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Roadway Optimizer - Layout #1

Luminaire Label: ECHUS-EC-70W-4300k
Luminaire Description: 70w Cobra
File Name: ECHUS-EC-70W-4300k.ies
Luminaire Arrangement: SINGLE
Arm Length = 1.056 Ft
Lumens Per Lamp = 6400
Number Of Lamps = 1
Total Light Loss Factor = 1

Layout Information:

R-Table: R3 (Slightly Specular), Q0=0.07
Calculation Method: IES

Layout Type: Two Rows, Staggered; 2R_STG
Luminaire Spacing (Within Row) = 135 Ft
Roadway Width = 24 Ft
Setback = 1 Ft
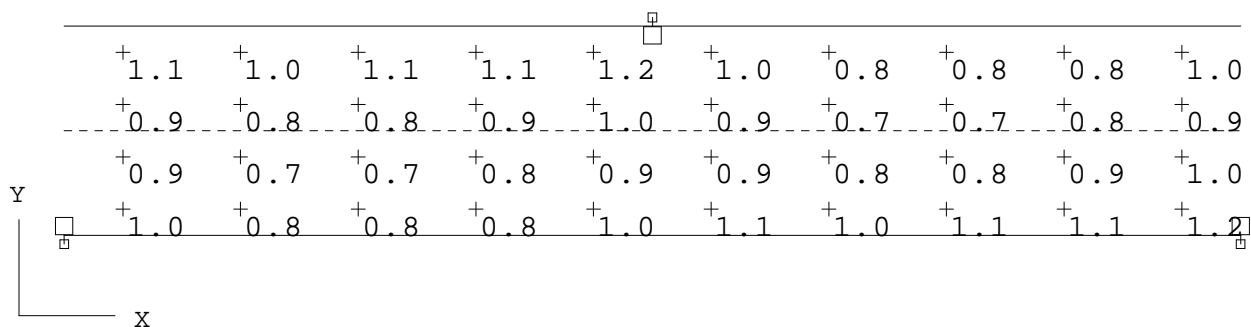Lanes Per Roadway = 2

Luminaire Location Summary:
Coordinates in Ft

X-Coord	Y-Coord	Z-Coord	Orient	Tilt
-270	-1	25	90	0
-202.5	25	25	270	0
-135	-1	25	90	0
-67.5	25	25	270	0
0	-1	25	90	0
67.5	25	25	270	0
135	-1	25	90	0
202.5	25	25	270	0
270	-1	25	90	0
337.5	25	25	270	0
405	-1	25	90	0
472.5	25	25	270	0

Total Number of locations = 12
Average Tilted Lamp Correction Factor Applied = 1

1

Roadway Optimizer - Layout #1

Luminance Grid:

```
Y
          + 1.1   + 1.0   + 1.1   + 1.1   + 1.2   + 1.0   + 0.8   + 0.8   + 0.8   + 1.0

          + 0.9   + 0.8   + 0.8   + 0.9   + 1.0   + 0.9   + 0.7   + 0.7   + 0.8   + 0.9

          + 0.9   + 0.7   + 0.7   + 0.8   + 0.9   + 0.9   + 0.8   + 0.8   + 0.9   + 1.0

          + 1.0   + 0.8   + 0.8   + 0.8   + 1.0   + 1.1   + 1.0   + 1.1   + 1.1   + 1.2

       X
```
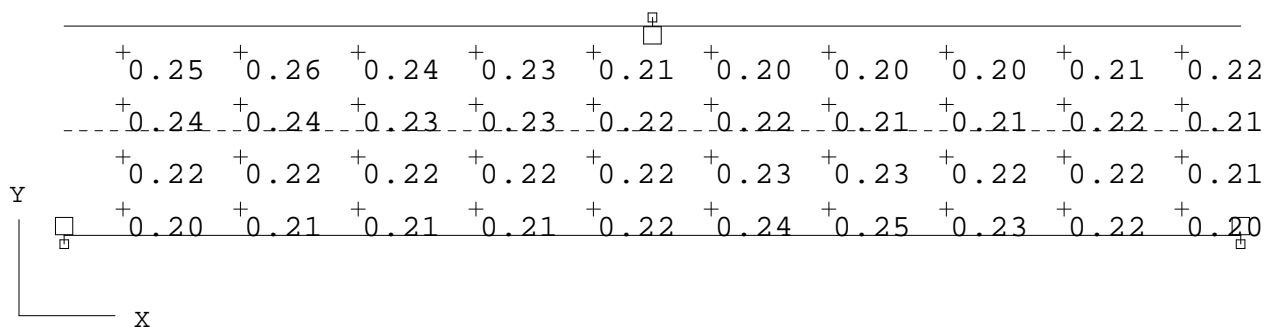
Numerical Summary:
Luminaire Spacing (Within Row) = 135 Ft
Grid begins at: X = 6.75   Y = 3   Z = 0
Point Spacing Left-To-Right = 13.5 Ft
Point Spacing Top-To-Bottom = 6 Ft
Values in Cd/Sq.M.

Average = 0.92   Maximum = 1.2   Minimum = 0.7
Avg/Min = 1.31
Max/Min = 1.71
Maximum Lv/Lavg Ratio = 0.28

Longitudinal Uniformity (Min/Max) per row starting with top row:
 0.67   0.7   0.7   0.67

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Roadway Optimizer - Layout #1

Veiling Luminance Grid:

```
                                        □
       +       +       +       +       +       +       +       +       +       +
        0.25    0.26    0.24    0.23    0.21    0.20    0.20    0.20    0.21    0.22
       +       +       +       +       +       +       +       +       +       +
   ─ ─ ─0.24 ─ 0.24 ─ ─0.23 ─ ─0.23 ─ ─0.22 ─ ─0.22 ─ ─0.21 ─ ─0.21 ─ ─0.22 ─ ─0.21
       +       +       +       +       +       +       +       +       +       +
        0.22    0.22    0.22    0.22    0.22    0.23    0.23    0.22    0.22    0.21
 Y     +       +       +       +       +       +       +       +       +       +
   □    0.20    0.21    0.21    0.21    0.22    0.24    0.25    0.23    0.22    0.20
   □                                                                            □

        X
```
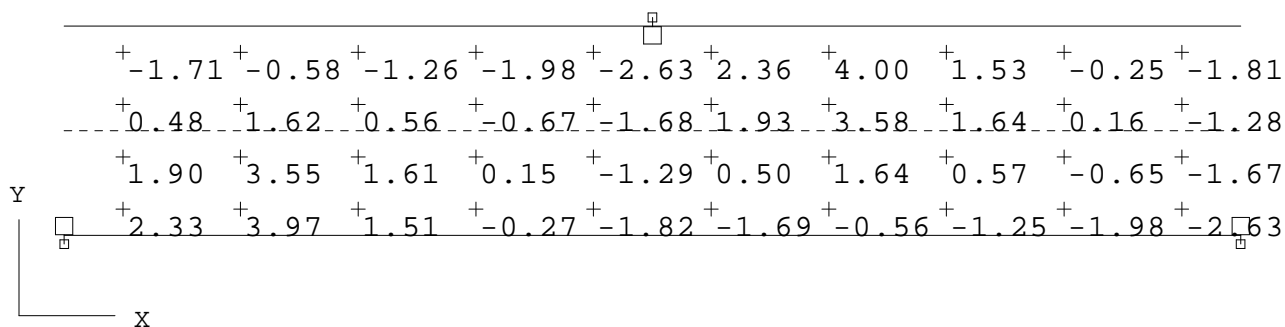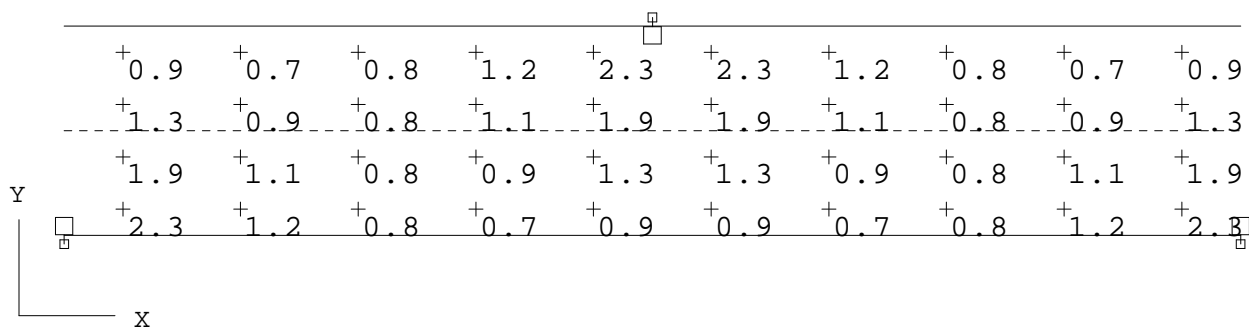
Numerical Summary:
Luminaire Spacing (Within Row) = 135 Ft
Grid begins at: X = 6.75   Y = 3   Z = 0
Point Spacing Left-To-Right = 13.5 Ft
Point Spacing Top-To-Bottom = 6 Ft
Values in Cd/Sq.M.

Average = 0.22   Maximum = 0.26   Minimum = 0.20
Avg/Min = 1.10
Max/Min = 1.30
Maximum Lv/Lavg Ratio = 0.28

Roadway Optimizer - Layout #1

Visibility Level Grid:

```
                                            ▯
       +       +       +       +       +       +       +       +       +       +
        -1.71   -0.58   -1.26   -1.98   -2.63  2.36    4.00    1.53    -0.25   -1.81
       +       +       +       +       +       +       +       +       +       +
        0.48    1.62    0.56    -0.67   -1.68  1.93    3.58    1.64    0.16    -1.28
       +       +       +       +       +       +       +       +       +       +
        1.90    3.55    1.61    0.15    -1.29  0.50    1.64    0.57    -0.65   -1.67
   Y   +       +       +       +       +       +       +       +       +       +
  ▯     2.33    3.97    1.51    -0.27   -1.82   -1.69   -0.56   -1.25   -1.98   -2▯63

   └──── X
```

Numerical Summary:

Luminaire Spacing (Within Row) = 135 Ft
Grid begins at: X = 6.75   Y = 3   Z = 0
Point Spacing Left-To-Right = 13.5 Ft
Point Spacing Top-To-Bottom = 6 Ft

Weighted Average VL (STV) = 1.47

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Roadway Optimizer - Layout #1

Illuminance Grid:

```
                                              □
        +      +      +      +      +      +      +      +      +      +
         0.9    0.7    0.8    1.2    2.3    2.3    1.2    0.8    0.7    0.9
        +      +      +      +      +      +      +      +      +      +
         1.3    0.9    0.8    1.1    1.9    1.9    1.1    0.8    0.9    1.3
        +      +      +      +      +      +      +      +      +      +
         1.9    1.1    0.8    0.9    1.3    1.3    0.9    0.8    1.1    1.9
   Y    +      +      +      +      +      +      +      +      +      +
      □  2.3    1.2    0.8    0.7    0.9    0.9    0.7    0.8    1.2    2.3 □

          X
```

Numerical Summary:
Luminaire Spacing (Within Row) = 135 Ft
Grid begins at: X = 6.75   Y = 3   Z = 0
Point Spacing Left-To-Right = 13.5 Ft
Point Spacing Top-To-Bottom = 6 Ft
Values in Fc

Average = 1.19   Maximum = 2.3   Minimum = 0.7
Avg/Min = 1.70
Max/Min = 3.29

Longitudinal Uniformity (Min/Max) per row starting with top row:
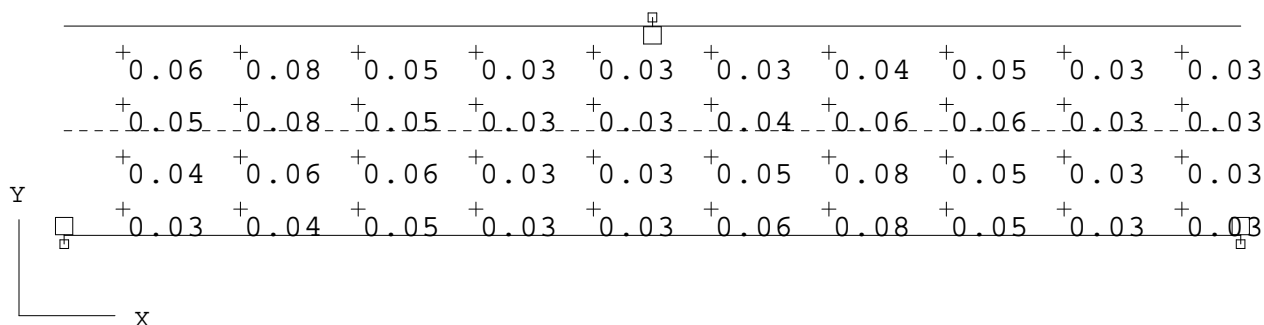 0.3   0.42   0.42   0.3

Roadway Optimizer - Layout #2

Luminaire Label: T3-SL_30LED_700mA_43k
Luminaire Description: BLD-STR-T3-__-025-LED-B-43K-700 (BXSL03025B-U)
File Name: T3-SL_30LED_700mA_43k.ies
Luminaire Arrangement: SINGLE
Arm Length = 1.056 Ft
Lumens Per Lamp = 3208
Number Of Lamps = 1
Total Light Loss Factor = 1

Layout Information:

R-Table: R3 (Slightly Specular), Q0=0.07
Calculation Method: IES

Layout Type: Two Rows, Staggered; 2R_STG
Luminaire Spacing (Within Row) = 135 Ft
Roadway Width = 24 Ft
Setback = 1 Ft
Lanes Per Roadway = 2

Luminaire Location Summary:
Coordinates in Ft

X-Coord	Y-Coord	Z-Coord	Orient	Tilt
-270	-1	25	90	0
-202.5	25	25	270	0
-135	-1	25	90	0
-67.5	25	25	270	0
0	-1	25	90	0
67.5	25	25	270	0
135	-1	25	90	0
202.5	25	25	270	0
270	-1	25	90	0
337.5	25	25	270	0
405	-1	25	90	0
472.5	25	25	270	0

Total Number of locations = 12
Average Tilted Lamp Correction Factor Applied = 1

Roadway Optimizer - Layout #2

Luminance Grid:

```
        +0.8   +0.6   +0.5   +0.5   +0.4   +0.4   +0.4   +0.3   +0.4   +0.6

        +0.6   +0.5   +0.3   +0.4   +0.4   +0.5   +0.4   +0.3   +0.4   +0.5

        +0.5   +0.4   +0.3   +0.4   +0.5   +0.6   +0.5   +0.3   +0.4   +0.4

   Y    +0.4   +0.4   +0.3   +0.4   +0.6   +0.8   +0.6   +0.5   +0.5   +0.4

              X
```
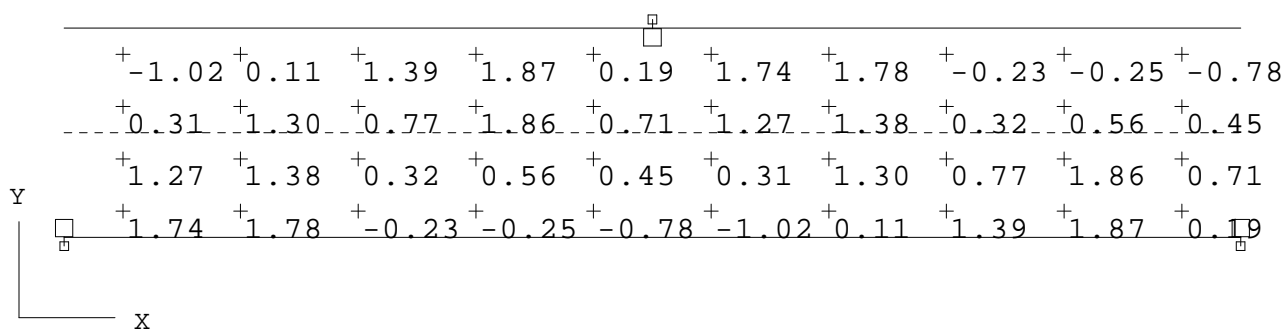
Numerical Summary:
Luminaire Spacing (Within Row) = 135 Ft
Grid begins at: X = 6.75   Y = 3   Z = 0
Point Spacing Left-To-Right = 13.5 Ft
Point Spacing Top-To-Bottom = 6 Ft
Values in Cd/Sq.M.

Average = 0.46   Maximum = 0.8   Minimum = 0.3
Avg/Min = 1.53
Max/Min = 2.67
Maximum Lv/Lavg Ratio = 0.18

Longitudinal Uniformity (Min/Max) per row starting with top row:
 0.38   0.5   0.5   0.38

Roadway Optimizer - Layout #2

Veiling Luminance Grid:

```
                                          □
      +0.06  +0.08  +0.05  +0.03  +0.03  +0.03  +0.04  +0.05  +0.03  +0.03

      +0.05  +0.08  +0.05  +0.03  +0.03  +0.04  +0.06  +0.06  +0.03  +0.03

      +0.04  +0.06  +0.06  +0.03  +0.03  +0.05  +0.08  +0.05  +0.03  +0.03
  Y
      □+0.03  +0.04  +0.05  +0.03  +0.03  +0.06  +0.08  +0.05  +0.03  +0.03

        X
```
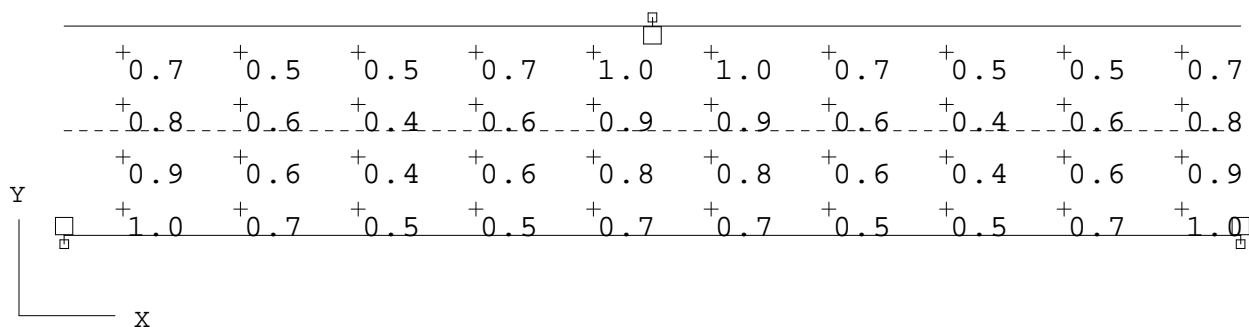
Numerical Summary:
Luminaire Spacing (Within Row) = 135 Ft
Grid begins at: X = 6.75   Y = 3   Z = 0
Point Spacing Left-To-Right = 13.5 Ft
Point Spacing Top-To-Bottom = 6 Ft
Values in Cd/Sq.M.

Average = 0.04   Maximum = 0.08   Minimum = 0.03
Avg/Min = 1.33
Max/Min = 2.67
Maximum Lv/Lavg Ratio = 0.18

Roadway Optimizer - Layout #2

Visibility Level Grid:

```
              +        +        +        +        +        +        +        +        +        +
              -1.02   0.11    1.39    1.87    0.19    1.74    1.78    -0.23   -0.25   -0.78

              +        +        +        +        +        +        +        +        +        +
             0.31    1.30    0.77    1.86    0.71    1.27    1.38    0.32    0.56    0.45

              +        +        +        +        +        +        +        +        +        +
             1.27    1.38    0.32    0.56    0.45    0.31    1.30    0.77    1.86    0.71

     Y        +        +        +        +        +        +        +        +        +        +
             1.74    1.78    -0.23   -0.25   -0.78   -1.02   0.11    1.39    1.87    0.19


          X
```

Numerical Summary:
Luminaire Spacing (Within Row) = 135 Ft
Grid begins at: X = 6.75   Y = 3   Z = 0
Point Spacing Left-To-Right = 13.5 Ft
Point Spacing Top-To-Bottom = 6 Ft

Weighted Average VL (STV) = 0.87

Roadway Optimizer - Layout #2

Illuminance Grid:

```
                                                  ▢
      ─────────────────────────────────────────────────────────────
        +        +        +        +        +        +        +        +        +        +
         0.7      0.5      0.5      0.7      1.0      1.0      0.7      0.5      0.5      0.7
        +        +        +        +        +        +        +        +        +        +
      ───0.8──────0.6──────0.4──────0.6──────0.9──────0.9──────0.6──────0.4──────0.6──────0.8───
        +        +        +        +        +        +        +        +        +        +
         0.9      0.6      0.4      0.6      0.8      0.8      0.6      0.4      0.6      0.9
  Y     +        +        +        +        +        +        +        +        +        +
      ▢  1.0      0.7      0.5      0.5      0.7      0.7      0.5      0.5      0.7      1.0▢

      └── X
```

Numerical Summary:
Luminaire Spacing (Within Row) = 135 Ft
Grid begins at: X = 6.75   Y = 3   Z = 0
Point Spacing Left-To-Right = 13.5 Ft
Point Spacing Top-To-Bottom = 6 Ft
Values in Fc

Average = 0.67   Maximum = 1.0   Minimum = 0.4
Avg/Min = 1.68
Max/Min = 2.50

Longitudinal Uniformity (Min/Max) per row starting with top row:
  0.5   0.44   0.44   0.5

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Roadway Optimizer - Layout Comparison

	Units	Layout #1	Layout #2
Luminaire Spacing (Within Row)	Ft	135	135
Luminance - Avg	Cd/Sq.M.	0.92	0.46
Luminance - Max	Cd/Sq.M.	1.2	0.8
Luminance - Min	Cd/Sq.M.	0.7	0.3
Avg/Min		1.31	1.53
Max/Min		1.71	2.67
Maximum Lv/Lavg Ratio		0.28	0.18
Weighted Average VL (STV)		1.47	0.87
Maximum Veiling Luminance	Cd/Sq.M.	0.26	0.08
Relative Thresold Increment (%)		N.A.	N.A.
Discomfort Glare Control Mark		N.A.	N.A.
Longitudinal Uniformity (Obs)		N.A.	N.A.
Illuminance - Avg	Fc	1.19	0.67
Illuminance - Max	Fc	2.3	1
Illuminance - Min	Fc	0.7	0.4
Avg/Min		1.7	1.68
Max/Min		3.29	2.5
Luminaire Label		ECHUS-EC-70W-430GL_30LED_700mA_43k	
Luminaire Arrangement		SINGLE	SINGLE
Arm Length	Ft	1.056	1.056
Mounting Height	Ft	25	25
Tilt		0	0
Flashed Area	Sq.Ft.	N.A.	N.A.
Color Constant		N.A.	N.A.
Specific Luminaire Index		N.A.	N.A.
Layout Type		2R_STG	2R_STG
Roadway Width	Ft	24	24
Setback	Ft	1	1
Lanes Per Roadway		2	2
Median Width	Ft	0	0
R-Table		R3	R3
Calculation Method		IES	IES

Roadway Optimizer - Definitions

IES method:

Average Pavement Luminance (L) - The overall average luminance of the road surface as observed from a specific point in Cd/m2 (metric units are used regardless). Observer position is 1.45 meters above the pavement surface, 83 meters back from each computation point along a longitudinal line parallel to the direction of travel. Observer line of sight is 1 degree below horizontal. Observer position changes relative to the curb line to align with each row of computation points.

Longitudinal Uniformity - The ratio of minimum to maximum pavement luminance along each longitudinal line of computation points.

Veiling Luminance (Lv) - A measure of disability glare, Veiling luminance is a luminance superimposed over the eyes retinal image produced by stray light within the eye. In the IES method, Lv is computed at the same points as pavement luminance with the observer assuming the location of each point. Observer line of sight is horizontal at 1.45 m above the road surface.

Veiling Luminance ratio - The IES method uses the maximum value of Veiling Luminance (Lv) divided by the Average Pavement Luminance (Lpavg) as a measure of the disability glare produced by a lighting system.

Weighted Average VL (STV) - Weighted Average Visibility Level or Small Target Visibility determines the visibility level of an array of targets on the roadway considering the following factors: luminance of the targets, luminance of the immediate background, adaptation level of the adjacent surroundings, and disability glare (Lv).

CIE method:

Average Pavement Luminance (L) - The overall average luminance of the road surface as observed from a specific point in Cd/m2 (metric units are used regardless). Observer position is 1/4 roadway width inset from the curb, 1.5 m above the pavement surface and 60 m back from each row of computation points. Line of sight is 1 degree below horizontal. Observer position is static relative to the curb line.

Longitudinal Uniformity - The ratio of minimum to maximum pavement luminance along each longitudinal line of computation points.

Veiling Luminance (Lv) - A measure of disability glare, Veiling luminance is a luminance superimposed over the eyes retinal image produced by stray light within the eye. In the CIE method, Lv is computed along a single row of calculation points directly in front of the observer position. Observer is 90m back from each point, 1/4 road width from the curb line. Line of sight is horizontal. The CIE method uses the maximum value of Lv to compute the relative Threshold Increment (TI) and Glare Control Mark.

Specific Luminaire Index (SLI) - A measure of a the glare control properties of a luminaire. The higher the number the greater the propensity for glare control. SLI forms the luminaire associated portion of the calculation for Glare Control Mark.

Relative Threshold Increment (TI) - A measure of the effect of disability glare produced by the lighting system. Threshold Increment is intended to yield the percentage increase in the luminance of the roads surface required to render an object just visible (threshold of visibility) under the proposed lighting system (glare present) as compared to the luminance required to render the object just visible in the absence of glare.

Glare Control Mark - A measure of the discomfort glare caused by a lighting system. Glare Control Mark is based on a relationship between the intensity of the luminaire at 80 degrees and 88 degrees, the luminaire flashed area, the lamp color constant, the height of the luminaire above the roadway, the average pavement luminance, and the number of luminaires per kilometer. The higher the value of Glare Control Mark the greater the glare control of the luminaire.

CIE-AS method:

The Australian variation of the CIE method differs in the following conventions:

Average Pavement Luminance Observer position - Observer position is 1/2 roadway width inset from the curb otherwise same as CIE.

Veiling Luminance Observer Position - Observer position is 1/2 roadway width inset from the curb otherwise same as CIE.

Longitudinal Uniformity - In addition to longitudinal uniformity along each line of computational points, longitudinal uniformity is computed from a single column of points directly in line with the observer position. Observer position is same as for pavement luminance.