

Next Generation Luminaire (NGL) Downlight Demonstration Project:

Alston & Bird, LLP, Law Offices

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Preface

As of 2012, the U.S. Department of Energy (DOE) estimates 700 million downlight luminaires were installed in residential and commercial buildings; light-emitting diode (LED) luminaires represent less than 1% of this installed base. Downlight luminaires using conventional incandescent, halogen, and compact fluorescent lamps have lower efficacies and shorter expected lifetimes than comparable LED systems; however, the lower initial cost of conventional technology combined with the public's uncertainties with new LED technology have limited widespread adoption of LED downlight luminaires. **If LED downlight luminaires were wholly adopted, about 278 trillion British Thermal Units (tBtu) could be saved annually, equating to an annual energy cost savings of \$2.6 billion.**¹

The Department of Energy conducts demonstration projects documenting the performance of LED luminaires relative to conventional technologies to increase market adoption of energy-efficient LED systems and to stimulate ongoing product development. These demonstration projects evaluate various aspects of lighting design, purchase, installation, and operation, and they assess the impacts LED technology might have on building owners and users. DOE collaborates with commercial building owners in these demonstrations and evaluates projects based on the general criteria of saving energy, matching or improving lighting quality, and offering cost-effective solutions relative to standard competing light sources.

This report is the second in a series of studies focusing on documenting the implementation of LED downlight luminaires. For these studies DOE sought projects where the host organization installed products available from manufacturers who had participated in the DOE Next Generation Luminaires (NGL) competitions. Preference for host organizations was given to members of the DOE's Better Buildings Alliance (BBA) which promotes energy efficiency in U.S. commercial buildings through collaborations with building owners, operators, and managers.

For this report DOE evaluated the use of LED downlight luminaires at the Alston & Bird, LLP, Law Offices in Atlanta, Georgia. A previous report documented LED downlight luminaires at the Hilton Downtown Columbus.

¹ DOE, *Adoption of Light-Emitting Diodes in Common Lighting Applications*, May 2013, (http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/led-adoption-report_2013.pdf).

Executive Summary

The Law Firm of Alston & Bird occupies approximately 365,000 ft² of space in One Atlantic Center, a high-rise office building in Atlanta, Georgia. The firm directed the design team working on a remodel completed in November 2013 to pursue energy efficiency and to strive to achieve Leadership in Energy and Environmental Design (LEED) certification. The project received LEED-Commercial Interiors (CI) Gold status.

The 16 remodeled floors included in the project use over 2,000 recessed LED downlights, wallwashers, and accent lights from USAI. This series of downlights received awards from the DOE's Next Generation Lighting (NGL) competition in 2012, which reinforced the design team's confidence that the downlight would exhibit the proper fit, finish, and photometric performance. The LED light sources are 3,500 Kelvin (K), 80 Color Rendering Index (CRI) for all applications except where 3,000 K, 90+ CRI LEDs were chosen to accentuate Alston & Bird's art collection. All downlights were equipped with 0-10 V dimming drivers capable of dimming down to less than 10% of full light output, and the light output appears to fade to off at the low end. **The cost of the LED downlights was estimated by the design team at 17% higher than the equivalent CFL downlight equipped with a premium dimming ballast, and that cost differential is dropping as LEDs become less of a novelty in the construction marketplace.**

One goal of the remodel was to expand and improve the firm's state-of-the-art video conferencing capabilities. Cameras must pick up face and body gesture details and present them onscreen just as someone within the room would see them. Video communication is enhanced when expressions and gestures are easy to see and facial appearances are not marred by harsh shadows, or exaggerated by video camera transmissions. Recessed LED wallwashers with frosted glass diffuser panels were selected to illuminate faces. Together with recessed linear fluorescent luminaires and light-colored room finishes, the selected wallwashers provide the needed vertical illuminance on faces without uncomfortable glare to the participants. The ratio of horizontal illuminance on the conference room table to vertical illuminance on the faces is around 2:1.

The Alston & Bird project successfully incorporated lighting controls into the firm's operations. Most floors use an Acuity Brands "nLight" system to automatically switch lights on and off during the work day, and switch lights according to occupancy outside of core hours. The LED luminaires are expected to decay slowly in light output throughout their lifetime, and the dimmable downlights have been programmed to deliver 90% of their maximum lumens now, saving 10% of the power while the installation is new. In a few years, when the LEDs have decayed in light output and additional light is needed, the lighting control system will be adjusted to deliver maximum output and draw full power. The video conference floors are controlled with a customized Crestron user interface that utilizes the dimming capabilities of the LEDs, allowing users to select different lighting scenes as needed for meetings.

The remodel work reduced Alston & Bird's energy use by 22-37% compared to the baseline, primarily due to changes in the lighting system. The building engineer has tracked the energy use since full re-occupancy and has been able to normalize each month's usage values based on heating degree days. This allows a comparison to the 2009 baseline data, despite weather differences between the comparable years.

- Winter months: 22% energy use reduction per square foot of tenant space after renovation.
- Summer months: 37% energy use reduction per square foot of tenant space after renovation.
- Over the 10 months of energy evaluation in 2014: 26.5% average energy use reduction per square foot of tenant space.

The total lighting power density (LPD) is 0.94 W/ft² for the 16 floors, 17.7% below the ASHRAE/IES 90.1-2007 code allowance, and does not factor in savings from dimming and controls. Much of the savings is due to the fact that the LED downlights use approximately half the wattage of similar compact fluorescent (CFL) downlights that would normally have been specified. Table ES1 shows the performance of comparable CFL and LED downlights offered by USAI.

Table ES1. Comparative Performance Data for CFL and LED USAI Downlight Luminaires.

	Aperture (dia.)	CCT (K)	Luminaire Light Output (lm)	Luminaire Power (W)	Luminaire Efficacy (lm/W)
CFL ¹	4.5"	3,500	980	35.3	27.8
LED ²	4.5"	3,500	1,316	16.0	82.3
¹ Product No.: 4400-10-F					
² Product No.: 3110-AB1-LSTD4-F-9016					

Acknowledgments

The design team, building owner, tenant, and downlight manufacturer were all enthusiastic about telling the story of the Alston & Bird renovation and the successful use of LED downlights. The Department of Energy's Commercial Building Integration gratefully acknowledges their contribution.

Project credits:

Architecture/Interior Design: Carson Guest, Atlanta GA

Lighting Design: Newcomb & Boyd Lighting Design Group, Atlanta GA

Mechanical and Electrical Engineering: Heery International, Atlanta GA

Property Owner and Manager: Hines, Atlanta GA

Tenant: Alston & Bird, LLP, Attorneys at Law

LED Downlight/Wallwasher/Accent Lighting Manufacturer: USAI Lighting, LLC, New Windsor NY

Acronyms and abbreviations

A/V	audiovisual
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BBA	Better Buildings Alliance
BIM	Building Information Models
Btu	British thermal unit
CBI	Commercial Building Initiative
CCT	correlated color temperature
CFL	compact fluorescent lamp
CRI	color rendering index
DOE	U.S. Department of Energy
fc	footcandle
HVAC	heating, ventilation and air conditioning
IES	Illuminating Engineering Society
lm	lumen
lx	lux
K	Kelvin
kWh	kilowatt hour
LED	light-emitting diode
LEED	Leadership in Energy and Environmental Design
LEED-CI	Leadership in Energy and Environmental Design-Commercial Interiors
LPD	lighting power density
lm/W	lumens per watt
LLP	Limited Liability Partnership
MR	multifaceted reflector
NGL	Next Generation Luminaires
SSL	solid-state lighting
V	volt
VAV	variable air volume
W	watt

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1.0 Introduction

1.1 Project Overview

Alston & Bird is a national AmLaw 50² firm whose Atlanta office occupies approximately 365,000 ft² in One Atlantic Center at 1201 West Peachtree Street. The firm values energy efficiency and sustainability and also strives to provide attractive, functional spaces for its employees, clients, and visitors. Alston & Bird sought and received LEED-CI Gold certification as part of its sustainability commitment. One Atlantic Center, an iconic Johnson/Burgee-designed tower, is also LEED Silver certified as an existing building. In renewing its lease, Alston & Bird achieved an important objective: consolidating the law practice in one building to gain space use efficiency. The firm's offices were previously split between two towers connected by a common tunnel, and took up 20 floors. In the consolidation, they were able to have all their attorneys, several administrative departments, and conference spaces in 16 floors of One Atlantic Center (Figure 1).



Figure 1. Alston & Bird, LLP, Law Offices occupies 16 floors of One Atlantic Center, a 50 story skyscraper in Atlanta GA. It is the third tallest building in Atlanta. © Hines.

PROJECT PROFILE

LEED Gold Certified, Commercial Interiors

- Remodel and expansion of 10 floors of office building to 16 floors.
- Fully reopened and occupied, January 2014.
- Design Team headed by Carson Guest (see complete credits in Acknowledgements).

Law Firm Tenant Floor Specifications

- 365,000 ft² total tenant area on 16 floors including core areas
- Space types include law offices, administrative areas, corridors, meeting rooms, videoconference rooms, mock trial courtrooms, dining room, kitchens, lobby, and reception spaces.

2,342 LED downlights installed instead of CFL downlights, at 17% higher cost for 50% annual energy savings (83,785 kWh).

² American Lawyer magazine ranking of 50 top-grossing law firms in America.

The renovation of the existing floors within One Atlantic Center gave the firm an opportunity to upgrade its office and conference spaces and it allowed the work to be done in phases, staggering staff and construction in groups of three to five floors at a time over a 2.5-year period to minimize law practice disruption during the major renovation project. Alston & Bird’s leadership also wanted to expand access to quality video and videoconferencing capability using the most cost-effective, state-of-the-art equipment. This has now been achieved on each office floor, and in multiple rooms on conference floors 48, 49, and 50.

Because replacing lamps and maintaining the lighting system can be time-consuming and disruptive to lawyers and their visitors, the firm wanted this facility to be as maintenance-free as possible. The original law offices contained a combination of recessed downlights that included low-voltage MR-16 lamps, a variety of CFLs, and medium-based halogen lamps. Most of these had been retrofitted by maintenance staff with a mixed collection of CFL lamps that resulted in issues of low light output, color inconsistency, and distracting glare.

One goal in the renovation was to have all 2,342 new downlights use a single type of light source to ensure they would match in appearance, even if the light engines were changed out in the future. During the design phase, dimmable LED downlights were just becoming viable in terms of lumen output and color quality, and their cost premium was acceptable compared to CFL downlights with full-range dimming ballasts. The design team found that USAI BeveLED® and NanoLED® downlights met their quality standards for fit, finish, and photometric performance (Figure 2). The BeveLED® downlight was recognized by the Department of Energy’s Next Generation Luminaires (NGL) program in 2012.³ The low power use of the LED products and their easy controllability helped the project earn LEED-CI Gold certification.



Figure 2. Entry corridor at Alston & Bird, LLP, Law Offices showing a conference room beyond the art wall. The firm has an extensive art collection; each piece is highlighted by the recessed adjustable LED downlights. © Carson Guest. Photography: Gabriel Benzur.

³ Next Generation Luminaires (NGL) program: <http://www.ngldc.org/>.

2.0 Alston & Bird Lighting

2.1 Lighting design goals

Together with the client, the design team set the following goals for the lighting:

- Provide excellent facial modeling in all spaces, especially conference rooms and videoconference rooms where gestures and expressions are critical for clear communication. Facial modeling is improved by vertical illuminance measured on the face, provided by a mix of direct light from a luminaire, and supplemented with light bounced towards the face from the tabletops, walls, and other surfaces.
- Deliver very good color rendering of skin tones in occupied spaces (3,500 K, 80+ CRI), as well as excellent color rendering for highlighting the firm’s extensive art collection (3,000 K, 90+ CRI).
- Control glare from luminaires for occupant comfort, especially from luminaires designed to light faces.
- Provide smooth dimming of luminaires in spaces like conference rooms.
- Within an enclosed space, specify downlights from a single manufacturer with the same LED module to reduce inconsistencies of emitted light color. (Even identical-CCT LED downlights from different manufacturers frequently appear different when placed alongside one another.) The lighting designer specified recessed downlights, adjustable accent lights, and wallwashers from the same manufacturer with a combination of round and square apertures.
- Use luminaires that deliver necessary light levels and satisfy quality issues while using minimum wattage.

Julia Dudley of the Newcomb and Boyd Lighting Design Group commented that “the maintenance staff at Alston & Bird attempted to retrofit incandescent and halogen lamps to CFL (even halogen MR16 lamps) in order to prolong lamp life and save energy, but the result was a hodgepodge of lamps, colors, and distracting glare. The all LED solution in this remodel means a much more consistent low-glare appearance, now and in the future.”

2.2 Design choices

One important lighting challenge involved lighting for faces during videoconferencing because cameras must pick up face and body gesture details and present them onscreen just as someone within the room would see them. Video communication is enhanced when expressions and gestures are easily seen and facial appearances are not marred by harsh shadows which can be exaggerated by video camera transmissions. Overhead downlighting tends to produce excess shadowing on people’s faces. Diffuse light that includes light striking the face from angles closer to horizontal provides the softest and most uniform shadow patterns, but is also more likely to produce glare for that individual. The lighting designer with Newcomb & Boyd Lighting Design Group chose recessed wallwashers with diffuse glass apertures as the best solution to light faces in most videoconference rooms because this provided a compromise between perfect facial modeling and visual comfort. Figure 3 shows a typical videoconference room with a T5 fluorescent linear slot luminaire above the table and pairs of recessed LED wallwashers with angled lenses specifically located to softly highlight faces for videocamera transmission. Figure 3 also shows a floor plan and reflected ceiling plan of a typical videoconference room with the featured artwork wall on the right.

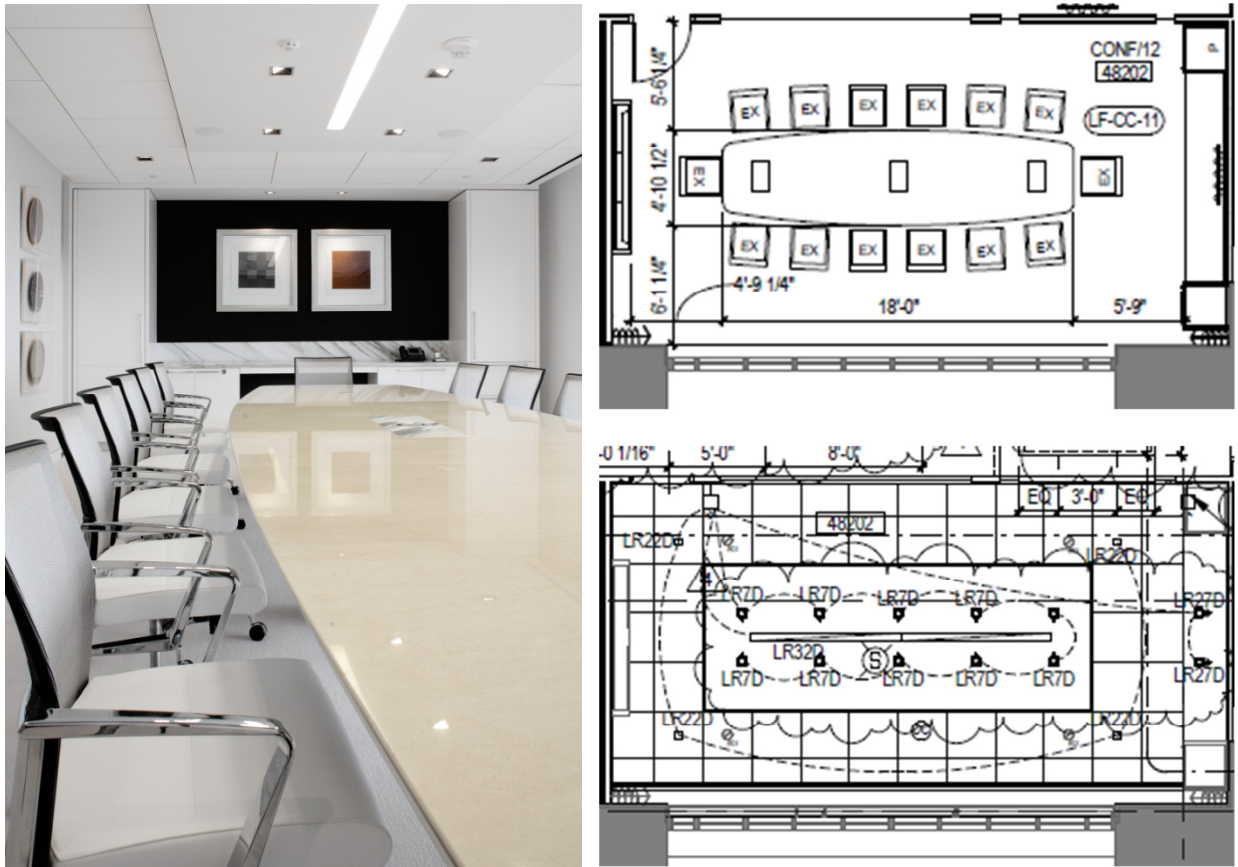


Figure 1. A typical videoconference room on left, with a T5 fluorescent linear ceiling slot luminaire, and pairs of recessed LED wallwashers with lenses for soft facial lighting for videocamera transmission. © Carson Guest. Photography: Gabriel Benzur. The right shows a floor plan and reflected ceiling plan of the same room. The recessed LED wallwashers are type LR7D, illustrated in Figure 4. © Carson Guest, and Newcomb and Boyd.

Artwork throughout the building is illuminated with matching recessed adjustable accent lights with small apertures that draw the eye to the artwork, not the luminaire itself. These were specified with 3,000 K color temperature and 90+ CRI to be slightly warmer and higher in color rendering than the 3,500 K, 80 CRI lighting used elsewhere.



Figure 2. Closeup view of the USAI wallwasher trim.

2.3 Specification and construction issues

Remodel projects are challenging because existing building systems and dimensions are often inflexible. The entire project was documented in 3D Building Information Models (BIM) using Autodesk® Revit® to provide coordination among trades because luminaire recessed depths could conflict with existing structure, ducts, and pipe runs. For that reason, the design team’s BIM documentation attempted to help identify and avoid conflicts early on. (This level of documentation is not normally required for LED retrofit projects, but was needed for this major renovation project.)

Luminaire manufacturers face frequent product changes because of new generations of LED chips and drivers with different characteristics. However, USAI maintained the same size, color, lumen output, and light distribution characteristics over time, so the design team did not have to deal with product evolution issues. Even if the power draw and efficacy had improved between the specification date and the product ordering date, the number, location, and appearance of the downlight remained unchanged.

Inevitably coordination issues arose during construction, but weekly jobsite meetings with the contractor, client, and design team allowed the conflicts to be addressed early enough for the problems to be quickly resolved. Of the 2,342 LED downlights installed, only 38 failures (1.6%) occurred within the first year, a rate considered acceptable by the design team. Although the failed components were not returned to the factory for autopsies, the manufacturer reported that they were most likely driver failures rather than LED chip or board failures.

2.4 Lighting controls

Most of the lighting on the 16 floors Alston & Bird occupies is LED, although linear T5 and T8 fluorescent luminaires are used in private offices, file areas, elevator lobbies, many conference rooms, attorney and administrative floor corridors, and building core service areas. Most of the LED and fluorescent luminaires are dimmable; on the attorney and administrative floors they are controlled by the Acuity Brands “nLight” control system and occupancy sensors, and use 0-10 V dimming drivers and ballasts. In rooms with direct sunlight, the sensors are set to vacancy operation, requiring the occupant to manually switch on lights, and the sensor automatically switches off luminaires when occupants leave. In interior areas the control system turns luminaires on and off according to the scheduled core work hours and uses occupancy sensors to control the luminaires outside those hours. The nLight system works with a control panel on each floor that sends 0-10 V control signals to each luminaire over CAT5 cable that is daisy-chained from luminaire to luminaire. Because the LED downlights were not provided by Acuity Brands, they were made controllable by adding an nLight module to the fixture junction box or to a switch that in turn controls a group of luminaires. Alston & Bird facilities staff is trained to modify the nLight system programming, if needed. This type of control capability is one way to comply with ASHRAE/IES 90.1 2007 lighting control requirements, and the controls also qualify for one to three points under credit EA 1.2 V 2009 toward LEED certification.

The conference floors are controlled by a Crestron system using their iLux integrated lighting system. Larger and more complex videoconference rooms and the mock courtroom are equipped with Crestron touchscreen control products or computers operating the iLux system. These also control the A/V equipment and the Crestron motorized shades and can be operated by staff using a wireless remote control on a laptop or wall-mounted dimmers. Crestron programmers worked closely with Alston & Bird’s A/V staff to write and implement a custom controls program for the system. It was then customized further by the firm to make room setup and videoconferencing controls simple and intuitive so that attorneys could use the controls without needing one of the on-staff A/V experts to set up a meeting.

Before the renovation all lighting was manually controlled and switched off by building cleaners and security staff, often not until 10 p.m. or later. Now, lighting in common spaces and corridors is energized from 7 a.m. until 7 p.m., Monday through Friday. After standard hours, dual-technology motion sensors – passive infrared (PIR) and microphonic sensing – set to 30-minute vacancy delays, automatically control lighting. Daylighted perimeter offices are controlled with manual-on PIR vacancy sensors. Each desk is also equipped with motion-sensor-controlled plug strips which automatically switch off noncritical plug loads, including task lighting, when the desk is unoccupied. After correcting some initial issues with properly setting the maximum 30 minute vacancy delay, there has been no reported negative staff reaction to the motion sensor control. However, a few

corridors were not initially programmed correctly to override the sensors during work hours and staff did not like distracting on-off cycling of corridor lights during normal work hours. This was corrected by setting the occupancy sensor control in corridors to be suppressed between 7 a.m. and 7 p.m. as specified.

The LED luminaires are expected to decay slowly in light output over time, and the downlights have been programmed to deliver 90% of their maximum lumens now, saving 10% of the power while the installation is new. In a few years, when the LEDs have decayed in light output and additional light is needed, the lighting control system can be adjusted to deliver maximum output and draw full power. In the meantime, the dimmed system saves approximately 10% of the lighting system power. The dimming drivers used in downlights and wallwashers in videoconference rooms dim down to less than 10% of full light output, and although the output drops more suddenly below that minimum level, it appears to fade to off which is acceptable behavior for this videoconferencing application.

3.0 Lighting Performance Measurements in Videoconference Space

Figure 5 illustrates the vertical illuminances on faces and the ambient light levels on the conference table. At the maximum level allowed by the lighting control system for all room lighting, with no daylight contribution, vertical illuminances on faces of participants around the table range from 461 to 708 lx (43 to 66 fc). Table illuminances ranged from 575 to 1,015 lx (53 to 94 fc). The facility managers commented that no room users have complained of glare, probably because the light patterns from the wallwashers and recessed linear fluorescent luminaires are soft-edged, producing surface and facial illuminances in a similar range (generally less than a 2:1 ratio). The light-emitting surfaces of the luminaires (such as the frosted glass lens) are diffuse, so no small, bright points of light are visible by occupants. Visual comfort is further improved by high wall surface reflectances which increase the participants' adaptation luminance and reduces the perception of glare. (Appendix A shows the catalog information for the product.)

Alston & Bird considers these videoconference spaces very successful because cameras in two locations of the room transmit clear visual information, and employees have no trouble using the controls and A/V technology.

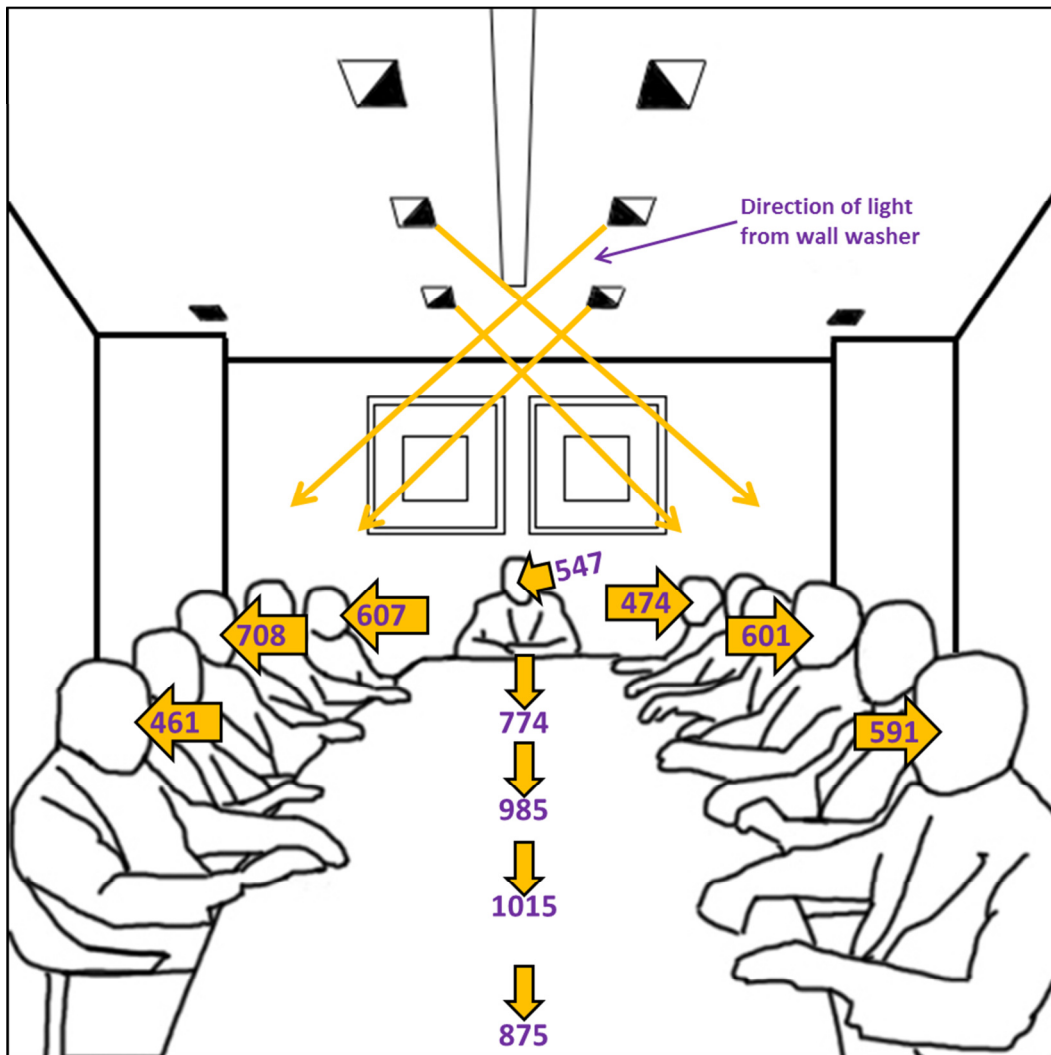


Figure 5. Illustration of vertical illuminances on faces and horizontal illuminances on table in videoconference room. Illuminances are expressed in lux (to convert to footcandles, divide by 10.76). Measurements were taken by PNNL using a Konica-Minolta T-10A meter.

4.0 Discussion of Energy Savings

4.1 Power and energy results

The floors of Alston & Bird are separately metered from the core building areas and other tenants at One Atlantic Center. The monthly power usage has been monitored since the beginning of January 2014, following construction completion and occupation of all floors. The numbers show dramatic electric energy savings compared to usage in earlier years. This is attributable to lighting and plug-load improvements and, to a lesser degree, the new HVAC ducting and VAV controllers, since the existing building air handlers remained in place. Because the electrical panels contain all three kinds of loads, it is not possible to accurately separate out the reductions due to lighting and controls alone.

Comparing energy use before and after the renovation is complicated because Alston & Bird increased their space within One Atlantic Center from 10 to 16 floors, and because any reduction in lighting watts during winter months may have resulted in increasing the use of the electric heating system. The building engineer has tracked the energy use since project completion and has been able to normalize each month’s usage values based on heating degree days. This allows a comparison to the 2009 baseline data despite weather differences between the comparison years.

- Winter months: 22% energy use reduction per square foot of tenant space after renovation.
- Summer months: 37% energy use reduction per square foot of tenant space after renovation.
- Over the 10 months of energy evaluation in 2014: 26.5% average energy use reduction per square foot of tenant space.

The total connected load was documented for energy code compliance using COMcheck™ software, and the total lighting power density (LPD) is 0.94 W/ft² for the 16 floors, including 11 floors of attorney offices, one floor for contract attorney services, three public floors for the conference center, reception, dining room, mock courtroom and executive offices, and one administration floor. This LPD is 17.7% below the ASHRAE/IES 90.1-2007 allowed watts using its Space-by-Space method of calculation. Of course, a 17.7% reduction in connected load compared to the energy code baseline does not include savings from occupancy sensors, occupant dimming, or tuning the output to trim off 10% of the load when the lighting installation is new, so the actual energy savings should be even greater.

Table 2. Comparative Performance Data for CFL and LED USAI Downlight Luminaires.

	Aperture (dia.)	CCT (K)	Luminaire Light Output (lm)	Luminaire Power (W)	Luminaire Efficacy (lm/W)
CFL ¹	4.5"	3,500	980	35.3	27.8
LED ²	4.5"	3,500	1,316	16.0	82.3
¹ Product No.: 4400-10-F					
² Product No.: 3110-AB1-LSTD4-F-9016					

Looking at LED downlights and wallwashers alone, the power savings from LEDs compared to triple-tube CFLs are substantial. As an example, USAI manufactures a 4.5-inch square BeveLED® aperture downlight with an approximate 50-degree beam angle in both 32 W CFL and 16 W LED. The comparative performance data are

summarized in Table 1 above. A rough estimate of the annual energy savings achieved by the 2,342 LED downlights is 83,785 kWh, for an annual electrical cost savings of \$8,546. **Assuming that the 2,342 LED downlights installed in the 16 floors draw an average of 15.9 W when dimmed to a 90% power level, the savings compared to CFL downlight is 50%, or 15.9 W each.** This is based on 3,000 operating hours per year, assuming 75% of downlights switched on during that time, and an electric rate of \$0.102 per kWh.

4.2 Cost of lighting and controls

At the time the luminaires were ordered for this project the contractor price for an LED downlight, wallwasher, or accent light averaged approximately 25% more than an equivalent non-dimmable CFL luminaire. However, the manufacturer supplied the LED version with a 0-10 V dimming driver as standard. The resulting LED dimming performance was equivalent to a CFL product equipped with a premium dimming ballast. Since high-quality dimming was required on the project, Alston & Bird considered the higher cost for the LED (17% greater) a good investment for a product that also draws less than half the watts to deliver the same light output as the CFL product, with longer life expectancy. That cost differential is already lower at the time of this report's publication date and it is likely to grow smaller with time.

5.0 Lessons Learned

Although there were few product failures, a handful of recessed downlights needed an LED board or driver change-out. For future projects, the design team would like to order a percentage of luminaire spare parts (primarily LED boards and drivers) to avoid the 3-to-5-week lead time to receive parts and perform repairs. Furthermore, having all downlight replaceable parts accessible from below the ceiling would be a labor and time saving benefit to the contractor.

Remodel construction is always a challenge because there are existing structural, plumbing, fire sprinkler, and other building systems that are difficult and costly to change in the field, and necessitate special lighting (with shallow recess depth, for example) or unusual locations. The earlier those “pinch” points can be detected in the construction process, the easier it is to accommodate them.

The design team also wished for a common 0-10 V control protocol among manufacturers that would make it possible for a single driver to speak to all control systems used in the remodeled floors without needing modification or translator devices. (0-10 V controls protocols are only partially defined; OFF is sometimes incorporated into the control signal and sometimes requires a separate switch or relay. Furthermore, a 5 V signal may indicate full output for one driver, but 20% output for another.)

The design team would use these LED downlights, wallwashers, and accent lights on future projects. John Guest, Principal of Carson Guest said, “We tried using LED downlights 7 years ago, but the output was too dim. Now LEDs are impressing us with their quality and quantity of emitted light.”

Appendix A. Wallwasher Downlight Information

USAI catalog sheet for the recessed wall-washer used in the conference room illustrated in Figures 4 and 5.

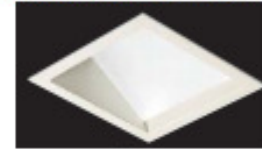


PROJECT INFORMATION

PROJECT _____

 DATE _____
 TYPE _____

WALL WASH 3151



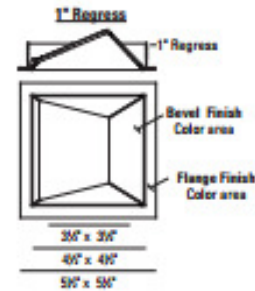
1" Regress

BeveLED 2.0 Recessed Wall Wash - It's a Downlight, Adjustable and Wall Wash - all in one housing - interchangeable anytime. The BeveLED 2.0 provides maximum delivered lumens and optical performance through the optimization of thermal, optical and LED science in the smallest possible aperture.

DELIVERED PERFORMANCE

BeveLED 2.0 WALL WASH	12 Watts	16 Watts	24 Watts	33 Watts
Color Rendering Index	80+ CRI	90+ HIGH CRI	80+ CRI	90+ HIGH CRI
Lumens per Watt	50	44	52	44
Source Lumens	1150	1800	1575	1300
Delivered Lumens	680	525	825	700
Color Consistency	2-Step MacAdam Ellipse			

Performance based on 3000K



CCT MULTIPLIER	2700K	3000K	3500K	4000K
Color Rendering Index	80+ CRI	90+ HIGH CRI	80+ CRI	90+ HIGH CRI
BS Value	21	59	21	59
Multiplier for Lumen Output	0.91	0.78	1.00	0.83

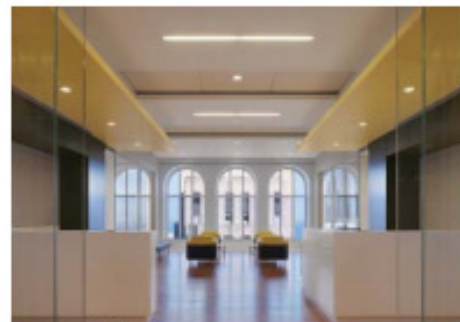
HOW TO SPECIFY

Ordering Example: Specify trim code and housing code to order: Example : 3151W - B1 - 10 - LSTW4 - 6012 - C2 - 2700K - NC - 277V - DIML2 - CB27

TRIM ORDERING INFORMATION

TRIM	OPTION	BEVEL STYLE	FLANGE FINISH
3151	_____	_____	_____
3151 Square Wall Wash 1" Regress	W Wet location ¹ EML Emergency EMLW Emergency and wet location ¹	B1 1" Regress Bevel, Die Cast AB1 1" Regress Bevel, Black AC1 1" Regress Bevel, Clear Matte	01 Clear Matte (w/ AC Bevel) 02 Black Anodized (W/ AS Bevel) 10 White 13 Statuary Bronze 21 Black 28 Metalized Grey RAL Custom Color (specify RAL #)

¹ Wet location, use with B1 trim only.



HOUSING ORDERING INFORMATION

HOUSING CODE	WATTAGE	ENGINE CODE	COLOR	HOUSING TYPE	VOLTAGE	OPTIONAL DIMMING DRIVER	ACCESSORIES
LSTW4	_____	C2	_____	_____	_____	_____	_____
LSTW4	6012 12W LED, 680 lumens 6016 16W LED, 825 lumens 6024 24W LED, 1150 lumens 6033 33W LED, 1450 lumens	C2	2700K 2700K, 80+ CRI 3000K 3000K, 80+ CRI 3500K 3500K, 80+ CRI 4000K 4000K, 80+ CRI 2700K 2700K, 80+ CRI 3000K 3000K, 90+ CRI	NC New Construction CP Chicago Plenum ² IC Insulation-Contact Rated / Airtight ²	120V 277V	DIML2 0-10V dim, 15% DIML3 Lutron HS-Lume 1% 2-wire, 120V only DIML4 Lutron HS-Lume 1% 3-wire/ECO DIML6A ELD0 0-10V 0.1%, logarithmic ³ DIML6B ELD0 0-10V 0.1%, linear ³ DIML7 ELD0 DALI 0.1% ³ DIML8 ELD0 DMX 0.1% ³ DIML9 TRIAC 15% ³ DIML10 ELV 15% ³ 2-wire, 120V only	CB27 27" C-Channel Bars CB52 52" C-Channel Bars EML Emergency battery ⁴ EMLW Emergency battery, wet location ⁴

² Not available with EM

³ Note: N/A with 33W

⁴ For use with NC housings.



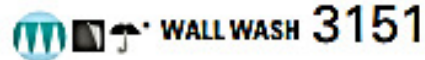
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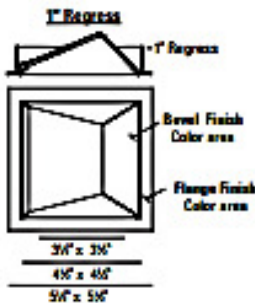
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BeveLED^{2.0}

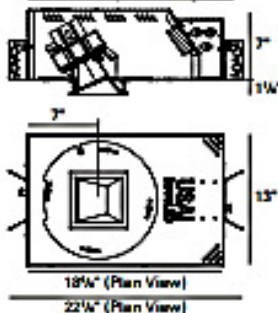


TRIM INFORMATION

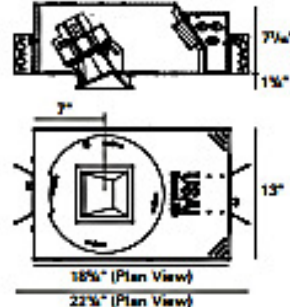


HOUSING INFORMATION

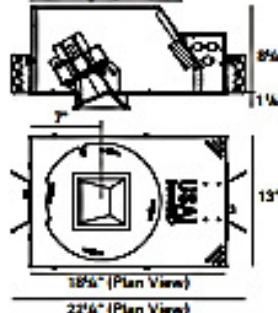
New Construction Universal Style Housing - NC



Chicago Plenum (12W, 16W & 24W) - CP IC / Airight (12W, 16W & 24W) - IC



Chicago Plenum (33W) - CP IC / Airight (33W) - IC



SPECIFICATIONS

TRIM: 4-1/2" square aperture with a 1" regressed bevel and 1/2" flange, retained by two mounting clips. Die cast aluminum bevel is self-flanged and is available in white, statuary bronze, black, and metalized grey finishes. Also available in black or clear matte bevel, with self finish or painted flange. Custom color flanges available (provide RAL#).

TRIM LENS: Trim is shipped with micro diffusion wall wash lens.

REFLECTOR: Proprietary precision injection molded wall wash reflector.

ADJUSTMENT: 362° horizontal locking in 90° increments.

FIELD REPLACEABLE LIGHT ENGINE: Available in 4 lumen packages: 12W (600 delivered lumens), 16W (825 lm), 24W (1150 lm) and 33W (1450 lm). Engine is field replaceable through the aperture without tools.

COLOR: BeveLED is available in 4 color temperatures (2700K, 3000K, 3500K, 4000K). All color options are tightly binned for fixture-to-fixture color consistency within a 2-Step MacAdam Ellipse. 80+ color rendering index provided standard. 90+ CRI available for 2700K and 3000K CCTs.

RATED LIFE: Based on IESNA LM80-2008 50,000 hours at 70% lumen maintenance (L70).

THERMAL MANAGEMENT: Proprietary high performance aluminum die cast heatsink for maximum LED life. Ambient temperatures at fixture location should not exceed 40°C during normal operation.

FIELD REPLACEABLE DRIVER: Solid state electronic constant current driver with a high power factor provided standard. Specify 120V or 277V. Driver complies with IEEE C62.41 surge protection.

DIMMING OPTIONS: Multiple dimming drivers available. See compatibility chart attached. Note: DIMLGA logarithmic control is intended for use with Lutron control systems; DIMLGB linear control is intended for use with non-Lutron controls. DIML2 and DIMLG dimming drivers source 2mA.

EMERGENCY: Emergency lighting battery pack with remote test switch is serviceable through aperture for NC housings. Bedine BSL25C provides 200mA for 90 minutes; delivers ~275-300 lumens. EMLW wall location option is available with B1 trim only and requires remote test switch. EM option is available with NC housings only.

MOUNTING: Butterfly brackets and adjustable nailer bars with integral nails provided. Nailer bars are extendable from 14" to 24" centers.

HOUSING: All-Ways Square® (covered by US Pat. No: US 7,832,883) housing allows alignment of square aperture (up to 20° rotation) after housing installation and prior to finish ceiling installation. Fabricated of 20 ga. galvanized steel with thru wire J-box, 4 in 4 out at min. 90°C, #12 AWG thru branch circuit wiring.

MAXIMUM CEILING THICKNESS: As per drawings above.

CEILING CUT OUT: 5-1/16" x 5-1/16"

LISTINGS: Dry/Damp. Wet location option available with B1 trim only. NRTL/CSA-US tested to UL standards. IBEW union made.

WARRANTY: 5 years



NOTES:

- * Not for use in corrosive environment.
- * Use of pressure washer voids warranty.

PHOTOMETRICS: Consult factory or website for IES files. Tested in accordance with IESNA LM79-2008.



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