CIRCADIAN® Zirc™ Lights reversed the harmful effects of conventional blue-rich LED light at night

The Issue:

The timing of blue light (440-490nm) is critical for human health & well-being.

- **Blue light exposure during the day is good**: Entrains our circadian rhythms and give us energy.
- **Blue light exposure at night causes is bad**: Causes circadian disruption, jet-lag like malaise, fatigue, and an increased risk of obesity, diabetes, heart disease and breast and prostate cancers.

The Intervention:

CIRCADIAN® Zirc™ Lights are spectrally engineered to provide blue-rich white light during the day, and automatically transition to blue-depleted white light at night (UL verified <2% blue content at night).

Medical Research Validation:

Controlled studies showed **CIRCADIAN® Zirc™ Lights reversed the harmful effects of conventional blue-rich LED light at night**, including:

- Circadian disruption, suppressed melatonin and impaired performance
- Elevated markers of obesity and diabetic risk (including increased appetite, insulin resistance at night)

Now...Real World Validation:

To validate CIRCADIAN® Zirc™ Lights in real world conditions, CIRCADIAN® Zirc™ Lights were installed in a 24/7 control center at a major energy company. Employee health & performance assessments were conducted before installation and one year after installation.
In the summer of 2017, CIRCADIAN® Zirc™ Lights featuring NightSafe™ LEDs and DynamicBlu™ Spectrum Control were installed in a 24/7 mission-critical control room of a global energy company.

The control room was previously illuminated by conventional blue-rich light during day and night. All Control Room Operators worked rotating 12 hour-day and 12-hour night shifts.

• To evaluate the impact of CIRCADIAN® Zirc™ Lights, a pre-installation and a post-installation “Shiftworker Health & Performance Assessment” was given to the Control Room Operators. The assessment evaluated alertness, fatigue, and performance as well as health risk parameters.

• In the summer of 2018, 1-year after installation, the Control Room Operators were given the same Shiftworker Health & Performance Assessment. Conducting the assessments at the same time of year avoided any seasonal effects.

• The impact of CIRCADIAN® ZircLight™ in the Control Room was compared for all employees who participated in both pre- and post-installation health assessments. 12 Control Room Operators: 9 males aged 29-33 (mean 30.1 years) and 3 females aged 27-28 at time of installation comparing individuals with their own pre- and post-installation data provided the most accurate assessment.
PART ONE: Alertness, Fatigue and Operator Errors

ISSUE: Circadian disruption caused by inadequate unhealthy lighting is associated with reduced alertness, increased fatigue and increased errors at work.

INTERVENTION: CIRCADIAN® Zirc™ Lights were installed and operated for One Year.

### Epworth Sleepiness Scale: Percent Reporting Excessive Sleepiness

<table>
<thead>
<tr>
<th>% Classified as Having Excessive Sleepiness</th>
<th>Pre-Installation</th>
<th>Post-Installation</th>
</tr>
</thead>
<tbody>
<tr>
<td>33.3%</td>
<td></td>
<td>16.7%</td>
</tr>
</tbody>
</table>

One-Year Follow Up with CIRCADIAN® Zirc™ Lights. 50% reduction in employees with excessive sleepiness on the Epworth Scale, a standardized fatigue metric.

### How often do you find yourself fighting sleep or briefly nodding-off while working?

<table>
<thead>
<tr>
<th>Several times per month or more</th>
<th>Pre-Installation</th>
<th>Post-Installation</th>
</tr>
</thead>
<tbody>
<tr>
<td>50.0%</td>
<td></td>
<td>33.3%</td>
</tr>
</tbody>
</table>

One-Year Follow Up with CIRCADIAN® Zirc™ Lights. 33% reduction in frequent nodding off/fighting sleep events. This represents a significant risk reduction of inattention and impaired performance in shiftworkers.
PART ONE CONTINUED: Alertness, Fatigue and Operator Errors

ISSUE: Circadian disruption caused by inadequate unhealthy lighting is associated with reduced alertness, increased fatigue and increased errors at work.

INTERVENTION: CIRCADIAN® Zirc™ Lights were installed and operated for One Year.

How would you describe your average alertness level at 5am?

<table>
<thead>
<tr>
<th>Somewhat Fresh or Alert</th>
<th>Pre-Installation</th>
<th>Post-Installation</th>
</tr>
</thead>
<tbody>
<tr>
<td>16.7%</td>
<td>33.3%</td>
<td></td>
</tr>
</tbody>
</table>

50% increase in employees alert and fresh at 5am, the hardest time to stay awake on the night shift.

How often do you make mistakes or errors?

<table>
<thead>
<tr>
<th>Several Times Per Month or More Frequently</th>
<th>Pre-Installation</th>
<th>Post-Installation</th>
</tr>
</thead>
<tbody>
<tr>
<td>25%</td>
<td>8.3%</td>
<td></td>
</tr>
</tbody>
</table>

67% reduction in employees reporting frequent mistakes or errors in their safety-critical jobs.

Reported in confidential survey.
**PART TWO: Obesity, Eating & Gastrointestinal Disorders**

**ISSUE:** Circadian disruption caused by inadequate unhealthy lighting is associated with increased appetite, increased risk of obesity, diabetes and gastrointestinal disorders.

**INTERVENTION:** CIRCADIAN® Zirc™ Lights were installed and operated for One Year.

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**How often do you eat or snack on the night shift?**

<table>
<thead>
<tr>
<th># of Snacks per Night Shift</th>
<th>Pre-Installation</th>
<th>Post-Installation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.8</td>
<td>1.8</td>
</tr>
</tbody>
</table>

One-Year Follow Up with CIRCADIAN® Zirc™ Lights. 45% reduction in average number of snacks eaten during the night shift. This represents a significant risk reduction of the excessive night shift appetite seen with conventional lights.

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**Body Mass Index (BMI) Classification**

<table>
<thead>
<tr>
<th>Overweight or Obese (BMI)</th>
<th>Pre-Installation</th>
<th>Post-Installation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>58.0%</td>
<td>41.6%</td>
</tr>
</tbody>
</table>

One-Year Follow Up with CIRCADIAN® Zirc™ Lights. 28% reduction in employees who rank as obese or overweight by the Body Mass Index (BMI). This represents a significant risk reduction of the obesity/diabetic risk associated with conventional lights at night.
PART TWO CONTINUED: Obesity, Eating & Gastrointestinal Disorders

ISSUE: Circadian disruption caused by inadequate unhealthy lighting is associated with increased appetite, increased risk of obesity, diabetes and gastrointestinal disorders.

INTERVENTION: CIRCADIAN® Zirc™ Lights were installed and operated for One Year.

Gastrointestinal Disorder Assessment

<table>
<thead>
<tr>
<th>GI Scores of 12 or higher</th>
<th>Pre-Installation</th>
<th>Post-Installation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>41.7%</td>
<td>33.3%</td>
</tr>
</tbody>
</table>

One-Year Follow Up with CIRCADIAN® Zirc™ Lights. 20% reduction in employees with gastrointestinal disorders:

- Disturbed appetite
- Food-related stomach upsets
- Feeling nauseous
- Heartburn
- Indigestion
- Bloated stomach or gas
- Constipation or diarrhea
- Abdominal pain

Use of Over-the-Counter Pain Relievers

Take Pain Relievers (i.e. Tylenol, Aspirin, etc.) several times a month or more often

<table>
<thead>
<tr>
<th>Take Pain Relievers</th>
<th>Pre-Installation</th>
<th>Post-Installation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>58.3%</td>
<td>33.3%</td>
</tr>
</tbody>
</table>

One-Year Follow Up with CIRCADIAN® Zirc™ Lights. 43% reduction in frequent users of over the counter pain medications.
CONCLUSIONS

One-year after installing CIRCADIAN® Zirc™ Lights in a 24/7 mission-critical control room:

Control room operators were less fatigued & made fewer errors
• 50% reduction in excessive sleepiness
• 67% reduction in employees making mistakes and errors

Employee health was improved
• 28% reduction in obese or overweight employees
• 20% reduction in gastrointestinal disorders
• 43% reduction in frequent use of OTC pain medication

Conclusion
CIRCADIAN® Zirc™ Lights provided a sustained improvement in employee performance and health.
CIRCADIAN® ZircLight™ is producing intelligent circadian white light fixtures which regulate the dosage and timing of bio-active blue light to increase human health and productivity throughout the 24/7 day-night cycle.

The initial CIRCADIAN® ZircLight™ products are fully autonomous light fixtures that can be installed by any qualified electrician and regulate the timing of the bio-active blue light by time of day, season of the year and zip code (i.e. latitude and longitude) for up to 10 years without requiring any changes or additional input. They are specifically designed to boost productivity and decrease absenteeism, turnover, errors, and accidents in workplaces that operate around the clock.

By controlling the bio-active blue dosage, the proprietary CIRCADIAN® LEDs reduce the harmful spectral wavelengths that have been associated with an increase of 35-65% in obesity, diabetes, heart disease, sleep disorders, depression, reproductive disorders and multiple cancers, including breast cancer and prostate cancer. CIRCADIAN® Zirc™ Lights solve the night lighting problem by providing high quality white light 24/7 and avoid the dimming and low color temperature approaches used by other so-called “circadian” lighting products, which do not sufficiently reduce the bio-active blue dosage.