How Our Eyes See Light & Color
**COLOR MEASUREMENT**

*Kelvin Temperature °K - A measure of lamp color*

The temperature that a standard black body must be heated to give off a particular color of light. Higher temperatures are generally more white and blue whereas lower temperatures are more pronounced in the yellows and reds.

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**Sunlight**

- **Sunrise**
  - Orange-Red light
  - 2000 °K

- **Mid-morning**
  - Yellow light
  - 3500 °K

- **Late-morning**
  - White reflected light
  - 5100 °K

- **Noon**
  - Blue-White light
  - 6500 °K

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**Lamps**

- **Orange-Red**
  - 2000°K

- **Yellow**
  - 3000°K

- **White**
  - 5100°K

- **Blue-White**
  - 6500°K
**Color Rendering Index (CRI)** - A measure of color accuracy

A percentage measurement of how closely an artificial light source approximates natural sunlight when the sun is emitting a particular color temperature (°K).

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**SUN at 3000°K**

- **CRI 100**
  - HEARTH-GLO®
  - at 3000°K
  - CRI 54 (A 54% approximation of sunlight at 3000°K)

**SUN at 4150°K**

- **CRI 100**
  - Spectra-COLWITE™
  - at 4150°K
  - CRI 67 (A 67% approximation of sunlight at 4150°K)

**SUN at 5100°K**

- **CRI 100**
  - XTRABRITE AW®
  - at 5100°K
  - CRI 86 (A 86% approximation of sunlight at 5100°K)

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The higher the CRI the closer the lamp matches the sun at that Kelvin temperature.
**How Light Is Measured**

**THE EYE SEES ENTIRE SPECTRUM**

- Designed to measure incandescent light.
- Measures yellow light seen by cones.
- Misses much of the blue light, which rods are sensitive to.

**LUMEN MEASUREMENT - Developed in the 1920’s.**

- Measures full spectrum as seen by eye.
- M.E. measures “Seeable” Lumens from entire spectrum.
- Lawrence Berkeley Labs in California developed this new measurement for light.
- “Seeable” Lumens measure both Photopic Light seen by cones in the eye and Scotopic Light seen by rods in the eye.

**SEEABLE LUMEN MEASUREMENT**

- Designed to measure incandescent light.
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**Lumen Measurement**

- Lumen Measurement - Developed in the 1920’s.
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- Measures yellow light seen by cones.
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**Seeable Lumen Measurement**

- Seeable Lumen Measurement
- Measures full spectrum as seen by eye.
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- Lawrence Berkeley Labs in California developed this new measurement for light.
- “Seeable” Lumens measure both Photopic Light seen by cones in the eye and Scotopic Light seen by rods in the eye.
### Seeable Lumen Table

<table>
<thead>
<tr>
<th>TYPE</th>
<th>COLOR TEMP</th>
<th>CRI</th>
<th>LIGHT METER* LUMENS</th>
<th>SEEABLE** LUMENS</th>
<th>COMPARE</th>
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</thead>
<tbody>
<tr>
<td><strong>INCANDESCENT</strong></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>• 60W</td>
<td>2700˚K</td>
<td>100</td>
<td>635</td>
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<td>• 75W</td>
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<td>100</td>
<td>875</td>
<td>1138</td>
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<tr>
<td>• 100W</td>
<td>2700˚K</td>
<td>100</td>
<td>1350</td>
<td>1750</td>
<td>-</td>
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<tr>
<td><strong>HALOGEN PAR</strong></td>
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<td></td>
</tr>
<tr>
<td>• 90W</td>
<td>3000˚K</td>
<td>100</td>
<td>1420</td>
<td>1948</td>
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<td><strong>FLUORESCENT</strong></td>
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<tr>
<td>• T-12</td>
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</tr>
<tr>
<td>• AWX8651</td>
<td>5100˚K</td>
<td>86</td>
<td>3700</td>
<td>6050</td>
<td>+ 69%</td>
</tr>
<tr>
<td>• VL9156</td>
<td>5600˚K</td>
<td>91</td>
<td>2200</td>
<td>3995</td>
<td>+ 12%</td>
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<tr>
<td>• CW6741(EC)</td>
<td>4150˚K</td>
<td>67</td>
<td>2650</td>
<td>3579</td>
<td>0% (Baseline)</td>
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<tr>
<td>• HG5430(EC)</td>
<td>3000˚K</td>
<td>54</td>
<td>2750</td>
<td>2750</td>
<td>- 23%</td>
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<td>• T-8</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• AWX8550</td>
<td>5000˚K</td>
<td>85</td>
<td>2950</td>
<td>4713</td>
<td>+ 42%</td>
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<tr>
<td>• VLX9155</td>
<td>5500˚K</td>
<td>91</td>
<td>3050</td>
<td>5237</td>
<td>+ 57%</td>
</tr>
<tr>
<td>• CW8541(CW)</td>
<td>4100˚K</td>
<td>85</td>
<td>2850</td>
<td>4055</td>
<td>+ 22%</td>
</tr>
<tr>
<td>• SR8535(3500˚K)</td>
<td>3500˚K</td>
<td>85</td>
<td>2850</td>
<td>3576</td>
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<tr>
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<td>86</td>
<td>2850</td>
<td>3330</td>
<td>0% (Baseline)</td>
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<td><strong>HID</strong></td>
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<td>• MH(400W) Clear</td>
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<td>36,000</td>
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<tr>
<td>• HPS(400W)</td>
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<td>21</td>
<td>50,000</td>
<td>34,438</td>
<td>-</td>
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<td><strong>COMPACT FLUORESCENTS</strong></td>
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<td><strong>QUAD, TWIN</strong></td>
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<td>• AWX8550(13W)</td>
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<td>85</td>
<td>855</td>
<td>1375</td>
<td>+ 61%</td>
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<tr>
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<td>800</td>
<td>1139</td>
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<tr>
<td>• SR8535(13W)</td>
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<td>85</td>
<td>800</td>
<td>1031</td>
<td>+ 21%</td>
</tr>
<tr>
<td>• HG8527(13W)</td>
<td>2700˚K</td>
<td>85</td>
<td>800</td>
<td>852</td>
<td>0% (Baseline)</td>
</tr>
<tr>
<td><strong>SPIRAL</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>• 13W</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• AWX8650</td>
<td>5000˚K</td>
<td>86</td>
<td>800</td>
<td>1293</td>
<td>+ 52%</td>
</tr>
<tr>
<td>• HG8222</td>
<td>2700˚K</td>
<td>82</td>
<td>800</td>
<td>852</td>
<td>0% (Baseline)</td>
</tr>
<tr>
<td>• 26W</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• AWX8650</td>
<td>5000˚K</td>
<td>86</td>
<td>1750</td>
<td>2955</td>
<td>+ 50%</td>
</tr>
<tr>
<td>• HG8222</td>
<td>2700˚K</td>
<td>82</td>
<td>1750</td>
<td>1965</td>
<td>0% (Baseline)</td>
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<tr>
<td>• 40W</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• AW9050</td>
<td>5000˚K</td>
<td>90</td>
<td>2400</td>
<td>4032</td>
<td>-</td>
</tr>
</tbody>
</table>

For 8' LAMPS = Approximately double 4' lumen output.

* **LIGHT METER LUMENS - STANDARD LIGHT METER READINGS**
  This is the light seen predominately by the cone receptors in the eye, which sense the yellow light of the photopic spectrum. This method of light measurement was developed in 1924 and was generally used to measure incandescent lighting. Even though this type of measurement is inaccurate, it is still widely used in the lighting industry today.

** **SEEABLE LUMENS - LIGHT THAT THE EYE CAN SEE**
  A new method of measuring light was developed by Lawrence Berkeley labs, Berkeley CA in 1992. Maintenance Engineering uses this new and more accurate method to measure called “Seeable Lumen." "Seeable Lumens" measure the full spectrum, which is both photopic (yellow light) seen by the cones, and scotopic (blue light) seen by the rods of the eye. "Seeable Lumens" give us a more accurate measurement of the usable light given off by a lamp.

* While these lamps are rated at 100 CRI remember this measurement is at a low Kelvin temperature. These lamps give off light primarily in the yellow and orange spectrum with low seeable lumens.
**COLOR SPECTRUM ANALYSIS**

**NATURAL SUNLIGHT**

- Sunlight Circle
- Represents natural sunlight
- Represents eye's sensitivity range

**STANDARD COOL WHITE/EC**

- Shown outside sunlight circle
- Causes glare and eyestrain
- Distorts colors

**Excess Color**

- Shown inside sunlight circle
- Makes those colors difficult to see
- Distorts colors

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**BLUE-WHITE**

**Spectra-DAYLITE**

- **D8265**
  - 6500˚K  CRI 82
  - TONE: Bluish White
  - Seeability: B
  - Color Matching: B

**FULL SPECTRUM**

- **VITALUX**
  - **VL9156 (T-12)**
  - **VLX9155 (T-8)**
  - 5400˚K-5600˚K  CRI 91-94
  - TONE: Balanced
  - Seeability: A
  - Color Matching: A+

**BALANCED SPECTRUM**

- **XTRABRITE ALPINEWITE**
  - **AWX8651**
  - 5100˚K  CRI 86
  - TONE: Brilliant White
  - Seeability: A+
  - Color Matching: A

- **ALPINEWITE**
  - **AW8251**
  - 5100˚K  CRI 82
  - TONE: Bright White
  - Seeability: A
  - Color Matching: A

**Benefits:**

- Excellent Color Rendition
- Easier to Read
- Reduced Glare & Eyestrain
- Cool Appearance
- Excellent for Growing Plants

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**SPECIALTY COLORS**

**Display Pink**

- 2800˚K  CRI 85  TONE: Violet
- Seeability: C
- Color Matching: B

**SPECTRA-75**

- 7500˚K  CRI 95  TONE: Blush White
- Seeability: B-
- Color Matching: A

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LCG6 - Light & Color Guide
**COLOR SPECTRUM ANALYSIS**

**EARTHTONE**

**Spectra-COLWITE CW8541 (T-8)**
- 4100°K CRI 75-82
- TONE: White
- Seeability: B
- Color Matching: B-

**Spectra-COLWITE CW6741 (T-12)**
- 4150°K CRI 67
- TONE: Yellow White
- Seeability: C
- Color Matching: C-

**Spectra-SUNRISE SR8235**
- 3500°K CRI 82
- TONE: Yellow White
- Seeability: C
- Color Matching: C-

**HEARTH-GLO HG5430**
- 3000°K CRI 54
- TONE: Golden White
- Seeability: D
- Color Matching: D

**Benefit:**
- Enhances Skin Tones
- Warms Earth Colors
- Enriches Wood Tones
- Warm Inviting Atmosphere
- Attracts & Holds People
- Color Rendering Fair to Good

**CW8541** (Colwhite) is a modern version of the old Cool White phosphor mix. Its yellow white tone is a result of the high output of yellow and orange colors as well as a slight deficiency in blue and red light. Warm colors such as skin or earth tones are strengthened while blues and reds are grayed or “muddied.” This special phosphor mix for the T-8 gives a very good CRI helping the eye to distinguish colors, reducing eyestrain. This high lumen output color provides a good general illumination source with high “seeable” lumens while giving the bonus of good color rendition.

**CW6741** (Cool White) for the T-12 lamps is one of the oldest and most common colors in use today. Its yellowish-white tone is a result of the high output of yellow and orange colors as well as its deficiency in blue and red light. Warm colors such as skin or earth tones are strengthened while blues and reds are grayed or “muddied.” The excess quantity of yellow light in **CW6741** “unbalanced” spectrum may cause glare in the form of excess reflected light to the eye. The deficiency in red and blue makes it difficult for the eye to distinguish colors, thus resulting in eyestrain. This high photopic lumen output color provides a general illumination source where accurate color rendition and visual acuity are not a primary concern.

**SR8235** is warm-toned color having the psychological appeal of a sunrise or campfire that is said to draw people into rooms and buildings illuminated with it. With its high content of yellow light, **SR8235** produces golden skin tones, vibrant earth tones and rich brown wood colors. Its red and blue colors are sufficient to render colors quite well, making it an ideal lamp for many retail applications, home furnishings stores, restaurants or any businesses that want the psychological draw of a warm tone with better color rendering ability than **HG5430** (Warm-White). **SR8235** also blends well with incandescent lighting.

With a golden white tone the **HG5430** (Warm-White) phosphor mix creates a light that has the psychological appeal of early morning light or a campfire. It is said to draw people towards it and into rooms and buildings illuminated with it better than any other lamp color. Its high content of yellow light produces golden skin tones, vibrant earth tones and rich wood colors. Deficiency in red and blue accounts for its poor color rendering ability. **HG5430**’s close match to incandescent light makes it the choice of many carpet and drapery shops who prefer to match colors under a light similar to the light found in most of their customers’ homes.

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**Compact Fluorescent Colors**

**Incanescent**
- 2700K CRI 100
- TONE: Very Warm Yellow
- Seeability: B
- Color Matching: C

Incanescent lamps are identical to the sun (100 CRI) at an early morning color temperature (2700K). They emit a color spectrum high in yellow, orange and red, while very deficient in violet, blue and green. It renders earth tone colors, skin and wood tones in a most flattering manner. Matching green, blue and black objects under incandescent light is difficult due to deficiencies in violet, blue and green. Only 10% of the consumed wattage is converted into visible light, the remaining 90% energy is emitted as invisible infrared (heat) energy.

**HG8527, HG8227**
- 2700K CRI 82-85
- TONE: Golden-Warm White
- Seeability: B-
- Color Matching: B+

Golden-warm white color matching the look of **HG5430** (Warm-White) fluorescents while outperforming them in color rendition. It is recommended for red lettered exit fixtures and can be mixed with incandescents.

**SR8535, SR8235**
- 3500K CRI 82-85
- TONE: Cool-Yellow White
- Seeability: B
- Color Matching: B+

Slightly warmer than **CW8541** and also has an exceptional CRI. **SR8535** is designed to improve on incandescent lighting. It mixes well with **CW8541** and is best kept in separate groups when used with incandescents.

**CW8541**
- 4100K CRI 85
- TONE: Magenta/Yellow White
- Seeability: B+
- Color Matching: B+

Appears almost white when compared to an incandescent lamp, or **HG8527** color, making it excellent for many display situations. It is an ideal upgrade from **HG8527** or **SR8535** lamps.

**AWX8550, AWX8650**
- 5000K CRI 85-90
- TONE: Brilliant White
- Seeability: A+
- Color Matching: A

Whiter than the **CW8541** and is a high CRI source. Designed to blend with the T-8 and T-12 **AWX8550**, these lamps are the whitest brightest compact fluorescent lamps available.
Benefits of Balanced Spectrum Light

M.E.'s Balanced Spectrum Improves Clarity & Focus

- **Standard Light Source**
  - Photopic light (yellow) dilates the pupil.
  - Decreased depth of field
  - Blurred objects

- **M.E.'s XTRABRITE™**
  - Added Scotopic light (blue) reduces pupil size.
  - Increased depth of field
  - Improved accuracy
  - Eye sees clearly*

*M.E.'s Balanced Spectrum Light improves accuracy, improves vision for the elderly and improves quality of life for all.

*ADULT EYE NEEDS: As adult eye age, the more develops small defects which interfere with the focusing of light and image onto the eye's retina. This problem is lessened with a small pupil caused by scotopic light (blue) contained in balanced spectrum light sources. A 50-60 year old person requires 2-3 times the light of a 20-30 year old person to do the same task. Balanced spectrum light is excellent for reduced eyestrain in older adults.

M.E.'s Balanced Spectrum Increases Contrast

- **Standard Light Source**
  - Photopic light (yellow) creates eyestrain.
  - Yellows whites
  - Dulls blacks
  - Lack of contrast reduces overall clarity

- **M.E.'s XTRABRITE™**
  - Added Scotopic light (blue) helps the eye.
  - Brightens whites
  - Darkens blacks
  - Enhanced contrast increases overall clarity and readability

M.E.'s Balanced Spectrum helps Treatment for S.A.D. *(Seasonal Affective Disorder)*

- **Medical Treatment**
  - Doctors use balanced spectrum light to cure S.A.D.
  - Energizes and revitalizes

- **Office S.A.D. Prevention**
  - XTRABRITE™ lighting in work areas may prevent S.A.D.
  - Keeps workers on the job
  - Employees are happier and more productive

* Increased productivity and improved quality of life.

*Balanced Spectrum light may lessen the severity of S.A.D. See your Doctor for diagnosis and treatment.*