

ACC Care Center 2017 Circadian Lighting Project

Sacramento Municipal Utility District



January 8, 2018



Prepared by:

David Bisbee, CEM

The information in this report is provided by SMUD as a service to our customers. SMUD does not endorse products or manufacturers. Mention of any particular product or manufacturer in this report should not be construed as an implied endorsement.

TABLE OF CONTENTS

1. Executive Summary	
1.1 Introduction.....	3
1.2 Project Objectives.....	3
1.3 Project Results.....	4
1.4 Acknowledgements.....	4
2. Project Description	
2.1 Background	5
2.2 Project Objectives.....	6
2.3 Research Methodology	7
2.4 Project Scope	7
3. Project Results	
3.1 Reality Check	8
3.2 Energy Monitoring Results.....	9
3.3 Behavioral Changes	10
4. Conclusions.....	11

1. Executive Summary

1.1 Introduction

During the last five years, the lighting industry has undergone tremendous changes. LEDs and wireless controls have completely disrupted the industry and have opened up exciting new opportunities for energy savings, data collection and even possible health benefits.

Research conducted by the Lighting Research Center (LRC), part of the Rensselaer Polytechnic Institute (www.lrc.rpi.edu), DOE and others has shown that lighting affects our circadian rhythms, and consequently may have significant impacts upon our health. Specifically the spectrum and the intensity of the light source, as well as the duration and timing of the exposure affect our sleep patterns. Because many seniors living in care centers often do not leave the facility, lighting systems have a major impact upon them.

During 2015, SMUD completed a research project at the ACC Care Center. This project consisted of installing tunable-white LED lighting and controls in two resident rooms, a hallway, the nurses' station and the family visitation room. This project dramatically improved the sleep patterns of the seniors, reduced the number of reported falls and received extremely positive feedback from the caregivers¹.

Although this project was very successful, the project team was forced to create customized lighting solutions for the resident rooms, because no manufacturers offered tunable–white LED lighting fixtures designed for this application.

1.2 Project Objectives

The ACC Care Center has plans to complete a major remodel and expansion project within the next few years and is interested in incorporating innovative lighting and control strategies. As with the 2015 project, the main purpose of this project was to identify which options (if any) ACC should consider incorporating into their upcoming project. Specifically, ACC was interested in lighting strategies that could:

- Improve safety by reducing the number of falls
- Improve the sleeping habits of their residents
- Help ACC Staff provide even better care

¹ The report for the 2015 ACC project is available at <https://www.smud.org/-/media/Business-Solutions-and-Rebates/ACC-Care-Center-Lighting-Project.ashx?la=en&hash=1EFC27D1D9663250B1C168133B04294C570D8454>

1.3 Project Results

Originally, the scope of this project included testing fixtures from three different manufacturers in twelve resident rooms. Unfortunately, despite a lengthy search and efforts by lighting manufacturers, the project team was unable to find suitable fixtures. Consequently, the project team decided to focus exclusively on lighting upgrades for the hallways and installing LED lights mounted under the beds of all 99 residents at the ACC Care Center.

The good news is that the LED lighting reduced energy consumption in the hallways by 32%. Unfortunately, data collection efforts for recordable Falls and Behaviors were severely impacted by a major shift in ACC's policy regarding the use of audible alarms. Consequently, the results of the behavioral analysis are believed to be inconclusive at best.

1.4 Acknowledgements

While many people contributed to this project, we particularly appreciate the cooperation and help from the following individuals:

- Melanie Segar (ACC)
- Mark Williams (ACC)
- Tamara Kario (ACC)
- All of the nursing staff who work to improve the quality of life for their residents at the ACC Care Center
- Connie Samla (SMUD)
- Katie Leichter (Cadmus Group)
- Emily Shackleton (Cadmus Group)

2. Project Description

2.1 Background

ACC Care Center

The ACC Care Center has been serving seniors in the Sacramento area since 1986 and is well known within the community for excellence. The Center provides rehabilitation and nursing services in an atmosphere that feels like home. The average age of the current residents is 87 years old and most of them are wheelchair bound. Many of the residents have been diagnosed with some form of dementia.

The Center currently has 99 beds and is planning an expansion within the next few years. ACC was excited to work with SMUD to explore new lighting concepts for possible inclusion into the planned expansion project.

2015 Project

During 2015, SMUD completed a research project at the ACC Care Center. This project consisted of installing tunable-white LED lighting and controls in two resident rooms, a hallway, the nurses' station and the family visitation room. This project dramatically improved the sleep patterns of the seniors, reduced the number of reported falls and received extremely positive feedback from the caregivers².

Although the 2015 project was very successful, we were forced to create customized lighting solutions for the resident rooms, because no manufacturers offered tunable-white LED lighting fixtures designed for this application. To get around this limitation, the team used linear LED fixtures mounted inside of rain gutters to provide indirect lighting (Figure 1). These fixtures were controlled by a rather elaborate system that was intended for theatrical lighting applications (Figure 2). In fact, we had to bring in a factory representative to program the controls.



Figure 1: Because manufacturers did not offer tunable-white headboard fixtures in 2015, the team used linear LED fixtures inside of rain gutters to provide indirect lighting for the resident rooms.



Figure 2: The fixtures in the patient rooms were controlled by a rather elaborate system that was intended for theatrical lighting applications.

² The report for the 2015 ACC project is available at <https://www.smud.org/-/media/Business-Solutions-and-Rebates/ACC-Care-Center-Lighting-Project.ashx?la=en&hash=1EFC27D1D9663250B1C168133B04294C570D8454>

During the site visit, the representative said that this was the first time he had ever seen this controller used for a tunable-white application. Understandably, the caretakers and staff at ACC said they found these controls somewhat difficult to use.

Another example of improvising was using amber LED rope lights and smart power strips for nighttime navigation. The rope lights were strapped to the bed frames with zip ties and controlled via power strips with remote motion sensors (Figure 3). Surprisingly, the LED rope lights provided excellent lighting for this purpose. The main drawbacks were that the rope lights were not dimmable and the power strips often became accidentally unplugged when caretakers changed the bed sheets.

Although using linear LED fixtures, theatrical controls, rope lights and smart power strips met the functional requirements for the 2015 project, they were not viable options for future installations.

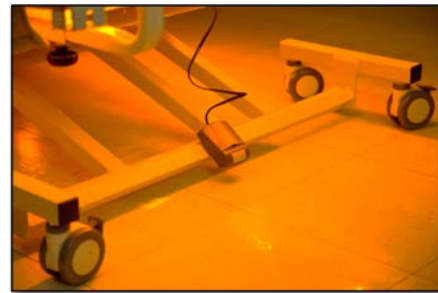


Figure 3: In 2015, the team used amber rope lights strapped to the bed frames and controlled via smart power strips to provide nighttime navigation.

2.2 Project Objectives

The objectives for this project were similar to the 2015 project and included:

- Learn more about how tunable-white lighting impacts the irritability and sleep patterns for residents with Alzheimer's or related dementias.
- Improve the quality of sleep and nighttime safety for residents living in the quarters selected for the study.
- Improve the quality of lighting (e.g. reduce glare, improve controllability) in the resident quarters and the adjacent hallways.
- Equip the caretakers and nursing staff to provide even better care during nighttime hours.
- Investigate, evaluate and identify potential lighting products and techniques for ACC's planned remodel and expansion.
- Determine the energy and cost savings for the hallways.

2.3 Research Methodology

Essentially, there were three primary research objectives for this project:

1. Understand the technical properties of the new lighting and control systems. This would be assessed using illumination measurements and energy monitoring equipment.
2. Obtain feedback regarding the new lighting system from ACC staff members and residents through personal interviews.
3. Observe and record behavioral changes for the twelve residents who received the new lighting systems as well as residents living near the retrofitted hallways. This data would be collected via PointClickCare, an electronic medical record system that contains the residents' entire medical records, as well as point of care reminders and documentation.

2.4 Project Scope

As stated earlier, one of the biggest challenges for the 2015 project was the lack of tunable-white headwall fixtures (Figure 4). At the beginning of 2017, three manufacturers believed they had products that would work for this application. The original project plan included testing twelve fixtures—four from each of the manufacturers, in different sections of the facility. The plan was to program these fixtures based on research conducted by the Lighting Research Center (LRC):

- 7 am – 2 pm: 6000K
- 2 pm – 6 pm: 4100K
- 6 pm – 8 pm: 2700K
- Nightlight mode: 2400K

In addition to the headwall fixtures, the project also included replacing the fluorescent fixtures in each of ACC's hallways (aka lanes) with the same type of tunable-white fixtures used during the 2015 project (Figure 5).

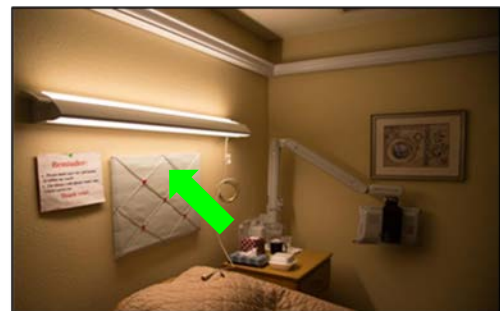


Figure 4: One of the biggest challenges for the 2015 project was the lack of tunable-white headwall fixtures. In 2017, three lighting manufacturers believed they had fixtures that would work for this application.

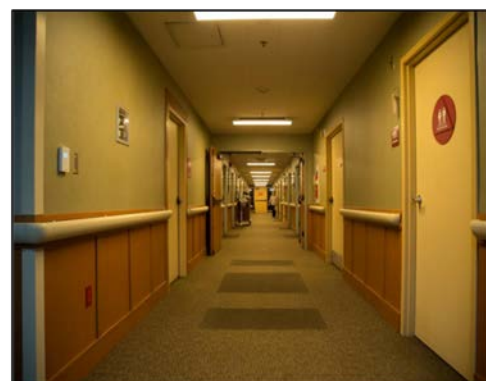


Figure 5: The 2017 project included replacing the fluorescent lights in all of ACC's hallways.

The new lighting system automatically controls the Kelvin settings, but ACC Care Center staff must manually control the output levels. The new LED fixtures were operated using the following protocols:

- 6:30 am – 2:00 pm: 6500K @ 66% output
- 2:00 pm – 7:30 pm: 4000K @ 66% output
- 7:30 pm – 6:30 am: 2700K @ 20% output

Finally, the original project scope included installing commercially available, motion-activated LED lights mounted under the beds of the twelve residents selected for the study. The purpose of these lights was to improve safety by providing lighting for nighttime navigation.

3. Project Results

3.1 Reality Check

During the first six months of this project, the project team obtained samples for nine products from five different lighting manufacturers. Our search for tunable-white headwall fixtures was reminiscent of the story of Goldilocks and the Three Bears. Some fixtures were:

- **Too heavy:** the project team was not comfortable hanging a 50lb. light fixture on a wall above the residents' heads—especially in a retrofit situation.
- **Too simple:** some of the products we looked at could only be tuned manually—they could not be programmed for circadian purposes.
- **Too complicated:** the controls needed to be sophisticated enough to handle advanced programming yet still be easy for the residents to use. Some products did not offer any control options and required using elaborate control systems from other companies.
- **Too expensive:** \$2,800 for one 4 foot fixture (plus another \$200-300 for controls) is simply not viable—even in a research environment.
- **Nice fixture, wrong application:** two of the products we looked at met most of our requirements except for one very important one: fixtures used in healthcare environments need to be easy to clean (i.e. wipe-down).

Since the project team was unable to find even one suitable headwall fixture, we were forced to change direction. The team decided to focus on improving the lighting in the hallways (and other common areas) and installing LED lights (Figure 6) under the beds of all 99 residents at the ACC Care Center. The revised project included three phases:

- Phase 1 (September): Since the team chose to use this period as the new project baseline, the new LED fixtures in the hallways were programmed to remain at 4100K and no LED lights were installed in the resident rooms.
- Phase 2 (October): The LED hallway lighting was programmed to change color temperatures (as described earlier). No LED lights were installed in the resident rooms during this period.
- Phase 3 (November): The LED hallway lighting was programmed to change color temperatures (using the same program as Phase Two). LED lights were installed and activated in all of the resident rooms.



Figure 6: the revised project included installing commercially available, motion-activated LED lights mounted under all 99 beds at the ACC Care Center.

During all three of these periods, Cadmus (SMUD’s consultant) monitored the energy consumption of the hallway lighting while ACC staff tracked the following metrics: (1) Falls (2) Observed Behaviors, and (3) feedback from residents, staff and visiting family members.

3.2 Energy Monitoring Results

The ACC Care Center includes five different sections (as shown in Figure 7). Four of these sections include resident rooms and hallways referred to as “lanes”. Each of these lanes is named after a tree: Azalea, Bamboo, Cherry and Elm. During the first few months of the study, the Cadmus Group monitored the energy consumption of each of the lanes.

The original lighting system consisted of 27 surface-mounted, 2-lamp, fluorescent fixtures. Each fixture consumed around 64 Watts and operated an average of approximately 5,030 hours per year.

The new lighting system consists of 27 tunable-white LED fixtures. Each fixture is dimmable and draws a maximum of 32 Watts. After the lights in the lanes were replaced with the LED fixtures, Cadmus monitored the energy consumption for a period of 137 days. A summary of the monitoring results is shown in Figure 8. The energy savings for the lanes was approximately 32%.



Figure 7: The ACC Care Center includes five different sections. Four of these sections (lanes) include patient rooms and are named after trees.

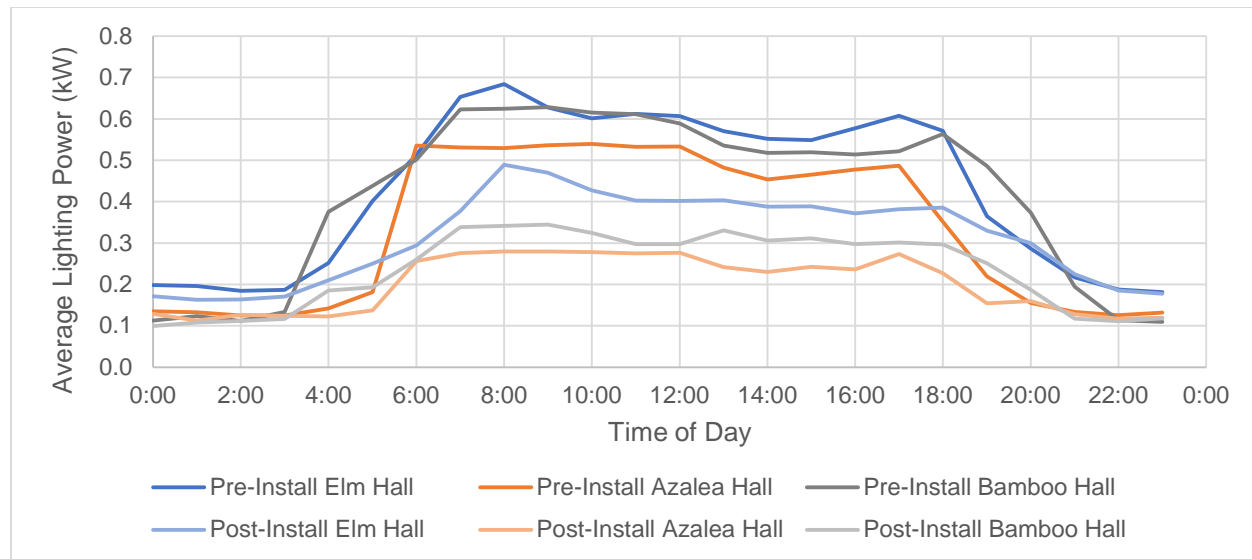


Figure 8: A summary of the monitoring results for all three lanes (hallways) at the ACC Care Center which were upgraded during this phase of the study. The new LED lighting reduced the energy consumption by 32% compared to the original fluorescent system.

3.3 Behavioral Changes

The recorded number of falls and Behaviors observed by ACC Care Center staff are shown in Figure 9. The total number of falls and recorded behaviors dipped during the month of October, but increased sharply during the month of November. At first glance, it would appear that installing LED lights under the beds had a negative impact upon the residents, but there is more to this story.

In senior care environments, some residents are unable to get out of their beds or wheelchairs without assistance, yet often attempt to do so (especially residents with dementia). Since healthcare regulations prohibit care providers from using any form of physical restraints, some providers, (including ACC), have used audible alarms to alert caregivers that a high fall-risk resident is attempting to get out of bed without assistance. During late October and early November, ACC stopped using audible alarms. Consequently, the number of falls actually *increased*. In fact, one high-risk resident fell five times during the month of November. Fortunately, none of these falls resulted in serious injuries.

Behaviors			
	September	October	November
Azalea	9	7	8
Bamboo	4	3	4
Elm	5	2	7
Cherry	6	4	5
Totals	24	16	24

Falls			
	September	October	November
Azalea	3	4	3
Bamboo	6	4	6
Elm	5	7	9
Cherry	6	4	4
Totals	20	19	22

Figure 9: Number of falls and Behaviors recorded by ACC staff during the study period. Unfortunately, their discontinued use of audible alarms during the study period completely obscured any possible changes that could have been due to the lighting.

Unfortunately, this change in policy completely obscured any possible behavioral changes that could have been due to the lighting. Although some of the caregivers believe the new lighting has had a positive impact, the discontinuation of using audible alarms during the study period rendered the results of this project inconclusive at best.

4. Conclusion

Conducting field research is often difficult at best. Sometimes outside factors have a major impact upon the project results. There were two factors that impacted this project:

1. The project team's inability to find cost-effective, tunable-white LED headwall fixtures reveals the lighting industry still has not fully embraced tunable-white lighting for healthcare applications.

In order to significantly impact sleep and behaviors, changing the lighting systems in the resident rooms is essential. Especially since this is where residents spend most of their time and most falls occur. Installing LED lights under the beds may be helpful, but the headwall fixtures need to be replaced to in order for provide maximum benefit.

2. Changes in operations, such as the use of audible alarms for residents who are at high risk for falling, can negate the results of changes in lighting. These types of changes must be avoided during the study period.

All in all, based upon the results from previous studies, the project team still believes that implementing circadian lighting principles and providing lighting for nighttime navigation can enhance senior care environments. ACC intends to incorporate several of the techniques used during our two research projects and hopes that manufacturers will offer more products in time for their upcoming expansion project.