A Demonstration Of Fluorescent Outdoor Lighting In Austin Texas

Final Report

Submitted to
Texas State Energy Conservation Office

SECO Contract #CM637

Submitted by
City of Austin – Austin Energy

January 2008

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EXECUTIVE SUMMARY

Final Report

This report completes the requirements of SECO Contract CM637 and the "City of Austin/Austin Energy's Demonstration of Fluorescent Outdoor Lighting Program". The contract amount was $35,000 in funds from the US Department of Energy, through a subcontract with the State Energy Conservation Office (SECO), and an Interlocal Agreement between SECO and the City of Austin/Austin Energy.

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Objective

Austin Energy (AE) contracted with the Lighting Research Center (LRC) of Rensselaer Polytechnic Institute of Troy, New York, to study the perceptions and effects of fluorescent light sources when applied in place of High Pressure Sodium (HPS) lighting in street and parking lot applications. The goals of this study are: to determine if the substitution of fluorescent lighting for HPS lighting is appropriate; the best applications; and the economics of this type of project.

The State Energy Conservation Office of the Texas Comptroller of Public Accounts approved the non-solicited proposal submitted by Austin Energy for consideration for this project. Using available oil-overcharge funds, SECO executed contract CM637 with the City of Austin/Austin Energy.

Background

Lighting systems are designed for the worst case scenario. For fluorescent lamps, the design point is near the end of their average rated life, and for HPS systems, the design point is at approximately 66% of the average rated life. The fluorescent lamp type used in this study (Long PL) will lose 10% to 12% of its light output over its rated life, and standard HPS lamps can lose as much as 20% to 35% of their initial light output. This means that a fluorescent lighting system would not need as much initial light output to equal the light output of an HPS system at end of life.

Another consideration in comparing the two different light sources is visual perception. Measurable light levels and the amount of light that can actually be

used by the human eye differ. The human eye is sensitive to the color of light particularly in low light levels or mesopic sight. Bluer light sources like fluorescent in the Correlated Color Temperature range of 4100° to 6500° Kelvin, are much more useful to the eye than in a light source like HPS with a Correlated Color Temperature around 2100° Kelvin.

Contract Milestones and Deliverables

1. Negotiate a contract agreement with the Lighting Research Center (LRC) and provide a copy to SECO.

   - ❖ A contract with the Lighting Research Center was executed on 11/28/2006.

   - ❖ The negotiation and contract documentation process is documented in Monthly Reports #1 thru #8.

2. Schedule a project kick-off meeting with SECO and LRC.

   - ❖ The Project Kick-off "Teleconference" Meeting was held on April 12, 2007.

3. Provide a brief summary of the fluorescent lighting technology with potential market opportunities, an economic analysis, barriers of the implementation phase, and technology transfer to other municipalities in Texas.

   - ❖ These requirements are included in the Project Findings section of this report.

4. Provide a project summary presentation that includes Austin Energy's plan to expand the fluorescent lighting testing or its market deployment.

   - ❖ The required Project Summary Presentation is located in the section of this report by the same name.

5. Provide monthly progress reports.

   - ❖ Monthly Reports #1 thru #17 are included in the Monthly Progress Report Section of this report.

6. Provide a Final Report with a summary of the completed project findings, including the fluorescent lighting replacement guidelines and an estimate of the potential savings for fluorescent lighting replacements in the Austin Energy service territory.

   - ❖ This Final Report satisfies this requirement.

Methodology

For this study, existing HPS fixtures were replaced with new fluorescent fixtures in three (3) Austin, Texas locations: the 900 block of West Avenue, the Energy Control Center parking lot, and the street and public parking area at the dead end of West Riverside Drive, in front of the Austin Parks and Recreation Department Headquarters Building.

The retrofits did reduce measured light levels; however, the new fixtures greatly reduced the glare from the previous HPS installation and the ability to "see" actually increased. The ability to discern details and to identify colors was greatly improved, and visual comfort also increased. These improvements are largely due to the fact that the characteristics of the fluorescent light used is very conducive to our mesopic sight, or how we see in low light levels.

Three (3) reference samples with HPS lighting were selected to compare to the fluorescent sites, including the parking lot at Gillis Park, the parking lot at the South Austin Health Clinic, and the 1000 block of West Avenue. LRC performed a study of human perceptions of safety, security, and brightness at the parking lot locations, and it was decided to use a telephone survey for the West Avenue comparison. The telephone survey for West Avenue had a low response rate, so previous studies performed by LRC in street type applications were included for that portion of the report.

Conclusions

The results showed that the perceptions of safety, security, and brightness were very similar for both sets of sites, even though the light levels were measurably lower in the fluorescent applications. Therefore, the results support the idea that there are good opportunities to use alternative light sources that are more effective in low light levels, such as fluorescent lighting.

An economic evaluation of substituting fluorescent for HPS lighting shows that it is most cost-effective in new construction; however, it can also be implemented in retrofit applications. The payback and lifecycle cost of installations will vary dependent upon the situation, but the best paybacks will most likely be in new applications, where the energy use is metered, and the end-user owns the equipment.

While fluorescent light was tested in this application, there are other light sources that operate in the mesopic spectral range, such as LEDs, and Induction Lighting. These light sources should also be explored in the future to identify their best possible applications and cost-effectiveness.

Acknowledgements

This report was prepared for, and in cooperation with, the State of Texas – State Energy Conservation Office of the Texas State Comptroller, and Rensselaer Polytechnic Institute's Lighting Research Center.

Thanks to Felix Lopez, P.E. with the State Energy Conservation Office, Peter Morante, Yukio Akashi, Mark Rea, Jennifer Brons, and John Bullough with the Lighting Research Center, and Larry Leetzow with MAGNARAY International, for their assistance in the initiation and preparation of this study.

PROJECT FINDINGS

1. Fluorescent Lighting Technology

Over the past few years, Austin Energy (AE) has tested several different types of alternative light sources in street and parking lot applications. Primarily, these tests were to demonstrate and compare alternative energy efficient lighting technologies to more traditional light sources such as High Pressure Sodium. The alternative light sources selected operate primarily in the mesopic or blue/green visual spectrum, and include: Light Emitting Diodes (LEDs), fluorescent, and an advanced form of neon. The results to date have been mixed; however, of this group, fluorescent lighting is the most proven and dependable technology with the least number of implementation problems.

Figures 1a and 1b below illustrate the photopic and scotopic sensitivity ranges for the rods and cones inside the human eye. The photopic sensitivity range represents how the eye sees in full light such as daylight using "cones", and has a maximum sensitivity of 555 nanometers in the green-yellow-red spectrum. The scotopic sensitivity range represents how the eye sees in low light levels to total darkness using the "rods", and has a maximum sensitivity of 507 nanometers in the blue-green spectrum.

Figure 1a –Photopic Sensitivity

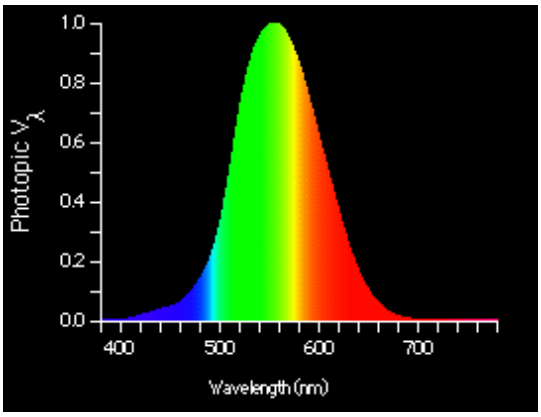
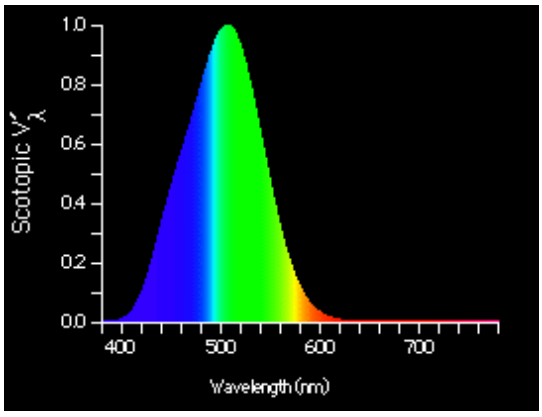


Figure 1b – Scotopic Sensitivity



Courtesy of MAGNARAY INTERNATIONAL, Inc.

Mesopic sensitivity, (in the middle) consists of the transition zone between twilight and normal interior light levels, and utilizes both rods and cones. This mesopic zone is optimized in the blue-green visual spectrum, and public acceptance is likely to be highest in that part of the zone where light levels are at 4100° to 6500° Kelvin (K) Correlated Color Temperature (CCT) range (See Figure 4).

For the purpose of this test, AE staff selected three (3) sites for the installation of new fluorescent street and parking lot lighting systems. The fixtures utilize 50-watt "long" PL or Biax type lamps (Figure 2), in individually enclosed housings, with electronic ballasts, and an option of a single lamp and double lamp profile. For this test, a double lamp profile (Figures 3a and 3b) was selected due to the need for increased light output and the flexibility of light distribution patterns. These fixtures are manufactured by MAGNARAY® International, and were purchased directly from the manufacturer by AE.

Figure 2 – 50-watt Long PL Lamp (22.5" maximum overall length)

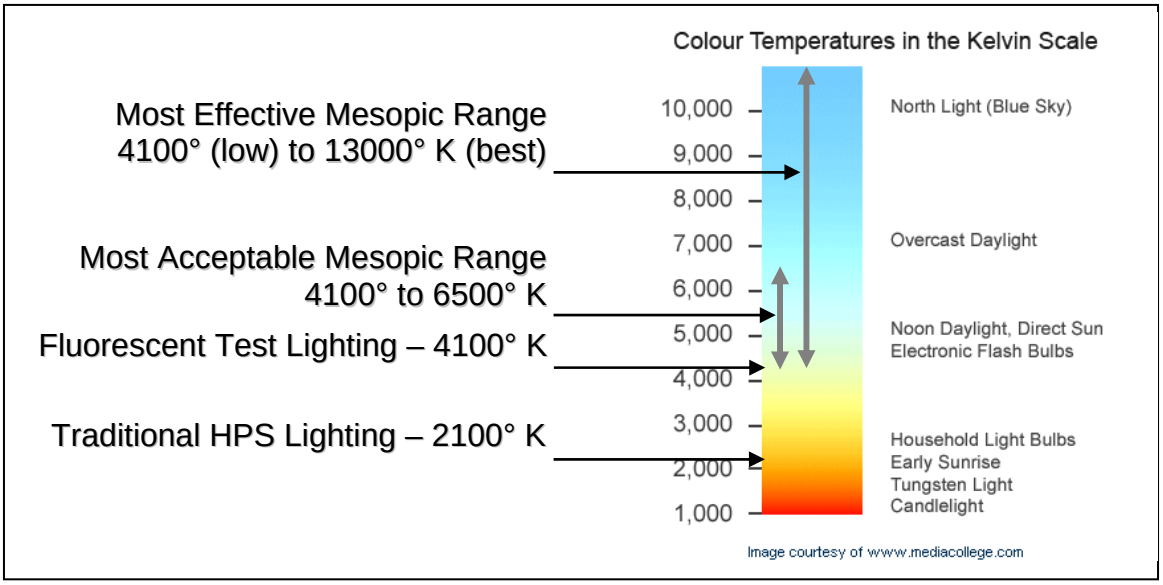
Figure 3a – Double Lamp MAGNARAY Fixture

Figure 3b – Double Lamp MAGNARAY Fixture ON

Performance characteristics of the lamp selected for the test include a Correlated Color Temperature (CCT) of 4100° Kelvin (K), and a Color Rendering Index (CRI) of 82. This compares to the performance of the existing High Pressure Sodium lamps with a CCT of 2100° K and a CRI of 22 as seen below in Figure 4.

The human eye cannot detect colors that are not in the light source, and the red-yellow-green spectrum of the HPS creates a reddish yellow light source as seen below. This is the reason that most people will only detect three (3) or four (4) colors under the HPS. The fluorescent's with their CCT of 4100° K is balanced in the red-green-blue range, and presents the opportunity so see better detail and more colors.

Figure 4 – The Correlated Color Temperature (CCT) of Light



An example of the perceived visual difference between HPS fixtures with a CCT of 2100° K with a CRI of 22 (Figure 5a), and the fluorescent MAGNARAY fixtures with a CCT of 4100° K, and a CRI of 82 (Figure 5b) is shown below. The high CRI and cooler color temperature increases the visual effectiveness and the ability to see detail and colors in the mesopic range.

Figure 5a – Traditional HPS Fixtures

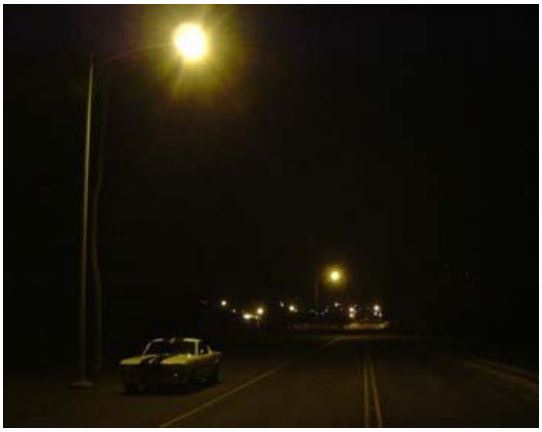


Figure 5b – Fluorescent MAGNARAY Fixtures

Courtesy of MAGNARAY INTERNATIONAL, Inc. and Marine Corp Base Hawaii (MCBH).

The Lighting Research Center (LRC) of Rensselaer Polytechnic Institute at Troy, New York, was selected for this study, because of their extensive research into the effects of short wave length "blue" light sources on the human eye in the mesopic spectrum. Also, LRC has developed a Unified Photometry System (UPS) that evaluates and predicts the visual performance

of a light source by comparing the luminance levels and the scotopic-to-photopic spectral ratio.

LRC's past research indicates that lighting sources with a CCT of 6500° K are optimal while remaining in the white light zone; however, this test was performed with a CCT of 4100° Kelvin. The fixtures had already been purchased, installed, and the color temperature of the lamps selected, prior to LRC's involvement.

2. Potential Market Opportunities

There appears to be marketing opportunities for this type of technology in Street Lighting, Parking Lots, and Parking Garages. Due to the adjustable cut-off angle of the fixtures tested, there are also opportunities for use in "Dark Sky" initiatives and wildlife sensitive applications such as coastal applications where "turtle friendly" lighting is required.

Because of the reduced energy use, this technology could also be included in climate protection initiatives and energy conservation programs. Table 1 below outlines some of the appropriate lighting system substitutions.

Table 1 – Fluorescent Lighting Replacement Guidelines

High Pressure Sodium Technology			Fluorescent Technology			Wattage Reduced
Fixture Type	**CCT***	**Wattage**	**Fixture Type**	**CCT***	**Wattage**	
70-watt HPS	2100° K	96 watts	1, 50-watt Fluorescent	6500° K	53 watts	45 %
100-watt HPS	2100° K	125 watts	1, 70-watt Fluorescent	6500° K	75 watts	40 %
250-watt HPS	2100° K	295 watts	2, 50-watt Fluorescent	6500° K	106 watts	64 %

CCT* Correlated Color Temperature measured in degrees Kelvin

It must also be noted that the recommendations in Table 1 above, are for example and testing purposes only, and in no case does AE recommend ignoring the exterior and roadway lighting recommendations as set down by the Illumination Engineering Society of North America (IESNA).

3. Economic Analysis

The ownership of street lighting and area lighting systems in Texas comprise a mixture of utility owned systems and government/customer owned systems, and most are not metered. The local utilities bill these customers a flat monthly kilowatt-hour (kWh) charge, estimated based on the size, type, and quantity of the light source. This specific fixture data is multiplied by a

preset number of annual burn hours, and divided by 12, to create an "average" monthly kWh.

In most cases, they also bill the customer a preset Maintenance or Facility fee, representing their estimated average annual maintenance cost for the appropriate fixture type, based on the cost of materials, labor, and the "mean time between failures" (MTBF). Based on the W.W. Grainger catalog, we estimate that the cost of a single "non-cycling" 250-watt HPS lamp and the cost of two (2) 50-watt fluorescent replacement lamps are roughly equal, so there may not be any real maintenance savings when passed through an electric utility. In addition, Electric Utilities buy commodities such as lighting products at wholesale, and it may actually cost more to buy two (2) 50-watt fluorescent replacement lamps at wholesale, than to purchase a standard 250-watt HPS because of the volume of HPS lamps on the market today and the type of lamp they purchase.

Since both the energy and maintenance rates are part of the Utility's Electric Tariff Manual, it will most likely require board and/or governmental approval to change these rates. Some examples of the rates charged for these services are located in Appendix B.

Table 2 – Estimates of Potential Savings for Fluorescent Replacements

High Pressure Sodium Technology			Fluorescent Technology			Annual kWh
Fixture Type	**Wattage**	**kWh/Mo[1]**	**Fixture Type**	**Wattage**	**kWh/Mo[2]**	**Reduced**
70-watt HPS	96 watts	35 kWh	1, 50-watt Fluorescent	53 watts	21 kWh	168 kWh/Yr
100-watt HPS	125 watts	40 kWh	1, 70-watt Fluorescent	75 watts	30 kWh	120 kWh/Yr
250-watt HPS	295 watts	100 kWh	2, 50-watt Fluorescent	106 watts	42 kWh	696 kWh/Yr

kWh/Mo[1] - This column represents the flat rate of monthly kWh charged by some of the utilities in Texas. Austin Energy's estimates are slightly lower.

kWh/Mo[2] - The monthly kWh listed in this column represent estimates based on the best available information.

The tariff structures and status of system ownership present a unique set of challenges to the cost-effectiveness of fluorescent street and area lighting in Texas. Where the fixtures are owned, operated, and maintained by the end-user, and the energy use is metered, fluorescent may be cost-effective, however, where these responsibilities are shared with a local electric utility, and energy use is estimated, the cost-effectiveness will need to be evaluated on a case-by-case basis.

The attached LRC study "Demonstration and Evaluation of Fluorescent Outdoor Lighting in the City of Austin, Texas", performs an economic analysis

for the substitution of a double lamp 106-watt fluorescent fixture, for a 250-watt HPS fixture using the information below.

Energy rate: $0.04844/kWh

1 - Dual lamp fluorescent fixture:
$260.00/fixture + 2 lamps @ 19.77 + $150 labor = $449.54
Wattage: 106 watts

1 - Single Lamp HPS Cobra head style fixture:
$80.00/fixture + 1 lamp non-cycling lamp @ 53.73 + $150 labor = $283.73
Wattage: 300 watts

Annual Burn hours used: 4100

The LRC's calculations show an estimated payback of 11.6 years for a retrofit scenario, and 3.5 years for new construction applications. This may vary case-by-case based on local energy rates, how energy use for street and area lighting is measured or estimated, and if the end-user purchases the more expensive non-cycling HPS lamps.

4. Barriers to Implementation

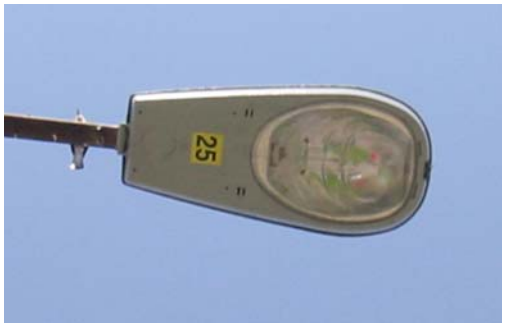
a. First Cost: The first cost of fluorescent type street and parking lot fixtures can be two (2) to three (3) times the cost of traditional High Pressure Sodium fixtures or Metal Halide fixtures, and other technologies such as LEDs can be five (5) times the cost or more. The high cost of the fixtures coupled with the moderate energy savings makes the implementation of these technologies hard to justify in retrofit applications based solely on cost-effectiveness. However, the first cost is much more palatable in new applications where only the incremental cost between the standard HPS or MH fixtures and the alternate technology is a factor.

b. Availability: The fluorescent lamps and ballast are regular commodity grade products, however, at the current time there is a limited number of companies developing and manufacturing these types of fixtures. This makes it more difficult to competitively bid products like these in an open and fair process, and a small beginning market share may be artificially inflating fixture prices. As these products continue to achieve acceptance in the public it should make them more affordable.

c. Installation and Maintenance: The fixture tested does not provide tool-free access to the fixture or maintenance. While the fixtures in the test are

prototypical, this provides a couple of challenges from the maintenance perspective and should be addressed in future product generations.
One of these challenges for Street Lighting applications is that the industry standard has become the "Cobra Head" style fixture. These fixtures provide a set of highly desirable features such as tool-free entry, easy access to the lamp and ballast for removal, easy mounting and fixture leveling, a universal slip fitting that accommodates various sizes of mast arms, and a minimal number of small parts to fall to the ground while the fixture is being serviced (Figure 6).

Figure 6 – 250-watt Cobra Head Style Fixture



The second set of challenges is largely institutional, and is based on field staff's objections. Field maintenance staff has become accustomed to the Cobra Head style fixture, and are reluctant to accept anything that gives the impression (real or not) that it might be more difficult to install, access, or maintain. The end result is that successful implementation will most likely require a paradigm shift for the field staff that install and maintain the equipment.

In addition, the fluorescent fixtures tested have two (2) lamps instead of the one (1) lamp in the High Pressure Sodium (HPS) fixtures normally used in these applications. This effectively doubles the number of lamps to be maintained in the system, and results in increasing the number of maintenance calls for burn outs, and/or doubling the annual cost of replacement lamps. In this case, it may be most cost-effective to replace both fluorescent lamps if one burns out, to reduce return trips to change out a single burned out lamp.

Since both the energy and maintenance rates are part of the Utility's Electric Tariff Manual, it will most likely require board and governmental approval to change these rates. Some examples of the rates charged for these services are located in Appendix B.

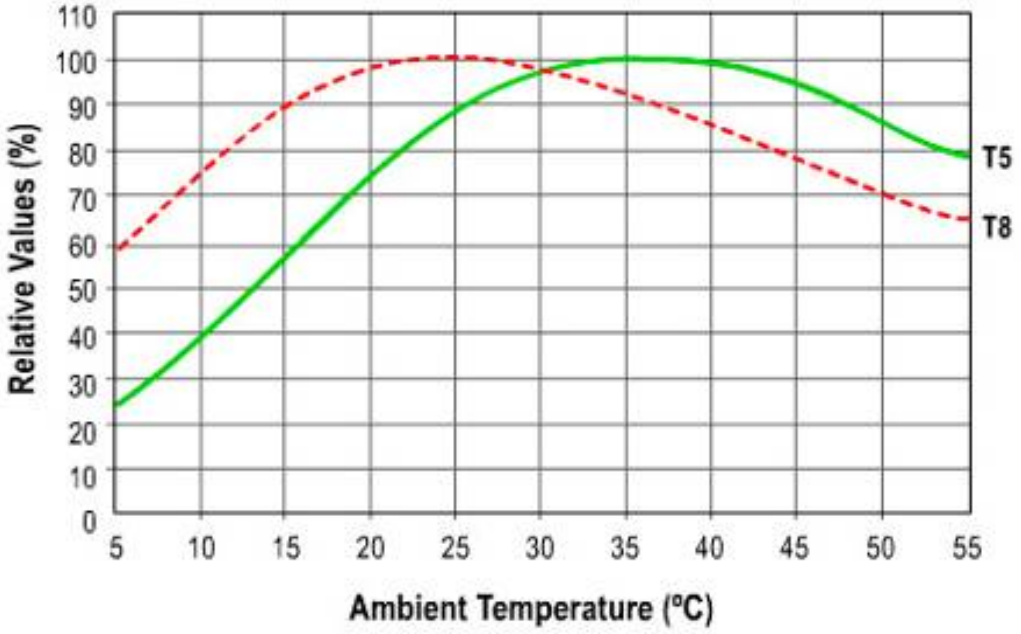
d. Lamp Cost and Average Rated Life: The City of Austin purchases frequently consumed commodities such as lamps, on a Master Purchase Agreement. Because of the buying power of an entity the size of the City of Austin and Master Purchase Agreements, our price for one (1) standard 100-watt or 250-watt HPS lamp is less than the cost of a single fluorescent 50-watt twin tube lamp. In addition, the average rated life of the fluorescent lamp may be shorter than the standard HPS lamp. The result

is that maintenance cost of the fluorescent systems could be higher than the traditional HPS systems in some cases.

e. Lamp Lumen Depreciation: The HPS and MH lighting most commonly used for exterior lighting today, suffers from lamp lumen depreciation due to aging. HPS and MH light sources can lose as much as 35% to 40% of the initial light output over the life of the lamp, and most of the MH lamps can experience severe color shifts. Normal lamp lumen depreciation brought on by aging for T8 and T5 lamps, ranges from 3% to 7% for linear T8s to as much as 12% for the Long PL type, with very little color shift. This provides a substantial improvement over the HPS and MH lamps.

While the HPS and MH lighting commonly in use today are not sensitive to ambient temperature, fluorescent lighting is sensitive to ambient temperature. Most fluorescent lighting was designed for use primarily in conditioned space, and therefore is sensitive to the temperature of its environment. The data in Figure 7 below demonstrates the effects of ambient temperature on fluorescent light output in T8 and T5 light sources.

Figure 7 – The effects of Ambient Temperature on T5 and T8 Fluorescent Light Output



This diagram is quoted from SILHOUETTE T5, T5 HO & T5 Circular Fluorescent Lamp Technology Guide, Philips Lighting Company.

Phillips Lighting is beginning to market a “Polar” version of this lamp rated to -25° Fahrenheit; however, no data on the lamps performance was available at the time of this study.

f. Over Current Protection: Traditional street lights house an inline 15 amp fuse that provides over current protection for the HPS ballast and keeps spikes and other system anomalies from damaging the ballast circuitry. The electronic ballasts for the fluorescent systems need an inline fuse rated at .75 amps to protect the circuitry.

   There may be availability issues of a suitable .75 amp substitute, and in some cases, there is a hesitance on the part of field personnel to reduce the size of the over current fusing enough to protect the new electronic ballast. This is also an added cost.

g. Safety: One of the main ways to make this technology cost-effective is by reducing light levels in times of low traffic; for example: 12:00 AM to 6:00 AM. There appears to be a hesitance on the part of government to reduce light levels, because of the safety problems that could be created by reduced light levels.

   This also creates a discussion of which strategy to implement: Strategy 1.) Turn off every other fixture, or Strategy 2.) Develop some form of hybrid multilevel switching control system. Strategy 1 will create inconsistent light levels which are less desirous than low light levels, and Strategy 2 will be expensive to implement. The best overall option may be to look to the Texas Department of Transportation for some kind of sanctioned guidelines for these types of applications.

h. Ownership of Street Lighting Systems: In many cases, the local Electric Utility actually owns the street lighting system, and therefore, there is no benefit to the utility of increasing their cost by installing a more expensive lighting system that uses less energy (reduces revenues). In addition, in many of these situations, the monthly energy use for street lighting is billed to the local government based on an "estimate" instead of metered data. In some of these cases, it could actually increase the monthly utility bills.

   The best alternative in these cases would most likely be to encourage the installation of new energy efficient systems in new construction and not in retrofits.

5. Technology Transfer to Other Local Governments

Austin Energy is recognized as an industry leader in the fields of demand side management, energy conservation, and innovative programs. As such, government and private sector companies from our state, our country, and

other parts of the world regularly inquire about our experiences with different strategies and types of emerging technologies. Therefore, the information obtained through this study can have far reaching effects when shared with the contacts AE makes on an annual basis.

This report can be used by other entities as a source of technical information and direction for the implementation of alternative street lighting systems, and to further their research into the effects of the color of light in low light levels.

The information contained in this report can be presented by AE at various meetings and conferences around the state, and the slides can be used to create presentations for other organizations. The fixture manufacturer is currently seeking the opportunity to present this study at the AEE GLOBALCON Conference in the spring of 2008.

6. Conclusions

a. In many situations, HPS and MH to fluorescent retrofits may be cost-effective, but this is most likely to the cases where the end-user owns, operates, and maintains the lighting system.

b. Implementation of an HPS and MH to fluorescent technology swap will require a paradigm shift on the part of the utilities, maintenance staff, end-users, and manufacturers.

   i. Local electric utilities will most likely require some type of incentive program or legislation due to the cost difference (2 to 3 times higher on average) in the new fluorescent technology.

   ii. Maintenance staff, regardless of whether they are end-user or utility based, will need to accept the new equipment and differences in servicing the fixtures

   iii. The end-users will need to be willing to pay more for the equipment and possibly more for maintenance in some cases.

   iv. The manufacturers will best serve the industry by reducing the number of small parts in the fixtures, designing better more universal mounting and leveling systems, and developing more fixture and lamp combinations to provide suitable light levels options for different applications.

c. The use of high Color Rendering Index light sources with Correlated Color Temperatures in the 4100° K to 6500° K appear to be more effective and use less energy to provide illumination.

d. Street lighting that operates effectively in the mesopic range can be used to lower lamp wattages by ~30%.

e. The subjects surveyed perceived the parking lots lit with HPS and fluorescent fixtures with good illuminance and spatial distribution of the fixtures, to be safe and well lit. The fact that the light levels were lower in the parking lots with fluorescent lights did not affect this perception because of the effect on mesopic sight.

f. The survey indicates that Color Rendering is much better under the fluorescent light sources than under the HPS.

g. The testing and use of light sources that operate in the mesopic spectral range show great promise for the future. We should continue to test fluorescent, LED, induction, and other similar light sources to determine the best light sources for specific applications.

A Demonstration of Fluorescent Outdoor Lighting in Austin, Texas

Fluorescent Outdoor Lighting

The goals of this study

- Determine the feasibility of replacing High Pressure Sodium (HPS) Outdoor Lighting with Fluorescent Outdoor Lighting.
- Evaluate the potential energy savings and environmental benefits of using Fluorescent Lighting

Fluorescent Outdoor Lighting

The goals of this study continued

- Investigate how fluorescent and HPS lights interact with mesopic sight (in low light levels).
- Evaluate the lighting performance of fluorescent vs. HPS.
- Evaluate the economics of fluorescent vs. HPS.

Fluorescent Outdoor Lighting

The goals of this study continued

- Investigate how the public reacts to HPS and fluorescent lighting systems.
- Develop recommendations for proper applications of fluorescent vs. HPS.

Fluorescent Outdoor Lighting

Traditional Outdoor Lighting

- Mercury Vapor – Lumen depreciation and color shift
- Incandescent – Low efficacy and short life
- Metal Halide – Lumen depreciation and color shift
- High Pressure Sodium – Some lumen depreciation and poor color rendering
- Low Pressure Sodium – Very poor color rendering

Fluorescent Outdoor Lighting

Traditional Outdoor Lighting

- 250 Watt High Pressure Sodium (HPS)
  - + Lamp Life 30,000 hours (Vertical)
  - + Not sensitive to ambient temperature
  - + Good-Fair lumen maintenance (Lamp specific)
  - + High Lumens-per-watt (Efficacy)
  - – Traditional fixtures can create a high percentage of glare

Fluorescent Outdoor Lighting

Traditional Outdoor Lighting

- 250 Watt High Pressure Sodium – continued
  - Low Color Rendering Index (22)
  - Low Correlated Color Temperature (2100° Kelvin)
  - Long re-strike cycle
  - Difficult to identify colors under HPS

Fluorescent Outdoor Lighting

New Technologies for Outdoor Lighting

- Fluorescent
  - + High Color Rendering Index (82+)
  - + Good Correlated Color Temperature (4100° to 6500° Kelvin)
  - + Lamp Life 24,000 to 30,000 hours (Vertical or Horizontal)

Fluorescent Outdoor Lighting

New Technologies for Outdoor Lighting

- Fluorescent
  - + Less glare than HPS
  - + Instant re-strike cycle
  - + Easy to identify colors
  - – Sensitive to ambient temperature

Fluorescent Outdoor Lighting

Other New Technologies for Outdoor Lighting

- Fluorescent
- Light Emitting Diodes (LEDs)
- Neon (Cold Cathode)
- Future Evaluations
  - More LEDs
  - Induction

Fluorescent Outdoor Lighting

The Photopic Spectrum

- How we see in full light like daylight
- Uses “cones” in the eye
- Maximum sensitivity of 555 nanometers
- Green-yellow-red color range

Fluorescent Outdoor Lighting

The Scotopic Spectrum

- How we see in the dark
- Uses “rods” in the eye
- Maximum sensitivity of 507 nanometers
- Blue-green color range

Fluorescent Outdoor Lighting

The Photopic and Scotopic Spectrums

Figure 1a –Photopic Spectrum

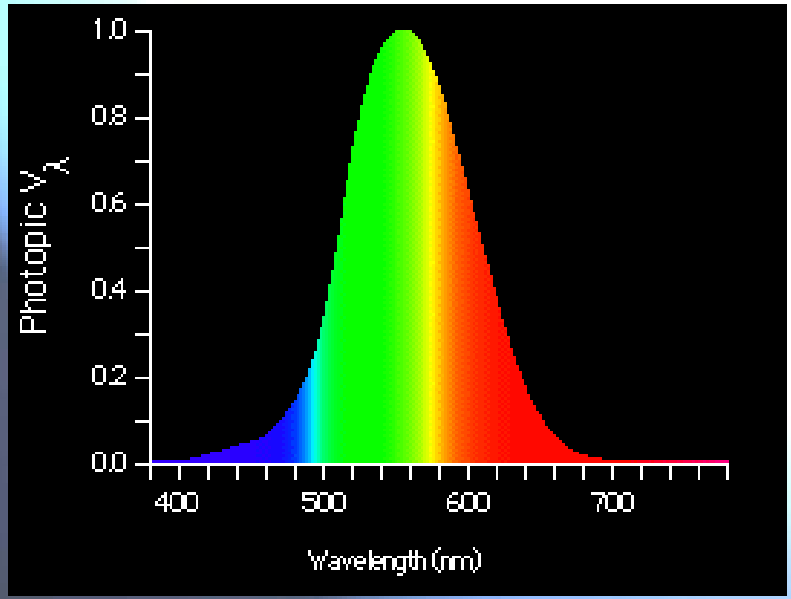
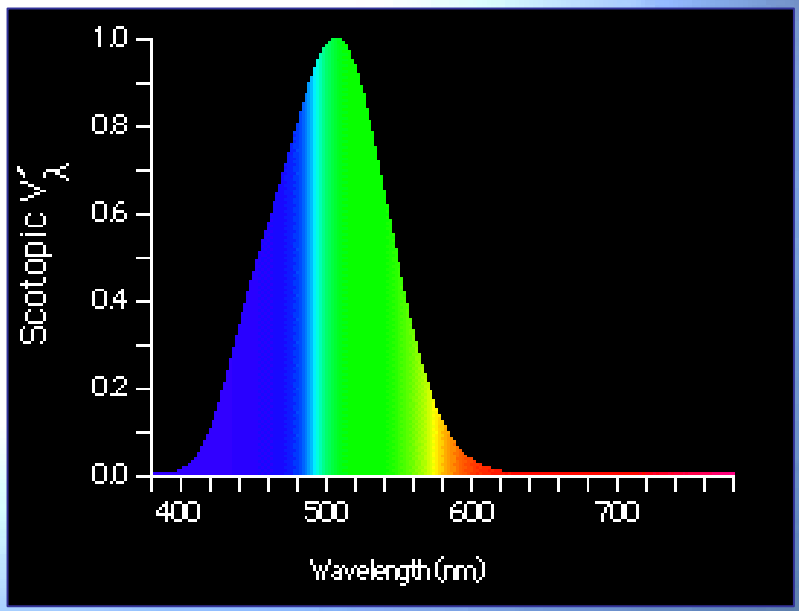


Figure 1b – Scotopic Spectrum



Courtesy of MAGNARAY INTERNATIONAL, Inc.

Fluorescent Outdoor Lighting

The Mesopic Spectrum

- A transition zone between twilight and normal interior light levels
- Uses both rods and cones
- Most acceptable at Correlated Color Temperatures (CCT) of 4100 to 6500° Kelvin
- Most effective at ~13,000° Kelvin, but very green in color

Fluorescent Outdoor Lighting

Light and Color Temperature

Most Effective Mesopic Range

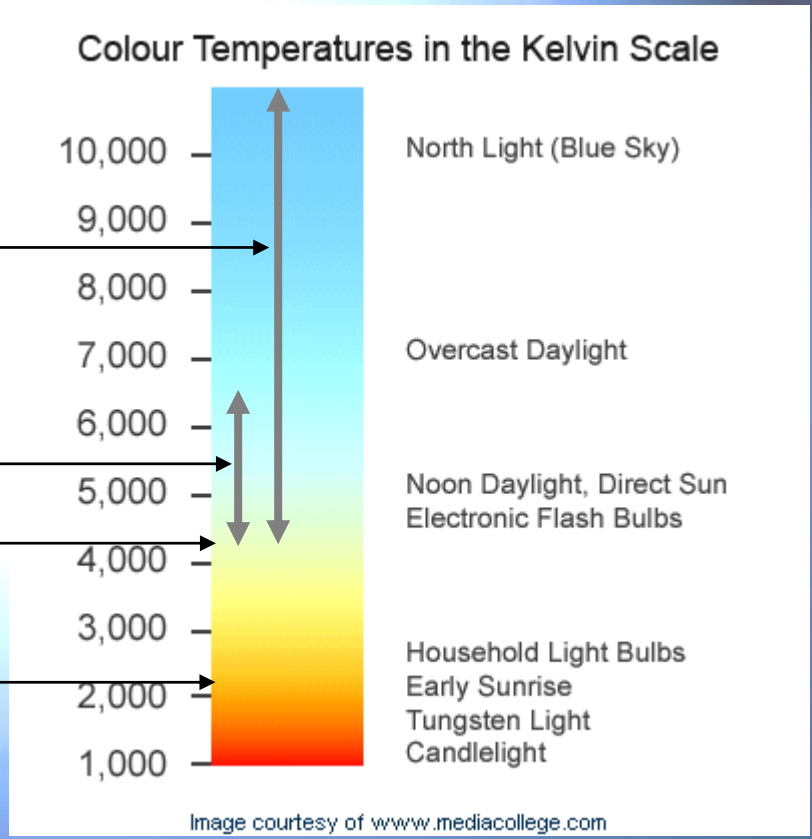
4100° K (low) to 13000° K (best)

Most Acceptable Mesopic Range

4100° K to 6500° K

Fluorescent Test Lighting – 4100° K

Traditional HPS Lighting – 2100° K



Fluorescent Outdoor Lighting

HPS vs. Fluorescent in the Mesopic Spectrum

Figure 4a – Traditional HPS Fixtures

Figure 4b – Fluorescent Test Fixtures

Courtesy of MAGNARAY INTERNATIONAL, Inc. and Marine Corp Base Hawaii (MCBH).

Fluorescent Outdoor Lighting

The Test Fixture

MAGNARAY International “W” Series 2-lamp Fixture

2-50 Watt Fluorescent Lamps with electronic ballast = 106 Watts/fixture

Fluorescent Outdoor Lighting

The Test Sites

- The 900 block of West Avenue
  - 1 City Block
- 301 West Avenue
  - Parking Lot
- 200 South Lamar
  - Parking Lot and Drive

Fluorescent Outdoor Lighting

The Test Conditions

- Fixtures allowed to burn-in for over 1 year
- Ambient Temperature of 75° to 85° F
- Light levels measured in May 2007
- Surveys taken (human perceptions) September of 2007

Fluorescent Outdoor Lighting

Fluorescent Streetlight Test

900 Block of West Avenue

Existing High Pressure Sodium

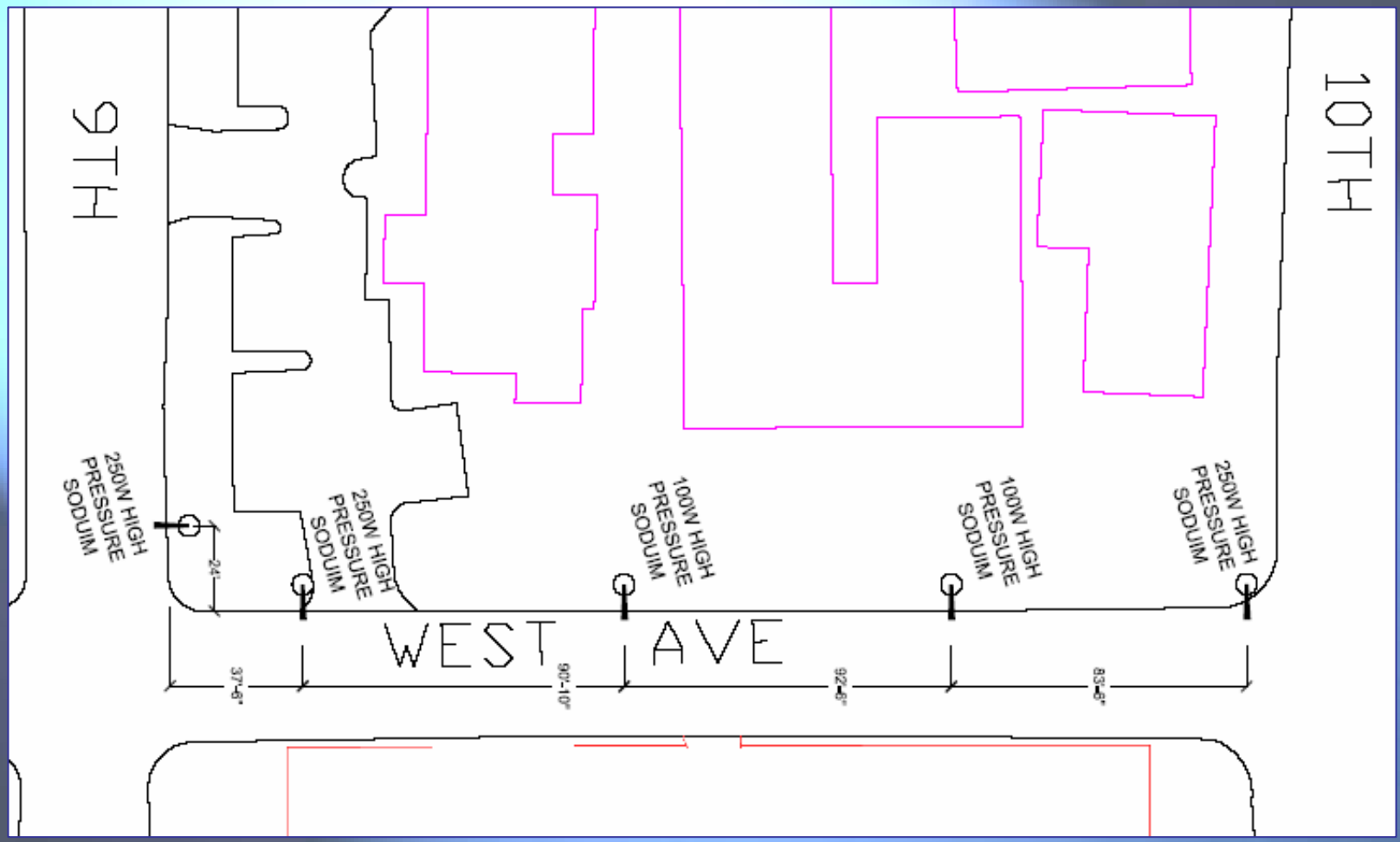
New Fluorescent

Existing 3-250 Watt HPS = 885 Watts (@295 Watts/Ea)
Existing 2-100 Watt HPS = 250 Watts (@125 Watts/Ea)
Existing Total 1,135 Watts

New 5-100 Watt Fluor = 530 Watts (@106 Watts/Ea)
Reduction = 605 Watts

A 53% Reduction

Fluorescent Outdoor Lighting



900 Block of West Avenue

Fluorescent Outdoor Lighting

900 Block of West Avenue looking South

Fluorescent Outdoor Lighting

Fluorescent Parking Lot Test

301 West Avenue

Existing High Pressure Sodium

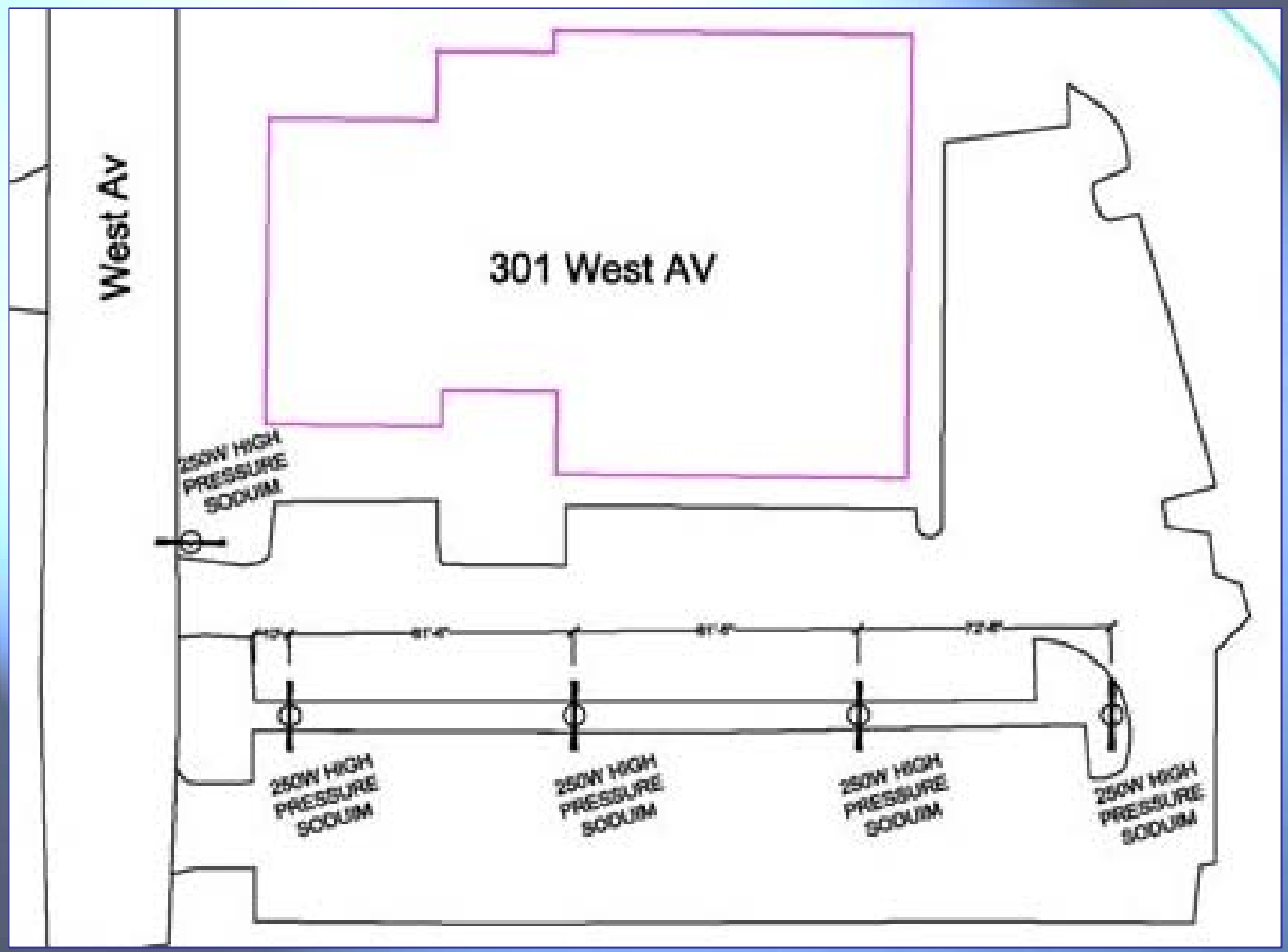
New Fluorescent

Existing 8-250 Watt HPS = 2,360 Watts (@295 Watts/Ea)

New 8-100 Watt Fluor = 848 Watts (@106 Watts/Ea)
Reduction = 1,512 Watts

A 64% Reduction

Fluorescent Outdoor Lighting



Parking Lot at 301 West Avenue

Fluorescent Outdoor Lighting

Parking Lot at 301 West Avenue with HPS Installed

Fluorescent Outdoor Lighting

Parking Lot at 301 West Avenue with test fixtures installed

Fluorescent Outdoor Lighting

Fluorescent Streetlight Test

200 South Lamar (W. Riverside)

Existing High Pressure Sodium

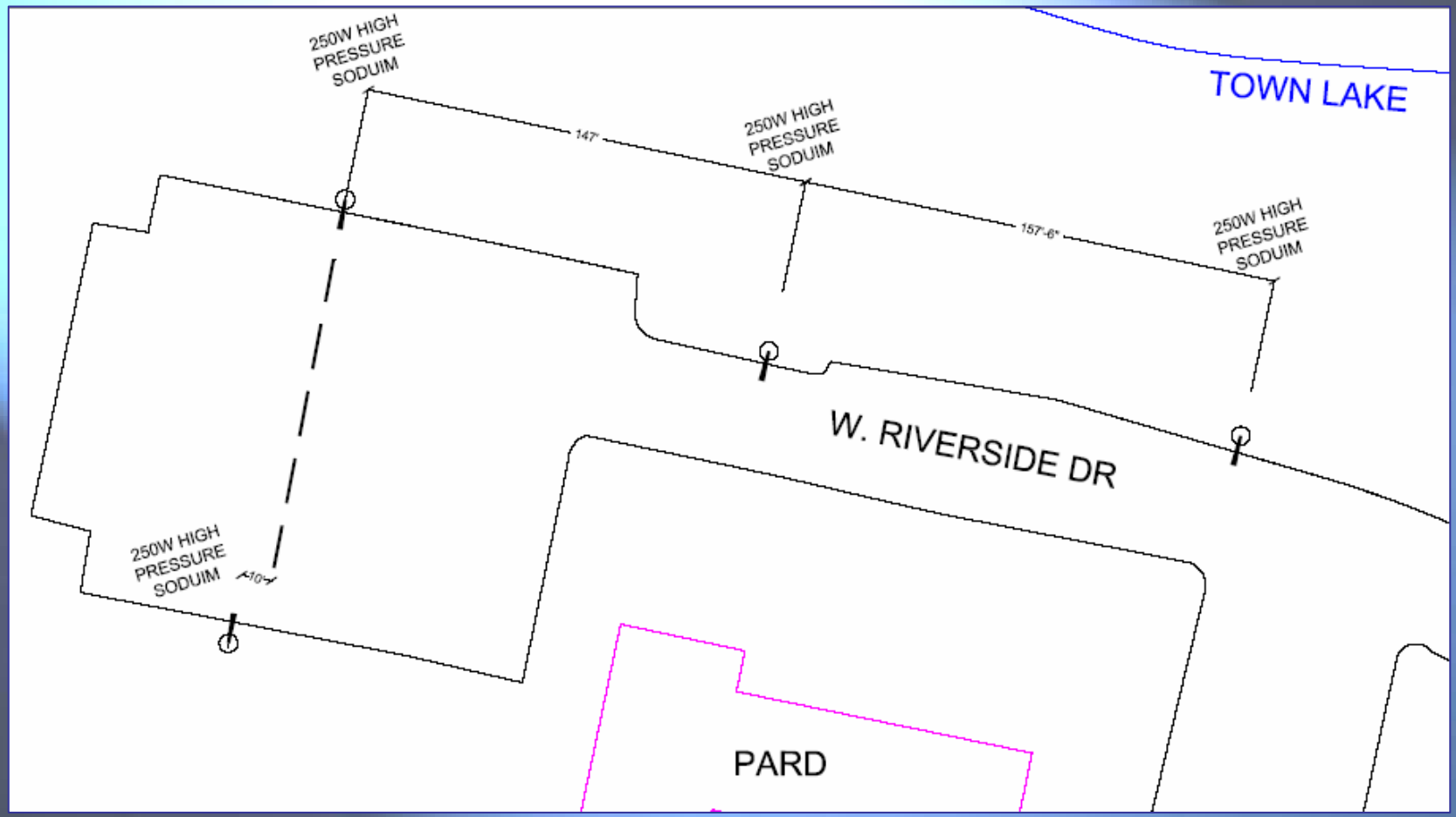
New Fluorescent

Existing 5-250 Watt HPS = 1,475 Watts (@295 Watts/Ea)
Existing Total 1,475 Watts

New 5-100 Watt Fluor = 530 Watts (@106 Watts/Ea)
Reduction = 945 Watts

A 64% Reduction

Fluorescent Outdoor Lighting



200 South Lamar – W. Riverside

Fluorescent Outdoor Lighting

200 South Lamar – W. Riverside with test fixtures installed

Fluorescent Outdoor Lighting

Survey Results

- The survey participants felt safe and secure in parking lots with high illuminance and good spatial light distribution. (HPS and Fluorescent)
- The survey participants felt unsafe in parking lots with low illuminance and poor spatial light distribution. (HPS and Fluorescent)

Fluorescent Outdoor Lighting

Survey Results - continued

- A good example of security lighting.
- Color rendering is better.
- Looks better than other portions of the street.

Fluorescent Outdoor Lighting

Potential Market Opportunities

- Street Lighting
- Parking Lots
- Parking Garages
- Dark Sky Applications
- Wildlife “Friendly” Applications

Fluorescent Outdoor Lighting

Table 1 – Fluorescent Lighting Replacement Guidelines

High Pressure Sodium Technology			Fluorescent Technology			
Fixture Type	**CCT***	**Wattage**	**Fixture Type**	**CCT***	**Wattage**	**Wattage Reduced**
70-watt HPS	2100° K	96 watts	1, 50-watt Fluorescent	6500° K	53 watts	45 %
100-watt HPS	2100° K	125 watts	1, 70-watt Fluorescent	6500° K	75 watts	40 %
250-watt HPS	2100° K	295 watts	2, 50-watt Fluorescent	6500° K	106 watts	64 %

CCT* Correlated Color Temperature measured in degrees Kelvin

The guidelines above are for example and testing purposes only. Austin Energy recommends following the exterior and roadway lighting guidelines established by the IESNA as a minimum.

Fluorescent Outdoor Lighting

Economic Analysis

Energy rate: $0.04844/kWh

1 - Dual lamp fluorescent fixture:

$260.00/fixture + 2 lamps @ 19.77 + $150 labor = $449.54

Wattage: 106 watts

1 - Single Lamp HPS Cobra head style fixture:

$80.00/fixture + 1 lamp non-cycling lamp @ 53.73 + $150 labor = $283.73

Wattage: 300 watts

Annual Burn hours used: 4100

Source: “Demonstration and Evaluation of Fluorescent Outdoor Lighting in the City of Austin, Texas”, by the Lighting Research Center, Rensselaer Polytechnic Institute, Troy New York (LRC).

Fluorescent Outdoor Lighting

Economic Analysis

- Retrofit –
  - Pays back in ~11.6 years
- New Construction
  - Incremental cost of the upgrade pays back in ~ 3.5 years.

Source: “Demonstration and Evaluation of Fluorescent Outdoor Lighting in the City of Austin, Texas”, by the Lighting Research Center, Rensselaer Polytechnic Institute, Troy New York (LRC).

Fluorescent Outdoor Lighting

Table 2 – Estimates of Potential Savings for Fluorescent Replacements

High Pressure Sodium Technology			Fluorescent Technology			
Fixture Type	**Wattage**	**kWh/Mo[1]**	**Fixture Type**	**Wattage**	**kWh/Mo[2]**	**Annual kWh Reduced**
70-watt HPS	96 watts	35 kWh	1, 50-watt Fluorescent	53 watts	21 kWh	168 kWh/Yr
100-watt HPS	125 watts	40 kWh	1, 70-watt Fluorescent	75 watts	30 kWh	120 kWh/Yr
250-watt HPS	295 watts	100 kWh	2, 50-watt Fluorescent	106 watts	42 kWh	696 kWh/Yr

kWh/Mo[1] - This column represents the flat rate of monthly kWh charged by some of the utilities in Texas. Austin Energy's estimates are slightly lower.

kWh/Mo[2] - The monthly kWh listed in this column represent estimates based on the best available information.

Fluorescent Outdoor Lighting

Barriers to Implementation

- First Cost
  - Fluorescent fixtures are 2 to 3 times the cost of traditional HPS fixtures.
  - The incremental cost (in new construction) of fluorescent fixtures vs. HPS is more acceptable.

Fluorescent Outdoor Lighting

Barriers to Implementation

- Availability
  - There are a small number of fluorescent street lighting manufacturers.
  - There may not be appropriate solutions for all applications.

Fluorescent Outdoor Lighting

Barriers to Implementation

- Installation and Maintenance
  - Fixtures are still in the prototype stage.
  - Not as easy to install and maintain as traditional fixtures.*

* Fixture designs are being modified to resolve some of these issues.

Fluorescent Outdoor Lighting

Barriers to Implementation

- Installation and Maintenance - continued
  - Institutional bias and resistance to change
  - Two lamps to maintain instead of one.

Fluorescent Outdoor Lighting

Barriers to Implementation

- Lamp Cost and Average Rated Life
  - The City of Austin pays less for one (1) 100-watt or 250-watt HPS than they do for one (1) 50-watt long PL Fluorescent lamp
  - The average rated lamp life of a 50-watt Long PL is shorter than a 100-watt or 250-watt HPS lamp

Fluorescent Outdoor Lighting

Barriers to Implementation

- Lamp Cost and Average Rated Life
  - There will be more fluorescent lamps in the new fixtures than the existing HPS fixtures. This increases the maintenance by increasing the number of components to be maintained.

Fluorescent Outdoor Lighting

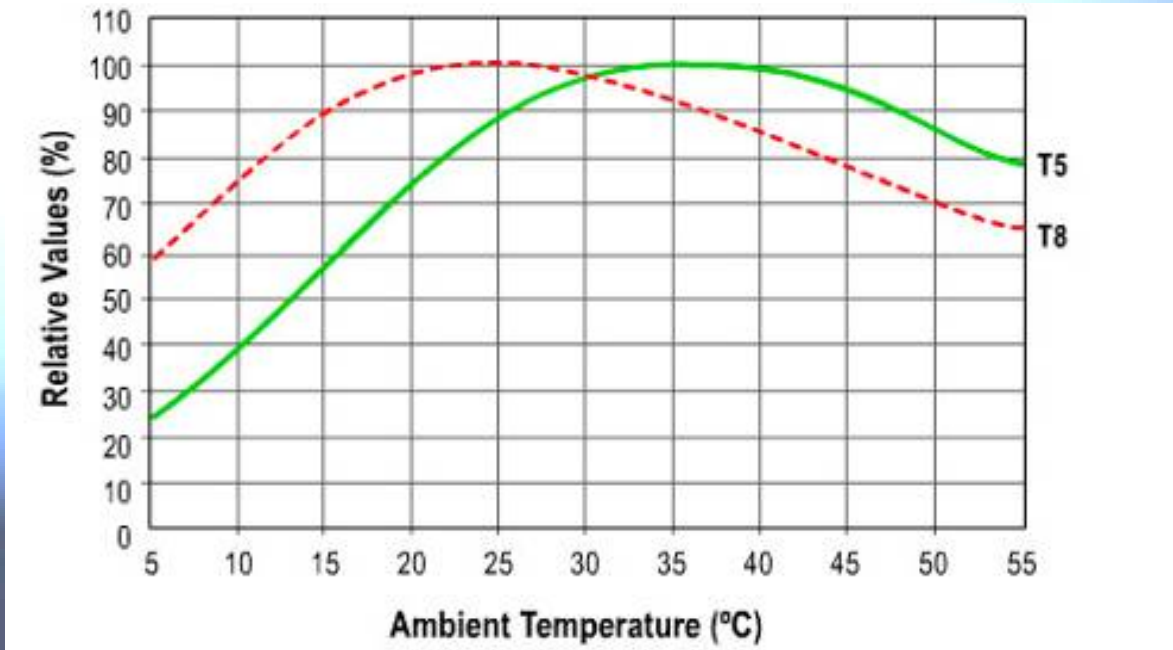
Barriers to Implementation

- Lamp Lumen Depreciation
  - Fluorescent lamps are sensitive to ambient temperature, and light output is reduced as the ambient temperature moves outside the optimum operating temperature range

Fluorescent Outdoor Lighting

Barriers to Implementation

The Effects of Ambient Temperature on Fluorescent Lighting



This diagram is quoted from SILHOUETTE T5, T5 HO & T5 Circular Fluorescent Lamp Technology Guide, Philips Lighting Company.

Fluorescent Outdoor Lighting

Barriers to Implementation

- Over Current Protection
  - Many traditional Street Lights use a 15 amp inline fuse for over current protection, but electronic fluorescent ballasts need a .75 amp substitute.
  - A street light compatible .75 amp inline fuse may be difficult to locate and is an added cost.

Fluorescent Outdoor Lighting

Barriers to Implementation

- Over Current Protection - continued
  - Maintenance staff are hesitant to implement .75 amp fuses, because some fixtures are being fed directly from “the grid”.

Fluorescent Outdoor Lighting

Barriers to Implementation

- Safety
  - Accepted lighting guidelines have not caught up with the state of technology.
  - Fixtures could be dual switched for low traffic hours, but officials are hesitant to accept the liability.
  - May require action by entities like TXDOT

Fluorescent Outdoor Lighting

Barriers to Implementation

- Ownership of Street Lighting Systems
  - Many Street Lighting systems in Texas are owned by the local Electric Utility.
  - There is no incentive for Electric Utilities to pay more for fixtures that will reduce their revenues, and could increase their maintenance cost.

Fluorescent Outdoor Lighting

Technology Transfer to Other Municipalities

- Austin Energy will transfer this information to other organizations by:
  - Public contacts, networking, and long-standing relationships with other organizations.
  - Requests for program information as an industry leader in energy conservation and environmental programs.

Fluorescent Outdoor Lighting

Technology Transfer to Other Municipalities

- Austin Energy will transfer this information to other organizations by: (continued)
  - The fixture manufacturer is giving a presentation at the Association of Energy Engineers GLOBALCON in March 2008.

Fluorescent Outdoor Lighting

Conclusions

- Fluorescent Street Lighting could be most cost effective when:
  - Owned, operated, and maintained by the end-user
  - The electric consumption is metered (not estimated)
  - Included in new construction

Fluorescent Outdoor Lighting

Conclusions

- Successful retrofits from HPS and MH to fluorescent will require paradigm shifts by:
  - Local Electric Utilities
  - Maintenance Staff
  - End-users
  - Manufacturers

Fluorescent Outdoor Lighting

Conclusions

- High Color Rendering Index light sources with Correlated Color Temperatures in the 4100° to 6500° K range, appear to provide more usable illumination for less energy.

Fluorescent Outdoor Lighting

Conclusions

- Street Lighting that operates effectively in the Mesopic range may allow lamp wattages to be reduced 30% or more.

Fluorescent Outdoor Lighting

Conclusions

- Participants surveyed perceived that lighting layout and spatial distribution was more important than the light source.

Fluorescent Outdoor Lighting

Conclusions

- Color Rendering is much better with fluorescent light sources than HPS.
- The testing and use of light sources that perform well in the mesopic range show great promise for the future.

Fluorescent Outdoor Lighting

Conclusions

- We should continue to test fluorescent, LED, induction, and other similar light sources to determine the best light sources for specific applications.

Fluorescent Outdoor Lighting

Thank You

Demonstration and Evaluation of Fluorescent Outdoor Lighting in the City of Austin, Texas

(Purchase Contract PC 110SS000379)

Prepared by:

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Rensselaer Polytechnic Institute
Troy, New York

For:

Austin Energy

November 30, 2007

Lighting Research Center

Rensselaer

Executive Summary

Can a fluorescent outdoor lighting system with lower wattage and light output replace a high-pressure sodium (HPS) outdoor lighting system and provide equal or greater perceptions of safety and security? If so, when and where should this fluorescent lighting system be used? The Lighting Research Center conducted research that investigated these questions in the context of three installations within the City of Austin, Texas: 100-watt fluorescent lighting systems that replaced a mix of 100-watt HPS and 250 watt HPS lighting systems on one block of street lighting; and 100-watt fluorescent lighting systems that replaced 250-watt HPS lighting systems in two parking lots.

The 100-watt fluorescent lighting systems consisted of two 50-watt T5 twin-tube fluorescent lamps with a correlated color temperature of 4100 K. The selection of the replacement lamps and lighting fixtures was made by Austin Energy and Magnaray® International. The use of the Lighting Research Center's Unified Photometry System* was not considered in the selection of the replacement fluorescent lamps for this project. However, the use of 4100 K CCT lamps moves in the correct direction toward optimizing lighting applications for vision at low light levels. Since the fluorescent lighting systems were already in place prior to the commencement of this research project, before and after installation surveys could not be administered to compare the two different lighting systems within the same environment. Because of this situation, HPS lighting installations similar to the fluorescent installations were found and used for comparison purposes. The street block and parking lots with HPS lighting were similar but not exactly the same as their counterpart installations utilizing the fluorescent lighting. The light levels and the spatial distribution of the light were not the same.

A phone survey of residents living on or near West Avenue between 9th and 11th Streets was conducted to collect residents' perceptions of visibility, safety, security, brightness, and color rendering regarding the fluorescent street lighting between 9th and 10th Streets and the HPS street lighting between 10th and 11th Streets. Only five completed surveys were received. This low number of responses allowed for minimum analysis to be performed. Therefore, the Lighting Research Center used results from other mesopic (low light level) street lighting research to develop recommendations for Austin Energy street lighting. Previous LRC research has shown that white lamp sources tuned to optimize mesopic vision (6500 K CCT) can provide similar or better perceptions of visibility, safety, security, and brightness with approximately 30% lower wattage than HPS lamps.

The Austin Energy use of 250 watt HPS for roadway intersections on West Avenue provides illuminance values within the intersection that far exceed Illuminating Engineering Society of North America recommendations. Because of this over lighting situation, Austin Energy has an opportunity to replace the 250 watt HPS with any of the

* The Unified Photometry System is a means of predicting visibility under low light conditions. The system considers the light level and spectral (color) range of an electric light source and how these factors assist human vision.

following options all of which will meet the IESNA illuminance recommendations or the unified photometry system for equal visual performance.

- 150 watt HPS at 2100 K CCT
- 100 watt HPS at 2100K CCT
- 2, 50 watt T5 twin tube Fluorescent at 4100K CCT
- 70 watt fluorescing light source at 6500K CCT

Parking lot lighting was evaluated using 15 subjects who visited the two fluorescent-lighted and two HPS-lighted parking lots three times each. The fluorescent lighting installation evaluations took place at Energy Control Center, which had high illuminance, and Parks and Recreation Headquarters, which had low illuminance. The HPS lighting installation evaluations took place at Gillis Park, which had high illuminance, and South Austin Community Health Center, which had low illuminance. To ensure there were actual similarities in perceptions of safety and security within the two sets of parking lots (high illuminance lots and low illuminance lots), study participants first rated their perceptions of safety and security during daylight hours and again in darkness with the parking lot lights turned off. The results of these surveys were similar in terms of people's perceptions of safety and security for each set of parking lots, without the influence of the parking lot lighting. Therefore, they could be successfully used as a comparison set.

A follow-on parking lot survey measured subjects' perceptions of brightness, safety, security, and color rendering for each of the four parking lot lighting systems and designs. By comparing the results of the surveys for each set of parking lots, the LRC could determine whether the fluorescent lighting system offered any advantages over the standard HPS lighting systems.

For the high illuminance level parking lots (Gillis and the Energy Control Center), subjects' perceptions of safety and security were found to be similar, regardless of the lamp spectral distribution. The perception of brightness also appeared to be similar according to the subjects, regardless of the light source. However, subjects' perceptions of color rendering seemed to slightly favor the fluorescent light source.

The low illuminance parking lot comparison indicated that subjects' perceptions of safety, security, and brightness were similar for both the fluorescent and HPS light sources. However, the results were essentially all negative: Both parking lots were perceived as having poor safety, security, and brightness. The spatial distribution of light within these parking lots was poor and the low illuminance levels added to the perception of poor safety. Preferences for color rendering appeared to favor the fluorescent light source.

In conclusion, a fluorescent lighting system with two 50-watt T5 twin tubes can replace a 250-watt high-pressure sodium system in parking lots while maintaining people's perceptions of safety and security. The cost effectiveness of installing the fluorescent lighting system for new parking lot lighting projects is a simple payback of 3.5 years.

Retrofitting existing high-pressure sodium systems requires a payback of 11.6 years. (please see details on page 36)

The following are recommendations for street and parking lot lighting:

- Using a fluorescing white lamp source tuned to optimize mesopic vision (6500 K CCT) offers opportunities to reduce lamp wattages by 30% from the HPS lamp it would replace without negatively impacting people's perceptions of visibility, safety, or security. Austin Energy should consider a program of replacing 100-watt HPS streetlights with a fluorescing lamp source of around 70 watts, and 70-watt HPS streetlights with a fluorescing lamp source of approximately 50 watts.
- Metal halide (even ceramic metal halide) used in street lighting has some serious shortcomings, including shorter lamp life (20,000 hours) than HPS (30,000 hours) and higher lumen depreciation over the life of the lamp. These shortcomings cause the LRC to be concerned in recommending the use of metal halide as a replacement for HPS. The added maintenance costs will more than offset any energy savings, causing higher total costs for Austin Energy.
- Parking lot lighting design should strive to provide average horizontal illuminance values greater than 10 lux, with good spatial light distribution to ensure high degrees of perceived safety and security. The use of the Illuminating Engineering Society of North America's guideline RP-20 for the design of parking lot lighting is encouraged.
- Strive to utilize lamps in outdoor lighting installations that are spectrally closer to maximizing mesopic vision within the white light range at 6500 K CCT.[1]
- Other fluorescing light sources, such as electrodeless (induction) lamps, should be explored beyond the T5 twin tubes. Electrodeless lamps provide longer lamp life, which could reduce maintenance costs. This exploration should occur prior to Austin Energy deciding to convert any outdoor lighting from HPS. An economic analysis such as presented in this report can be used to determine the cost effectiveness of all HPS replacement options.
- Based on the Unified Photometry System[3], properly designed parking lot lighting systems can reduce lamp wattage by approximately 30% while maintaining visual performance if the light source is tuned at 6500K CCT to maximize mesopic vision within the white light range.
- The use of the Unified Photometry System to determine replacement wattages of lamps with different spectral distributions that will provide similar visibility is encouraged. Austin Energy can examine replacing HPS wattages other than 250 watts for both street and parking lot lighting by using this system. Once replacement lamps are selected, an economic analysis can be performed to determine if a reasonable payback is possible.

Introduction

The Lighting Research Center (LRC) conducts research, demonstrations and evaluations regarding human vision under low light (mesopic) conditions. Mesopic lighting conditions occur at night in areas with lighting such as what is found with many street and area lighting systems. How humans see under this condition is very different than how humans see during the day or in lit buildings (photopic conditions) and how humans see at night in unlit spaces (scotopic conditions).

The human vision system has two types of receptors in the retina, cones and rods, to transmit visual signals to the brain. The current system of determining the amount of light needed to perform a task, regardless of the time of day or lighting conditions, is based on how the eye's cones function. Cones are the dominant visual receptor under photopic (daylight) lighting conditions. Rods function primarily under dark conditions. Under mesopic lighting conditions, which are typically found outdoors at night, a combination of cones and rods perform the vision function. Therefore, outdoor electric light sources that are tuned to how humans see under mesopic lighting conditions can be used to reduce the luminance of the road surface while providing the same or better visibility. This light source must account for how both the cones and rods in the eye see. Light sources with shorter wavelengths, which produce a "cooler" (more blue and green) light, are needed to produce better mesopic vision.[1,2] Based on this understanding, the LRC developed a means of predicting visibility under low light conditions through comparing luminance levels and a lamp's scotopic-to-photopic spectral ratio. This system is called the Unified Photometry System.[3] It predicts degrees of visual performance and not perceptions of brightness. Perceptions of brightness are more associated with perceptions of ones safety and security.

Current photometry underestimates the effectiveness of lamps with relatively more short-wavelength output at mesopic light levels. The unified photometry system can more appropriately evaluate the effectiveness of lamps with various spectral power distributions (SPD) by providing "unified" luminance according to the light levels to which human eyes adapt.[1,3]

Table 1 shows photopic illuminance and relative electric power required to obtain criterion levels of off-axis visual performance when illuminated by various SPDs. As the light level decreases, the performance of high-pressure sodium (HPS) lamps, relative to other sources, is reduced. Conversely, metal halide (MH) and fluorescent lamps, which have more short-wavelength components, reduce their relative power requirements to meet criterion visual performance levels.

The LRC developed the unified photometry system based on a series of laboratory studies (He et al. 1997; He et al. 1998). Simulated driving studies verified the validity of the fundamental findings but found a difference in off-axis detection between MH and HPS lamps to be sometimes larger than would be predicted by the unified photometry

system (Bullough and Rea 2000; Lingard and Rea 2002). A recent field study to examine target detection by subjects driving along a closed track found that targets illuminated by MH lamps can be more quickly detected by the subjects than those made visible by HPS lamps (Akashi and Rea 2002). The results dramatically underscored the benefits of the unified photometry system.[4]

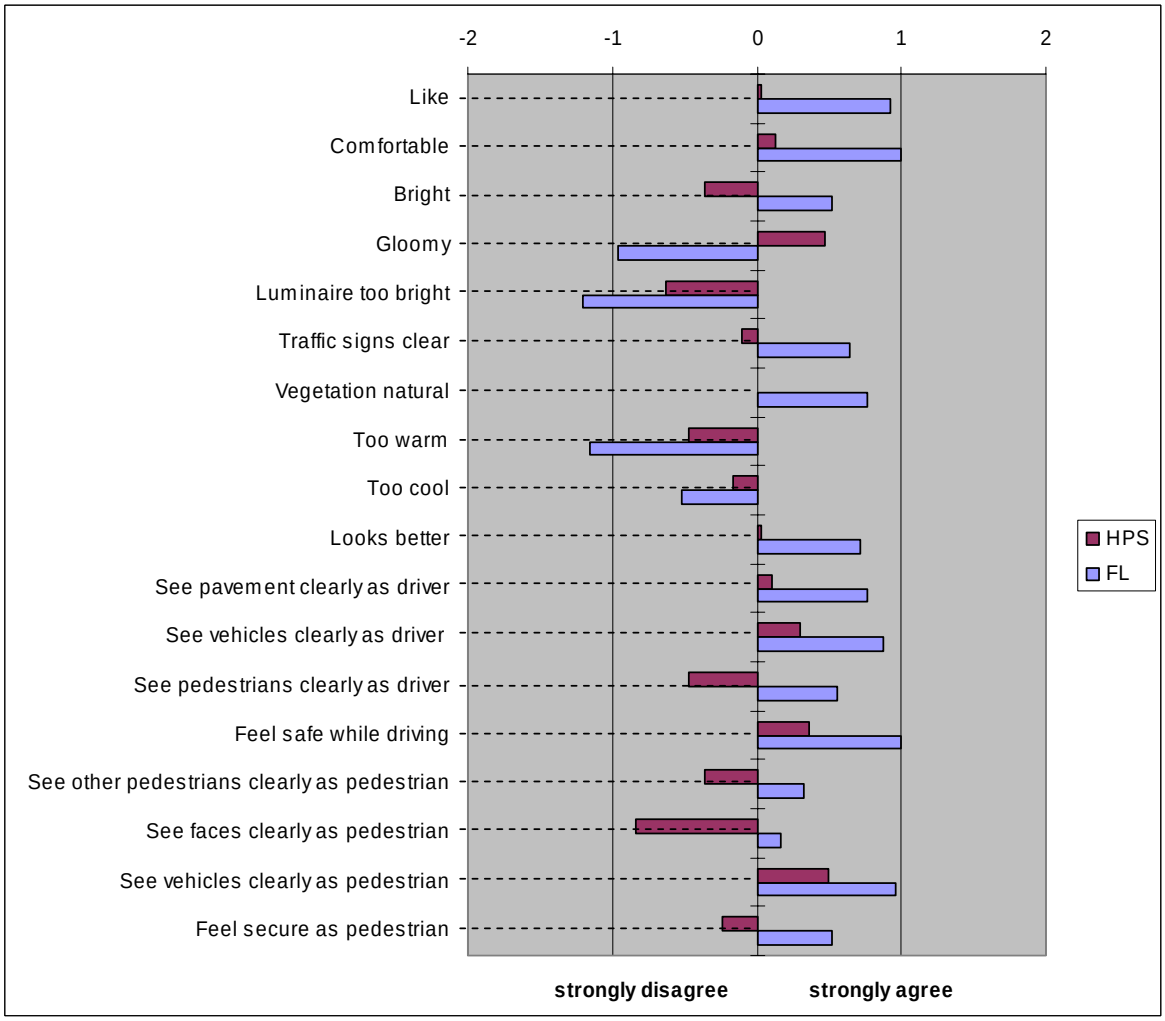
Table 1. Photopic illuminance and relative power required to obtain the same brightness perception and visibility of spaces and objects illuminated by various SPD lamps[4]

Light source	S/P ratio*	0.6 cd/m²		0.3 cd/m²		0.1 cd/m²	
		E (lx)**	Relative power***	E (lx)	Relative power	E(lx)	Relative power
400 W HPS	0.66	26.9	100%	13.5	100%	4.5	100%
1000 W incandescent	4.41	26.9	833%	10.5	648%	2.6	478%
3500 K fluorescent	1.44	26.9	130%	10.4	100%	2.5	73%
400 W MH	1.57	26.9	119%	10.0	88%	2.4	63%
5000 K fluorescent	1.97	26.9	130%	9.0	87%	1.9	57%
6500 K fluorescent	2.19	26.9	130%	8.5	82%	1.8	52%

* - S/P ratio: the ratio of scotopic lumens to photopic lumens of each lamp
** - E: illuminance measured in lux (lx)
***-Relative power (%) normalized to HPS

To prove the theory that a light source tuned to how humans see under low light conditions could provide the same or better visibility with lower luminance values, in 2004 the LRC conducted a comparison field study of 70-watt (84 watts with ballast) high-pressure sodium (HPS), semi-cutoff cobra head streetlight fixtures mounted on utility overhead distribution poles versus 50-watt (54 watts with ballast), 6500 K correlated color temperature (CCT) (a light source tuned to mesopic vision conditions), twin compact fluorescent lamps in a semi-cutoff fixture on a residential street in Easthampton, Massachusetts. The purpose of the experiment was to determine how well the residents saw objects while both driving and walking under the two different lighting conditions. Figure 1 below, which shows residents' responses to survey questions comparing fluorescent and HPS lighting, indicates a strong preference toward the fluorescent lighting for both driving and walking. People said they could see better and felt safer with lighting that used 30% less energy.[4] These data provided the basis for Austin Energy to conduct a demonstration and evaluation of a fluorescent outdoor lighting system with the belief that it would have a significant opportunity for success.

Figure 1: Streetlight Comparison Results, Easthampton, Massachusetts



To identify the potential benefits of fluorescent lighting for outdoor lighting applications within the City of Austin, Texas, Austin Energy (a municipal electric utility) and Magnaray® International (a lighting manufacturer) replaced conventional high-pressure sodium (HPS) luminaires (250 watts and 100 watts) on one street and in two parking lots in the City of Austin with luminaires consisting of two 50-watt, twin-tube, 4100 K CCT fluorescent lamps plus ballasts. Total wattage including the electronic ballast was 106 watts.[5] Input power was reduced 10% as compared to the 100 watt HPS and 65% when compared to the 250 watt HPS for streetlights and 65% for parking lots using the fluorescent lighting rather than HPS lighting. The selection of the replacement lamps and lighting fixtures was made by Austin Energy and Magnaray®. The use of the LRC's Unified Photometry System was not considered in the selection of the fluorescent replacement lamps for this project. However, the use of the 4100 K CCT lamps moves in the correct direction toward optimizing the lighting applications for mesopic vision.

Before proceeding with additional conversions of HPS outdoor lighting to fluorescent, Austin Energy wanted to ensure that true energy savings could be achieved while maintaining or improving public perception of brightness and the sense of security and safety. Therefore, this demonstration and evaluation of fluorescent outdoor lighting in the City of Austin was undertaken to compare the new fluorescent lighting installation to HPS lighting in order to develop guidelines of whether, where, and how fluorescent lighting can be implemented in the City of Austin. The LRC was contracted to conduct the evaluation and develop recommendations on the use of fluorescent outdoor lighting systems.

Project Goals

The goals of the "Demonstration and Evaluation of Fluorescent Outdoor Lighting in the City of Austin" project were to determine whether, where, and how fluorescent outdoor lighting could be implemented for the City of Austin while reducing energy needs by examining the current City of Austin fluorescent lighting installations and comparing results with other LRC outdoor lighting research and knowledge.

Research Methodology

Selection of Comparison Lighting Installations

The fluorescent street and parking lot lighting were installed prior to Austin Energy requesting an evaluation by the LRC of these sites. Therefore, conducting a before-installation survey of the original HPS outdoor lighting system to determine residents' and parking lot users' perceptions of brightness, safety, and security was not possible. The method chosen to compare the new fluorescent lighting systems to the original HPS systems was to select HPS outdoor lighting locations similar to those that were converted to the fluorescent systems. The location similarities most important were:

- uniformity or lack of uniformity of illuminance throughout the street or parking lot
- a perception of similar brightness
- illuminance levels that would be higher for the HPS lighting than the comparison fluorescent sites, but within the predictable range for mesopic lighting.

With assistance from Dennis Lilley of Austin Energy, who developed a list of potential comparison HPS lighting sites, personnel from the LRC visited each site, took illuminance measurements, and selected two parking lots and an adjacent block on the same street as the fluorescent street lighting for the comparison HPS sites. These HPS sites were deemed similar enough to the sites of the three fluorescent installations, based on the criteria above.

Street lighting comparison sites

The fluorescent streetlights were located on West Avenue on the block between 9th and 10th Streets. A similar block (approximately the same length, same number of streetlights, similar uniformity illuminance, and similar perception of brightness) with HPS street lighting was found on West Avenue between 10th and 11th Streets. This block was chosen as the comparison site. Illuminance measurements of both blocks confirmed their similar illuminance uniformity and levels.

Lamp and light fixture information for the street lighting is listed in Table 2 below. Photographs of each of the streetlight installations are shown in Figures 2 and 3.

Table 2: Streetlight Fixture Information

	West Avenue Between 9th and 10th Streets	West Avenue Between 10th and 11th Streets
Lamp Type	Fluorescent	HPS
Lamp Wattage[5,6]	2 lamps - 50 watts each	250 watts at intersections and 100 watts between intersections
CCT[5,6]	4100 K	2100 K
Fixture Type	Twin Magnaray® W Series[5]	Cobra Head
Number of Fixtures	4	4
Lighting Control	Photo cell	Photo cell
Mounting Height	25 feet	25 feet
Avg. Illuminance (lux)	8.94 lux	12.22 lux

Figure 2: West Avenue Between 9th and 10th Streets (Fluorescent lighting)

Figure 3: West Avenue Between 10th and 11th Streets (HPS lighting)

Parking lot lighting comparison sites

Gillis Park's HPS-lighted parking lot was chosen because it has high illuminance levels, is relatively uniform in its illuminance, and gives a perception of high brightness, as does its comparison fluorescent lighting site, the Energy Control Center parking lot. The South Austin Community Health Center's HPS-lighted parking lot was chosen because it has low average illuminance levels, is not uniform in its illuminance, and gives little perception of brightness. These conditions were also found at the selected comparison fluorescent lighting site, the Parks and Recreation Headquarters parking lot. Overall, the comparison parking lots were similar, but they did vary in spatial light distribution and illuminance.

Lamp and light fixture information is listed in Table 3 below for the four parking lots. Photographs of each of the parking lots are shown in Figures 4, 5, 6 and 7.

Table 3: Parking Lot Fixture Information

	Comparison 1		Comparison 2	
	Gillis Park	Energy Control Center	Parks and Rec Headquarters	South Austin Health Center
Lamp Type	HPS	Fluorescent	Fluorescent	HPS
Lamp Wattage[5,6]	250 watts	2 lamps - 50 watts each	2 lamps - 50 watts each	250 watts
CCT[5,6]	2100 K	4100 K	4100 K	2100 K
Fixture Type	Cobra Head	Twin Magnaray® W Series[5]	Twin Magnaray® W Series[5]	Shoebox
Number of Fixtures	5	8	2	2
Lighting Control	Photo Cell	Photo Cell	Photo Cell	Time Clock
Mounting Height	25 feet	25 feet	25 feet	20 feet
Avg. Illuminance (lux)	19.32 lux	11.36 lux	2.69 lux	5.36 lux

Figure 4: Gillis Park (HPS lighting)

Figure 5: Energy Control Center (Fluorescent lighting)

Figure 6: South Austin Health Clinic (HPS lighting)

Figure 7: Parks and Recreation Headquarters (Fluorescent lighting)

Light Illuminance Measurements

Illuminance measurements were taken by LRC personnel using a Hagner, model E2, illuminance meter calibrated against the LRC standard. For the street lighting on West Avenue, horizontal illuminance measurements were taken every 20 feet along the length and width of the road for the blocks between 9th and 10th Streets (fluorescent lighting) and 10th and 11th Streets (HPS lighting). For the parking lot lighting, horizontal illuminance measurements were taken every 30 feet along both the width and length of the Gillis Park and Parks and Recreation parking lots. Measurements were taken every 20 feet at the Energy Control Center and South Austin Community Health Center parking lots.

Figures 8 and 9 illustrate the illuminance levels and lighting uniformity of the two sections of street lighting on West Avenue.

Figure 8: West Avenue Between 9th and 10th Streets, Fluorescent Streetlights

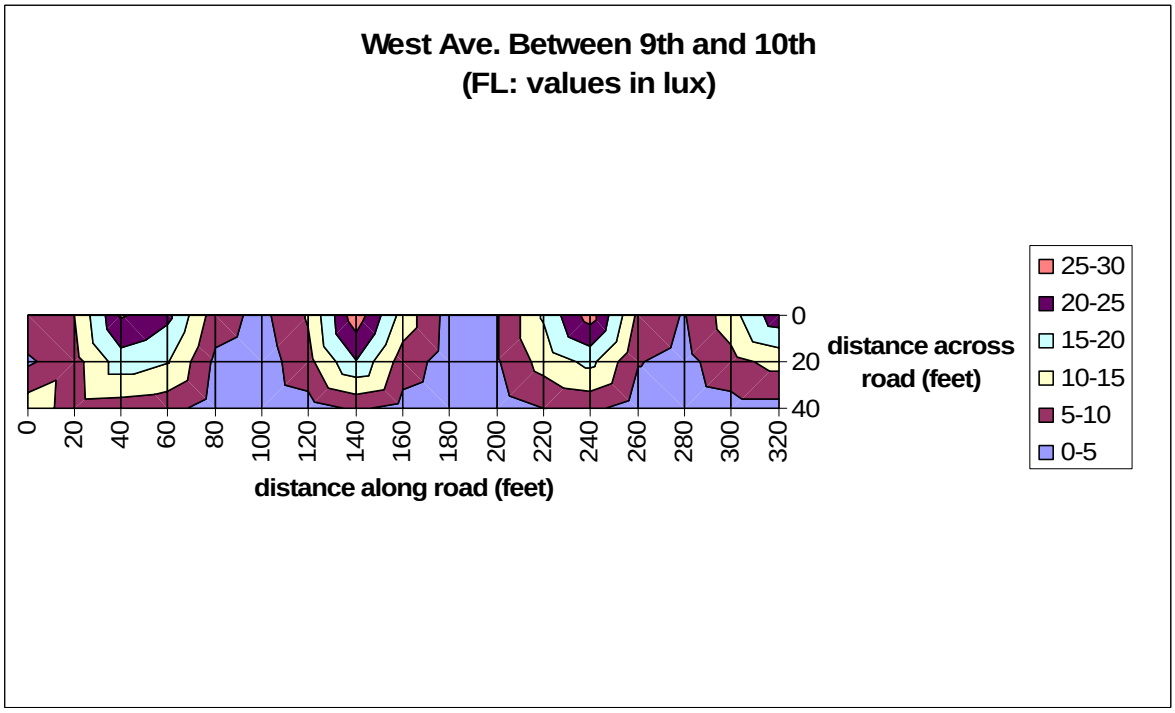
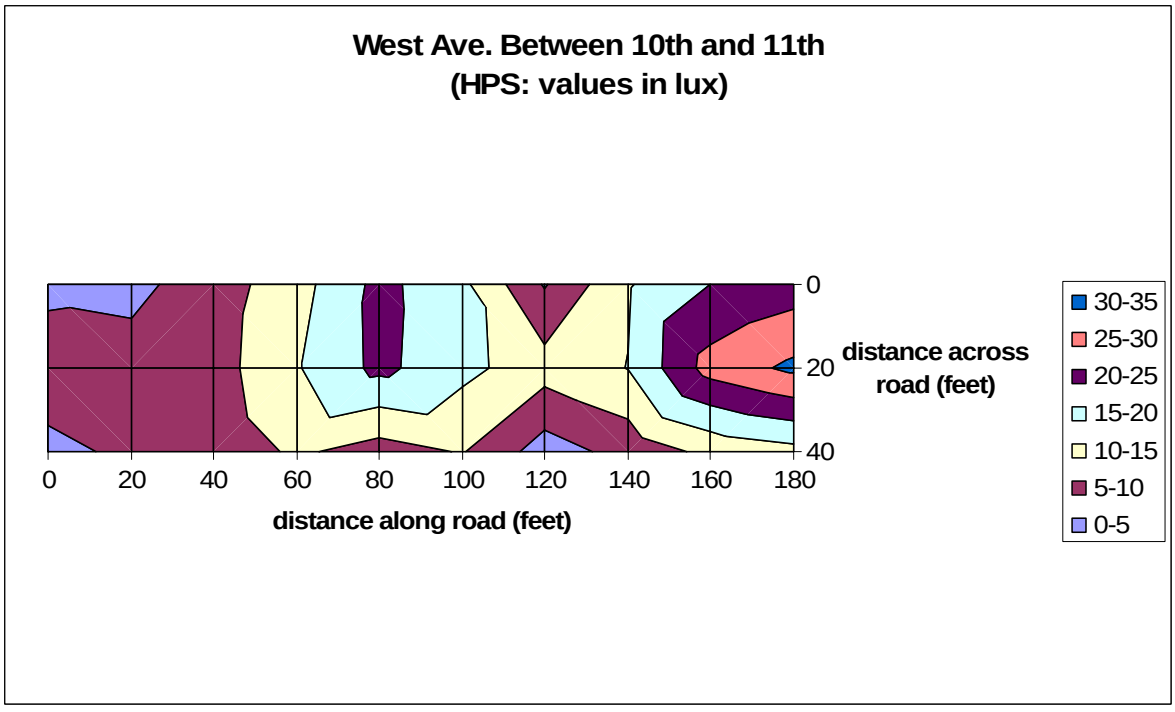


Figure 9: West Avenue Between 10th and 11th Streets, HPS Streetlights



Figures 10, 11, 12, and 13 illustrate the illuminance levels and lighting uniformity of each parking lot.

Figure 10: Gillis Park Illuminance Distribution (HPS lighting)

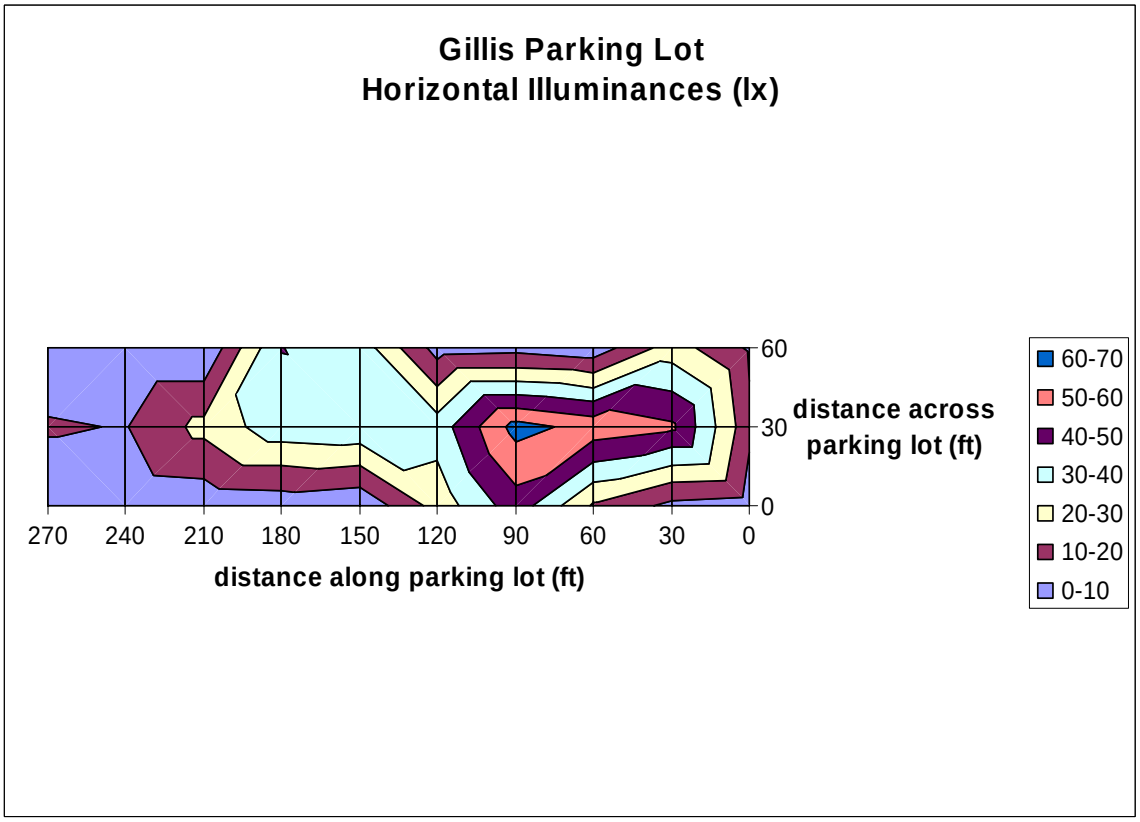
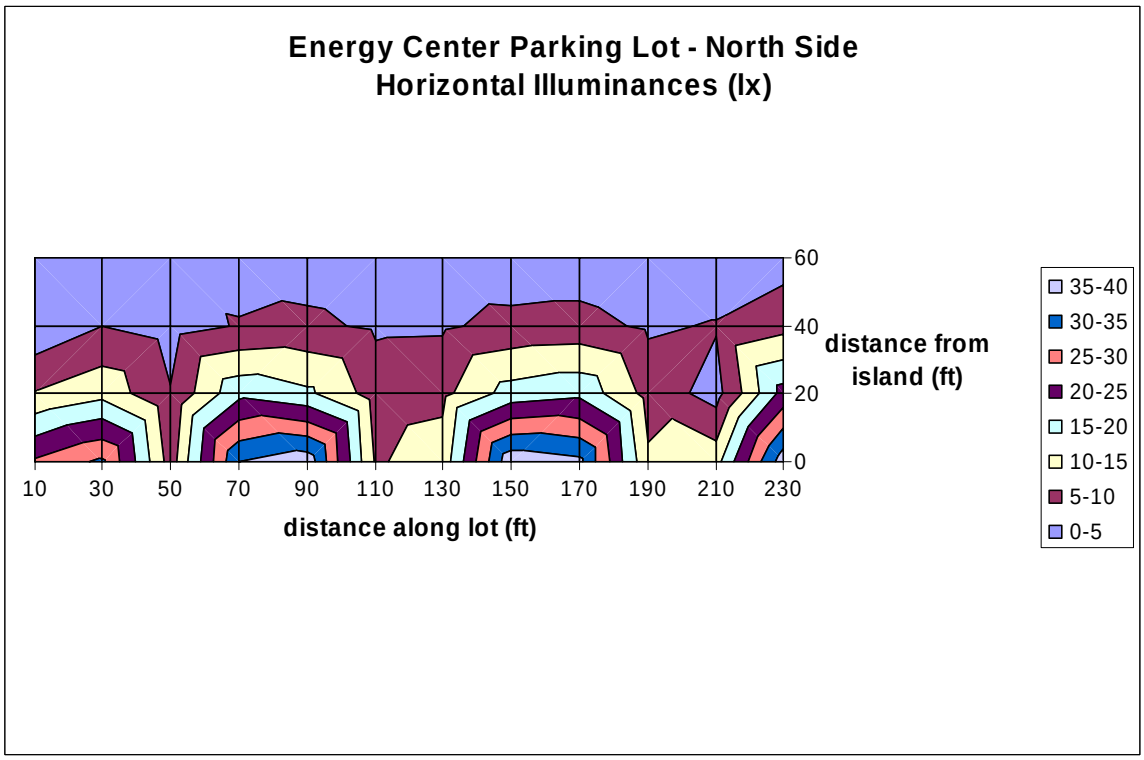


Figure 11a and 11b: Energy Control Center Illuminance Distribution (Fluorescent Lighting)



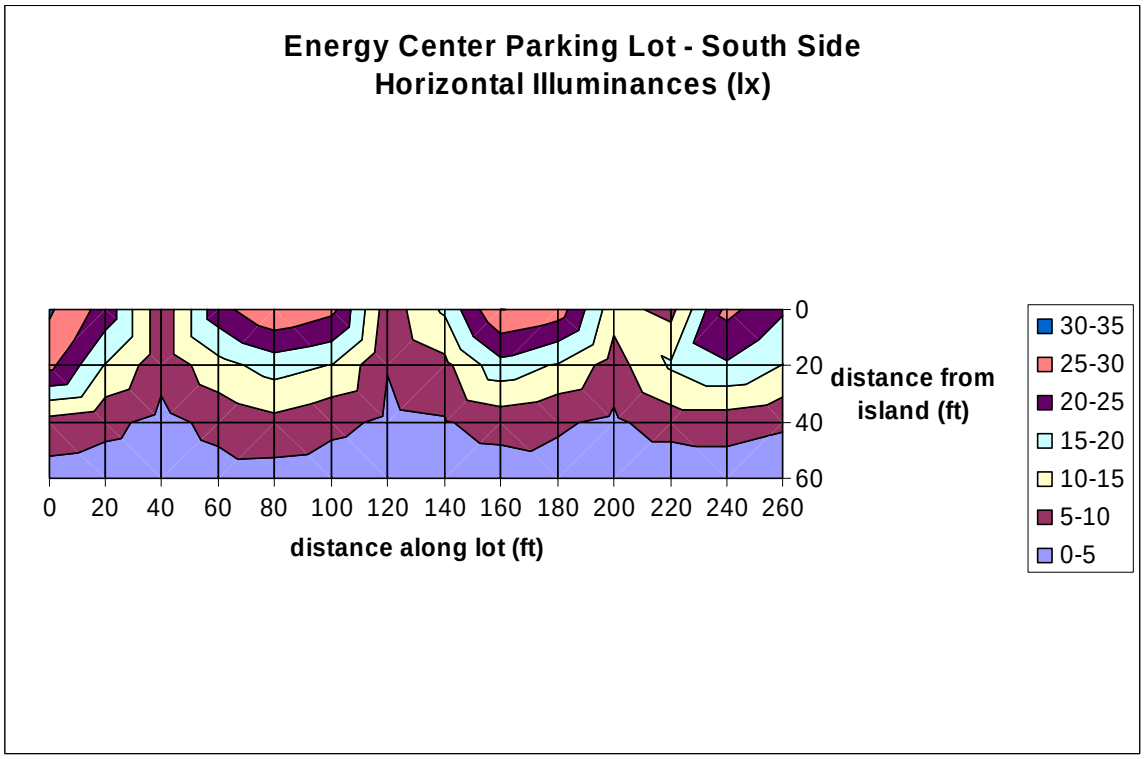
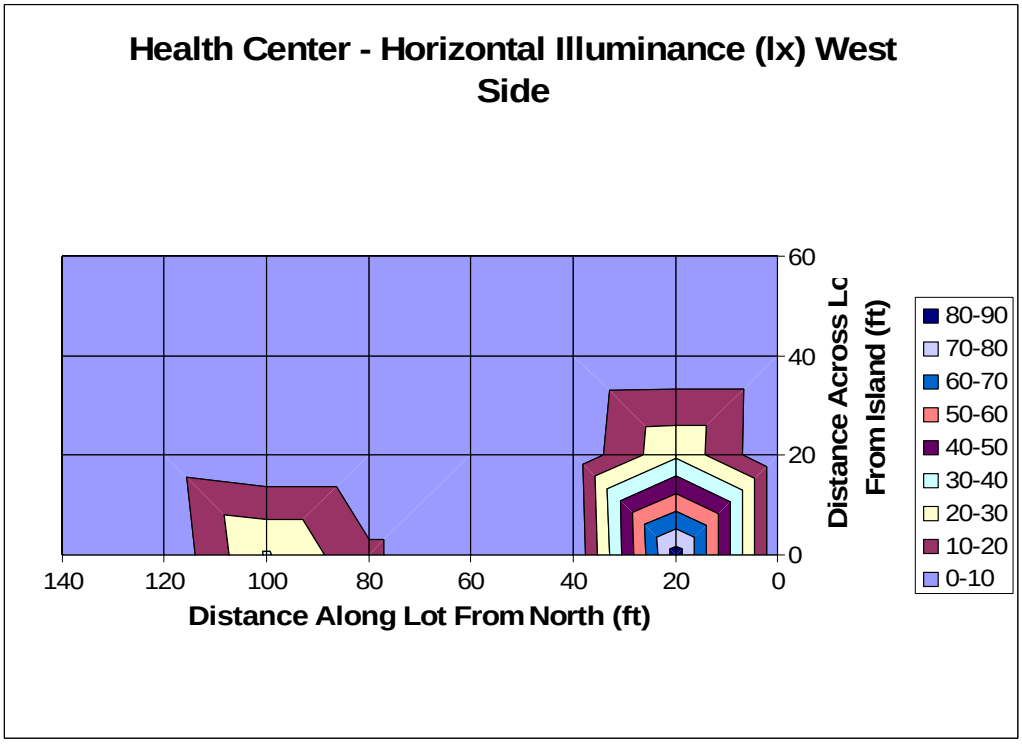


Figure 12a and 12b: South Austin Community Health Center Illuminance Distribution (HPS Lighting)



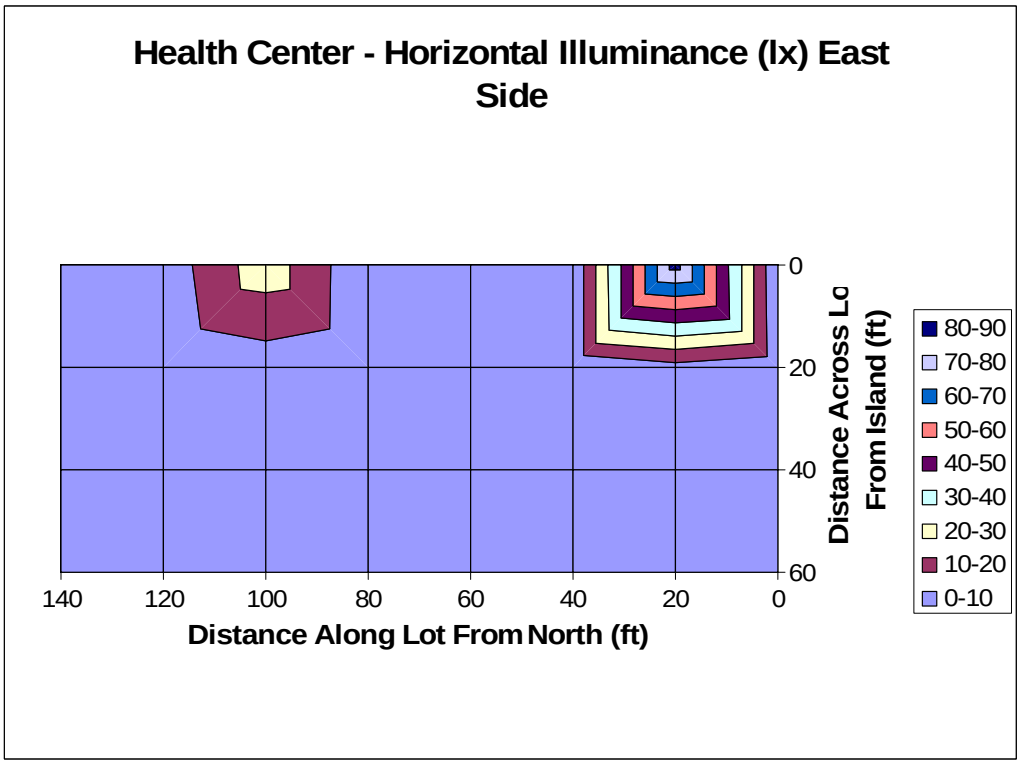
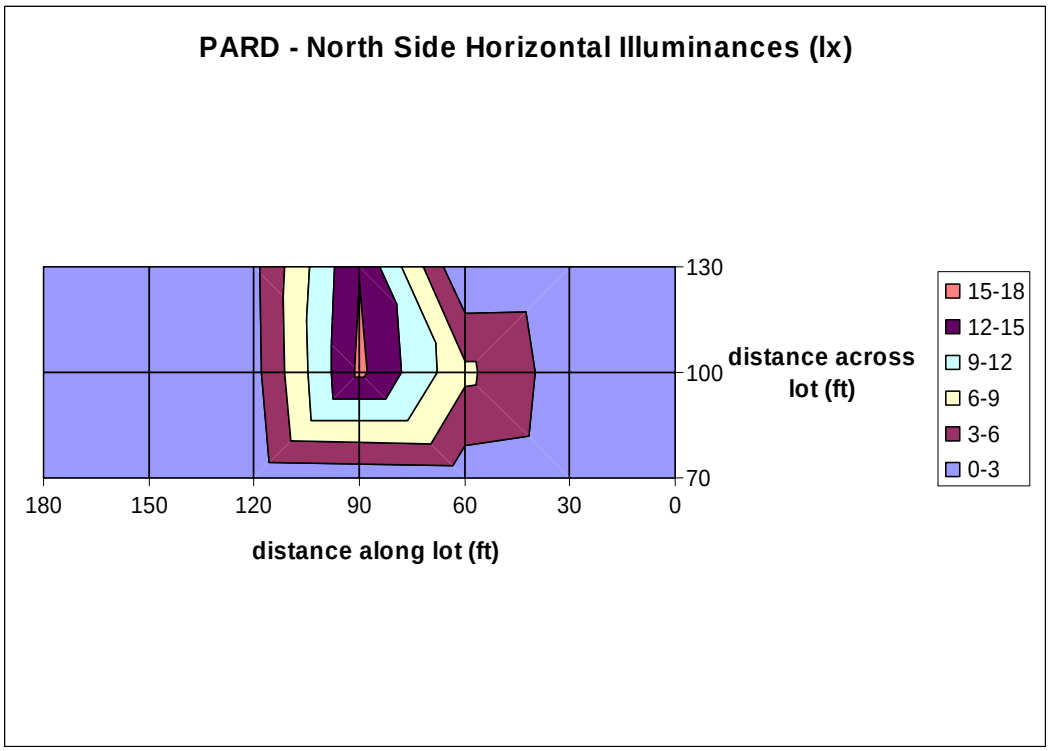
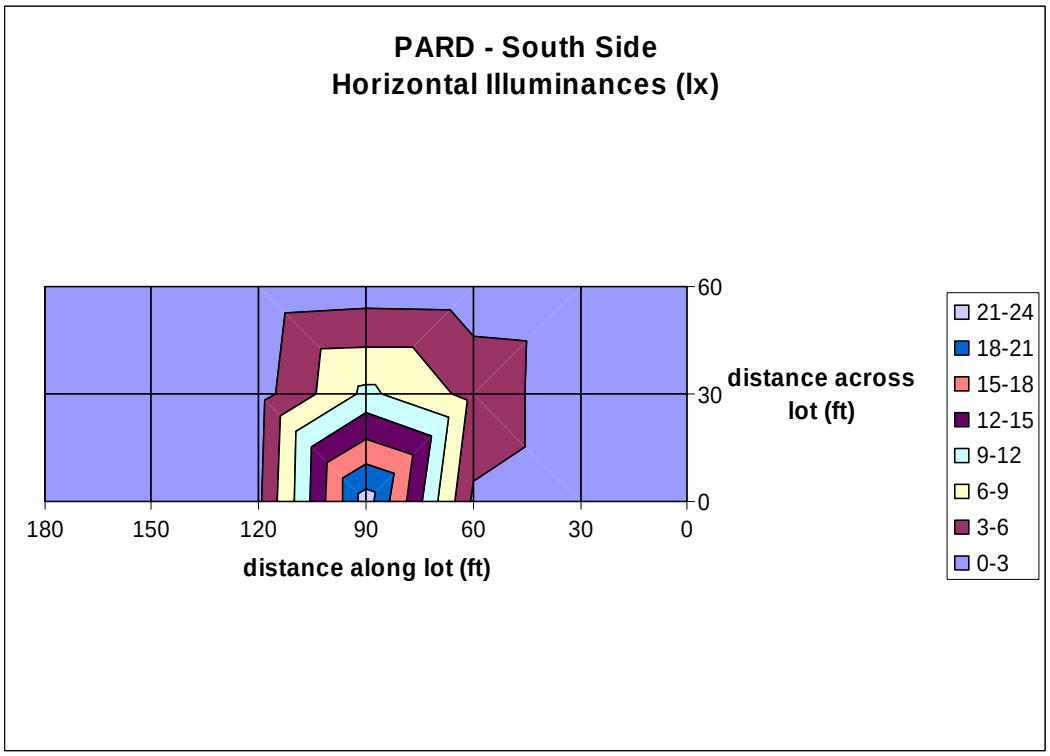


Figure 13a and 13b: Parks and Recreation Illuminance Distribution (Fluorescent lighting)





Street Lighting Evaluation Methodology

A phone survey of residents living on or near West Avenue between 9th and 11th Streets was conducted between September 24 and October 23, 2007, by Creative Consumer Research, a company hired by Austin Energy. Residents were first contacted to determine their acceptance to participating in the study. They were asked to observe the street lighting between 9th and 10th Streets and 10th and 11th Streets at night as both a driver and as a pedestrian for several days. Creative Consumer Research established a date and time to call back each participating resident to complete the survey questionnaire. Each resident who completed the survey was given a $10 gift certificate to a local supermarket. The questionnaire was developed by the LRC and reviewed and modified by Austin Energy and Creative Consumer Research to put it into a format that would be conducive to a phone survey. A copy of the questionnaire is included in Appendix A. Creative Consumer Research called participating residents back at the appointed time and obtained responses to each question. The questions were designed to ascertain residents' opinions of the two different streetlight systems, fluorescent and HPS, as it pertained to perceptions of visibility, brightness, safety, security, and color rendition.

Parking Lot Lighting Evaluation Methodology

A within-subject survey methodology was applied to compare the two sets of parking lots each having one HPS system and one fluorescent system. A group of 15 subjects was recruited through a market research company to participate in the survey. Each subject was paid a stipend of $125 if they completed all three surveys. The group consisted of eight males and seven females of varying ages and education. All resided within the Austin, Texas, metropolitan area. The subjects were driven to each site three times in the following order: during daylight hours, after darkness with the parking lot lights turned off, and after darkness with the parking lot lights on.

To ensure there were actual similarities in perceptions of safety and security within the two sets of parking lots (high illuminance and low illuminance), study participants first rated their perceptions of safety and security during daylight hours and then again in darkness with the parking lot lights turned off. The same survey was used for all parking lots during both the daylight and darkness-with-no-lights scenarios. A copy of the survey, which was developed by the LRC and reviewed by Austin Energy, is attached in Appendix B. If the results of these surveys were similar in their perceptions of safety and security for each set of parking lots without the influence of the parking lot lighting, then it could be said that the parking lots demonstrated similar characteristics and could be successfully used as a comparison set.

A follow-on survey developed by the LRC and reviewed by Austin Energy, which is included in Appendix C, measured the brightness, safety, security, and color rendering perceptions of the subjects for each of the four parking lot lighting systems and designs. By comparing the results of the surveys for each of the sets of parking lots (Gillis Park and the Energy Control Center, and the South Austin Community Health Center and the Parks

and Recreation Headquarters), the LRC could determine whether the fluorescent lighting system offered any advantages over the standard HPS lighting systems.

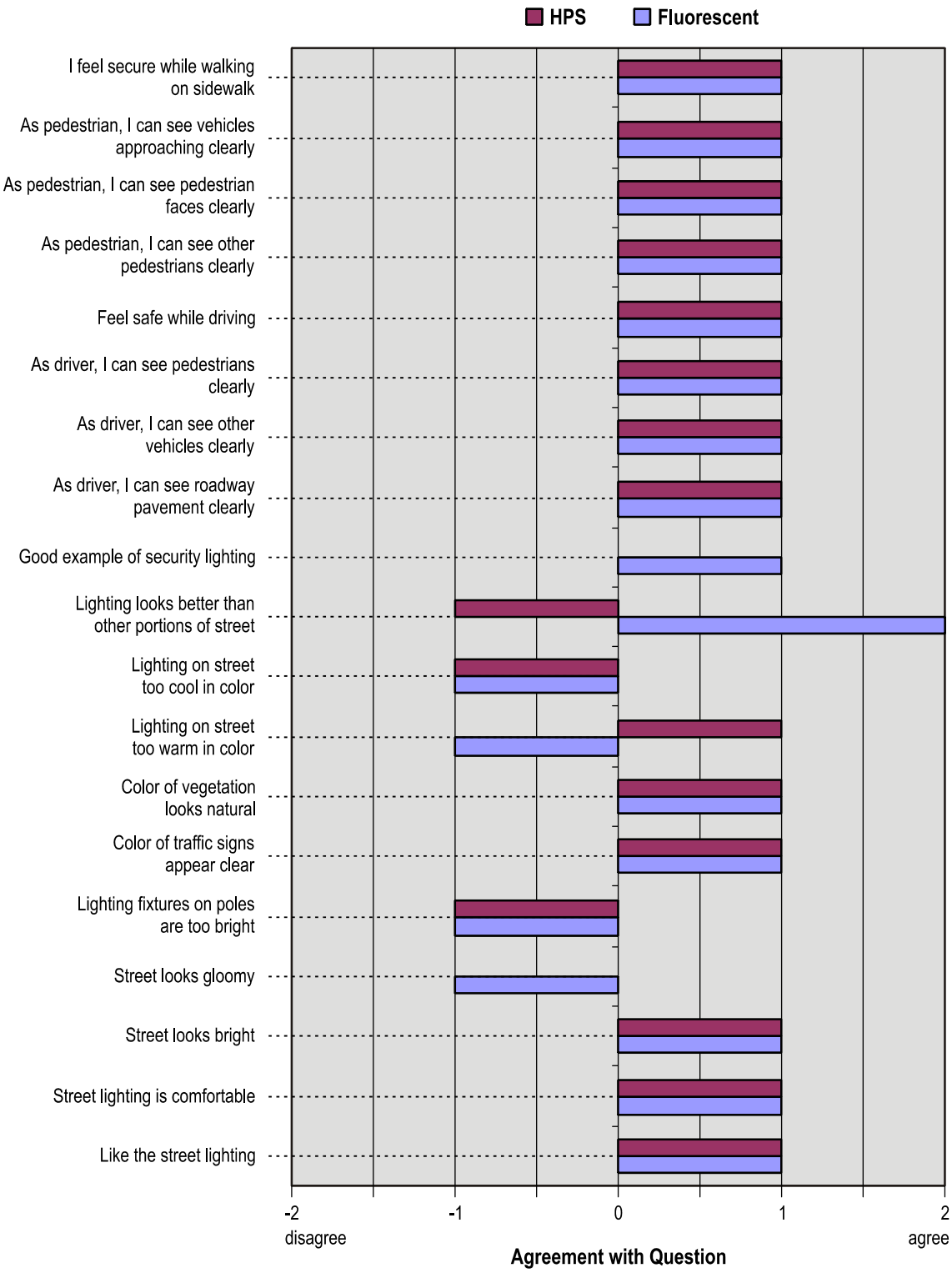
Research Results

Street Lighting Results

With only five completed surveys of perceptions of visibility, safety, security, brightness, and color rendering regarding the fluorescent and HPS street lighting on West Avenue, it is impossible to reach any statistically based conclusions. Therefore, the LRC will present the results of the five completed surveys with minimal analysis and will not draw any conclusions based on these data. However, the LRC has previously conducted street lighting research at three locations in the northeastern United States where fluorescing light sources or metal halide were utilized to replace HPS. The results of these research projects where sufficient data was received are presented below and conclusions and recommendations based on this research are made. The LRC believes the results of these research projects are applicable to Austin Energy.

Figure 14 below illustrates the results of comparing the fluorescent and HPS street lighting on West Avenue. Median (rather than average) values were used because of the limited responses. Average values could be skewed if question responses for only five participants are not clustered together. Graph bars tracking to the right toward the positive end of the scale indicate agreement with the survey statement, while bars tracking to the left toward the negative end of the scale indicate disagreement with the statement.

Figure 14: Street Lighting Systems Comparisons of Different Light Sources

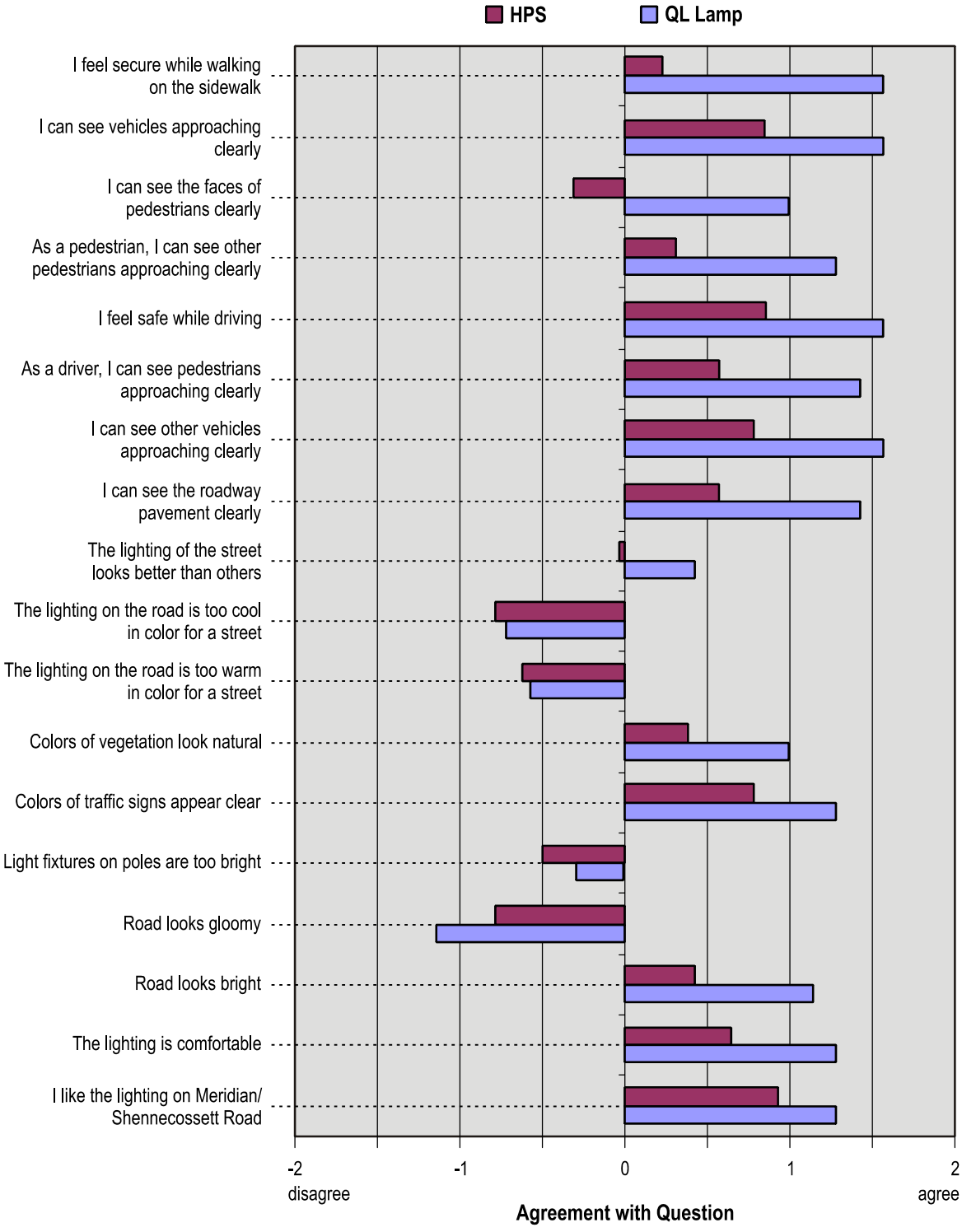


Based on the survey results, both the fluorescent and HPS street lighting on West Avenue had the same positive results for visibility, safety, and security. The greatest difference between the two light sources was found in responses to how the lighting looked. Subjects indicated that they believed the fluorescent streetlights looked better than the rest of the HPS street lighting on West Avenue.

Previous to the Austin street lighting study, the LRC conducted streetlight research into visibility, safety, security, brightness, and color rendering perceptions using different light sources with differing spectral distributions. One study was of street lighting in a residential neighborhood of Easthampton, Massachusetts. Residents were asked to rate the visibility, safety, security, brightness, and color rendering of the existing 70-watt HPS streetlights and then after the installation of 50-watt twin-tube fluorescent lamps and fixtures with a CCT of 6500 K. The 50-watt, 6500 K lamps were chosen based on equal visible performance, as predicted by the Unified Photometry System. As shown in Figure 1 above, the results indicated a strong preference as both a driver and pedestrian toward the fluorescent lighting. People said they could see better and felt safer with lighting that used 30% less energy.[4] The full study results are included in Appendix D.

A second study was conducted in Groton, Connecticut, where the existing 100-watt HPS streetlights were replaced with 55-watt induction lamps, 6500 K CCT, in a modified cobra head fixture along a street that could be considered a collector road under Illuminating Engineering Society of North America (IESNA) standards. These study results have not yet been published. However, the analysis of the survey results of residents' perceptions of visibility, safety, security, brightness, and color rendering is complete. Figure 15 presents the results of the comparison of the HPS and induction (QL Lamp) street lighting.

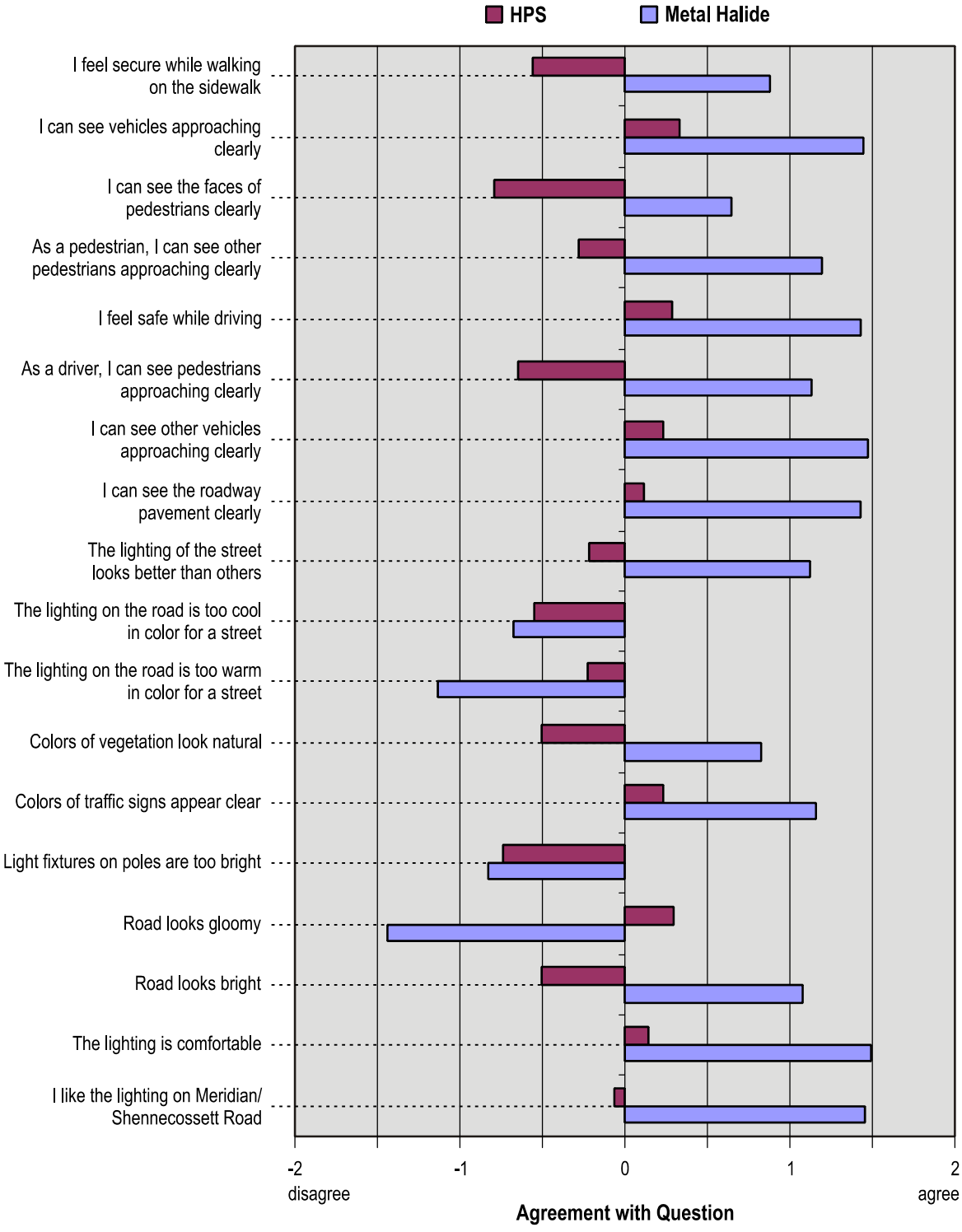
Figure 15: Streetlight Comparison Groton, CT: HPS and Induction



The results depicted in Figure 15 show a strong preference for the induction lamp at 6500 K CCT. Survey respondents indicated that they felt safer and could see better with the 55-watt induction lamp at 6500 K CCT than with the 100-watt HPS at 2100 K CCT. The 6500 K CCT was chosen because it matches optimum mesopic vision conditions.

A third street lighting research project, also located in Groton, Connecticut, compared the existing 100-watt HPS street lighting with 70-watt ceramic metal halide lighting at 4000 K CCT along another collector-type roadway. Figure 16 shows the results of residents' perceptions of visibility, safety, security, brightness, and color rendering when comparing the HPS system to the metal halide light sources. Again, the results from this study have not yet been published.

Figure 16: Streetlight Comparison Groton, CT: HPS and Metal Halide



These perception results are similar to those found in the Easthampton study with the 50-watt, 6500 K CCT fluorescent lighting, and the Groton study with the 55-watt, 6500 K CCT induction lamps. Residents favored the metal halide light source over the HPS.

As observed on West Avenue, Austin Energy uses 250 watt HPS streetlights at roadway intersections. There is also a second streetlight on the intersecting streets of West Avenue that is believed to be 100 watt HPS. These streetlights provide an average illuminance within the intersection of approximately 34 lux as determined through AGI 32 computer modeling of the intersection and its street lighting. IESNA, RP-8, Guide to Roadway Lighting, recommends an average illuminance value for intersections where a collector type road intersects with a local road and the pedestrian conflict is medium to be 16 lux. West Avenue is viewed as a collector road and the intersecting streets are considered local roads.

Currently, Austin Energy is over lighting these intersections by more than double the IESNA recommended illuminance levels. The recommended potential replacements for the 250 watt HPS at the intersections are based on providing sufficient lighting to meet the IESNA recommended practices or to meet the unified photometry system recommendations for mesopic street lighting to match or exceed the visual performance provided by 100 watt HPS lighting. The following are the recommended replacements for the 250 watt HPS intersection lighting.

- 150 watt HPS at 2100K CCT. This light source will still provide average illuminance values (24.6 lux) that exceed IESNA recommended levels.
- 100 watt HPS at 2100K CCT. This light source will provide close to the IESNA recommended levels of illuminance of 16 lux.
- 2, 50 watt, T5 Twin Tube Fluorescent at 4100K CCT. Based on the unified photometry system, this light source will provide higher visual performance than the 100 watt HPS.
- A 70 watt fluorescing light source at 6500K CCT. Based on the unified photometry system, this light source will provide similar visual performance as the 100 watt HPS.

Parking Lot Lighting Results

Gillis Park and the Energy Control Center parking lots were found to have similar lighting conditions in terms of brightness, horizontal illuminance, and spatial light distribution. These parking lots were used to compare subject perceptions of safety, security, brightness, and color rendering under high illuminance (above 10 lux) and two different spectral lighting conditions (Gillis Park, HPS; Energy Control Center, fluorescent). Two additional parking lots, South Austin Community Health Center and the Parks and Recreation Headquarters, were used to compare subject perceptions of safety, security, brightness, and color rendering under lower illuminance (5 lux or less). South Austin Community Health Center utilized HPS lighting and Parks and Recreation used fluorescent lighting.

To ensure the two sets of parking lots had similar subject perceptions of safety and security, subjects were asked to rate these perceptions during daylight hours and at night

with the parking lot lights turned off. Figures 17 and 18 show the results of the subject perceptions of safety and security for the parking lots with higher illuminance values, Gillis Park and Energy Control Center, during daylight hours and at night with the lights turned off. Figures 19 and 20 shows the results of the subject perceptions of safety and security for parking lots with lower illuminance values, South Austin Community Health Center and Parks and Recreations Headquarters, during daylight and at night with the lights turned off.

Figure 17: Daytime Subject Perceptions of Safety and Security, High Illuminance Parking Lots

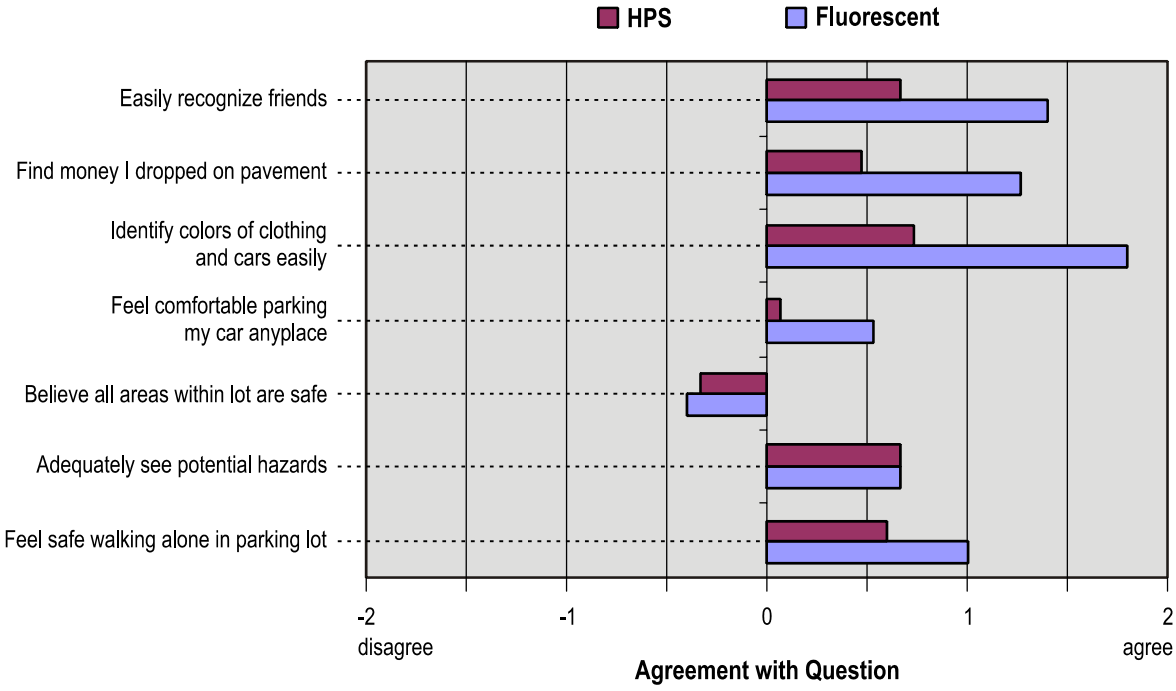


Figure 18: Night, No Lights, Subject Perceptions of Safety and Security, High Illuminance Parking Lots

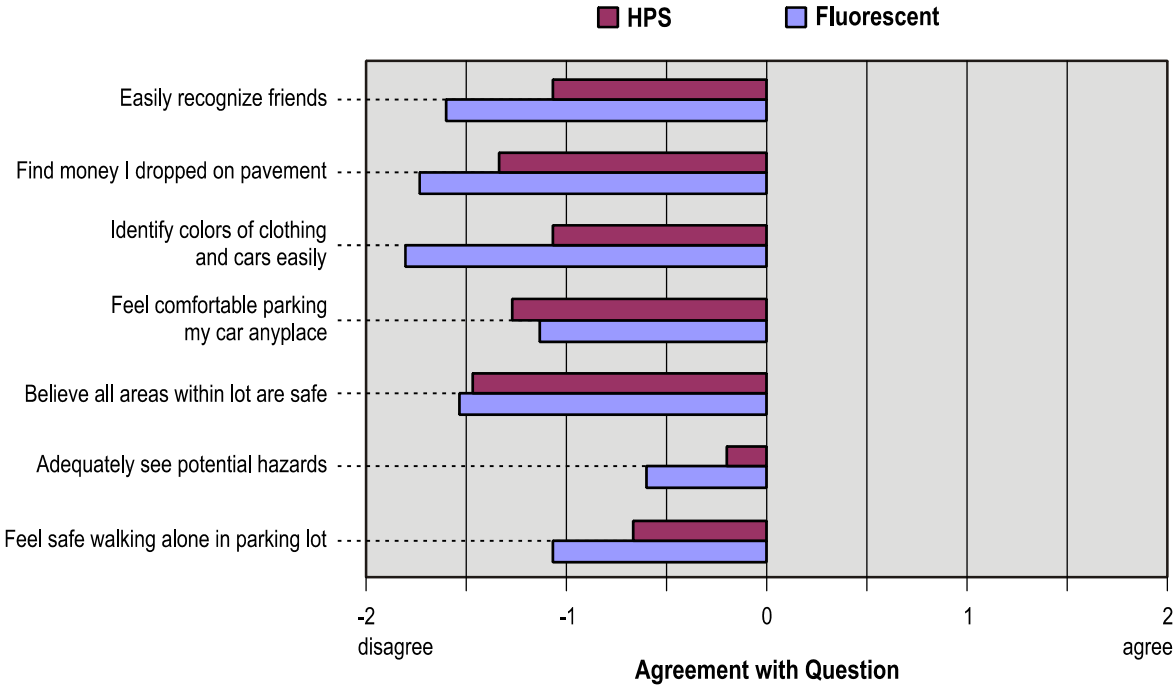


Figure 19: Daytime Subject Perceptions of Safety and Security, Low Illuminance Parking Lots

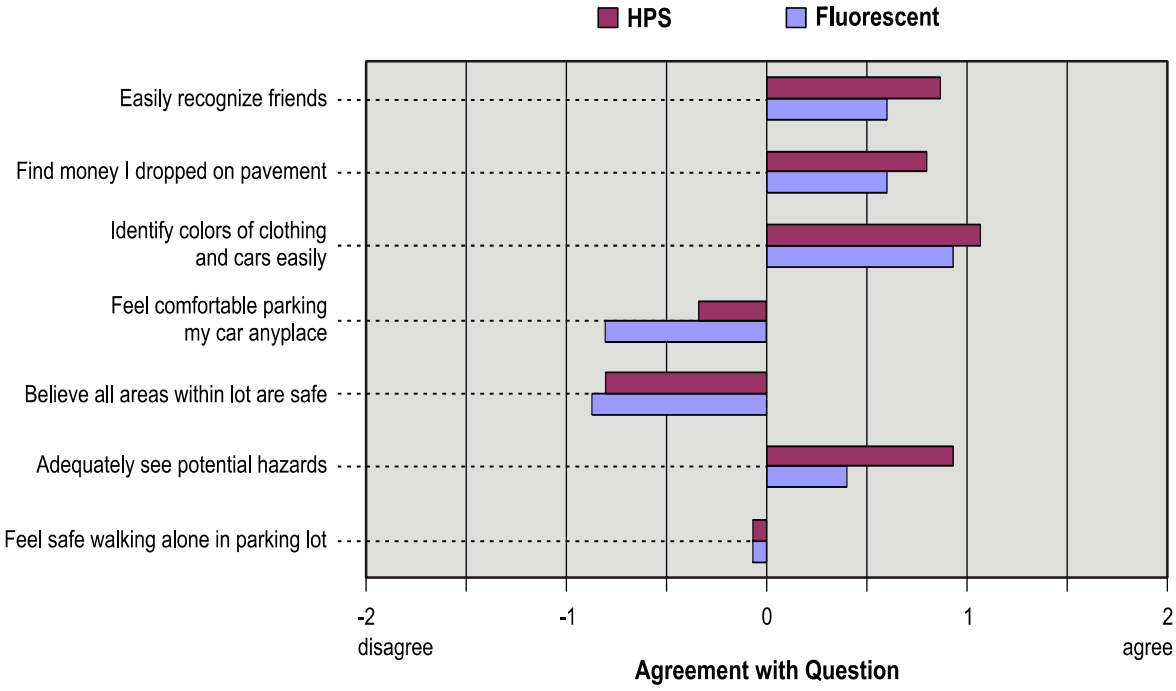
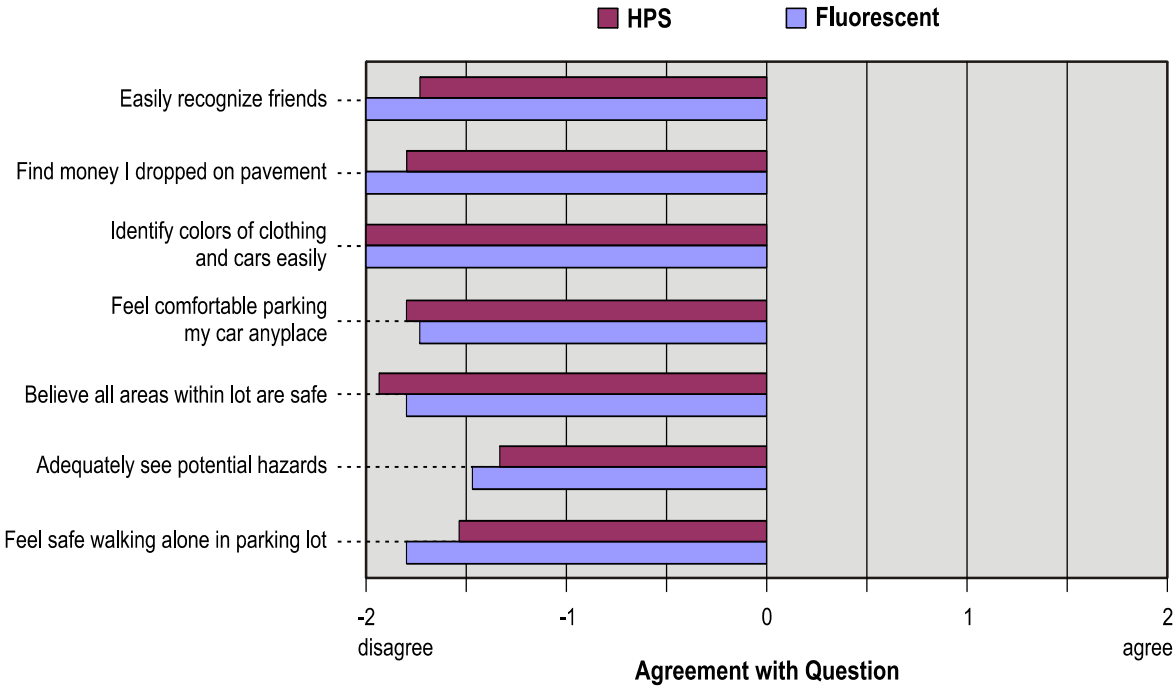


Figure 20: Night, No Lights Subject Perceptions of Safety and Security, Low Illuminance Parking Lots



Subjects' perceptions of safety and security were similar for the high illuminance parking lots during both daylight and at night with the lights turned off for the HPS (Gillis Park) and the fluorescent (Energy Control Center). The fluorescent parking lot (Energy Control Center) showed a slightly higher level of safety and security perception during the daytime than the HPS (Gillis Park) parking lot. This is probably true because the Energy Control Center parking lot is fenced in with a key card controlled gate. However, the same two parking lots under nighttime, no lighting conditions showed subjects' perceptions of safety and security for the fluorescent (Energy Control Center) to be less than for the HPS (Gillis Park) parking lot.

Based on the above findings and the average illuminance of each parking lot lighting system, the results show that subjects' perceptions of safety and security of the two parking lots with high illuminance levels under daytime and nighttime, no lighting conditions were similar. Therefore, the parking lots' lighting systems could be used successfully to measure subjects' perceptions of safety, security, brightness, and color rendering under the two spectral parking lot lighting conditions of HPS and fluorescent.

Similar results are depicted in Figures 19 and 20 for the low illuminance set of parking lots (South Austin Community Health Center, HPS; and Parks and Recreation Headquarters, fluorescent). However, there is a perception of lower levels of safety for the Parks and Recreation parking lot during daytime as shown in Figure 19 for the "Fee comfortable parking my car anyplace" question. Even with this discrepancy, it is believed these parking lots' lighting systems also could be used to measure subjects' perceptions of safety, security, brightness, and color rendering under low illuminance conditions and different spectral lighting, HPS and fluorescent.

After verifying that the two comparison parking lots within each set of parking lots (one set with high illuminance and one set with low illuminance) garnered similar subject perceptions of safety and security, subjects were asked to provide their perceptions of safety, security, brightness, and color rendering of all parking lot lighting systems at night with the lights turned on. The results of the subjects' perceptions are depicted in Figures 21 and 22.

Figure 21: Lighting Systems Comparison of Subjects' Perceptions under High Illuminance Conditions

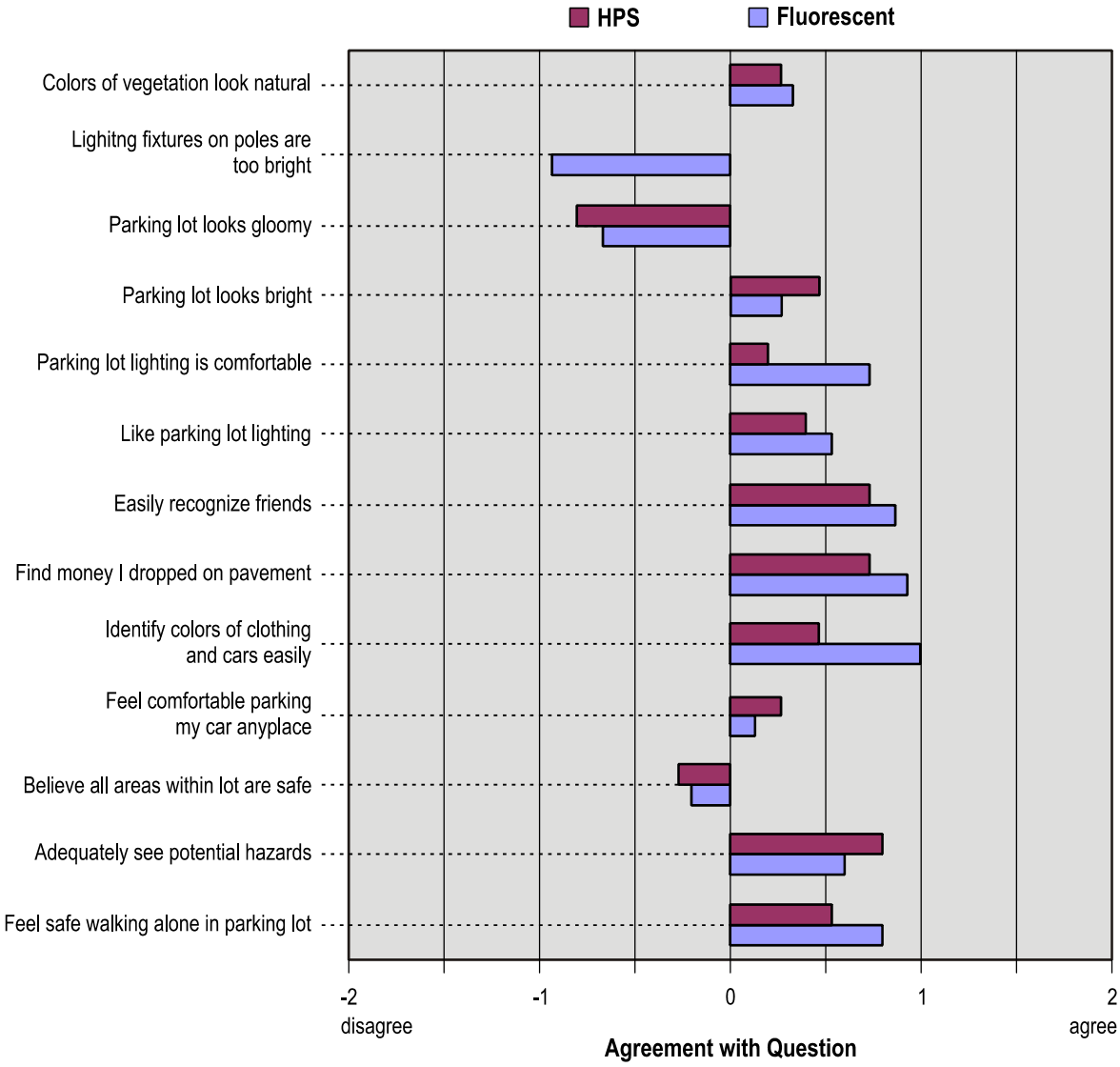
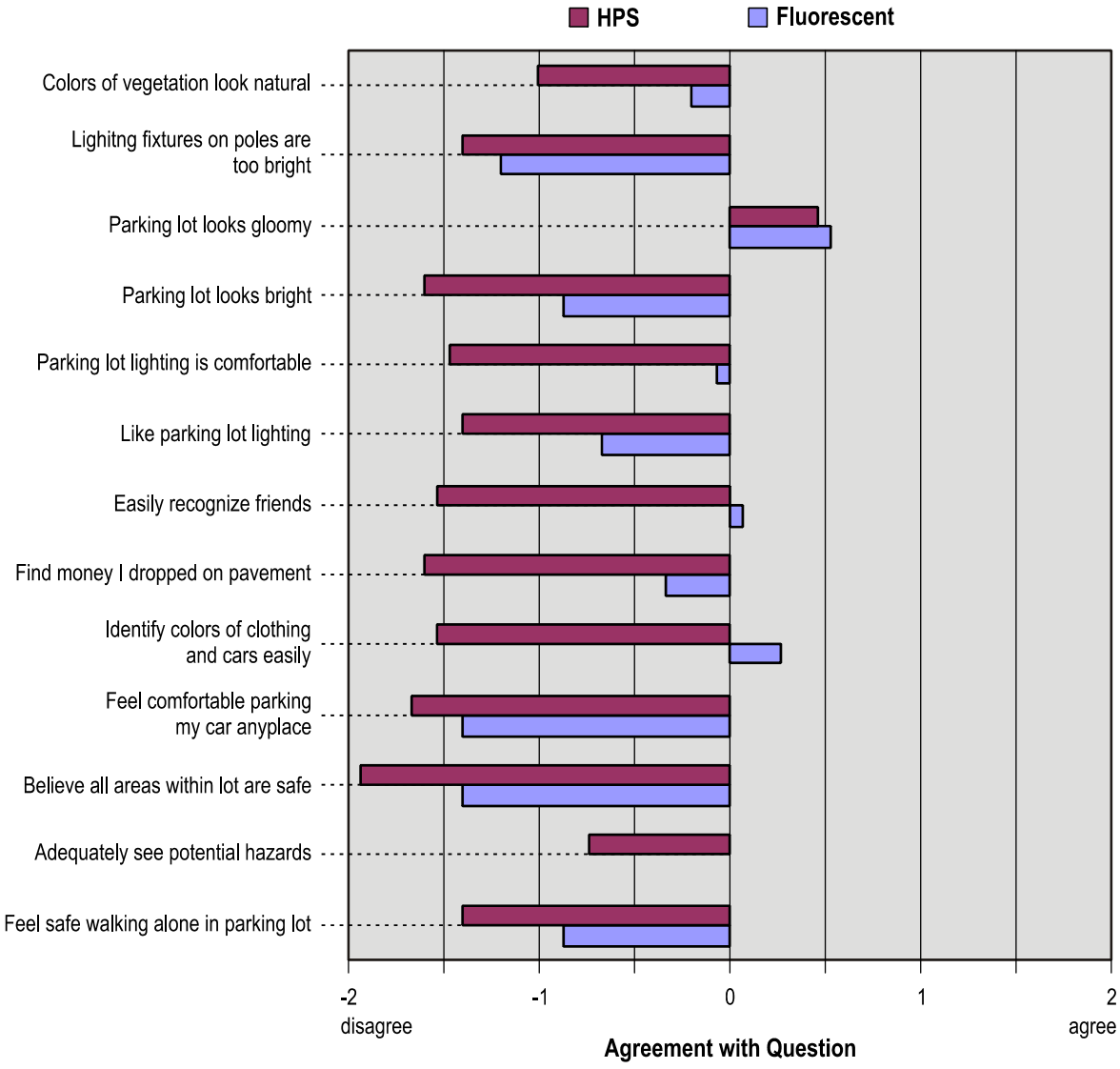


Figure 21 results for high illuminance levels indicate that subjects' perceptions of safety and security were similar, regardless of the lamp spectral distribution. Answers to questions regarding safety or security, such as "easy to recognize friends," "feel comfortable parking my car anyplace," "believe all areas within the parking lot are safe," "adequate to see potential hazards," and "feel safe walking alone in the parking lot," indicate both the HPS lamp source and the fluorescent lamp source provided similar results. For some questions ("feel comfortable parking my car anyplace" and "adequately see potential hazards"), the HPS source scored more positively. For the remaining questions, the fluorescent source was believed to have provided higher safety or security.

Perceptions of brightness, as indicated in the results shown in Figure 21 for questions of "light fixtures on poles too bright," "parking lot looks gloomy," "parking lot looks bright," "like parking lot lighting," and "find money dropped on pavement" indicated similar subject responses, regardless of the lamp spectral distribution. However, perceptions of color rendering seemed to slightly favor the fluorescent light source.

Figure 22: Lighting Systems Comparison of Subjects' Perceptions Under Low Illuminance Conditions



The low illuminance comparison of HPS and fluorescent, as depicted in Figure 22, indicated that subjects' perceptions of safety, security, and brightness were similar for both the fluorescent and HPS light sources. However, the results were all negative. The spatial distribution of light within these parking lots was poor, as can be seen in Figures 12a, 12b, 13a, and 13b. Also, the low illuminance levels added to the perception of poor safety. Perceptions of color rendering appeared to favor the fluorescent light source.

A major study was conducted in 2000 by Dr. Peter Boyce and colleagues, titled *Perception of Safety at Night in Different Lighting Conditions*.[7] This study compared HPS outdoor lighting conditions in more than 20 parking lots in the greater Albany, New York, area. The study asked subjects to rate the safety and security of each parking lot. Each parking lot had different values of horizontal illuminance. Figure 23 shows the results of this study. As illuminance increased to approximately 10 lux, the perception of safety dramatically increased. Between 10 lux and 30 lux, perceptions of safety continued to increase but at a decreasing rate. Over 30 lux, the perception of safety increased very little as horizontal illuminance continued to increase.

Figure 23: Perception of Safety at Night in Different Lighting Conditions[7]

The Austin parking lots examined as part of this study had differing horizontal illuminance values. When comparing these parking lot illuminance values to the results from the Boyce et al. study, one can see why the parking lots within the "high illuminance" set and within the "low illuminance" set would have similar subject perceptions of safety and security. The two high illuminance parking lots, Gillis Park (19.32 lux average) and the Energy Control Center (11.36 lux average), both had horizontal illuminance values greater than 10 lux. Figure 23 indicates that these parking lots should feel relatively safe to subjects and should produce relatively similar perceptions of safety and security. The results from the Austin area parking lot study, as depicted in Figure 21, bear this out.

Similarly, the two parking lots with low illuminance, Parks and Recreation Headquarters (2.69 lux average) and the South Austin Community Health Center (5.36 lux average), would be expected to have low perceptions of safety and security based on Boyce et al.'s study. The results of the subject surveys, as depicted in Figure 22, prove that low levels of horizontal illuminance below 10 lux produced a sense of insecurity for both the Parks and Recreation parking lot and the health center parking lot.

Similar results for the subjects' perceptions of safety, security, and brightness were recorded for the two matched sets (high and low illuminance) of parking lots. Each set had one parking lot with HPS and a second parking lot with fluorescent light sources. Similar results were achieved using the fluorescent light source at 100 watts of lamp energy, compared with 250 watts for the HPS source. This reduction in energy use is possible by tuning the light source closer to how the eye adjusts under low illuminance levels. Also, as seen in Boyce et al.'s study, horizontal parking lot surface illuminances above 10 lux will produce higher perceptions of safety. However, the increase in illuminance from 11 lux for the fluorescent parking lot (Energy Control Center) to 19 lux for the HPS lot (Gillis Park) will not provide dramatically higher perceptions of safety, as predicted using Boyce's study.

Brightness, more so than illuminance, will guide people's perceptions of safety and security. In reports by Rea[8] and Fotios et al.[9], it was found that metal halide and fluorescent outdoor lighting provided perceptions of higher brightness than HPS. This allows photopic luminance to be less for the whiter light sources while providing the same degree of brightness. Therefore, white light sources can be of less wattage than an HPS source. Rea, through experimentation, estimated the ratio of HPS luminance to metal halide luminance to be 1.4 to provide perceptions of equal brightness at a background luminance of 0.1 cd/m^2 to 1.0 cd/m^2.

The background photopic luminance of both Gillis Park (0.43) and the Energy Control Center (0.25) fall within this range. The ratio of Gillis Park HPS luminance to the Energy Control Center luminance is 1.7. The fluorescent lighting of the Energy Control Center has a similar CCT (4100 K vs. 4000 K) as the metal halide used in the Rea experiment. Therefore, Rea's outcome would predict that subjects viewing the lighting at Gillis Park and the Energy Control Center would have similar perceptions of brightness. In fact, the outcome from the subject surveys verifies that people perceive the brightness to be similar in both parking lots.

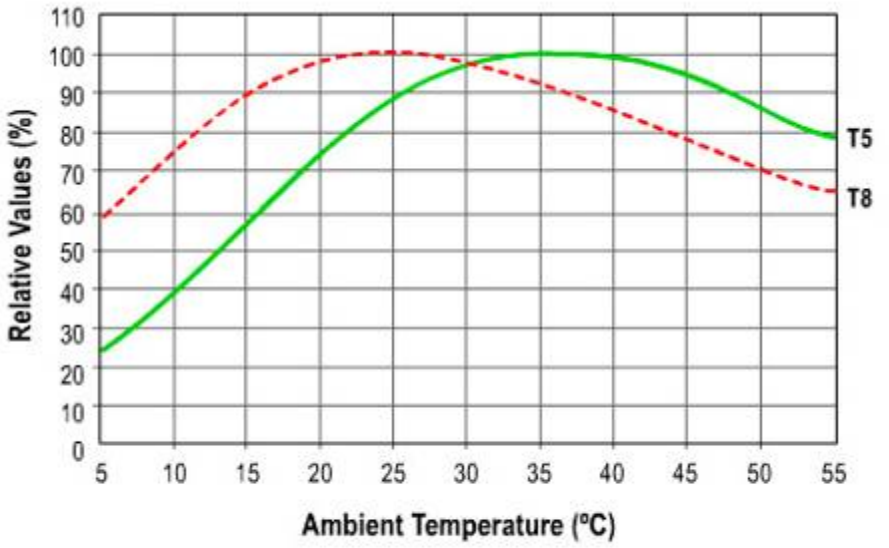
Performance and Economics Considerations

Outdoor temperatures vary throughout the year. Lamps enclosed in water-tight light fixtures located outdoors will experience changes in the ambient temperature in which they operate. Changes in ambient temperature will affect the lamp efficiency and total lumen output. This is truer for fluorescent lamps than for HPS lamps. HPS lamps experience minimal losses in lumen output as the ambient temperature changes.

Fluorescent lamps are rated for maximum lumen output at a certain ambient temperature, 25°C for T8 and 35°C for T5. Fluorescent lamps operated at either higher or lower temperatures will experience lumen losses.

The LRC's National Lighting Product Information Program has published a *Lighting Answers* publication that discusses the effects of ambient temperature on fluorescent lighting systems.[10] Figure 24 illustrates the effects of ambient temperature on T5 and T8 lamps. An ambient temperature of 50°C (122°F), which is highly possible in Austin, Texas, within a totally enclosed outdoor light fixture during summer months, will reduce T5 light output by approximately 14%. Conversely, an ambient temperature within the light fixture of 20°C (68°F) will reduce light output by approximately 25%. (Winter temperatures in Austin, Texas go below 20°F on a regular basis. Therefore, a 68° F within the enclosed fixture can be expected.)

Figure 24: Light Output and Ambient Temperature[10]



This diagram is quoted from SILHOUETTE T5, T5 HO & T5 Circular Fluorescent Lamp Technology Guide, Philips Lighting Company.

Replacing a 250-watt HPS light source (300 watts with ballast[11]) with a 100-watt fluorescent light source (106 watts with ballast[5]) saves a considerable amount of energy. Assuming 4,100 hours of operation per year[12], the 250-watt HPS system will use 1,230 kilowatt-hours, compared to the 100-watt fluorescent system at 435 kilowatt-hours (kWh). This is a 65% reduction in annual energy use. Cost savings to the user of the fluorescent system at 4.844 cents per kWh[13] for off-peak energy purchases would be $38.53 per year ($59.58 for 250-watt HPS versus $21.05 for 100-watt fluorescent). Other wattages of either the HPS or fluorescent systems would produce different energy savings.

Using fluorescent T5 twin-tube systems with lower wattages in lieu of HPS outdoor lighting systems for either parking lots or streetlights would slightly reduce annual maintenance costs. Lamp costs for the twin-tube fluorescent are $19.17[14] each, and two lamps are required. HPS lamp costs are $84.41.[14] The lamp life, as published in a lamp manufacturer's catalog, is 20,000 hours[15] for twin-tube fluorescent lamps. Lamp life is determined by cycling the lamps at three hours on and 20 minutes off. Lamps used in outdoor applications will usually start only once per day, which will extend fluorescent lamp life. Therefore, a lamp life of 27,000 hours was used for the payback analysis below. The lamp life for an HPS 250-watt non-cycling lamp is 30,000 hours.[6] The cost for a utility crew to change a streetlight lamp is estimated to be $100.[16] Therefore, the annual maintenance cost with 4,100 burn hours per year is $21.01 for the 100-watt fluorescent system and $25.20 for the 250-watt HPS system.

To determine the simple payback of using the fluorescent lighting system, the capital cost of the fluorescent and HPS systems must be determined and the savings from using the fluorescent system must be included in the calculation. Two different scenarios exist for simple payback, one for newly designed/installed lighting systems and one for retrofitting existing HPS lighting systems. For new outdoor lighting, the differential capital cost of the fluorescent versus the HPS lighting system is used. For retrofit situations, the full cost of the fluorescent system plus the labor costs to install the system must be considered.

The following assumptions were used in calculating simple payback:

- Capital cost for the fluorescent system less lamp and photo cell is $260[*,17]
- Capital cost for HPS system less lamp and photo cell is $80[*,16]
- Labor to install a new area or streetlight is $150[16]
- The outdoor lighting system operates 4,100 hours per year[12]
- Lamp costs are $19.17[14] for a 50-watt twin-tube fluorescent and $53.75[14] for a 250-watt HPS
- Labor to change a lamp on an existing outdoor fixture is $100.[17] This includes travel time to the site and use of bucket truck.
- Lamp life is 27,000 hours[15] for the 50-watt twin-tube fluorescent and 30,000 hours[6] for the 250-watt HPS
- Energy cost is $0.04844 per kWh[13] for off-peak energy
- Total system wattage for fluorescent is 106 watts[5] and for HPS 300 watts[11]

*Note: Approximate costs of the different outdoor lighting fixtures are subject to price changes due to the ever-changing prices of raw materials.

Simple Payback: New Outdoor Lighting Installations

Differential Capital Cost, Fluorescent versus HPS = (Fluorescent fixture cost + lamp costs + labor cost) – (HPS fixture cost + lamp cost + labor cost)
= ($260 + 2 lamps @ $19.17 ea. + $150) – ($80 + $53.75 + $150)
= $448.34 – $283.75
Differential Capital Cost = $164.59

Annual Energy Savings, Fluorescent versus HPS = (HPS wattage – Fluorescent wattage)/1000 × 4,100 hours of operation × $0.04844 per kWh
= (300 W – 106 W)/1000 × 4,100 × $0.04844
Annual Energy Savings = $38.53

Annual Maintenance Savings, Fluorescent versus HPS = (HPS lamp cost + labor cost) × (annual operating hours / lamp life) – (Fluorescent lamp costs + labor cost) × (annual operating hours / lamp life)
= ($53.75 + $100) × (4,100/30,000) – (2 lamps × $19.17 + $100) × (4,100/27,000)
Annual Maintenance Savings = $21.01 – $21.01 = $4.19

Simple Payback = Differential Capital Cost / (Annual Energy Savings + Annual Maintenance Savings)
= $133.93 / $38.53
Simple Payback = 3.5 years

Simple Payback: Retrofit Outdoor Lighting Installations

Capital Cost of Fluorescent System = Fixture cost + lamp costs + labor
= $260 + 2 lamps @ $19.17 ea. + $150
Capital cost = $448.34

Annual energy savings and maintenance savings will be the same as new installations described above.

Simple Payback = Capital Cost / (Annual Energy Savings + Annual Maintenance Savings)
= $448.34 / $38.53
Simple Payback = 11.6 years

Conclusions

Limited conclusions based on the Austin street lighting survey results could be drawn because of the low number of survey responses. However, the LRC has conducted other street lighting research utilizing fluorescing lamp sources and metal halide lamps in comparison to HPS. The results of these studies presented above are the basis for the street lighting conclusions and recommendations provided here. The minimal results from the five Austin street lighting surveys were similar to the results achieved in the other LRC research projects.

Based on LRC research and the Unified Photometry System, street lighting in mesopic illuminance ranges can be used to reduce lamp wattages by 30% without affecting perceptions of visibility, safety, or security if the lamp possesses a CCT within the white light range of approximately 6500K. For white light sources, mesopic sensitivity is better at 6500K CCT than at 4100K CCT.

The replacement of 100-watt HPS (118 watts with ballast[12]) for the Austin street lighting scenario with two 50-watt, twin-tube fluorescent lamps (106 watts with ballast[5]) saves a minimal amount of energy. There annual maintenance costs for the HPS and fluorescent systems are virtually the same.

The fluorescent and HPS comparison parking lot sets, one set with high illuminance and one set with low illuminance, were found to have similar subject perceptions of safety and security during daylight hours and at night with the lights turned off. The similarities allowed for successful comparison research to be conducted on the two different lighting systems.

The fluorescent lamps selected for both the street and parking lots studies were chosen before the LRC became involved in this project and the Unified Photometry System was not considered as the basis for the selection. The Unified Photometry System allows for lamp substitution based on the lamp's scotopic-to-photopic ratio and the desired luminance on the road surface while providing equal visibility. However, the 4100 K CCT lamps chosen by Austin Energy and Magnaray® are closer to the optimum mesopic vision range than the HPS lamp source.

Currently, Austin Energy is over lighting these intersections by more than double the IESNA recommended illuminance levels.

Similar subject perceptions of safety, security, and brightness were recorded within the high illuminance set of comparison parking lots and within the low illuminance set of comparison parking lots, regardless of the spectral distribution of the lamp used. In both the fluorescent and HPS high illuminance parking lots, subjects indicated they felt safe and secure. However, in the parking lots with low illuminance, subjects indicated they

felt unsafe. The low illuminance and poor spatial light distribution in both low illuminance parking lots were the causes for subjects' perceptions of inadequate safety and security.

The results of perceptions of safety and security follow closely with the results achieved by Boyce et al.'s research, *Perception of Safety at Night in Different Lighting Conditions*.[7] Parking lots with horizontal illuminance greater than 10 lux will exhibit acceptable subject perceptions of safety and security. Both Gillis Park and the Energy Control Center had average illuminance values greater than 10 lux, and survey respondents indicated acceptable levels of safety and security. Conversely, the Parks and Recreation Headquarters and the South Austin Community Health Center had considerably lower average horizontal illuminance values. Subjects' perceptions of safety and security were poor for both these parking lots, regardless of the spectral distribution of the light source.

Subjects found color rendering to be better with the fluorescent light sources in both the high and low illuminance conditions.

Spatial light distribution influences subject perceptions of safety and security as much as average illuminance values. Parking lots with reasonable distributions of light, such as Gillis Park and the Energy Control Center, are perceived as being safer compared to parking lots such as South Austin Community Health Center and the Parks and Recreation Headquarters with poor light distribution. Good lighting design that provides some uniformity in light levels rather than pools of light surrounded by dark areas is as important as providing enough illuminance.

Considerable energy savings (65%) is possible when utilizing the 100-watt (106 watts with ballast[5]) fluorescent lighting system compared to the standard HPS 250-watt (300 watts with ballast[11]) outdoor lighting system while maintaining similar perceptions of safety, security, and brightness. At 4.844 cents per kWh[13], the energy savings translates into an annual cost savings of $38.53 per light fixture.

The annual maintenance costs are the same, even though the fluorescent lamps have a shorter lamp life than the HPS lamps, 27,000 hours[15] versus 30,000 hours.[6] This occurs because the fluorescent lamps' purchase price is less than the HPS lamps.

The use of the 100-watt fluorescent outdoor lighting system for newly lit parking lots provides a reasonable payback for the higher initial cost to the City of Austin (3.5 years). Retrofitting existing HPS 250-watt parking lot lighting with the 100-watt fluorescent system has a longer payback of 11.6 years. The latter case may be beyond the financial criteria for the City to retrofit existing parking lot lighting.

Recommendations

Street Lighting Recommendations

- Using a fluorescing lamp source tuned to optimize mesopic vision within the white light range (6500 K CCT) offers opportunities to reduce lamp wattages by 30% from the HPS lamp it would replace without negatively impacting perceptions of visibility, safety, or security. Austin Energy should consider a program of replacing 100-watt HPS streetlights with a fluorescing lamp source of around 70 watts, and 70-watt HPS streetlights with a fluorescing lamp source of approximately 50 watts.

- Other fluorescing light sources, such as electrodeless lamps, should be explored beyond the T5 twin tubes. Electrodeless lamps provide longer lamp life that could reduce maintenance costs. This exploration should occur prior to Austin Energy deciding to convert any outdoor lighting from HPS. An economic analysis such as presented in this report can be used to determine the cost effectiveness of all HPS replacement options.

- Strive to utilize lamps in outdoor lighting installations that are spectrally closer to the optimum mesopic vision range of 6500 K CCT.

- Metal halide (even ceramic metal halide) used in street lighting has some serious shortcomings of shorter lamp life (20,000 hours) than HPS (30,000 hours) and higher lumen depreciation over the life of the lamp. These shortcomings cause the LRC to be concerned in recommending the use of metal halide as a replacement for HPS. The added maintenance costs will more than offset any energy savings, causing higher total costs for Austin Energy.

- The recommended potential replacements for the 250 watt HPS at the intersections are based on providing sufficient lighting to meet the IESNA recommended practices or to meet the unified photometry system recommendations for mesopic street lighting to match or exceed the visual performance provided by 100 watt HPS lighting. The following are the recommended replacements for the 250 watt HPS intersection lighting.
  - 150 watt HPS at 2100K CCT. This light source will still provide average illuminance values (24.6 lux) that exceed IESNA recommended levels.
  - 100 watt HPS at 2100K CCT. This light source will provide close to the IESNA recommended levels of illuminance of 16 lux.
  - 2, 50 watt, T5 Twin Tube Fluorescent at 4100K CCT. Based on the unified photometry system, this light source will provide higher visual performance than the 100 watt HPS.
  - A 70 watt fluorescing light source at 6500K CCT. Based on the unified photometry system, this light source will provide similar visual performance as the 100 watt HPS.

Parking Lot Lighting Recommendations

- Parking lot lighting design should strive to provide average horizontal illuminance values greater than 10 lux with good spatial light distribution to ensure high degrees of perceived safety and security. The use of the Illuminating Engineering Society of North America's guideline RP-20 for the design of parking lot lighting is encouraged.

- Strive to utilize lamps in outdoor lighting installations that are spectrally closer to maximizing mesopic vision within the white light range at 6500 K CCT.[1]

- Other fluorescing light sources, such as electrodeless lamps, should be explored beyond the T5 twin tubes. Electrodeless lamps provide longer lamp life that could reduce maintenance costs. This exploration should occur prior to Austin Energy deciding to convert any outdoor lighting from HPS. An economic analysis such as presented in the report can be used to determine the cost effectiveness of all HPS replacement options.

- Based on the Unified Photometry System[3], properly designed parking lot lighting systems can reduce lamp wattage by approximately 30% while maintaining visual performance if the light source is tuned at 6500K CCT to maximize mesopic vision within the white light range.

- The use of the Unified Photometry System[3] to determine replacement wattages of lamps with different spectral distributions that will provide similar visibility is encouraged. Austin Energy can examine replacing HPS wattages other than 250 watts by use of this system. Once replacement lamps are selected, an economic analysis can be performed to determine if a reasonable payback is possible.

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Acknowledgements

Our many thanks go to:

Dennis Lilley, Austin Energy, for coordinating site visits, choosing potential HPS comparison sites to the fluorescent lighting parking lots, arranging for the parking lot lighting to be turned off for part of the nighttime testing, assisting with focus group transportation, and coordinating efforts between Austin Energy and the LRC. Without Dennis' assistance, this project would have been much more difficult.

Frank DiSiena and Christopher Frye, Austin Energy, for reviewing survey questionnaires and for arranging for the execution of the street lighting survey.

Larry Leetzow, Magnaray® International, for assisting with site illuminance measurements and for providing information regarding Magnaray® products.

Dan Frering, LRC, for conducting the illuminance study at the South Austin Community Health Center.

Jenny Taylor and Dennis Guyon, LRC, for editing this report.

Donna Watson, Tammadge Market Research, for recruiting subjects for the parking lot study and somehow ensuring that all 15 subjects invited showed up for the study.

Appendix A: Street Lighting Survey Questionnaire

START TIME:

_____

CCR #10-2771
08/28/07 – V2

AUSTIN ENERGY STREETLIGHT SURVEY

NAME: _____ PHONE #:
(_____)_____

INTERVIEWER:_____DATE:_____

ASK TO SPEAK TO PERSON ON LIST. MUST SPEAK TO PERSON ON LIST.

Hi _____, this is (YOUR NAME) from Creative Consumer Research calling on behalf of Austin Energy. We called you a few days ago and asked that you view some street lights in your area so that we could ask you a few questions and send you a $10 Whole Foods gift card. Did you have a chance to look at the lighting on both of these streets?

Yes 1 CONTINUE
No 2 SCHEDULE CALLBACK:
When would be a good time to call you back to give you a chance to look at these lights?

IF THE PERSON WANTS SPONSOR INFORMATION:

Please call the Peter Morante at 518-687-7173

CONTINUE WITH THE SURVEY.

For this survey, please think about the street lights you observed at night on West Avenue between 9th, 10th, and 11th street, and tell me which response most closely describes the degree of your agreement with each statement: (READ LIST)

Strongly disagree, disagree, are neutral, agree, or strongly agree.

Overall

1. I like the lighting on West Ave. between 9th and 10th Streets. (READ LIST AS NEEDED TO PROMPT THROUGHOUT SURVEY)

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

2. The lighting on West Ave. between 9th and 10th Streets is comfortable.

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

3. West Ave. between 9th and 10th Streets looks bright.

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

4. West Ave. between 9th and 10th Streets looks gloomy.

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

5. The light fixtures on the poles on West Ave. between 9th and 10th Streets are too bright

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

6. Colors of traffic signs along West Ave. between 9th and 10th Streets appear clear.

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

7. Colors of vegetation along West Ave. between 9th and 10th Streets look natural.

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

8. The lighting on West Ave. between 9th and 10th Streets is too warm in color for a street

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

9. The lighting on West Ave. between 9th and 10th Streets is too cool in color for a street.

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

10. The lighting on West Ave. between 9th and 10th Streets looks better than other portions of West Ave.

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

11. The street lights between 9th and 10th street are a good example of security lighting

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

As a driver, with this lighting,

12. I can see the roadway pavement on West Ave. between 9th and 10th Streets clearly.

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

13. I can see other vehicles approaching on West Ave. between 9th and 10th Streets clearly.

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

14. I can see pedestrians approaching on West Ave. between 9th and 10th Streets clearly.

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

15. I feel safe while driving along West Ave. between 9th and 10th Streets.

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

As a pedestrian, with this lighting,

16. I can see other pedestrians approaching on West Ave. between 9th and 10th Streets clearly.

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

17. I can see faces of pedestrians on West Ave. between 9th and 10th Streets clearly.

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

18. I can see vehicles approaching on West Ave. between 9th and 10th Streets clearly.

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

19. I feel secure while walking on the sidewalk of West Ave. between 9th and 10th Streets.

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

West Avenue between 10th and 11th streets

Overall

20. I like the lighting on West Ave. between 10th and 11th Streets.

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

21. The lighting on West Ave. between 10th and 11th Streets is comfortable.

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

22. West Ave. between 10th and 11th Streets looks bright.

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

23. West Ave. between 10th and 11th Streets looks gloomy.

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

24. The light fixtures on the poles on West Ave. between 10th and 11th Streets are too bright Strongly disagree 1

Disagree	2
Neutral	3
Agree	4
Strongly agree	5

25. Colors of traffic signs along West Ave. between 10th and 11th Streets appear clear.

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

26. Colors of vegetation along West Ave. between 10th and 11th Streets look natural.

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

27. The lighting on West Ave. between 10th and 11th Streets is too warm in color for a street

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

28. The lighting on West Ave. between 10th and 11th Streets is too cool in color for a street.

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

29. The lights on West Ave. between 10th and 11th Streets looks better than other portions of West Ave.

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

30. The street lights between 10th and 11th streets are a good example of security lighting

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

As a driver, with this lighting,

31. I can see the roadway pavement on West Ave. between 10th and 11th) Streets clearly.

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

32. I can see other vehicles approaching on West Ave. between 10th and 11th Streets clearly.

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

33. I can see pedestrians approaching on West Ave. between 10th and 11th) Streets clearly.

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

34. I feel safe while driving along West Ave. between 10th and 11th Streets.

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

As a pedestrian, with this lighting,

35. I can see other pedestrians approaching on West Ave. between 10th and 11th Streets clearly.

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

36. I can see faces of pedestrians on West Ave. between 10th and 11th Streets clearly.

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

37. I can see vehicles approaching on West Ave. between 10th and 11th Streets clearly.

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

38. I feel secure while walking on the sidewalk of West Ave. between 10th and 11th Streets.

Strongly disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly agree	5

DEMOGRAPHICS

These last few demographic questions will allow us to group your responses with those of other Austin residents for analytical purposes.

39. BY OBSERVATION: Gender

Male	1
Female	2

40. To be sure that we talk to a variety of Austin area residents, please tell me which of the following categories includes your age. Would it be . . . (READ LIST.)

18 to 24	1
25 to 30	2
31 to 35	3
36 to 40	4
41 to 45	5
46 to 50	6
51 to 55	7
56 to 60	8
61 to 65	9
66 years of age or older	x
(Do Not Read) Refused	x

41. Again to be sure that we talk to a variety of Austin area residents, please tell me which of the following best describes your ethnic background or race. Are you … (READ LIST)

Of Hispanic origin, such as Mexican American, Latin American, Puerto Rican, or Cuban	1
White	2
African-American	3
Asian, Pacific Islander	4
Aleutian, Eskimo, or American Indian	5
Other: _____	❑
(Do not read) DK/unsure	7
(Do not read) Refused	8

42. What is the highest grade of school you have completed? Is it . . . **(READ LIST)**

Some high school	1
Graduated high school	2
Some college	3
Graduated college	4
Post-graduate work	5
(Do Not Read) DK/unsure	6
(Do Not Read) Refused	7

43. What is your marital status? Are you . . . **(READ LIST)**

Single	1
Married	2
Separated	3
Divorced	4
Widowed	5
In transition	6
(Do Not Read) Refused	7

44. Which of the following **best** describes your residence? (READ LIST. ACCEPT ONLY ONE RESPONSE.)

Single-family home.....1
Townhouse/Duplex.....2
Condo.....3
Apartment 4
Other ***(Specify)*** _____.....0

45. Do you rent or own your current place of residence?

Rent	*1*
Own	*2*
DK/unsure	3

46. How long have you lived in the Austin metropolitan area? **(DO NOT READ LIST)**

Less than 1 year	1
1 year to 5 years	2
6 to 10 years	3
11 to 15 years	4
16 to 20 years	5
21 to 30 years	6

31 to 40 years	7
41 to 50 years	8
More than 50 years	9
Refused	10

47. Do you currently wear any of the following?

Contact lenses	1
Reading glasses	2
Everyday glasses	3
Any other corrective eyewear (SPECIFY)_____	4
None	5

If you have any questions and comments, please feel free to contact Peter Morante at 518-687-7173 (moranp@rpi.edu) or the Institute Review Board; Rensselaer Polytechnic Institute; CII 7015; 110 8th Street; Troy, NY 12180. Thank you for your time and cooperation.

(CONFIRM RESPONDENT NAME,
AREA CODE AND TELEPHONE NUMBER;
RECORD ON FRONT PAGE OF SURVEY.)

THAT CONCLUDES OUR SURVEY.
THANK YOU VERY MUCH FOR YOUR PARTICIPATION!

END
TIME: _____

Appendix B: Parking Lot Lighting Questionnaire Daytime and Night No Lights

Lighting Questionnaire for Daytime Gillis Park, Austin, Texas

Lighting Research Center, Rensselaer Polytechnic Institute, 21 Union Street, Troy, NY 12180

Austin Energy and the Lighting Research Center (LRC) are conducting an evaluation of outdoor lighting. We would like to know your opinions of the parking lot lighting, under the present conditions. Please observe the parking lot and the lighting, then circle the number which most closely describes the *degree of your agreement* with each statement:

-2: strongly disagree, -1: disagree, 0: neutral, +1: agree, +2: strongly agree.

1. I would feel safe walking alone in this parking lot ……. -2 -1 0 +1 +2
2. I can adequately see potential hazards and threats in this parking lot. -2 -1 0 +1 +2
3. I believe all areas within this parking lot are safe …….-2 -1 0 +1 +2
4. I would feel comfortable parking my car anyplace within this lot …...-2 -1 0 +1 +2
5. I can identify the colors of clothing and cars easily within this lot …..-2 -1 0 +1 +2
6. If I dropped some money on this parking lot pavement, I could find it easily …….-2 -1 0 +1 +2
7. I would be able to easily recognize a friend, appearing unexpectedly, in this parking lot …….-2 -1 0 +1 +2

Thank you for your cooperation.

Appendix C: Parking Lot Lighting Questionnaire, Lights On

Lighting Questionnaire for Lights Gillis Park, Austin, Texas

Lighting Research Center, Rensselaer Polytechnic Institute, 21 Union Street, Troy, NY 12180

Austin Energy and the Lighting Research Center (LRC) are conducting an evaluation of outdoor lighting. We would like to know your opinions of the parking lot lighting, under the present conditions. Please observe the parking lot and the lighting, then circle the number which most closely describes the *degree of your agreement* with each statement:

-2: strongly disagree, -1: disagree, 0: neutral, +1: agree, +2: strongly agree.

1. I would feel safe walking alone in this parking lot.....-2 -1 0 +1 +2

2. I can adequately see potential hazards and threats in this parking lot. .-2 -1 0 +1 +2

3. I believe all areas within this parking lot are safe.....-2 -1 0 +1 +2

4. I would feel comfortable parking my car anyplace within this lot. .....-2 -1 0 +1 +2

5. I can identify the colors of clothing and cars easily within this lot. .....-2 -1 0 +1 +2

6. If I dropped some money on this parking lot pavement, I could find it easily.....-2 -1 0 +1 +2

7. I would be able to easily recognize a friend, appearing unexpectedly, in this parking lot. .....-2 -1 0 +1 +2

8. I like the parking lot lighting. .....-2 -1 0 +1 +2

9. The parking lot lighting is comfortable. .....-2 -1 0 +1 +2

10. The parking lot looks bright.....-2 -1 0 +1 +2

11. The parking lot looks gloomy. .....-2 -1 0 +1 +2

12. The light fixtures on the poles are too bright. .....-2 -1 0 +1 +2

13. The colors of vegetation surrounding the parking lot look natural.....-2 -1 0 +1 +2

Thank you for your cooperation.

Appendix D: Unified Photometry: An Energy-Efficient Street Lighting Demonstration in Easthampton, Massachusetts

Rensselaer

Progress Report: Improving Acceptance and Use of Energy-Efficient Lighting

Unified photometry: An energy-efficient street lighting demonstration in Easthampton, Massachusetts

Submitted to:	**The U.S. Energy Protection Agency**
Prepared by:	**Yukio Akashi, Mark Rea, Peter Morante**
Date:	**April 9, 2004**
Sponsor:	**The U.S. Energy Protection Agency**
Collaboration:	**Western Massachusetts Electric Company**
	Town of Easthampton, Massachusetts
	Magnaray International
	Paclantic International

Lighting Research Center
Rensselaer Polytechnic Institute
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Troy, NY 12180
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518-687-7120 (fax)

Lighting Research Center

Unified photometry: An energy-efficient street lighting demonstration in Easthampton, Massachusetts

Yukio Akashi, Mark Rea, Peter Morante

Lighting Research Center
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April 9, 2004

SUMMARY: The Lighting Research Center (LRC) has developed a new, unified photometry system, covering all light levels—from photopic (e.g., lit interior and daytime) through mesopic (e.g., lit streets at night) to scotopic (e.g., unlit spaces at night) light levels (Rea et al. 2003; Rea et al., 2004). This new system is consistent with existing photometry and maintains all orthodox photometric conventions. And, it is easy to use by lighting engineers and manufacturers. However, to evaluate the suitability of the new photometry system for practical applications, it was still necessary to conduct a demonstration of its benefits. The LRC, in partnership with Western Massachusetts Electric Company (WMECO) and the Town of Easthampton, Massachusetts, conducted a demonstration study along Clark Street in Easthampton. The results of the demonstration showed that the new fluorescent lighting system can save 30% of the energy consumed by conventional HPS lighting on the street. In addition, the results of the surveys suggested, on the average, that residents evaluated the fluorescent lighting system as better than the HPS system regarding brightness perception, color appearance, and the perception of safety and security. Finally, this study supported the use of the new, unified photometry system.

1. INTRODUCTION

Human eyes have two types of visual receptors in the retina—cones and rods. The current system of photometry, based on the spectral sensitivity of foveal cones, does not function well at characterizing the visual effectiveness of electric light sources at mesopic light levels where rods are also involved. Since the peak wavelength sensitivity of rods is shorter than it is for cones, human visual sensitivity shifts toward shorter wavelengths at lower light levels. Therefore, current photometry underestimates the effectiveness of lamps with relatively more short-wavelength output at mesopic light levels. The unified photometry system can more appropriately evaluate the effectiveness of lamps with various spectral power distributions (SPD) by providing “unified” luminance according to the light levels to which human eyes adapt (Rea et al. 2003; Rea et al. 2004).

The use of unified photometry may completely change practices in outdoor lighting. Table 1 shows photopic illuminance and relative electric power required to obtain criterion levels of off-axis visual performance when illuminated by various SPDs. As the light level decreases, the performance of high-pressure sodium (HPS) lamps, relative to other sources, is reduced. Conversely, metal halide (MH) and fluorescent lamps, which have more short-wavelength components, reduce their relative power requirements to meet criterion visual performance levels.

The LRC developed the unified photometry system based on a series of recent laboratory studies (He et al. 1997; He et al. 1998). Simulated driving studies verified the validity of the fundamental findings but found a difference in off-axis detection between MH and HPS lamps to be sometimes larger than would be predicted by the unified photometry system (Bullough and Rea 2000; Lingard and Rea 2002). A recent field study to examine target detection by subjects driving along a closed track found that targets illuminated by MH lamps can be more quickly detected by the subjects than those made visible by HPS lamps (Akashi and Rea 2002). The results dramatically underscored the benefits of the unified photometry system. This demonstration study was conducted to extend the findings from those controlled studies to real street lighting contexts.

The objectives of the study were to demonstrate how much lighting power can be reduced through the use of the unified photometry system while improving subjective impressions.

Table 1. Photopic illuminance and relative power required to obtain the same brightness perception and visibility of spaces and objects illuminated by various SPD lamps

Light source	S/P ratio*	0.6 cd/m²		0.3 cd/m²		0.1 cd/m²	
		E (lx)**	Relative power***	E (lx)	Relative power	E(lx)	Relative power
400 W HPS	0.66	26.9	100%	13.5	100%	4.5	100%
1000 W incandescent	4.41	26.9	833%	10.5	648%	2.6	478%
3500 K fluorescent	1.44	26.9	130%	10.4	100%	2.5	73%
400 W MH	1.57	26.9	119%	10.0	88%	2.4	63%
5000 K fluorescent	1.97	26.9	130%	9.0	87%	1.9	57%
6500 K fluorescent	2.19	26.9	130%	8.5	82%	1.8	52%

* - S/P ratio: the ratio of scotopic lumens to photopic lumens of each lamp
** - E: illuminance measured in lux (lx)
***-Relative power (%) normalized to HPS

2. DEMONSTRATION

2.1. Location

For the demonstration site, the LRC sought a typical rural residential street where HPS lamps were installed. HPS lamps are one of the most efficacious lamps under the current photometry system. There are other lamps that are more efficacious under the new photometry system and therefore a change from HPS lamps was desirable for this demonstration. Streets in rural residential areas are typically illuminated by 70-100 W HPS lamps; the luminaires are widely spaced along the streets. The low lamp wattages and the wide luminaire spacing may reduce adaptation luminances down to light levels (e.g., 0.1 cd/m²) where the new system of photometry could demonstrate an advantage for a new lamp type.

In cooperation with WMECO, the LRC found Clark Street in Easthampton, Mass., where town officials have pursued energy-efficient street lighting technologies. Clark Street is approximately 1.2 km long and eight meters wide, located in a typical rural residential

area, and illuminated by 70W HPS lamps attached to every two or three utility poles. Since it met all requirements listed above, Clark Street was suitable for this demonstration. Figure 1 shows the location of Clark Street and Figure 2 is a photo of the street.

Figure 1. Demonstration site, Clark Street in Easthampton, Mass. (shown in red)

Figure 2. A view of Clark Street looking east

2.2. Existing luminaires

Clark Street was equipped with 19 HPS luminaires of the type shown in Figure 3. This study used seven of the 19 luminaires between Laura Street and Admiral Street. These luminaires were installed at a height approximately 8.2 meters (27 feet) from the road pavement and approximately 61 meters (200 feet) apart. Figure 4 shows the layout of the luminaires. Table 2 summarizes specifications for the lamp, ballast, and luminaire. As the table shows, each HPS luminaire system required 86W input power. Each luminaire has a photosensor so that it can be automatically turned on or off according to ambient illuminance.

Figure 3. Existing HPS luminaire

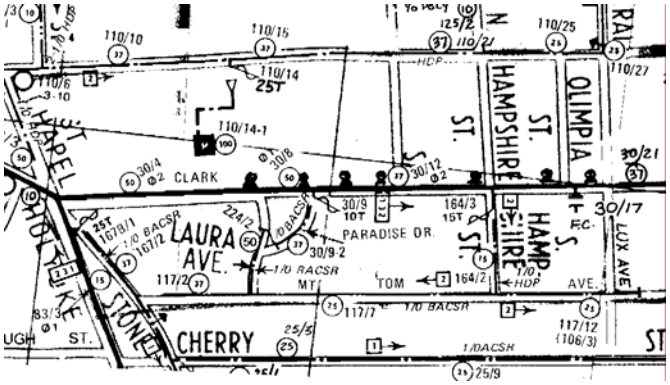

Figure 4. Luminaire layout along Clark Street

Table 2. Specification of existing HPS luminaires

Item	Description	Product #	Manufacturer
Lamp	HPS, 70 W, 6300 lm	LU70/MED	GE Lighting Systems
Ballast	Magnetic ballast, 120 V, 60 Hz, input power: 86 W	S0070-02C-511	Howard Industries
Luminaire	Semi-cutoff, cobrahead luminaire	M2RR07S1N2AMS2	GE Lighting Systems

2.3. Selection of luminaire and lamps

As the unified photometry system suggests, lamps with relatively more short-wavelength output perform better at mesopic light levels than current photometry estimates. For nominally white light sources, higher correlated color temperature (CCT) lamps usually have more short-wavelength output than those with lower CCT. Therefore, it is believed that higher CCT lamps perform better than current illuminance or luminance meters indicate. However, to estimate the performance of a given lamp at mesopic light levels compared to their photopic performance, the ratio of scotopic luminance to photopic

luminance (S/P ratio) is more accurate than CCT. As the S/P ratio of lamps increases, the mesopic efficacy of the lamps improves.

Using the S/P ratio as an input variable for calculating mesopic efficacy, LRC researchers sought an efficacious lamp at mesopic light levels among fluorescent lamps because it is easy to control their S/P ratios without impairing color rendering properties. In addition, fluorescent lamps have less initial cost than HPS lamps. A potential downside of fluorescent lamps is reduced output at lower temperatures. It was not yet clear how well fluorescent lamps would perform in closed luminaires at cold temperatures. To examine lamp performance in cold weather, the researchers planned to measure illuminances when the temperature was below the freezing point.

The fluorescent lamps for this study had to meet two requirements—the lamps should have (1) a high S/P ratio and (2) a "unified" luminous flux equivalent to HPS lamps. To achieve the high S/P ratio, a 6500 K fluorescent product line (Paclantic International) was chosen with an S/P ratio of 2.88 (compared to 0.65 for the existing HPS lamps). Figure 5 shows the SPD of the fluorescent product line. To calculate "unified" luminous flux, however, it is important to know the ambient luminance to which human eyes adapt at the demonstration site.

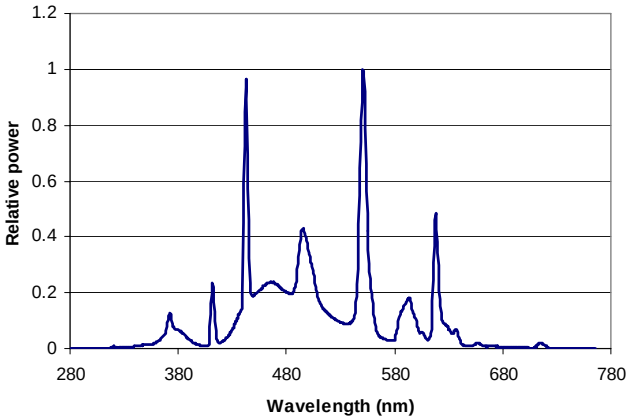

Figure 5. Spectral power distribution of fluorescent lamp

Horizontal photopic illuminance levels were measured across Clark Street every 3.6 meters (12 feet) and every 3 meters (10 feet) along the street between two luminaires, creating a grid 7.2 meters (24 feet) wide by 61 meters (200 feet) long between Laura Avenue and Paradise Drive. Table 3 shows the results of the illuminance measurements. The average illuminance of the measured area was approximately 3.4 lx. The average luminance of the roadway surface is approximately 0.08 cd/m^2, assuming the typical reflectance of asphalt is 7% (Gillet and Rombauts 2001). If the value of 0.08 cd/m^2 is used for the average luminance, the calculation result suggests a very large potential for energy savings by using this fluorescent technology. However, it was unknown how well the average luminance on the pavement could represent the overall brightness perception on the street. Therefore, this study used a higher and more conservative photopic luminance value for the calculation of power and control luminance: 0.3 cd/m^2. The 0.3

cd/m^2 luminance is also recommended by the IESNA as a maintained luminance for local residential streets (Rea 2000).

Table 3 Photopic illuminance distribution of HPS lighting (lx)

Distance Foot (m)	Edge 0' (0.0)	Center 12' (3.6)	Edge 24' (7.2)
0 (0.0)	10.00*	14.80	7.50
10 (3.0)	7.30	11.00	5.20
20 (6.1)	6.10	10.50	3.20
30 (9.1)	3.00	5.90	4.30
40 (12.2)	3.20	4.00	3.60
50 (15.2)	1.00	2.90	3.20
60 (18.3)	0.60	2.30	2.80
70 (21.3)	0.50	1.50	2.00
80 (24.4)	0.40	0.80	1.00
90 (27.4)	0.20	0.50	0.60
100 (30.5)	0.20	0.50	0.60
110 (33.5)	0.30	1.00	1.10
120 (36.6)	0.40	1.30	1.50
130 (39.6)	0.60	1.40	1.50
140 (42.7)	0.90	1.80	1.70
150 (45.7)	1.20	2.20	2.50
160 (48.8)	1.50	2.80	3.50
170 (51.8)	2.80	4.80	3.00
180 (54.9)	5.30	7.20	3.30
190 (57.9)	5.10	8.60	4.40
200 (61.0)	6.70*	9.50	6.00

* Illuminances measured directly below luminaire

The results of the power and luminance calculations are shown in Table 4. When the photopic luminance of the roadway pavement under HPS lighting (S/P = 0.65) is 0.3 cd/m^2, the equivalent mesopic luminance under the same lighting condition is 0.22 cd/m^2. Conversely, when the equivalent mesopic luminance of the pavement under fluorescent lighting (S/P = 2.88) is 0.22 cd/m^2, the photopic luminance is 0.18 cd/m^2. Hence, only 3900 photopic lumens are required for each new fluorescent luminaire to create a mesopic luminance of 0.22 cd/m^2, while an HPS luminaire needs 6300 photopic lumens to create the same mesopic luminance.

Table 4 Comparison between HPS and fluorescent systems in photopic and mesopic luminances

	Mesopic luminance (cd/m^2)	S/P ratio	Photopic luminance (cd/m^2)	Luminous flux (lm)	Lamp input power (W)
HPS	0.22	0.65	0.30	6300	70
Fluorescent	0.22	2.88	0.18	3900	49

Among the lamps in the 6500 K fluorescent product line described above, a 55W, T5 biaxial fluorescent lamp could achieve the lumens of 3900 lm (the actual light output of the lamp was measured at 4000 lm). The input power to the fluorescent lamp-ballast system was 60W compared to 85W with the HPS lamp-ballast system, resulting in a 30%

power reduction. Based on the calculation, the LRC chose this fluorescent lamp for the replacement of the existing HPS lamps. In addition to energy conservation, the fluorescent system has additional expectable advantages over HPS lamps. The fluorescent luminaires have a sharper cutoff angle resulting in less glare. The color rendering index (CRI) of the fluorescent lamps was 78 compared to 22 for the HPS lamps. It was expected that color appearance of traffic signs, vegetation, and vehicles would be improved by the lamp replacement. Additionally, the good color rendering property of the fluorescent lamps would enhance the perception of brightness, safety, and security in the street.

The LRC chose fluorescent luminaire equipped with a parabolic high-reflectance aluminum reflector and a full-cutoff flat lens (Table 5). The luminaire is shown in Figure 6. Subsequently, the flat lens was changed to a drop lens (Figure 7) for a reason described later. Each luminaire was equipped with a photosensor identical to the one used with the existing HPS luminaire (Figure 3).

Table 5. Fluorescent system details

	Description	Product #	Manufacturer
Lamp	55W 6500K T5 biax fluorescent lamp, 4000 lm	Prototype	Paclantic International
Ballast	Electronic ballast for FT55W/2G11 (input power: 59 W)	B254PUNV-D	Universal Lighting Technologies
Luminaire	Flat lens luminaire (changed into drop lens before the second questionnaire evaluation)	W4T55496EB	Magnaray International

Figure 6. Fluorescent luminaire with flat lens

Figure 7. Fluorescent luminaire with drop lens

2.4. Evaluation method

To compare the HPS and fluorescent lamps, the LRC issued questionnaires before and after the installation to residents who lived along and near the street. Each of the first and the second questionnaire sheets contained 18 questions. The questions in both sets were nearly identical to each other to allow for a comparison of the before- and after-replacement responses. Appendices 1 and 2 show the first and second questionnaire sheets respectively. Both questionnaires sheets were sent by mail. A self-addressed envelope was enclosed in each mailing so that the residents could easily send their responses back to the LRC. To further encourage residents' participation, WMECO offered a $25 gift certificate to each participant responding to both surveys.

2.5. Procedure

The schedule of this study is listed below:

Jul. 30	Representatives of the town of Easthampton, WMECO, and the LRC had a meeting and chose Clark Street as a demonstration site.
Sep. 17	WMECO, the town of Easthampton, and the LRC held a meeting with residents. The LRC measured illuminance distribution on Clark Street. WMECO and the LRC sent questionnaire sheets to approximately 70 nearby residents.
Oct. 8	The LRC received 30 responses out of the 70 residents and analyzed the data. The LRC prepared the luminaires (wiring and attaching sensors).
Oct. 10	WMECO replaced the HPS luminaires with fluorescent luminaires.
Nov. 18	The LRC sent postcards to let participants know the delay caused by lens replacement.
Dec. 17	WMECO replaced flat lenses with drop lenses.
Dec. 19	The LRC measured illuminance distribution on Clark Street.
Jan. 9	The LRC sent the second questionnaire sheets to the 30 participants.
Feb. 2	The LRC measured illuminance distribution at a temperature of 15°F and took pictures.
Feb. 10	The LRC received 25 responses out of the 30 first-respondents. WMECO provided gift certificates to the 25 participants.
Feb. 15	WMECO restored HPS luminaires. The LRC analyzed the data.

Prior to the replacement of the HPS lighting, the LRC first conducted a field survey, measured illuminance distribution and took photographs along the street. The illuminance measurements were conducted between the two luminaires as described previously. In

addition, to evaluate luminaire luminous intensity distribution around a luminaire located at the intersection of Paradise Drive and Clark Street, illuminance levels were also measured every 1.8 meters (6 feet) across the street and 1.5 meters (5 feet) along the street covering a grid 10.2 meters (36 feet) wide and 12 meters (40 feet) long.

On September 17, 2004, WMECO called a meeting with nearby residents at the community center on Clark Street. Approximately 15 residents attended the meeting (Appendix 3). At the meeting, Mayor Michael Tautznik of Easthampton spoke to the attendees and encouraged their participation in the demonstration. Then the representatives from the LRC explained the replacement procedure and the demonstration schedule and provided the first questionnaires to the attendees. On the next day following the meeting, WMECO sent the first questionnaires to the remainder of the residents for the LRC. In total, 70 residents received the initial surveys. By October 8, the LRC had received 30 responses from the 70 recipients.

On October 10, 2003, WMECO replaced the existing HPS luminaires with the above described fluorescent luminaires. However, LRC researchers observed the street and found that the area illuminated by the flat lens fluorescent luminaires appeared dark due to their low luminaire brightness (Akashi 2003b). Contrarily, the semi-cutoff beam distribution of the initial HPS cobrahead luminaires, emitting light sideward, increased the brightness perception of the street. To make a fair comparison between HPS and fluorescent systems, researchers decided to replace the flat lens with a drop lens having a semi-cutoff luminous intensity distribution. The LRC sent postcards to the participants notifying them of potential delay caused by the lens replacement. Magnaray International prepared seven drop lenses for replacement. On December 17, 2003, WMECO completed the replacement. Once again, LRC researchers measured illuminance distribution in the same manner as done for the HPS lighting on September 17, 2003. The temperature was near the freezing point (0°C/32°F) when the measurements were made.

After several weeks, the LRC sent a second questionnaire to the 30 participants on January 9, 2004. By the middle of the February, the LRC received 25 responses out of the 30 participants. WMECO provided $25 gift certificates to each of the 25 participants. To examine the performance of the fluorescent system, the LRC chose a colder day at a temperature of approximately 15°F and measured illuminance distribution around a luminaire on Paradise Drive. Finally, WMECO restored the HPS lamps on February 15, 2004.

In Appendix 4, Figures A4-1, A4-2, and A4-3 show views of the initial HPS lighting, the fluorescent lighting with flat lenses, and the fluorescent lighting with drop lenses.

2.6. Results of illuminance measurements

Table 3 and Figure A5-1 (Appendix 5) show the photopic illuminance distribution between the two luminaires in the initial HPS condition. Figure A6-1 (Appendix 6) shows the results of the photopic illuminance measurements near the luminaire on the Paradise Drive. For the new fluorescent systems with drop lenses, Table 6, Figure A5-2 (Appendix 5), and Figure A6-2 (Appendix 6) show the results of the illuminance measurements.

A comparison in illuminance distributions between the two luminaires suggests that the average illuminance was 2.8 lx compared to 3.4 lx for the HPS lamps, meaning that the average illuminance of the fluorescent system was approximately 20% lower than the average illuminance of the HPS lighting. On Paradise Drive, Figures A6-1 and A6-2 demonstrate that the fluorescent system had much narrower illuminance distribution and higher illuminance levels just below the luminaire than those of the HPS system.

Illuminance measurement results under a colder temperature condition (15°F, or -9.40°C) on February 2, 2004 are shown in Figure A6-3 (Appendix 6). As the figure suggests, the average illuminance was 35% lower than the previous measurements (at 32°F). Therefore, the average illuminance between the two poles could be around 1.8 lx, or approximately 45% lower than the HPS lighting (3.4 lx) under the low temperature condition. Since it was very cold while the fluorescent systems were installed, the average illuminance may have been lower than the initial photopic illuminance measurement of 2.8 lx. However, the input power of fluorescent lamps may have also been decreased in proportion to the reduction in output as described later.

Table 6. Illuminance distribution of fluorescent system (lx)

Distance Foot (m)	Edge 0' (0.0)	Center 12' (3.6)	Edge 24' (7.2)
0 (0.0)	25.00*	20.10	6.60
10 (3.0)	14.30	10.50	3.70
20 (6.1)	5.20	4.10	2.10
30 (9.1)	2.04	1.80	1.05
40 (12.2)	0.82	0.68	0.68
50 (15.2)	0.75	0.33	0.45
60 (18.3)	0.19	0.17	0.16
70 (21.3)	0.12	0.10	0.08
80 (24.4)	0.09	0.08	0.10
90 (27.4)	0.15	0.08	0.08
100 (30.5)	0.08	0.06	0.09
110 (33.5)	0.12	0.07	0.06
120 (36.6)	0.09	0.08	0.03
130 (39.6)	0.10	0.08	0.10
140 (42.7)	0.17	0.15	0.16
150 (45.7)	0.37	0.37	0.33
160 (48.8)	0.71	0.60	0.65
170 (51.8)	1.56	1.62	1.29
180 (54.9)	3.62	3.56	2.29
190 (57.9)	8.55	8.40	4.56
200 (61.0)	17.60*	13.50	6.10

* Illuminances measured directly below luminaires

2.7. Results of evaluation

The analysis of the evaluation data took the mean and median of five-point rating data over the 30 responses for the HPS and 25 responses for the fluorescent lighting. Figures 8

and 9 show the evaluation data for the 18 questions. A comparison of the before- and after-replacement evaluations suggests, on the average, that the fluorescent system was evaluated as better than the HPS lighting on all questions. The results of the medians also suggest that the fluorescent system was better than (on 13 questions) or the same as (on 5 questions) the HPS lighting.

To examine statistically significant differences between the two lighting conditions, a paired t-test was applied to each of the 18 questions by using the 25 response data. Table 7 shows the results of the statistical analysis as well as the mean and standard deviations of the evaluations of the 25 participants for the 18 questions. Appendix 7 details the results of the t-tests. From Table 7, the data again shows that the mean of the 25 responses for the fluorescent system were better than those for the HPS lighting. The results of the t-tests suggests that the difference in evaluation between the HPS lighting and the fluorescent system was statistically significant in terms of questions 2: comfort, 3: brightness, 4: gloom, 5: luminaire glare, 6: color appearance of traffic signs, 7: color appearance of vegetation, 8: too warm light color, 11: pavement visibility from drivers, 13: pedestrian visibility from drivers, 14: safe feeling while driving, 15: pedestrian visibility from pedestrians, 16: face visibility from pedestrians, and 18: secure feeling while walking. Regarding preference (question 1) and comprehensive evaluation (question 20), no significant difference was found between the HPS and the fluorescent lighting although, on average, the fluorescent lighting was better than the HPS lighting.

Consequently, the results of the evaluations suggested under the fluorescent lighting condition:

- The street appeared brighter and more comfortable;
- The luminaires caused less glare;
- Colors of traffic signs appeared more clearly;
- Vegetation colors looked more natural;
- Pavement visibility, pedestrian visibility, and perception of safety while driving were improved;
- Pedestrian visibility, facial recognition, and perception of security while walking were improved

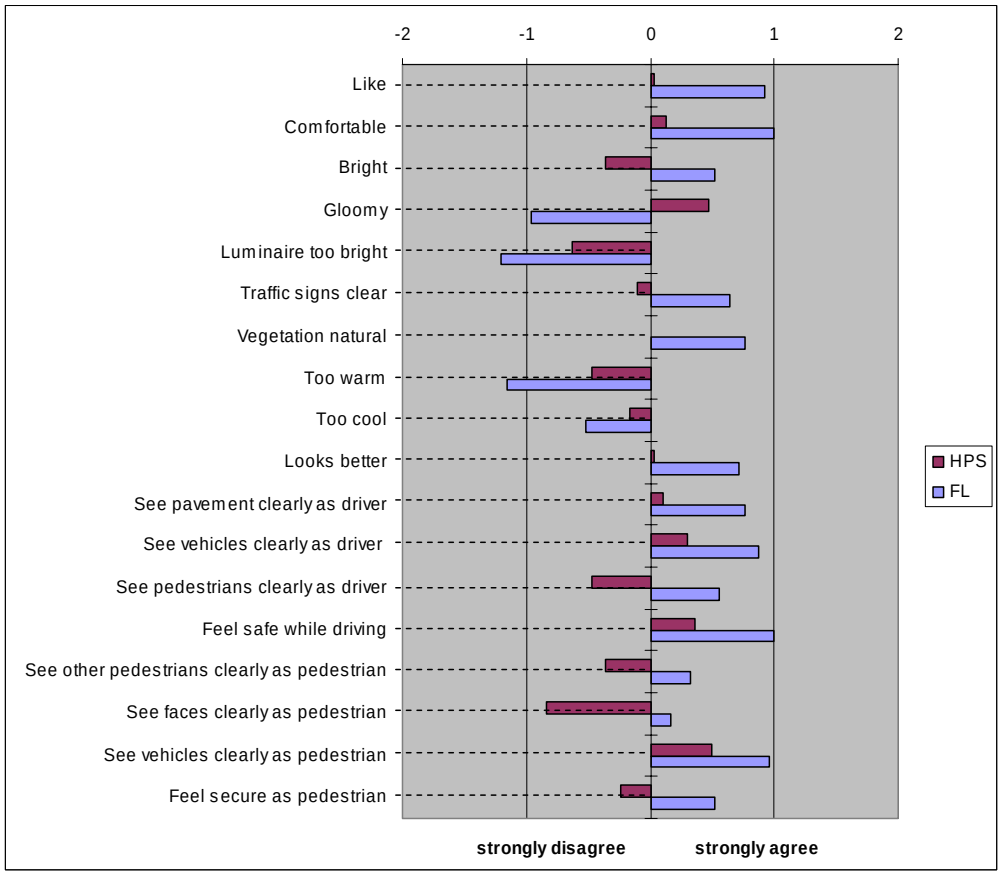

Figure 8. Mean evaluation results (30 responses for HPS and 25 responses for fluorescent lighting)

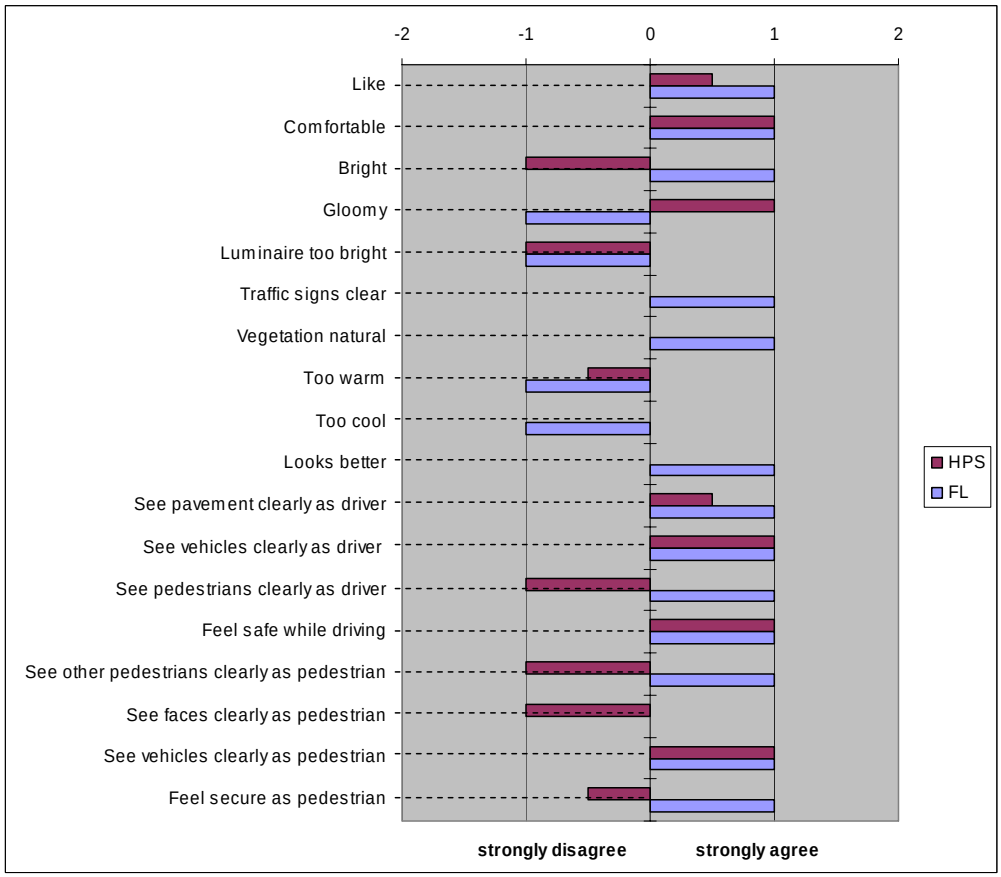

Figure 9. Median evaluation results (30 responses for HPS and 25 responses for fluorescent lighting)

Table 7. Results of evaluations: mean, standard deviation, and results of paired t-tests (25 responses for both HPS and fluorescent lighting conditions)

#	Questions	HPS		FL		p-value
		Mean	SD	Mean	SD	
1	Like	0.08	1.222	0.92	1.288	0.054
2	Comfortable	0.2	1.118	1	1.08	0.020 *
3	Bright	-0.4	1.118	0.52	1.262	0.015 *
4	Gloomy	0.48	1.262	-0.96	1.172	0.000 **
5	Luminaire too bright	-0.6	1.041	-1.2	0.957	0.040 *
6	Traffic signs clear	-0.04	1.136	0.64	0.995	0.038 *
7	Vegetation natural	-0.08	1.152	0.76	0.831	0.018 *
8	Too warm	-0.32	0.9	-1.16	1.028	0.002 **
9	Too cool	-0.16	0.943	-0.52	1.358	0.280
10	Looks better	0.08	1.038	0.72	1.37	0.111
11	See pavement clearly as driver	0.16	1.143	0.76	0.831	0.049 *
12	See vehicles clearly as driver	-0.56	1.158	0.56	0.87	0.067
13	See pedestrians clearly as driver	0.44	0.917	1	0.764	0.000 **
14	Feel safe while driving	-0.36	1.15	0.32	1.03	0.010 *
15	See other pedestrians clearly as pedestrian	-0.92	0.997	0.16	1.179	0.047 *
16	See faces clearly as pedestrian	0.64	0.907	0.96	0.676	0.001 **
17	See vehicles clearly as pedestrian	-0.2	1.118	0.52	0.872	0.175
18	Feel secure as pedestrian	0.08	1.222	0.92	1.288	0.005 **

*p<0.05, **p<0.01

3. DISCUSSION

3.1. Calculation of mesopic luminance

As previously described, this study measured photopic illuminance distributions for the HPS and fluorescent lighting. By using those measurements, this study tried to calculate the "unified" luminance to which human eyes actually adapted. However, it is unknown to what luminance human eyes adapt while driving and walking along streets which have non-uniform, complex luminance distributions. This study assumed that human eyes would adapt to the average luminance of each unit area (3.2 meters by 3.0 meters) corresponding to the measurement grid of the study. Another assumption made in this calculation was that the asphalt surface has the perfect diffuse reflection characteristics with a reflectance of 7% (Gillet and Rombauts 2001). Based on those assumptions, this calculation first obtained photopic luminance distributions on the pavement. Table 8 shows the photopic luminances for the HPS and the fluorescent lighting.

Table 8. Photopic luminance distribution of HPS and fluorescent systems (cd/m^2)

Distance		Edge 0' (0.0)		Center 12' (3.6)		Edge 24' (7.2)	
Foot	(m)	HPS	FL	HPS	FL	HPS	FL
0	(0.0)	0.223*	0.577*	0.330	0.508	0.167	0.249
10	(3.0)	0.163	0.413	0.245	0.340	0.116	0.164
20	(6.1)	0.136	0.210	0.234	0.177	0.071	0.105
30	(9.1)	0.067	0.103	0.131	0.093	0.096	0.058
40	(12.2)	0.071	0.047	0.089	0.040	0.080	0.040
50	(15.2)	0.022	0.043	0.065	0.020	0.071	0.027
60	(18.3)	0.013	0.012	0.051	0.011	0.062	0.010
70	(21.3)	0.011	0.008	0.033	0.006	0.045	0.005
80	(24.4)	0.009	0.006	0.018	0.005	0.022	0.006
90	(27.4)	0.004	0.009	0.011	0.005	0.013	0.005
100	(30.5)	0.004	0.005	0.011	0.004	0.013	0.006
110	(33.5)	0.007	0.008	0.022	0.004	0.025	0.004
120	(36.6)	0.009	0.006	0.029	0.005	0.033	0.002
130	(39.6)	0.013	0.006	0.031	0.005	0.033	0.006
140	(42.7)	0.020	0.011	0.040	0.010	0.038	0.010
150	(45.7)	0.027	0.022	0.049	0.022	0.056	0.020
160	(48.8)	0.033	0.041	0.062	0.035	0.078	0.038
170	(51.8)	0.062	0.082	0.107	0.085	0.067	0.070
180	(54.9)	0.118	0.161	0.160	0.159	0.074	0.113
190	(57.9)	0.114	0.297	0.192	0.293	0.098	0.191
200	(61.0)	0.149*	0.469*	0.212	0.399	0.134	0.235

*Illuminances measured directly below luminaires

Using the unified photometry system, the photopic luminances in Table 8 were converted into "unified" luminances in Table 9. The averaged "unified" luminance of the fluorescent system was 0.097 cd/m^2 compared to 0.059 cd/m^2 for the HPS system. Those values suggest that luminance to which human eyes might adapt to under the fluorescent lighting condition was approximately 40% higher than adaptation luminance under the HPS lighting. A recent study suggested that an illuminance change of over 20% is noticeable by 50% of the people (Akashi and Neches 2004).

Table 9. Unified luminance distribution of HPS and fluorescent systems (cd/m^2)

Distance		Edge 0' (0.0)		Center 12' (3.6)		Edge 24' (7.2)	
Foot	(m)	HPS	FL	HPS	FL	HPS	FL
0	(0.0)	0.187*	0.577*	0.297	0.508	0.134	0.249
10	(3.0)	0.130	0.413	0.209	0.340	0.088	0.164
20	(6.1)	0.106	0.210	0.198	0.177	0.051	0.105
30	(9.1)	0.048	0.103	0.102	0.093	0.071	0.058
40	(12.2)	0.051	0.047	0.066	0.040	0.059	0.040
50	(15.2)	0.015	0.043	0.046	0.020	0.051	0.027
60	(18.3)	0.009	0.012	0.036	0.011	0.045	0.010
70	(21.3)	0.007	0.008	0.023	0.006	0.031	0.005
80	(24.4)	0.006	0.006	0.012	0.005	0.015	0.006
90	(27.4)	0.003	0.009	0.007	0.005	0.009	0.005
100	(30.5)	0.003	0.005	0.007	0.004	0.009	0.006
110	(33.5)	0.004	0.008	0.015	0.004	0.017	0.004
120	(36.6)	0.006	0.006	0.020	0.005	0.023	0.002
130	(39.6)	0.009	0.006	0.021	0.005	0.023	0.006
140	(42.7)	0.014	0.011	0.028	0.010	0.026	0.010
150	(45.7)	0.018	0.022	0.034	0.022	0.039	0.020
160	(48.8)	0.023	0.041	0.045	0.035	0.057	0.038
170	(51.8)	0.045	0.082	0.081	0.085	0.048	0.070
180	(54.9)	0.090	0.161	0.128	0.159	0.053	0.113
190	(57.9)	0.086	0.297	0.157	0.293	0.073	0.191
200	(61.0)	0.118*	0.469*	0.176	0.399	0.104	0.235

* Illuminances measured directly below luminaires

The unified photometry system may also allow us to more appropriately evaluate luminance uniformity on the pavement. Using current photopic photometry, the luminance uniformity (L_{ave}/L_{min}) of the HPS lighting had a ratio of 17 and the fluorescent lighting 86. Using unified photometry, the luminance uniformity (L_{ave}/L_{min}) of the HPS lighting had a ratio of 20 and the fluorescent lighting 46. This suggests that the use of lamps with higher S/P ratios can improve the "unified" luminance uniformity on the pavement. This may overcome a disadvantage of fluorescent lamps that their larger lamp sizes make their optical control more difficult than HPS lamps.

3.2. Limitations of this demonstration

The results of this demonstration study indicated that the unified photometry functioned well in a real street context. However, there were several factors that could not be controlled during the experiment. One of the issues was that the fluorescent system provided less uniform light distribution than the HPS system. This was because the fluorescent luminaire was designed for fence lighting and not optimized for street lighting. The luminous intensity distribution of the luminaire was too narrow for the mounting height of 8.2 meters (27 feet), although it is unclear how the non-uniform luminance distribution influenced the evaluation. To better assess the fluorescent luminaire system, a different angular distribution should be demonstrated.

Second, as the measurements suggested, low temperatures (0°F to 32°F) reduced the output of the fluorescent lamps. Illuminance reduction caused by the low temperature might have affected the evaluations. Nonetheless, the results of the evaluations proved

that most participants felt that the fluorescent lighting condition was brighter. Also, during the demonstration, there were no complaints from residents or town officials. Figure 10 shows the relative output of T8 and T5 linear fluorescent lamps as a function of ambient temperature (Akashi 2003a). As the figure suggests, T8 and T5 lamps are optimized at temperatures of 25°C and 35°C. If the ambient temperature is higher or lower than the optimal temperature, the output of those lamps is decreased. The input power is also reduced in proportion to the decrease of the output. For a more accurate energy-efficiency evaluation of fluorescent lighting systems, it is necessary to examine the profile of output and input power of fluorescent lamps in closed fixtures at both high and low temperatures.

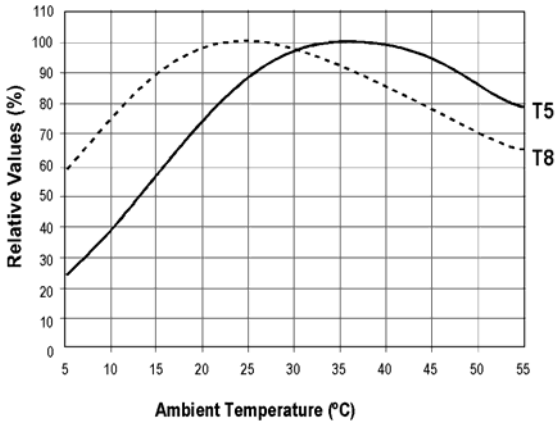

Figure 10. Relative light output variation as a function of ambient temperature for T5 and T8 fluorescent lamps.

(This diagram is based on SILHOUETTE T5, T5HO & T5 Circular Fluorescent Lamp Technology Guide, Philips Lighting)

The influence of seasonal factors such as color of leaves, fallen leaves, and fallen snow pose potential problems. These factors were uncontrollable and their influence on the evaluations is unknown. To avoid these problems in future studies, it is important to compare both lighting conditions simultaneously throughout the year.

This study used fluorescent lamps because they are relatively easy to change their SPD by selecting phosphors and their proportions. However, high intensity discharge lamps such as metal halide lamps with a high S/P ratio can also replace HPS lamps in the same contexts.

4. CONCLUSIONS

This study successfully demonstrated how the use of a unified photometry system can conserve street lighting energy in rural areas. Fluorescent lamps with a high S/P ratio (2.88) reduced power by at least 30% relative to conventional HPS street lighting. The results of the evaluations suggested, on the average, that the fluorescent lighting system was evaluated as better than the HPS lighting for all 18 questions and that, on 13 of the 18 questions, the difference in evaluation between the fluorescent lighting and HPS

lighting was statistically significant. Consequently, the results of the evaluations suggested under the fluorescent lighting condition: the street appeared brighter and more comfortable; the luminaires caused less glare; colors of traffic signs appeared more clearly; vegetation colors looked more natural; pavement visibility, pedestrian visibility, and perception of safety while driving were improved; pedestrian visibility, facial recognition, and perception of security while walking were improved. Therefore, this demonstration supported the used of the unified photometry in a street lighting context.

ACKNOWLEDGEMENTS

This demonstration study was supported by the United States Environmental Protection Agency. The authors would like to acknowledge Easthampton Mayor Michael Tautznik; Paul P. Tangredi, John E. Scanlon, and Elizabeth of Western Massachusetts Electric Company for their collaboration. The authors would like to thank Larry Leetzow of Magnaray International, Inc. and Jack Johng of Paclantic International, Inc. for their donation of prototype luminaires and lamps respectively. Mariana Figueiro, Martin Overington, Dennis Guyon, and Jennifer Taylor of the Lighting Research Center made valuable contributions to this demonstration study.

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Appendix 1: First questionnaire sent September 18, 2003

Questionnaire on Lighting of Clark Street in Easthampton, Massachusetts:
A demonstration project sponsored by the U.S. Environmental Protection Agency

Yukio Akashi, Mark Rea, Peter Morante
Lighting Research Center, Rensselaer Polytechnic Institute, 21 Union Street, Troy, NY 12180

The Lighting Research Center (LRC), in partnership with the Western Massachusetts Electric Company (WMECO) and the Town of Easthampton, will conduct an energy efficient lighting demonstration. The LRC and WMECO will temporally replace existing high pressure sodium lamps with fluorescent lamps for the seven of the 19 poles along Clark Street (between Laura St. and Admiral St.) Before replacing the lighting, we would like to know your opinions on the street. Please observe the street and the lighting at night, then, circle the number which most closely describes the degree of your agreement with each statement— -2: strongly disagree, -1: disagree, 0: neutral, +1: agree, +2: strongly agree. Then, please return this sheet to us by September 26th, 2003.

Overall

12. I like the lighting on Clark Street.	(-2 -1 0 +1 +2)
13. The lighting on Clark Street is comfortable.	(-2 -1 0 +1 +2)
14. Clark Street looks bright.	(-2 -1 0 +1 +2)
15. Clark Street looks gloomy.	(-2 -1 0 +1 +2)
16. The light fixtures on the poles in Clark Street are too bright.	(-2 -1 0 +1 +2)
17. Colors of traffic signs along Clark Street appear clear.	(-2 -1 0 +1 +2)
18. Colors of vegetation along Clark Street look natural.	(-2 -1 0 +1 +2)
19. The lighting on Clark Street is too warm in color for a street.	(-2 -1 0 +1 +2)
20. The lighting on Clark Street is too cool in color for a street.	(-2 -1 0 +1 +2)
21. The lighting of the street looks better than others.	(-2 -1 0 +1 +2)

As a driver, with this lighting,

11. I can see the roadway pavement on Clark Street clearly.	(-2 -1 0 +1 +2)
12. I can see other vehicles approaching on Clark Street clearly.	(-2 -1 0 +1 +2)
13. I can see pedestrians approaching on Clark Street clearly.	(-2 -1 0 +1 +2)
14. I feel safe while driving along Clark Street.	(-2 -1 0 +1 +2)

As a pedestrian, with this lighting,

15. I can see other pedestrians approaching on Clark Street clearly.	(-2 -1 0 +1 +2)
16. I can see faces of pedestrians on Clark Street clearly.	(-2 -1 0 +1 +2)
17. I can see vehicles approaching on Clark Street clearly.	(-2 -1 0 +1 +2)
18. I feel secure while walking on the sidewalk of Clark Street.	(-2 -1 0 +1 +2)

If you have any questions and comments, please feel free to contact Yukio Akashi at 518-687-7126 (akashy@rpi.edu). Thank you for your time and cooperation.

Appendix 2: Second questionnaire sent January 9, 2004

Lighting Questionnaire for Clark Street, Easthampton, Massachusetts
A demonstration project sponsored by the U.S. Environmental Protection Agency

Lighting Research Center, Rensselaer Polytechnic Institute, 21 Union Street, Troy, NY 12180

Thank you for your participation in the energy efficient lighting demonstration that the Lighting Research Center (LRC) is conducting with the Western Massachusetts Electric Company (WMECO) and the Town of Easthampton. The LRC and WMECO temporarily replaced the original orange-colored light bulbs with white light bulbs for the seven of the 19 poles along Clark Street (between Laura Avenue and Admiral Street) in October 2003. Then, we slightly modified the lenses of the white light fixtures in December 2003. Now, we would like to know your opinions of the current white street lighting. Please observe the street and the lighting at night, then, circle the number which most closely describes the degree of your agreement with each statement:

-2: strongly disagree, -1: disagree, 0: neutral, 1: agree, 2: strongly agree.

Then, please return this sheet with the enclosed envelope to us by January 31st, 2004.

Overall for the new white lighting,

22. I like the new white lighting on Clark Street.	-2	-1	0	1	2
23. The lighting on Clark Street is comfortable.	-2	-1	0	1	2
24. Clark Street looks bright.	-2	-1	0	1	2
25. Clark Street looks gloomy.	-2	-1	0	1	2
26. The light fixtures on the poles in Clark Street are too bright.	-2	-1	0	1	2
27. The colors of traffic signs along Clark Street appear clear.	-2	-1	0	1	2
28. The colors of vegetation along Clark Street look natural.	-2	-1	0	1	2
29. The lighting on Clark Street is too warm (orange) in color for a street.	-2	-1	0	1	2
30. The lighting on Clark Street is too cool (blue) in color for a street.	-2	-1	0	1	2
31. The new lighting of the street looks better than the old lighting (you may also compare the new lighting with the orange-colored lighting along Clark Street between Charles St. and East St.).	-2	-1	0	1	2

As a driver, with this white lighting,

11. I can see the roadway pavement on Clark Street clearly.	-2	-1	0	1	2
12. I can see other vehicles approaching on Clark Street clearly.	-2	-1	0	1	2
13. I can see pedestrians approaching on Clark Street clearly.	-2	-1	0	1	2
14. I feel safe while driving along Clark Street.	-2	-1	0	1	2

As a pedestrian, with this white lighting,

15. I can see other pedestrians approaching on Clark Street clearly.	-2	-1	0	1	2
16. I can see faces of pedestrians on Clark Street clearly.	-2	-1	0	1	2
17. I can see vehicles approaching on Clark Street clearly.	-2	-1	0	1	2
18. I feel secure while walking on the sidewalk of Clark Street.	-2	-1	0	1	2

If you have any questions and comments, please feel free to contact Yukio Akashi at 518-687-7126 (akashy@rpi.edu). Thank you for your time and contribution.

Appendix 3: Meeting with nearby residents at Clark Street Community Center

Figure A3-1. Easthampton Mayor Michael Tautznik speaks at the meeting at the Clark street community center

Figure A3-2. Yukio Akashi of the LRC explains the demonstration procedure

Appendix 4: Views of lighting conditions

Figure A4-1. HPS lighting

Figure A4-2. Fluorescent lighting with flat lens

Figure A4-3. Fluorescent lighting with drop lens

Appendix 5: Photopic illuminance measurements between two luminaires

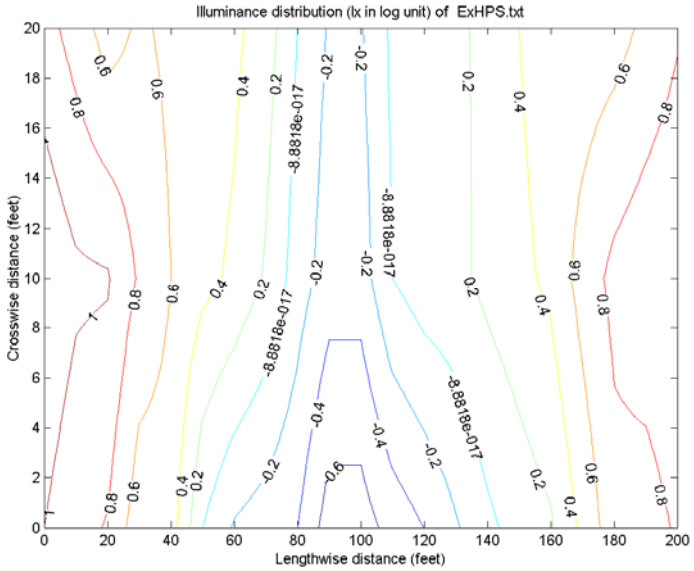

Figure A5-1. Illuminance distribution between two poles for HPS lighting (log lx)

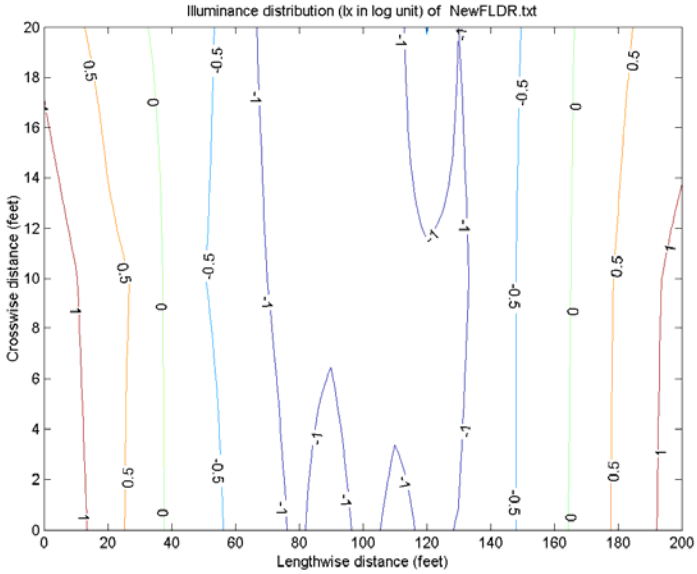

Figure A5-2. Illuminance distribution between two poles for fluorescent lighting (log lx)

Appendix 6: Photopic illuminance distribution near the luminaire at the intersection of Paradise Drive and Clark Street.

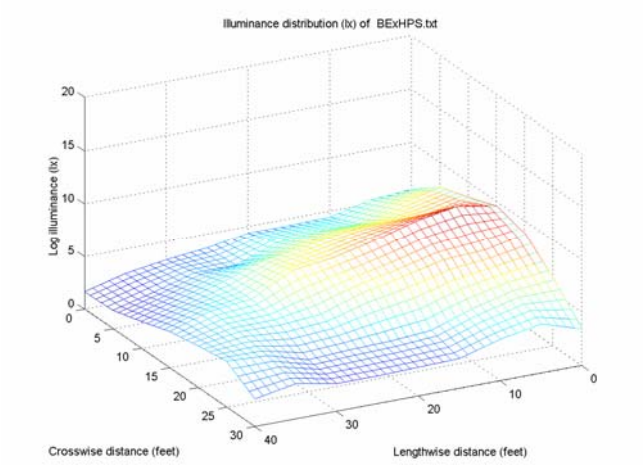

Figure A6-1. Illuminance distribution around a pole for the existing HPS lighting (log lx)

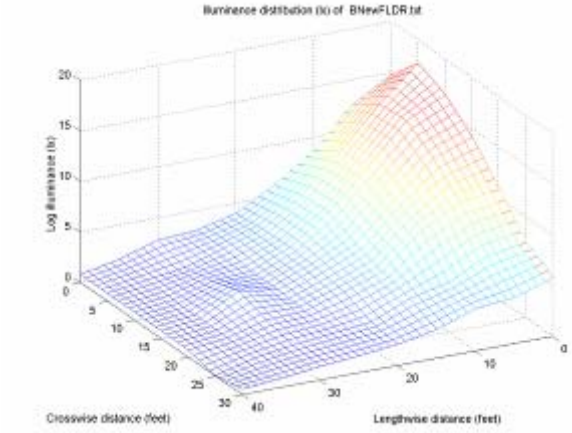

Figure A6-2. Illuminance distribution around a pole for the fluorescent lighting (log lx) (data measured at 32°F)

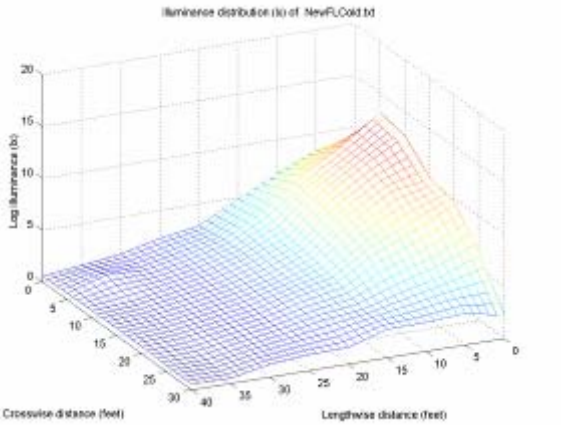

Figure A6-3. Illuminance distribution around a pole for the fluorescent lighting (log lx) (data measured at 15°F)

Appendix 7: Results of paired T-test and confidence interval

1. I like the lighting on Clark Street

	N	Mean	StDev	SE Mean
HPS	25	0.080	1.222	0.244
FL	25	0.920	1.288	0.258
Difference	25	-0.840	2.075	0.415

95% CI for mean difference: (-1.697, 0.017)
T-Test of mean difference = 0 (vs not = 0): T-Value = -2.02, P-Value = 0.054

2. The lighting on Clark Street is comfortable.

	N	Mean	StDev	SE Mean
HPS	25	0.200	1.118	0.224
FL	25	1.000	1.080	0.216
Difference	25	-0.800	1.607	0.321

95% CI for mean difference: (-1.463, -0.137)
T-Test of mean difference = 0 (vs not = 0): T-Value = -2.49, P-Value = 0.020*

3. Clark Street looks bright.

	N	Mean	StDev	SE Mean
HPS	25	-0.400	1.118	0.224
FL	25	0.520	1.262	0.252
Difference	25	-0.920	1.754	0.351

95% CI for mean difference: (-1.644, -0.196)
T-Test of mean difference = 0 (vs not = 0): T-Value = -2.62, P-Value = 0.015*

4. Clark Street looks gloomy.

	N	Mean	StDev	SE Mean
HPS	25	0.480	1.262	0.252
FL	25	-0.960	1.172	0.234
Difference	25	1.440	1.502	0.300

95% CI for mean difference: (0.820, 2.060)
T-Test of mean difference = 0 (vs not = 0): T-Value = 4.79, P-Value = 0.000**

5. The light fixtures on the poles in Clark Street are too bright.

	N	Mean	StDev	SE Mean
HPS	25	-0.600	1.041	0.208
FL	25	-1.200	0.957	0.191
Difference	25	0.600	1.384	0.277

95% CI for mean difference: (0.029, 1.171)
T-Test of mean difference = 0 (vs not = 0): T-Value = 2.17, P-Value = 0.040*

6. Colors of traffic signs along Clark Street appear clear.

	N	Mean	StDev	SE Mean
HPS	25	-0.040	1.136	0.227
FL	25	0.640	0.995	0.199
Difference	25	-0.680	1.547	0.309

95% CI for mean difference: (-1.319, -0.041)
T-Test of mean difference = 0 (vs not = 0): T-Value = -2.20, P-Value = 0.038*

7. Colors of vegetation along Clark Street look natural.

	N	Mean	StDev	SE Mean
HPS	25	-0.080	1.152	0.230
FL	25	0.760	0.831	0.166
Difference	25	-0.840	1.650	0.330

95% CI for mean difference: (-1.521, -0.159)
T-Test of mean difference = 0 (vs not = 0): T-Value = -2.55, P-Value = 0.018*

8. The lighting on Clark Street is too warm in color for a street.

	N	Mean	StDev	SE Mean
HPS	25	-0.320	0.900	0.180
FL	25	-1.160	1.028	0.206
Difference	25	0.840	1.214	0.243

95% CI for mean difference: (0.339, 1.341)
T-Test of mean difference = 0 (vs not = 0): T-Value = 3.46, P-Value = 0.002**

9. The lighting on Clark Street is too cool in color for a street.

	N	Mean	StDev	SE Mean
HPS	25	-0.160	0.943	0.189
FL	25	-0.520	1.358	0.272
Difference	25	0.360	1.630	0.326

95% CI for mean difference: (-0.313, 1.033)
T-Test of mean difference = 0 (vs not = 0): T-Value = 1.10, P-Value = 0.280

10. The lighting of the street looks better than others.

	N	Mean	StDev	SE Mean
HPS	25	0.080	1.038	0.208
FL	25	0.720	1.370	0.274
Difference	25	-0.640	1.934	0.387

95% CI for mean difference: (-1.438, 0.158)
T-Test of mean difference = 0 (vs not = 0): T-Value = -1.65, P-Value = 0.111

11. I can see the roadway pavement on Clark Street clearly while driving.

	N	Mean	StDev	SE Mean
HPS	25	0.160	1.143	0.229
FL	25	0.760	0.831	0.166
Difference	25	-0.600	1.443	0.289

95% CI for mean difference: (-1.196, -0.004)
T-Test of mean difference = 0 (vs not = 0): T-Value = -2.08, P-Value = 0.049*

12. I can see other vehicles approaching on Clark Street clearly.

	N	Mean	StDev	SE Mean
HPS	25	0.360	1.075	0.215
FL	25	0.880	0.726	0.145
Difference	25	-0.520	1.358	0.272

95% CI for mean difference: (-1.080, 0.040)
T-Test of mean difference = 0 (vs not = 0): T-Value = -1.92, P-Value = 0.067

13. I can see pedestrians approaching on Clark Street clearly while driving.

	N	Mean	StDev	SE Mean
HPS	25	-0.560	1.158	0.232
FL	25	0.560	0.870	0.174
Difference	25	-1.120	1.333	0.267

95% CI for mean difference: (-1.670, -0.570)
T-Test of mean difference = 0 (vs not = 0): T-Value = -4.20, P-Value = 0.000**

14. I feel safe while driving along Clark Street.

	N	Mean	StDev	SE Mean
HPS	25	0.440	0.917	0.183
FL	25	1.000	0.764	0.153
Difference	25	-0.560	1.003	0.201

95% CI for mean difference: (-0.974, -0.146)
T-Test of mean difference = 0 (vs not = 0): T-Value = -2.79, P-Value = 0.010*

15. I can see other pedestrians approaching on Clark Street clearly.

	N	Mean	StDev	SE Mean
HPS	25	-0.360	1.150	0.230
FL	25	0.320	1.030	0.206
Difference	25	-0.680	1.626	0.325

95% CI for mean difference: (-1.351, -0.009)
T-Test of mean difference = 0 (vs not = 0): T-Value = -2.09, P-Value = 0.047*

16. I can see faces of pedestrians on Clark Street clearly

	N	Mean	StDev	SE Mean
HPS	25	-0.920	0.997	0.199
FL	25	0.160	1.179	0.236
Difference	25	-1.080	1.412	0.282

95% CI for mean difference: (-1.663, -0.497)
T-Test of mean difference = 0 (vs not = 0): T-Value = -3.82, P-Value = 0.001**

17. I can see vehicles approaching on Clark Street clearly.

	N	Mean	StDev	SE Mean
HPS	25	0.640	0.907	0.181
FL	25	0.960	0.676	0.135
Difference	25	-0.320	1.145	0.229

95% CI for mean difference: (-0.792, 0.152)
T-Test of mean difference = 0 (vs not = 0): T-Value = -1.40, P-Value = 0.175

18. I feel secure while walking on the sidewalk of Clark Street.

	N	Mean	StDev	SE Mean
HPS	25	-0.200	1.118	0.224
FL	25	0.520	0.872	0.174
Difference	25	-0.720	1.173	0.235

95% CI for mean difference: (-1.204, -0.236)
T-Test of mean difference = 0 (vs not = 0): T-Value = -3.07, P-Value = 0.005**

Monthly Progress Reports

City of Austin - Austin Energy

Monthly Report #1

Monthly Progress Report to the State Energy Conservation Office (SECO)
Dates Covered: June 15, 2006 – July 31, 2006

SECO Contract #CM 637:

Demonstration and Evaluation of Fluorescent Outdoor Lighting

Program Overview

The purpose of this contract is for the City of Austin - Austin Energy (AE) to provide services to the Texas State Energy Conservation Office (SECO), Mr. Felix Lopez, P.E., Program Manager, pursuant to the U.S. Department of Energy (DOE) award number DE-FG48-04R806410, commencing on June 15, 2006 and ending April 30, 2007, to form a joint venture with the Lighting Research Laboratory of the Rensselaer Polytechnic Institute of New York (LRC). The objective of this joint venture is to study the feasibility and possible use of fluorescent street lighting technologies, the projected economic analysis, potential market opportunities, barriers to implementation, and technology transfer to other municipalities.

Up to Date Summary of Progress

Interlocal Contract CM637, between AE and SECO has been executed, and AE is currently negotiating and executing a sole-source contract with the LRC for the services as prescribed in ATTACHMENT A, STATEMENT OF SERVICES TO BE PERFORMED of that contract.

Status of Deliverables and Milestones:

Task 1: Negotiate a contract agreement with the Lighting Research Center (LRC) and provide a copy to SECO.

Status: In progress.

Task 2: Schedule a project kick-off meeting with SECO and LRC.

Status: Ongoing. This task cannot be scheduled until the LRC has executed their contract with the City of Austin – Austin Energy.

Task 3: Provide a brief summary of the fluorescent lighting technology with potential market opportunities, an economic analysis, barriers of the implementation phase, and technology transfer to other municipalities in Texas.

Status: Ongoing.

Task 4: Provide a project summary presentation that include Austin Energy's plan to expand the fluoresecent lighting testing or its market deployment.

Status: Ongoing.

Task 5: Provide monthly progress reports.

Status: In Progress.

Task 6: Provide a Final Report with a summary of the completed project findings, including the lighting replacement guidelines and an estimate of the potential savings for lighting replacements in the Austin Energy service territory.

Status: To be completed by April 30, 2007.

City of Austin - Austin Energy

Monthly Report #2

Monthly Progress Report to the State Energy Conservation Office (SECO)
Dates Covered: August 1, 2006 – August 31, 2006

SECO Contract #CM 637:

Demonstration and Evaluation of Fluorescent Outdoor Lighting

Program Overview

The purpose of this contract is for the City of Austin - Austin Energy (AE) to provide services to the Texas State Energy Conservation Office (SECO), Mr. Felix Lopez, P.E., Program Manager, pursuant to the U.S. Department of Energy (DOE) award number DE-FG48-04R806410, commencing on June 15, 2006 and ending April 30, 2007, to form a joint venture with the Lighting Research Laboratory of the Rensselaer Polytechnic Institute of New York (LRC). The objective of this joint venture is to study the feasibility and possible use of fluorescent street lighting technologies, the projected economic analysis, potential market opportunities, barriers to implementation, and technology transfer to other municipalities.

Up to Date Summary of Progress

Interlocal Contract CM637, between AE and SECO has been executed, and a Purchase Order sent to LRC. AE is currently negotiating with LRC over standard City of Austin contract language and executing a sole-source contract with the LRC for the services as prescribed in ATTACHMENT A, STATEMENT OF SERVICES TO BE PERFORMED of that contract.

An email string documenting the correspondence is included in Attachment 1. The negotiations are ongoing between AE, LRC, and both of our legal departments to resolve the contractual issues at hand.

Status of Deliverables and Milestones:

Task 1: Negotiate a contract agreement with the Lighting Research Center (LRC) and provide a copy to SECO.

Status: In progress.

Task 2: Schedule a project kick-off meeting with SECO and LRC.

Status: Ongoing. This task cannot be scheduled until the LRC has executed their contract with the City of Austin – Austin Energy.

Task 3: Provide a brief summary of the fluorescent lighting technology with potential market opportunities, an economic analysis, barriers of the implementation phase, and technology transfer to other municipalities in Texas.

Status: Ongoing.

Task 4: Provide a project summary presentation that include Austin Energy's plan to expand the fluoresecent lighting testing or its market deployment.

Status: Ongoing.

Task 5: Provide monthly progress reports.

Status: In Progress.

Task 6: Provide a Final Report with a summary of the completed project findings, including the lighting replacement guidelines and an estimate of the potential savings for lighting replacements in the Austin Energy service territory.

Status: To be completed by April 30, 2007.

City of Austin - Austin Energy

Monthly Report #3

Monthly Progress Report to the State Energy Conservation Office (SECO)
Dates Covered: September 1, 2006 – September 30, 2006

SECO Contract #CM 637:

Demonstration and Evaluation of Fluorescent Outdoor Lighting

Program Overview

The purpose of this contract is for the City of Austin - Austin Energy (AE) to provide services to the Texas State Energy Conservation Office (SECO), Mr. Felix Lopez, P.E., Program Manager, pursuant to the U.S. Department of Energy (DOE) award number DE-FG48-04R806410, commencing on June 15, 2006 and ending April 30, 2007, to form a joint venture with the Lighting Research Laboratory of the Rensselaer Polytechnic Institute of New York (LRC). The objective of this joint venture is to study the feasibility and possible use of fluorescent street lighting technologies, the projected economic analysis, potential market opportunities, barriers to implementation, and technology transfer to other municipalities.

Up to Date Summary of Progress

Interlocal Contract CM637, between AE and SECO has been executed, and a Purchase Order sent to LRC. AE is still in negotiations with LRC over standard City of Austin contract language and executing a sole-source contract with the LRC for the services as prescribed in ATTACHMENT A, STATEMENT OF SERVICES TO BE PERFORMED of that contract.

An email string documenting the correspondence between AE's Buyer and Rensselaer's representative is included in Attachment 1. The negotiations are still ongoing between AE and LRC. Currently, AE is waiting for a response from LRC's representative and Legal Department.

Status of Deliverables and Milestones:

Task 1: Negotiate a contract agreement with the Lighting Research Center (LRC) and provide a copy to SECO.

Status: In progress.

Task 2: Schedule a project kick-off meeting with SECO and LRC.

Status: Ongoing. This task cannot be scheduled until the LRC has executed their contract with the City of Austin – Austin Energy.

Task 3: Provide a brief summary of the fluorescent lighting technology with potential market opportunities, an economic analysis, barriers of the implementation phase, and technology transfer to other municipalities in Texas.

Status: Ongoing.

Task 4: Provide a project summary presentation that include Austin Energy's plan to expand the fluoresecent lighting testing or its market deployment.

Status: Ongoing.

Task 5: Provide monthly progress reports.

Status: In Progress.

Task 6: Provide a Final Report with a summary of the completed project findings, including the lighting replacement guidelines and an estimate of the potential savings for lighting replacements in the Austin Energy service territory.

Status: To be completed by April 30, 2007.

City of Austin - Austin Energy

Monthly Report #4

Monthly Progress Report to the State Energy Conservation Office (SECO)
Dates Covered: October 1, 2006 – October 31, 2006

SECO Contract #CM 637:

Demonstration and Evaluation of Fluorescent Outdoor Lighting

Program Overview

The purpose of this contract is for the City of Austin - Austin Energy (AE) to provide services to the Texas State Energy Conservation Office (SECO), Mr. Felix Lopez, P.E., Program Manager, pursuant to the U.S. Department of Energy (DOE) award number DE-FG48-04R806410, commencing on June 15, 2006 and ending April 30, 2007, to form a joint venture with the Lighting Research Laboratory of the Rensselaer Polytechnic Institute of New York (LRC). The objective of this joint venture is to study the feasibility and possible use of fluorescent street lighting technologies, the projected economic analysis, potential market opportunities, barriers to implementation, and technology transfer to other municipalities.

Up to Date Summary of Progress

Interlocal Contract CM637, between AE and SECO has been executed, and a Purchase Order sent to LRC. AE is still in negotiations with LRC over standard City of Austin contract language and executing a sole-source contract with the LRC for the services as prescribed in ATTACHMENT A, STATEMENT OF SERVICES TO BE PERFORMED of that contract.

An email string documenting the correspondence between AE's Buyer, AE Legal, and Rensselaer's representatives is included in Attachment 1. The negotiations are still ongoing between AE and LRC. The current sticking points are mostly about insurance and the confidentiality of the final study.

Status of Deliverables and Milestones:

Task 1: Negotiate a contract agreement with the Lighting Research Center (LRC) and provide a copy to SECO.

Status: In progress.

Task 2: Schedule a project kick-off meeting with SECO and LRC.

Status: Ongoing. This task cannot be scheduled until the LRC has executed their contract with the City of Austin – Austin Energy.

Task 3: Provide a brief summary of the fluorescent lighting technology with potential market opportunities, an economic analysis, barriers of the implementation phase, and technology transfer to other municipalities in Texas.

Status: Ongoing.

Task 4: Provide a project summary presentation that include Austin Energy's plan to expand the fluoresecent lighting testing or its market deployment.

Status: Ongoing.

Task 5: Provide monthly progress reports.

Status: In Progress.

Task 6: Provide a Final Report with a summary of the completed project findings, including the lighting replacement guidelines and an estimate of the potential savings for lighting replacements in the Austin Energy service territory.

Status: To be completed by April 30, 2007.

City of Austin - Austin Energy

Monthly Report #5

Monthly Progress Report to the State Energy Conservation Office (SECO)
Dates Covered: November 1, 2006 – November 30, 2006

SECO Contract #CM 637:

Demonstration and Evaluation of Fluorescent Outdoor Lighting

Program Overview

The purpose of this contract is for the City of Austin - Austin Energy (AE) to provide services to the Texas State Energy Conservation Office (SECO), Mr. Felix Lopez, P.E., Program Manager, pursuant to the U.S. Department of Energy (DOE) award number DE-FG48-04R806410, commencing on June 15, 2006 and ending April 30, 2007, to form a joint venture with the Lighting Research Laboratory of the Rensselaer Polytechnic Institute of New York (LRC). The objective of this joint venture is to study the feasibility and possible use of fluorescent street lighting technologies, the projected economic analysis, potential market opportunities, barriers to implementation, and technology transfer to other municipalities.

Up to Date Summary of Progress

Interlocal Contract CM637, between AE and SECO has been executed, and a Purchase Order sent to LRC. AE is still in negotiations with LRC over standard City of Austin contract language and executing a sole-source contract with the LRC for the services as prescribed in ATTACHMENT A, STATEMENT OF SERVICES TO BE PERFORMED of that contract.

An email string documenting the correspondence between AE's Buyer, AE Legal, and Rensselaer's representatives is included in Attachment 1. AE received a signed contract from LRC as of the end of this month. Rensselaer's representatives must now provide Certificates of Insurance in accordance with the requirements of the project to proceed.

Status of Deliverables and Milestones:

Task 1: Negotiate a contract agreement with the Lighting Research Center (LRC) and provide a copy to SECO.

Status: In progress.

Task 2: Schedule a project kick-off meeting with SECO and LRC.

Status: Ongoing. This task cannot be scheduled until the LRC has executed their contract with the City of Austin – Austin Energy.

Task 3: Provide a brief summary of the fluorescent lighting technology with potential market opportunities, an economic analysis, barriers of the implementation phase, and technology transfer to other municipalities in Texas.

Status: Ongoing.

Task 4: Provide a project summary presentation that include Austin Energy's plan to expand the fluoresecent lighting testing or its market deployment.

Status: Ongoing.

Task 5: Provide monthly progress reports.

Status: In Progress.

Task 6: Provide a Final Report with a summary of the completed project findings, including the lighting replacement guidelines and an estimate of the potential savings for lighting replacements in the Austin Energy service territory.

Status: To be completed by April 30, 2007.

City of Austin - Austin Energy

Monthly Report #6

Monthly Progress Report to the State Energy Conservation Office (SECO)
Dates Covered: December 1, 2006 – December 31, 2006

SECO Contract #CM 637:

Demonstration and Evaluation of Fluorescent Outdoor Lighting

Program Overview

The purpose of this contract is for the City of Austin - Austin Energy (AE) to provide services to the Texas State Energy Conservation Office (SECO), Mr. Felix Lopez, P.E., Program Manager, pursuant to the U.S. Department of Energy (DOE) award number DE-FG48-04R806410, commencing on June 15, 2006 and ending April 30, 2007, to form a joint venture with the Lighting Research Laboratory of the Rensselaer Polytechnic Institute of New York (LRC). The objective of this joint venture is to study the feasibility and possible use of fluorescent street lighting technologies, the projected economic analysis, potential market opportunities, barriers to implementation, and technology transfer to other municipalities.

Up to Date Summary of Progress

Interlocal Contract CM637, between AE and SECO has been executed, and a Purchase Order sent to LRC. LRC and AE have negotiated standard and supplemental terms and conditions and contract language, and executing a sole-source contract with the LRC for the services as prescribed in ATTACHMENT A, STATEMENT OF SERVICES TO BE PERFORMED of that contract. The term of the contract between AE and LRC is twelve (12) months, from November 28th, 2006 to November 28th, 2007.

A signed copy of the final contract between AE and Rensselaer is attached to this status report. Rensselaer's representatives must now provide Certificates of Insurance in accordance with the requirements of the project to proceed.

This is month six (6) of a nine (9) month contract. AE has still not been able to schedule a kick-off meeting due to contract negotiations, and consequentially AE recommends a no-cost contract extension. AE's contract with Rensselaer is in force until November 28th, 2007, and we recommend an extension to November 30, 2007.

Status of Deliverables and Milestones:

Task 1: Negotiate a contract agreement with the Lighting Research Center (LRC) and provide a copy to SECO.

Status: Complete, a copy is attached. Certificates of insurance are pending from Rensselaer.

Task 2: Schedule a project kick-off meeting with SECO and LRC.

Status: Ongoing. This task cannot be scheduled LRC has provided Certificates of Insurance in accordance with the contract to the City of Austin – Austin Energy.

Task 3: Provide a brief summary of the fluorescent lighting technology with potential market opportunities, an economic analysis, barriers of the implementation phase, and technology transfer to other municipalities in Texas.

Status: Ongoing.

Task 4: Provide a project summary presentation that include Austin Energy's plan to expand the fluoresecent lighting testing or its market deployment.

Status: Ongoing.

Task 5: Provide monthly progress reports.

Status: In Progress.

Task 6: Provide a Final Report with a summary of the completed project findings, including the lighting replacement guidelines and an estimate of the potential savings for lighting replacements in the Austin Energy service territory.

Status: A seven (7) month no-cost extension is recommended from April 30, 2007 to November 30th, 2007.

City of Austin - Austin Energy

Monthly Report #7

Monthly Progress Report to the State Energy Conservation Office (SECO)
Dates Covered: January 1, 2007 – January 31, 2007

SECO Contract #CM 637:

Demonstration and Evaluation of Fluorescent Outdoor Lighting

Program Overview

The purpose of this contract is for the City of Austin - Austin Energy (AE) to provide services to the Texas State Energy Conservation Office (SECO), Mr. Felix Lopez, P.E., Program Manager, pursuant to the U.S. Department of Energy (DOE) award number DE-FG48-04R806410, commencing on June 15, 2006 and ending April 30, 2007, to form a joint venture with the Lighting Research Laboratory of the Rensselaer Polytechnic Institute of New York (LRC). The objective of this joint venture is to study the feasibility and possible use of fluorescent street lighting technologies, the projected economic analysis, potential market opportunities, barriers to implementation, and technology transfer to other municipalities.

Up to Date Summary of Progress

Interlocal Contract CM637, between AE and SECO has been executed, and a Purchase Order sent to LRC. LRC and AE have negotiated standard and supplemental terms and conditions and contract language, and executing a sole-source contract with the LRC for the services as prescribed in ATTACHMENT A, STATEMENT OF SERVICES TO BE PERFORMED of that contract. The term of the contract between AE and LRC is twelve (12) months, from November 28th, 2006 to November 28th, 2007.

The contract between AE and Rensselaer has been finalized; however Rensselaer still has not provided Certificates of Insurance in accordance with the contract. AE cannot proceed until these requirements have been met.

This is month seven (7) of a nine (9) month contract. AE has still not been able to schedule a kick-off meeting pending Certificates of Insurance, and consequentially AE recommends a no-cost contract extension. AE's contract with Rensselaer is in force until November 28th, 2007, and we recommend an extension to November 30, 2007.

Status of Deliverables and Milestones:

Task 1: Negotiate a contract agreement with the Lighting Research Center (LRC) and provide a copy to SECO.

Status: Complete.

Task 2: Schedule a project kick-off meeting with SECO and LRC.

Status: Ongoing. This task cannot be scheduled LRC has provided Certificates of Insurance in accordance with the contract to the City of Austin – Austin Energy.

Task 3: Provide a brief summary of the fluorescent lighting technology with potential market opportunities, an economic analysis, barriers of the implementation phase, and technology transfer to other municipalities in Texas.

Status: Ongoing.

Task 4: Provide a project summary presentation that include Austin Energy's plan to expand the fluoresecent lighting testing or its market deployment.

Status: Ongoing.

Task 5: Provide monthly progress reports.

Status: In Progress.

Task 6: Provide a Final Report with a summary of the completed project findings, including the lighting replacement guidelines and an estimate of the potential savings for lighting replacements in the Austin Energy service territory.

Status: A seven (7) month no-cost extension is recommended from April 30, 2007 to November 30th, 2007.

City of Austin - Austin Energy

Monthly Report #8

Monthly Progress Report to the State Energy Conservation Office (SECO)
Dates Covered: February 1, 2007 – February 28, 2007

SECO Contract #CM 637:

Demonstration and Evaluation of Fluorescent Outdoor Lighting

Program Overview

The purpose of this contract is for the City of Austin - Austin Energy (AE) to provide services to the Texas State Energy Conservation Office (SECO), Mr. Felix Lopez, P.E., Program Manager, pursuant to the U.S. Department of Energy (DOE) award number DE-FG48-04R806410, commencing on June 15, 2006 and ending April 30, 2007, to form a joint venture with the Lighting Research Laboratory of the Rensselaer Polytechnic Institute of New York (LRC). The objective of this joint venture is to study the feasibility and possible use of fluorescent street lighting technologies, the projected economic analysis, potential market opportunities, barriers to implementation, and technology transfer to other municipalities.

Up to Date Summary of Progress

Interlocal Contract CM637, between AE and SECO has been executed, and a Purchase Order sent to LRC. LRC and AE have negotiated standard and supplemental terms and conditions and contract language, and executing a sole-source contract with the LRC for the services as prescribed in ATTACHMENT A, STATEMENT OF SERVICES TO BE PERFORMED of that contract. The term of the contract between AE and LRC is twelve (12) months, from November 28th, 2006 to November 28th, 2007.

Rensselaer provided the missing Certificates of Insurance in accordance with the contract in early February, and AE is proceeding with the project. AE is currently working to schedule a kick-off meeting between AE, SECO, and LRC, and to firm up the LRC's proposed schedule.

AE recommends a no-cost contract extension. AE's contract with Rensselaer is in force until November 28th, 2007, and we recommend an extension to November 28, 2007.

Status of Deliverables and Milestones:

Task 1: Negotiate a contract agreement with the Lighting Research Center (LRC) and provide a copy to SECO.

Status: Complete. The required insurance documentation was provided to AE by LRC as of the first week of February.

Task 2: Schedule a project kick-off meeting with SECO and LRC.

Status: Ongoing. LRC provided AE with a draft schedule including a tentative date for a kick-off meeting (Attached). AE and LRC have determined that a teleconference will suffice for the kick-off meeting, is currently working to firm up the schedule and teleconference date.

Task 3: Provide a brief summary of the fluorescent lighting technology with potential market opportunities, an economic analysis, barriers of the implementation phase, and technology transfer to other municipalities in Texas.

Status: Ongoing.

Task 4: Provide a project summary presentation that include Austin Energy's plan to expand the fluorescent lighting testing or its market deployment.

Status: Ongoing.

Task 5: Provide monthly progress reports.

Status: In Progress.

Task 6: Provide a Final Report with a summary of the completed project findings, including the lighting replacement guidelines and an estimate of the potential savings for lighting replacements in the Austin Energy service territory.

Status: A seven (7) month no-cost extension is recommended from April 30, 2007 to November 28th, 2007.

City of Austin - Austin Energy

Monthly Report #9

Monthly Progress Report to the State Energy Conservation Office (SECO)
Dates Covered: March 1, 2007 – March 31, 2007

SECO Contract #CM 637:

Demonstration and Evaluation of Fluorescent Outdoor Lighting

Program Overview

The purpose of this contract is for the City of Austin - Austin Energy (AE) to provide services to the Texas State Energy Conservation Office (SECO), Mr. Felix Lopez, P.E., Program Manager, pursuant to the U.S. Department of Energy (DOE) award number DE-FG48-04R806410, commencing on June 15, 2006 and ending April 30, 2007, to form a joint venture with the Lighting Research Laboratory of the Rensselaer Polytechnic Institute of New York (LRC). The objective of this joint venture is to study the feasibility and possible use of fluorescent street lighting technologies, the projected economic analysis, potential market opportunities, barriers to implementation, and technology transfer to other municipalities.

Up to Date Summary of Progress

Interlocal Contract CM637, between AE and SECO has been executed, and a Purchase Order sent to LRC. LRC and AE have negotiated standard and supplemental terms and conditions and contract language, and executing a sole-source contract with the LRC for the services as prescribed in ATTACHMENT A, STATEMENT OF SERVICES TO BE PERFORMED of that contract. The term of the contract between AE and LRC is twelve (12) months, from November 28th, 2006 to November 28th, 2007.

During the month of March, AE and RPI worked toward developing a draft schedule including a kick-off meeting/teleconference between AE, SECO, and LRC. This effort was successful and a teleconference is scheduled for Thursday April 12th, 2007.

AE has begun development of the documentation to request a no-cost time extension to this Interlocal Agreement, that would extend the contract date from April 30, 2007 to November 30, 2007.

Status of Deliverables and Milestones:

Task 1: Negotiate a contract agreement with the Lighting Research Center (LRC) and provide a copy to SECO.

Status: Complete. The required insurance documentation was provided to AE by LRC as of the first week of February.

Task 2: Schedule a project kick-off meeting with SECO and LRC.

Status: Ongoing. LRC and AE have tentatively agreed upon a draft schedule and a kick-off meeting/teleconference on April 12, 2007 @ 10:00 AM CST.

Task 3: Provide a brief summary of the fluorescent lighting technology with potential market opportunities, an economic analysis, barriers of the implementation phase, and technology transfer to other municipalities in Texas.

Status: Ongoing.

Task 4: Provide a project summary presentation that include Austin Energy's plan to expand the fluorescent lighting testing or its market deployment.

Status: Ongoing.

Task 5: Provide monthly progress reports.

Status: In Progress.

Task 6: Provide a Final Report with a summary of the completed project findings, including the lighting replacement guidelines and an estimate of the potential savings for lighting replacements in the Austin Energy service territory.

Status: A seven (7) month no-cost extension is recommended from April 30, 2007 to November 30th, 2007.

City of Austin - Austin Energy

Monthly Report #10

Monthly Progress Report to the State Energy Conservation Office (SECO)
Dates Covered: April 1, 2007 – April 30, 2007

SECO Contract #CM 637:

Demonstration and Evaluation of Fluorescent Outdoor Lighting

Program Overview

The purpose of this contract is for the City of Austin - Austin Energy (AE) to provide services to the Texas State Energy Conservation Office (SECO), Mr. Felix Lopez, P.E., Program Manager, pursuant to the U.S. Department of Energy (DOE) award number DE-FG48-04R806410, commencing on June 15, 2006 and ending April 30, 2007, to form a joint venture with the Lighting Research Laboratory of the Rensselaer Polytechnic Institute of New York (LRC). The objective of this joint venture is to study the feasibility and possible use of fluorescent street lighting technologies, the projected economic analysis, potential market opportunities, barriers to implementation, and technology transfer to other municipalities.

Up to Date Summary of Progress

Interlocal Contract CM637, between AE and SECO has been executed, and a Purchase Order sent to LRC. LRC and AE have negotiated standard and supplemental terms and conditions and contract language, and executing a sole-source contract with the LRC for the services as prescribed in ATTACHMENT A, STATEMENT OF SERVICES TO BE PERFORMED of that contract. The term of the contract between AE and LRC is twelve (12) months, from November 28th, 2006 to November 28th, 2007.

During the month of April, AE and LRC held a kick-off teleconference on April 12, 2007, a follow-up teleconference on April 19, 2007 to resolve issues identified during the kick-off meeting, refined the draft project schedule, and determined that May 1, 2007 would be LRC's initial site visit to evaluate the candidate sites selected by AE for the study.

AE submitted a no-cost time extension to this Interlocal Agreement that extends the contract date from April 30, 2007 to November 30, 2007. The request was approved by SECO and the new effective date of the contract is now November 30, 2007.

Status of Deliverables and Milestones:

Task 1: Negotiate a contract agreement with the Lighting Research Center (LRC) and provide a copy to SECO.

Status: Complete. The required insurance documentation was provided to AE by LRC as of the first week of February.

Task 2: Schedule a project kick-off meeting with SECO and LRC.

Status: Complete. AE hosted a kick-off teleconference with SECO and LRC on April 12, 2007 at 10:00 AM CST.

Task 3: Provide a brief summary of the fluorescent lighting technology with potential market opportunities, an economic analysis, barriers of the implementation phase, and technology transfer to other municipalities in Texas.

Status: Ongoing.

Task 4: Provide a project summary presentation that include Austin Energy's plan to expand the fluorescent lighting testing or its market deployment.

Status: Ongoing.

Task 5: Provide monthly progress reports.

Status: Ongoing.

Task 6: Provide a Final Report with a summary of the completed project findings, including the lighting replacement guidelines and an estimate of the potential savings for lighting replacements in the Austin Energy service territory.

Status: Revised. A no-cost time extension was requested by AE that revised the contract ending date from April 30, 2007 to November 30th, 2007. SECO approved the extension.

Attachment 1

Revised Draft Schedule – April 19, 2007

March:

1. AE will request an extension to Interlocal Agreement CM637 with a new ending date of November 28th, 2007. *In progress.*
2. Schedule kickoff teleconference between Austin Energy, the State Energy Conservation Office, and RPI. *Set for 10:00 AM April 12, 2007*
3. Begin identification and evaluation of high-pressure sodium reference sites for the study. *Ongoing.*
4. Experiment protocol proposal approval by RPI's Institutional Review Board *Ongoing.*
5. Install missing test fixtures and verify operational condition of all test samples. *Complete.*

April:

1. Hold the kickoff teleconference between Austin Energy, the State Energy Conservation Office, and Rensselaer on April 12, 2007, at 10:00 AM *Complete.*
2. Follow-up teleconference. *April 19th.*
3. AE and RPI will finalize selection of the reference sites.
4. AE and RPI will visit the reference sites and measure illuminances May 1st and 2nd.
5. RPI will prepare a detailed experiment protocol for the evaluation.

May:

1. RPI will conduct the evaluation at the test and reference sites.
2. RPI will analyze data.
3. AE and RPI will schedule a teleconference to review preliminary results.

June and July:

1. RPI will develop and submit the draft report and guidelines.
2. AE, RPI, and SECO will provide feedback and revisions for the report.

City of Austin - Austin Energy

Monthly Report #11

Monthly Progress Report to the State Energy Conservation Office (SECO)
Dates Covered: May 1, 2007 – May 31, 2007

SECO Contract #CM 637:

Demonstration and Evaluation of Fluorescent Outdoor Lighting

Program Overview

The purpose of this contract is for the City of Austin - Austin Energy (AE) to provide services to the Texas State Energy Conservation Office (SECO), Mr. Felix Lopez, P.E., Program Manager, pursuant to the U.S. Department of Energy (DOE) award number DE-FG48-04R806410, commencing on June 15, 2006 and ending April 30, 2007, to form a joint venture with the Lighting Research Laboratory of the Rensselaer Polytechnic Institute of New York (LRC). The objective of this joint venture is to study the feasibility and possible use of fluorescent street lighting technologies, the projected economic analysis, potential market opportunities, barriers to implementation, and technology transfer to other municipalities.

AE submitted a no-cost time extension to this Interlocal Agreement that extends the contract date from April 30, 2007 to November 30, 2007. The request was approved by SECO and the new effective date of the contract is now November 30, 2007.

Up to Date Summary of Progress

Interlocal Contract CM637, between AE and SECO has been executed, and a Purchase Order sent to LRC. LRC and AE have negotiated standard and supplemental terms and conditions and contract language, and executing a sole-source contract with the LRC for the services as prescribed in ATTACHMENT A, STATEMENT OF SERVICES TO BE PERFORMED of that contract. The term of the contract between AE and LRC is twelve (12) months, from November 28th, 2006 to November 28th, 2007.

During the month of May, LRC staff traveled to Austin to evaluate the potential sites identified by AE for the study. The visit began with a brief meeting to map out a course of action for reviewing the proposed sites, and included representatives of AE, SECO, and LRC. LRC also met with AE Market Research staff to begin developing a game plan for the survey process.

LRC determined which sites are to be used for the study, and night-time light levels were measured at the sites to create a lighting baseline. LRC decided that their preference would be to survey the West Avenue "Street" Site by mail, and to visit the Riverside and West Avenue Parking Lot sites in person with the survey subjects. In addition, LRC

decided to use the Parking Lots at Gillis Park and the South Austin Health Center for representative pre-retrofit examples in the site visit portion of the survey.

Status of Deliverables and Milestones:

Task 1: Negotiate a contract agreement with the Lighting Research Center (LRC) and provide a copy to SECO.

Status: Complete.

Task 2: Schedule a project kick-off meeting with SECO and LRC.

Status: Complete. AE hosted a kick-off teleconference with SECO and LRC on April 12, 2007 at 10:00 AM CST.

Task 3: Provide a brief summary of the fluorescent lighting technology with potential market opportunities, an economic analysis, barriers of the implementation phase, and technology transfer to other municipalities in Texas.

Status: Ongoing.

Task 4: Provide a project summary presentation that include Austin Energy's plan to expand the fluorescent lighting testing or its market deployment.

Status: Ongoing.

Task 5: Provide monthly progress reports.

Status: Ongoing.

Task 6: Provide a Final Report with a summary of the completed project findings, including the lighting replacement guidelines and an estimate of the potential savings for lighting replacements in the Austin Energy service territory.

Status: Revised. A no-cost time extension was requested by AE that revised the contract ending date from April 30, 2007 to November 30th, 2007. SECO approved the extension.

City of Austin - Austin Energy

Monthly Report #12

Monthly Progress Report to the State Energy Conservation Office (SECO)
Dates Covered: June 1, 2007 – June 30, 2007

SECO Contract #CM 637:

Demonstration and Evaluation of Fluorescent Outdoor Lighting

Program Overview

The purpose of this contract is for the City of Austin - Austin Energy (AE) to provide services to the Texas State Energy Conservation Office (SECO), Mr. Felix Lopez, P.E., Program Manager, pursuant to the U.S. Department of Energy (DOE) award number DE-FG48-04R806410, commencing on June 15, 2006 and ending April 30, 2007, to form a joint venture with the Lighting Research Laboratory of the Rensselaer Polytechnic Institute of New York (LRC). The objective of this joint venture is to study the feasibility and possible use of fluorescent street lighting technologies, the projected economic analysis, potential market opportunities, barriers to implementation, and technology transfer to other municipalities.

AE submitted a no-cost time extension to this Interlocal Agreement that extends the contract date from April 30, 2007 to November 30, 2007. The request was approved by SECO and the new effective date of the contract is now November 30, 2007.

Up to Date Summary of Progress

Interlocal Contract CM637, between AE and SECO has been executed, and a Purchase Order sent to LRC. LRC and AE have negotiated standard and supplemental terms and conditions and contract language, and executing a sole-source contract with the LRC for the services as prescribed in ATTACHMENT A, STATEMENT OF SERVICES TO BE PERFORMED of that contract. The term of the contract between AE and LRC is twelve (12) months, from November 28, 2006 to November 28, 2007.

During the month of June, AE and AE Market Research staff worked with LRC to develop a mail-out survey for the site in the 900 block of West Avenue. AE staff developed a tentative map for the mail-out survey area (attached), and identified a sample of 115 addresses surrounding the 900 block of West Avenue. The subjects will be asked about their perceptions of the area in visibility, safety, and security as compared to the surrounding areas with High Pressure Sodium lighting.

LRC staff felt that they needed to reevaluate the questions in the site visit surveys internally, and began the process of tightening up the surveys. LRC made a recommendation to move the site visit surveys to late summer (possibly September),

because of the long nights in June and the resulting late starting/ending times for the site visits. AE began a Legal review of the mail-out process recommended, and how it relates to customer privacy and other issues.

Status of Deliverables and Milestones:

Task 1: Negotiate a contract agreement with the Lighting Research Center (LRC) and provide a copy to SECO.

Status: Complete.

Task 2: Schedule a project kick-off meeting with SECO and LRC.

Status: Complete. AE hosted a kick-off teleconference with SECO and LRC on April 12, 2007 at 10:00 AM CST.

Task 3: Provide a brief summary of the fluorescent lighting technology with potential market opportunities, an economic analysis, barriers of the implementation phase, and technology transfer to other municipalities in Texas.

Status: Ongoing.

Task 4: Provide a project summary presentation that include Austin Energy's plan to expand the fluorescent lighting testing or its market deployment.

Status: Ongoing.

Task 5: Provide monthly progress reports.

Status: Ongoing.

Task 6: Provide a Final Report with a summary of the completed project findings, including the lighting replacement guidelines and an estimate of the potential savings for lighting replacements in the Austin Energy service territory.

Status: Revised. A no-cost time extension was requested by AE that revised the contract ending date from April 30, 2007 to November 30th, 2007. SECO approved the extension.

Mail-Out Survey Area

City of Austin - Austin Energy

Monthly Report #13

Monthly Progress Report to the State Energy Conservation Office (SECO)
Dates Covered: July 1, 2007 – July 31, 2007

SECO Contract #CM 637:

Demonstration and Evaluation of Fluorescent Outdoor Lighting

Program Overview

The purpose of this contract is for the City of Austin - Austin Energy (AE) to provide services to the Texas State Energy Conservation Office (SECO), Mr. Felix Lopez, P.E., Program Manager, pursuant to the U.S. Department of Energy (DOE) award number DE-FG48-04R806410, commencing on June 15, 2006 and ending April 30, 2007, to form a joint venture with the Lighting Research Laboratory of the Rensselaer Polytechnic Institute of New York (LRC). The objective of this joint venture is to study the feasibility and possible use of fluorescent street lighting technologies, the projected economic analysis, potential market opportunities, barriers to implementation, and technology transfer to other municipalities.

AE submitted a no-cost time extension to this Interlocal Agreement that extends the contract date from April 30, 2007 to November 30, 2007. The request was approved by SECO and the new effective date of the contract is now November 30, 2007.

Up to Date Summary of Progress

Interlocal Contract CM637, between AE and SECO has been executed, and a Purchase Order sent to LRC. LRC and AE have negotiated standard and supplemental terms and conditions and contract language, and executing a sole-source contract with the LRC for the services as prescribed in ATTACHMENT A, STATEMENT OF SERVICES TO BE PERFORMED of that contract. The term of the contract between AE and LRC is twelve (12) months, from November 28, 2006 to November 28, 2007.

During the month of July, LRC and AE staff worked to develop the methodologies and final surveys for the studies. The area and addresses to be used in the West Avenue "Street" test were finalized, and LRC began negotiations with local marketing vendors to help facilitate the studies. Based on recent experiences, AE's Market Research staff recommended that a "Phone Survey" might be more successful than the mail-out survey planned for the West Avenue neighborhood. This was taken under advisement and the phone survey should be started in early August.

The night-time site surveys are currently planned for early September, but an exact date is to be determined in the August.

Status of Deliverables and Milestones:

Task 1: Negotiate a contract agreement with the Lighting Research Center (LRC) and provide a copy to SECO.

Status: Complete.

Task 2: Schedule a project kick-off meeting with SECO and LRC.

Status: Complete. AE hosted a kick-off teleconference with SECO and LRC on April 12, 2007 at 10:00 AM CST.

Task 3: Provide a brief summary of the fluorescent lighting technology with potential market opportunities, an economic analysis, barriers of the implementation phase, and technology transfer to other municipalities in Texas.

Status: Ongoing.

Task 4: Provide a project summary presentation that include Austin Energy's plan to expand the fluorescent lighting testing or its market deployment.

Status: Ongoing.

Task 5: Provide monthly progress reports.

Status: Ongoing.

Task 6: Provide a Final Report with a summary of the completed project findings, including the lighting replacement guidelines and an estimate of the potential savings for lighting replacements in the Austin Energy service territory.

Status: Revised. A no-cost time extension was requested by AE that revised the contract ending date from April 30, 2007 to November 30, 2007. SECO approved the extension.

City of Austin - Austin Energy

Monthly Report #14

Monthly Progress Report to the State Energy Conservation Office (SECO)
Dates Covered: August 1, 2007 – August 31, 2007

SECO Contract #CM 637:

Demonstration and Evaluation of Fluorescent Outdoor Lighting

Program Overview

The purpose of this contract is for the City of Austin - Austin Energy (AE) to provide services to the Texas State Energy Conservation Office (SECO), Mr. Felix Lopez, P.E., Program Manager, pursuant to the U.S. Department of Energy (DOE) award number DE-FG48-04R806410, commencing on June 15, 2006 and ending April 30, 2007, to form a joint venture with the Lighting Research Laboratory of the Rensselaer Polytechnic Institute of New York (LRC). The objective of this joint venture is to study the feasibility and possible use of fluorescent street lighting technologies, the projected economic analysis, potential market opportunities, barriers to implementation, and technology transfer to other municipalities.

AE submitted a no-cost time extension to this Interlocal Agreement that extends the contract date from April 30, 2007 to November 30, 2007. The request was approved by SECO and the new effective date of the contract is now November 30, 2007.

Up to Date Summary of Progress

Interlocal Contract CM637, between AE and SECO has been executed, and a Purchase Order sent to LRC. LRC and AE have negotiated standard and supplemental terms and conditions and contract language, and executed a sole-source contract with the LRC for the services as prescribed in ATTACHMENT A, STATEMENT OF SERVICES TO BE PERFORMED of that contract. The term of the contract between AE and LRC is twelve (12) months, from November 28, 2006 to November 28, 2007.

During the month of August, LRC and AE staff worked to finalize the survey forms for the site visit studies. Final preparations for the site surveys with LRC and the test subjects were made and scheduled for September 5th, with a rain date of September 6th. A final draft of LRC's proposed lighting survey is attached.

The survey participants will be obtained through a local marketing firm (Tammadge Market Research), and they will be given incentives by the marketing firm for their participation in the project. The plan is to send out 15 invitations in an attempt to acquire 12 participants.

Status of Deliverables and Milestones:

Task 1: Negotiate a contract agreement with the Lighting Research Center (LRC) and provide a copy to SECO.

Status: Complete.

Task 2: Schedule a project kick-off meeting with SECO and LRC.

Status: Complete. AE hosted a kick-off teleconference with SECO and LRC on April 12, 2007 at 10:00 AM CST.

Task 3: Provide a brief summary of the fluorescent lighting technology with potential market opportunities, an economic analysis, barriers of the implementation phase, and technology transfer to other municipalities in Texas.

Status: Ongoing.

Task 4: Provide a project summary presentation that includes Austin Energy's plan to expand the fluorescent lighting testing or its market deployment.

Status: Ongoing.

Task 5: Provide monthly progress reports.

Status: Ongoing.

Task 6: Provide a Final Report with a summary of the completed project findings, including the lighting replacement guidelines and an estimate of the potential savings for lighting replacements in the Austin Energy service territory.

Status: Revised. A no-cost time extension was requested by AE that revised the contract ending date from April 30, 2007 to November 30, 2007. SECO approved the extension.

City of Austin - Austin Energy

Monthly Report #15

Monthly Progress Report to the State Energy Conservation Office (SECO)
Dates Covered: September 1, 2007 – September 30, 2007

SECO Contract #CM 637:

Demonstration and Evaluation of Fluorescent Outdoor Lighting

Program Overview

The purpose of this contract is for the City of Austin - Austin Energy (AE) to provide services to the Texas State Energy Conservation Office (SECO), Mr. Felix Lopez, P.E., Program Manager, pursuant to the U.S. Department of Energy (DOE) award number DE-FG48-04R806410, commencing on June 15, 2006 and ending April 30, 2007, to form a joint venture with the Lighting Research Laboratory of the Rensselaer Polytechnic Institute of New York (LRC). The objective of this joint venture is to study the feasibility and possible use of fluorescent street lighting technologies, the projected economic analysis, potential market opportunities, barriers to implementation, and technology transfer to other municipalities.

AE submitted a no-cost time extension to this Interlocal Agreement that extends the contract date from April 30, 2007 to November 30, 2007. The request was approved by SECO and the new effective date of the contract is now November 30, 2007.

Up to Date Summary of Progress

Interlocal Contract CM637, between AE and SECO has been executed, and a Purchase Order sent to LRC. LRC and AE have negotiated standard and supplemental terms and conditions and contract language, and executed a sole-source contract with the LRC for the services as prescribed in ATTACHMENT A, STATEMENT OF SERVICES TO BE PERFORMED of that contract. The term of the contract between AE and LRC is twelve (12) months, from November 28, 2006 to November 28, 2007.

The planned site surveys were performed on September 5th, and included visits to the test sites during day time hours, in the dark with no artificial light, and again in the dark with the lighting systems energized. Photographs of the test sites during the actual surveys are included in this report. The survey participants are visible in some of the photographs.

Fifteen (15) survey participants were invited to participate in the survey, in an attempt to acquire twelve (12) participants. All fifteen (15) were available at the time of the surveys, and a decision was made to include all of them in the study. The telephone surveys for the 900 West Avenue location are in progress.

Status of Deliverables and Milestones:

Task 1: Negotiate a contract agreement with the Lighting Research Center (LRC) and provide a copy to SECO.

Status: Complete.

Task 2: Schedule a project kick-off meeting with SECO and LRC.

Status: Complete. AE hosted a kick-off teleconference with SECO and LRC on April 12, 2007 at 10:00 AM CST.

Task 3: Provide a brief summary of the fluorescent lighting technology with potential market opportunities, an economic analysis, barriers of the implementation phase, and technology transfer to other municipalities in Texas.

Status: Ongoing.

Task 4: Provide a project summary presentation that includes Austin Energy's plan to expand the fluorescent lighting testing or its market deployment.

Status: Ongoing.

Task 5: Provide monthly progress reports.

Status: Ongoing.

Task 6: Provide a Final Report with a summary of the completed project findings, including the lighting replacement guidelines and an estimate of the potential savings for lighting replacements in the Austin Energy service territory.

Status: Ongoing. Analysis of the site survey data and preparation of a "Draft" version of the Final Report was initiated in September.

Site Survey Time-Line

Survey Date: September 5, 2007

6:45 PM All participants meet at Tammadge Market Research.

6:50 PM Leave for Energy Control Center (West Ave.) to conduct survey. Ten (10) minutes allotted for each survey, and five (5) minutes travel time at each site.

7:00 PM Arrive at Austin Energy, Energy Control Center for daytime survey.

7:15 PM Arrive at Parks and Recreation Department Headquarters site for daytime survey.

7:30 PM Arrive at Gillis Park for daytime survey.

7:45 PM Arrive at Community Health Center for daytime survey.

7:55 PM Return to Tammadge Market Research to await darkness (snack served).

8:30 PM Leave Tammadge for "dark" night time site surveys with lights turned off.

8:40 PM Arrive at Energy Control Center for "dark" survey.

8:50 PM Lights at Energy Control Center energized for next phase of the survey.

8:55 PM Arrive at Parks and Recreation Department Headquarters site for "dark" survey.

9:05 PM Lights at Parks and Recreation Department Headquarters site energized for next phase of the survey.

9:10 PM Arrive at Gillis Park for "dark" survey.

9:20 PM Lights at Gillis Park energized for next phase of the survey.

9:25 PM Arrive at Community Health Center for "dark" survey.

9:35 PM Lights at Community Health Center energized for next phase of the survey.

9:40 PM Arrive at Energy Control Center for "lit" survey.

9:55 PM Arrive at Parks and Recreation Department Headquarters site for "lit" survey.

10:10 PM Arrive at Gillis Park for "lit" survey.

10:25 PM Arrive at Community Health Center for "lit" survey.

10:40 PM Return to Tammadge Market Research. **Survey complete.**

Site Surveys

Figure 1: Energy Control Center, Fluorescent Lighting – 9:40 PM, 9/5/07

Figure 2: Parks and Rec. Headquarters, Fluorescent Lighting – 9:55 PM, 9/5/07

Site Surveys

Figure 3: Gillis Park, High Pressure Sodium Lighting – 10:10 PM, 9/5/07

Figure 4: South Austin Health, High Pressure Sodium Lighting – 10:25 PM, 9/5/07

City of Austin - Austin Energy

Monthly Report #16

Monthly Progress Report to the State Energy Conservation Office (SECO)
Dates Covered: October 1, 2007 – October 31, 2007

SECO Contract #CM 637:

Demonstration and Evaluation of Fluorescent Outdoor Lighting

Program Overview

The purpose of this contract is for the City of Austin - Austin Energy (AE) to provide services to the Texas State Energy Conservation Office (SECO), Mr. Felix Lopez, P.E., Program Manager, pursuant to the U.S. Department of Energy (DOE) award number DE-FG48-04R806410, commencing on June 15, 2006 and ending April 30, 2007, to form a joint venture with the Lighting Research Laboratory of the Rensselaer Polytechnic Institute of New York (LRC). The objective of this joint venture is to study the feasibility and possible use of fluorescent street lighting technologies, the projected economic analysis, potential market opportunities, barriers to implementation, and technology transfer to other municipalities.

AE submitted a no-cost time extension to this Interlocal Agreement that extends the contract date from April 30, 2007 to November 30, 2007. The request was approved by SECO and the new effective date of the contract is now November 30, 2007.

Up to Date Summary of Progress

Interlocal Contract CM637, between AE and SECO has been executed, and a Purchase Order sent to LRC. LRC and AE have negotiated standard and supplemental terms and conditions and contract language, and executed a sole-source contract with the LRC for the services as prescribed in ATTACHMENT A, STATEMENT OF SERVICES TO BE PERFORMED of that contract. The term of the contract between AE and LRC is twelve (12) months, from November 28, 2006 to November 28, 2007.

During the month of October, a "2nd Draft" of LRC's portion of the Final Report was prepared by analyzing the surveys and comparing the outcome to some historical data. A copy of this draft study is attached for review.

AE has begun preparations to complete the required deliverables and milestones, based on the content of the current draft study from LRC.

To date, only five (5) of the telephone surveys for the lighting systems in the 900 and 1000 blocks of West Avenue have been completed. If more of these surveys are not completed soon this site will have to be left out of the final version of the study.

Status of Deliverables and Milestones:

Task 1: Negotiate a contract agreement with the Lighting Research Center (LRC) and provide a copy to SECO.

Status: Complete.

Task 2: Schedule a project kick-off meeting with SECO and LRC.

Status: Complete. AE hosted a kick-off teleconference with SECO and LRC on April 12, 2007 at 10:00 AM CST.

Task 3: Provide a brief summary of the fluorescent lighting technology with potential market opportunities, an economic analysis, barriers of the implementation phase, and technology transfer to other municipalities in Texas.

Status: Ongoing.

Task 4: Provide a project summary presentation that includes Austin Energy's plan to expand the fluorescent lighting testing or its market deployment.

Status: Ongoing.

Task 5: Provide monthly progress reports.

Status: Ongoing.

Task 6: Provide a Final Report with a summary of the completed project findings, including the lighting replacement guidelines and an estimate of the potential savings for lighting replacements in the Austin Energy service territory.

Status: Ongoing. Analysis of the site survey data and preparation of a "2nd Draft" version of the LRC study was completed in October. AE has begun preparations to complete Tasks 3, 4, and 6, as required.

City of Austin - Austin Energy

Monthly Report #17

Monthly Progress Report to the State Energy Conservation Office (SECO)
Dates Covered: November 1, 2007 – November 28, 2007

SECO Contract #CM 637:

Demonstration and Evaluation of Fluorescent Outdoor Lighting

Program Overview

The purpose of this contract is for the City of Austin - Austin Energy (AE) to provide services to the Texas State Energy Conservation Office (SECO), Mr. Felix Lopez, P.E., Program Manager, pursuant to the U.S. Department of Energy (DOE) award number DE-FG48-04R806410, commencing on June 15, 2006 and ending April 30, 2007, to form a joint venture with the Lighting Research Laboratory of the Rensselaer Polytechnic Institute of New York (LRC). The objective of this joint venture is to study the feasibility and possible use of fluorescent street lighting technologies, the projected economic analysis, potential market opportunities, barriers to implementation, and technology transfer to other municipalities.

AE submitted a no-cost time extension to this Interlocal Agreement that extends the contract date from April 30, 2007 to November 30, 2007. The request was approved by SECO and the new effective date of the contract is now November 30, 2007.

Up to Date Summary of Progress

Interlocal Contract CM637, between AE and SECO has been executed, and a Purchase Order sent to LRC. LRC and AE have negotiated standard and supplemental terms and conditions and contract language, and executed a sole-source contract with the LRC for the services as prescribed in ATTACHMENT A, STATEMENT OF SERVICES TO BE PERFORMED of that contract. The term of the contract between AE and LRC is twelve (12) months, from November 28, 2006 to November 28, 2007.

During the month of November, a “Draft” of the Final Report was prepared, and AE began verifying completion of the required contract deliverables and milestones. A copy of this draft Final Report is attached for review.

Status of Deliverables and Milestones:

Task 1: Negotiate a contract agreement with the Lighting Research Center (LRC) and provide a copy to SECO.

Status: Complete.

Task 2: Schedule a project kick-off meeting with SECO and LRC.

Status: Complete. AE hosted a kick-off teleconference with SECO and LRC on April 12, 2007 at 10:00 AM CST.

Task 3: Provide a brief summary of the fluorescent lighting technology with potential market opportunities, an economic analysis, barriers of the implementation phase, and technology transfer to other municipalities in Texas.

Status: Draft.

Task 4: Provide a project summary presentation that includes Austin Energy's plan to expand the fluorescent lighting testing or its market deployment.

Status: Draft.

Task 5: Provide monthly progress reports.

Status: Ongoing.

Task 6: Provide a Final Report with a summary of the completed project findings, including the lighting replacement guidelines and an estimate of the potential savings for lighting replacements in the Austin Energy service territory.

Status: Draft.

Appendix A – Contract Documents

Austin Energy's

Grant Proposal for

Evaluating Fluorescent Outdoor Lighting Alternatives

To

High Pressure Sodium Lighting

In

The City of Austin, Texas

Presented to

The Texas

State Energy Conservation Office

The City of Austin, through its municipally owned utility Austin Energy, spends approximately $5,000,000 in annual energy charges for outdoor illumination. This $5,000,000 is largely energy for the outdoor illumination of public streets, sidewalks, and parks, and does not include traffic signals.

In 2003, Austin Energy established a strategic plan that includes a goal of meeting 15% of its energy needs through conservation efforts. To that aim, street lighting consists of one of the largest single uses of electrical energy for the City of Austin as it does for many cities. Austin Energy has invested in several outdoor lighting technologies over the past few years on a pilot basis, including Light Emitting Diodes, cold cathode, and induction technologies.

One of the more promising technologies uses standard fluorescent lamps for the light source. As part of a demonstration, AE has installed 17 street lights in three locations based on this fluorescent technology. The fluorescent fixtures produce fewer measurable lumens, but have much better color rendering and the amount of light usable by the human eye is greater. These fixtures use about ½ the energy of the comparable High Pressure Sodium (HPS) fixture they replace.

There is much debate in the lighting industry regarding visibility and the trade-offs between lumens and color rendering. One of the goals of this study is to demonstrate if acceptable visibility can be provided by florescent alternatives, with fewer initial lumens,

better lumen depreciation curves, and better color rendering. If this can be proven, wider acceptance of fluorescent technologies in these types of applications may result.

To conduct this evaluation, Austin Energy proposes to partner with an organization that can provide the necessary resources, is accepted by the lighting community as an unbiased source of information, and has performed similar evaluations on other outdoor lighting projects.

The Lighting Research Center (LRC) at Rensselaer Polytechnic Institute in Troy, New York, is uniquely qualified to partner with Austin Energy. The LRC is the world's largest university-based research center dedicated to lighting. It has conducted numerous evaluations of outdoor lighting systems throughout the United States. It is recognized as a leader in developing unbiased information regarding lighting and lighting related products through its National Lighting Product Information Program, the Consumer Reports of Lighting Products.

The LRC has developed a system to integrate photopic illuminance (how humans see under higher light conditions) and scotopic illuminance (how humans see under low light conditions such as night time) into a single unified photometry system. They are the only entity to develop and utilize this system effectively, and have already done some study of alternate light sources for outdoor lighting.

A study of this type would utilize LRC's unified photometry system to accurately evaluate the use of fluorescent outdoor lighting systems and compare it to other outdoor lighting systems. Their previous outdoor and street lighting evaluations will give this study a common foundation and methodology, and provide Austin Energy with an "Apples-to-Apples" comparison of alternate street and outdoor lighting technologies.

Austin Energy proposes to evaluate the application of a prototype florescent outdoor lighting system to better understand the acceptance of florescent street lighting in terms of "brightness" and the perception of safety and security. The study will utilize prototype florescent street lighting that is installed in Austin Energy's service area and currently under evaluation.

The goal is to achieve the following objectives:

- Austin Energy will gain a set of guidelines for the application of florescent outdoor lighting technologies in its service territory.

- The State will gain valuable information on the appropriate application of florescent street lighting that can be transferred to other entities that specify and install area lighting such as municipalities, utilities, transportation authorities, and well as architects and engineers.

- The City of Austin and the State will gain unique market insights into possible market transformation programs to promote increased use of fluorescent outdoor lighting technologies.

Proposed Scope of Proposal:

- Austin Energy will purchase, install, and maintain the fluorescent street lighting for the test sites.
- The LRC's researchers will visit the test sites and conduct an in-depth assessment of both vertical and horizontal light illuminance distribution and confirm that they are consistent with the calculations.
- Austin Energy and the LRC will select two reference sites that utilize HPS lighting that are similar to sites with Fluorescent lighting both in terms of size and environment. One site will be low illuminance (~.5 Foot candles), and others will have higher illuminances (>1 foot candles).
- The LRC will conduct a study using an equal number of male and female subjects to determine their perceptions of safety and brightness in both the HPS and Fluorescent sites and compare the data. This study will include questions on glare, facial recognition, and preference. This data will in tern be compared to a much larger study done in the State of New York, to help validate the results.
- Based on the evaluation results, the LRC will publish a final report that will include a set of guidelines for the replacement of HPS lighting with Fluorescent lighting for streets and parking lots in the City of Austin.

Responsibilities:

Task	Provider
Purchase, install, and maintain the fluorescent outdoor lighting for the test sites.	Austin Energy
Assist with data collection and site selection	Austin Energy
Visit test sites and conduct an in-depth assessment of both vertical and horizontal illuminance distribution and confirm that they are consistent with the calculations.	LRC
Select two reference sites that utilize HPS lighting similar to the sites with Fluorescent lighting in size and environment.	LRC
Study the perceptions of safety and brightness in both the HPS and Fluorescent sites.	LRC

Project Timeline:

Austin Energy and the LRC are prepared to execute a contract forming the above described partnership within 30 calendar days of the approval of the grant. We project that study should be complete within 180 calendar days of the approval date.

Commercial Terms of Agreement:

Program cost: ~$41,000

Itemization of costs:

Evaluation of Fluorescent Outdoor Lighting by LRC		$35,000
Test Fixtures and installation by Austin Energy		~$6,000
	Total	$41,000
Less Austin Energy's investment	(~15%)	($6,000)
	Grant Amount Requested	$35,000

Attachments:

Lighting Research Center's proposal

CAROLE KEETON STRAYHORN
Comptroller

COMPTROLLER OF PUBLIC ACCOUNTS

P.O. BOX 13528
AUSTIN, TX 78711-3528

June 21, 2006

Mr. Roger Duncan
Deputy General Manager
City of Austin dba Austin Energy
721 Barton Springs Road
Austin, Texas 78704

Dear Mr. Duncan:

I am pleased to forward the enclosed contract between the State Energy Conservation Office (SECO) of the Comptroller of Public Accounts and the City of Austin dba Austin Energy.

Enclosed you will find a Voucher Information Summary Sheet and instructions to assist you in preparing reimbursement requests for contract activities performed according to the Statement of Services to be Performed (Attachment A). Vouchers for reimbursement should reference Contract #CM637 and be submitted to:

David Schiller
Comptroller of Public Accounts
State Energy Conservation Office
LBJ State Office Building
111 East 17th Street, Room 1114
Austin, Texas 78774

We look forward to working with you. If you have any questions or concerns regarding your contract or billing procedures, please contact me at (512) 463-1080.

Sincerely,

Felix A. Lopez, P.E.
Senior Engineer
State Energy Conservation Office

FAL:fal

Enclosures

COMPTROLLER OF PUBLIC ACCOUNTS, STATE ENERGY CONSERVATION OFFICE

CONTRACTOR REIMBURSEMENT GUIDELINES

All SECO contractors are required to submit a Voucher Information Summary Sheet (VISS) for each request for reimbursement. Documentation for all expenses claimed on the VISS should be attached to and submitted along with the form.

The following information should be included on the VISS:

Contractor
Contract Number
Vendor ID Number
Contact Person
Period Covered by Claim
Amount of Claim

In the Budget Itemization section, the line items corresponding to the line items in Attachment B - Budget of the contract should be completed. The most commonly used lines are:

04 Personnel
05 Travel
07 Subcontract
08 Equipment
09 Other Direct Operating Expenses
11 Contractor Provided Match

A cover sheet should be placed before each section of documentation. The cover sheet should state the budget category and amount being claimed. A calculator tape showing the category expenses and total should be attached to each cover sheet. Budget category documentation should include the following:

Personnel - Copies of payment records or time sheets which reflect the name, time worked, salary, and benefits of the persons working directly on the project. To reduce the amount of paper submitted, a spread sheet similar to the given example may be submitted. (See next page.) Copies of the actual time sheets should be kept on file with the contractor.

Travel - Original SECO Contractor Reimbursement Forms recording travel expenses, purposes, and activities. Receipts are required for all travel expenses and should be attached to the form. A copy of the SECO Contractor Out-of-State Travel Approval Form should be submitted along with the travel reimbursement form. **NOTE:** All travel expenses will be reimbursed according to the SECO Contractor Travel Reimbursement Guidelines.

Subcontract - Copies of subcontractors' agreements, pay schedules, and expense receipts. One copy of each subcontract agreement should be submitted to SECO upon execution. It will be helpful to supply the subcontractor with all SECO forms and guidelines to ensure that all reporting requirements are uniform and met.

Equipment & Other Direct Operating Expenses - Copies of receipts for all purchases. If the receipt does not give an item description, indicate the description and purpose of the item. Single-item purchases over $500 require Agency approval. Submit a memo at least two (2) weeks prior to the anticipated order or purchase date. The memo should state the item description, purpose, and direct benefit to the project. **NOTE:** Items specifically listed by name in Attachment B - Budget of the contract do not require written approval.

Contractor Provided Match - Copies of receipts and records for all expenses used to calculate contractor match. The expenses should be broken out in the above categories according to the amounts listed in Attachment B - Budget of the contract. To reduce the amount of paper submitted, a spreadsheet similar to the example below may be submitted. Copies of the actual receipts and records should be kept on file with the contractor.

PERSONNEL RECORD
January 1- 31, 1999

EMPLOYEE	HOURS	SALARY	BENEFITS	TOTAL
Jim Brown	40.00	500.00	125.00	**625.00**
Suzy Friend	40.00	750.00	187.50	**937.50**
Paul Kenner	25.00	200.00	50.00	**250.00**
TOTAL		**1450.00**	**362.50**	**1812.50**

CONTRACTOR PROVIDED MATCH
January 1 - 31, 1999

PERSONNEL			600.00
	Robin Wren	250.00	
	Victor Hearne	350.00	
TRAVEL			300.00
	Dallas(1/12-14)	200.00	
	Houston(1/20-21)	100.00	
SUBCONTRACT			2000.00
	Corp One	2000.00	
EQUIPMENT			1750.00
	Computer	1250.00	
	Printer	500.00	
OTHER DIRECT			650.00
	Printing	150.00	
	Office Space	500.00	
	TOTAL		**5300.00**

VOUCHER INFORMATION SUMMARY SHEET

Contractor must fully complete, sign and submit with each claim

CONTRACTOR _____

CONTRACT NUMBER (5 DIGITS) _____

VENDOR I.D.# (14 DIGITS) _____

PROGRAM CONTACT PERSON AT ENERGY OFFICE _____

PERIOD COVERED BY CLAIM _____ THRU _____

TOTAL AMOUNT OF THIS CLAIM $ _____

ITEMIZATION OF THIS CLAIM BY CONTRACT BUDGET CATEGORY:

01 Professional Services	$
02 Salaries	$
03 Benefits	$
04 Personnel	$
05 Travel	$
06 Supplies & Materials	$
07 Subcontract	$
08 Equipment	$
09 Other Direct Operating Expenses	$
10 Indirect Costs	$
12 Engineering Services	$
13 Loans	$
11 Contractor Provided Match	$

CERTIFICATION OF CLAIM
BY CONTRACTOR: _____

TITLE: _____

STATE ENERGY CONSERVATION OFFICE

CONTRACTOR TRAVEL REIMBURSEMENT GUIDELINES

IN-STATE TRAVEL

travel directly related to delivery of project services is permitted.

OUT-OF-STATE TRAVEL

Travel outside the state of Texas requires the **PRIOR written approval of the agency and must be fully justified. The SECO Contractor Out-of-State Travel Approval Form should be submitted at least two (2) weeks prior to travel date.**

LODGING

Reimbursement of actual expenses incurred up to a **maximum of $80.00 per night. Hotel tax is not included in the $80.00 per night maximum and may be claimed as a separate expense.**

MEALS

Reimbursement of actual expenses incurred up to a **maximum of $30.00 per day for travel that includes an overnight stay. Tax** is included in the $30.00 per day maximum. Tips **are not reimbursable.**

TRANSPORTATION

Personal car mileage is reimbursed at a rate of **$ .345 per mile.**

Airline expenses are reimbursed at actual rate for **coach fare.**

Rental car expenses are reimbursed at actual rate. **No luxury cars are allowed.**

Taxi/cab expenses are reimbursed at actual rate. Tips **are not reimbursable.**

RECEIPTS ARE REQUIRED FOR ALL EXPENDITURES.

STATE ENERGY CONSERVATION OFFICE

CONTRACTOR TRAVEL REIMBURSEMENT FORM

Traveler: _____ Title: _____

Travel Dates: From_____ To _____

Travel Purpose: _____

_____

_____

_____

_____

Expense Itemization:

FARES	$
Public Transportation	
Taxi	
Air fare	
Rental car	
PERSONAL CAR MILEAGE (Miles @$.345/mile)	$
MEALS	$
LODGING	$
PARKING	$
OTHER TRAVEL EXPENSES	$
Hotel tax	
Business phone calls/copies/faxes	
Registration fee	
Gasoline	
TOTAL	$

* See reverse side for daily expenses (meals, lodging, lodging tax, mileage) and travel record.

\VOUGUIDE

DATE	MEALS	LODGING	LODGING TAX	MILEAGE
TOTALS:				Miles X $.345
	$	$	$	$

IN-STATE TRAVEL REIMBURSEMENTS:
MEALS - $30/day on overnight stays. No tips. LODGING – $80/night. LODGING TAX – Actual.

OUT-OF-STATE TRAVEL REIMBURSEMENTS:
MEALS AND LODGING – Approved state rates for the location. No tips. LODGING TAX – Actual.

DATE	TRAVEL RECORD

STATE OF TEXAS *

COUNTY OF TRAVIS *

STATE ENERGY CONSERVATION OFFICE
AGREEMENT – Interlocal Cooperation Act
INTERLOCAL CONTRACT # CM637

g:\contract\felix\ae_coa 06 lighting demonstration contract.doc
Revised: 10/24/2005

Recitals

Whereas, the City of Austin, a Texas home-rule municipal corporation acting and through its Electric Utility dba Austin Energy and the Comptroller of Public Accounts, State Energy Conservation Office, will enter into an Agreement to provide for the administration and facilitation of the City of Austin dba Austin Energy's Demonstration and Evaluation of Fluorescent Outdoor Lighting Program; and

Whereas, Chapter 403 and Section 2305.033, Texas Government Code, and Rider 9, Section B.1.1 of the Appropriations Act, Seventy-Seventh Texas Legislature, authorize the Comptroller and State Energy Conservation Office (Comptroller or SECO) to enter into contracts and provide for the administration and activities of the City of Austin dba Austin Energy's Demonstration of Fluorescent Outdoor Lighting Program; and

Whereas, Section 791.011, Texas Government Code, authorizes agreements between agencies and entities of the state and local entities, including the City of Austin dba Austin Energy; and

Whereas, under this Agreement, the City of Austin dba Austin Energy will form a joint venture with the Lighting Research Laboratory of the Rensselaer Polytechnic Institute of New York (LRC) for the administration and other activities associated with the City of Austin's Demonstration of Fluorescent Outdoor Lighting Program, as more fully set forth in Attachment A, "Statement of Services", to this Agreement. Under this Agreement, the City of Austin dba Austin Energy and LRC shall provide all personnel, equipment, materials, services, and other services as more fully set forth in Attachment A; and

Whereas, Comptroller agrees to pay to the City of Austin dba Austin Energy in return for the performance of the services as set forth in Attachment A, the total cost of the services not to exceed $35,000.00, as more fully detailed in Attachment B, "Budget" to this Agreement; and

Whereas, the foregoing amount fairly, reasonably, and adequately compensates the City of Austin/Austin Energy for all personnel, services, materials, and other expenses, provided to Comptroller and the City of Austin/Austin Energy's Demonstration of Fluorescent Outdoor Lighting Program under this Agreement,

Now, Therefore, in consideration of all of the foregoing, the parties hereby agree as follows:

I. Parties

This Interlocal Agreement ("Agreement") is made and entered into by the following parties:

The Agency: (Receiving Agency)
Comptroller of Public Accounts, ("Agency")
State Energy Conservation Office
LBJ State Office Building
111 E. 17th Street, Room 1114
Austin, Texas 78774

The Contractor: (Performing Agency)
City of Austin dba Austin Energy, ("Contractor")
721 Barton Springs Road
Austin, Texas 78704

II. Authority

This Agreement is entered into pursuant to the Oil Overcharge Restitutionary Act, Chapter 2305, Texas Government Code; the Interlocal Cooperation Act, Chapter 791, Texas Government Code, and the State of Texas Oil Overcharge Funds Disbursement Plan. Funding of this program is provided by Exxon Oil Overcharge Funds and/or Federal Funds received from the United States Department of Energy.

III. Services

Contractor shall provide all of the services described in Attachment A to this Agreement, which is attached hereto and incorporated herein for all purposes. In addition, Contractor shall provide all services reasonably related to those specified in Attachment A.

Contractor shall retain full control over the personnel, equipment, supplies, and other items Contractor selects as necessary to provide all of the services described in Attachment A.

Contractor shall submit such records, information, and reports in such form and at such times as may be required by Agency; these reports shall include, but are not limited to, the reports specified in Attachment A.

IV. Payments

Total payments to Contractor under this Agreement shall not exceed Thirty Five Thousand Dollars ($35,000.00). Contractor's payments under this Agreement are limited to reimbursements of authorized costs and out-of-pocket expenses incurred pursuant to the budget provided in Attachment B, which is attached hereto and incorporated herein for all purposes. No other amounts shall be paid. Contractor shall submit each request for payment by submitting a detailed invoice, listing expenses by budget categories. Contractor shall submit invoices that are fully supported by receipts and such other documentation; Agency reserves the right, in its sole discretion, to withhold payment of invoices for which Contractor does not submit documentation acceptable to Agency. Contractor shall submit monthly invoices for services performed and costs incurred in the prior month. Contractor shall submit performance reports as required by Attachment A.

Contractor shall be reimbursed for authorized travel under this Agreement only if travel is a budget category in Attachment B. If travel is included in Attachment B, Contractor shall be reimbursed for reasonable out-of-pocket travel expenses at rates not to exceed the approved Texas Comptroller of Public Accounts employee rates.

Contractor shall not purchase any equipment or computer software for its performance under this Agreement without prior written approval from Agency. For this purpose, equipment is defined as tangible personal property having a useful life of more than one year and an acquisition cost of five hundred dollars ($500.00) or more per unit. Title to and control over equipment or license of any software so purchased for Contractor's performance under this Agreement shall remain with Contractor so long as it is being used for the purpose for which it was intended under the terms of this Agreement.

Agency reserves the right, in its sole discretion, to authorize revisions to budgeted amounts to provide for flexibility within budget categories. Agency must give prior approval of all such revisions through its execution of a written amendment to this Agreement.

V. Inspection, Monitoring and Records

Contractor shall permit Agency to inspect and shall make available to Agency for inspection any and all pertinent records, files, information and other written material pertaining to the operation of programs and expenditure of funds under this Agreement. This information includes, but is not limited to, all information maintained by Contractor or any of its subcontractors. Contractor shall maintain, keep and preserve at its principal office all such records for a period of four years and make the same available to Agency, other state or federal agencies for auditing or other purposes authorized by applicable federal or state law or guidelines. Agency may also carry out monitoring and evaluation activities to ensure Contractor's compliance with the programs that are the subject of this Agreement and to make available copies of all financial audits and related management letters of Contractor and any subcontractors as required under any applicable federal or state law or guidelines.

Contractor shall also comply with the inspection, monitoring and records requirements described in Attachment A.

VI. Termination

Either party may terminate this Agreement by delivering written notice of the termination to the other party at least thirty (30) days prior to the effective date of termination specified in the notice.

Upon receipt of notice of termination from Agency, Contractor shall have thirty (30) days in which to complete projects which have been substantially performed. Upon receipt of such notice, Contractor shall cancel, withdraw or otherwise terminate any outstanding orders or subcontracts of this Agreement as of the effective date of such termination and shall otherwise cease to incur any costs; Agency shall have no liability for costs incurred after such termination date.

VII. Indemnification

To the extent permitted under the Constitution and laws of the State of Texas, Contractor shall indemnify, save and hold harmless Agency, its officers, agents, representatives and employees, and the State of Texas, its officers, agents, representatives and employees, from all suits, actions, losses, damages, claims, or liability of any character, type, or description, including without limiting the generality of the foregoing all expenses of litigation, court costs, and attorney's fees for injury or death to any person, or injury to any property, received or sustained by any person or persons or property, arising out of, or occasioned by, the negligent acts of Contractor or its officers, agents, representatives or employees, in the execution or performance of this Agreement.

VIII. Subcontracting

Contractor may subcontract for services to be provided under this Agreement with Agency's prior written approval of each such subcontract and subcontractor. Contractor, in subcontracting any of its performance hereunder, shall legally bind subcontractors to perform and make such subcontractors subject to all the duties, requirements, and obligations of Contractor under this Agreement. Contractor shall be jointly and severally liable for all performances under this Agreement, including, but not limited to, the performance of its subcontractors to the extent permitted under the Constitution and laws of the State of Texas.

Contractor represents and warrants that it has obtained all necessary permits, licenses, easements, waivers and permissions of whatsoever kind required for its performance and the performance of its subcontractors under this Agreement. In no event shall any provision of this Paragraph, including, but not limited to, the requirement that Contractor obtain the prior approval of Agency on Contractor's subcontracts, be construed as relieving Contractor of the responsibility for ensuring that all services rendered under its subcontracts comply with all the terms and provisions of this Agreement as if they were rendered by Contractor. Contractor shall furnish Agency with copies of all proposed subcontracts and all proposed amendments, assignments, cancellations or terminations of said subcontracts no later than thirty (30) days prior to the proposed effective date of such contracts, amendments, assignments, cancellations or terminations; provided, however, that this thirty (30) day period may be shortened by written agreement of the parties.

IX. Amendments

This Agreement may only be amended upon the written agreement of the parties by executing an amendment to this Agreement; however, Agency may unilaterally amend this Agreement as provided in Paragraph XVIII.

X. Incorporation of Attachments; Incorporation by Reference

All of the following attachments are attached hereto and incorporated into this Agreement for all purposes:

Attachment A:	Statement of Services To Be Performed
Attachment B:	Budget
Attachment C-1:	DOE Assurance of Compliance, as completed by Contractor
Attachment C-2:	DOE Assurance of Compliance, as completed by each subcontractor
Attachment D:	Certification Regarding Debarment, Suspension, Ineligibility, and Voluntary Exclusion-Lower Tier Covered Transactions, as completed by Contractor
Attachment E:	Certifications Regarding Lobbying; Debarment, Suspension and Other Responsibility Matters; and Drug-Free Workplace Requirements, as completed by Contractor
Attachment F:	Disclosure of Lobbying Activities, as completed by Contractor
Attachment G:	Assurances -- Non-Construction Programs, as completed by Contractor
Attachment H:	Intellectual Property Provisions, as completed by Contractor
Attachment I:	Nondisclosure Agreement, as completed by Contractor

Contractor represents and warrants that it completed and provided the following Attachments to Agency prior to executing this Agreement: C-1, D, E, F, G, H and I. In addition, Contractor represents and warrants that each

of its subcontractors will complete and provide an Attachment C-2 to Contractor and Agency prior to Contractor executing this Agreement.

All applicable rules, regulations and all other requirements imposed by law, including, but not limited to, those pertinent rules and regulations of the State of Texas and those of federal agencies providing funds to the State of Texas are incorporated into this Agreement by reference as if specifically written herein.

XI. Funding

Agency's performance of its obligations under this Agreement is contingent upon and subject to availability of and actual receipt by Agency of sufficient and adequate funds from the sources contemplated by this Agreement. This Agreement is subject to immediate cancellation or termination, without penalty to Agency or the State of Texas, subject to the availability and receipt of these funds. In addition, Agency is a state agency whose authority and appropriations are subject to the actions of the Texas Legislature. If Agency becomes subject to a legislative change, revocation of statutory authority or lack of funds that would render the services to be provided under this Agreement impossible or unnecessary, Agency may terminate this Agreement without penalty to Agency or the State of Texas. In the event of a termination or cancellation under this Paragraph, Agency shall not be required to give notice and shall not be liable for damages or losses caused or associated with such termination or cancellation.

XII. Term of Agreement

The term of this Agreement shall be upon signature by Agency until April 30, 2007 unless terminated earlier in accordance with other provisions of this Agreement. The provisions of the following shall survive the termination or expiration of this Agreement: Paragraphs V, VII, XV, XVI, XVII; Sections 19.2, 19.3, 19.6; and Attachments C-1, C-2, G, H and I.

XIII. Force Majeure

Except as otherwise provided, neither Contractor nor Agency shall be liable to the other for any delay in, or failure of performance, of any requirement contained in this Agreement caused by force majeure. The existence of such causes of delay or failure shall extend the period of performance until after the causes of delay or failure have been removed provided the non-performing party exercises all reasonable due diligence to perform. Force majeure is defined as acts of God, war, fires, explosions, hurricanes, floods, failure of transportation, or other causes that are beyond the reasonable control of either party and that by exercise of due foresight such party could not reasonably have been expected to avoid, and which, by the exercise of all reasonable due diligence, such party is unable to overcome. Each party must inform the other in writing with proof of receipt within three (3) business days of the existence of such force majeure or otherwise waive this right as a defense.

XIV. Assignment

Without the prior written consent of Agency, Contractor may not transfer or assign any rights or duties under or any interest in this Agreement.

XV. Property Rights

For the purposes of this Agreement, the term "Work" is defined as all reports, work papers, work products, materials, approaches, designs, specification, systems, documentation, methodologies, concepts, intellectual property or other property developed, produced or generated in connection with the services provided under this Agreement. Agency and Contractor intend this Agreement to be a contract for services and each considers the Work and any and all documentation or other products and results of the services rendered by Contractor to be work made for hire. Contractor acknowledges and agrees that the Work (and all rights therein) belongs to and shall be the sole and exclusive property of Agency.

If for any reason the Work would not be considered work-for-hire under applicable law, Contractor does hereby sell, assign, and transfer to Agency, its successors and assigns, the entire right, title and interest in and to the copyright in the Work and any registrations and copyright applications relating thereto and any renewals and extensions thereof, and in and to all works based upon, derived from, and incorporating the Work, and in and to all income, royalties, damages, claims, and payments now or hereafter due or payable with respect thereto, and in and to all causes of action, either in law or in equity for past, present, or future infringement based on the copyrights, and in and to all rights corresponding to the foregoing. Contractor agrees to execute all papers and

to perform such other property rights as Agency may deem necessary to secure for Agency or its designee the rights herein assigned.

Contractor and Contractor's employees shall have no rights in or ownership of the Work and any and all documentation or other products and results of these services or any other property of Agency.

No later than the first calendar day after the termination or expiration of this Agreement or at Agency's request, Contractor shall deliver to Agency all completed, or partially completed, Work and any and all documentation or other products and results of these services. Failure to timely deliver such Work and any and all documentation or other products and results of services shall be considered a material breach of this Agreement. Contractor shall not make or retain any copies of the Work or any and all documentation or other products and results of the services without the prior written consent of Agency.

In the event of any conflicting provisions between this Paragraph and Attachment H, Attachment H shall control.

XVI. Severability Clause

In the event that any provision of this Agreement is later determined to be invalid, void, or unenforceable, then the remaining provisions of this Agreement shall remain in full force and effect, and shall in no way be affected, impaired, or invalidated.

XVII. Dispute Resolution Process

Chapter 2260 of the Texas Government Code ("Chapter 2260") prescribes dispute resolution processes for certain breach of contract claims applicable to certain contracts for goods and services. As required by Chapter 2260, Agency has adopted rules under Chapter 2260, codified at 34 Texas Administrative Code §§1.360 – 1.387, and may adopt revisions to these rules throughout the term of this Agreement, including any extensions. Contractor shall comply with such rules.

The dispute resolution process provided for in Chapter 2260 of the Government Code shall be used, as further described herein, by Agency and Contractor to attempt to resolve any claim for breach of contract made by Contractor under this Agreement:

(A) Contractor's claim for breach of this Agreement that the parties cannot resolve in the ordinary course of business shall be submitted to the negotiation process provided in Chapter 2260. To initiate the process, Contractor shall submit written notice, as required by Chapter 2260, to the Deputy Comptroller or his or her designee. Said notice shall also be given to all other representatives of Agency and Contractor otherwise entitled to notice under this Agreement. Compliance by Contractor with Chapter 2260 is a condition precedent to the filing of a contested case proceeding under Chapter 2260.

(B) The contested case process provided in Chapter 2260 is Contractor's sole and exclusive process for seeking a remedy for an alleged breach of contract by Agency if the parties are unable to resolve their disputes under subparagraph (A) of this Section.

(C) Compliance with the contested case process provided in Chapter 2260 is a condition precedent to seeking consent to sue from the Legislature under Chapter 107, Civ. Prac. and Rem. Code. Neither the execution of this Agreement by Agency nor any other conduct of any representative of Agency relating to this Agreement shall be considered a waiver of sovereign immunity to suit.

For all other specific breach of contract claims or disputes under this Agreement, the following shall apply:

Should a dispute arise out of this Agreement, Agency and Contractor shall first attempt to resolve it through direct discussions in a spirit of mutual cooperation. If the parties' attempts to resolve their disagreements through negotiations fail, the dispute will be mediated by a mutually acceptable third party to be chosen by Agency and Contractor within fifteen (15) days after written notice by one of them demanding mediation under this Section. Contractor shall pay all costs of the mediation unless Agency, in its sole good faith discretion, approves its payment of all or part of such costs. By mutual agreement, Agency and Contractor may use a non-binding form of dispute resolution other than mediation. The purpose of this Section is to reasonably ensure that Agency and Contractor shall in

good faith utilize mediation or another non-binding dispute resolution process before pursuing litigation. Agency's participation in or the results of any mediation or another non-binding dispute resolution process under this Section or the provisions of this Section shall not be construed as a waiver by Agency of (1) any rights, privileges, defenses, remedies or immunities available to Agency as an agency of the State of Texas or otherwise available to Agency; (2) Agency's termination rights; or (3) other termination provisions or expiration dates of this Agreement.

Notwithstanding any other provision of this Agreement to the contrary, Contractor shall continue performance and shall not be excused from performance during the period any breach of Contract claim or dispute is pending under either of the above processes; however, Contractor may suspend performance during the pendency of such claim or dispute if Contractor has complied with all provisions of §2251.051, Tex Govt Code, and such suspension of performance is expressly applicable and authorized under that law.

XVIII. Applicable Law and Conforming Amendments

Contractor shall comply with all laws, regulations, requirements and guidelines applicable to a contractor providing services to the State of Texas, as these laws, regulations, requirements and guidelines currently exist and as they are amended throughout the term of this Agreement. Agency reserves the right, in its sole discretion, to unilaterally amend this Agreement prior to award and throughout the term of this Agreement to incorporate any modifications necessary for Agency's or Contractor's compliance with all applicable state and federal laws, regulations, requirements and guidelines. Other than this provision, this Agreement may only be amended by the written agreement of the parties.

XIX. Additional Provisions

19.1 Time Limits

Time is of the essence in the performance of this Agreement and accordingly all time limits shall be strictly construed and rigidly enforced.

19.2 No Waiver

This Agreement shall not constitute or be construed as a waiver of any of the privileges, rights, defenses, remedies, or immunities available to Agency as an agency of the State of Texas or otherwise available to Agency. The failure to enforce or any delay in the enforcement of any privileges, rights, defenses, remedies, or immunities available to Agency under this Agreement or under applicable law shall not constitute a waiver of such privileges, rights, defenses, remedies, or immunities or be considered as a basis for estoppel. Agency does not waive any privileges, rights, defenses, remedies or immunities available to Agency as an agency of the State of Texas, or otherwise available to Agency, by entering into this Agreement or by its conduct prior to or subsequent to entering into this Agreement. **The modification of any privileges, rights, defenses, remedies, or immunities available to Agency must be in writing, must reference this section, and must be signed by Agency to be effective, and such modification of any privileges, rights, defenses, remedies, or immunities available to Agency shall not constitute waiver of any subsequent privileges, rights, defenses, remedies, or immunities under this Agreement or under applicable law.**

19.3 No Liability Upon Termination

If this Agreement is terminated for any reason, the parties and the State of Texas shall not be liable for any damages, claims, losses, expenses, costs or any other amounts arising from or related to any such termination.

19.4 Limitation on Authority; No Other Obligations

Contractor shall have no authority to act for or on behalf of Agency or the State of Texas except as expressly provided for in this Agreement; no other authority, power, use, or joint enterprise is granted or implied. Contractor may not incur any debts, obligations, expenses or liabilities of any kind on behalf of Agency.

19.5 No Other Benefits

Contractor shall have no exclusive rights or benefits other than those set forth herein.

19.6 Supporting Documents; Right to Audit; Independent Audits

Contractor shall maintain and retain supporting fiscal documents adequate to ensure that claims for contract funds are in accordance with applicable Agency and State of Texas requirements. Contractor shall maintain all such documents and other records relating to this Agreement and the State's property for a period of four (4) years after the date of submission of the final invoices or until a resolution of all billing questions, whichever is later. Contractor shall make available at reasonable times and upon reasonable notice, and for reasonable periods, all information related to the State's property, such as work papers, reports, books, data, files, software, records, and other supporting documents pertaining to this Agreement, for purposes of inspecting, monitoring, auditing, or evaluating by Agency, the State of Texas or their authorized representatives. Contractor shall cooperate with auditors and other authorized Agency and State of Texas representatives and shall provide them with prompt access to all of such State's property as requested by Agency or the State of Texas. By example and not as an exclusion to other breaches or failures, Contractor's failure to comply with this Section shall constitute a material breach of this Agreement and shall authorize Agency to immediately assess liquidated damages for such failure. For purposes of this Section, the "State's property" includes, but is not limited to, "Work" as defined in this Agreement. Agency may require, at Contractor's sole cost and expense, independent audits by a qualified certified public accounting firm of Contractor's books and records or the State's property. The independent auditor shall provide Agency with a copy of such audit at the same time it is provided to Contractor. Agency retains the right to issue a request for proposals for the services of an independent certified public accounting firm under this Agreement. In addition to and without limitation on the other audit provisions of this Agreement, pursuant to Section 2262.003, Tex Gov't Code, the state auditor may conduct an audit or investigation of the Contractor or any other entity or person receiving funds from the state directly under this Agreement or indirectly through a subcontract under this Agreement. The acceptance of funds by the Contractor or any other entity or person directly under this Agreement or indirectly through a subcontract under this Agreement acts as acceptance of the authority of the state auditor, under the direction of the legislative audit committee, to conduct an audit or investigation in connection with those funds. Under the direction of the legislative audit committee, the Consultant or other entity that is the subject of an audit or investigation by the state auditor must provide the state auditor with access to any information the state auditor considers relevant to the investigation or audit. This Agreement may be amended unilaterally by the Comptroller to comply with any rules and procedures of the state auditor in the implementation and enforcement of Section 2262.003. Under procedures provided by the state auditor on September 5, 2003, in addition to the above, (1) the Contractor understands that the acceptance of funds under this Agreement acts as acceptance of the authority of the state auditor to conduct an audit or investigation in connection with those funds; (2) the Contractor further agrees to cooperate fully with the state auditor in the conduct of the audit or investigation, including providing all records requested; (3) the Contractor shall ensure that this paragraph concerning the authority to audit funds received indirectly by subcontractors through the Contractor and the requirement to cooperate is included in any subcontract it awards; and (4) the state auditor shall at any time have access to and the rights to examine, audit, excerpt, and transcribe any pertinent books, documents, working papers, and records of the Contractor relating to this Agreement.

19.7 Debts or Delinquencies to State

Contractor acknowledges and agrees that, to the extent Contractor owes any debt or delinquent taxes to the State of Texas, any payments or other amounts Contractor is otherwise owed under or related to this Agreement may be applied by the Comptroller of Public Accounts toward any debt or delinquent taxes Contractor owes the State of Texas until the debt or delinquent taxes are paid in full. These provisions are effective at any time Contractor owes any such debt or delinquency. Contractor shall comply with rules adopted by the Comptroller under §§403.055, 403.0551, 2252.903, Tex Gov't Code, and other applicable laws and regulations regarding satisfaction of debts or delinquencies to the State of Texas.

XX. Signatories

The undersigned signatories represent and warrant that they have full authority to enter into this Agreement on behalf of the respective parties.

XXI. Merger

This Agreement contains the entire agreement between the parties relating to the rights granted and the obligations assumed in it. Any oral representations or modifications concerning this Agreement shall be of no force or effect unless contained in a subsequent writing, signed by both parties.

AGENCY:
Comptroller of Public Accounts

By _____

Billy C. Hamilton
Deputy Comptroller

Date 6/15/06

CONTRACTOR:
City of Austin dba Austin Energy

By _____

Roger Duncan
Deputy General Manager

Date 6/12/06

ATTACHMENT A Contract No. _____

STATEMENT OF SERVICES TO BE PERFORMED

A. Contractor shall perform all of the services described in this Attachment A, or otherwise required by this Agreement, ("services"). These services include, but are not limited to, the furnishing of all personnel and the procurement of all equipment, supplies, and other items necessary to provide those services in compliance with this Agreement. Contractor shall provide all services in accordance with the Standards of Performance established by Agency for these services. Contractor shall review and implement Agency recommendations, as Agency adopts them from time to time, so that the services may be expeditiously and satisfactorily completed. Contractor shall meet with Agency at such times as Agency may reasonably request to discuss the progress of services and any other matters that may arise in regard to this Agreement.

B. Contractor shall provide all of the following services:

1. Negotiate a contract agreement with the Lighting Research Center (LRC) and provide a copy to SECO.

2. Schedule a project kick-off meeting with SECO and LRC.

3. Provide a brief summary of the fluorescent lighting technology with potential market opportunities, an economical analysis, barriers of the implementation phase, and technology transfer to other municipalities in Texas.

4. Provide a project summary presentation that include Austin Energy plan to expand the fluoresecent lighting testing or its market deployment.

5. Provide monthly progress reports.

6. Provide a Final Report with a summary of the completed project findings, including the lighting replacement guidelines and an estimate of the potential savings for lighting replacements in the Austin Energy service territory.

STATEMENT OF SERVICES TO BE PERFORMED

C. Contractor shall provide the following services during the period of this Agreement and all services reasonably related to them. Agency may request additional records, information or reports related to the services hereinafter described and funded by Agency pursuant to Attachment B. These services are as follows:

The minimum deliverables are summarized in the following chart:

	Deliverables and Milestones	Schedule
1.	Negotiate contract agreement with the Lighting Research Center (LRC) and provide a copy to SECO.	30 days after contract start
2.	Schedule a project kick-off meeting with SECO and LRC.	60 days after contract start
3.	Provide a brief summary of the fluorescent lighting technology with potential market opportunities, an economical analysis, barriers of the implementation phase, and technology transfer to other municipalities in Texas.	90 days after contract start
4.	Provide a project summary presentation that include Austin Energy plan to expand the fluoresecent lighting testing or its deployment.	120 days after contract start
5.	Provide monthly progress reports.	Monthly
6.	Provide a Final Report with a summary of the completed project findings, including the lighting replacement guidelines and an estimate of the potential savings for lighting replacements in the Austin Energy service territory.	April 30, 2007

ATTACHMENT B Contract No. _____

BUDGET

Benefits	$0.00
Engineering Services	$0.00
Equipment [1]	$0.00
Indirect Costs	$0.00
Other Direct Operating Expenses	$0.00
Personnel [2]	$0.00
Professional Services	$0.00
Salaries	$0.00
Subcontract	**$35,000.00**
Supplies and Materials	$0.00
Travel [3] Airfare, per diem, mileage, and other direct travel expenses	$0.00
Total Direct Costs	**$35,000.00**
Contractor Provided Match	**$0.00**

[1] Contractor shall not purchase any equipment or computer software for its performance under this Agreement without prior written approval from Agency. For this purpose, equipment is defined as tangible personal property having a useful life of more than one year and an acquisition cost of five hundred dollars ($500.00) or more per unit. Title to and control over equipment or license of any software so purchased for Contractor's performance under this Agreement shall remain with Contractor so long as it is being used for the purpose for which it was intended under the terms of this Agreement.

[2] Fred Yebra, Austin Energy Director, Demand Side Management, shall be Project Director for this project and shall be responsible for the overall supervision and conduct of the project on behalf of Contractor. Any Change of Project Director shall be subject to the prior written approval of Agency.

[3] Out-of-state travel requires prior written approval of Agency. All actual, reasonable travel expenses will be reimbursed at state authorized rates.

DOE F 1600.5
(06-94)
All Other Editions Are Obsolete

OMB Control No.
1910-0400

U.S. DEPARTMENT OF ENERGY
Assurance of Compliance
Nondiscrimination in State Assisted Programs

OMB Burden Disclosure Statement

Public reporting burden for this collection of information is estimated to average 15 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Office of Information Resources Management Policy, Plans, and Oversight, Records Management Division, HR-422-GTN, Paperwork Reduction Project (1910-0400), U.S. Department of Energy, 1000 Independence Avenue, S.W., Washington, DC 20585; and to the Office of Management and Budget (OMB), Paperwork Reduction Project (1910-0400), Washington, DC 20503.

City of Austin dba Austin Energy (Hereinafter called the "Applicant") HEREBY AGREES to comply with Title VI of the Civil Rights Act of 1964 (Pub. L. 88-352), Section 16 of the Federal Energy Administration Act of 1974 (Pub. L. 93-275), Section 401 of the Energy Reorganization Act of 1974 (Pub. L. 93-438), Title IX of the Education Amendments of 1972, as amended (Pub. L. 92-318, Pub. L. 93-568, and Pub. L. 94-482), Section 504 of the Rehabilitation Act of 1973 (Pub. L. 93-112), the Age Discrimination Act of 1977 (Pub. L. 94-135), Title VIII of the Civil Rights Act of 1968 (Pub. L. 90-284), the Department of Energy Organization Act of 1977 (Pub. L. 95-91), the Energy Conservation and Production Act of 1976, as amended, (Pub. L. 94-385) and Title 10 Code of Federal Regulations, Part 1040. In accordance with the above laws and regulations issued pursuant thereto, the Applicant agrees to assure that no person in the United States shall, on the ground of race, color, national origin, sex, age, or disability, be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity in which the Applicant receives Federal assistance from the Department of Energy.

Applicability and Period of Obligation

In the case of any service, financial aid, covered employment, equipment, property, or structure provided, leased, or improved with Federal assistance funding extended to the Applicant by the Department of Energy, this assurance obligates the Applicant for the period during which the Federal assistance is extended. In the case of any transfer of such service, financial aid, equipment, property, or structure, this assurance obligates the transferee for the period during which Federal assistance is extended. If any personal property is so provided, this assurance obligates the Applicant for the period during which it retains ownership or possession of the property. In all other cases, this assurance obligates the Applicant for the period during which the Federal assistance is extended to the Applicant by the Department of Energy.

Employment Practices

Where a primary objective of the Federal assistance is to provide employment or where the Applicant's employment practices affect the delivery of services in programs or activities resulting from Federal assistance extended by the Department of Energy, the Applicant agrees not to discriminate on the ground of race, color, national origin, sex, and disability, in its employment practices. Such employment practices may include, but are not limited to, recruitment, advertising, hiring, layoff or termination, promotion, demotion, transfer, rates of pay, training and participation in upward mobility programs, or other forms of compensation and use of facilities.

Subrecipient Assurance

The Applicant shall require any individual, organization, or other entity with whom it subcontracts, subgrants, or subleases for the purpose of providing any service, financial aid, equipment, property, or structure to comply with laws cited above. To this end, the subrecipient shall be required to sign a written assurance form; however, the obligation of both recipient and subrecipient to ensure compliance is not relieved by the collection or submission of written assurance forms.

Data Collection and Access to Records

The Applicant agrees to compile and maintain information pertaining to programs or activities developed as a result of the Applicant's receipt of Federal assistance from the Department of Energy. Such information shall include, but is not limited to the following: (1) the manner in which services are or will be provided and related data necessary for determining whether any persons are or will be denied such services on the basis of prohibited discrimination; (2) the population

eligible to be serviced by race, color, national origin, sex, and disability; (3) data regarding covered employment, including use or planned use of bilingual public contact employees serving beneficiaries of the program where necessary to permit effective participation by beneficiaries unable to speak or understand English; (4) the location of existing or proposed facilities connected with the program and related information adequate for determining whether the location has or will have the effect of unnecessarily denying access to any person on the basis of prohibited discrimination; (5) the present or proposed membership by race, color, national origin, sex, and disability, in any planning or advisory body which is an integral part of the program; and (6) any additional written data determined by the Department of Energy to be relevant to the obligation to assure compliance by recipients with laws cited in the first paragraph of this assurance.

The Applicant agrees to submit requested data to the Department of Energy regarding programs and activities developed by the Applicant from the use of Federal funds extended by the Department of Energy. Facilities of the Applicant (including the physical plants, buildings, or other structures) and all records, books, accounts, and other sources of information pertinent to the Applicant's compliance with the civil rights laws shall be made available for inspection during normal business hours of request of an officer or employee of the Department of Energy specifically authorized to make such inspections. Instructions in this regard will be provided by the Director, Office of Civil Rights, U. S. Department of Energy.

This assurance is given in consideration of and for the purpose of obtaining any and all Federal grants, loans, contracts (excluding procurement contracts), property, discounts or other Federal assistance extended after the date hereto, to the Applicants by the Department of Energy, including installment payments on account after such date of application for Federal assistance which are approved before such date. The Applicant recognizes and agrees that such Federal assistance will be extended in reliance upon the representations and agreements made in this assurance and that the United State shall have the right to seek judicial enforcement of this assurance. This assurance is binding on the Applicant, its successors, transferees, and assignees, as well as the person(s) whose signature appears below and who is authorized to sign this assurance on behalf of the Applicant.

Applicant Certification

The Applicant certifies that it has complied, or that, within 90 days of the date of the grant, it will comply with all applicable requirements of 10 C.F.R. § 1040.5 (a copy will be furnished to the Applicant upon written request to DOE.)

Designated Responsible Employee	
Fred Yebra, Director, Demand Side Management	(512) 482-5305
Name and Title (Printed or Typed)	**Telephone Number**
Fred Yebra	5+2 6/5/06
Signature	**Date**
Contractor	
City of Austin dba Austin Energy	(512) 322-6157
Name of Organization	**Telephone Number**
721 Barton Springs Road Austin, Texas 78704	
Address	
Authorized Official:	
Roger Duncan, Deputy General Manager	(512) 322-6157
Name and Title (Printed or Typed)	**Telephone Number**
	6/12/06
Signature	**Date**

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DOE F 1600.5
(06-94)
All Other Editions Are Obsolete

OMB Control No.
1910-0400

U.S. DEPARTMENT OF ENERGY
Assurance of Compliance
Nondiscrimination in State Assisted Programs

OMB Burden Disclosure Statement

Public reporting burden for this collection of information is estimated to average 15 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Office of Information Resources Management Policy, Plans, and Oversight, Records Management Division, HR-422-GTN, Paperwork Reduction Project (1910-0400), U.S. Department of Energy, 1000 Independence Avenue, S.W., Washington, DC 20585; and to the Office of Management and Budget (OMB), Paperwork Reduction Project (1910-0400), Washington, DC 20503.

_____ (Hereinafter called the "Applicant") HEREBY AGREES to comply with Title VI of the Civil Rights Act of 1964 (Pub. L. 88-352), Section 16 of the Federal Energy Administration Act of 1974 (Pub. L. 93-275), Section 401 of the Energy Reorganization Act of 1974 (Pub. L. 93-438), Title IX of the Education Amendments of 1972, as amended (Pub. L. 92-318, Pub. L. 93-568, and Pub. L. 94-482), Section 504 of the Rehabilitation Act of 1973 (Pub. L. 93-112), the Age Discrimination Act of 1977 (Pub. L. 94-135), Title VIII of the Civil Rights Act of 1968 (Pub. L. 90-284), the Department of Energy Organization Act of 1977 (Pub. L. 95-91), the Energy Conservation and Production Act of 1976, as amended, (Pub. L. 94-385) and Title 10 Code of Federal Regulations, Part 1040. In accordance with the above laws and regulations issued pursuant thereto, the Applicant agrees to assure that no person in the United States shall, on the ground of race, color, national origin, sex, age, or disability, be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity in which the Applicant receives Federal assistance from the Department of Energy.

Applicability and Period of Obligation

In the case of any service, financial aid, covered employment, equipment, property, or structure provided, leased, or improved with Federal assistance funding extended to the Applicant by the Department of Energy, this assurance obligates the Applicant for the period during which the Federal assistance is extended. In the case of any transfer of such service, financial aid, equipment, property, or structure, this assurance obligates the transferee for the period during which Federal assistance is extended. If any personal property is so provided, this assurance obligates the Applicant for the period during which it retains ownership or possession of the property. In all other cases, this assurance obligates the Applicant for the period during which the Federal assistance is extended to the Applicant by the Department of Energy.

Employment Practices

Where a primary objective of the Federal assistance is to provide employment or where the Applicant's employment practices affect the delivery of services in programs or activities resulting from Federal assistance extended by the Department of Energy, the Applicant agrees not to discriminate on the ground of race, color, national origin, sex, and disability, in its employment practices. Such employment practices may include, but are not limited to, recruitment, advertising, hiring, layoff or termination, promotion, demotion, transfer, rates of pay, training and participation in upward mobility programs, or other forms of compensation and use of facilities.

Subrecipient Assurance

The Applicant shall require any individual, organization, or other entity with whom it subcontracts, subgrants, or subleases for the purpose of providing any service, financial aid, equipment, property, or structure to comply with laws cited above. To this end, the subrecipient shall be required to sign a written assurance form; however, the obligation of both recipient and subrecipient to ensure compliance is not relieved by the collection or submission of written assurance forms.

Data Collection and Access to Records

The Applicant agrees to compile and maintain information pertaining to programs or activities developed as a result of the Applicant's receipt of Federal assistance from the Department of Energy. Such information shall include, but is not limited to the following: (1) the manner in which services are or will be provided and related data necessary for determining whether any persons are or will be denied such services on the basis of prohibited discrimination; (2) the population

eligible to be serviced by race, color, national origin, sex, and disability; (3) data regarding covered employment, including use or planned use of bilingual public contact employees serving beneficiaries of the program where necessary to permit effective participation by beneficiaries unable to speak or understand English; (4) the location of existing or proposed facilities connected with the program and related information adequate for determining whether the location has or will have the effect of unnecessarily denying access to any person on the basis of prohibited discrimination; (5) the present or proposed membership by race, color, national origin, sex, and disability, in any planning or advisory body which is an integral part of the program; and (6) any additional written data determined by the Department of Energy to be relevant to the obligation to assure compliance by recipients with laws cited in the first paragraph of this assurance.

The Applicant agrees to submit requested data to the Department of Energy regarding programs and activities developed by the Applicant from the use of Federal funds extended by the Department of Energy. Facilities of the Applicant (including the physical plants, buildings, or other structures) and all records, books, accounts, and other sources of information pertinent to the Applicant's compliance with the civil rights laws shall be made available for inspection during normal business hours of request of an officer or employee of the Department of Energy specifically authorized to make such inspections. Instructions in this regard will be provided by the Director, Office of Civil Rights, U. S. Department of Energy.

This assurance is given in consideration of and for the purpose of obtaining any and all Federal grants, loans, contracts (excluding procurement contracts), property, discounts or other Federal assistance extended after the date hereto, to the Applicants by the Department of Energy, including installment payments on account after such date of application for Federal assistance which are approved before such date. The Applicant recognizes and agrees that such Federal assistance will be extended in reliance upon the representations and agreements made in this assurance and that the United State shall have the right to seek judicial enforcement of this assurance. This assurance is binding on the Applicant, its successors, transferees, and assignees, as well as the person(s) whose signature appears below and who is authorized to sign this assurance on behalf of the Applicant.

Applicant Certification
The Applicant certifies that it has complied, or that, within 90 days of the date of the grant, it will comply with all applicable requirements of 10 C.F.R. § 1040.5 (a copy will be furnished to the Applicant upon written request to DOE.)

Designated Responsible Employee

_____ _____
Name and Title (Printed or Typed) **Telephone Number**

_____ _____
Signature **Date**

Contractor

_____ _____
Name of Organization **Telephone Number**

_____
Address

Authorized Official:

_____ _____
Name and Title (Printed or Typed) **Telephone Number**

_____ _____
Signature **Date**

ATTACHMENT D Contract No. _____
Certification Regarding Debarment, Suspension, Ineligibility, and Voluntary Exclusion-Lower Tier Covered Transactions

Instructions for Certification

1. The prospective lower tier participant is required to sign the attached certification.

2. The certification in this clause is a material representation of fact upon which reliance was placed when this transaction was entered into. If it is later determined that the prospective lower tier participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the department or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

3. The prospective lower tier participant shall provide immediate written notice to the person to which this proposal is submitted if at any time the prospective lower tier participant learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.

4. The terms "covered transaction," "debarred," "suspended," "ineligible," "lower tier covered transaction," "participant," "person," "primary covered transaction," "principle," "proposal," and "voluntarily excluded," as used in this clause, have the meanings set out in the Definitions and Coverage sections of the rules implementing Executive Order 12549. You may contact the person to which this proposal is submitted for assistance in obtaining a copy of those regulations.

5. The prospective lower tier participant agrees by submitting this proposal that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency with which this transaction originated.

6. The prospective lower tier participant further agrees by submitting this proposal that it will include the clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion-Lower Tier Covered Transaction," without modification, in all solicitations for lower tier covered transactions.

7. A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that it is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant may decide the method and frequency by which it determines the eligibility of its principals. Each participant may, but is not required to, check the Nonprocurement List.

8. Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render in good faith the certification required by this clause. The knowledge and information of a participant is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

9. Except for transactions authorized under paragraph 5 of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

   (1) The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principals is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department or agency.
   (2) Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

City of Austin dba Austin Energy
Organization Name

Roger Duncan, Deputy General Manager
Name and Title of Authorized Representative

Signature

6/12/06
Date

LAW
DEPT

ATTACHMENT E Contract No. _____
CERTIFICATIONS REGARDING LOBBYING; DEBARMENT, SUSPENSION AND OTHER RESPONSIBILITY MATTERS; AND DRUG-FREE WORKPLACE REQUIREMENTS

Applicants should refer to the regulations cited below to determine the certification to which they are required to attest. Applicants should also review the instructions for certification included in the regulations before completing this form. Signature of this form provides for compliance with certification requirements under 34 CFR Part 82, "New Restrictions on Lobbying," and 34 CFR Part 85, "Government-wide Debarment and Suspension (Nonprocurement) and Government-wide Requirements for Drug-Free Workplace (Grants)." The certifications shall be treated as a material representation of fact upon which reliance will be placed when the Department of Energy determines to award the covered transaction, grant, or cooperative agreement.

1. LOBBYING

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

2. DEBARMENT, SUSPENSION, AND OTHER RESPONSIBILITY MATTERS

(1) The prospective primary participant certifies to the best of its knowledge and belief, that it and its principals:

(a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;

(b) Have not within a three-year period receding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(c) Are not presently indicted for or otherwise criminally or civilly charged by a government entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and

(d) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default.

(2) Where the prospective primary participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

3. DRUG-FREE WORKPLACE

This certification is required by the Drug-Free Workplace Act of 1988 (Pub. L. 100-690, Title V, Subtitle D) and is implemented through additions to the Debarment and Suspension regulations, published in the Federal Register on January 31, 1989, and May 25, 1990.

ALTERNATE I
(GRANTEES OTHER THAN INDIVIDUALS)

(1) The grantee certifies that it will or will continue to provide a drug-free workplace by:

(a) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition;

(b) Establishing an ongoing drug-free awareness program to inform employees about:
(1) The dangers of drug abuse in the workplace;
(2) The grantee's policy of maintaining a drug-free workplace;
(3) Any available drug counseling, rehabilitation, and employee assistance programs; and
(4) The penalties that may be imposed upon employees for drug abuse violations occurring in the workplace;

(c) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (a);

(d) Notifying the employee in the statement required by paragraph (a) that, as a condition of employment under the grant, the employee will:
(1) Abide by the terms of the statement; and
(2) Notify the employer in writing, of his or her conviction for a violation of criminal drug statute occurring in the work-place not later than five calendar days after such conviction;

(e) Notifying the agency, in writing, within ten calendar days after receiving notice under subparagraph (d)(2) from an employee or otherwise receiving actual notice of such conviction. Employers of convicted employees must provide notice, including position title, to energy grant officer or other designee on whose grant activity the convicted employee was working, unless the Federal agency has designated a central point for the receipt of such notices. Notice shall include the identification number(s) of each affected grant;

(f) Taking one of the following actions, within 30 calendar days of receiving notice under subparagraph (d)(2), with respect to any employee who is so convicted:
(1) Taking appropriate actions against such an employee, up to and including termination, consistent with the requirements of the Rehabilitation Act 9f 1973, as amended; or
(2) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State or local health, law enforcement, or other appropriate agency;

(g) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraphs (a), (b), (c), (d), (e), and (f).

(2) The grantee may insert in the space provided below the site(s) for the performance of work done in connection with the specific grant:

Place of Performance:
(Street address, city, county, state, zip code)

_____
_____
_____

☐ Check if there are workplaces on file that are not identified here.

ALTERNATE II (GRANTEES WHO ARE INDIVIDUALS)

(1) The grantee certifies that, as a condition of the grant, he or she will not engage in the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substances in conducting any activity with the grant.

(2) If convicted of a criminal drug offense resulting from a violation occurring during the conduct of any grant activity, he or she will report the conviction, in writing, within 10 calendar days of the conviction, to every grant officer or other designee, unless the Federal agency designates a central point for the receipt of such notices. When notice is made to such a central point, it shall

include the identification number(s) of each affected grant.

4. **LOBBYING DISCLOSURE ACT OF 1995, SIMPSON-CRAIG AMENDMENT**

Applicant organization which are described in section 501 (c)(4) of the Internal Revenue Code of 1986 and engage in lobbying activities after December 31, 1995, shall not be eligible for the receipt of Federal funds constituting an award, grant, or loan. Section 501(c)(4) of the Internal Revenue Code of 1986 covers:

> *Civic leagues or organizations not organized for profit but operated exclusively for the promotion of social welfare, or local associations of employees, the membership of which is limited to the employees of a designated persons or person in a particular municipality, and the net earning of which are devoted exclusively to charitable, educational, or recreational purposes.*

As set forth in the Lobbying Disclosure Act of 1995 (Public Law 104-65, December 19, 1995), as amended ["Simpson-Craig Amendment," see Section 129 of The Balanced Budget Downpayment Act, I (Public Law 104-99, January 26, 1996)], lobbying activities is defined broadly. (See section 3 of the Act.)

The undersigned certifies, to the best of his or her knowledge and belief, that: it IS NOT an organization described in section 501 (c)(4) of the Internal Revenue Code of 1986: OR that it IS an organization described in section 501 (c)(4) of the Internal Revenue Code of 1986, which, after December 31, 1995, HAS NOT engaged in any lobbying activities as defined in the Lobbying Disclosure Act of 1995, as amended.

As the duly authorized representative of the applicant, I hereby certify that the applicant will comply with the above certifications.

City of Austin dba Austin Energy
Name of Applicant

Pre/Award Number and/or Project Name

Roger Duncan, Deputy General Manager
Printed Name and Title of Authorized Representative

Signature

6/12/06
Date

LAW DEPT

ATTACHMENT F Contract No. _____

DISCLOSURE OF LOBBYING ACTIVITIES

Complete this form to disclose lobbying activities pursuant to 31 U.S.C. 1352

1. Type of Federal Action: ____ a. contract b. grant c. cooperative agreement d. loan e. loan guarantee f. loan insurance	2. Status of Federal Action: ___ a. bid/offer/application b. initial award c. post award	3. Report Type: ___ a. initial filing b. material change For Material Change Only: year _____ quarter ___ date of last report ____

4. Name and Address of Reporting Entity: Name Address ___ Prime ___ Subawardee Tier, if known:	5. If Reporting Entity in No. 4 is Subawardee, Enter Name and Address of Prime:
6. Federal Department/Agency:	7. Federal Program Name/Description CFDA Number, if applicable:
8. Federal Action Number, If known:	9. Award Amount, if known:
10.a. Name and Address of Lobbying Entity: (if individual, last name, first name, MI): (attach Continuation Sheet(s) SF-LLL-A, if necessary)	10.b. Individual Performing Services (including address if different from No. 10A) (last name, first name, MI):
11. Amount of Payment (check all that apply): $_____ ___ actual ___ planned	12. Form of Payment (check all that apply): a. cash b. in-kind; specify: nature ____ value ____

13. Type of Payment (check all that apply):

___ a. retainer ___ c. commission ___ e. deferred

___ b. one-time fee ___ d. contingent fee ___ f. other; specify _____

14. Brief Description of Services Performed or to be Performed and Date(s) of Service, including officer(s), employee(s), or Member(s) contacted, for Payment indicated in Item 11:

15. Continuation Sheet(s) SF-LLL-A attached: ___ Yes ___ No

16. Information requested through this form is authorized by title 31 U.S.C. section 1352. This disclosure of lobbying activities is a material representation of fact upon which reliance was placed by the tier above when this transaction was made or entered into. This disclosure is required pursuant to 31 U.S.C. 1352. This information will be reported to the Congress semi-annual and will be available for public inspection. Any person who fails to file the required disclosure shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure	Authorized Representative: Roger Duncan Title: Deputy General Manager Signature: _____ Telephone: (512) 322-6157 Date: 6/12/06

LAW DEPT

ATTACHMENT G Contract No. _____
ASSURANCES -- NON-CONSTRUCTION PROGRAMS
OMB Approval No. 0348-0040

Note: Certain of these assurances may not be applicable to your project or program. If you have questions, please contact the awarding agency. Further, certain Federal awarding agencies may require applicants to certify to additional assurances. If such is the case, you will be notified.

As the duly authorized representative of the applicant, I certify that the applicant:

1. Has the legal authority to apply for Federal assistance, and the institutional, managerial and financial capability (including funds sufficient to pay the non-Federal share of project costs) to ensure proper planning, management and completion of the project described in this application.

2. Will give the awarding agency, the Comptroller, the United States, and if appropriate, the State, through any authorized representative, access to and the right to examine all records, books, papers, or documents related to the award; and will establish a proper accounting system in accordance with generally accepted accounting standards or agency directives.

3. Will establish safeguards to prohibit employees from using their positions for a purpose that constitutes or presents the appearance of personal or organizational conflict of interest, or personal gain.

4. Will initiate and complete the work within the applicable time frame after receipt of approval of the awarding agency.

5. Will comply with the Intergovernmental Personnel Act of 1970 (42 U.S.C. §§ 4728-4763) relating to prescribed standards for merit systems for programs funded under one of the nineteen statutes or regulations specified in Appendix A of OPM's Standards for a Merit System of Personnel Administration (5 C.F.R. 900, Subpart F).

6. Will comply with all Federal statutes relating to nondiscrimination. These include but are not limited to: (a) Title VI of the Civil Rights Act of 1964 (P.L. 88-352) which prohibits discrimination on the basis of race, color or national origin; (b) Title IX of the Education Amendments of 1972, as amended (20 U.S.C. §§ 1681-1683, and 1685-1686), which prohibits discrimination on the basis of sex; (c) Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S.C. § 794), which prohibits discrimination on the basis of handicaps; (d) the Age Discrimination Act of 1975, as amended (42 U.S.C. §§ 6101-6107), which prohibits discrimination on the basis of age; (e) the Drug Abuse Office and Treatment Act of 1972 (P.L. 92-255), as amended, relating to nondiscrimination on the basis of drug abuse; (f) the Comprehensive Alcohol Abuse and Alcoholism Prevention, Treatment and Rehabilitation Act of 1970 (P.L. 91-616), as amended, relating to nondiscrimination on the basis of alcohol abuse or alcoholism; (g) §§ 523 and 527 of the Public Health Service Act of 1912 (42 U.S.C. 290 dd-3 and 290 ee-3), as amended, relating to confidentiality of alcohol and drug abuse patient records; (h) Title VIII of the Civil Rights Act of 1968 (42 U.S.C. § 3601 et seq.), as amended, relating to nondiscrimination in the sale, rental or financing of housing; (i) any other nondiscrimination provisions in the specific statute(s) under which application for Federal assistance is being made; and (j) the requirements of any other nondiscrimination statute(s) which may apply to the application.

7. Will comply, or has already complied, with the requirements of Titles II and III of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (P.L. 91-646) which provide for fair and equitable treatment of persons displaced or whose property is acquired as a result of Federal or federally assisted programs. These requirements apply to all interests in real property acquired for project purposes regardless of Federal participation in purchases.

8. Will comply with the provisions of the Hatch Act (5 U.S.C. §§ 1501-1508 and 7324-7328) which limit the political activities of employees whose principal employment activities are funded in whole or in part with Federal funds.

9. Will comply, as applicable, with the provisions of the Davis-Bacon Act (40 U.S.C. §§ 276a to 276a-7), the Copeland Act (40 U.S.C. § 276c and 18 U.S.C. §§ 874), and the Contract Work Hours and Safety Standards Act (40 U.S.C. §§ 327-333), regarding labor standards for federally assisted construction sub-agreements.

10. Will comply, if applicable, with flood insurance purchase requirements of Section 102(a) of the Flood Disaster Protection Act of 1973 (P.L. 93- 234) which requires recipients in a special flood hazard area to participate in the program and to purchase flood insurance if the total cost of insurable construction and acquisition is $10,000 or more.

11. Will comply with environmental standards which may be prescribed pursuant to the following: (a) institution of environmental quality control measures under the National Environmental Policy Act of 1969 (P.L. 91-190) and Executive Order (EO) 11514; (b) notification of violating facilities pursuant to EO 11738; (c) protection of wetlands pursuant to EO 11990; (d) evaluation of flood hazards in flood plains in accordance with EO 11988; (e) assurance of project consistency with the approved State management program developed under the Coastal Zone Management Act of 1972 (16 U.S.C. §§ 1451 et seq.); (f) conformity of Federal actions to State (Clear Air) Implementation Plans under Section 176(c) of the Clear Air Act of 1955, as amended (42 U.S.C. § 7401 et seq.); (g) protection of underground sources of drinking water under the Safe Drinking Water Act of 1974, as amended, (P.L. 93-523); and (h) protection of endangered species under the Endangered Species Act of 1973, as amended, (P.L. 93-205).

12. Will comply with the Wild and Scenic Rivers Act of 1968 (16 U.S.C. §§ 1271 et seq.) related to protecting components or potential components of the national wild and scenic rivers system.

13. Will assist the awarding agency in assuring compliance with Section 106 of the National Historic Preservation Act of 1966, as amended (16 U.S.C. 470), EO 11593 (identification and protection of historic properties), and the Archaeological and Historic Preservation Act of 1974 (16 U.S.C. 469 a-1 et seq.)

14. Will comply with P.L. 93-348 regarding the protection of human subjects involved in research, development, and related activities supported by this award of assistance.

15. Will comply with the Laboratory Animal Welfare Act of 1966 (P.L. 89-544, as amended, 7 U.S.C. 2131 et seq.) pertaining to the care, handling, and treatment of warm blooded animals held for research, teaching, or other activities supported by this award of assistance.

16. Will comply with the Lead-Based Paint Poisoning Prevention Act (42 U.S.C. §§ 4801 et seq.) which prohibits the use of lead based paint in construction or rehabilitation of residence structures.

17. Will cause to be performed the required financial and compliance audits in accordance with the Single Audit Act of 1984.

18. Will comply with all applicable requirements of all other Federal laws, executive orders, regulations and policies governing this program.

Signature of Authorized Certifying Official

Deputy General Manager
Title

City of Austin dba Austin Energy
Applicant Organization

6/12/06
Date Submitted

ATTACHMENT H Contract No. _____
Intellectual Property Provisions

AUTHORIZATION AND CONSENT (41 CFR 9-9.102-1)

The Government hereby gives its authorization and consent (without prejudice to any rights of indemnification) for all use and manufacture, in the performance of this grant or any part hereof or any amendment hereto or any subcontract hereunder (including all lower-tier subcontracts hereunder), of any invention described in and covered by a patent of the United States.

(a) embodied in the structure or composition of any article, the delivery of which is accepted by the Government under this grant, or

(b) utilized in the machinery, tools, or methods, the use of which necessarily results from compliance by the Grantee or the using subcontractor with

(i) specifications or written provisions now or hereafter forming a part of this grant, or

(ii) specific written instructions given by the Contracting Officer directing the manner of performance.

The entire liability to the Government for infringement of a patent of the United States shall be determined solely by the provisions of the indemnity clauses, if any, included in this grant or any subcontract hereunder (including all lower-tier subcontracts hereunder), and the Government assumes liability for all other infringement to the extent of the authorization and consent herein above granted.

PATENT INDEMNITY (41 CFR 9-9.103-1)

If the amount of this contract is in excess of $10,000 the contractor shall indemnify the Government and its officers, agents, and employees against liability, including costs, for infringement of any United States letters patent (except U.S. letters patent issued upon an application which is now or may hereafter be kept secret or otherwise withheld from issue by order of the Government) arising out of the manufacture or delivery of supplies or out of construction, alteration, modification, or repair of real property (hereinafter referred to as "construction work") under this contract, or out of the use or disposal by or for the account of the Government of such supplies or construction work. The foregoing indemnity shall not apply unless the contractor shall have been informed as soon as practicable by the Government of the suit or action alleging such infringement, and shall have been given such opportunity as is afforded by applicable laws, rules, or regulations to participate in the defense thereof; and further, such indemnity shall not apply to: (a) an infringement resulting from compliance with specific written instructions of the Contracting Officer directing a change in the supplies to be delivered or in the materials or equipment to be used, or directing a manner of performance of the contract not normally used by the contractor; (b) an infringement resulting from addition to or change in, such supplies or components furnished or construction work performed which addition or change was made subsequent to delivery or performance by the contractor; or (c) a claimed infringement which is settled without the consent of the contractor, unless required by final decree of a court of competent jurisdiction.

NOTICE AND ASSISTANCE REGARDING PATENT AND COPYRIGHT INFRINGEMENT (41 CFR 9-9.104(b))

The provisions of this clause shall be applicable only if the amount of this grant exceeds $10,000.

(a) The Grantee shall report to the Contracting Officer, promptly and in reasonable written detail, each notice of claim of patent or copyright infringement based on the performance of this grant of which the Grantee has knowledge.

(b) In the event of any claim or suit against the Government on account of any alleged patent or copyright infringement arising out of the performance of this grant or out of the use of any supplies furnished or work or services performed hereunder, the Grantee shall furnish to the Government, when requested by the Contracting Officer, all evidence and information in possession of the Grantee pertaining to such suit or claim. Such evidence and information shall be furnished at the expense of the Government except where the Grantee has agreed to indemnify the Government.

(c) This clause shall be included in all contracts and subgrants under this grant.

REPORTING OF ROYALTIES (41 CFR 9-9.110)

If this grant is in an amount which exceeds $10,000 and if any royalty payments are directly involved in the grant or are reflected in the grant price to the Government, the Grantee agrees to report in writing to the Patent Counsel (with notification by Patent Counsel to the Contracting Officer) during the performance of this grant and prior to its completion of final settlement the amount of any royalties or other payments paid or to be paid by it directly to others in connection with the performance of this grant together with the names and addresses of licensers to whom such payments are made and either the patent numbers involved or such other information as will permit the identification of the patents or other basis on which the royalties are to be paid. The approval of DOE of any individual payments or royalties shall not stop the Government at any time from contesting the enforceability, validity or scope of, or title to, any patent under which a royalty or payments are made.

RIGHTS IN TECHNICAL DATA (SHORT FORM)

(a) Definitions. The definitions of terms set forth in DEAR 927.401 apply to the extent these terms are used herein.

(b) Allocation of Rights.

(1) The Government shall have:

(i) Unlimited rights in technical data first produced or specifically used in the performance of this grant;

(ii) The right of the Contracting Officer or his representatives to inspect, at all reasonable times up to three years after final payment under this grant, all technical data first produced or specifically used in the grant (for which inspection the Grantee or its contractor or subgrantee shall afford proper facilities to DOE); and

(iii) The right to have any technical data first produced or specifically used in the performance of this grant delivered to the Government as the Contracting Officer may from time-to-time direct during the progress of the work, or in any event as the Contracting Officer shall direct upon completion or termination of this grant.

(2) The Grantee shall have:

The right to use for its private purposes, subject to patent, security or other provisions of this grant, technical data it first produces in the performance of this grant provided the date requirements of this grant have been met as of the date of the private use of such data. The Grantee agrees that to the extent it receives or is given access to proprietary data or other technical, business or financial data in the form of recorded information from DOE or a DOE contractor or subcontractor, the Grantee shall treat such data in accordance with any restrictive legend contained thereon, unless use is specially authorized by prior written approval of the Contracting Officer.

(c) Copyrighted Material.

(1) The Grantee agrees to, and does hereby grant to the Government, and to others acting on its behalf:

(i) A royalty-free, nonexclusive, irrevocable, worldwide license for Governmental purposes to reproduce, distribute, display, and perform all copyrighted material first produced or composed in the performance of this grant by the Grantee, its employees or any individual or concern specifically employed or assigned to originate and prepare such material and to prepare derivative works based thereon; and

(ii) A license as aforesaid under any and all copyrighted or copyrighted work not first produced or composed by the Grantee in the performance of this grant but which is incorporated in the material furnished under the grant, provided that such license shall be only to the extent the Grantee now has, or prior to completion or close-out of the grant, may acquire the right to grant such license without becoming liable to pay compensation to others solely because of such grant.

(2) The Grantee agrees that it will not knowingly include any material copyrighted by others in any written or copyrighted material furnished or delivered under this grant without a license as provided for in subparagraph (c) (1) (ii) of this section, or without the consent of the copyright owner, unless it obtains specific written approval of the Contracting Officer for the inclusion of such copyrighted material.

RIGHTS TO PROPOSAL DATA (TECHNICAL) (48 CFR 52.227-23)

It is agreed that as a condition of award of this grant or modification and notwithstanding the conditions of any notice appearing on the proposal(s), the Government shall have the right to use, duplicate, and disclose and have others to do so for any purpose whatsoever, the technical data contained in the proposal(s) upon which the grant or modification is based.

City of Austin dba Austin Energy
Organization Name

LAW DEPT

Roger Duncan, Deputy General Manager
Name and Title of Authorized Representative

Signature

6/12/06
Date

ATTACHMENT I **Contract No. _____**

Nondisclosure Agreement

In consideration of the Comptroller retaining the services of City of Austin/Austin Energy (Contractor) and because of the sensitivity of certain information which may come under the care and control of Contractor, both parties agree that all information regarding Comptroller, or gathered, produced, or derived from or accessed as a result of the Agreement (Confidential Information) must remain confidential subject to release only by written permission of Comptroller, and more specifically agree as follows:

1. The Confidential Information may be used by Contractor only to assist Contractor in connection with its engagement with Comptroller.
2. Contractor shall not, at any time, use the Confidential Information in any fashion, form, or manner except in its capacity as independent contractor to Comptroller.
3. Contractor shall maintain the confidentiality of any and all deliverables resulting from the Agreement in the same manner that it protects the confidentiality of its own proprietary products of like kind.
4. The Confidential Information may not be copied or reproduced without Comptroller's written consent.
5. All Confidential materials made available to Contractor, including copies thereof, must be returned to Comptroller upon the first to occur of; (a) completion of the project, or (b) request by Comptroller.
6. The foregoing must not prohibit or limit Contractor use of the information (including, but not limited to, ideas, concepts, know-how, techniques and methodologies) (a) previously known to it, (b) independently developed by it, (c) acquired by it from a third party, or (d) which is or becomes part of the public domain through no breach to Contractor of this agreement.
7. This agreement shall become effective as of the date Confidential Information is first made available to Contractor and must survive the Agreement and be a continuing requirement.

The breach of this Nondisclosure Agreement by Contractor shall entitle Comptroller to immediately terminate the Agreement upon written notice to Contractor for such breach. The parties acknowledge that the measure of damages in the event of a breach of this Nondisclosure Agreement may be difficult or impossible to calculate, depending on the nature of the breach. Regardless of whether Comptroller elects to terminate the Agreement upon the breach hereof, Comptroller may require Contractor to pay to Comptroller the sum of $1,000 for each breach as liquidated damages. This amount is not intended to be in the nature of a penalty, but is intended to be a reasonable estimate of the amount of damages to Comptroller in the event of a breach hereof by Contractor. Comptroller does not waive any right to seek additional relief, either equitable or otherwise, concerning any breach of this Agreement.

City of Austin dba Austin Energy
Organization Name

LAW
DEPT

Roger Duncan, Deputy General Manager
Name and Title of Authorized Representative

Signature

6/12/06
Date

SUSAN COMBS

TEXAS COMPTROLLER of PUBLIC ACCOUNTS

P.O. BOX 13528 • AUSTIN, TX 78711-3528

May 11, 2007

Roger Duncan
Deputy General Manager
City of Austin dba Austin Energy
721 Barton Springs Road
Austin, Texas 78704

Dear Mr. Duncan:

I am pleased to forward the enclosed Amendment #1 between the State Energy Conservation Office (SECO) of the Comptroller of Public Accounts and the City of Austin dba Austin Energy.

Vouchers for reimbursement should continue to reference Contract #CM637 and be submitted to:

David Schiller
Comptroller of Public Accounts
State Energy Conservation Office
LBJ State Office Building
111 East 17th Street, Room 1114
Austin, Texas 78774-0100

We look forward to working with you. If you have any questions or concerns regarding your contract or billing procedures, please contact me at (512) 463-1080.

Sincerely,

Felix A. Lopez, P.E.
Senior Engineer
State Energy Conservation Office

FAL:fal

Enclosures

AMENDMENT NO. 1

TO

CONTRACT NO. CM637

BETWEEN

City of Austin dba Austin Energy, ("Contractor")
721 Barton Springs Road
Austin, Texas 78704

AND

Comptroller of Public Accounts, ("Agency")
State Energy Conservation Office
LBJ State Office Building
111 E. 17th Street, Room 1114
Austin, Texas 78774-0100

Recitals

WHEREAS, the State Energy Conservation Office ("SECO") of Agency and Contractor entered into Contract No. CM637, ("Agreement") effective June 15, 2006, for services related to the State Agencies Program;

WHEREAS, Agency and Contractor desire to execute an Amendment No. 1 to amend the Agreement by modifying the Statement of Services and to amend the Agreement by extending the term effective May 1, 2007.

Agency and Contractor hereby agree as follows:

I. Amendment Agreement

The terms set forth in this Amendment No. 1 shall be in addition to and construed together with the terms of the Agreement.

The parties acknowledge that amendments are subject to the terms and conditions of the Agreement.

In the event of conflicting language between the Agreement and any prior Amendments, the language in this Amendment No. 1 shall control as follows:

1. This no-cost time extension amendment extends the term of the Agreement from May 1, 2007 to November 30, 2007.

2. This amendment modifies Attachment A, Statement of Services to be Performed. The revised Attachment A is attached hereto and incorporated herein.

All other provisions of the Agreement shall remain the same.

II. Incorporation of Amendments

Upon and after the date of execution of this Amendment No. 1 to the Agreement, all references to the Agreement in that document and any related document shall mean the Agreement as modified by this document and previous amendments. That Agreement shall consist of the original Agreement, together with all documents incorporated therein, executed on or about June 15, 2006; and this Amendment No. 1,

together with all documents incorporated herein. These documents shall constitute the entire agreement of the parties.

Except as provided in this Amendment No. 1, execution and delivery of this Amendment No. 1 shall not amend, modify, or supplement any provision of, or constitute a consent to, or waiver of, any noncompliance with the provisions of the original Agreement and except as specifically provided in this Amendment No. 1, the Agreement shall remain in full force and effect.

AGENCY:

Comptroller of Public Accounts

By _____

Martin A. Hubert
Deputy Comptroller

Date 5/7/07

CONTRACTOR:

City of Austin dba Austin Energy

By _____

Roger Duncan
Deputy General Manager

Date 4/30/07

ATTACHMENT A Contract No. CM637

STATEMENT OF SERVICES TO BE PERFORMED

A. Contractor shall perform all of the services described in this Attachment A, or otherwise required by this Agreement, ("services"). These services include, but are not limited to, the furnishing of all personnel and the procurement of all equipment, supplies, and other items necessary to provide those services in compliance with this Agreement. Contractor shall provide all services in accordance with the Standards of Performance established by Agency for these services. Contractor shall review and implement Agency recommendations, as Agency adopts them from time to time, so that the services may be expeditiously and satisfactorily completed. Contractor shall meet with Agency at such times as Agency may reasonably request to discuss the progress of services and any other matters that may arise in regard to this Agreement.

B. Contractor shall provide all of the following services:

1. Negotiate a contract agreement with the Lighting Research Center (LRC) and provide a copy to SECO.

2. Schedule a project kick-off meeting with SECO and LRC.

3. Provide a brief summary of the fluorescent lighting technology with potential market opportunities, an economical analysis, barriers of the implementation phase, and technology transfer to other municipalities in Texas.

4. Provide a project summary presentation that include Austin Energy plan to expand the fluoresecent lighting testing or its market deployment.

5. Provide monthly progress reports.

6. Provide a Final Report with a summary of the completed project findings, including the fluorescent lighting replacement guidelines and an estimate of the potential savings forfluorescent lighting replacements in the Austin Energy service territory.

STATEMENT OF SERVICES TO BE PERFORMED

C. Contractor shall provide the following services during the period of this Agreement and all servic reasonably related to them. Agency may request additional records, information or reports related to t services hereinafter described and funded by Agency pursuant to Attachment B. These services are follows:

	Deliverables and Milestones	Schedule
1.	Negotiate a contract agreement with the Lighting Research Center (LRC) and provide a copy to SECO.	Contract start to Apr 30, 2007
2.	Schedule a project kick-off meeting with SECO and LRC.	Contract start to May 31, 2007
3.	Provide a brief summary of the fluorescent lighting technology with potential market opportunities, an economical analysis, barriers of the implementation phase, and technology transfer to other municipalities in Texas.	Contract start to Oct 31, 2007
4.	Provide a project summary presentation that include Austin Energy plan to expand the fluoresecent lighting testing or its market deployment.	Contract start to Oct 31, 2007
5.	Provide monthly progress reports.	Monthly
6.	Provide a Final Report with a summary of the completed project findings, including the fluorescent lighting replacement guidelines and an estimate of the potential savings forfluorescent lighting replacements in the Austin Energy service territory.	Nov 30, 2007

SUSAN COMBS

TEXAS COMPTROLLER of PUBLIC ACCOUNTS

P.O. BOX 13528 • AUSTIN, TX 78711-3528

April 25, 2007

Roger Duncan
Deputy General Manager
City of Austin dba Austin Energy
721 Barton Springs Road
Austin, Texas 78704

Dear Mr. Duncan:

Enclosed is Amendment #1 to Contract CM637 between the State Energy Conservation Office (SECO) of the Comptroller of Public Accounts and the City of Austin dba Austin Energy to form a joint venture with the Lighting Research Center of the Rensselaer Polytechnic Institute of New York to demonstrate and evaluate a prototype fluorescent outdoor lighting system in the City of Austin.

Please sign the amendment and return the original document to:

Felix A. Lopez, P.E.
Comptroller of Public Accounts
State Energy Conservation Office
LBJ State Office Building
111 East 17th Street, Room 1114
Austin, Texas 78774-0100

Once the contract amendment is fully executed, SECO will send you a copy. Should you have any questions, please call Felix A. Lopez at (512) 463-1080.

Sincerely,

Felix A. Lopez, P.E.
Senior Engineer
State Energy Conservation Office

FAL:fal

Enclosures

AMENDMENT NO. 1

TO

CONTRACT NO. CM637

BETWEEN

City of Austin dba Austin Energy, ("Contractor")
721 Barton Springs Road
Austin, Texas 78704

AND

Comptroller of Public Accounts, ("Agency")
State Energy Conservation Office
LBJ State Office Building
111 E. 17th Street, Room 1114
Austin, Texas 78774-0100

Recitals

WHEREAS, the State Energy Conservation Office ("SECO") of Agency and Contractor entered into Contract No. CM637, ("Agreement") effective June 15, 2006, for services related to the State Agencies Program;

WHEREAS, Agency and Contractor desire to execute an Amendment No. 1 to amend the Agreement by modifying the Statement of Services and to amend the Agreement by extending the term effective May 1, 2007.

Agency and Contractor hereby agree as follows:

I. Amendment Agreement

The terms set forth in this Amendment No. 1 shall be in addition to and construed together with the terms of the Agreement.

The parties acknowledge that amendments are subject to the terms and conditions of the Agreement.

In the event of conflicting language between the Agreement and any prior Amendments, the language in this Amendment No. 1 shall control as follows:

1. This no-cost time extension amendment extends the term of the Agreement from May 1, 2007 to November 30, 2007.

2. This amendment modifies Attachment A, Statement of Services to be Performed. The revised Attachment A is attached hereto and incorporated herein.

All other provisions of the Agreement shall remain the same.

II. Incorporation of Amendments

Upon and after the date of execution of this Amendment No. 1 to the Agreement, all references to the Agreement in that document and any related document shall mean the Agreement as modified by this document and previous amendments. That Agreement shall consist of the original Agreement, together with all documents incorporated therein, executed on or about June 15, 2006; and this Amendment No. 1,

together with all documents incorporated herein. These documents shall constitute the entire agreement of the parties.

Except as provided in this Amendment No. 1, execution and delivery of this Amendment No. 1 shall not amend, modify, or supplement any provision of, or constitute a consent to, or waiver of, any noncompliance with the provisions of the original Agreement and except as specifically provided in this Amendment No. 1, the Agreement shall remain in full force and effect.

AGENCY:

Comptroller of Public Accounts

By _____

Martin A. Hubert
Deputy Comptroller

Date _____

CONTRACTOR:

City of Austin dba Austin Energy

By _____

Roger Duncan
Deputy General Manager

Date 4/30/02

ATTACHMENT A Contract No. CM637

STATEMENT OF SERVICES TO BE PERFORMED

A. Contractor shall perform all of the services described in this Attachment A, or otherwise required by this Agreement, ("services"). These services include, but are not limited to, the furnishing of all personnel and the procurement of all equipment, supplies, and other items necessary to provide those services in compliance with this Agreement. Contractor shall provide all services in accordance with the Standards of Performance established by Agency for these services. Contractor shall review and implement Agency recommendations, as Agency adopts them from time to time, so that the services may be expeditiously and satisfactorily completed. Contractor shall meet with Agency at such times as Agency may reasonably request to discuss the progress of services and any other matters that may arise in regard to this Agreement.

B. Contractor shall provide all of the following services:

1. Negotiate a contract agreement with the Lighting Research Center (LRC) and provide a copy to SECO.

2. Schedule a project kick-off meeting with SECO and LRC.

3. Provide a brief summary of the fluorescent lighting technology with potential market opportunities, an economical analysis, barriers of the implementation phase, and technology transfer to other municipalities in Texas.

4. Provide a project summary presentation that include Austin Energy plan to expand the fluoresecent lighting testing or its market deployment.

5. Provide monthly progress reports.

6. Provide a Final Report with a summary of the completed project findings, including the fluorescent lighting replacement guidelines and an estimate of the potential savings forfluorescent lighting replacements in the Austin Energy service territory.

STATEMENT OF SERVICES TO BE PERFORMED

C. Contractor shall provide the following services during the period of this Agreement and all services reasonably related to them. Agency may request additional records, information or reports related to the services hereinafter described and funded by Agency pursuant to Attachment B. These services are as follows:

	Deliverables and Milestones	Schedule
1.	Negotiate a contract agreement with the Lighting Research Center (LRC) and provide a copy to SECO.	Contract start to Apr 30, 2007
2.	Schedule a project kick-off meeting with SECO and LRC.	Contract start to May 31, 2007
3.	Provide a brief summary of the fluorescent lighting technology with potential market opportunities, an economical analysis, barriers of the implementation phase, and technology transfer to other municipalities in Texas.	Contract start to Oct 31, 2007
4.	Provide a project summary presentation that include Austin Energy plan to expand the fluoresecent lighting testing or its market deployment.	Contract start to Oct 31, 2007
5.	Provide monthly progress reports.	Monthly
6.	Provide a Final Report with a summary of the completed project findings, including the fluorescent lighting replacement guidelines and an estimate of the potential savings forfluorescent lighting replacements in the Austin Energy service territory.	Nov 30, 2007

City of Austin
Austin's Municipally Owned Electric Utility

Town Lake Center 721 Barton Springs Road • Austin, Texas 78704-1194 • (512) 322-9600

April 2, 2007

Mr. Felix A. Lopez, P.E.
Senior Engineer
State Energy Conservation Office
Comptroller of Public Accounts
111 East 17th Street, Room 1114
Austin, Texas 78701

RE: Interlocal Agreement CM637

Dear Felix:

As you know, we have been working with Rensselaer Polytechnic Institute of Troy, New York (RPI), to study the feasibility of fluorescent street lighting for public roadways and parks, following the main goal of our State Energy Conservation Office (SECO) and Austin Energy (AE) contract #CM637. Unfortunately, the final contract between AE and RPI could not be executed until November 28 2006, and was further delayed due to RPI's failure to provide the required Certificates of Insurance in a timely manner. This issue with RPI is documented in our monthly reports. Because of the delays in the AE-RPI contract, we will not be able to make the April 30, 2007 deadline of the SECO-AE contract.#CM637.

AE has a substantial investment in staff time and lighting equipment and we are very committed to this study. The majority of preliminary work has already been completed, including the identification of test sites, purchase, installation and aiming of the test fixtures, and identification of some of the reference sample sites for comparison.

The process is finally beginning to move forward, and my staff has been working with RPI to develop a schedule for the study. I have attached the updated schedule developed by AE and RPI for your consideration. It includes a set Kick-off Meeting with AE, SECO, and RPI.

As a result of delays beyond the control of AE or SECO, and because the project will be underway at the current deadline, we are requesting a no-cost time extension to Interlocal Agreement CM637 to the end of our contract with RPI, November 28, 2007. This will provide sufficient time for the study to be completed per the attached schedule.

Best Regards,

Fred Yebra

Fred Yebra
Director of Demand Side Management

FY/DL/lvr

Attachments: Draft Schedule

Draft Schedule

For

Interlocal Agreement #CM637

Fluorescent Street Lighting Study

March:

1. AE will request an extension to Interlocal Agreement CM637 with a new ending date of November 28th, 2007. *In progress.*
2. Schedule kickoff teleconference between Austin Energy, the State Energy Conservation Office, and RPI. *Set for 10:00 AM April 12, 2007*
3. Begin identification and evaluation of high-pressure sodium reference sites for the study. *Ongoing.*
4. Experiment protocol proposal approval by RPI's Institutional Review Board *Ongoing.*
5. Install missing test fixtures and verify operational condition of all test samples. *Complete.*

April:

1. Hold the kickoff teleconference between Austin Energy, the State Energy Conservation Office, and Rensselaer on April 12, 2007, at 10:00 AM
2. AE and RPI will finalize selection of the reference sites.
3. AE and RPI will visit the reference sites and measure illuminances week of April 23rd.
4. RPI will prepare a detailed experiment protocol for the evaluation.

May:

1. RPI will conduct the evaluation at the test and reference sites.
2. RPI will analyze data.
3. AE and RPI will schedule a teleconference to review preliminary results.

June and July:

1. RPI will develop and submit the draft report and guidelines.
2. AE, RPI, and SECO will provide feedback and revisions for the report.

Appendix B – Cut Sheets

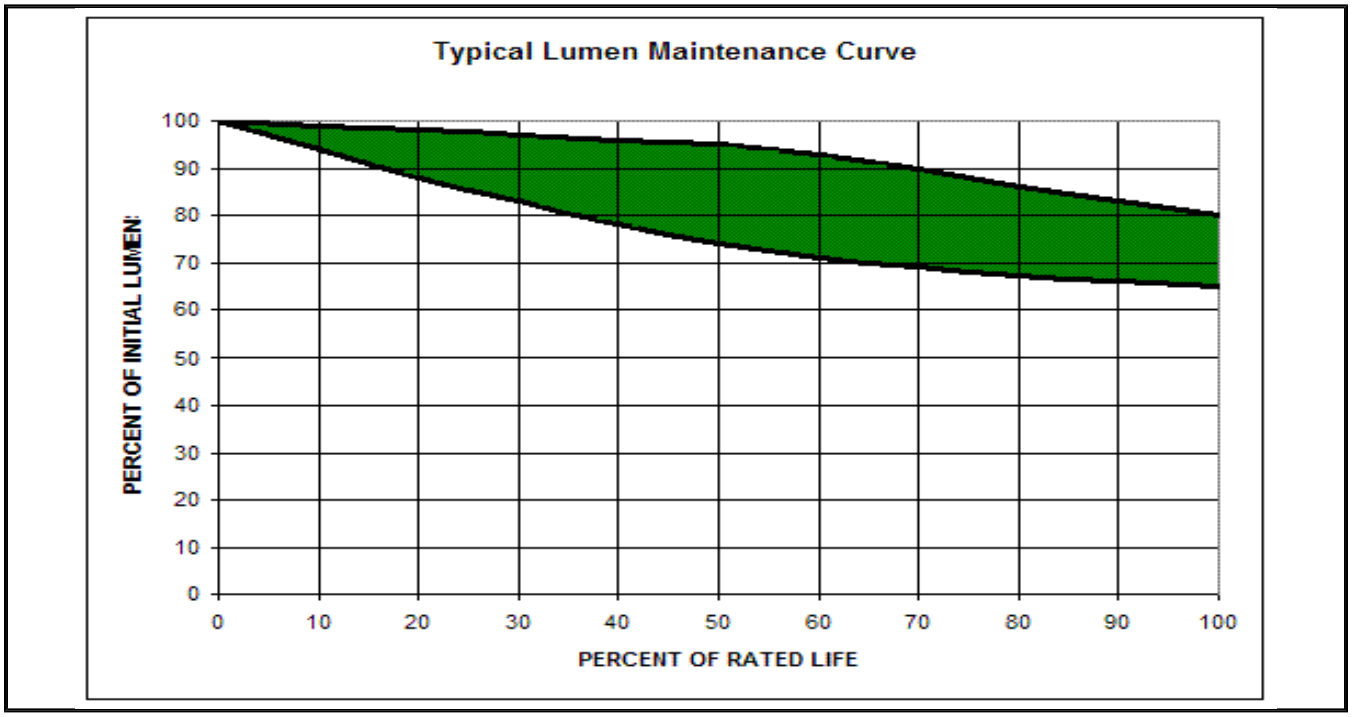
Return to: Standard | Print Page

Product Number: 67521
Order Abbreviation: LU250/D
General Description: 250W mogul based general lighting high pressure sodium lamp, coated

Product Information	
Abbrev. With Packaging Info.	LU250D 10/CS 1/SKU
ANSI Code	S50
Approx. Lumens (initial - horizontal)	26000
Approx. Lumens (initial - vertical)	26000
Approx. Lumens (mean - horizontal)	23400
Approx. Lumens (mean - vertical)	23400
Avg Rated Life (hrs)	24000+
Base	E39 Mogul
Bulb	BT28
Color Rendering Index (CRI)	22
Color Temperature/CCT (K)	2100
Diameter (in)	3.53
Diameter (mm)	90
Family Brand Name	Lumalux®
Fixture Requirement	O
Hot Restrike Time (min)	1 MIN
Lamp Finish	Coated
Light Center Length - LCL (in)	5
Light Center Length - LCL (mm)	127
Maximum Base Temperature - Fahrenheit	482
Maximum Base Temperature - Celsius	250
Maximum Bulb Temperature - Fahrenheit	752
Maximum Bulb Temperature - Celsius	400
Maximum Overall Length - MOL (in)	8.98
Maximum Overall Length - MOL (mm)	228
Nominal Voltage (V)	100.00
Nominal Wattage (W)	250.00
Operating Position	Universal

Lumen Maintenance Curve

Product Number: 67521
Description: Lumalux, Lumalux/ECO, Standby, Plantastar and MercuryFree



Not a specification or standard.
Actual results may vary.

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Visually and Energy Efficient

Street Lighting by

Magnaray® International

Magnaray®'s Street Lighting Units Save From 30% - 60+% In Lighting Energy Cost, While Improving Light Quality, Safety, and Security.

Maintenance Savings With Maintained Light Output Is Superior to HID systems.

50 watt Residential Decorative Shown

Dual 106 Watt Units Shown

Magnaray®'s 106 Watt Units Are Replacing 250 Watt HPS Systems to Provide 63% in Lighting Energy Savings. Dimming Via Power Line Carrier Will Be available Shortly, To Save Even More Energy!!

Business Partner
Rebuild America
U.S. Dept. of Energy

ENERGY STAR PARTNER

MAGNARAY® INTERNATIONAL
Div. World Institute of Lighting and Development Corp.

LIRC

P.O. BOX 990
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FON: (941) 755-2111
WEB: http://www.magnaray.com

IES SUSTAINING MEMBER

)OP
4243
FAX (941) 751-5483
sales@magnaray.com

Magnaray® International
Street Light Specifications

The Magnaray® # W1P501SL is a single lamp unit using a 50 watt Twin Tube T5 lamp, rated at 27,000 hours life when used with a “Program Start Ballast”. Scroll work optional. Bracket mounts to 1.5” – 2.0” pole tenon, or arm. Standard color is anodized aluminum with powder coat Bronze, White, Black or custom colors available. Unit replaces 70-100 watt HPS for street lighting applications.

SPECIFICATIONS

REFLECTOR	Precision-formed, highly polished aluminum reflector, scientifically shaped to produce optical magnification. 185.105 sq. in of reflecting surface.
LENS	Water Clear acrylic lens is break-resistant, will not discolor in sunlight, permits maximum light transmission. Gasketed. Clear Polycarbonate available.
HOUSING	Clear anodized aluminum with cast aluminum ends, blends with landscape and surroundings. Furnished with 360° conduit type swivels.
ELECTRICAL SPECIFICATIONS	Standard 120 Volt/60 Hz, magnetic or electronic ballast. Also available in 277 Volt/60 Hz, 220 Volt/50 Hz, and 12 VDC. CSA listed. Self contained emergency ballast available.
ADAPTATIONS	For easy surface mounting use FB124 brackets. For pole top mounting use catalog #PT20 Pole Top Assembly.

DIMENSIONS				
Measure	A	B	C	D
Inches	5”	6-1/2”	2-1/2”	27-3/4”
MM	127	165	63	705

The Magnaray® #W1P502SL is a dual lamped unit using 2- 50 watt Twin Tube T5 lamps rated 27,000 hours hours life when used with a “Program Start Ballast”. Scroll work optional. Bracket mounts to 1.5” – 2.0” pole tenon, or arm. Standard color is anodized aluminum with powder coat bronze, White, Black or custom colors available. Unit replaces up to 250 watt HPS for street lighting applications. Photo cell receptacle optional – twist-lok photo cell not included (#W1P502SP).

6” (H)

|--------27.75” Deep -------|

|----------18”-(W)----------|

Saving Energy and the Environment Since 1964

"Quality is never an accident; it is always the result of high intention, sincere effort, intelligent direction and skillful execution; it represents the wise choice of many."

Product Information Bulletin

DULUX® L ECOLOGIC®

T5 Compact Fluorescent Lamps

- High lumen single-ended twin-tube lamps
- 18 through 80 Watts
- 2' x 2' fixture provides equal lumen output to a 2' x 4' fixture
- 55 & 80 Watt lamps provide high lumen output for indirect and higher mounting height applications
- 3000K, 3500K, 4100K
- Excellent color rendition, CRI of 82
- Operate on QUICKTRONIC® systems with QUICKSENSE circuitry
- Passes Federal TCLP tests

Product Availability

Lamp Type	Watts	Lumens
FT18DL	18	1250
FT18DL/RS	18	1250
FT24DL	24/27	1800
FT36DL	36/39	2900
FT40DL/RS	40	3150
FT55DL	55	4800
FT80DL	80	6000

SYLVANIA DULUX® L T5 lamps are high lumen, single-ended twin-tube lamps that provide lumen outputs similar to 2', 3' and 4' linear fluorescent lamps, yet are half the length. With lumen outputs up to 6000 and lamp efficacies up to 87 lumens per watt, these compact lamps can be used in indirect as well as direct applications.

QUICKTRONIC® ballasts are available to operate FT24DL, FT36DL, FT40DL/RS, FT55DL and FT80DL lamps. The QUICKSENSE® circuitry in these ballasts provides the end-of-life protection required by NEMA* for these lamps. The QUICK 60+® warranty program applies to DULUX L lamp/QUICKTRONIC® ballasts installations.

*NEMA: National Electrical Manufacturers Association

System Comparison

Lamp Type	No. of Lamps	System Watts	Ballast Factor	System Lumens	Mean System Lumens	Mean LPW
FB40/CW/SS ES MAG	2	72	.88	4576	3890	54
FB40/700 Std. MAG	2	96	.95	5795	5100	53
FB40/700 ES MAG	2	86	.95	5795	5216	61
FBO31/800 IS	3	84	.90	7358	6769	81
FBO31/800 PLUS	3	109	1.18	9647	8875	81
FT40DL/800 40DL	3	110	.96	9072	8165	74

Application Information

Applications

Recessed and surface mounted fixtures
Indirect fixtures
Wall sconces, wall washing fixtures
Stage and set lighting
Sign lighting
Portable sports lighting
Task lighting
Landscape lighting

Application Notes

1. The FT18DL and FT18DL/RS lamps are not electrically interchangeable.
2. The FT24DL, FT36DL, FT40DL/RS and FT55DL lamps: various methods of operation (preheat, rapid start, instant start, programmed start) possible.
3. FT80DL designed for high frequency rapid start, programmed rapid start and dimming ballasts.
4. Lamp life may vary with method of operation.
5. FT24DL: 27W on RS ballasts
6. FT36DL: 39W on RS ballasts

Sample Specification
Lamp(s) shall be DULUX L T5 lamp(s). Lamp(s) shall have a correlated color temperature of (3000K, 3500K, 4100K, 5000K) and a CRI of 82. The DULUX L T5 (24, 36, 40, 55, 80) shall be operated on QUICKTRONIC electronic high frequency (System PHO 39/24, System 40DL, System PHO 54, System PHO80) ballasts with QUICKSENSE circuitry. The manufacturer shall provide a complete system warranty covering lamps and ballasts.

Ordering and Specification Information

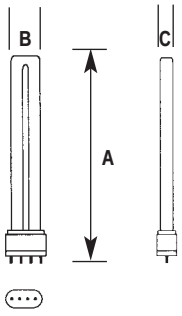
Item Number	Ordering Abbreviation	Watts	Volts	Lumens	Avg. Rated Life (hrs.)	Color Temp.	CRI	Base
20587	FT18DL/830	18	61	1250	12,000	3000K	82	2G11
20588	FT18DL/835	18	61	1250	12,000	3500K	82	2G11
20589	FT18DL/841	18	61	1250	12,000	4100K	82	2G11
20595	FT18DL/830/RS	18	76	1250	20,000	3000K	82	2G11
20594	FT18DL/835/RS	18	76	1250	20,000	3500K	82	2G11
20593	FT18DL/841/RS	18	76	1250	20,000	4100K	82	2G11
20597	FT24DL/830	24	91	1800	12,000	3000K	82	2G11
20580	FT24DL/835	24	91	1800	12,000	3500K	82	2G11
20596	FT24DL/841	24	91	1800	12,000	4100K	82	2G11
20581	FT36DL/830	36	112	2900	12,000	3000K	82	2G11
20582	FT36DL/835	36	112	2900	12,000	3500K	82	2G11
20583	FT36DL/841	36	112	2900	12,000	4100K	82	2G11
20584	FT40DL/830/RS	40	152**	3150	20,000*	3000K	82	2G11
20585	FT40DL/835/RS	40	152**	3150	20,000*	3500K	82	2G11
20586	FT40DL/841/RS	40	152**	3150	20,000*	4100K	82	2G11
20576	FT40DL/850/RS	40	152**	3150	20,000*	5000K	82	2G11
20590	FT55DL/830	55	100	4800	12,000	3000K	82	2G11
20591	FT55DL/835	55	100	4800	12,000	3500K	82	2G11
20592	FT55DL/841	55	100	4800	12,000	4100K	82	2G11
20572	FT80DL/830	80	145**	6000	12,000	3000K	82	2G11
20622	FT80DL/835	80	145**	6000	12,000	3500K	82	2G11
20624	FT80DL/841	80	145**	6000	12,000	4100K	82	2G11

* Avg. Rated Life on instant start ballast = 15,000 hrs.
** At rated line voltage and nominal lamp current at 25kHz

Ordering Guide

FT	40	DL	/	8	35	/	RS
Fluorescent Tubular	Wattage: 18, 24, 36 40, 55 & 80	DULUX Long		82 CRI	30=3000K 35=3500K 41=4100K 50=5000K		Rapid Start

Dimensions



Ordering Abbreviation	(A) MOL [in (mm)]	(B) Width of Lamp [in (mm)]	(C) Max. Bulb Diameter [in (mm)]
FT18DL	8.9 (225.0)	1.6 (40.0)	0.8 (20)
FT18DL/RS	10.6 (268.0)	1.6 (40.0)	0.8 (20)
FT24DL	12.6 (320.0)	1.6 (40.0)	0.8 (20)
FT36DL	16.3 (415.0)	1.6 (40.0)	0.8 (20)
FT40DL	22.4 (570.0)	1.6 (40.0)	0.8 (20)
FT55DL	21.1 (535.0)	1.6 (40.0)	0.8 (20)
FT80DL	22.4 (570.0)	1.6 (40.0)	0.8 (20)

OSRAM SYLVANIA
National Customer
Service and Sales Center
18725 N. Union Street
Westfield, IN 46074

Industrial & Commercial
Phone: 1-800-255-5042
Fax: 1-800-255-5043

National Accounts
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Fax: 1-800-562-4674

OEM/Specialty Markets
Phone: 1-800-762-7191
Fax: 1-800-762-7192

Display/Optic
Phone: 1-888-677-2627
Fax: 1-800-762-7192

In Canada
OSRAM SYLVANIA LTD.
Headquarters
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Industrial & Commercial
Phone: 1-800-263-2852
Fax: 1-800-667-6772

Special Markets
Phone: 1-800-265-2852
Fax: 1-800-667-6772

Visit our website: www.sylvania.com

Return to: Dulux L High Lumen (single, long, 4-Pin) | Print Page

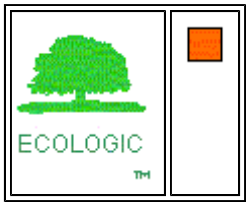
Product Number: 20276
Order Abbreviation: FT50DL/841/RS/ECO
General Description: 50-watt DULUX L ECOLOGIC

Product Information	
Abbrev. With Packaging Info.	FT50DL/841/RS/ECO 10/CS 1/SKU
Average Rated Life (hr)	14000
Base	2G11
Bulb	T5
Color Rendering Index (CRI)	82
Color Temperature/CCT (K)	4100
Family Brand Name	Dulux® L
Nominal Wattage (W)	50.00

Additional Product Information

Product Documents, Graphs, and Images

Packaging Information

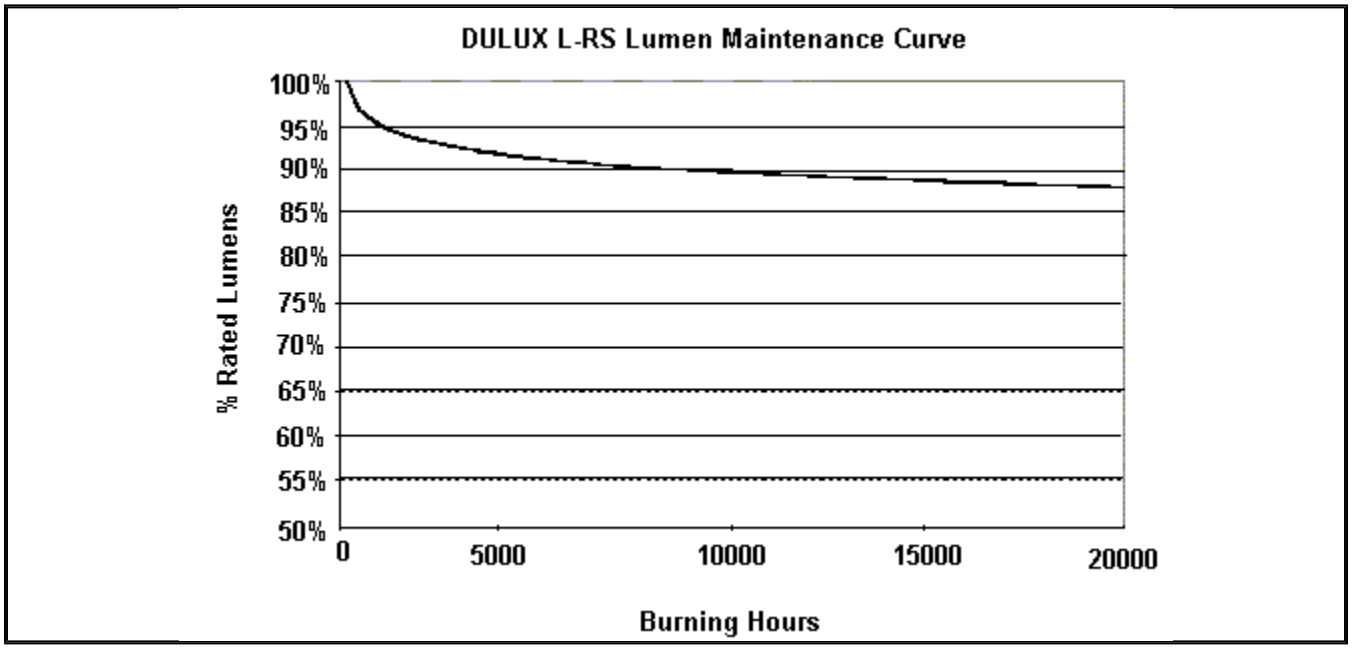


Footnotes

- Approximate initial lumens after 100 hours operation.
- Minimum starting temperature is a function of the ballast; consult the ballast manufacturer.
- There is a NEMA supported, industry issue where T2, T4, and T5 fluorescent and compact fluorescent lamps operated on high frequency ballasts may experience an abnormal end-of-life phenomenon. This end-of-life phenomenon can resultin one or both of the following: 1. Bulb wall cracking near the lamp base. 2. The lamp can overheat in the base area and possibly melt the base and socket. NEMA recommends that high frequency compact fluorescent ballasts have an end-of-life shutdown circuit which will safely and reliably shut down the system in the rare event of an abnormal end-of-life failure mode described above. The final requirements of this system are yet to be defined by ANSI. For additional information refer to NEMA papers on their WEBSITE at www.NEMA.org.
- The life ratings of fluorescent lamps are based on 3 hr. burning cycles under specified conditions and with ballast meeting ANSI specifications. If burning cycle is increased, there will be a corresponding increase in the average hours life.
- Rule of Thumb for Compact Fluorescent Lamps: Divide wattage of incandescent lamp by

Lumen Maintenance Curve

Product Number: 20592
Description: DULUX L - RS



Not a specification or standard.
Actual results may vary.

Close Window Print

PL-L 50W/841 2G11 /4P 1CT

Product family description
PL-L Long 4pin Fluorescent Lamp.

Features/Benefits

- High lumen Output in a slim, compact size.
- Broad range of available wattages: 18, 24, 36, 40, 50, 55, and 80W.
- Excellent Color Rendering - 82 Color Rendering Index (CRI); 55W available with 91 CRI.
- Available in 3000, 3500 and 4100K; 55W available as 5000K only.
- Dimmable - PL-L 4-pin lamps may be used with electronic dimming ballasts.
- Long life: 15,000 to 20,000 hours average life depending on wattage.

Applications

- Ideal for commercial interior lighting applications in 2'x2' fixtures,1'x2' fixtures, and indirect lighting.

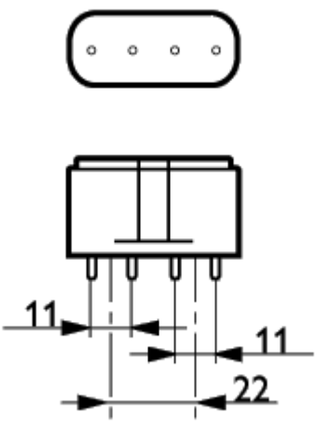
Notes

- Rated average life under specified test conditions with lamps turned off and restarted no more frequently than once every 3 operating hours. Lamp life is appreciably longer if lamps are started less frequently. (202)
- Approximate Initial Lumens. The lamp lumen output is based upon lamp performance after 100 hours of operating life, when the output is measured during operation on a reference ballast under standard laboratory conditions. (203)
- Design Lumens are the approximate lamp lumen output at 40% of the lamp's Rated Average Life. This output is based upon measurements obtained during lamp operation on a reference ballast under standard laboratory conditions. (208)

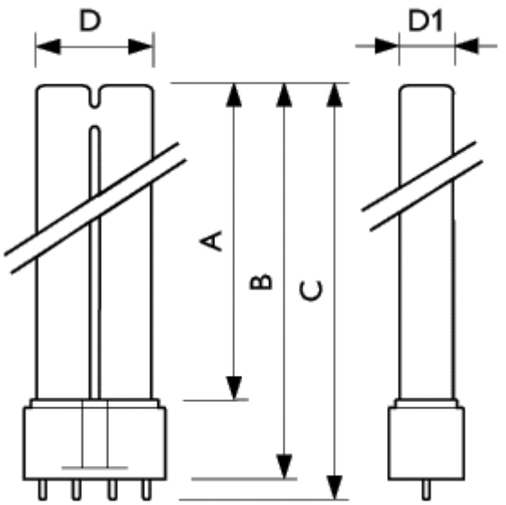
Product data	
Product Number	347708
Full product name	PL-L 50W/841 2G11 /4P 1CT
Ordering Code	PL-L 50W/841/4P RS
Pack type	1 Lamp in a Folding Carton
Pieces per Sku	1
Skus/Case	25
Pack UPC	046677347703
EAN2US	
Case Bar Code	50046677347708

Product data	
Successor Product number	
System Description	Rapid Start
Base	2G11
Base Information	4P
Execution	/4P [4 Pins]
Packing Type	1CT [1 Lamp in a Folding Carton]
Packing Configuration	25
Avg. Life	10000 hr
Avg. Hrs. Life	- hr
Ordering Code	PL-L 50W/841/4P RS
Pack UPC	046677347703
Case Bar Code	50046677347708
Watts	50W
Lamp Voltage	150 V
Dimmable	Yes
Color Code	840 [CCT of 4000K]
Color Rendering Index	82 Ra8
Color Designation	Cool White
Color Description	840 Cool White
Color Temperature	4000 K
Initial Lumens	4000 Lm
Overall Length C	571.6 mm
Diameter D	39 mm
Diameter D1	18 mm
Product Number	347708

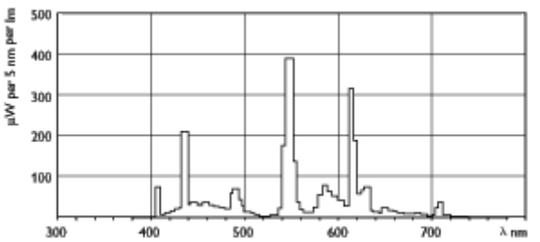
PL-L



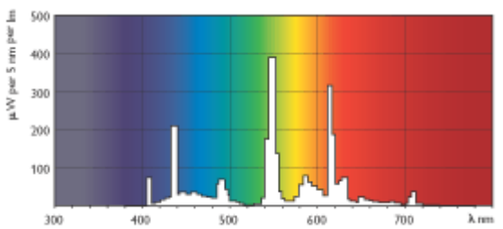
Base 2G11



PL-L



PL-L/840



PL-L/840

Appendix C – Street Lighting Rate Tariffs

CITY OF AUSTIN
ELECTRIC RATE SCHEDULE
STREETLIGHTING AND TRAFFIC SIGNALS

Application

This rate is applicable to electric service required for the illumination and operation of traffic signals on all dedicated public streets, highways and expressways or thoroughfares within the city limits of Austin or any other incorporated area or municipal utility district requesting streetlighting service This rate is also applicable for the illumination of any property owned operated and/or maintained by the City of Austin

Character of Service

The Character of Service provided under this rate shall be alternating current 60 cycles single phase

Rate (E05)

	Winter Billing Months of November through April	Summer Billing Months of May through October
Energy Rate (E05)	14 98¢ per kWh, for all kWh	14 98¢ per kWh for all kWh

Fuel Adjustment Clause (FAC) plus an adjustment for variable costs calculated according to the Fuel Adjustment Clause Tariff multiplied by all kWh

Minimum Bill

Customer will be assessed a monthly Minimum Bill of $12 00 if the above calculations result in a charge of less than $12 00

CITY OF AUSTIN
ELECTRIC RATE SCHEDULE
SECURITY LIGHTING

Application

This rate applies to private outdoor overhead lighting installed owned operated and maintained by the City of Austin It applies to service received under a contract that was effective before passage of the Non Metered Outdoor Lighting Tariff

Rate (ENW)

	Facilities Charge	Energy Charge	Monthly kWh
175W Mercury Vapor	$1 74	$ 7 34	60
100W High Pressure Sodium	$1 74	$ 4 28	35
400W Mercury Vapor	$1 74	$17 11	140
250W High Pressure Sodium	$1 74	$11 00	90

Fuel Adjustment Clause (FAC) plus an adjustment for variable costs, calculated according to the Fuel Adjustment Clause Tariff multiplied by all kWh

CONTRIBUTIONS IN AID OF CONSTRUCTION
FEES FOR THE INSTALLATION OF
SECURITY LIGHTING POLES

A Contribution in Aid of Construction will be required for the installation of poles for security lighting The fee will be based on the sum of (1) the average labor cost for installing (machine set) a pole and (2) the direct cost of the pole itself The fees will be recalculated annually

The current required contributions for the most common installations are

	25 Steel	30' Steel	35' Wood
Labor	$ 349	$ 349	$ 391
Pole	495	568	105
Total	$ 844	$ 917	$ 498

CITY OF AUSTIN
ELECTRIC RATE SCHEDULE
NON METERED OUTDOOR LIGHTING

Application

This rate applies to non metered outdoor lighting installed owned operated and maintained by the City of Austin Lights are subject to availability

Rate (ENW)

Energy Rate	$0 0428 per watt X watt age of bulb
Fuel Rate	0 35 hours X watt age of bulb X FAC

Fuel Adjustment Clause (FAC) – an adjustment for variable costs calculated according to the Fuel Adjustment Clause Tariff

6.1.1.6 Lighting Service

6.1.1.6.1 Municipal Street Lighting Service

AVAILABILITY

This schedule is available only to municipalities, government agencies, colleges, universities and eleemosynary institutions for service to Company-owned and maintained street lighting fixtures installed upon request for the purpose of illuminating public streets, highways, parking lots and campuses.

Service will be provided by means of Company-owned and maintained lamps installed on overhead fixtures supported by poles in Company's existing distribution system. Costs for added wood poles or ornamental poles conforming to standard specifications and mutually satisfactory to both the Retail Customer and the Company will be reimbursed to the Company by non-refundable payment and Retail Customer will not acquire any title in said facilities by reason of payment. Retail Customer will also be responsible for the cost of any associated circuit work. Additional costs associated with ornamental fixtures will be recovered from Retail Customer. Lamps may be supplied from either series or multiple systems and from overhead circuit at the option of the Company. The Retail Customer agrees to provide, at no cost to the Company, all required right-of-way together with tree trimming permits for installation of the system and any permit necessary to allow the Company the right to use highway, parkway, and street right-of-way for maintenance of the system. Service to mercury vapor lamps and incandescent lamps is available to existing service only.

TYPE OF SERVICE

Mercury vapor and incandescent lamps will be closed to new installations; service will continue to be provided until those fixtures fail or service is otherwise terminated.

MONTHLY RATE

I. Transmission and Distribution Charges:

Customer Charge	$2.49	per account
Facilities Charge		See chart
Transmission System Charge	$.001869	per kWh

Distribution System Charge $.019006 per kWh

MUNICIPAL STREET LIGHTING FACILITIES RATE

Description	Code	kWh	Facilities Price
Mercury Vapor			
100 Watt	MA0	40	$4.34
175 Watt	MA2	75	$5.32
250 Watt	MA3	100	$9.01
400 Watt	MA6	145	$9.76
1000 Watt	MA8	365	$13.76
Twin 400 Watt	ME6	290	$15.64
Metal Halide			
175 Watt	HD0	75	$9.11
250 Watt	HD2	105	$9.34
400 Watt	HA4	155	$9.90
Twin 250 Watt	HE2	210	$16.67
Twin 400 Watt	HE4	310	$22.15
High Pressure Sodium			
70 Watt	SA0	35	$5.19
100 Watt	SA2	39	$5.32
150 Watt	SA4	70	$5.47
250 Watt	SA6	105	$8.13
400 Watt	SA8	165	$8.89
Twin 150 Watt	SE4	140	$8.29
Twin 250 Watt	SE6	210	$13.63
Twin 400 Watt	SE8	330	$15.14

NON-ROADWAY LIGHTING FACILITIES RATE

Description	Code	kWh	Facilities Price
Metal Halide 1000 Watt	565	367	$8.12
High Pressure Sodium 1000 Watt	555	367	$6.44

II. System Benefit Fund Charge: $.000662 per kWh See Rider SBF

III. Transition Charge: See Schedule TC

IV. Nuclear Decommissioning Charge: Not Applicable

V. Transmission Cost Recovery Factor: See Rider TCRF

VI. Excess Mitigation Credit: See Rider EMC

VII. State Colleges and Universities Discount: See Rider SCUD

VIII. Other Charges or Credits

A. Net Merger Savings Rider See Rider NMS

B. Rate Reduction Rider See Rider RR

COMPANY-SPECIFIC APPLICATIONS

The Company will furnish to the Retail Customer, street light facilities for the operation from dusk to dawn of street lights served under this Tariff.

In the case where the lighting service is provided utilizing underground circuit(s), the Retail Customer will provide all trenching and back-filling necessary for the installation of the circuit(s).

The Company will, upon request of Retail Customer, relocate, remove, or change any of its facilities used in rendering service hereunder insofar as it may be practical and permissible, or will render service under any other street lighting service rate offered by the Company provided Retail Customer pays to Company, prior to the time such change is made or such different street lighting service is rendered, all costs incurred by Company in making the change, including costs of equipment or facilities rendered unusable.

If an outage of a street light occurs, Retail Customer shall notify the Company promptly of such outage and Company will be allowed five (5) working days after such outage has been reported in which to restore the lamp to service.

In the event that a lighting service is being provided in an area where it is subject to vandalism, the Retail Customer will be responsible for reimbursing the Company for all costs of maintaining the light(s), and if the vandalism is severe enough, in the Company's sole opinion, lighting service under this Tariff may be refused or terminated.

NOTICE

This rate schedule is subject to the Company's Tariff and Applicable Legal Authorities.

6.1.1.6.2 Street Lighting Service - Company Owned – Cities of McAllen, Odem and Uvalde

AVAILABILITY

This schedule is available at the Company's option to political subdivisions and eleemosynary institutions for street lighting service on public streets and highways, in public parks, and schoolyards of educational institutions not organized for profit. Service will be provided by means of Company-owned and maintained lamps installed on ornamental standards conforming to Company's specifications mutually satisfactory to both the Retail Customer and the Company. Lamps will normally be supplied from underground circuit.

TYPE OF SERVICE

The electric service furnished hereunder is unmetered and billing is based on the kilowatt hours (kWhs) stated in this Tariff.

MONTHLY RATE

I. Transmission and Distribution Charges:

Customer Charge	$2.49	per account
Facilities Charge		See chart
Transmission System Charge	$.001869	per kWh
Distribution System Charge	$.019006	per kWh

MONTHLY FACILITIES RATE

Description	kWh	Facilities Rate
Metal Halide		
400 Watt Street Light	155	$11.39
175 Watt Post Top Light	75	$19.20
H.P. Sodium Lamp		
100 Watt Post Top Light	39	$18.60

II. System Benefit Fund Charge: $0.000662 per kWh See Rider SBF

III. Transition Charge: See Schedule TC

IV. Nuclear Decommissioning Charge: Not Applicable

V. Transmission Cost Recovery Factor: See Rider TCRF

VI. Excess Mitigation Credit: See Rider EMC

VII. State Colleges and Universities Discount: See Rider SCUD

VIII. Other Charges or Credits

A. Net Merger Savings Rider See Rider NMS

B. See Rate Reduction Rider See Rider RR

COMPANY-SPECIFIC APPLICATIONS

The Company will furnish to Retail Customer lighting facilities for the operation from dusk to dawn of street lights served under this tariff provided that the cost to the Company of installation of lamps, including pole mounted brackets, ornamental standards and the required circuit is no more than $1,325.00 for each Post Top Light or $750.00 for each street light. All costs of installation in excess of those stated above will be reimbursed to Company by Retail Customer by non-refundable payment in aid to construction, but Retail Customer will not acquire any title in said facilities by reason of such payment.

Company will, upon request of Retail Customer, relocate or change any of its facilities used in rendering service hereunder insofar as it may be practical and permissible, or will render service under any other street lighting service rate offered by the Company provided Retail Customer pays to Company, prior to the time such change is made or such different street lighting service is rendered, all costs incurred by Company in making the change, including costs of equipment or facilities rendered unusable.

If an outage of a street light occurs, Retail Customer shall notify the Company promptly of such outage and Company will be allowed five working days after such outage has been reported in which to restore the lamp to service. If Company fails to restore any lamp which it is obligated to maintain to service within five working days after official notice from Retail Customer of the outage, Retail Customer shall be entitled to a credit for the pro rata cost or charge by Company for such lamp for the period of time it remained out after the report of the outage by the Retail Customer.

NOTICE

This rate schedule is subject to the Company's Tariff and Applicable Legal Authorities.

6.1.1.6.3 Non-Roadway Lighting Service

AVAILABILITY

This schedule is for private lighting systems owned and operated by the Company and is only available to currently installed facilities.

TYPE OF SERVICE

The Company will own and operate complete luminaire units of approved design with an automatic control device for lights to burn from dusk until dawn.

The Retail Customer agrees to provide, at no cost to the Company, tree trimming permits for maintenance of the system.

The facilities installed by the Company will remain the property of the Company.

The Non-Roadway Lighting Tariff is closed to new service as of September, 2000.

MONTHLY RATE

I. Transmission and Distribution Charges:

Customer Charge		Not Applicable
Facilities Charge		See chart
Transmission System Charge	$.001869	per kWh
Distribution System Charge	$.019006	per kWh

MONTHLY FACILITIES RATE

Description	Code	KWh	Facilities Price
Security Lighting			
Mercury Vapor			
175 Watt	715	75	$4.43
400 Watt	705	145	$6.12
High Pressure Sodium			
100 Watt	785	39	$4.68
150 Watt	775	70	$4.99
250 Watt	725	105	$5.94
Flood Lighting			
Sodium Vapor			
100 Watt	505	39	$3.44
250 Watt	515	105	$4.10
400 Watt	535	155	$4.64
1000 Watt	555	367	$6.44
Metal Halide			
250 Watt	525	105	$6.25
400 Watt	545	155	$6.76
1000 Watt 6x7 NBP	565	367	$8.12
1000 Watt 3x3 NBP	575	367	$8.12

II. System Benefit Fund Charge: $0.000662 per kWh See Rider SBF

III. Transition Charge: See Schedule TC

IV. Nuclear Decommissioning Charge: Not Applicable

V. Transmission Cost Recovery Factor: See Rider TCRF

VI. Excess Mitigation Credit: See Rider EMC

VII. State Colleges and Universities Discount: See Rider SCUD

VIII. Other Charges or Credits

A. Net Merger Savings Rider See Rider NMS

B. Rate Reduction Rider See Rider RR

COMPANY-SPECIFIC APPLICATIONS

In the event that a luminaire unit were to require major maintenance or replacement to maintain service after September 2000, any new investment would be at the sole discretion of the Company.

In the event that a lighting service is being provided in an area where it is subject to vandalism, the Retail Customer will be responsible for reimbursing the Company for all costs of maintaining the light(s), and if the vandalism is severe enough, in the Company's sole opinion, lighting service under this Tariff may be refused or terminated.

NOTICE

This rate schedule is subject to the Company's Tariff and Applicable Legal Authorities.

6.1.1.6- LIGHTING SERVICES
(Street Lighting and Miscellaneous Lighting Services)

STREET LIGHTING SERVICE

AVAILABILITY

Street lighting service is available in areas designated by Reliant Energy HL&P (HL&P or Company) where facilities of adequate capacity and suitable voltage are adjacent to the street lighting fixtures and standards to be served. The standard street lighting service provided by the Company is installed along public streets, roadways or other public access areas in accordance with Section 6.1.2.2, Construction Services, in this Tariff. Company will only provide for the delivery of electric power and energy, the street lighting fixtures and standards, and maintenance. Retail Customer's electric power and energy must be provided by the Retail Customer's REP in accordance with Applicable Legal Authorities and the Company's Tariff.

TYPE OF SERVICE

Street lights under this rate schedule will be served at various voltages as determined by the Company. This rate schedule is applicable to the requirements of cities, governmental agencies, real estate developers and other groups requesting street lighting service, herein referred to as Retail Customer. Street lighting service includes the provision of street lighting fixtures and standards, as well as the provision of Delivery Service for electric power and energy provided by the Retail Customer's REP and required for the lighting service. Delivery Service under this rate schedule will be un-metered.

Company will install, own and maintain the installation served hereunder. Company will replace burned out lamps and/or make maintenance repairs during regular working hours at its own cost and expense and will normally have the lighting service restored within 48 hours after notification by the Retail Customer. Street lighting fixtures furnished hereunder shall operate under normal conditions from approximately thirty minutes after sunset to approximately thirty minutes before sunrise every night in the year and the total time of operations will be approximately four thousand (4,000) hours each year for each light furnished.

RELIANT ENERGY HL&P
Applicable: Entire Service Area

HL&P 8020

MONTHLY RATE

I. Transmission and Distribution Charges

In addition to the T&D Charge per lamp for various configurations in the table below, an additional $1.14 per month will be charged for all lamps with a break-away base.

Lamp Type	Schedule A*	Schedule B*	Schedule C*	Schedule D*	Schedule E*	Monthly KWH
Mercury Vapor						
60,000 Lumen	$ 8.47	$ 22.04	$ 14.96	$ 24.85	$ 16.55	365
20,000 Lumen	$ 4.94	$ 17.03	$ 11.19	$ 21.08	$ 12.61	150
7,500 Lumen	$ 3.49	N.A.	N.A.	$ 16.96	$ 9.98	69
3,300 Lumen	$ 3.40	N.A.	N.A.	$ 13.16	N.A.	41
High Pressure Sodium Vapor						
50,000 Lumen	$ 8.47	$ 22.04	$ 14.96	$ 24.85	$ 16.55	160
25,500 Lumen	$ 4.94	$ 17.03	$ 11.19	$ 21.08	$ 12.61	106
16,000 Lumen	$ 3.49	$ 15.54	$ 10.33	$ 16.96	$ 9.98	58
9,500 Lumen	$ 3.49	N.A.	N.A.	$ 13.79	$ 8.52	38
5,800 Lumen	$ 3.43	N.A.	N.A.	$ 12.72	N.A.	29
Metal Halide						
36,000 Lumen	$ 10.13	N.A.	N.A	$ 25.55	$ 17.80	159
20,500 Lumen	$ 9.92	N.A.	N.A.	$ 25.35	$ 17.60	96
7,800 Lumen	$ 11.21	N.A.	N.A.	$ 24.86	$ 18.88	40

* DESCRIPTION OF LIGHTING CONFIGURATIONS:

Schedule A -one or more lamps mounted on existing distribution poles and served by overhead conductors.
Schedule B -single lamp mounted on ornamental standard and served by overhead conductors. Limited to existing installations.
Schedule C -twin lamps mounted on ornamental standard and served by overhead conductors. Limited to existing installations.
Schedule D -single lamp mounted on ornamental standard and served by underground conductors, or decorative residential streetlights.
Schedule E -twin lamps mounted on ornamental standard and served by underground conductors.

II.	**System Benefit Fund Charge:**	$.000655	per kWh See Rider SBF
III.	**Transition Charge:**		See Schedule TC
IV.	**Nuclear Decommissioning Charge:**		Not Applicable
V.	**Transmission Cost Recovery Factor:**		See Rider TCRF
VI.	**Excess Mitigation Credit:**		See Rider EMC
VII.	**State Colleges and Universities Discount:**		See Rider SCUD
VIII.	**Other Charges or Credits**		Not Applicable

OTHER PROVISION
Additional mercury vapor lighting will not be installed after December 31, 1982. Existing mercury vapor installations will be converted to sodium vapor installations as required during the normal course of maintenance. Mercury vapor installations with 3,300, 7,500, and 20,000 lumen lamps will be converted to 9,500, 16,000, or 25,500 lumen high pressure sodium lamps, respectively, when individual lamps burn out at no up front cost to the Retail Customer.

MISCELLANEOUS LIGHTING SERVICE

AVAILABILITY
Electric Power Delivery Service for lighting fixtures served hereunder, is available in areas designated by Company with suitable locations and where facilities of adequate capacity and suitable voltage are adjacent to the lighting fixture(s) to be served. Reliant Energy HL&P will only provide for the delivery of electric power. Retail Customer's electric power must be provided by the Retail Customer's REP in accordance with Applicable Legal Authorities and the Company's Tariff.

TYPE OF SERVICE

The lighting fixtures served under this rate schedule will be served at standard secondary voltages as determined by Company. This tariff is applicable to any Retail Customer receiving un-metered service for one or more Company approved lighting fixtures provided and owned by the Retail Customer or their REP, which operate automatically every night from dusk to dawn. The Company will install, make electrical connection(s), and maintain the lighting fixture(s). Charges for services hereunder shall commence on the date that the electrical connection is made.

MONTHLY RATE

I. Transmission and Distribution Charges

In addition to the T&D Charge for each lamp type in the table below an additional charge of $2.60 per month is charged for a span of secondary which was installed exclusively for Miscellaneous Lighting Service and Retail Customer did not reimburse Company for construction cost (applies only to installations existing as of 1-1-2002).

TYPE OF LAMP	T&D CHARGE	LUMEN RATING	TOTAL WATTAGE	MONTHLY KWH
Floodlighting/Directional Lighting				
High Pressure Sodium (150 watts)	$5.04	16,000	185	61
High Pressure Sodium (250 watts)	$5.04	27,500	315	105
High Pressure Sodium (400 watts)	$5.04	50,000	475	158
High Pressure Sodium (1,000 watts)	$5.04	130,000	1,100	367
Metal Halide (175 watts)	$5.04	14,400	210	70
Metal Halide (250 watts)	$5.04	21,500	294	98
Metal Halide (400 watts)	$5.04	36,000	476	159
Metal Halide (1,000 watts)	$5.04	107,000	1,100	367
Roadway/General Lighting				
High Pressure Sodium (150 watts)	$5.04	16,000	185	61
Guard Lighting				
High Pressure Sodium (100 watts)	$5.04	9,500	120	40
Mercury Vapor (no new installations)	$5.04	7,500	215	72

II.	**System Benefit Fund Charge:**	$.000655	per kWh See Rider SBF
III.	**Transition Charge:**		See Schedule TC
IV.	**Nuclear Decommissioning Charge:**		Not Applicable
V.	**Transmission Cost Recovery Factor:**		See Rider TCRF
VI.	**Excess Mitigation Credit:**		See Rider EMC
VII.	**State Colleges and Universities Discount:**		See Rider SCUD
VIII.	**Other Charges or Credits**		
	A. Municipal Account Franchise Credit (see application and explanation below)	$(.001874)	Per kWh

INSTALLATION AND MAINTENANCE

Company will install and maintain the lighting fixture(s) served hereunder. For all installations except Guard Lights, the Company will provide for each fixture the bulb and the photoelectric relay at the time of installation. Company will replace burned out lamps and make other maintenance repairs during Company's regular working hours at Company's expense, but with no adjustment of payments hereunder due to outage. Maintenance includes replacement of burned-out lamps (bulbs) and malfunctioning photoelectric relays. Damages due to vandalism, storms, accidents or manufacturing defects are not included under maintenance. Normally, Company will make maintenance repairs under this tariff within 72 hours after notification by the Retail Customer or REP.

The Retail Customer will be charged a one-time fee per lighting fixture to cover the Company's standard installation as detailed below. Standard installation consists of installing the lighting fixture on an existing wooden distribution pole and connecting service supplied from an existing or new overhead secondary conductor on the pole as detailed below. Standard installations are made during normal Company business hours. The charges below include both the labor to install and eventually remove fixtures. Any additional construction and/or cost required to provide service will be at the Retail

Customer's expense, for an additional charge. Any additional facilities so required will be owned, installed and maintained by the Company.

Retail Customer or REP must purchase/ provide all lighting fixtures. Only un-metered lighting fixtures meeting Company Service Standards and specifications will be allowed under this tariff. The Retail Customer or REP will own the lighting fixture.

STANDARD INSTALLATION FEES	One Light per Pole	Two Lights per Pole	Three Lights per Pole
High Pressure Sodium			
Installations without secondary			
150w, 250w, 400w	$325	$350	$405
1000w	$370	$450	$550
Installations with 150 feet of secondary			
150w, 250w, 400w	$425	$450	$505
1000w	$470	$550	$655
Metal Halide			
Installations without secondary			
175w, 250w, 400w	$330	$365	$430
1000w	$370	$450	$550
Installations with 150 feet of secondary			
175w, 250w, 400w	$430	$470	$530
1000w	$470	$550	$655
Guard Light			
Installations without secondary			
100w HPS	$325	N/A	N/A
Installations with secondary			
100w HPS	$365	N/A	N/A
Roadway Light			
Installations without secondary			
150w HPS	$335	N/A	N/A
Installations with secondary			
150w HPS	$375	N/A	N/A

EXTRAORDINARY MAINTENANCE ACTIVITIES

Company will charge Retail Customer an additional fee as detailed below for each occurrence of the extraordinary maintenance activities listed hereunder.

EXTRAORDINARY MAINTENANCE FEE	
ACTIVITY	FEE
(1) Replace a vandalized shield (parts and labor)	$125.00
(2) Make adjustments to the fixture (labor only)	$125.00
(3) Replace a fixture (labor only)	$125.00
(4) Relocate a fixture (labor only)	See Section 6.1.2.2, Construction Services

NOTICE

This Rate Schedule is subject to the Company's Tariff and Applicable Legal Authorities.

6.1.1.6 - Lighting Service

Street Lighting Service

AVAILABILITY

Applicable to Competitive Retailer for street lighting, pedestrian walkway lighting, and overhead sign lighting service to governmental entities in areas served by Company. Overhead sign lighting is available only under the provisions of Schedule D of the Monthly Rate - Unmetered Facilities or the Monthly Rate - Metered Facilities - Non-Company-Owned provisions.

TYPE OF SERVICE

Single or three phase, 60 hertz, at any of the Company's standard secondary or primary service voltages as required by Competitive Retailer. Where existing distribution facilities are not adjacent to the point of delivery, additional charges and special contract arrangements may be required prior to its being furnished. If service is provided at primary voltage, Company may at its option meter service on the secondary side of the governmental entity's transformers and adjust for transformer losses in accordance with Company's Tariff for Retail Delivery Service.

MONTHLY RATE

I. Unmetered Facilities

Points of Delivery (POD) Charge: $22.50 per governmental entity served by the Competitive Retailer.

Facilities Charge, per Luminaire									
Lamp	Watts	Lumens	KWh	Schedule				Rect-angular	Post-Top
				A	B	C	D		
Mercury Vapor	175	7,900	70	$ 7.35	$15.15	$ 3.35	$ 2.25	$18.65	$12.00
	400	21,000	150	$11.25	$18.10	$ 6.65	$ 5.15	N.A.	N.A.
	1,000	63,000	370	$25.00	$33.05	$17.70	$12.75	N.A.	N.A.
Sodium Vapor	100	9,500	40	$ 6.90	$14.25	$ 2.75	$ 1.40	$18.65	$11.20
	150	16,000	70	$ 8.50	$15.65	$ 4.15	$ 2.30	$23.45	N.A.
	200	22,000	80	$ 9.45	$16.35	$ 4.60	$ 2.75	$23.85	N.A.
	250	27,500	100	$ 9.90	$17.00	$ 5.30	$ 3.45	$24.30	N.A.
	400	50,000	160	$14.25	$23.45	$ 8.50	$ 5.30	$35.45	N.A.
	1,000	140,000	375	$27.35	$36.60	$19.30	$12.90	$48.00	N.A.
Metal Halide	175	14,000	65	$ 9.20	$16.80	$ 5.05	$ 2.10	$20.90	$16.60
	250	25,000	100	$11.75	$20.25	$ 6.70	$ 3.70	$30.40	N.A.
	400	36,000	160	$14.00	$23.70	$ 8.50	$ 4.85	$39.60	N.A.
	1,000	110,000	370	$26.45	$35.65	$18.85	$12.45	$48.55	N.A.
Other									
Incandescent*	All			$ 6.90					
Wallpack Mercury Vapor*	250W			$16.10					
Fluorescent*	$19.55								
Historical	$19.55								
*Closed to new street lighting installations									

II. System Benefit Fund:	$0.000655	per kWh, See Rider SBF
III. Transition Charge:	See Rider TC	
IV. Nuclear Decommissioning Charge:	$0.000147	per kWh, See Rider NDC
V. Transmission Cost Recovery Factor:	Not Applicable	
VI. Excess Mitigation Credit:	See Rider EMC	
VII. State Colleges and Universities Discount:	See Rider SCUD	

VIII. Other Charges or Credits:

Not Applicable

MONTHLY RATE

I. Metered Facilities - Non-Company-Owned

Applicable for distribution service supplied at one point of delivery and measured through one meter to Retail Customer owned, operated and maintained street and highway lighting, overhead sign lighting, and incidental safety lighting equipment which operates same hours as normal street lighting.

Distribution Charges	Amount
Customer Charge	$ 2.72
Meter Charge	$10.78
Distribution System Charge	$ 0.0340 per kWh

II. System Benefit Fund:	$0.000655	per kWh, See Rider SBF
III. Transition Charge:	See Rider TC	
IV. Nuclear Decommissioning Charge:	$0.000147	per kWh, See Rider NDC
V. Transmission Cost Recovery Factor:	Not Applicable	
VI. Excess Mitigation Credit:	See Rider EMC	
VII. State Colleges and Universities Discount:	See Rider SCUD	

VIII. Other Charges or Credits:

Not Applicable

MONTHLY RATE

I. Metered Facilities - Company-Owned (Closed to new installations)

Distribution Charges	Amount
Customer Charge	$ 2.55
Meter Charge	$19.95
Distribution System Charge	$ 0.1195 per kWh

II. System Benefit Fund: $0.000655 per kWh, See Rider SBF

III. Transition Charge: See Rider TC

IV. Nuclear Decommissioning Charge: $0.000147 per kWh, See Rider NDC

V. Transmission Cost Recovery Factor: Not Applicable

VI. Excess Mitigation Credit: See Rider EMC

VII. State Colleges and Universities Discount: See Rider SCUD

VIII. Other Charges or Credits:

Not Applicable

DEFINITIONS

Schedule A applies to:

Group 1 Company installed, owned, operated, and maintained street lights mounted on wood poles and served overhead.

Group 2 Company installed, owned, operated, and maintained street lights mounted on wood, steel, or ornamental poles of a type normally used by Company, and served overhead or underground, and Retail Customer has contributed to Company an amount equivalent to the difference between the total installed cost of such street lighting and the total installed cost of an equivalent lighting system mounted on wood poles and served overhead.

Schedule B applies to:

Group 1 Company installed, owned, operated, and maintained street lights mounted on steel or other ornamental poles of a type normally used by Company and served overhead. If the number of steel and/or other ornamental poles exceeds the number of such poles on which lights are mounted, there will be an additional charge of $4.85 per month for each such excess pole. Where two street lights with lamps of the same size are mounted on the same steel and/or other ornamental pole, Schedule B applies to one of the lights and Schedule A to the other.

Group 2 Company installed, owned, operated, and maintained street lights mounted on steel or other ornamental poles of a type normally used by Company and served underground, and Retail Customer has contributed to Company an amount equivalent to the difference between the total installed cost of the underground circuits serving the street lights and the total installed cost of overhead circuits. Where two street lights with lamps of the same size are mounted on the same steel and/or other ornamental pole, Schedule B applies to one of the lights and Schedule A to the other.

Schedule C* applies to:

Group 1 Street lights installed for the use of Retail Customer by Retail Customer or by a governmental subdivision. All equipment replacement and maintenance is performed by Retail Customer or the governmental subdivision. Company provides lamp replacement service only which includes lamp and labor (unless otherwise requested in writing by Retail Customer).

Group 2 Company owned street lights mounted on steel or other ornamental poles of a type not normally used by Company, and Retail Customer has contributed to Company an amount equivalent to the entire construction cost of the street lighting facilities including luminaires and circuits.

*Company operates all street lights under Schedule C (must be of a type suitable for use with the lamp sizes provided for herein) and makes all normal lamp replacements which includes lamp and labor at its expense. All other maintenance will be billed to Retail Customer on the basis of actual costs including appropriate overhead expenses.

Schedule D applies to:

Retail Customer operated and maintained street lights and overhead sign lights or where such lights are installed by a governmental subdivision for the use of Retail Customer, and Company supplies distribution service to Retail Customer for the operation of the street lights or overhead sign lights.

Rectangular, Post-Top and Historical apply to:

Company installed, owned, operated, and maintained street lights mounted on steel or other ornamental poles of a type normally used by Company and served either overhead or underground.

Pedestrian Walkway Lighting :

Pedestrian walkway lighting is used to illuminate sidewalks along municipally-owned streets and roads and within municipally-owned parks and recreational areas.

CONVERSION OR REPLACEMENT OF EXISTING FACILITIES

Company will convert existing Company-owned facilities (size or type of luminaire) to a different Company-offered size or type of luminaire upon request of and payment by Retail Customer of an amount equal to the estimated cost of such conversion, including labor and materials, less the salvage value of the existing facilities.

Company will replace existing lighting facilities upon request of and payment by Retail Customer of an amount equal to the estimated removal cost less salvage value of existing facilities. Installation of new facilities requested by Retail Customer will be performed pursuant to the appropriate Schedule and Group described above.

SPECIAL CONDITIONS

For billing purposes the monthly street lighting and overhead sign lighting burning hours are 333 hours per month and all connections and disconnections are assumed to have occurred at the beginning of the current month's billing period.

Retail Customer-owned unmetered lamps other than those of the lamp sizes shown under Schedule D are billed under the metered rate and the amount of monthly energy is determined by multiplying the connected load (including ballast) by the number of burning hours.

Company reserves the right to discontinue service at locations where excessive maintenance and/or lamp replacement occur, or Company may charge Retail Customer for such maintenance and/or lamp replacements. Company makes all connections and disconnections to its distribution system.

AGREEMENT

An Agreement for Delivery Service with a term of not less than ten years is required.

NOTICE

This rate schedule is subject to the Company's Tariff and Applicable Legal Authorities.

Outdoor Lighting Service (CLOSED)

AVAILABILITY

Applicable to Competitive Retailers for unmetered lighting service supplied exclusively to one or more existing outdoor lamps as specified below operating automatically from dusk to dawn.

Not applicable to street lighting.

MONTHLY RATE

I. Unmetered Facilities

Guard Lights

Type	Watts	kWh	Lumens	Facilities Charge
Mercury Vapor	175	70	7,900	$ 7.10
	400	150	21,000	$10.85
Sodium Vapor	100	40	9,500	$ 6.75
	200	80	22,000	$ 9.45

Flood Lights

Type	Watts	kWh	Lumens	Facilities Charge
Metal Halide	250	100	25,000	$12.55
	400	180	36,000	$15.10
Sodium Vapor	100	40	9,500	$ 9.10
	250	100	27,000	$11.70
	400	160	50,000	$14.95

II. System Benefit Fund: $0.000655 per kWh, See Rider SBF

III. Transition Charge: See Rider TC

IV. *Nuclear Decommissioning* Charge: $0.000147 per kWh, See Rider NDC

V. Transmission Cost Recovery Factor: Not Applicable

VI. Excess Mitigation Credit: See Rider EMC

VII. State Colleges and Universities Discount: See Rider SCUD

VIII. Other Charges or Credits:

Extra Spans: Plus $2.85 per span of secondary line installed hereunder in excess of one span per light.

Asset Recovery Cost: Plus $2.78 per light for the unrecovered investment and removal cost at January 1, 2002.

MAINTENANCE OF FACILITIES

Company will maintain all facilities incidental to providing this service, including replacement of burned-out lamps.

Company reserves the right to discontinue service at locations where excessive maintenance and/or lamp replacements are, in Company's sole judgment, likely to or actually do occur.

Company will remove all facilities incidental to providing this service for the following reasons:

(1) excessive maintenance and/or lamp replacement is occurring;
(2) Competitive Retailer requests facilities to be removed;
(3) pole on which outdoor lighting facilities are attached must be moved or replaced; or
(4) the cost of the requested maintenance of the facilities exceeds the removal cost of the facilities.

NOTICE

This rate schedule is subject to the Company's Tariff and Applicable Legal Authorities.