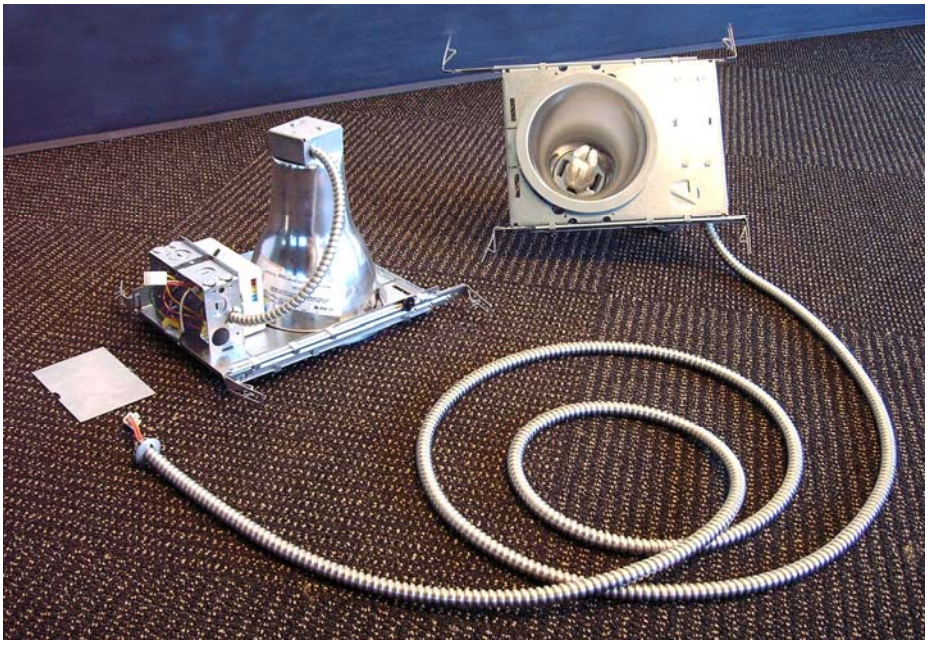
LIGHTING RESEARCH PROGRAM

Project 4.3 CFL Downlight Systems
FINAL REPORT



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Preface

The Public Interest Energy Research (PIER) Program supports public interest energy research and development that will help improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

The PIER Program, managed by the California Energy Commission (Commission), annually awards up to $62 million to conduct the most promising public interest energy research by partnering with Research, Development, and Demonstration (RD&D) organizations, including individuals, businesses, utilities, and public or private research institutions.

PIER funding efforts are focused on the following six RD&D program areas:

- Buildings End-Use Energy Efficiency
- Industrial/Agricultural/Water End-Use Energy Efficiency
- Renewable Energy
- Environmentally-Preferred Advanced Generation
- Energy-Related Environmental Research
- Strategic Energy Research.

What follows is the final report for the Retrofit Energy Efficient Downlighting Project, conducted under the PIER Lighting Research Program Contract #500-01-041, by the California Lighting Technology Laboratory under contract to the Lawrence Berkeley National Laboratory and directed by Architectural Energy Corporation. The report is titled CFL Downlight Systems and includes three interim deliverables as well: 1) Concept Development Report, 2) Prototype Retrofit Lighting Solutions Report, and 3) System Solutions Workshop Report. This project contributes to the Building End-Use Energy Efficiency program.

The key deliverables for each project, in the form of guidelines and technical reports, are attachments to this report and are listed and described at the start of the attachment section. Due to market dynamics and the normal passage of time between the completion of research and the publication of research results, products anticipated for market delivery in this report may not necessarily reflect the actual array of products as delivered, or planned for delivery, by manufacturers. Therefore, the reader is advised to contact the lighting product manufacturers directly to ascertain the current status of products.

For more information on the PIER Program, please visit the Commission's Web site at: http://www.energy.ca.gov/research/index.html or contact the Commission's Publications Unit at 916-654-5200.

EXECUTIVE SUMMARY

A large majority of the downlights currently being installed in the residential sector use inefficient incandescent sources. In the commercial sector, most of the downlighting currently being installed use compact fluorescent lamps (CFLs), but a large existing stock of incandescent downlights remains in operation. One of the primary objectives of this project was to provide consumers and facility managers with a relatively straightforward mechanism to convert incandescent downlighting to CFLs.

This project's development of renovation (retrofit) downlighting systems for residential and commercial applications was built upon a downlighting approach that had been previously established under a prior PIER-funded R&D project (see California Energy Commission report 500-04-005). The prior project developed the CKP62; a residential new construction product developed in collaboration with Lithonia Lighting. The key features of the CKP62 were as follows:

- Thermally enhanced ballast configuration.
- Master-remote ballast geometry.
- Plug-and-play wire connections.
- Simplified housing and reduced components.
- Institutionally transparent/builder-friendly.
- High performance optics.

The master-remote concept that was utilized in the CKP62 was again used as the basis for the development of the renovation system. This was because the advantages that the master-remote approach were found to have in new construction applications were also applicable in renovation applications. The master-remote approach minimized ballast costs while allowing for significantly less field wiring.

Two different types of renovation systems were developed to accommodate both residential and commercial applications. The design for the residential approach shared much in common with the residential-based CKP62 system. The commercial approach shared master-remote concept, but needed to conform to the unique realities of the commercial sector.

A series of residential renovation prototypes were developed in parallel with the development of the new construction system. Most of these prototypes closely paralleled the commercial system specification, sharing many of the same components and features. The primary difference was that the commercial system was designed to be installed prior to the building's sheetrock installation while the renovation system was designed to be installed after sheetrock installation.

One of residential renovation designs was UL-certified so it could be installed and evaluated in real-world environments. Several dozen of these systems were installed in residential new construction and renovation applications. Interviews with the installers and/or homeowners indicated that this system provided certain installation advantages: half as many hard-wired connections to make, plug-and-play connections, faster installation, etc. Additionally, the project participants noted several areas that would need to be addressed prior to full commercialization.

These included potential design modifications to address aesthetic concerns as well as the potential to include dimming as an available upgrade option.

The development of a commercial renovation system was undertaken separately from the residential system because commercial applications typically require high wattages and higher outputs and can generally support higher price-points. The predominant usage of T-bar ceilings in commercial applications had the important effect of allowing for a single commercial design that was appropriate for both new construction and renovation applications. This is because the drop ceiling panels can easily be removed and reinstalled, thus allowing for access to the ceiling plenum during renovations in a manner that is very similar to during initial construction.

In December 2004, Lithonia introduced to the market the CCR62 (6 inch diameter) and CCR82 (8 inch diameter) master-remote commercial downlighting systems capable of using 26-, 32-, or 42-Watt lamps. These downlight systems use smart programmed-start electric ballasts that can operate various wattage CFLs. The CCR is currently not available with dimming, but this issue is currently being looked into by Lithonia engineers. This system is not available for residential applications because the ballast is rated only for commercial installations.

This product promises to cut installation time and cost by about 20% compared to standard downlight systems, making it more cost effective when replacing incandescent systems or upgrading from linear or U-tube T12 fluorescent systems. The new system offers energy efficiency improvements as well:

- 6% compared to standard CFL
- 15% compared to older T12 fluorescent
- 75% compared to incandescent

The new system is thought to be applicable to 15–25 percent of California's office areas as well as retail spaces currently using downlights or U-tube fluorescents.

A field demonstration will be conducted at a University of California campus in 2005 to evaluate system performance.

ABSTRACT

This project developed compact fluorescent lamp (CFL) downlighting systems for renovation applications. This involved two separate R&D efforts: one focused on residential applications and the other on commercial. Both efforts leveraged the results of a previous PIER project that developed a CFL downlighting system for residential new construction applications. This prior PIER project resulted in Lithonia Lighting commercializing a CFL downlighting system known as the CKP62. The CKP62 utilized a master-remote approach in which a master downlight contained a two-lamp ballast that powered both a CFL in the master downlight as well as a CFL in the remote downlight. This approach was applied in both the residential and commercial renovation designs in this project. One of the residential renovation designs included a remote ballast box in which a central ballast or group of ballasts controlled multiple remote downlights. This system was field tested in 30 new construction and renovation applications. A commercial system was developed and commercialized by Lithonia Lighting as the CCR62 (or CCR82) which used a master-remote design. This product promises to cut installation cost by about 20% compared to standard downlight systems. The new system offers energy efficiency improvements as well:

- 6% compared to standard CFL
- 15% compared to older T12 fluorescent
- 75% compared to incandescent

Field demonstrations will be conducted in 2005 to evaluate system performance.

INTRODUCTION

This project's primary goal was to develop a novel CFL downlight system for residential and commercial retrofit and renovation applications. Downlighting remains a popular lighting design option in both residential and commercial applications largely due to aesthetic considerations relative to the unobtrusive "clean look" that it provides to the space. While downlighting has been popular in commercial environments for some time, it has seen significant growth in the residential sector over the past decade. New homes now typically have 15 or more downlights. Furthermore, the addition of downlighting has become one of the most common renovations in the US.

A large majority of the downlights that are currently being installed in the residential sector utilize inefficient incandescent sources. In the commercial sector, most of the downlighting currently being installed utilize CFLs, but a large existing stock of incandescent downlights remains in operation. One of the primary objectives of this project was to provide consumers and facility managers who currently have incandescent downlighting with a relatively straightforward mechanism to converting to CFL downlighting.

This ease-of-installation needs to be balanced with the need to provide a viable long-term solution. For this reason, classic "retrofit" approaches, in which the existing incandescent housing is maintained while the fixture is converted into a CFL system, were not seriously considered. While this retrofit approach has certain drawbacks related to "snap-back" (the system being retrofit back to incandescent at a later date) there are even greater technical concerns. It was determined that there are serious optical and thermal issues that cannot be adequately addressed when forced to utilize an existing incandescent housing for a CFL downlighting system. These considerations have a measurable detrimental effect on the final systems overall efficiency as well as expected useful life.

Thus, it was decided to focus on a renovation approach in which the existing downlighting housing would be discarded and replaced with a new housing appropriate to the CFL system. This approach allows for an optimization of the optical and thermal elements of the system to ensure a high efficiency and a robust life. A secondary benefit to this approach is the new system represents a complete, stand-alone system that can be installed in any renovation application, as opposed to only being able to be installed in applications that currently have incandescent downlights.

This final report summarizes the entire project and includes the following three interim deliverables that are included in the Project Approach and Project Outcomes sections later in this report:

- Concept Development Report
- Prototype Retrofit Lighting Solutions Report
- System Solutions Workshop Report

PROJECT APPROACH

Price, performance, and ease of installation were quickly identified as key attributes to the overall success or failure of renovation downlighting system. The proposed system would have to be cost competitive with other approaches, perform at a high level (high efficiency, lumen output, etc.), and present tangible timesaving installation benefits.

To address these desired attributes, the research team focused their initial design concepts on a design approach developed in a prior PIER-funded effort on CFL downlighting system for residential new construction applications. In doing so, researchers were able to build upon and leverage this prior development work and knowledge base obtained in the prior research to quickly develop renovation based designs.

Concept Development

It is important to review the key features of the residential new construction CFL downlighting system in order to understand the starting point for this project. The residential new construction product was developed in collaboration with Lithonia Lighting as a 3-year PIER funded effort initiating in June 2000. Lithonia ultimately introduced this product to the market in October 2004 under the product name CKP62 (for "California Kitchen Pack") (See Figure 1).

Figure 1: The CKP62 is a master-remote downlighting system designed for residential new construction applications.

The overall goal of this initial PIER project was to develop a novel, low cost, high performance, and high efficiency kitchen lighting system. Ultimately, the project's R&D efforts resulted in the development of a new approach regarding the ballast in which a standard, off-the-shelf ballast could be utilized in a master-remote arrangement. This approach allowed ballast costs to be greatly reduced while opening a number of options for existing ballast products to choose from. Homebuilders strongly encouraged adoption of an approach in which industry standard ballasts

with proven track records for reliability could be used, rather than an approach in which a new, customized, proprietary ballast was developed.

The key features of the final prototype CKP62 were as follows.

- **Thermally enhanced ballast configuration.** The CKP62 ballast was thermally optimized by connecting it to the main metallic housing for the downlight pan itself.
- **Master-remote ballast geometry.** This approach greatly reduced material and installation costs.
- **Plug-and-play wire connections.** This flexible and removable connection significantly simplified the wiring to the remote fixture.
- **Simplified housing and reduced components.** These reductions led to associated reductions the cost of the downlighting system.
- **Institutionally transparent/builder-friendly.** The installation of the CKP62 follows the same process that builders are familiar with.
- **Improved maintenance.** There are several features of the CKP62 that improved the maintenance of the overall system, including accessible ballasts, plug-and-play design, and flexible fixture whips.
- **High performance optics.** The reflector optics for the CKP62 are based on existing commercial grade CFL products that maximize output while minimizing glare.
- **High quality CFL.** The CFLs included with the CKP62 are 26W high quality, high output lamps.
- **High quality ballast.** The ballast chosen for the CKP62 is produced by Advance Transformer. This ballast is approved for residential applications (FCC Class B), and features a quick startup characteristic.

The CKP62 proved to be a very strong performer, comparing favorably to even the much more expensive commercial-grade CFL systems. Economically, the CKP62 measures up very well against both incandescent and CFL downlight alternatives. The system offers 75% energy savings with negligible cost increase compared to standard incandescent downlighting. Thus, the CKP62 provides a 0.4 year simple payback compared to incandescent systems and 4.2 year payback compared to standard residential CFL units, all while providing higher, more-uniform illumination levels.

The California electric utilities played (and continue to play) a significant role in the commercialization of the CKP62. Sacramento Municipal Utility District (SMUD) continues to lead the transition of this project from research to market, and has integrated the CKP62 into their “Advantage Homes” program encouraging homebuilders to adopt energy saving devices in new homes. Southern California Edison and Pacific Gas and Electric have also initiated demonstration projects with the CKP62.

PROJECT OUTCOMES

This section discusses the key issues considered during the development of the renovation system as well as the key attributes of the system. The renovation systems were developed and refined as a result of a series of system solutions workshops that including meetings with the following groups:

- Lithonia Lighting
- Sacramento Municipal Utility District (SMUD)
- ConSol, Inc.
- Building Industry Research Alliance (BIRA)
- California Builder Industry Association (CBIA)
- Marticus Electric
- Vasko Electric
- Harrison Construction
- Evans Homes

These workshops and design review meetings resulted in new prototype designs for both the residential and commercial versions of the system. The following sections provide a detailed discussion of these prototypes.

Master-Remote

The master-remote concept that was utilized in the CKP62 was again used as the basis for the development of the renovation system. This was because the advantages that the master-remote approach was found to have in new construction applications were also applicable in renovation applications. The master-remote approach minimized ballast cost while allowing for significantly less field wiring.

Two Approaches: Commercial and Residential

It became clear early in the development process a single design approach that could be utilized for both residential and commercial applications would not be possible. There were simply too many technical and market-based criteria, which called for divergent solutions. Some of these key differences are summarized in Table 1 below.

Table 1: Key differences between residential and commercial CFL downlights

Criteria	Residential	Commercial
Ballast Type	Must meet FCC Class B	No FCC requirements
Ceiling Type	Sheetrock	T-bar
Lumen Requirement	600-1000 lumens	1200-2000 lumens
Price Point	$20-$60 per downlight	$100-$200 per downlight

The design for the residential approach would share much in common with the residential-based CKP62 system. The commercial approach shared the master-remote concept, but needed to conform to the unique realities of the commercial sector. Both of these systems are described in greater detail in below.

Existing Componentry

A critical lesson from the CKP62 development effort that was applied to the renovation project was the strong benefits yielded by utilizing existing components. This approach greatly accelerated the development process as Lithonia was much more willing to act on prototype development when they could do so with existing "hard tool" components, rather than custom building prototype components. This utilization of existing components ultimately helped keep downlighting systems material costs in check as each of the components were already being purchased or manufactured by Lithonia in large quantities.

Dimming

Dimming was one of the initial design requirements for the original CKP62 product, but was abandoned when it was discovered that dimming is very rarely utilized in incandescent downlights in residential new construction applications, even though it could be included very cheaply. Dropping the dimming requirement seemed appropriate as it did not seem logical to add $30 to the cost of the system that added an amenity consumers were currently unwilling to pay $5 for from incandescent systems.

But in renovation applications (both residential and commercial), dimming is much more in demand and required serious consideration. Consumers in renovation applications are generally more demanding about the level of control they require of their lighting systems and are more willing to pay the cost premium associated with adding dimming.

The master-remote design platform presents some unique opportunities as well as some technical challenges relative to dimming. One of the primary benefits of the master-remote approach is that ballast costs are essentially cut in half as compared to standard downlighting approaches because half as many ballasts are needed. This is a significant advantage as the electronic ballast cost (at approximately $6-$10) is typically the single largest component cost in a downlight. This advantage increases as the cost of the ballast increases. Thus, when considering dimming ballasts, which are often 2 to 3 times the cost of standard electronic ballasts, the master-remote approach is very appealing.

There are some technical concerns though related to dimming on the master-remote systems. These concerns relate to potential voltage drop issues associated with the long distance between the dimming ballast and the remote downlight. These issues may necessitate either a shorter whip to the remote head (such as 6 feet instead of 10 feet) or limitation in the overall dimming range (such as only dimming down to 25% rather than down to 5%). These technical issues related to dimming were still being explored by Lithonia and Lithonia's ballast suppliers as of the writing of this report.

Residential Prototype Overview

A series of residential renovation prototypes were developed in parallel with the development of the new construction CKP62 system. Most of these prototypes closely paralleled the specification of the CKP62 sharing many of the same components and features. The primary

difference was that the CKP62 was designed to be installed prior to the building sheetrock installation while the renovation system was designed to be installed after sheetrock installation.

These prototype designs were all based on the 26W CFL platform, with a single 2-lamp ballast driving two discrete downlights. In a design departure from the CKP62 and its master-remote architecture, many of the renovation designs featured a remote ballast arrangement. In this arrangement, a central ballast box was used to house multiple ballasts, which where wired to remote downlight optical heads (see Figure 2).

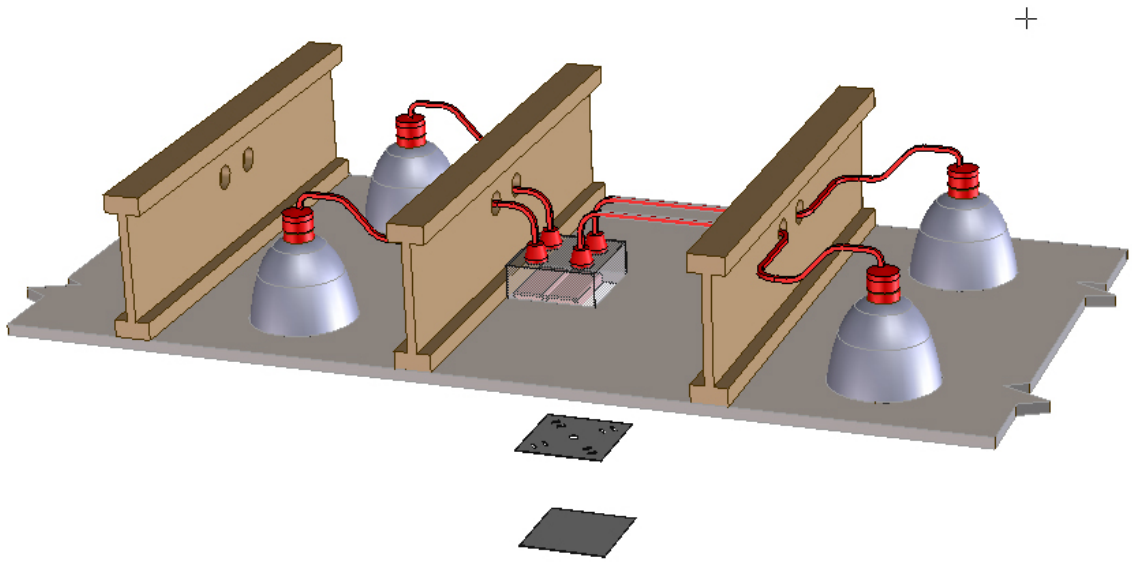

Figure 2: Design architecture of ballast box and remote downlight optical heads

The ballast box and associated wiring harness would either be installed from the attic or from below by cutting a hole for the ballast box and then fishing the wiring harness to the locations of the downlights. The downlight optical head themselves would be installed from below the sheetrock. Holes would be cut in the sheetrock at the location of the downlight and a retaining ring would be installed in the hole. The wiring harness would be connected to the downlight optical head, which would finally be press flush to the ceiling and held by the retaining ring. An animation of the installation process for the optical heads is shown in Figure 3.

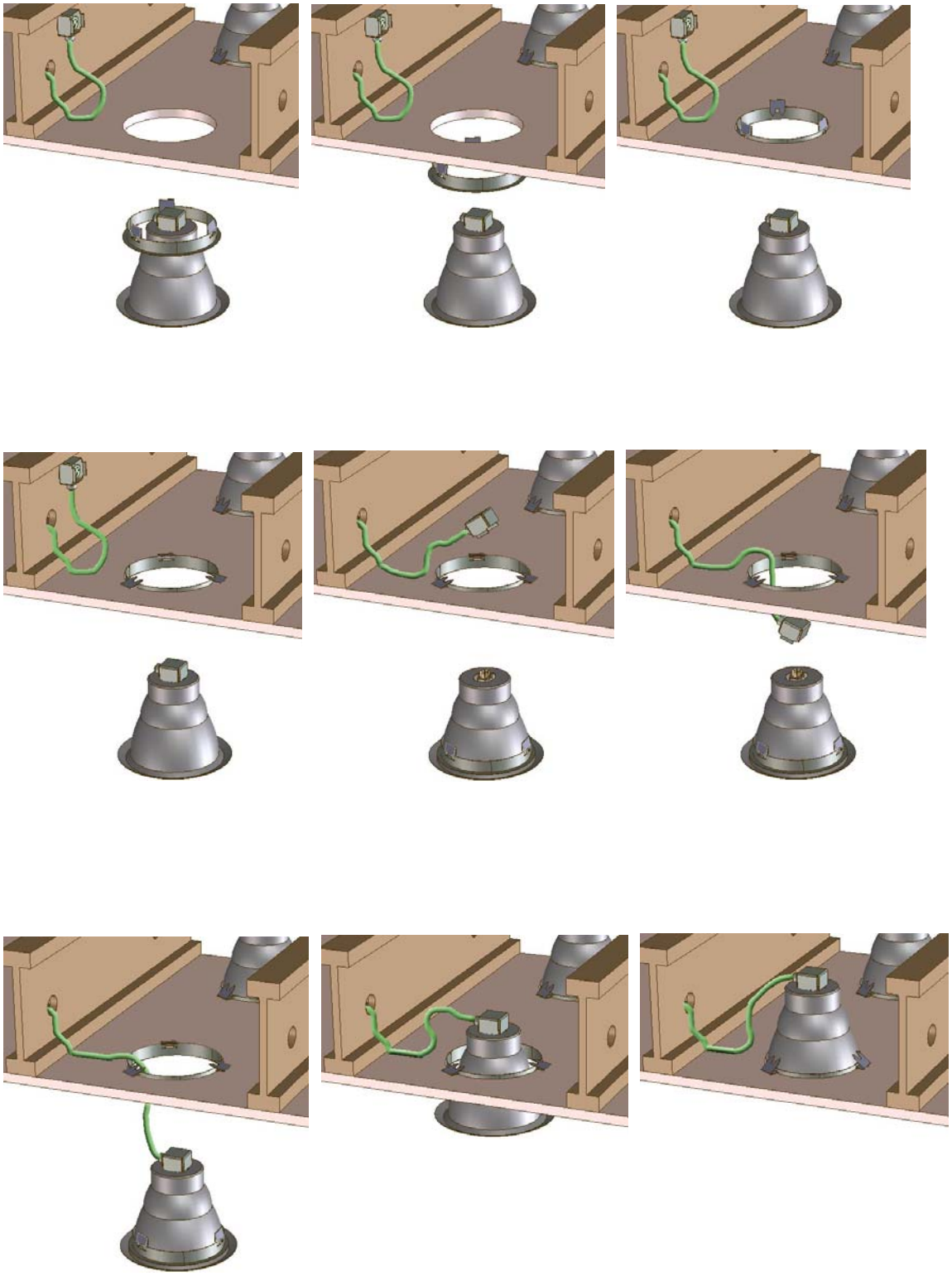

Figure 3: A sequence showing the installation of a remote optical head

This design was considered to have several benefits. One was related to thermal management and accessibility of the ballasting. An access plate to the ballast box could be placed on the ceiling (room) side and/or the attic side allowing the consumer/electrician easy access to the ballast compartment if ever there were a need to reballast the system. This central location also greatly reduces initial wiring as all electrical connections are done at this one location, with only plug-and-play connections at the downlights themselves. With the ballast box exposed to the relatively cool air environment of the room below, the risk of the ballast box experiencing temperatures that would shorten ballast life were essentially eliminated. The primary drawback to this design was the aesthetic considerations of having a visible access plate on the ceiling. While the location of the ballast box could be hidden if chosen thoughtfully (such as inside a kitchen cabinet or pantry), this remained a concern for some design reviewers.

Residential Field Test

One of renovation designs was UL-certified so it could be installed and evaluated in real-world environments. This remote ballast box design was produced in a 2-head configuration (shown in Figure 4) as well as a 4-head configuration. The 4-head design utilized a larger ballast box, which held two 2-lamp ballast that whipped out to four downlight optical heads. Ultimately, several dozen of these systems were installed new construction and renovation applications (Figure 5 and Figure 6).

Figure 4: Design of remote ballasted renovation prototype that was field tested.

The evaluation of the field test focused on interviews with the installers and homeowners to evaluation opinions of the installation process and the ultimate satisfaction with the overall lighting system. A limited set of photometric data was collected at some of the sites.

Figure 5: Before—Many of the retrofit application involved replacing existing T12 fixtures

Figure 6: After—Kitchen with six new CFL downlights

One of the objectives of the field study was to determine if installers considered the remote ballast box system to be easier to install verses standard downlight installation. Furthermore, installers where queried on the relative merits of the 2-headed and the 4-headed designs. To this end, many of the installation sites included applications of both the 2-headed and 4-headed systems, such as those shown in Figure 7 and Figure 8.

Overall, installer feedback indicated that this system did appear to provide certain installation advantages. In addition to the expected advantages (half as many hard-wired connections to make, plug-and-play connections, etc.), several new insights were gathered from the field tests. One was that installers consistently mentioned that having all of the ballasts in a single location greatly simplified their electrical work. This allowed them to simply bring the house wiring (Romex) to a single location and taking care of all wiring there rather than having to do wiring at each and every fixture location. This advantage was well complimented by renovations that involved replacing a single central fixture (such as common application of a 2x4 T12 box). In this application, the wiring to the central fixture could simply be re-routed to the ballast box.

Many usefully comments were also collected on the relative merits of the 2-headed system verses the 4-headed system. The general consensus was that, even though there were fewer electrical connections to make with the 4-headed system (because a single electrical connection powered 4 heads rather than 2) the 2-headed approach was preferred because of the flexibility and ease of use. The primary complaint about the 4-headed system was that any installation efficiencies gained by less wiring over the 2-headed approach were more than lost by having to deal with the 4-headed systems unruly “octopus” of wiring. The 12 feet of flexible metal conduit for each of the four downlights were simply too unwieldy for most of the installers. It was also noted that the 2-headed system could do everything the 4-headed system could do, while the 4-headed system could not do everything the 2-headed system could do (such as applications of 2, 6, 10 downlights etc.). This flexibility advantage of the 2-headed approach also extended to it switching, as the 4-headed system needed to turn on/off in banks of at least 4 downlights at a time. Without an overwhelming advantage, electricians and electrical distributors would be reluctant to stock both systems and, thus, would prefer the more flexible 2-headed system. For these reasons, the 2-headed system was generally considered to be a stronger design.

The primary concerns raised were related to the aesthetics of the access plate and the availability of dimming. Electricians very clearly indicated that these room-sided access plates would greatly ease future reballasting, but raised the concern that this might present an objectionable aesthetic for many homeowners. While appropriate “hiding spots” for the access plates were found for nearly all applications (such as in a kitchen cabinet as shown in Figure 9), these concerns persisted.

Finally, the increased demand for dimming in renovation applications was frequently mentioned. There were several recommendations/requests that the 2-headed system be made available with a dimming ballast option.

Figure 7: This field test application utilized a 4-head system and a 2-head system. System is shown with wiring whips exposed prior to the plug-and-play connection of downlight optical heads.

Figure 8: Access plate to ballast box for a 4-head system (left) and a 2-headed system (right). These access plates were placed in the ceiling in the pantry to address any potential aesthetic concerns.

Figure 9: This 2-headed ballast box access plate was hidden inside a kitchen cabinet.

Commercial System

As was previously discussed, the development of a commercial renovation system was undertaken separately from the residential system because of the many technical and market differences between these two applications. Commercial applications typical require high wattages and higher outputs and can generally support higher price points.

The predominant usage of T-bar ceilings instead of sheetrock ceilings is also a key difference between these two applications and has an important effect on the ultimate downlight systems produced. One of the effects of designing a downlight system for T-bar applications is that the difference between "new construction" and "renovation" is no longer significant. This is because the drop ceiling panels can so easily be removed and reinstalled, thus allowing for access to the ceiling plenum during renovations in a manner than is very similar to during initial construction. For this reason, the commercial system developed during this project was a "new construction and renovation system" rather that just a "renovation" system.

Early in the design process, it was determined that the commercial system would be a master-remote system, much like the residential CKP62 downlight system. The master-remote system has many advantages in commercial application. Essentially all of the advantages already discussed for the CKP62 apply as well as a few new advantages. One of the unique commercial application advantages relates to the usage of the flexible metal conduit utilized between the master and the remote downlight. In the residential system, the metal conduit represents a significant material cost that partial offsets the material savings of reducing the number of

required ballasts by half.[1] In commercial applications though, electrical codes already require that fixtures be connection by metal conduit. Thus, an area that represented an additional cost for the master-remote in the residential application became an asset for the commercial application.

Another important difference relates to the plug-and-play connector itself. The residential market is typically much more material cost-driven than the commercial market. As such, it does not currently have many pre-wired electrical components that might carry a higher initial cost in order to yield a labor savings that will ultimately produce a bottom line savings. Thus, there was an important educational effort necessary in the promotion of the labor savings benefits of the residential CKP62 system. This is much less of a concern in commercial applications as commercial electricians and specifiers are much more accustomed to utilizing pre-wired electrical assemblies to achieve labor savings.

These additional advantages along with the enthusiastic initial feedback for the emerging CKP62 system led to a high priority, accelerated development process for the commercial system. Ultimately, this design was able to be specified completely from components that Lithonia was currently manufacturing or purchasing for other product lines. This included the flexible metal conduit and plug-and-play connectors that were by this point being made in production quantities for the CKP62 system. This served to greatly collapse the time required from specification to commercialization as well as greatly reduced initial costs, as there was no need for any new hard-tooling investments.

In December 2004, Lithonia introduced the CCR62 (6-inch diameter) and CCR82 (8-inch diameter) master-remote commercial downlighting systems to the market. These vertical downlight systems utilize a smart electronic ballast capable of driving CFLs in a range of wattages. The key CCR specifications are summarized in Table 2. The CCR62 system is show in Figure 10.

Table 2: Key Specifications for CCR commercial downlighting system

Architecture	master-remote
Diameter	6 inch or 8 inch
Lamp Orientation	Vertical
Lamps	26W, 32W, 42W
Voltage	120V or 277V
Fixture Efficiency	74%

[1] Because of the nature of the high voltage operation and the plug-and-play connection between the master downlight and the remote downlight, the National Electrical Code required the usage of flexible metal conduit rather than the significantly less expensive Romex wiring used by standard systems.

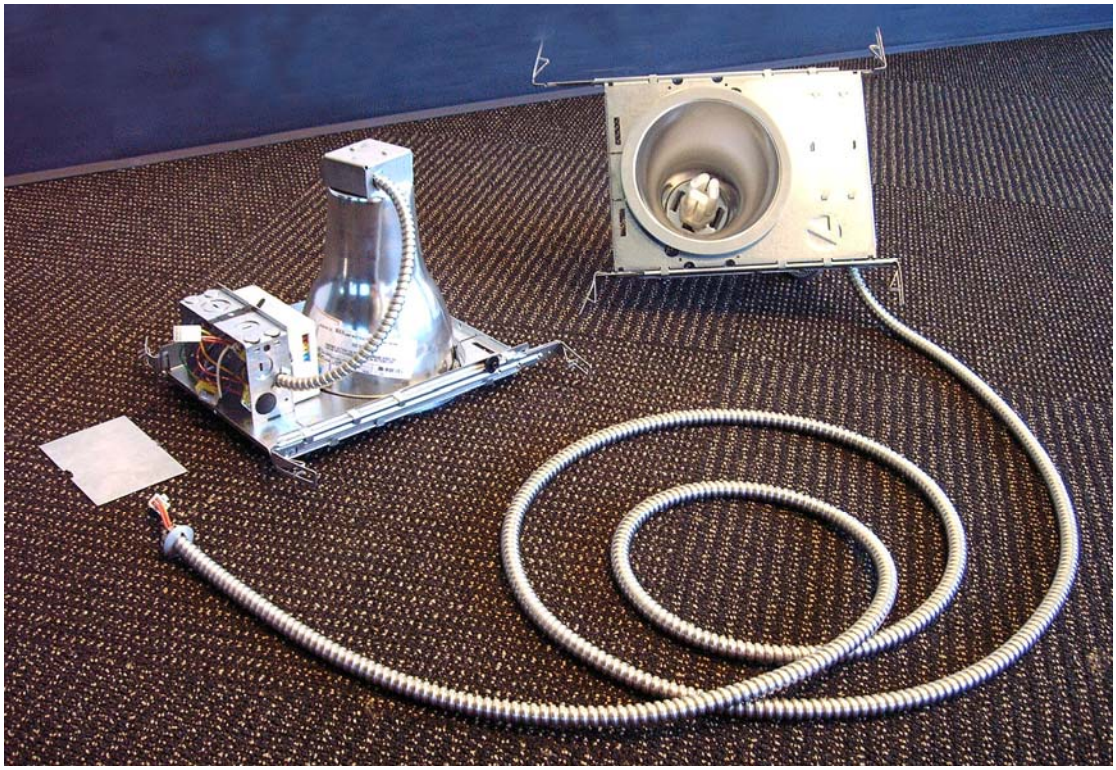

Figure 10: The CCR62 master-remote commercial downlight system.

The CCR is currently not available with dimming, but Lithonia engineers are currently reviewing this issue. Lithonia is keenly aware of the advantages of dimming when combined with a master-remote approach. Lithonia is currently working with their various ballast suppliers to identify and address any potential technical issues that might limit the usage of dimming in master-remote applications. The technical concerns relate to the potential that the voltage drop between the ballast at the master fixture and the CFL at the remote fixture may inhibit lamp starting when utilized at a dimmed state. If this turns out to be a genuine concern, and it is still unclear at this point, it potentially can be addressed by either limiting the overall dimming range of the system or shortening the wiring whip between the master and the remote.

Product Benefits—Energy and Installation Savings

This product promises to cut installation time and cost by about 20% compared to standard downlight systems, making it more cost effective when replacing incandescent systems or upgrading from linear or U-tube T12 fluorescent systems. As shown in Appendix D: Energy Savings Analysis, the new system offers energy efficiency improvements as well:

- 6% compared to standard CFL
- 15% compared to older T12 fluorescent
- 75% compared to incandescent

The new system is thought to be applicable to 15–25 percent of California's office areas as well as retail spaces currently using downlights or U-tube fluorescents.

MARKET CONNECTION ACTIVITIES

During the prototype development phase, the research team conducted informal workshops with staff from SCE, PG&E, & SMUD, as well as with several California homebuilders and homebuilder organizations.

The research team also has publicized the project results in many ways, including:

- Demonstrated the prototype systems to hundreds of industry professionals during California Lighting Technology Center tours and industry meetings, including:
    - IESNA chapter meetings (October 2004 and January 2004)
    - BIRA[2] controls meeting (October 2004)
    - PG&E lighting seminar (November 2004)
    - Lithonia lighting controls seminar (December 2004)
    - EPA Energy Star staff (December 2004)
    - US Congressional tour with Alliance to Save Energy (December 2004)
- On March 4th, 2004 made a public presentation of the new residential new construction downlighting system to about 50 homebuilders, electrical contractors, and consumers.
- Keynote CBIA presentation on April 15, 2004 on Title 24 changes, including CFL downlight applications.
- SMUD displayed the prototype system at a California Builder Industry Association (CBIA) meeting in the summer of 2004. They estimated there were 500 people in attendance at this builder meeting and they received a significant level of interest.
- The CLTC presented a review of the downlighting system at a “Title 24 Early Adopters” meeting attended by representatives of all the major California utilities, the California Energy Commission, and other interested parties.
- Demonstrated the unit at ACEEE’s August 2004 Summer Session technology forum in Monterrey, California.
- Discussed the project in presentations, including the Emerging Technologies Summit in San Francisco in October 2004.

Demonstration projects are described in Conclusions and Recommendations section later in this report.

[2] Building Industry Research Alliance

CONCLUSIONS AND RECOMMENDATIONS

Several new downlighting systems have been developed during this project that build off of the successful Lithonia CKP62 master-remote residential new construction downlighting system. These include both a residential renovation remotely ballasted system as well as a commercial master-remote system for new construction and renovation applications. The residential system has been prototyped and field-tested, but not yet commercialized while the commercial system was commercialized in December 2004.

The residential renovation downlighting system was shown to have much promise in field tests. The remote ballasting arrangement reduced the overall cost of the system by cutting in half the total number of ballasts needed, while installation was simplified reducing the number of electrical connections to make. But aesthetic concerns relative to the placement of the ballast access plate as well as strong calls to include a dimming option require some reevaluation of this system.

The research team suggested one design alternative to address the aesthetic concerns of having a visible access plate for the ballast box and it will be considered in more detail in the near future. This design involves a more narrowly focused product for applications in which a central fixture in a single story home is to be replaced with multiple downlights. While this may sound like a relatively narrow niche, initial market research indicates that may include well over half of the existing kitchen applications. With this design, the central fixture would be removed and its wiring would be rerouted to a ballast box. This single electrical connection will be made in the attic (thus the initial limitation to single story applications) while pre-wired plug-and-play whips would be routed to the downlight locations. Downlight holes would then be cut from the ceiling side of the kitchen where optical heads would be connected to the wire whips and snapped into sheetrock retention rings. This approach will be further explored with Lithonia in the near future.

Dimming remains an important factor in the residential renovation market. While dimming was identified as an important option to make available, the current availability of residential-grade dimming ballast is very limited. In fact, the CLTC is not aware of any residential-grade, two-lamp dimming ballasts on the market. Commercial-grade ballasts can not be used in residential application because of FCC Class B code requirements, and it is necessary to utilize two-lamp ballasts to leverage the benefits of the remote ballasted approach. Thus, the CLTC will be watching the residential dimming ballast market closely to determine the future steps for this approach.

Lithonia recently commercialized the commercial system as the CCR62 and CCR82 and it is now available through their distribution channels. The CCR system is one of eight PIER-developed lighting technologies that have been selected for an upcoming demonstration and field testing program in partnership with the University of California and the California State University systems. It is anticipated that approximately 50-100 CCR systems will be installed in university applications for demonstration and evaluation. Dimming remains an important factor for the commercial system as well. The potential technical issues related to dimming that have been discussed are currently being addressed with the goal of allowing dimming to be an available option for the CCR system in the near future.

APPENDICES

Appendix A: CCR Specification Sheet

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Appendix B: CKP62 Promotional Brochure

LITHONIA LIGHTING
Innovative Lighting System Meets Title 24 Requirements
Sacramento Municipal Utility District, Lawrence Berkeley National Laboratory, California's PIER Program and Lithonia Lighting have joined forces to bring you an innovative lighting system that utilizes energy efficient compact fluorescent downlights.
Meets Title 24 requirements
High-performance lighting system
Instant-on compact fluorescent recessed lighting
More light than standard incandescent fixtures
Five times the life of incandescent
Uses one third of the energy requirement of incandescent
Premium trims for superior finished look

Title 24 Compliant System Components

Series
CKP62

Trims
6O3A

Features

- 10 foot flex conduit assemblies for remote downlight
- Residential-grade ballast
- IC rated
- UL listed
- Plug & light wiring system
- Housing with bar hangers
- Premium reflector with specular finish
- Clips riveted to reflector
- Thermally enhanced ballast

Series
CK62
CK64

Trims
6TK2
6TK4

Features

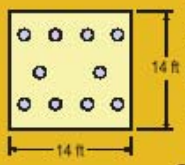
- 12 foot flex conduit assemblies for 2 or 4 remote downlights
- Nail-in J-Box
- Residential-grade ballast
- IC rated
- UL listed
- Plug & light wiring system
- Pan with bar hangers
- Thermally enhanced ballast
- Air-Tight construction
- Mounting clips
- White finishing plate

Operating Cost Comparison

Room Details

- 14' x 14' room
- Work surface 3'
- 30 foot candles
- 4 hours per day
- 365 day per year
- $.08 per kwh

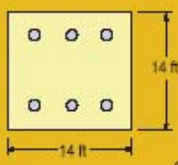
Incandescent



65R30/FL/65WM
Luminaires - 10
Total watts - 650

Cost per year - $75.92

Fluorescent



26 watt CF TRT in a 6O3A
Luminaires - 6
Total watts - 180

Cost per year - $21.00

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Appendix C: CKP62 Specification Sheet

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Replace this sheet with spec sheet page 2

Appendix D: Energy Savings Analysis

CFL Downlight Analysis

NEW CFL DOWNLIGHT SYSTEM

75% fixture efficiency (est)
1 CFL @ 32 W 36 W ballast input
2 CFL @ 32 W 68 W ballast input w/1 ballast
efficiency benefit = 5.6%
ballast factor = 0.98

T12 SYSTEM

Std T12 2x2 fixture w/U-tubes, 40W each
71 W input w/electronic ballast
60% fixture efficiency (est)
0.85 ballast factor

COMPARE

System	*# lamps*	*# ballasts*	*W per lamp*	*lamp lumens*	*sys W*	*fixt. effic*	*BF*	*lumens total*	*lumens relative*	*LPW approx*	*LPW relative*
New system	2	1	32	2400	68	75%	0.98	3528	100%	52	100%
Std CFL	2	2	32	2400	72	75%	0.98	3528	100%	49	94%
2x2 T12 U-tube	2	1	40	3050	71	60%	0.85	3111	88%	44	84%
Incan BR40	3	0	120	1150	360	90%	1.00	3105	88%	9	17%

Notes: lamp lumens from Osram Sylvania on-line catalog; initial lumens (mean ~86-90% for fluorescent)
ballast wattage from Advance catalog
fixture efficiencies are estimates; old T12 systems are less efficient than many new T8 systems
incancescent system has no ballast; 1 ballast noted to simplify equations