fixture supports, applicable control components, control cables, and device coverplates. The installer shall supply standard electrical components such as, but not limited to, electrical boxes, conduit, building wire, etc.

1.5 SUBMITTALS

A. Product Data: For specified lighting fixture. Include data on features, accessories, finishes, and the following:

   1. Physical description of luminaire, including dimensions and verification of indicated parameters.
   2. Certified Photometric Test Report prepared by an independent testing laboratory.
   3. Fluorescent ballasts.
   4. Lamps.
   5. Control components: Switches, dimmers, occupancy sensors, light level sensors, relays.

B. Shop Drawings: Show details of luminaires. Indicate dimensions, weights, and method of field assembly, components, features, accessories, and location and size of each field connection.

C. Wiring Diagrams: Power, and control wiring.

   1. Operation and Maintenance Data: For lighting equipment and fixtures to include: in-operation, and maintenance manuals.

D. Warranties: Special warranties specified in this Section.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: The manufacturer shall have not less that ten years experience of manufacturing pendent fluorescent luminaires.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

D. Mockups: If required for this project, provide luminaires and accessories for room or module mockups. Install luminaires for mockups with power and control connections.

1. Obtain Architect's approval of luminaires for mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approved luminaires in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Source Limitations: Obtain Classroom Lighting System through one source from a single manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

1.8 PROJECT CONDITIONS: Existing Facilities

A. Interruption of Existing Classrooms: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify [**Architect**] [**Construction Manager**] [**Owner**] no fewer than four days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without [**Architect's**] [**Construction Manager's**] [**Owner's**] written permission.

1.9 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.10 WARRANTY

A. Special Warranty for Fluorescent Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Electronic Ballasts: Five years from date of Substantial Completion.

B. Manufacturer's Special Warranty for T8 Fluorescent Lamps: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: Two years from date of Substantial Completion.

1.11 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: 1 for every 200 of each type and rating installed. Furnish at least one of each type.
2. Parabolic Diffusers: 1 for every 500 of each type and rating installed. Furnish at least one of each type.
3. Ballasts: 1 for every 500 of each type and rating installed. Furnish at least one of each type.
4. Occupancy Sensors: 1 for every 200 of each type and rating installed. Furnish at least one of each type.
5. Light Level Sensors: 1 for every 200 of each type and rating installed. Furnish at least one of each type.
6. Dimmer Controllers: 1 for every 200 of each type and rating installed. Furnish at least one of each type.
7. Power Pack Relays: 1 for every 200 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Classroom Lighting System:

Finelite or approved equal. Submit documents for approval 10 days prior to bid.

B. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.

2.2 FIXTURES AND COMPONENTS, GENERAL

A. Fluorescent Fixtures: Comply with UL [**1570**] [**1598**]. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

B. Metal Parts: Free of burrs and sharp corners and edges.

C. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

E. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 96 percent.
2. Specular Surfaces: 95 percent.
3. Diffusing Specular Surfaces: 85 percent.

F. Plastic Diffusers, Covers, and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

a. Lens Thickness: At least 0.125 inch minimum unless different thickness is scheduled.
b. UV stabilized.

2.3 LUMINAIRES

A. Fixture:

1. Fixture - Optical Operation:

a. Pendent mounted luminaire with direct/indirect distribution using a perforated white cross-blade baffle contoured to match the fixture radius, spaced approximately 1.8" apart to control the down light portion and a 96% or greater reflective center optical section to control the down light mode of operation.

b. In the up light mode, the fixture shall be at least 83% efficient with 2T8 lamps operating in the up light mode. 64% of the light distribution shall be upward and 36% down in this mode. Candela power from 55 degree to 90 degrees shall be 300 or less at all angles.

c. In the down light mode, the fixture shall be at least 64% efficient with 1 T8 lamp operating in the down light mode. 100% of the light from this lamp will be in the downward direction. Brightness of the baffle shall be less than 360 candelas across all angles from 55 degrees to 90 degrees.

d. To achieve the requirement of 1 watt per square foot or less, the fixtures must be designed to accept T8 electronic ballasts with BF ranging from .71 to 1.18. Generally, 2-row per classroom systems will use 1.18 BF ballasts for 960 square feet and 3-row per classroom systems will use .77 BF ballasts for 960 square feet.

2. Voltage: [**120**] [**277**] Volts AC.
3. Mounting: Adjustable aircraft cable system to allow up to 48-inch suspension.
4. Nominal Dimensions: 10 inches wide x 2 1/2 inches high in multiples of 48 inches long.
5. Lamps: Three per cross section**.** Sylvania 32 watt T8, Cat# FO32/835/XPS/ECO with a lumen rating of 3100 Lumens.
6. High Ballast Factor Ballasts: 1.18 BF 3-T8 electronic ballasts. Sylvania # QT3X32 PLUS or equal.
7. Low Ballast Factor Ballasts: .77 BF 3-T8 electronic ballasts, Sylvania # QT3X32 ISL-SC or equal.
8. Dimming Ballasts: 5% - 100% 3-T8 electronic dimming ballasts with 0 to 10-volt dc control. Sylvania # QTP3X32 DIM5-Q or equal.

2.4 FLUORESCENT LAMP BALLASTS

A. Description: Include the following features, unless otherwise indicated:

1. Designed for type and quantity of lamps indicated at full light output.

B. Electronic ballasts for linear lamps shall include the following features, unless otherwise indicated:

1. Comply with NEMA C82.11.
2. Ballast Type: Instant Start, unless otherwise indicated.
3. Dimming Ballasts: Will be rapid start or programmed start units.
4. Sound Rating: A.
5. Total harmonic distortion rating of less than 20 percent according to NEMA C82.11.
6. Transient Voltage Protection: IEEE C62.41, Category A.
7. Operating Frequency: 20 kHz or higher.
8. Lamp Current Crest Factor: Less than 1.7.
9. Parallel Lamp Circuits: Multiple lamp ballasts connected to maintain full light output on surviving lamps if one or more lamps fail.

C. Ballasts for dimmer-controlled fixtures shall comply with general and fixture-related requirements above for electronic ballasts and the following features:

1. Dimming Range: 100 to 5% percent of rated lamp lumens.
2. Ballast Input Watts: Can be reduced to 25 percent of normal (93 watts reduced to 23 watts.)
3. Compatibility: Certified by manufacturer for use with specific dimming system indicated.

2.5 FLUORESCENT LAMPS

A. Low-Mercury Lamps: Comply with Federal toxic characteristic leaching procedure test, and yield less than 0.2 mg of mercury per liter, when tested according to NEMA LL 1.

B. T8 rapid-start low-mercury lamps, rated 32 W maximum, 3100 initial lumens (minimum), CRI of 85 (minimum), color temperature of 3500 K, and average rated life of 20,000 hours, unless otherwise indicated.

2.6 FIXTURE SUPPORT COMPONENTS

A. Comply with Division 16 Section "Basic Electrical Materials and Methods" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated, [**12 gage**].

C. Wires For Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.

D. Rod Hangers: 3/16-inch- minimum diameter, cadmium-plated, threaded steel rod.

E. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.

2.7 FINISHES

A. Fixtures: Manufacturers' standard, unless otherwise indicated.

1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.
2. Metallic Finish: Corrosion resistant.

2.8 LIGHTING CONTROL DEVICES

A. Teacher Control Switch: SPDT switch rated for its operating voltage and current. Specification grade decorator style.

B. Row Control Switches: 2PST switches rated for its operating voltage and current. Specification grade decorator style.

C. Dimming Ballast Controls: Sliding-handle type with on/off control; compatible with ballast and having light output and energy input over a dimming range or 100% to 5%.

D. Coverplates: Nylon, quantity of opens to match quantity of decorator style devices.

E. Occupancy Sensors: Adjustable sensitivity and off delay time range of 5 to 30 minutes.

1. Device Color: White
2. Mounting: Ceiling-mounted.
3. Occupancy detection indicator.
4. Combination Sensors: Ultrasonic and infrared sensors combined.
   a. Ultrasonic Sensor: Crystal controlled with circuitry that causes no detection interference between adjacent sensors.

b. Infrared Sensor: With daylight filter and lens to afford coverage applicable to space to be controlled

.

F. Light Level Sensor: Detect changes in ambient lighting level and provide supply for on/off control.

1. Sensor Capacity: At least [**40**] <**Insert number**> electronic dimming ballasts.
2. Adjustable Ambient Detection Range: [**10 to 100 fc minimum**] <**Insert detection range**>.

2.9 Retain below to allow photometric tests by manufacturer's laboratory.

PART 3 - Execution

3.1 INSTALLATION

A. Fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Support for Fixtures in or on Grid-Type Suspended Ceilings: Use grid for support.

1. Install a minimum of one ceiling support system rod or wire for each pendent support cable.
2. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

C. Continuous Rows: Suspend from cable, brace to limit swinging as required by seismic conditions.

3.2 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Ground equipment according to Division 16 Section "Grounding and Bonding."

C. Connect wiring according to Division 16 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Verify normal operation of each fixture after installation.

C. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify normal transfer to battery power source and retransfer to normal.

D. Corroded Fixtures: During warranty period, replace fixtures that show any signs of corrosion.

3.4 ADJUSTING

A. Set field-adjustable components on Occupancy Sensors, Light Level Sensors, and Dimmer Control.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.

3.5 CLEANING AND PROTECTION

A. Remove and dispose of clear plastic protection from around luminaires.

B. Clean luminaire optical surfaces.

C. After completing installation of exposed, factory-finished luminaires, inspect exposed finishes and repair damaged finishes.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain Classroom Lighting System. Refer to Division 1.

END OF SECTION 16512