



PIER Lighting Research Program



California Energy Commission
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Manufacturers Feedback Report

Deliverable 2.3.5a-b – *Elevator Downlight*

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Manufacturers Feedback Report

1 Introduction

This report for *Project 2.3 LED Low-profile Fixtures* summarizes the feedback obtained from manufacturers that were approached by the project team at different stages of the project. A description and overarching goals of the PIER programs were presented at the time the manufacturers were approached, and additional information on the PIER programs and related projects was offered to them for further reference.

The publication *Deliverable 2.3.3e – Final List of Most Promising Applications* from this project describes seven potential applications that could benefit from LED technology in the near term. In the same publication, elevator downlighting, along with jewelry display cabinets, museum lighting, and under-cabinet lighting were recommended for further development.

After further consideration, the team concluded that building prototypes with the support of at least one lighting manufacturer and performing a field evaluation for just one application would be more beneficial to the objectives of Project 2.3 than building laboratory prototypes for two of the selected applications. The application chosen for the field demonstration of the benefits of LED technology was elevator downlighting.

While speaking with the different manufacturers, the team explained the two specific goals of project 2.3: first, to design, build, and demonstrate in the field a working prototype of a low-profile LED luminaire that is 25 percent more efficient than a comparable incandescent luminaire; and second, to install the low-profile LED luminaires in an elevator application to evaluate their electrical and photometric performance, and people's reactions to this technology in a realistic environment.

The project team includes Lighting Research Center (LRC) researchers Nadarajah Narendran, Jean Paul Freyssonier, Richard Pysar, and Ramesh Raghavan.

2 Companies that were approached for feedback

Table 1 lists the companies that were contacted about the development of the low-profile LED luminaire.

Table 1. Companies contacted by the project team to obtain collaboration or feedback.

Otis Elevator Co. (Headquarters) www.otis.com	1 Farm Springs Road Farmington, CT 06032 Phone: (860) 676-6000 Toll Free: (800) 233-6847
Otis Elevator Co. (Albany, NY) www.otis.com	20 Loudonville Road Albany, NY 12204 Phone: (518) 426-4006 Fax: (518) 426-1101
Westinghouse Lighting Corporation www.westinghouselighting.com	12401 McNulty Road Philadelphia, PA 19154-1099 Toll Free: (800) 999-2226 Fax: (215) 464-4115
Lumileds Lighting, LLC www.lumileds.com	370 West Trimble Road San Jose, California, 95131 Phone: (877) 298-9455 Fax: (408) 435-6855
Advance Transformer Company www.advancetransformer.com/index.jsp	10275 West Higgins Road Rosemont, IL 60018-5603 Phone: (847) 390-5000 Toll free: (800) 322-2086
OSRAM Opto Semiconductors www.osram-os.com	100 Endicott Street Danvers, MA 01923 Phone: (978) 777-1900 Fax: (978) 777-2152
KONE Inc. www.kone.com	One KONE Court Moline, IL 61265 Phone: (309) 764-6771 Toll Free: (800) 956-KONE

3 Feedback from Otis Elevator's Headquarters

The LRC team visited Otis' headquarters in Connecticut in June 2003. During the visit, the LRC made two presentations to a group of 24 people representing most of the companies of United Technologies Corporation, Otis' parent company. Among the attendees were five representatives of Otis Elevator. The LRC presentations focused on the benefits of solid-state lighting for elevator applications and potential collaboration with the LRC in Project 2.3. After the LRC presentations, a private meeting with representatives from Otis Elevator took place.

Additionally, the LRC team met in 2004 with representatives of the Albany office of Otis on at least four occasions to discuss the details of the field installation. During those meetings, feedback was also offered regarding the desirable features of downlights for commercial elevators. Following is a summary of the information gathered from Otis.

3.1 Background information on Otis Elevator Co.

Otis Elevator Company, owned by United Technologies Corporation, is the largest maker of elevators and electric escalators in the world. In 2003, Otis' revenues were almost \$8 billion, which represented approximately 25 percent of United Technologies' revenues. A large contribution to Otis' recurring revenues comes from servicing installed Otis equipment (i.e., elevators, electric escalators, and other horizontal movement equipment). The company has service contracts on approximately 700,000 of the 1.2 million Otis-made elevators currently installed in the world.

Otis is expanding rapidly its presence in other countries, especially in Eastern Europe, Russia, and China. Currently, Otis has a 25 percent share of the world's new elevator market. Otis' largest competitors include Swiss-based Schindler Elevator Co. (15 percent of the market), German-based ThyssenKrupp Elevator, and Finland-based KONE Corp.

3.2 Summary of information relevant to project 2.3

Otis representatives acknowledged the potential benefits of LED technology regarding ruggedness and durability, lower energy use, flexibility in intensity control and color, and creation of innovative cabin designs. However, none of these characteristics are intrinsically attractive to Otis since they manufacture a limited series of standard products that use either fluorescent or incandescent lighting. These elevator cabins are usually modified or refinished by third party companies, including contractors and industrial designers. Section 8 of this report lists a few examples of companies that customize and renovate elevator cabins. Most of the modifications to standard cabins appear to be the result of requests by architects, interior designers, and decorators.

Otis does not support custom orders for the interior of the cabin; rather, they refer customers to one of several industrial design companies they have worked with in the past, most of which appear to operate overseas (UK). Otis does provide customization on options such as shape, cabin dimensions and capacity, travel speed, travel distance, etc.

For existing elevators, Otis offers modernization kits (five examples are depicted in Figure 1). These options include different materials for the ceiling, walls, and floor, as well as different trims, reveals, and handrails. However, similar to new standard products, the lighting options of the modernization kits are either fluorescent or incandescent. The fluorescent lighting option is rated at 160 W (Watts), and the incandescent lighting option is rated at 200 W to 300 W (four or six downlights).



Figure 1. Examples of modernization kits offered by Otis Elevator for existing elevators. The options include ceiling, wall, and floor materials, as well as different trims, reveals, handrails, and lighting systems (fluorescent or incandescent downlights). (Photos from www.otis.com/modernizationdetail)

Other companies manufacture products for elevator cabin renovation, including lighting. The following is one example from Form+Surfaces, an architectural materials and products company. Many options for material, finishes, and colors are available, including the size of the modules, handrails, ceiling materials, reveals, and frames. Notably, there is only one option for lighting that comes preinstalled in the ceiling. For this product series, the lighting consists of six 12Volt, 20W halogen downlights with an optional dimmer. As with many other companies, emergency lighting is optional and includes a battery pack and two additional incandescent lamps inside two of the downlights. Figure 2 shows one of the six possible configurations from Forms+Surfaces. Items marked 1 to 5 are options selected by the customer.

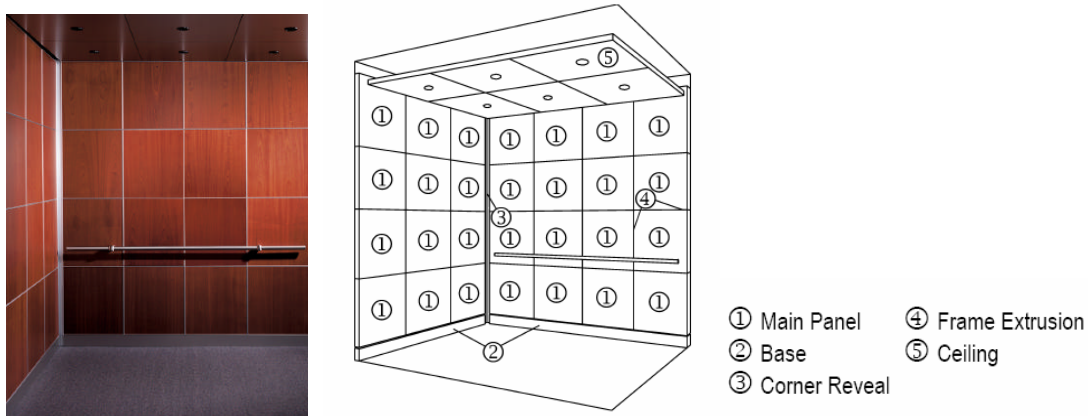


Figure 2. Example of prefabricated interiors offered by Forms+Surfaces for existing elevators. The options include different materials for the ceiling, walls, floor, trims, reveals, and handrails, but only one lighting system (six 12V/20W halogen downlights) is offered. (Graphic from www.forms-surfaces.com)

The examples in Figures 1 and 2 are shown in this report to illustrate the lack of energy-efficient lighting options for elevators and the similarity of products in the marketplace.

According to Otis and other elevator manufacturers, most of the challenges in energy efficiency are in the lifting and braking system, and the control logic of the elevator. Modern elevator controllers are sophisticated systems that consider many traffic pattern

variables in order to optimize elevator operation in a building. Monitoring the elevator is also important, but traffic analysis and control account for the majority of the systems' efficiency.

On average, for example, the electric load of any lighting system would be less than 500 W, while the peak load demand of an elevator could be easily as high as 15,000 W. While the lighting system does not provide the largest potential for energy savings in an individual elevator, given the constant operation and congregated load from the nearly 700,000 elevators currently operating in the United States, lighting consumes a significant amount of energy.

Another potential benefit is reduced maintenance of the lighting system. Otis services most of its elevators; however, in many cases (at least for the Albany office), service to the lighting system is not included. In such cases, these maintenance benefits could be passed on to the facilities manager or building administrator.

One of the key benefits of LED lighting technologies is the enormous flexibility to create custom lighting design solutions that are much simpler than with any other lighting technology. As explained, this flexibility is not largely of interest to Otis itself, given that they do not provide, for the most part, custom interiors. However, this same flexibility would be of great interest to third party companies that design, create, install, and sometimes service such custom cabins.

Finally, the benefit that seemed to resonate most with Otis was the ability of low-profile LED luminaires to reduce the space necessary to install them in the cabin's false ceiling. During the visit to Otis headquarters, the LRC showed a rapid-prototype sample of a low-profile LED luminaire. It was estimated that the low-profile LED luminaire could save between 4 and 6 inches of space in the ceiling, therefore allowing for the reduction in the overall height of the elevator shell. This space savings could result in less material and therefore less weight, allowing the nominal ratings of the motor and braking system to be reduced. Those aspects combined could result in significant energy savings in the near term. Nevertheless, the question of whether LEDs could be used as one of the options offered by Otis as a standard finish is still open. Other than a cost decision, there is no clear reason why it would not be feasible. The LRC team will follow up as this project progresses in trying to answer this and other questions.

4 Feedback from Westinghouse Lighting Corporation

The LRC team contacted Westinghouse Lighting in December 2003 to request their collaboration in project 2.3, specifically in the development and production of the low-profile LED luminaire prototypes. Given the long history of Westinghouse in promoting energy efficiency, its participation on the project was a perfect match with the objectives set for project 2.3. Westinghouse Lighting funded the production of the low-profile LED luminaire prototypes designed by the LRC.

4.1 Background information on Westinghouse Lighting

Westinghouse Lighting Corporation is one of the largest lighting manufacturers with a workforce of over 2,500 people and more than 5,000 different products. Westinghouse

has a global presence with offices in Mexico, Germany, the United Kingdom, China, Hong Kong, and Taiwan.

Westinghouse has a long history of energy-efficient product design. Currently, it is the only company to meet ENERGY STAR[®] requirements in three product categories: ceiling fans, luminaires, and compact fluorescent lamps. Its commitment to supporting energy-efficient technologies includes a dedicated group for the development and support of energy-efficient products.

4.2 Summary of information relevant to project 2.3

The LRC team is still collaborating with Westinghouse in order to further develop the low-profile LED luminaire and bring it to commercialization in the near term. The current plans include a potential second field installation or pilot testing to greater detail the benefits of LED technology in this type of application. Further testing would ideally involve Otis and KONE Inc., a second elevator manufacturer that has also shown interest in the project.

Some manufacturing details of the low-profile LED luminaire are still undefined, but most likely the reflector will be mass-produced either in a plastic material finished with a vaporized aluminum coating or stamped in high reflectance aluminum sheet (e.g., MIRO series from Alanod, with a minimum specular reflection of 95 percent). The preferred option would be plastic reflector coated with vaporized aluminum, but further thermal testing is needed to determine potential durability problems.

Other areas that Westinghouse is currently exploring include manufacturability, commercialization channels and pricing, and after-sales service and warranties.

5 Feedback from Advance Transformer, Lumileds Lighting, and OSRAM Opto Semiconductors

Communication with these companies regarding this project was established on different occasions. Recognizing the potential of LED technology for the elevator application, all three companies were interested in collaborating with the LRC, the Architectural Energy Corporation (AEC), and the California Energy Commission (CEC) on the project. The intention was to develop at least two options of the low-profile LED luminaire using LED products from OSRAM Opto Semiconductors and Lumileds Lighting.

5.1 Background information on the above companies

5.1.1 Advance Transformer

Advance Transformer is generally recognized as the number one manufacturer of ballasts and drivers for fluorescent, HID, and LED technologies. The company has a long and sustained history of developing energy-efficient products for different applications, and was the first company to offer an extensive line of driver products for different types of high power LEDs. Advance Transformer is a division of Philips Electronics North America Corporation.

5.1.2 Lumileds Lighting

Lumileds Lighting is currently the world's leading manufacturer of high-power LEDs. The company's Luxeon product line provided the first viable LED solution for applications such as automotive lighting, signage and signaling, and general illumination. Lumileds Lighting is a joint venture between Hewlett-Packard and Philips Lighting with a global presence. Lumileds' headquarters are located in San Jose, California, but operates in the Netherlands, Japan, and Malaysia, and has sales offices throughout the world.

5.1.3 OSRAM Opto Semiconductors

OSRAM Opto Semiconductors is the world's second largest manufacturer of solid-state products for the lighting, sensor, and visualization industries. OSRAM Opto Semiconductors' headquarters are in Regensburg, Germany but a global presence is evident with sales, development, and manufacturing offices in Danvers, Massachusetts, San José, California, and Penang, Malaysia. Of the many products of OSRAM Opto Semiconductors is a series of LEDs for the lighting industry. An important development in 2004 was the introduction of high power LEDs, commercially known as the Dragon Series.

5.2 Summary of information relevant to project 2.3

The main feedback from OSRAM Opto Semiconductors and Lumileds Lighting was regarding thermal management. Both companies emphasized the importance of dimensioning adequately the heat sink of the LEDs and referred the LRC to the corresponding application notes and literature detailing the needs of each company's products.

The LRC team visited the OSRAM Opto Semiconductors facility in January 2004. The LRC team made two presentations on the project's objectives and background. OSRAM Opto Semiconductors offered to collaborate in the project by donating products needed for the prototypes, including the custom metal-core printed circuit boards and drivers. Additionally, OSRAM Opto Semiconductors offered to mediate with a luminaire manufacturer on the potential creation of the prototypes. Unfortunately, a conflict in the production schedule of the 1 W LEDs could not be resolved within the timeframe of this project. However, the potential for collaboration in a future stage of the project still exists, and OSRAM Opto Semiconductors demonstrated special interest in participating in the creation and field evaluation of luminaires with white LEDs. Advance Transformer and Lumileds Lighting were eager to participate in the project as well and provided the LRC with the necessary LEDs and driver products to build all the prototypes produced during this project.

6 Feedback from KONE, Inc.

Communication with KONE started in early November 2004 after a lead from Judie Porter of the AEC. In the past few weeks, the LRC has explained the background of the PIER projects, the specifics of project 2.3, and the potential of solid-state lighting especially in elevator applications. Publications from project 2.3 were also provided to KONE for further reference. Since the first communication, KONE has shown interest in

future collaboration. An invitation to visit the field installation of the low-profile LED luminaire was extended to KONE and we remain confident that it will take place in the near term following the resolution of scheduling conflicts. Representatives from KONE provided the feedback listed below.

6.1 Background information on KONE, Inc.

Based in Finland, KONE is the world's fourth largest elevator and escalator company. KONE operates approximately 800 service centers in over 40 countries. KONE is a full service company that manufactures, installs, services, and upgrades elevators, escalators, and automatic building doors.

KONE delivers approximately 25,000 elevators worldwide annually and provides service on a contractual basis for approximately 520,000 elevators and escalators. KONE is known for product innovation and services for the elevator industry with a large interest in energy efficiency and sustainability.

6.2 Summary of information relevant to project 2.3

Approximately 80 percent of the 25,000 elevators that KONE produces every year are shipped with standard panel, flooring, and ceiling (including lighting) selections from options available at the factory. Of the many potential benefits of LEDs for elevator applications, KONE ranks long life as one of the most important, apparently because they provide contract services for maintenance that include lighting. Having a lighting system that lasts longer than any of the current technologies is appealing to KONE as a potential way of reducing operating costs.

One of the primary concerns of KONE is the design of “green elevators”—systems that are intrinsically energy efficient and environmentally responsive. KONE also sees the value of LED technology in that it does not contain mercury, is very easily controllable for added energy savings, and because it lasts a long time, it reduces materials and waste in general.

However, there is a business reality associated with these environmental goals. Cost is one of the driving concerns in the elevator industry in general, second only to safety. Consequently, there is a cost/benefit relationship with elevator lighting that needs to be further understood in order to make LEDs an attractive option for the elevator industry.

7 Conclusions

Feedback gathered from the different manufacturers and related companies throughout the duration of this project was very useful in understanding the needs of the different stakeholders in elevator applications, the market conditions and drivers of the elevator industry, and the potential for commercialization of the low-profile LED luminaire in the near term. All of the companies that provided such feedback are gratefully acknowledged.

Based on the feedback presented in this report, it appears that elevator lighting is truly a good opportunity to showcase the many benefits of an energy-efficient and long-lasting LED solution.

It is worth emphasizing that project 2.3 benefited greatly from the collaboration between the Lighting Research Center and Westinghouse Lighting Corporation in manufacturing the prototypes. The participation of Lumileds Lighting and Advance Transformer Company in the project also helps to leverage the visibility of PIER's efforts in trying to promote new energy-efficient lighting technologies. Rensselaer Polytechnic Institute provided the site for the field evaluation, and Otis Elevators' local office (Albany, N.Y.) agreed to support the team by facilitating the installation of the LED luminaire prototypes in the elevator.

8 References for further information

This section lists the principal references that may be useful to better understand the low-profile LED luminaire design and application in commercial elevators.

8.1 Elevator associations

Elevator Contractors of America

www.elevatorcontractors.org/Default.aspx?tabid=1

Elevator Industry of Southern California

www.elevatorindustry.org/

International Union of Elevator Contractors

www.iuec.org/default.asp

National Association of Elevator Contractors

www.naec.org/naec/default.asp

National Elevator Industry, Inc.

www.neii.org

8.2 Elevator manufacturers

Hitachi Elevator

www.hitachi.co.jp/Prod/elv/en/index.html

KONE Inc.

www.kone.com/en_US/main

Mitsubishi Elevator

www.mitsubishi-elevator.com/

Otis Elevator Company

www.otis.com/otis/1,1352,CLII_RES1,00.html

Schindler

www.us.schindler.com/SEC/websecen.nsf/pages/home

ThyssenKrupp Elevator

www.thyssenkruppelevator.com/

8.3 Custom interior elevator cabin designers and manufacturers

Eklund's Inc.

www eklunds.com

Forms+Surfaces

www.forms-surfaces.com/products/category/cabforms.htm

Gunderlin

www.gunderlin.com/about/default.htm

Retro Elevator

www.retroelevator.com/

8.4 Publications

Elevator World Magazine

www.elevator-world.com/

US Census Bureau

www.census.gov/cgi-bin/epcd/srchnaics97ind2

www.census.gov/epcd/ec97/industry/E333921.HTM

www.census.gov/prod/ec02/ec0231i333921.pdf