Maintenance Practices for LED Street Lights

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City of Boston – Public Works
Department
Street Lighting Section
Maintenance Practices for LED Street Lights
Status of Program - 2014

- As of March 31, 2014 – over 33,000 Installs have been completed
- Over next fiscal year – 8,000 to 10,000 additional conversions will be completed
- Balance of system (21,000 lights) to be completed by end of Fiscal Year 2017 (June 2017). We anticipate that all 64,000 electric lights will be completed
Maintenance Practices for LED lights
Lights Installed

- All of the lights currently installed in Boston are still under Manufacturers Warrantee
  - Initial 23,000 units have a five year Warrantee which includes
    - Complete replacement of unit not just the defective component
    - All shipping charges returns and replacements are paid for by the Manufacturer
Maintenance Practices for LED Street Lights

What we have learned thus far

- Initial installation performed November 2010 to March 2011
  - All units installed were cobra Head style installations – Mercury Vapor Lamp Source
  - 3000 Units installed primarily on Residential Streets
    - Of the 3000 initial installs, there have been 97 defective units returned to this manufacturer
      - This equates to a 3% defective rate over the three and a half year installation
Maintenance Practices for LED Street Lights
Sample of first unit installed in Boston
Second Installation - April 2011 through November 2012

Again all units installed were Cobra Head Style – Mercury and Sodium Vapor Lamp Source

- 20,000 lights installed on Residential, collector and Commercial streets throughout the City of Boston
- Of the 20,000 lights installed, 156 were returned as defective. This equates to a .8% defective rate over the past 2 ½ - 3 years
Maintenance Practices for LED Street Lights
Typical Unit installed in Second Phase of Conversion
Maintenance Practices for LED Street Lights

- Third Phase of LED Conversions November 2012 to April 2013
  - Units were to replace all Mercury Vapor Post Top Luminaires
    - Approximately 3000 units of this classification were targeted
  - Specifically in Downtown residential areas
  - Neighborhood very pleased with installation
  - Units have five year warrantee
  - To date 88 units have been defective
    - This equates to 2.9% defective rate over the past 1 ½ years
Maintenance Practices for LED Street Lighting
Typical unit in third phase of LED Conversion
Maintenance Practices for LED Street Lights

- **Fourth Phase (April 2013 to Date)**
  - Replacement of 10,000 of what we call in Boston the Shoe box or Rectilinear Luminaire. Mercury Vapor and Sodium Vapor Street Lights are targeted.
  - First units to offer 10 year total replacement Warrantee.
    - Unit dates back to the 1960’s
    - Units on Residential Streets City-wide
    - To date 6,000 units have been completed
    - Of the 6,000, 30 units have been defective
    - This amounts thus far to a defect rate of 0.5% over the past year
  - All installation failure rates have been acceptable within industry standards.
Maintenance Practices for LED Street Lights
Out with the old
Maintenance Practices for LED Street Lights
In with the new
Maintenance Practices for LED Street Lights

- What have we learned thus far (Engineering)
  - Not all Luminaires are created equal.
    - Specifications are critical to ensure that the products used are of the highest quality available
    - Write specifications that are clear and concise
    - Even with the best Specifications issues arise during installation
      - Minor issues have occurred with the units but the Manufacturers are quick to analyze and revise the manufacturing process
Defects in LED units thus far

- Majority of failures have been in the driver assembly. These units were replaced by the Manufacturer.
- One manufacturer had exhibited leakage in the LED chamber causing the LED board to fail.
- One Manufacturer’s unit started to flash or strobe. This is currently under investigation between the City and the Manufacturer.
- There has been a rise in what we call Major system Failures, but these aren’t related to LED installs but due to the aging infrastructure in the City.
Maintenance Practices for LED Street Lights

- **Impact of LED Installations**
  - Decrease of the number of Complaints regarding outages.
    - Prior to Conversion, City responded to over 9000 complaints for light outages
    - FY14 we anticipate to see the number drop to 6500 based on current trends
    - As conversion goes forward, we anticipate the number to drop
    - Crews will switch to Deferred Maintenance such as replacement of old damaged cable, pole replacements and re-splicing of underground cables. Some splices in ground still have friction tape as the primary insulator
    - Complaints even today are still filed by Constituents who feel that they are getting less light then before. Once we explain how LED lights work, they are generally satisfied
Maintenance Practices of LED Street Lights

- **Impact on Inventory**
  - In process of reduction of Inventory prior to our relocation to a new facility along with the conversion to LED
  - Auctioning off obsolete equipment – HPSV, MV and MH Cobra Heads
  - Reducing overall inventory by 30% due to LED installation along with smaller interim facility
  - Updating inventory processes to streamline operation based on a Kanban system
  - Look into the bar coding of all future street lighting equipment to keep a more up to date inventory system
Maintenance Practices of LED Street Lights

• Inventory
  • Future Inventory
    • With the constant changes in LED technology, we are unsure as to how the future stock room will look
  • Assumptions:
    • There will be an inventory of complete luminaires for replacement of luminaires that reach the 70% threshold as well as replacements due to motor vehicle accidents
    • Inventory of drivers for each luminaire in our inventory. As LED chips reach there optimal output, we anticipate the number of drivers required for inventory should decrease
    • Increase of infrastructure inventory as we switch from luminaire maintenance to infrastructure maintenance. Such items would consist of cable, connectors, conduit, splicing kits
Maintenance Practices for LED Street Lights

**Future recommendations and practices**

- Prior to conversion to LED, existing infrastructure should be investigated and if necessary, replace old components as part of the conversion. It will reduce call backs.
- Consider using long life photocells. It may cost a few dollars more, but it will reduce the need for crews to revisit the location to replace the photocell. One repeat trip back will more than pay for the photocell.
- Ensure that Manufacturer can provide a house shield to minimize light trespass.
- Utilize the same color temperature on all luminaires regardless of roadway types. Uniformity is key to any successful lighting project.
Questions or Comments

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Seattle City Light

An LED conversion story

Steve Crume
Streetlight Engineering Manager

MSSLC Maintenance Webinar | April 14, 2014
SCL Lighting Types by Use
(Streetlights are City Light’s 5th largest customer)

- Residential: 41,000 – 48%
- Arterial: 31,300 – 37%
- Pedestrian: 12,700 – 15%

85,000 Total Fixtures
Streetlight system maintenance costs

- 4-year re-lamping cycle (HPS)
  - 21,000 re-lamps per year

- Annual cost for labor and materials
  - $1.4 million
Annual O&M cost of HPS system = $14.4 million

- Total annual cost of HPS system
  - Operation $13 million
  - Maintenance $1.4 million

- $14.4 million
Difficulty maintaining a fully operating system

- Slow repair response to streetlight failures
  - Up to 4 months to respond to one streetlight
- At one point, there were 5,000 trouble tickets in queue
  - Hence the scheduled re-lamping every 4 years
- Installed fixtures exceeded design life
  - Caused ballast inefficiency
  - Affected light output
Mayor’s Accountability Agreement

• Improve customer experience and rate predictability
• Continue conservation and environmental stewardship leadership
• Enhance organizational performance
In 2009, we began exploring LED technology

- Longer life
- Less maintenance
- Energy efficient
- Whiter light
Initial LED goals

- Reduce energy use by 40%
- Reduce carbon footprint
- Lower maintenance costs
- Improve customer service
- Increase system reliability
- Improve operation on bridges (vibration resistance)
41,000 Total Residential LED Streetlights Converted
Investment on LED Conversion

Total LED Capital Costs = $21,700,000

- 2010: $2.2M
- 2011: $5.6M
- 2012: $4.9M
- 2013: $4.5M
- 2014: $4.5M
Residential LED fixture costs decreased by half in 4 years

Cost per fixture

Fall 2009  Spring 2010  Fall 2011  Winter 2012  Spring 2013  Summer 2013

$-$  $200.00  $300.00  $400.00

2,500+ orders
To date:

**Annual Cost ($0.178/kWh)**

- **HPS**: $4,574,600
- **LED**: $1,931,300

**Annual Consumption**

- **HPS**: 25,700,000 kWh
- **LED**: 10,850,000 kWh

**Total Savings**

- **$2,643,300 savings**
- **14,850,000 kWh savings**
# LED Streetlight Program Savings

<table>
<thead>
<tr>
<th>Units Converted</th>
<th>Savings Per LED</th>
<th>Monthly Savings</th>
<th>Annual Savings at end of period</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Residential Streets Completed</td>
<td>41,000</td>
<td>$5.16</td>
<td>$211,560.00</td>
</tr>
</tbody>
</table>

Cleaning Costs (prorated based on 1 cleaning cycle every 7.5 years) ($246,000.00)
Residential conversions are completed with arterial conversions ramping up

2013
Arterial conversion has begun with 1800 units

2014 – 2018
Arterial LED conversion *

2019+
Decorative/pedestrian, and flood lighting LED conversion
Lessons learned from the field

- Customer Complaints
  - Color Quality
  - Light Trespass
  - Visibility
- Remedy
  - Installing shields
  - Lowering drive current
- Compatibility issues between fixture and PE cell
  - Remedied by additional training
1. Specify design requirements
2. Datasheet/test report evaluation
3. Sample request
4. Fixture/housing analysis | Mock-up
5. In-situ light level evaluation

- Lab study to confirm light-level claims
- Evaluate each fixture for handling issues

Fixture count: 10
1. Specify design requirements
2. Datasheet/test report evaluation
3. Sample request
4. Fixture/housing analysis | Mock-up
5. In-situ light level evaluation

Fixture count: 3
Other maintenance considerations

- 10 year warranty on new luminaires
- Use 20 year life photocells
- Reduces load on streetlight circuits
- Eliminates vibration caused failures on bridge structures
- LED conversion & group re-lamping have reduced outages from several thousand to less than 200
Resources

• Department of Energy
  Municipal Solid-State Street Lighting
  http://www1.eere.energy.gov/buildings/ssl/consortium.html

• Illuminating Engineering Society
  ies.org

• Seattle City Light
  seattle.gov/light/engstd
Thank you!

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City of Las Vegas Street Light Upgrade

Patrick Batte’ AIA LEED AP
City of Las Vegas
Architectural Project Manager
City of Las Vegas

- 600,000 Habitants
- 135.9 Sq. Miles
- Six Districts (Wards)
- Part of Las Vegas Valley with a population of 2,000,000
- 54,000 Streetlights Total
- 19,000 Residential Streets-Converted to LED May 2013
- 21,000 Commercial Streets-Converted to LED May 2013
- 4,000 Intersections- 2014
- 10,000 Decorative Commercial Lights-2015

All Public Lighting is Metered
City of Las Vegas

STREET LIGHTS ON LOCAL AND RESIDENTIAL STREETS
(excluding decorative lamp head types)

- 22 - 70 watt
- 19,560 - 100 watt
- 1728 - 150 watt
- 250 - 200 watt
- 1127 - 250 watt
- 136 - 400 watt

19,000 Residential Lights
City of Las Vegas

STREET LIGHTS ON MAJOR ARTERIALS AND COLLECTORS
(excluding decorative lamp head types)

21,000 Commercial Lights
10,000 Decorative
4,000 Intersection Lights
Streetlight Upgrade-Testing Phase

• 4 month process-5 Different Products
• City staff Measured Illumination Levels by RP-8.
• Testing of Brands Occurred at Same Location
• Additional Fixture - Staff Examination for Service and Maintenance
Streetlight Upgrade-Evaluation Phase

• Percentage Point System based on five categories /

1. Durability-10%
2. Serviceability-20%
3. Energy Savings-20%
4. Illumination Evaluation-25%
5. Cost-15%
Streetlight Upgrade-Evaluation Phase-Service/ Maintenance Category

• M1 – Luminarie have a slim, low profile design?
• M2 – Is Luminarie constructed of Extruded aluminum with cast aluminum components?
• M4 – Is Luminarie equipped with a shorting cap for future 3-prong twist lock socket?
• M5 – Is Luminaire able to be mounted on standard horizontal tenon?
• M6 – Is Luminaire adjustable for fixture leveling (+- 5 degrees)?
• M7 – Is the ballast/driver located within the housing and easily accessible.
• M8 – Is Luminaire clearly labeled with full catalog number?
• M10 – Is Luminaire equipped with integrated bubble level?
• M11 – Are all serviceable parts free from sharp edges or corners?
• M12 – Luminaire weight. Actual weight of the fixture.
• M13 – Is internal wiring rated for 105 degree Celsius and routed away from heat generating components?
• M14 – Are all covers provided for access to serviceable parts securely attached but easily removable?
Streetlight Upgrade - Evaluation Phase

**LOCAL ROADWAY: Total Points**

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5.8</td>
<td>4.6</td>
<td>5.4</td>
<td>8.0</td>
<td>6.8</td>
</tr>
</tbody>
</table>

- Durability - Section 1.0/10%
- Serviceability - Section 2.0/20%
- Energy Savings - Section 3.0/30%
- Lighting Evaluation - Section 4.0/25%
- Cost - Section 5.0/15%

**ARTERIAL ROADWAY: Total Points**

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>A</th>
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- Durability - Section 1.0/10%
- Serviceability - Section 2.0/20%
- Energy Savings - Section 3.0/30%
- Lighting Evaluation - Section 4.0/25%
- Cost - Section 5.0/15%
Street Light Upgrade
Contract and Installation Phase

- **6,600 LED Lights-1st Phase:**
  - Started May 2011 Completed September 2011

- **33,400 LED Lights-2nd Phase:**
  - Started February 2012 Completed May 2013
Streetlight Upgrade-Lessons Learned

• Existing Infrastructure- old conductors, large wire unable to fuse at new terminal blocks. Manufacturer built UL listed terminal block with intergretated fuse.
• Light trespass- Complaints regarding reduced light on private property. Masking used in lieu of shields. Public outreach a solution.
• Bubble Level- Not effective on bottom of fixture. On top of fixture or omit.
• Cul de sac – Directional light from LED coverage issues.
• Viability –Vegetation still a cause of lighting issues.
Streetlight Upgrade-Maintenance-Moving Forward

• Outages and Public Complaints-80% reduction in service call requests.
• Warranty replacement- Less than .05%
• Staff Reduction by Attrition- Staff reassigned to repairs and other deferred maintenance issues, such as photocell relocation and replacement, circuit repairs, infrastructure upgrades, installations, retrained to maintain and program traffic signals.
• Improving Customer Service-Staff being trained to provide better service with more time to dedicate on other assets.
• Improved Inventory Control- less bulbs, and miscellaneous parts in warehouse. GIS Database more accurate regarding field fixtures and quantities. 30% storage area reduction.
Streetlight Upgrade-Maintenance-Moving Forward

City of Las Vegas Maintenance Costs 2010  $3.74M Budget

- Line relocation, New Construction, Inspections: $1M
- Lamp Replacement: $.5M
- Vehicle Damage, Wire theft, Service Issues: $440K
- Area Lighting-Parks, Parking Lots: $1.8M

Yearly HPS Lamp installation Cycle 7,000 units

City of Las Vegas Maintenance Costs 2013  $3.3M Budget

- Line relocation, New Construction, Inspections: $1M
- Lamp Replacement: $.5M
- Vehicle Damage, Wire theft, Service Issues: $40K
- Area Lighting-Parks, Parking Lots: $1.76M
Streetlight Upgrade-Maintenance Budget

- Plan Ahead for LED Replacement- Require a future retrofit in specifications.

### HPS VS. LED Lamp Replacement Cost Over Time

Total Cost Saving Prior to Year 10 = $4M

- Year 13: HPS = $5.2M
- Year 13: LED = $4.8M

$400K @ 4% over 10 years = $4.8M

Total savings year 13

- HPS $5.2M
- LED $4.0 M
- $1.2 M
Future- 2014-2016

- Intersections 4,000 – (8) 120W replacing (4) 400W
- Bridges and Underpass Locations.
- Parking Garages
- 10,000 Decorative Lights to LED – RFP Process
- Replace 12,000 Lights on 200 City Properties with LED
- Inverse ratio photo cell 1.5fc turn on (ANSI standard) and a .9 fc turn off. Previous type a 1.5 fc on with a 1.5 fc X 1.5 = 2.25 fc off. Saves about .5 hr/fixture/day on the back end (dawn).
Thank you!

Questions?

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