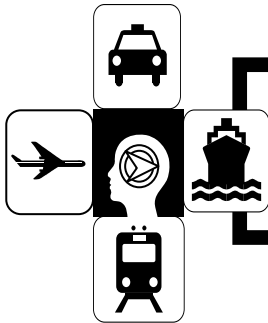


JERSEY DOT'S

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Tech Brief

Use of LED or Other New Technology to Replace Standard Overhead and Sign Lighting

(Mercury and/or Sodium)

FHWA-NJ-2005-029

June 2005

HERE IS THE PROBLEM

Roadway lighting can be an effective tool to provide efficient and safe traffic movement during evening or nighttime driving. There is a growing concern in the New Jersey Department of Transportation (NJDOT) to identify cutting-edge technology and quantify the key issues of energy efficiency and associated cost in roadway lighting.

To attain these goals, the research team analyzed the facts on roadway lighting to assist the NJDOT on future purchases, plans, and costs.



Retrofit of QL85 in a Cobrahead

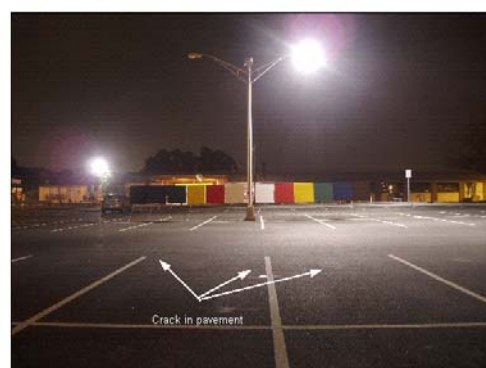
AND, HERE IS THE SOLUTION...

The initial research phase consisted of a literature search focusing on the basic factors of vision, and introducing issues in lighting. In addition, it covered the construction and important features of almost all lamps and technologies used in street lighting. The second phase investigated the small target visibility and color rendering on two light sources. The third phase, decision support, covered the Life Cycle Cost Analysis (LCCA) for the following lamps: Mercury Vapor, High Pressure Sodium (HPS), HPS retro-white, HPS Restrike, QL, Icetron, and LED with different wattages over a 20-year duration.

IMPLEMENTATION; HERE WE COME...

The results of this research are already being implemented:

- The NJDOT is installing nearly two thousand Restrikes on Route 78, one of the busiest corridors in the State. Restrike HPS will not save any energy costs, but will have a substantial labor savings to the department, potentially cutting the necessary relamping effort in half; all other costs for energy and materials will remain roughly the same.
 - Each Restrike lamp installed will save the State money. Even more importantly, due to a longer relamping cycle, it will not only ensure quality lighting but will enable the NJDOT maintenance staff to focus on higher priority tasks.
 - We have all seen the burnt out “red” or “green” light on a traffic signal, and think hmmm somebody should do something about that. Even with limited staff and resources, NJDOT will now be able to allocate more resources to replacing burnt out lights and making your traveling route safer.
 - Also, replacing overhead lights on the side of a busy highway, such as Route 78, is not an easy job and sometimes is fatal. A tragedy such as this is unacceptable and anything that can be done to protect our workers and avoid putting them into dangerous situations is a step in the right direction.
- The research team installed lamps at the NJDOT complex just outside Ewing in Trenton for observation and comparison purposes. It was observed by the research team that pavement details were more noticeable. The primary goal of overhead lighting is to provide adequate lighting levels to illuminate obstructions and other roadway objects which will assist drivers in making decisions. The lamps were left in place at NJDOT.



Quality of Yellow and White Light Sources effects on vision with respect to hazard identification and driver decision support.

- The NJDOT also installed QL lamps at the War Memorial in Trenton. Recent research advises that roadway visual tasks that are affected by vision and that have a higher quality white light, increases visibility and could result in the increase of safety.
 - In critical areas, such as near police stations, high accident areas, emergency management areas, evacuation routes, and others, these

lamps can provide better lighting and thus enhance the safety of such locations.

- One of the best features of this lamp is the manufactures rated mean life of about 100,000 hours. This is more than **quadruple** that of the traditional HPS lamps used today.
- In general these demonstrations and initial implementation help reduce operating costs while upholding the quality of the roadway environment in relationship to nighttime visibility.

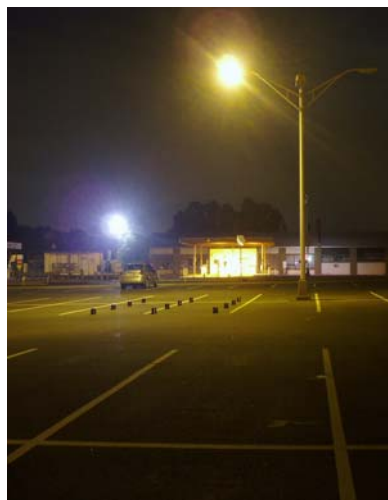
THESE ARE OBJECTIVES OF THE STUDY...

- Reduce operating costs while upholding the quality of the roadway environment in relationship to nighttime visibility.
- Provide NJDOT with information such that they can substitute out-of-date technology with newer, more efficient lighting equipment.
- Supply NJDOT with a lighting plan that is able to offer equal or better illumination with significantly lower energy consumption and cost.
- Establish recommendations that are sensitive to lamp replacement, cleaning, and equipment maintenance that ensure quality lighting, while enabling the NJDOT maintenance staff to focus on higher priority tasks.

HERE IS WHAT WE DID...

The initial research phase consisted of a literature search focusing on the basic factors of vision and introducing issues in lighting. In addition, it covered the construction and important features of almost all lamps and technologies used in street lighting, from past to present. However, based on the needs of NJDOT this research focused on two lamps: High Pressure Sodium and induction. HPS lamps are widely used in street lighting and induction lamps are one of the most promising new technologies.

The second phase investigated the small target visibility and color rendering on two light sources: sodium (yellow) light source and white light source.



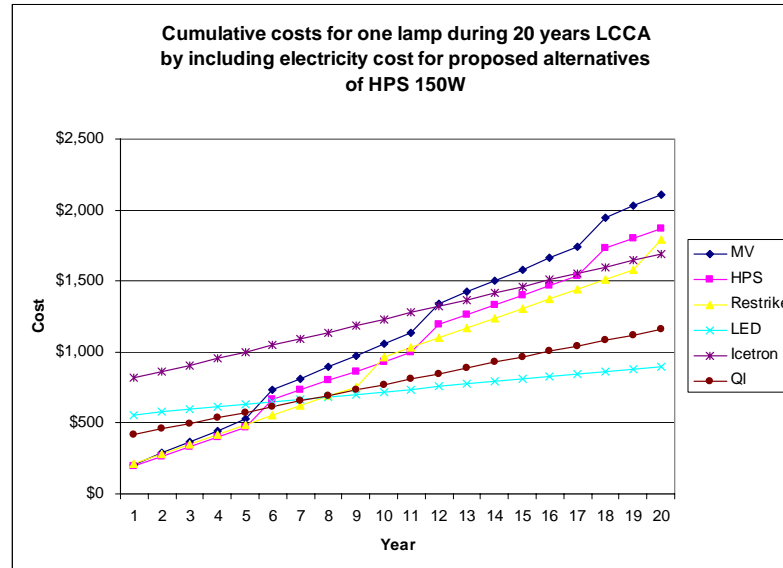
Yellow Light Source

vs



White Light Source

The third phase, decision support, covered the Life Cycle Cost Analysis (LCCA) for the several different lamps with different wattages over a 20-year duration. After introducing applied cost for each lamp during the 20 year LCCA, cumulative costs were applied for current lamps and proposed lamps. Subsequently, the LCCA was implemented for New Jersey roadway lighting for current and alternative NJDOT specific scenarios.



Cumulative Cost for HPS 150W Alternatives

Based on obtained data from NJDOT, there are an estimated 45,000 lamps on the New Jersey State roadways, 15,750 of them (35%) are HPS 250W, 22,500 of them (50%) are HPS 150W, and 6750 of them (15%) are HPS 400W. The above LCCA figure for the 150W HPS (the predominant lamps on the State roads) alternatives shows that there are various levels of savings in considering new technologies. As it can be observed from the figure, Induction, HPS restrike, and LED have the better performance than HPS. Of these three technologies, Induction and LED's do not meet the NJDOT lighting requirements in terms of lumens per watt; even though experimental results imply similar performance. Also, the research team believes LED technology is still in its preliminary stage and can be considered as an option in the near future.

WHAT IS THE NEXT STEP?

The research team reviewed the available literature and experimental data. The authors believe the study should be revisited after several years of applied research (field trials) results. At present, NJDOT claims that a large percentage of roadway lighting is not working properly and that the small relamping personnel are struggling to keep up with proper maintenance. The same personnel are responsible for traffic signals and other high priority lighting, thus straining to maintain the over 45,000 overhead lamps on the highways. In addition, the operation of the 45,000 lamps has significant energy consumption costs. These, and many other factors, clearly demonstrate the extent of the problem; it is not merely a dollar issue or a labor/maintenance issue or a safety and public assistance issue, but a complicated combination of these issues. A high initial cost solution could solve many of the NJDOT's long-term labor and safety issues, however, the solution must meet accepted specifications.

CONCLUSION...

Lamps can no longer be compared by lumens per watt, and new specifications must be developed to accommodate new types of technologies. LEDs are recommended once the manufacturers improve the light distribution and the revised specifications are released. The HPS Restrike meets the current specifications and it produces an equivalent quality light. The lamps have an increased life and use the same energy as the traditional HPS.



Cobrahead luminaries style

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A final report is available online at

<http://www.state.nj.us/transportation/research/research.html>

If you would like a copy of the full report, please FAX the NJDOT, Division of Research and Technology, Technology Transfer Group at (609) 530-3722 or send an e-mail to Research.Bureau@dot.state.nj.us and ask for: **Use of LED or Other New Technology to Replace Standard Overhead and Sign Lighting (Mercury and/or Sodium)**

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