

Saving Energy in Outdoor Lighting



GARDCO
LIGHTING

IMPORTANCE OF ENERGY SAVINGS IN OUTDOOR LIGHTING

Little has been written about the opportunities for energy savings in outdoor lighting. The primary reason is that energy consumed for outdoor lighting is typically off-peak and is therefore not of critical concern to the energy providers. Since generating off-peak power rarely requires new capital outlays by energy producers, they lack incentives for encouraging off-peak energy conservation. For energy users however, the electrical power required for outdoor lighting has become an important component of the energy budget.

There are three important reasons for users to pay attention to this critical area of energy consumption.

1 Initial Cost



Many business decisions weigh the trade-off between initial investment vs. life cycle energy savings. In the case of designing outdoor lighting systems however, these two issues are often in harmony. If a high performing luminaire optical system can reduce the number of required poles at a site, invariably there will be substantial savings in both the initial system cost and the life cycle energy consumption.

The chart to the right illustrates the potential per pole savings resulting from good design and high performance equipment. Depending on site geometry and design criteria, it may be possible to eliminate 10% or more of the total pole locations on the site by using high performance lighting equipment.

Typical initial cost savings resulting from elimination of each pole location

| | |
|---------------------|----------------|
| Trenching | \$500 |
| Base | \$400 |
| Labor and Equipment | \$500 |
| Luminaires/Pole* | \$1000 |
| Other Material | \$100 |
| Total | \$2,500 |

* Twin 400W metal halide luminaires with lamps on 25' steel pole

Cover photo courtesy of Site Photometrics. For information about turnkey outdoor lighting retrofit solutions, contact Site Photometrics at (888)244-SITE.

2 Life Cycle Cost

While off-peak energy costs are certainly lower than peak energy costs, they can still add up. If during the lighting design, wattage can be reduced or fixtures eliminated, cost savings will continue throughout the life of the project.



| SAVINGS EXAMPLES | | | |
|---|---------------------|----------------|----------------------|
| Small Area with Complex Site Geometry (page 14-15) | | | |
| Annual energy cost | 5¢ kWh | 10¢ kWh | |
| With inefficient fixtures/lamps | \$2003 | \$4006 | |
| With high performance fixtures/lamps | \$1577 | \$3154 | |
| Potential savings | \$426 | \$852 | |
| Open Parking Area Scenario (pages 10-11) 10¢ kWh | | | |
| Annual energy cost | 10 Acre Site | | 100 Acre Site |
| With inefficient fixtures/lamps | \$20,806 | | \$208,055 |
| With high performance fixtures/lamps | \$5,224 | | \$52,241 |
| Potential savings | \$15,582 | | \$155,814 |

In this manual, several strategies will be presented for reducing energy in outdoor lighting. For illustration purposes, performance comparisons are shown which demonstrate different power usage resulting from the application of different lighting equipment. In all cases, the lighting equipment shown is currently available from major US manufacturers. For copies of actual test data and calculation methodology consult Gardco Lighting.

The chart at the left, illustrates actual potential dollar savings that can be achieved by using high performance lighting equipment and employing some simple principles of design. The site parameters, design criteria and lighting equipment utilized are shown on the referenced pages.

3 Environmental Protection



Most electricity generated in America today is produced from the burning of fossil fuels – natural gas, coal, and oil. These plants all produce harmful pollutants and CO₂'s. Most scientists today believe that these CO₂'s contribute significantly to global warming.

Although nuclear power plants are considerably cleaner than fossil fuel plants and produce no CO₂'s, they do create the problem of nuclear waste disposal. Unfortunately these inevitable byproducts of energy plants are just as harmful during off-peak and peak consumption periods. Energy conservation is unquestionably the best solution for the environment – day or night.

ENERGY SAVING TRADE-OFFS IN OUTDOOR LIGHTING

Often times significant energy savings can be realized with a minimal investment of capital and common sense. Replacing mercury vapor or incandescent sources with metal halide or high pressure sodium will generally result in reduced energy costs and increased visibility. Installing and maintaining photocontrols, time clocks, and energy management systems can also achieve extraordinary savings.

However in some cases it may be necessary to consider modifications of the lighting design in order to achieve the desired energy savings. In other situations, new design criteria or local ordinances may simply render energy saving objectives unachievable. Nevertheless, even in those situations, intelligent design can minimize the energy impacts.

Gardco Lighting believes that it is important to candidly address these potential trade-offs and let the owner determine the relative importance of energy savings to such issues as visibility and quality of illumination.

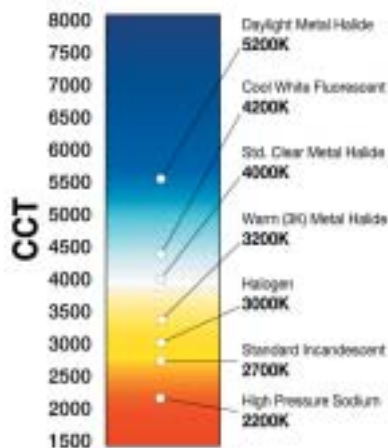
Illumination Levels

Frequently older sites are substantially under lit by today's standards of safety and security. In most of these cases, it is simply not possible to retrofit these sites and achieve contemporary lighting standards without incurring some additional energy consumption. The important point is that because of technological advances in lamps, ballasts, and luminaire optical systems, increasing light levels by 300-400% doesn't require comparable increases in energy consumption.



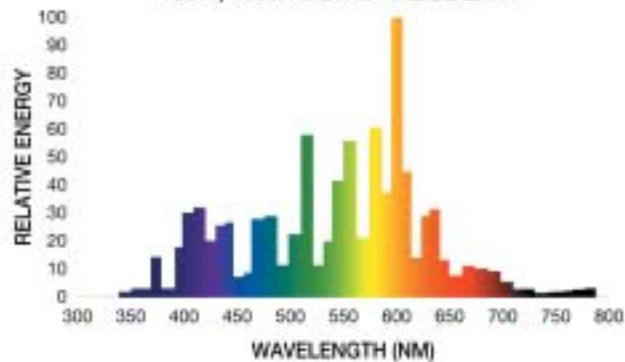
Older sites often have light levels which are substantially below contemporary standards.

Lamp Color



Courtesy of Venture Lighting

TYPICAL SPECTRAL ENERGY DISTRIBUTION 400W, 4000K METAL HALIDE LAMP



Courtesy of Venture Lighting

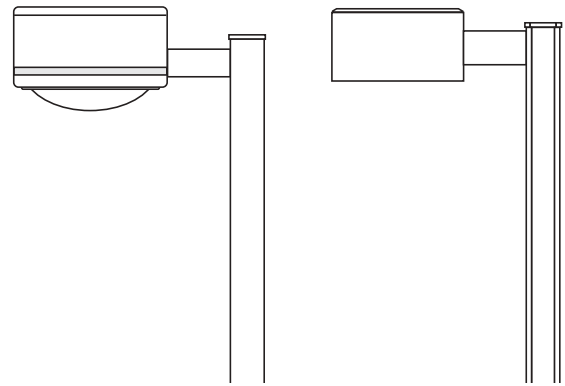
Whereas low pressure sodium lighting offers the most energy efficient lighting source commercially available in North America, the poor color rendering properties make it unsuitable for most commercial applications. Similarly, although the color rendering characteristics of high pressure sodium lighting are often found to be adequate for roadway lighting, increasingly metal halide is the preferred source for area illumination. The crisp white light of metal halide appears to enhance nighttime visibility. Furthermore, with recent advances in metal halide technology, this source now approaches the efficacy of high pressure sodium.

High Angle Glare, Light Trespass

There are many proponents of non-cutoff site luminaires who claim to achieve superior pole spacings and uniformity ratios with their equipment. The trade-off of these systems however is often high angle glare and light trespass.

Glare actually reduces nighttime visibility and may therefore offset any perceived energy efficiencies. Light trespass into adjacent properties creates ill will (and occasionally litigation) towards property tenants.

This guide will therefore only be evaluating lighting equipment which meets the IES cutoff classification. In most cases, recommended luminaires meet full cutoff – meaning they produce **absolutely no light above 90°**.



Non-Cutoff Luminaire

Cutoff Luminaire

Sky Pollution

Many of these non-cutoff fixtures which may achieve wider pole spacings also create sky pollution. Dr. David L. Crawford of the International Dark Sky Association writes:

A priceless part of our human heritage is fading into the night sky. Most Americans are growing up unable to see the stars their grandparents knew so well. They see the night sky only in pictures or at planetariums. This is true not only in cities, but also in many suburbs where street lamps and other sources of "light pollution" have obscured our view of constellations, meteor showers, and planets.¹

To address this problem, the IDSA specifically identifies site luminaires which are:

GOOD - Flat-lens shoebox fixtures come in many forms; square, rectangular, circular, etc. All control the light with internal reflectors. Glare and light trespass are minimized; no uplight is produced.¹



1) www.darksky.org

BAD (sometimes) The telltale sag lens gives this luminaire away as a possible problem.¹



Luminaire Mounting Height



Low mounting heights often result in visual clutter as well as increased energy use.



Permitting the application of taller poles will allow for wider spacings resulting in significantly reduced energy consumption.

Systems designed with taller poles often allow for wider spacings and reduced energy consumption. Also, some advocates of these systems point out that the reduced number of poles can create a less cluttered and attractive site. Nonetheless, some communities have determined that excessive pole heights are out of scale to their environmental design and they are willing to sacrifice some energy savings to maintain that design integrity. Their local ordinances often reflect this position.

ENERGY WASTERS IN OUTDOOR LIGHTING

Poor Lighting Design

Frequently a "cookie cutter" approach is taken to site lighting. Luminaires, lamps, mounting heights and pole spacings are all determined from what was used on a previous job. Unfortunately this approach often fails to recognize the unique characteristics of and the opportunities presented by the individual site geometry. Taking advantage of all of the distributions offered by the luminaire manufacturer and orienting them appropriately can often reduce the required number of pole locations and substantially lower energy costs over the life of the project.



Inefficient Luminaires

To reduce costs, many luminaire manufacturers use hydroformed or spun aluminum reflectors. These products inherently lack the reflectivity and lighting control offered by highly specular faceted optical systems. Low cost polycarbonate lenses often yellow prematurely and significantly impair the output of the luminaire. Non-yellowing acrylic or tempered glass will normally maintain their optical clarity. Higher quality luminaires which offer these features will provide higher light levels without any additional energy consumption.



Poor quality hydroformed reflectors lack the control of specular faceted reflector systems.



Precision optical systems comprised of highly specular facets set in arch image duplicating patterns provide optimal control of light distributions often resulting in substantial energy savings.

Poor or Non-Existent Controls

Burning all outdoor luminaires from dusk to dawn (and often from dawn to dusk as well) is obviously a horrendous energy waster. A well conceived control system can offer remarkable energy savings. A simple system utilizing astronomical time clocks and photo controls may cut power consumption by over 70%. Sophisticated energy management systems with multi-level switching can save even more.

An important design consideration with all controls system however is maintenance. Systems have to be occasionally reprogrammed to reflect changing usage patterns and photo controls have to be cleaned periodically.



Obsolete Lamps and Ballasts

Although most incandescent, fluorescent, and mercury vapor outdoor lighting systems have been replaced, many of these systems still exist. Because of the substantial energy savings achieved by converting these to metal halide or high pressure sodium, the payback times for these projects are typically very short.

In addition, recent innovations in pulse start metal halide technology in combination with high performing luminaires can even make retrofitting older metal halide projects viable.

Obsolete lamps such as mercury vapor not only have poor initial lumens per watt, but their efficacy declines significantly over their life.



Contemporary pulse start metal halide technology not only provides greater lumens per watt consumed, but better lumen maintenance throughout the life of the lamp.



Courtesy of Venture Lighting

Poor Maintenance

Lamp lumen depreciation can exceed 35% on many high intensity discharge lamps. Without a group relamping program, sites can eventually become excessively dark while still consuming energy at the initial levels. Also, lenses can become dirty over time which will further impair luminaire efficiencies. Before specifying a maintained light level criteria at the design phase of the project, it is important to have an understanding of the likely maintenance procedures throughout the life of the project.

Polycarbonate lenses used with metal halide lamps will often yellow over time substantially reducing light output. These should be replaced with glass or acrylic wherever possible.



Group relamping programs will maintain light levels on the job site without increasing energy use. Designing for group relamping may allow for initial cost savings in luminaires and poles.



DESIGNING NEW APPLICATIONS FOR ENERGY SAVINGS

1 Establish Criteria

• Illumination Levels

Current IESNA recommendations for outdoor area lighting are generally acknowledged to be well below current standards for safety and security. The IESNA RP-20 illumination guidelines for outdoor parking areas are shown in the chart here. In addition, light levels which are more commonly seen in site lighting applications today are also presented.

| IESNA RP-20 Guidelines for Parking Lots | | | Common Site Lighting Illumination Levels | |
|---|--------|----------|--|---------------------|
| | Basic | Enhanced | | Minimum Illuminance |
| Minimum Illuminance | 0.2 fc | 0.5 fc | Security Lighting | 0.2 fc |
| Uniformity Ratio (maximum to minimum) | 20:1 | 15:1 | Office, Rural, Schools | 0.5 fc |
| | | | Standard Retail | 1.0 fc |
| | | | High Profile Retail | 1.5-3.0 fc |
| | | | 24 Hour Grocery Store | 3-5 fc |

• Uniformity

Gardco also recommends that the uniformity ratio doesn't exceed 15-1 maximum to minimum footcandle values. Based on over 30 years of site lighting application engineering, it has been determined that where uniformity ratios greater than 15-1 exist, areas between poles and at the site perimeters begin to appear dark.

2 Identify Critical Issues

• Mounting Height Restrictions

If local customs or ordinances limit the maximum pole height, this can significantly impact the lighting design and selection of luminaires.

• Light Trespass Sensitivity

Being a good neighbor is good business. Understanding proximity to residential areas and apartment high-rises may affect the placement and orientation of luminaires. Also, the presence of an observatory in the community may impact luminaire selection, source color, and hours of operation.

• Site Geometry

Creating a lighting design for large open parking areas with consistent driving lanes may be a fairly straightforward process. When buildings and adjacent properties dictate unique dimensions and driving lanes, the design may become much more complex.

• Architectural Design Considerations

Increasingly today, building owners want more than just a sea of shoeboxes at the top of poles on their site. Architectural preferences today are for soft graceful forms which subtly compliment the facility without making a strong design statement. Fortunately, these preferences don't preclude the use of high performance optical systems which provide energy savings.

3 Determine Control Options

Specifying the lighting control strategy early in the project can often dictate the luminaire selection. For example, if it is feasible to reduce the light levels to 50% for security only after a certain hour, this may be accomplished by simply having an astronomical time clock be set to shut off half of the fixtures. In this scenario, designing the job using twin symmetrical Type V luminaires instead of asymmetrical Type III luminaires might be an appropriate strategy.



Security lighting mode

4 Establish Wattage Strategy

Invariably most larger scale site lighting is accomplished with either 400W class (320W, 350W, 400W or 450W) products or 1000W luminaires. Usually the design criteria, the critical issues cited, and budget considerations will dictate this strategy.



Typical 400W and 1000W metal halide lamps

5 Select Luminaire

At this point the luminaire type can be selected based on desired performance characteristics, lamp and optical system offering, daytime appearance, and budget considerations.

Representative Cutoff Luminaires from Gardco Lighting:



Circa



Gullwing



Square Form 10

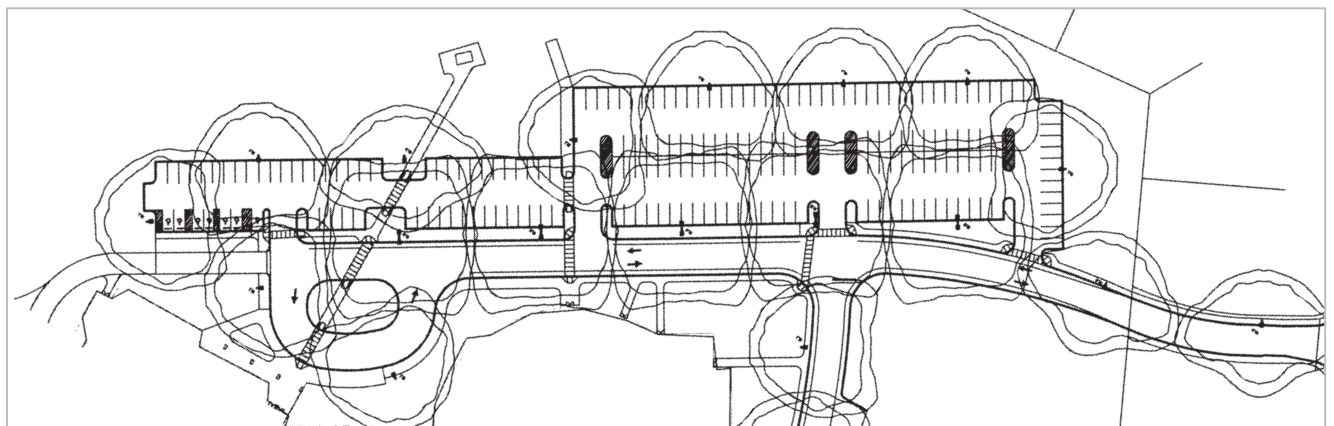


Round Form 10



Glowtop

6 Specify pole locations and lamp/optical system(s) configurations

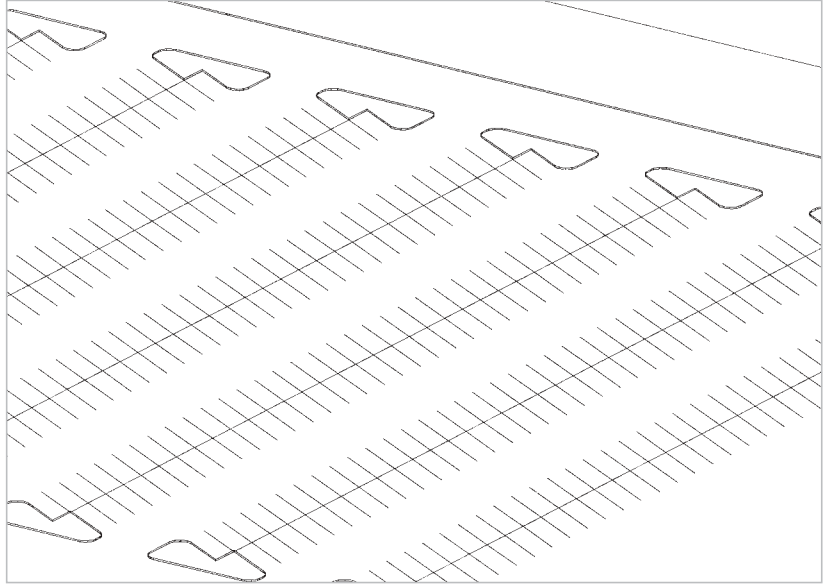


NEW INSTALLATION – LARGE OPEN PARKING AREA

20' – Mounting Height

Design Criteria

- 1.5 fc minimum
- 15-1 maximum to minimum uniformity
- Full cutoff luminaires (no light above 90°) required
- 25' mounting height maximum allowed



Lighting Scenario #1

Luminaires:

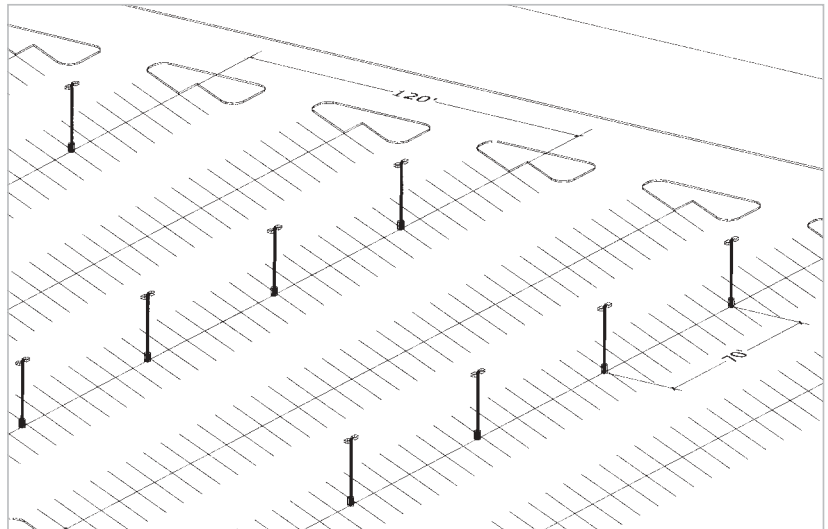
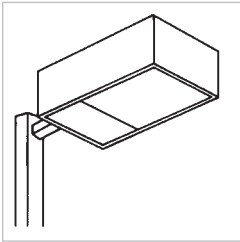
Generic "Shoebboxes" – Type III

Lamps:

400W Standard Metal Halide
(Horizontal Burn)

32,000 Initial Lumens -

.72 Light Loss Factor Applied



Mounting Height 21.5'

Spacing Required to Meet Criteria

120' X 70'

Illumination

| | |
|---------|----------|
| Maximum | 10.56 fc |
| Minimum | 1.47 fc |
| Average | 4.58 fc |
| Max/Min | 7.18 : 1 |
| Avg/Min | 3.12 : 1 |

Life Cycle Costs

| | |
|---|----------|
| Estimated installation costs per pole* | \$2,400 |
| Installation costs per acre illuminated | \$12,446 |
| Input watts per pole | 916 |
| Watts consumed per acre illuminated | 4,750 |

Annual energy costs per acre 5¢ per kWh 10¢ per kWh

| | | |
|----------------------------|---------|---------|
| Burning 4 hours per night | \$347 | \$694 |
| Burning 12 hours per night | \$1,040 | \$2,081 |

* Includes trenching, pole base, all labor, cranes, bucket trucks, 20' pole, luminaires, lamps, wire, conduit, fittings, etc.

Because these luminaires use poor performing hydroformed reflectors, extremely narrow pole spacings are required to achieve the design criteria. Both the extremely high initial installation cost and ongoing energy costs make this a poor lighting solution.

Lighting Scenario #2

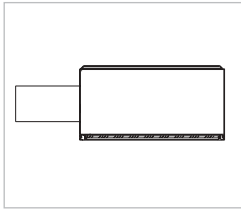
Luminaires:

Twin Gardco Square or Round Form 10X - Type IV

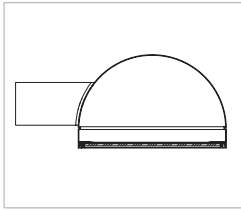
Lamps:

400W Pulse Start Metal Halide (Horizontal Burn)

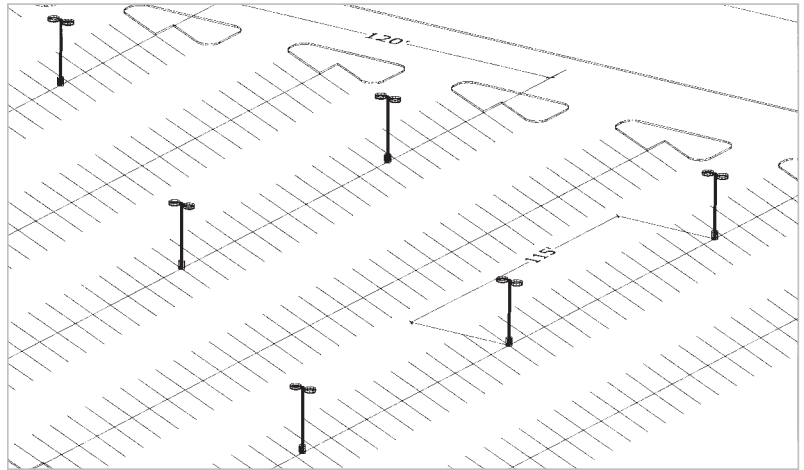
40,000 Lumens - .80 Light Loss Factor Applied



Gardco H/EH19



Gardco CA/MA22



Mounting Height 21.5'

Spacing Required to Meet Criteria

120' X 115'

Illumination

| | |
|---------|-----------|
| Maximum | 17.37 fc |
| Minimum | 1.56 fc |
| Average | 4.25 fc |
| Max/Min | 11.13 : 1 |
| Avg/Min | 2.72 : 1 |

Life Cycle Costs

| | |
|---|---------|
| Estimated installation costs per pole* | \$2,600 |
| Installation costs per acre illuminated | \$8,207 |
| Input watts per pole | 904 |
| Watts consumed per acre illuminated | 2,853 |

Annual energy costs per acre

| | 5¢ per kWh | 10¢ per kWh |
|----------------------------|------------|-------------|
| Burning 4 hours per night | \$208 | \$417 |
| Burning 12 hours per night | \$625 | \$1,250 |

* Includes trenching, pole base, all labor, cranes, bucket trucks, 20' pole, luminaires, lamps, wire, conduit, fittings, etc.

The high performing luminaire optical systems and pulse start metal halide lamps specified in this design allow for substantially wider pole spacings. The obvious benefit is the savings of over 33% in installation costs and 40% in energy costs as compared with the first design.

Lighting Scenario #3

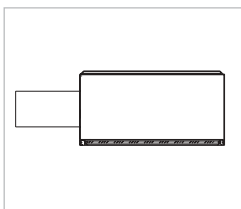
Luminaires:

Twin Gardco Square or Round Form 10X
Full Cutoff Vertical Luminaires

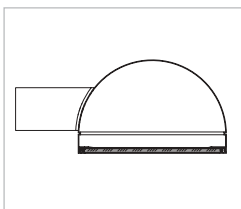
Lamps:

320W Pulse Start Metal Halide (Vertical Burn)

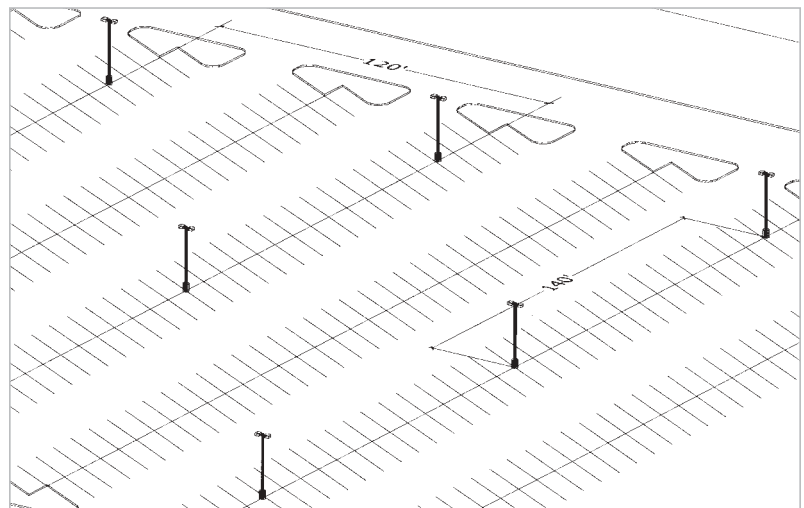
34,000 Lumens - .80 Light Loss Factor Applied



Gardco H/EH19



Gardco CA/MA22



Mounting Height 21.5'

Spacing Required to Meet Criteria

120' X 140'

Illumination

| | |
|---------|----------|
| Maximum | 4.48 fc |
| Minimum | 1.48 fc |
| Average | 2.49 fc |
| Max/Min | 3.03 : 1 |
| Avg/Min | 1.68 : 1 |

Life Cycle Costs

| | |
|---|---------|
| Estimated installation costs per pole* | \$2,600 |
| Installation costs per acre illuminated | \$6,741 |
| Input watts per pole | 736 |
| Watts consumed per acre illuminated | 1,908 |

Annual energy costs per acre

| | 5¢ per kWh | 10¢ per kWh |
|---------------------------------|------------|-------------|
| Burning 4 hours per night | \$139 | \$279 |
| Burning 12 hours per night | \$418 | \$836 |
| 3 hours full/9 hours half level | \$261 | \$522 |

* Includes trenching, pole base, all labor, cranes, bucket trucks, 20' pole, luminaires, lamps, wire, conduit, fittings, etc.

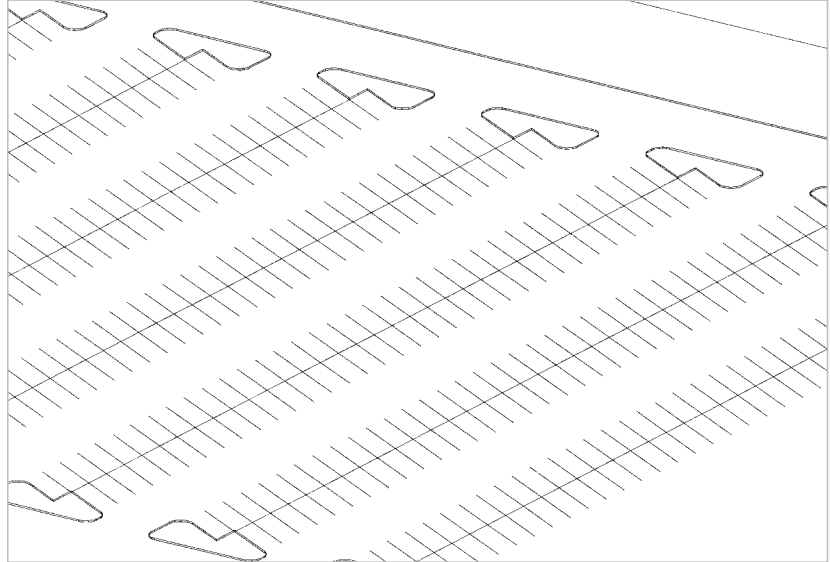
This design uses a special base-up, 320W, metal halide pulse start lamp with a lowered arc tube. This unique configuration allows for a flat glass/full cutoff vertical lamp optical system. The performance of this design is quite remarkable. In addition, because of the symmetrical lighting distribution, a high/low control system may be employed. This is especially useful for retail applications which only require security lighting levels after the store closes. When this lighting system is combined with a high/low control system, energy savings of almost 75% can be achieved!

NEW INSTALLATION – LARGE OPEN PARKING AREA

35' – Mounting Height

Design Criteria

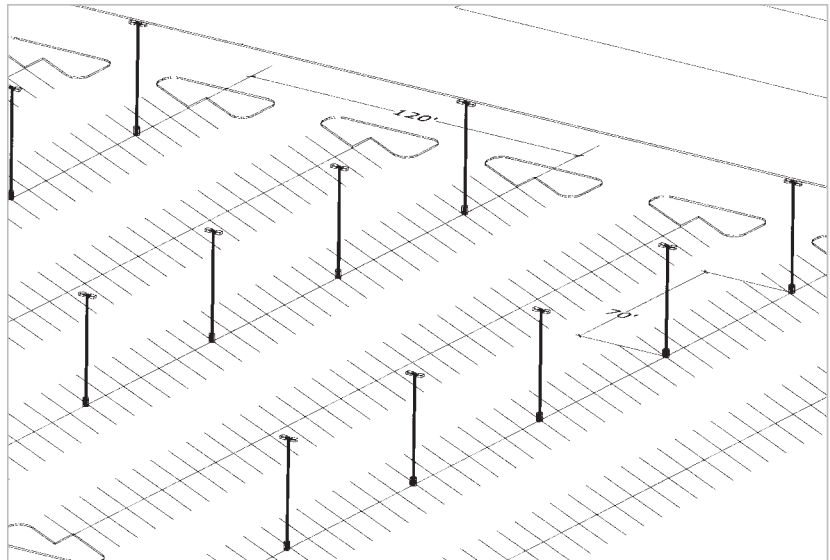
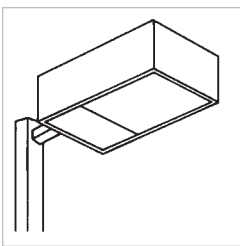
- 1.5 fc minimum
- 15-1 maximum to minimum uniformity
- Full cutoff luminaires (no light above 90°) required
- 37' mounting height maximum allowed



Lighting Scenario #1

Luminaires:
Generic "Shoebboxes" – Type III

Lamps:
400W Standard Metal Halide
(Horizontal Burn)
32,000 Initial Lumens -
.72 Light Loss Factor Applied



Mounting Height 36.5'

Spacing Required to Meet Criteria 120' X 70'

Illumination

| | |
|---------|----------|
| Maximum | 11.17 fc |
| Minimum | 1.54 fc |
| Average | 4.18 fc |
| Max/Min | 7.25 : 1 |
| Avg/Min | 2.71 : 1 |

Life Cycle Costs

| | |
|---|----------|
| Estimated installation costs per pole* | \$2,700 |
| Installation costs per acre illuminated | \$14,001 |
| Input watts per pole | 916 |
| Watts consumed per acre illuminated | 4,750 |

Annual energy costs per acre

| | 5¢ per kWh | 10¢ per kWh |
|----------------------------|------------|-------------|
| Burning 4 hours per night | \$347 | \$694 |
| Burning 12 hours per night | \$1,040 | \$2,081 |

* Includes trenching, pole base, all labor, cranes, bucket trucks, 35' pole, luminaires, lamps, wire, conduit, fittings, etc.

Typically taller pole heights can provide significantly wider pole spacings and corresponding energy savings. Unfortunately, with the poor quality optical system in this luminaire, it is not possible to achieve adequate pole spacings and meet the lighting design criteria.

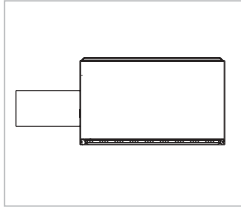
Lighting Scenario #2

Luminaires:

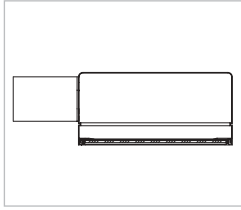
Twin Gardco Square or Round Form10X - Type IV

Lamps:

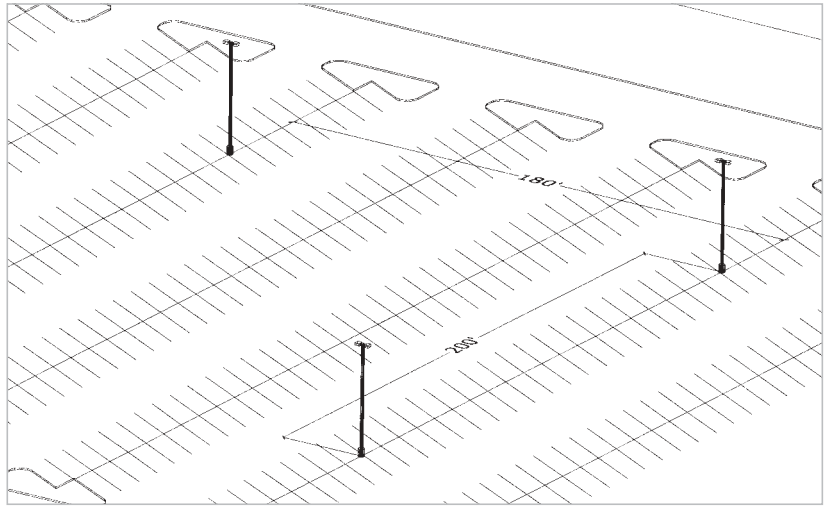
1000W Metal Halide (Horizontal Burn)
107,800 Lumens - .72 Light Loss Factor Applied



Gardco HT19



Gardco CA22



Mounting Height 36.5'

Spacing Required to Meet Criteria

180' X 200'

Illumination

| | |
|---------|----------|
| Maximum | 14.39 fc |
| Minimum | 1.48 fc |
| Average | 3.53 fc |
| Max/Min | 9.72 : 1 |
| Avg/Min | 2.39 : 1 |

Life Cycle Costs

| | |
|---|---------|
| Estimated installation costs per pole* | \$3,000 |
| Installation costs per acre illuminated | \$3,630 |
| Input watts per pole | 2,160 |
| Watts consumed per acre illuminated | 2,614 |

Annual energy costs per acre

| | 5¢ per kWh | 10¢ per kWh |
|----------------------------|------------|-------------|
| Burning 4 hours per night | \$191 | \$382 |
| Burning 12 hours per night | \$572 | \$1,145 |

* Includes trenching, pole base, all labor, cranes, bucket trucks, 35' pole, luminaires, lamps, wire, conduit, fittings, etc.

Another advantage of taller pole heights, is the ability to efficiently use higher lumen lamps. In this scenario, twin 1000W metal halide luminaires are effectively used to meet the established design criteria with extremely wide pole spacings. This results in a savings in installation costs of over 74% and in energy costs of almost 45%.

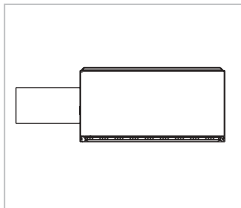
Lighting Scenario #3

Luminaires:

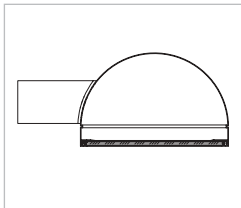
Quad Gardco Square or Round Form10X - Type IV

Lamps:

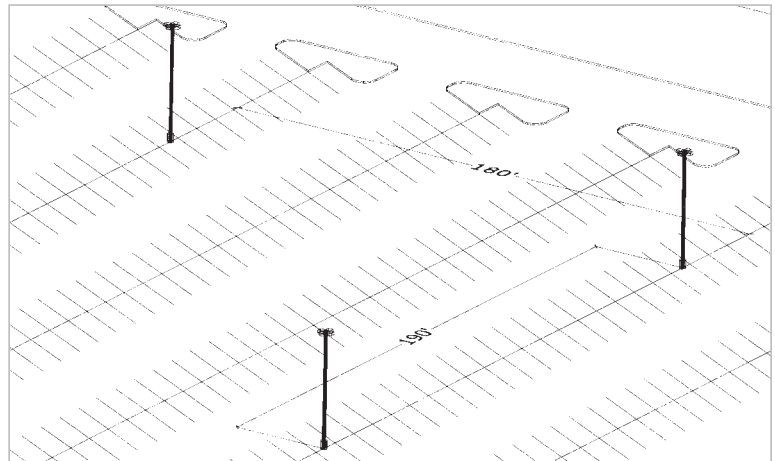
400W Pulse Start Metal Halide
(Horizontal Burn)
40,000 Lumens - .80 Light Loss Factor Applied



Gardco H/EH19



Gardco CA/MA22



Mounting Height 36.5'

Spacing Required to Meet Criteria

180' X 190'

Illumination

| | |
|---------|----------|
| Maximum | 11.53 fc |
| Minimum | 1.48 fc |
| Average | 3.17 fc |
| Max/Min | 7.79 : 1 |
| Avg/Min | 2.14 : 1 |

Life Cycle Costs

| | |
|---|---------|
| Estimated installation costs per pole* | \$3,700 |
| Installation costs per acre illuminated | \$4,713 |
| Input watts per pole | 1,808 |
| Watts consumed per acre illuminated | 2,303 |

Annual energy costs per acre

| | 5¢ per kWh | 10¢ per kWh |
|----------------------------|------------|-------------|
| Burning 4 hours per night | \$168 | \$336 |
| Burning 12 hours per night | \$504 | \$1,009 |

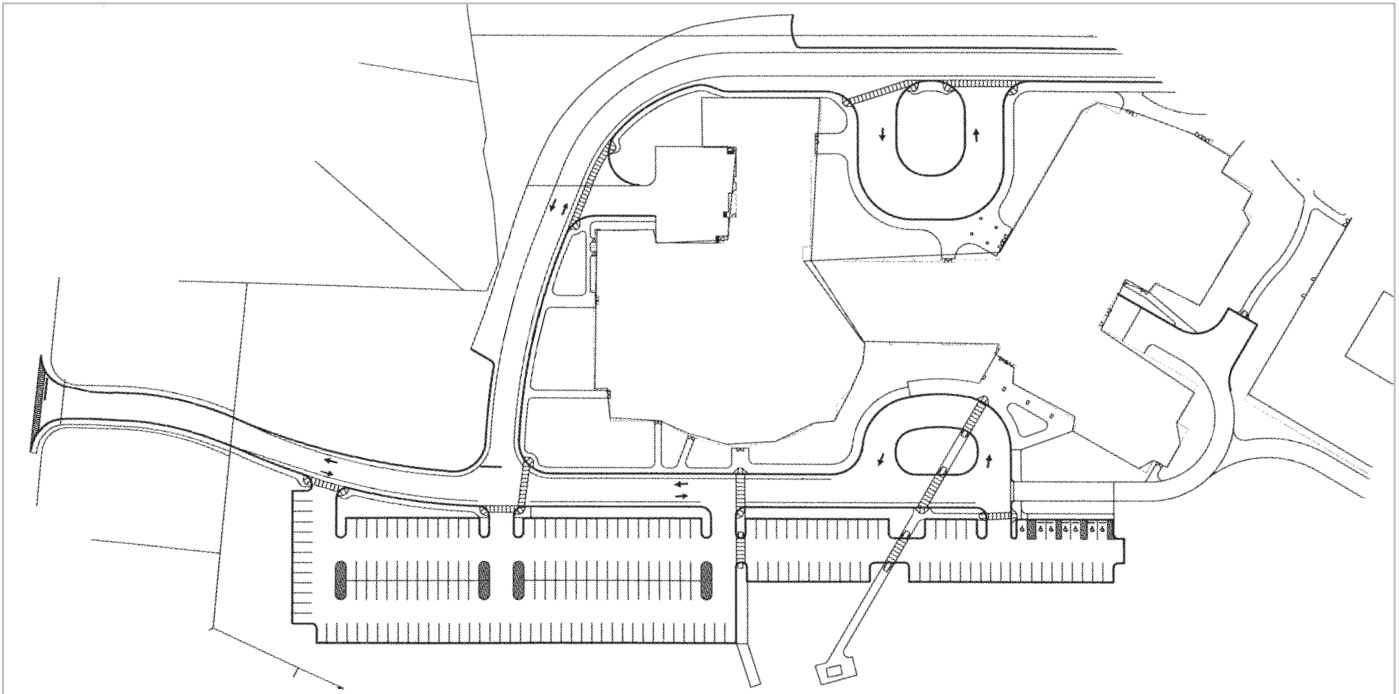
* Includes trenching, pole base, all labor, cranes, bucket trucks, 35' pole, luminaires, lamps, wire, conduit, fittings, etc.

In this scenario, 4-way luminaires with 400W pulse start metal halide lamps are used. Here again, the high performance optical system provides wider pole spacings and a savings in installation costs of over 66% and in energy costs of over 50%.

NEW INSTALLATION – COMPLEX SITE GEOMETRY

In the "real world", pole locations, mounting heights, lamp wattages and luminaire distribution patterns are often dictated by the site geometry. Although useful for comparison purposes, totally open sites with completely uniform driving lanes and without obstructions are fairly unusual.

Site Description



This site is an actual application for lighting parking areas and roadways on a school campus. Because of the complex site geometry, multiple distribution types were used. For the traditional roadway areas, Type II optical systems were used. For the wider roadway areas and the parking perimeters, Type III or IV (depending on manufacturer) luminaires were used. For the open parking areas, twin back-to-back Type III or Type IV were specified. Insofar as there were no adjacent commercial facilities and the normal evening traffic level was low, a minimum .5 footcandle illuminance level was specified.

The opportunities for energy savings in small sites like this with relatively low light levels are typically less dramatic than in large commercial sites. Nonetheless as shown in these examples, applying high performance equipment and thoughtful design can reduce both initial installation costs as well as energy usage.

Design Criteria

- .5 fc minimum
- 15-1 maximum to minimum uniformity
- Full cutoff luminaires
(no light above 90°) required
- 25' mounting height maximum allowed

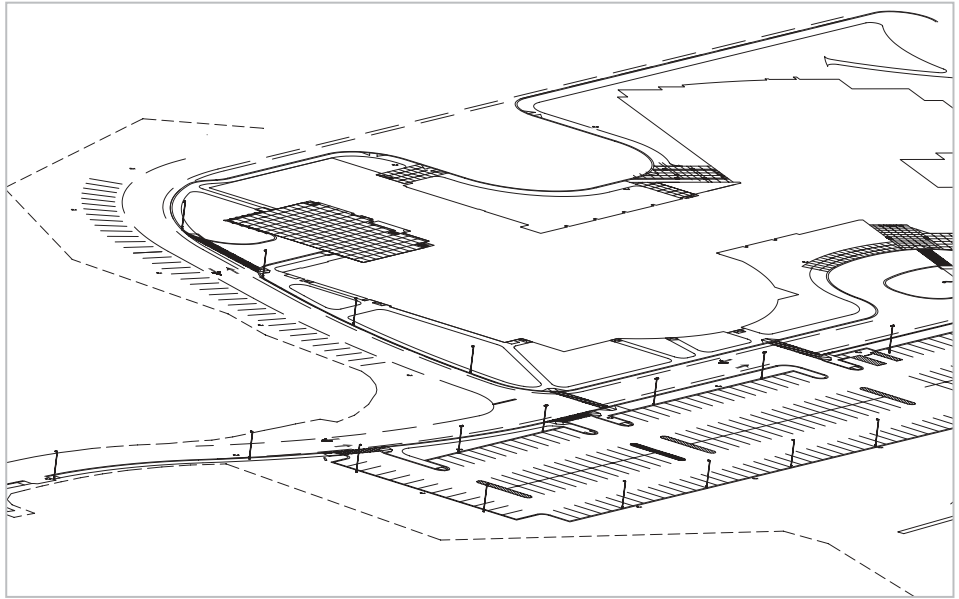
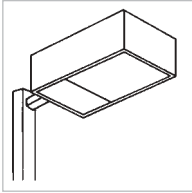
Lighting Scenario #1

Luminaires:

Generic "Shoeboxes"

Lamps:

250W Standard Metal Halide
(Horizontal Burn)
20,000 Lumens -
.72 Light Loss Factor Applied



Mounting Height

illumination

| | |
|---------|---------|
| Maximum | 6.38 fc |
| Minimum | .54 fc |
| Average | 1.83 fc |
| Max/Min | 11.81 |
| Avg/Min | 3.39 |

Life Cycle Costs

| | |
|---|----------|
| Number of poles required | 24 |
| Number of luminaires required | 31 |
| Initial installation cost (\$2000/per single/\$2400 per twin) | \$50,800 |
| Total watts consumed | 9,145 |
| Annual energy costs at 5¢ per kWh | \$2,003 |
| Annual energy costs at 10¢ per kWh | \$4,006 |

With the inefficient fixtures and lamps used in this design, it is necessary to use 17 single and 7 twin luminaire pole configurations.

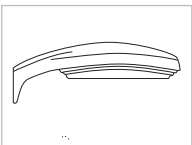
Lighting Scenario #2

Luminaires:

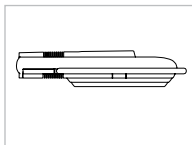
Gardco Gullwing or Circa
with Form10X Reflectors

Lamps:

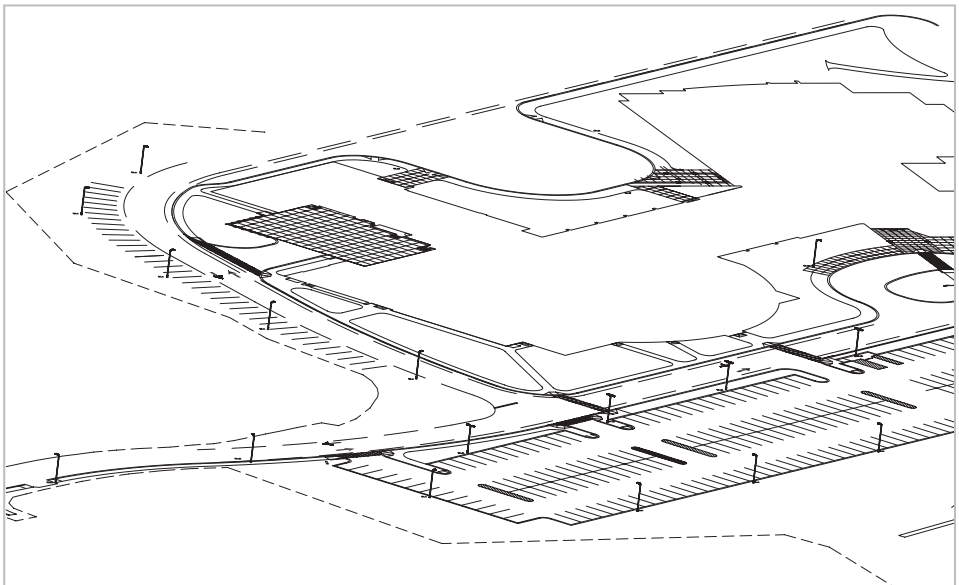
250W Pulse Start Metal Halide
(Horizontal Burn)
22,500 Lumens -
.80 Light Loss Factor Applied



Gardco G18



Gardco CR25



Mounting Height

illumination

| | |
|---------|---------|
| Maximum | 6.78 fc |
| Minimum | .59 fc |
| Average | 1.90 fc |
| Max/Min | 11.49 |
| Avg/Min | 3.22 |

Life Cycle Costs

| | |
|---|----------|
| Number of poles required | 20 |
| Number of luminaires required | 25 |
| Initial installation cost (\$2100/per single/\$2600 per twin) | \$44,500 |
| Total watts consumed | 7,200 |
| Annual energy costs at 5¢ per kWh | \$1,577 |
| Annual energy costs at 10¢ per kWh | \$3,154 |

By simply upgrading to high performance luminaires and lamps, only 15 single and 5 twin fixtures are now required. This will reduce installation costs over 12% and energy costs over 20% compared with the previous scenario. In addition, the minimum light levels are almost 10% higher with this design.

UPGRADING EXISTING FACILITIES

Frequently older sites are lit with obsolete or inefficient equipment, lack quality control systems or simply have poor application design. These sites can often be easily upgraded with a resulting energy savings.

Often however, older sites are dramatically underlit and energy saving opportunities may not be readily apparent. However even in these cases, by installing new equipment, light levels can often be significantly increased with only modest increases in energy consumed. Furthermore, even these modest energy increases can often be offset by introducing control systems.

RETROFIT – LARGE OPEN PARKING AREA

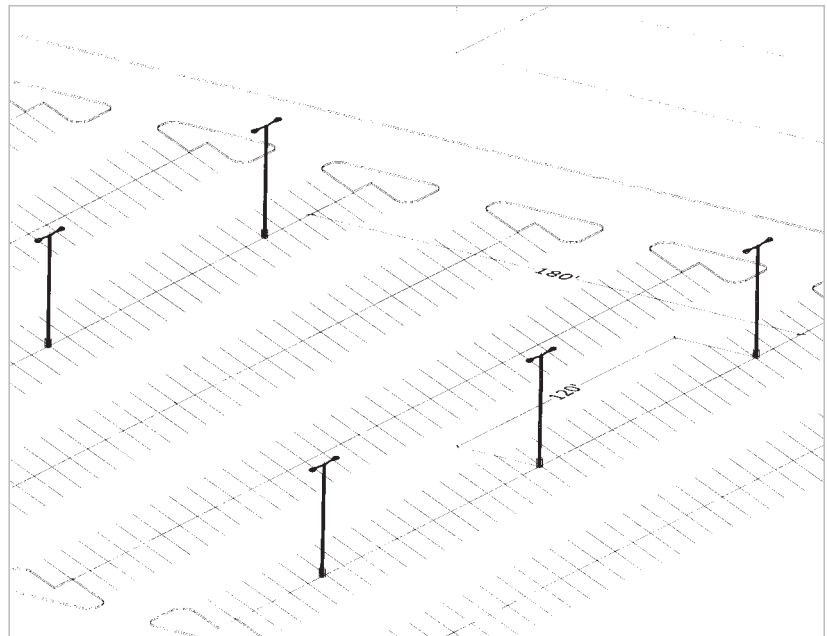
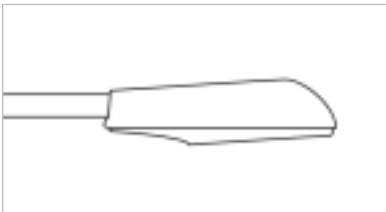
Existing Scenario

Luminaires:

Twin Generic "Cobraheads"
(on 5' arms) – Type III

Lamps:

400W Standard Metal Halide
(Horizontal Burn)
32,000 Initial Lumens -
.72 Light Loss Factor Applied



Mounting Height 31.5'

Existing Spacing 120' X 180'

Illumination

| | |
|---------|-----------|
| Maximum | 7.14 fc |
| Minimum | .16 fc |
| Average | 1.47 fc |
| Max/Min | 44.63 : 1 |
| Avg/Min | 9.19 : 1 |

Life Cycle Costs

| | |
|-------------------------------------|-------|
| Input watts per pole | 916 |
| Watts consumed per acre illuminated | 1,847 |

Annual energy costs per acre

| | 5¢ per kWh | 10¢ per kWh |
|----------------------------|------------|-------------|
| Burning 4 hours per night | \$135 | \$270 |
| Burning 12 hours per night | \$405 | \$809 |

Note that in this scenario, the parking facility is significantly underlit. This is especially common in older sites. The minimum illumination level of .16 footcandles is only about one tenth of the lighting level typically seen at newer sites. In addition, the uniformity ration of 44 to 1 substantially impairs nighttime visibility.

Lighting Solution #1 – Energy Savings, Improved Lighting

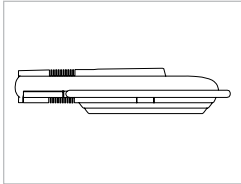
Luminaires:

Twin Gardco Circas – Form10X Type IV

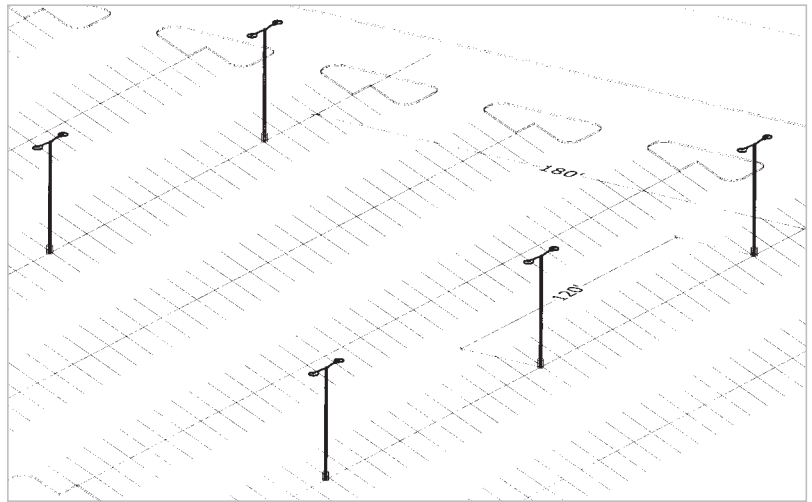
Lamps:

400W Pulse Start Metal Halide
(Horizontal Burn)

40,000 Lumens - .80 Light Loss Factor Applied



Gardco CR25



Mounting Height 31.5'

Existing Spacing

120' X 180'

Illumination

| | |
|---------|----------|
| Maximum | 8.11 fc |
| Minimum | .89 fc |
| Average | 2.41 fc |
| Max/Min | 9.11 : 1 |
| Avg/Min | 2.71 : 1 |

Life Cycle Costs

| | |
|---|---------|
| Estimated installation costs per pole* | \$1,100 |
| Installation costs per acre illuminated | \$1,997 |
| Input watts per pole | 904 |
| Watts consumed per acre illuminated | 1,823 |

Annual energy costs per acre

| | 5¢ per kWh | 10¢ per kWh |
|----------------------------|------------|-------------|
| Burning 4 hours per night | \$133 | \$266 |
| Burning 12 hours per night | \$399 | \$799 |

* Includes labor, bucket trucks, new luminaires and lamps.

Because of budget constraints, no poles could be relocated in this retrofit. In this design, a luminaire was selected because of its high performance, contemporary architectural form and unique mechanical design allowing direct fit to the existing mast arm. The results are quite remarkable. In this application, the minimum light level was increased by 556% while reducing total energy consumption! This new light level might be quite adequate for an office or rural parking application.

Lighting Solution #2 – Upgrading Lighting to Contemporary Standards

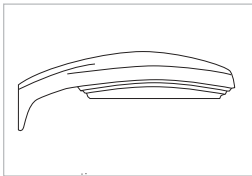
Luminaires:

Quad Gardco Gullwings/Circas – Form10X Type IV

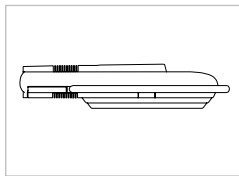
Lamps:

400W Pulse Start Metal Halide
(Horizontal Burn)

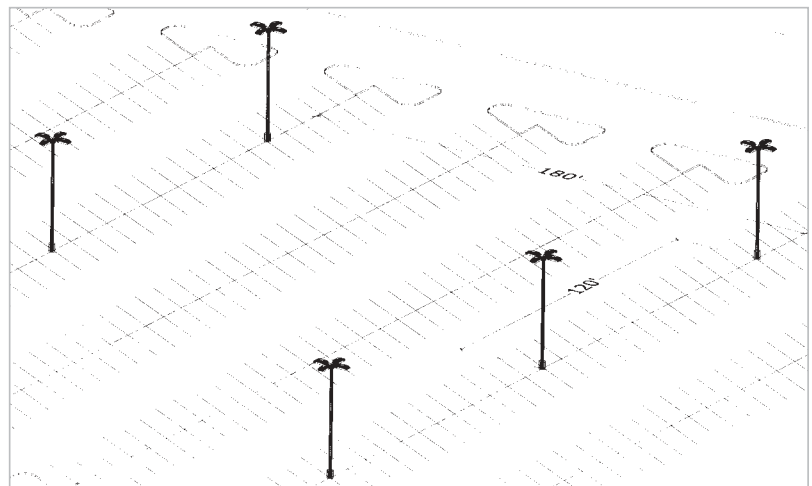
40,000 Lumens - .80 Light Loss Factor Applied



Gardco G18



Gardco CR25



Mounting Height 31.5'

Existing Spacing

120' X 180'

Illumination

| | |
|---------|----------|
| Maximum | 16.22 fc |
| Minimum | 1.78 fc |
| Average | 4.82 fc |
| Max/Min | 9.11 : 1 |
| Avg/Min | 2.71 : 1 |

Life Cycle Costs

| | |
|---|---------|
| Estimated installation costs per pole* | \$2,200 |
| Installation costs per acre illuminated | \$3,993 |
| Input watts per pole | 1,808 |
| Watts consumed per acre illuminated | 3,646 |

Annual energy costs per acre

| | 5¢ per kWh | 10¢ per kWh |
|---|------------|-------------|
| Burning 4 hours per night | \$266 | \$532 |
| Burning 12 hours per night | \$799 | \$1,597 |
| Burning 3 hours full/9 hours half level | \$499 | \$998 |

* Includes labor, bucket trucks, new luminaires and lamps.

Often as result of crime or litigation, it becomes necessary to retrofit an older site to contemporary lighting standards. In this scenario, it was desired to bring the minimum light level up to 1.5 footcandles without adding or moving any pole locations. Here, four high performance luminaires with 400W pulse start metal halide were put on each pole. Because of this particular design, it was now possible to create a control system with two lighting levels. Half of the luminaires would turn off one hour after store closing and the other units would remain on providing security lighting. In this scenario, the minimum light level was increased by over 1100% during the hours the store was open and total energy usage was only increased by 23%.

SAVING ENERGY ON OUTDOOR LIGHTING WITH CONTROLS

Lighting Controls

Considering the control options early in the outdoor lighting design process can usually increase the flexibility of the system resulting in greater energy savings. Because of the significant potential for savings, the payback for some control systems are often calculated in months rather than years.

Looking at the last example from page 17, and only applying the impact of a controls system on energy savings, it is readily apparent how effective a high/low system can be.

| | Open Parking Area Retrofit (Page 17- Lighting Solution #2) | | | | |
|---------------------------------|---|---------------------|----------------|----------------------|-----------------|
| | kWh per Acre each night | 10 Acre Site | | 100 Acre Site | |
| | | 5¢ kWh | 10¢ kWh | 5¢ kWh | 10¢ kWh |
| With no controls ¹ | 43.75 | \$7,984 | \$15,968 | \$79,844 | \$159,688 |
| With time controls ² | 27.35 | \$4,990 | \$9,980 | \$49,903 | \$99,805 |
| Potential Savings | 16.40 | \$2,994 | \$5,988 | \$29,941 | \$59,883 |

1) 12 hours full level per night 2) 3 hours full/9 hours half level



Courtesy of timecontrolsystems.com

Frequently simple photocontrols or inexpensive electromechanical time clocks may be adequate for a particular application. In addition however, current technology makes some highly sophisticated and maintenance free systems surprisingly affordable.

Units, such as the one shown here, provide such features as automatic adjustments for times of dusk and dawn and daylight savings, remote programming via Internet, daily calibration to the atomic clock, and battery backup in the event of power outages.

SAVING ENERGY WITH WALL-MOUNTED PRODUCTS

Another energy savings strategy which is often overlooked is the use of high performance wall mounted luminaires. Depending on the design criteria and site geometry, it may be possible to eliminate a row of pole mounted products adjacent to the building. In addition, there is typically a significant savings in installation costs for building mounted products as compared with pole mounted products. Even greater energy savings can be achieved when the wall mounted luminaires are specified with pulse start lamps and an appropriate control system.



High performance wall mounted luminaires may eliminate the need for an extra row of poles adjacent to the building.



Architectural cutoff luminaires, such as the Gardco 100 Line Sconce, are available up to 400 watts and offer appealing daytime forms and reduce energy costs.

GLOSSARY

BALLAST - An auxiliary electrical device used with fluorescent and HID lamps to provide the necessary starting voltage and to limit the current during operation.

CUTOFF LUMINAIRES - Outdoor luminaires that meet the IESNA cutoff criteria based on percentage of light output at 80° and 90°.

EFFICACY - Generally refers to the efficiency of a lamp. Expressed as lumens produced per watt consumed (lpw).

FULL CUTOFF - Classification for outdoor luminaires that meet IESNA cutoff criteria and produce no light above 90°.

FOOTCANDLE (FC) - The unit of illuminance when the foot is taken as the unit of length. It is the illuminance on a surface one square foot in area on which there is a uniformly distributed flux of one lumen.

GROUP RELAMPING - The method of replacing all lamps in an area at a designated point in the lamp's life instead of individually as they fail.

HIGH INTENSITY DISCHARGE (HID) LAMP - A discharge lamp in which the light producing arc is stabilized by wall temperature, and the arc tube has a bulb wall loading in excess of three watts per square centimeter. HID lamps include groups of lamps known as mercury, metal halide, high pressure sodium, and low pressure sodium.

HIGH PRESSURE SODIUM (HPS) LAMP - High intensity discharge (HID) lamp in which light is produced by radiation from sodium vapor. Includes clear and diffuse-coated lamps.

IESNA - Abbreviation for Illumination Engineering Society of North America.

ILLUMINANCE - A photometric term that quantifies light incident on a surface or plane. Illuminance is commonly referred to as light level and expressed as lumens per square foot (footcandles), or lumens per square meter (lux).

ILLUMINATION - The lighting in an area, or the result of the use of light. Also, the intensity of light per unit of area, sometimes called "illuminance"; usually measured in footcandles.

KILOWATT (kW) - One thousand watts.

KILOWATT-HOUR (kWh) - a unit energy equivalent to one kilowatt (1 kW) of power expended for one hour of time.

LAMP - An artificial source of light (also a portable luminaire equipped with a cord and plug). Industry term for light bulb.

LIGHT - Radiant energy capable of exciting the retina and producing a visual sensation. The visible portion of the electromagnetic spectrum extends from about 380 to 770 nm

LIGHT LOSS FACTOR (LLF) - A factor used in calculating the level of illumination that takes into account such factors as dirt accumulation on luminaire and room surfaces, lamp depreciation, maintenance procedures and atmosphere conditions.

LIGHT OUTPUT - Amount of light produced by a light source such as a lamp measured in lumens.

LIGHT POLLUTION - Adverse effect of manmade outdoor lighting directed or reflected upwards. Primarily refers to urban sky glow wherein celestial bodies no longer become visible from adjacent areas.

LIGHT TRESPASS - Outdoor lighting directed or reflected to undesired location. Spill light.

LOW PRESSURE SODIUM LAMP - A discharge lamp in which light is produced by radiation of sodium vapor at low pressure producing a single wavelength of visible energy, i.e. yellow.

LUMEN - A measurement of light output; The unit of luminous flux. It is the luminous flux emitted within a unit solid angle (one steradian) by a point source having a uniform luminous intensity of one candela.

LUMENS PER WATT - Lumen (light) output divided by lamp watts consumed (i.e. amount of light for electricity used); also known as efficacy.

LUMINAIRE - A complete lighting unit consisting of a lamp or lamps together with the parts designed to distribute the light, to position and protect the lamps and to connect the lamps to the power supply.

LUMINAIRE EFFICIENCY - Total lumen output from luminaire as a ratio of total lamp lumens produced.

LUMINANCE - The amount of light reflected or transmitted by an object.

LUX - The metric unit of illuminance. One lux is one lumen per square meter (lm/m²).

MAINTAINED FOOTCANDLES - Footcandles calculated through application of light loss factors.

MEAN LUMENS - Amount of light output at 40% of rated lamp life.

MERCURY LAMP - A high intensity discharge (HID) lamp in which the major portion of the light is produced by radiation from mercury.

METAL HALIDE LAMP - A high intensity discharge lamp in which the major portion of the light is produced by radiation from mercury and other elements in the arc tube. Includes clear and phosphor-coated types.

NADIR - Vertically down, directly below the luminaire or lamp; designated as 0°.

PHOTOCELL - A light sensing device used to control luminaires in response to detected light levels.

PULSE START METAL HALIDE LAMPS - Metal halide lamps which operate in systems incorporating a high voltage ignitor similar to high pressure sodium systems. Pulse start systems provide significantly higher efficiency and lower light loss factors than traditional metal halide systems.

REFLECTOR - A piece of material with a reflective surface that directs light in a desired direction.

UNDERWRITERS LABORATORY - Commonly referred to as "UL". An independent organization whose responsibilities include establishing standards and rigorous testing of electrical products. When products pass these tests, they can be labeled (and advertised) as "UL listed."

UNIFORMITY - A measure of the variation of illuminance over a given plane expressed as the ratio of either the maximum to the minimum illuminance or of the average to the minimum illuminance.

WATT (W) - The unit for measuring electric power. It defines the power or energy consumed by an electrical device.



GARDCO
LIGHTING

2661 Alvarado Street
San Leandro, CA 94577
800/227-0758
510/357-6900 in California
Fax: 510/357-3088
sitelighting.com

© Gardco Copyright 2001
Genlyte Thomas Group LLC
All Rights Reserved.
International Copyright Secured.
79103-27/302

Gardco Lighting is a business partner of Rebuild America.



For more information about Gardco, contact your local Gardco representative or visit sitelighting.com.