1.1 PRODUCT DESCRIPTION

The SYLVANIA ICETRON® QUICKTRONIC® system consists of an inductively coupled fluorescent lamp and a high frequency ballast. These systems use magnetic-induction technology instead of an electrode at each end of the fluorescent tube to power the discharge. Removal of the electrodes eliminates one of the major life-limiting components of a fluorescent lamp. The system design is optimized for high efficacy, high lumen output and maximum reliability.

SYLVANIA ICETRON lamp and ballast systems can reduce maintenance costs due to an average rated life of 100,000 hours. This is five to eight times the typical service life of conventional fluorescent and metal halide lamps. The ICETRON system is especially well suited for application where relamping is difficult or expensive.

The high output ICETRON lamp is constructed of 2-1/8" (54 mm) diameter tubing with a closed loop discharge path. The lamp is driven with a high frequency (250 kHz) electronic ballast. Power is coupled to the lamp inductively through two ferrite core transformers located on the ends of the lamp. With no electrode to break or emissive coating to evaporate, lamp life is limited only by lumen maintenance. Further, lumen maintenance is improved over that of conventional fluorescent or HID systems due to the electrodeless design.

Figure 1: ICETRON System
1.1.1 System Features

- High lumen output
- High system efficacy – up to 76 LPW
- 100,000 hour life
- Instant on/instant restrike
- Fast warm-up time
- White light – minimal color shift over life
- 3500K, 4100K and 5000K color temperatures
- Excellent color rendering – 80 CRI for 3500K, 4100K & 5000K lamps
- Blacklight lamps with peak energy at 360nm available in 100W & 150W versions
- Starting temperatures as low as -40°F
- Amalgam technology for wide operating temperature range
- 70% lumen maintenance at 60,000 hours of life (70W & 150W ICE 3500K, 4100K & 5000K lamps)
- 65% lumen maintenance at 60,000 hours of life (100W ICE 3500K, 4100K & 5000K lamps)
- Low EMI – Complies with FCC non-consumer limits
- Low inrush current at starting

1.1.2 System Offering

Table 1: System Availability

<table>
<thead>
<tr>
<th>Ballast</th>
<th>Lamp</th>
<th>System Power 120V/277V</th>
<th>Initial System Lumens* (5000K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>QT1x100 ICE/UNV</td>
<td>ICETRON 70</td>
<td>79/77</td>
<td>6500 (6250)</td>
</tr>
<tr>
<td>QT1X100 ICE/UNV</td>
<td>ICETRON 100</td>
<td>106/103</td>
<td>8000 (7600)</td>
</tr>
<tr>
<td>QT1X150 ICE/UNV</td>
<td>ICETRON 100</td>
<td>154/149</td>
<td>11,000 (10,600)</td>
</tr>
<tr>
<td>QT1X150 ICE/UNV</td>
<td>ICETRON 150</td>
<td>161/156</td>
<td>12,000 (11,650)</td>
</tr>
</tbody>
</table>

*values for 3500K & 4100K (values in parenthesis is for 5000K)
1.2 LAMP SYSTEM TECHNOLOGY AND OPERATION

1.2.1 Operating Principle

The ICETRON® QUICKTRONIC® lighting system incorporates an electrodeless fluorescent lamp which is excited by a radio frequency (RF) magnetic field. As a fluorescent lamp, ICETRON utilizes the same mechanism for light generation as found in conventional fluorescent lamps with internal electrodes. That is, the ultraviolet (UV) radiation generated by the internal discharge is converted to visible light by the phosphor coating on the inner wall of the lamp envelope. In contrast with conventional discharge lamps of fluorescent type, ICETRON does not require electrodes. Furthermore, the discharge current path forms a closed loop as shown in Figure 2 below.

The electric field that initiates and maintains the plasma inside the discharge vessel is created not by electrodes but by an RF magnetic field concentrated within ferromagnetic ring cores. In essence, the ICETRON lamp is an electrical transformer with the closed loop discharge plasma serving as a one-turn secondary winding coupled to ferromagnetic cores whose multi-turn primary windings are excited by an electronic RF power converter (the ballast).

The ICETRON lamp utilizes an inductively coupled plasma that is driven in a closed loop discharge tube. Within that tube, RF power is evenly distributed along the discharge path. This allows a low profile geometry that avoids excessive thermal stress near the excitation area (typical of RF lamps with internal RF drive).

ICETRON operates at a frequency of 250 kHz (relatively low when compared to other RF lamps which function at 2.65 and 13.56 MHz). This frequency minimizes electromagnetic interference problems and ballast complexity. Together with the decentralized power injection, the low frequency operation results in a long-life electrodeless fluorescent lamp with unprecedented light output and system efficiency.

Figure 2: How does the ICETRON lamp work?
## 1.3 SYSTEM OVERVIEW

### 1.3.1 Ordering and Specification Information

### Table 2: Ordering and Specification Information

**SYSTEMS**

<table>
<thead>
<tr>
<th>System Description</th>
<th>Lamp Wattage</th>
<th>System Watts</th>
<th>System Lumens* (5000K)</th>
<th>Mean Lumens** (5000K)</th>
<th>Av. System Life (hrs.)</th>
<th>Initial LPW</th>
<th>Burning Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICETRON® 70/QT100</td>
<td>70</td>
<td>79/77</td>
<td>6500 (8250)</td>
<td>4830 (4645)</td>
<td>100,000</td>
<td>82/84</td>
<td>Universal</td>
</tr>
<tr>
<td>ICETRON 100/QT100</td>
<td>100</td>
<td>106/103</td>
<td>8000 (7600)</td>
<td>5945 (5645)</td>
<td>100,000</td>
<td>75/77</td>
<td>Universal</td>
</tr>
<tr>
<td>ICETRON 100/QT150</td>
<td>150</td>
<td>154/149</td>
<td>11,000 (10,600)</td>
<td>8175 (7875)</td>
<td>100,000</td>
<td>71/73</td>
<td>Universal</td>
</tr>
<tr>
<td>ICETRON 150/QT150</td>
<td>150</td>
<td>161/156</td>
<td>12,000 (11,650)</td>
<td>8915 (8655)</td>
<td>100,000</td>
<td>74/76</td>
<td>Universal</td>
</tr>
</tbody>
</table>

* values for 3500K & 4100K (value in parenthesis is for 5000K)

** Mean lumens at 40,000 hours

Ballast Factor for the ICETRON 70/QUICKTRONIC® QT100W is 105%

Ballast Factor for ICETRON 100/QUICKTRONIC® QT150W is 138%

**LAMPS**

<table>
<thead>
<tr>
<th>Item Number</th>
<th>Ordering Abbreviation</th>
<th>Initial Lamp Lumens</th>
<th>Color Temp K</th>
<th>CRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>26087</td>
<td>ICE70/835/2P/ECO</td>
<td>6200</td>
<td>3500</td>
<td>80</td>
</tr>
<tr>
<td>26088</td>
<td>ICE70/841/2P/ECO</td>
<td>6200</td>
<td>4100</td>
<td>80</td>
</tr>
<tr>
<td>26089</td>
<td>ICE70/850/2P/ECO</td>
<td>5950</td>
<td>5000</td>
<td>80</td>
</tr>
<tr>
<td>26102</td>
<td>ICE100/835/2P/ECO</td>
<td>8000</td>
<td>3500</td>
<td>80</td>
</tr>
<tr>
<td>26103</td>
<td>ICE100/841/2P/ECO</td>
<td>8000</td>
<td>4100</td>
<td>80</td>
</tr>
<tr>
<td>26105</td>
<td>ICE100/850/2P/ECO</td>
<td>7600</td>
<td>5000</td>
<td>80</td>
</tr>
<tr>
<td>26152</td>
<td>ICE150/835/2P/ECO</td>
<td>12,000</td>
<td>3500</td>
<td>80</td>
</tr>
<tr>
<td>26153</td>
<td>ICE150/841/2P/ECO</td>
<td>12,000</td>
<td>4100</td>
<td>80</td>
</tr>
<tr>
<td>26155</td>
<td>ICE150/850/2P/ECO</td>
<td>11,650</td>
<td>5000</td>
<td>80</td>
</tr>
<tr>
<td>26106</td>
<td>ICE100/BL/2P*</td>
<td>N/A</td>
<td>360 nm Peak</td>
<td>N/A</td>
</tr>
<tr>
<td>26154</td>
<td>ICE150/BL/2P*</td>
<td>N/A</td>
<td>360 nm Peak</td>
<td>N/A</td>
</tr>
</tbody>
</table>

* The Blacklight lamps also produce some visible wavelengths. If the application requires that the visible wavelengths be blocked, the system should be used in a fixture with a cobalt blue lens.

** When used in cold temperature applications, it is recommended that amalgam tip covers be used to insulate the amalgam tips and improve lumen output.

**BALLASTS**

<table>
<thead>
<tr>
<th>Item Number</th>
<th>Ordering Abbreviation</th>
<th>Voltage Range</th>
<th>Compatible Lamps</th>
<th>Input Current (AMPS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>49753</td>
<td>QT1X100 ICE/UNV-T</td>
<td>120-277</td>
<td>ICE 100</td>
<td>0.88/0.37</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ICE 70</td>
<td>0.66/0.29</td>
</tr>
<tr>
<td>49772</td>
<td>QT1X150 ICE/UNV-T</td>
<td>120-277</td>
<td>ICE 150</td>
<td>1.34/0.58</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ICE 100</td>
<td>1.28/0.54</td>
</tr>
</tbody>
</table>

Note: The 100W lamp is able to operate on both QT100W and QT150W ballasts. The QT100W ballast will operate both the 70W and 100W ICETRON lamp.

Specifications: UL Listed Class P, Type 1, Outdoor, CSA Certified

- Temp Test Point (Tc) on ballast label: 70°C Max (150W) 65°C Max (100W)
- FCC 47CFR Part 18 Non-Consumer Sound Rated A
- ANSI C62.41 Cat. A Transient Protection
- Remote Mounting: Contact OSRAM SYLVANIA
1.3.2 Ordering Guide

Table 3: Ordering Guide

<table>
<thead>
<tr>
<th>QT</th>
<th>X</th>
<th>100</th>
<th>ICE</th>
<th>/UNV</th>
<th>-T</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUICKTRONIC® No. Lamps Lamp Wattage Inductively Coupled Electrodeless Line Voltage (120 to 277V) T = Top Mount</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>QT1X100ICE/UNV-T</td>
<td>1</td>
<td>X</td>
<td>100</td>
<td>/</td>
<td>UV</td>
</tr>
<tr>
<td>ICE100/835/2P/ECO</td>
<td>100</td>
<td>/</td>
<td>8</td>
<td>8 = 80 CRI</td>
<td></td>
</tr>
<tr>
<td>ICE</td>
<td>Inductively Coupled Electrodeless</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICE100/BL/2P</td>
<td>100</td>
<td>/</td>
<td>BL</td>
<td>2P</td>
<td></td>
</tr>
<tr>
<td>ICE</td>
<td>Inductively Coupled Electrodeless</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICE100/BL/2P</td>
<td>100</td>
<td>/</td>
<td>BL</td>
<td>2P</td>
<td></td>
</tr>
<tr>
<td>ICE</td>
<td>Inductively Coupled Electrodeless</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1.3.3 System Comparison

Table 4: System Comparison

<table>
<thead>
<tr>
<th>System</th>
<th>System</th>
<th>System</th>
<th>System</th>
<th>Average Life (hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watts</td>
<td>Lumens</td>
<td>LPW</td>
<td>@</td>
<td>10 hrs/start CRI</td>
</tr>
<tr>
<td>(5000K)</td>
<td>(5000K)</td>
<td>(5000K)</td>
<td>10,000 hours</td>
<td>(5000K)</td>
</tr>
<tr>
<td>ICETRON 70</td>
<td>79/77</td>
<td>6500 (6250)</td>
<td>82/84 (79/81)</td>
<td>5545 (5330)</td>
</tr>
<tr>
<td>70W Metal Halide</td>
<td>90</td>
<td>5200</td>
<td>58</td>
<td>3400</td>
</tr>
<tr>
<td>2 – 1-5/8 Curvalume*</td>
<td>57</td>
<td>4905</td>
<td>86</td>
<td>4400</td>
</tr>
<tr>
<td>ICETRON 100</td>
<td>106/103</td>
<td>8000 (7600)</td>
<td>75/77 (72/74)</td>
<td>6825 (6485)</td>
</tr>
<tr>
<td>100W Metal Halide</td>
<td>129</td>
<td>8500</td>
<td>66</td>
<td>5500</td>
</tr>
<tr>
<td>3 – 1-5/8 Curvalume*</td>
<td>84</td>
<td>7360</td>
<td>88</td>
<td>6600</td>
</tr>
<tr>
<td>ICETRON 150</td>
<td>161/156</td>
<td>12,000 (11,650)</td>
<td>74/76 (72/75)</td>
<td>10,235 (9940)</td>
</tr>
<tr>
<td>150W Metal Halide</td>
<td>185</td>
<td>12,900</td>
<td>70</td>
<td>8400</td>
</tr>
</tbody>
</table>

* On instant start electronic ballast.

Figure 3: Comparison of lamp life and lumens for ICETRON® to 175W metal halide lamps. Ten metal halide lamps would be required to replace one ICETRON lamp based on the 100,000 system life of the ICETRON QUICKTRONIC system.
2.1 LAMP DIMENSIONS

Table 5: Lamp Dimensions

<table>
<thead>
<tr>
<th>Dim.</th>
<th>ICETRON 70</th>
<th>ICETRON 100</th>
<th>ICETRON 150</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height of glass H1</td>
<td>2.13</td>
<td>54</td>
<td>2.13</td>
</tr>
<tr>
<td>Overall height H2</td>
<td>2.87</td>
<td>73</td>
<td>2.87</td>
</tr>
<tr>
<td>Tube to mount height H3</td>
<td>0.39</td>
<td>10</td>
<td>0.39</td>
</tr>
<tr>
<td>Length of main body L1</td>
<td>9.84</td>
<td>250</td>
<td>9.84</td>
</tr>
<tr>
<td>Overall length L2</td>
<td>12.40</td>
<td>315</td>
<td>12.40</td>
</tr>
<tr>
<td>Mount hole spacing (between cores) L3</td>
<td>5.02</td>
<td>127.4</td>
<td>5.02</td>
</tr>
<tr>
<td>Mount hole spacing (each core) L4</td>
<td>3.36</td>
<td>85.3</td>
<td>3.36</td>
</tr>
<tr>
<td>Bracket spacing L5</td>
<td>4.13</td>
<td>105</td>
<td>4.13</td>
</tr>
<tr>
<td>Amalgam tip length L6</td>
<td>0.59</td>
<td>15</td>
<td>0.59</td>
</tr>
<tr>
<td>Lead wire length L7</td>
<td>24.00</td>
<td>609.6</td>
<td>24.00</td>
</tr>
<tr>
<td>Slot width S</td>
<td>0.20</td>
<td>5.1</td>
<td>0.20</td>
</tr>
<tr>
<td>Tip to centerline T</td>
<td>0.98</td>
<td>25</td>
<td>0.98</td>
</tr>
<tr>
<td>Width W</td>
<td>5.41</td>
<td>137.5</td>
<td>5.41</td>
</tr>
<tr>
<td>Lamp Weight</td>
<td>2.1 lb</td>
<td>0.95 kg</td>
<td>2.1 lb</td>
</tr>
</tbody>
</table>

Note: Dimensions subject to change.

Figure 4: ICETRON® Lamp

2.2 BALLAST DIMENSIONS

Table 6: Ballast Dimensions

<table>
<thead>
<tr>
<th>Dim.</th>
<th>in.</th>
<th>mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case Width W1</td>
<td>3.96</td>
<td>100</td>
</tr>
<tr>
<td>Case Length L2</td>
<td>6.30</td>
<td>160</td>
</tr>
<tr>
<td>Overall Length L1</td>
<td>7.15</td>
<td>181</td>
</tr>
<tr>
<td>Case Height H1</td>
<td>1.70</td>
<td>43</td>
</tr>
<tr>
<td>Mount Slot (Ctr. To Ctr.) S1</td>
<td>1.90</td>
<td>48.3</td>
</tr>
<tr>
<td>Mount Slot (Ctr. To Ctr.) S2</td>
<td>6.70</td>
<td>170</td>
</tr>
<tr>
<td>Slot Width W2</td>
<td>0.31</td>
<td>8</td>
</tr>
<tr>
<td>Mount Slot (Ctr. To Edge) S3</td>
<td>0.97</td>
<td>25</td>
</tr>
<tr>
<td>Ballast Weight</td>
<td>1.9 lb</td>
<td>0.86 kg</td>
</tr>
</tbody>
</table>
2.3 LAMP ADAPTER AND WIRE HARNESS

Figure 6: The old-lamp-to-new-ballast adapter, NAED 26240, allows the use of the original ICETRON® lamp with 3-Prong connectors with the ICETRON QUICKTRONIC ballast with 2-Prong connectors on ballast (no leads).

Figure 7: The 24" wiring extension/harness (NAED 49755)

Figure 8: The 24" panel-mount extension/harness (NAED 49757)
3.1 ELECTRICAL AND PHOTOMETRIC CHARACTERISTICS

The ICETRON® QUICKTRONIC® ballast is designed to operate at line voltages of 120 to 277±10% VAC. Electrical and photometric characteristics listed in Table 7 below apply to operation on 120 VAC line voltage. System efficacy increases slightly when operated at 277 VAC. The table below applies to the following test conditions:

- 120 V, 60 Hz input
- Lamps aged 100 hours
- 4-hour warm-up time
- Amalgam tip temperature of 158°F (70°C) for ICE 70 lamp
- Amalgam tip temperature of 149°F (65°C) for ICE 100 lamp
- Amalgam tip temperature of 158°F (70°C) for ICE 150 lamp

Table 7: Electrical and Photometric Characteristics

<table>
<thead>
<tr>
<th>Measure</th>
<th>Unit</th>
<th>QT 1x150 Ballast</th>
<th>QT 1x100 Ballast</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ballast Input Voltage</td>
<td>V</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>System Power</td>
<td>W</td>
<td>161</td>
<td>154</td>
</tr>
<tr>
<td>System Lumens (5000K)</td>
<td>Lm</td>
<td>12,000 (11,650)</td>
<td>11,000 (10,600)</td>
</tr>
<tr>
<td>System Efficiency</td>
<td>Lm/W</td>
<td>74</td>
<td>71</td>
</tr>
<tr>
<td>Ballast Input Current</td>
<td>A</td>
<td>1.34</td>
<td>1.28</td>
</tr>
<tr>
<td>Ballast Input Frequency</td>
<td>Hz</td>
<td>50/60</td>
<td>50/60</td>
</tr>
<tr>
<td>Ballast Inrush Current max.</td>
<td>A</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Ballast Power Factor min.</td>
<td>BF</td>
<td>.95</td>
<td>.95</td>
</tr>
<tr>
<td>Ballast THD max.</td>
<td>%</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Lamp operating frequency</td>
<td>kHz</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>Starting voltage max</td>
<td>Vrms</td>
<td>1400</td>
<td>1200</td>
</tr>
</tbody>
</table>

Nominal values unless otherwise noted.

* System is also able to operate at supply voltage up to 277 VAC. Contact OSRAM SYLVANIA for electrical and photometric characteristics at these line voltages.
3.2 LAMP SPECTRAL CHARACTERISTICS

3.2.1 Color Characteristics

The x and y chromaticity coordinates determine the correlated color temperature (CCT) of the lamp. For many applications, the color rendering properties are also important. The color rendering index (CRI) provides an indication of how colors appear when illuminated by the lamp. An ideal source is given an index value of 100.

The color data in Table 8 applies to lamps aged 100 hours and with an amalgam tip temperature of 149°F (65°C) for ICETRON® 100 lamps and 158°F (70°C) for ICETRON 70 and 150 lamps.

Table 8: Color Characteristics

<table>
<thead>
<tr>
<th>System Lamp/Ballast</th>
<th>Color</th>
<th>Chromaticity Coordinates</th>
<th>CCT</th>
<th>CRI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>x</td>
<td>y</td>
<td>K</td>
</tr>
<tr>
<td>ICETRON 70/QT100</td>
<td>/835</td>
<td>0.411</td>
<td>0.393</td>
<td>3400</td>
</tr>
<tr>
<td></td>
<td>/841</td>
<td>0.380</td>
<td>0.380</td>
<td>4100</td>
</tr>
<tr>
<td></td>
<td>/850</td>
<td>0.346</td>
<td>0.359</td>
<td>5000</td>
</tr>
<tr>
<td>ICETRON 100/QT100</td>
<td>/835</td>
<td>0.411</td>
<td>0.393</td>
<td>3400</td>
</tr>
<tr>
<td></td>
<td>/841</td>
<td>0.380</td>
<td>0.380</td>
<td>4050</td>
</tr>
<tr>
<td></td>
<td>/850</td>
<td>0.346</td>
<td>0.359</td>
<td>5000</td>
</tr>
<tr>
<td>ICETRON 100/QT150</td>
<td>/835</td>
<td>0.406</td>
<td>0.393</td>
<td>3500</td>
</tr>
<tr>
<td></td>
<td>/841</td>
<td>0.375</td>
<td>0.380</td>
<td>4150</td>
</tr>
<tr>
<td></td>
<td>/850</td>
<td>0.341</td>
<td>0.359</td>
<td>5200</td>
</tr>
<tr>
<td>ICETRON 150/QT150</td>
<td>/835</td>
<td>0.411</td>
<td>0.393</td>
<td>3400</td>
</tr>
<tr>
<td></td>
<td>/841</td>
<td>0.380</td>
<td>0.380</td>
<td>4050</td>
</tr>
<tr>
<td></td>
<td>/850</td>
<td>0.346</td>
<td>0.359</td>
<td>5000</td>
</tr>
</tbody>
</table>

3.2.2 Color Tolerance Chart

Chromaticity coordinate tolerance ovals represent the maximum allowable variation of lamp color. The ovals in Figure 9 are 4-step for 3500K, 4100K and 5000K. One step represents the minimum perceivable difference in color between two lamps. The tolerance ovals are plotted relative to the black body locus in the figure below.

![Figure 9: Color Tolerance Ovals for Nominal Amalgam Tip Temperature](image-url)
3.2.2.1 Effect of Temperature on Color

The color temperature, chromaticity coordinates, and color rendering index of these lamps are influenced by the mercury vapor pressure, which in turn is determined by the amalgam tip temperature. There are two tip temperatures for optimum performance of ICETRON® 100 lamps:

149°F (65°C) and 229°F (108°C). For more details see section 3.7.2, page 15.

Optimum performance of ICETRON 70 and 150 lamps occurs at amalgam tip temperatures of 158°F (70°C) and 229°F (108°C).

At tip temperatures below 149°F for ICETRON 100 (or 158°F for ICETRON 70 and 150), color temperature decreases. At temperatures above 229°F, color temperature is increased. At temperatures between the two nominal operating points, the color temperature increases.

3.2.3 Spectral Power Distributions

A Spectral Power Distribution curve (SPD) shows the distribution of the spectral components of a given light source by plotting the level of power associated with each wavelength within the visible portion of the electromagnetic spectrum. This spectral information is a basic characteristic from which several simple descriptors may be calculated, for example, correlated color temperature (CCT), color rendering index (CRI), and chromaticity coordinates. These terms are often used in place of the SPD because of their simplicity and the relative ease with which distinct light sources may be compared on a quantitative basis. The spectral power from a fluorescent lamp is produced by two separate mechanisms. First, the mercury discharge generates narrow bands of radiation in the UV and blue regions. Second, the triphosphor coating is excited by ultraviolet radiation from the mercury discharge, which produces the radiated visible power at specific frequency bands centered at red, green, and blue, the primary colors of white light.
3.2.4 UV Emission

There are several metrics that characterize the UV emission from a lamp. Many materials, such as paints, dyes, cloth, paper, leather, etc. will discolor and/or weaken when exposed to radiant energy. UV has the greatest potential for such damage. In many lighting situations the total UV (λ < 400 nm) is taken as a simple benchmark of potential damage.

Because UV below about 320 nm has a high probability of interaction with many materials, this is possibly a better indicator of UV damage, especially to plastics.

There are also some health hazards associated with exposure to radiation below 400 nm where the biological action spectrum varies over several orders of magnitude. Exposure is evaluated in terms of the ACGIH $S(\lambda)$ weighted power which gives higher weighting to the more damaging UV below 300 nm.

The UV exposure under common lighting systems is below the accepted safe exposure limits.

The UV metrics of the ICETRON® 150 lamp are shown in Table 9 on the following page. The values are normalized to a per unit light basis expressed in microwatts per lumen. Some other representative light sources are listed in the table for comparison.

Most fluorescent blacklight lamps emit sufficient energy in the UV range to have Risk Group ratings based on ANSI/IESNA RP-27.3-96 (American National Standards Institute and Illuminating Engineering Society of North America). The Risk Group (RG) rating for the 100W and 150W lamps follows Table 10.
3.3 LUMINOUS INTENSITY DISTRIBUTION

![Luminous Intensity Distribution Diagram](image)

Table 9: Comparison of UV Metrics

<table>
<thead>
<tr>
<th>Lamp Type</th>
<th>λ &lt; 320 nm</th>
<th>UV Microwatts Per Lumen</th>
<th>λ &lt; 400nm</th>
<th>S(λ) Weighted</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICETRON® 150</td>
<td>9</td>
<td>75</td>
<td>0.15</td>
<td></td>
</tr>
<tr>
<td>Incandescent (2850K)</td>
<td>2</td>
<td>75</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>OCTRON® Fluorescent</td>
<td>25 – 45</td>
<td>90 – 150</td>
<td>0.4 – 1.2</td>
<td></td>
</tr>
<tr>
<td>Standard Metal Halide</td>
<td>8 – 16</td>
<td>-500</td>
<td>0.2 – 0.6</td>
<td></td>
</tr>
</tbody>
</table>

Table 10: UVA Output Characteristics – Blacklight

<table>
<thead>
<tr>
<th>Emission peak at wavelength</th>
<th>Nm</th>
<th>368 ± 2 nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum UVA irradiance (320-400 nm) at 100 hr</td>
<td>µW/cm²</td>
<td>3700</td>
</tr>
</tbody>
</table>

1 Measured on a line normal to the plane of the bulb centerline aligned with the geometric center of the bulb and at a distance of 25 cm from the surface of the bulb.

CAUTION: This lamp emits ultraviolet (UV) power during operation and is in Risk Group 2 per ANSI/IESNA RP-27.3-96. Exposure at less than 0.75 meters (30 inches) should be limited; for example exposure at 0.55m (22 inches) should not exceed 4 hours in an 8 hour interval (see ANSI/IESNA RP-27.1-96). Certain medications and chemicals can increase an individual's sensitivity. Consult your physician for specific information. Protective eyewear should be worn in occupational situations involving long term exposure in close proximity to the lamp. This lamp is not intended and should not be used for diagnostic, therapeutic or cosmetic purposes.

3.4 STARTING

3.4.1 Run-Up Time

The lumen output of ICETRON® QUICKTRONIC® systems is dependent on the mercury vapor pressure in the lamp which in turn is determined by the ambient temperature. These lamps use an amalgam system which results in low mercury vapor pressure before starting. However, an auxiliary amalgam is located in the discharge to ensure fast lumen run-up. After switch-on, this auxiliary amalgam heats rapidly, releasing mercury into the discharge. Light output quickly peaks and then dips slightly as mercury vapor pressure increases above optimum. After a few minutes, the mercury begins diffusing back to the main amalgam. The time required for thermal equilibrium depends on ambient temperature, fixture design, and off time; but typically requires about four hours.

A typical run-up curve for an ICETRON lamp after 16 hours of off time at 77°F (25°C) ambient temperature is shown in Figure 15. Under these conditions, lumen output is more than 90% of peak after about 10 seconds. Subsequent lumen variations are measurable but not noticeable to the eye. For off periods of less than 1 minute, the light output returns almost immediately to the equilibrium value.
3.4.2 Low/High Temperature Starting

The 150W and 100W ICETRON® QUICKTRONIC® systems provide fast, flicker free starting at ambient temperatures down to -40°F (-40°C). The 70W system provides reliable, flicker free starting down to -13°F (-25°C) ambient temperature. In most applications, including hot strike, the start time will be less than 50 msec.

3.5 LIFE EXPECTANCY

3.5.1 Typical Lumen Maintenance

When a fluorescent lamp is new, its light output reaches the maximum value for which the plasma discharge and phosphor coating have been designed. As the lamp operates, various processes (plasma, chemical, and thermal) within the lamp envelope causing a gradual reduction of its light generating capability.

The degree to which the actual light output decreases with operating time is referred to as lumen maintenance. A typical lumen maintenance curve for the ICETRON lamp is shown in Figure 16 on the following page. Light output (normalized to 100% of the 100 hour value) is displayed as a function of time (operating hours).

3.5.2 System Mortality

The ICETRON QUICKTRONIC systems are designed to have an average rated life of 100,000 hours at a maximum ballast case temperature of 158°F (70°C) for the 150W ballast (or 149°F/ 65°C for the 100W ballast). After 100,000 hours 50% of the ballasts will be surviving. (At 60,000 hours, 10% failures are expected.) However, the luminous flux of the ICETRON lamp is expected to have depreciated after 60,000 hours to no less than 70% (65% for 100W lamp) of the initial rated lumens. See Figures 16 and 17 for lumen maintenance curves. See Figure 18 for lamp life and lumen maintenance comparison to HID lamps.

3.6 LAMP ORIENTATION

The ICETRON lamp may be operated in any position. If the lamp is operated in the vertical or an angled position, the lamp should be mounted with the amalgam tip in the downward position. The amalgam tip is on the lamp connector side. Operating position has a slight effect on the amalgam tip temperature and this should be considered in fixture design to ensure optimum performance. (See section 3.7 for detailed information on performance versus temperature). The lamp should be attached to the fixture only by the mounting feet. There should be no other direct contact between the fixture and the lamp. Any thermally conductive contact with the lamp glass can result in a relatively cool spot where mercury can condense, creating a competing mercury vapor pressure control point which will adversely affect the lamp performance.
3.7 TEMPERATURE CONSIDERATIONS

3.7.1 System Temperature Limits

The 150W ICETRON QUICKTRONIC® system has a maximum allowable ballast case temperature of 158°F (70°C), the 100W ICETRON QUICKTRONIC system has a maximum allowable ballast case temperature of 149°F (65°C). To maximize system life, ambient temperature of the ballast should be kept as low as possible. It is also important to maintain effective dissipation of heat using the lighting fixture as a heat-sink for the ballast enclosure and the lamp induction cores. For more detail, see section 4.4.

The temperature of the lamp should also be controlled. The maximum allowable temperature at the mounting base of the lamp induction core is 212°F (100°C). The amalgam tip temperature must be within the range of 131°F to 257°F (55°C to 125°C) to exceed 90% light output. For the 150W and 100W lamp the minimum starting temperature of the system is -40°F (-40°C). For the 70W lamp the minimum starting temperature of the system is -13°F/-25°C.
3.7.2 Effect of Amalgam Tip Temperature on System Performance

The light output and system wattage of ICETRON® QUICKTRONIC® systems depend on the amalgam temperature during operation. Figure 19 shows this relationship for a nominal ICETRON 70 lamp operated on QT100 ballast. Light output is at least 90% of peak over the temperature range of 131°F to 257°F (55°C to 125°C). Figure 20 shows this relationship for a nominal ICETRON 100 lamp operated on QT100 or QT150 ballast. Light output is at least 90% of peak over the temperature range of 122°F to 257°F (50°C to 125°C). The effect of amalgam temperature on relative luminous flux and system power for the ICETRON QUICKTRONIC 150 system is illustrated in Figure 21. A nominal ICETRON QUICKTRONIC 150 system produces at least 90% of peak output over amalgam temperature range of 131°F to 257°F (55°C to 125°C).

The amalgam temperature during operation is determined by the ambient temperature, the ICETRON QUICKTRONIC system used, and the lighting fixture construction.

- In general, a one degree increase in ambient temperature will result in a corresponding one degree increase in amalgam temperature. However, the actual temperature difference (between ambient and amalgam tip temperature) depends on the system used and fixture construction. A fixture that reflects light back onto the lamp or that concentrates heat near the amalgam tip will result in a higher ΔT.
- The ICETRON 100 lamp operated on our QT150 ballast runs substantially hotter than either the ICETRON QUICKTRONIC 150 system or standard ICETRON QUICKTRONIC 100 system due to the higher power dissipation per unit area of lamp surface. This results in a higher amalgam temperature at a given ambient temperature. Therefore, this system is better suited for lower temperature applications.
- The ICETRON 70 lamp operated on the QT100 ballast will run cooler than both the 100W and the 150W; its amalgam tip temperature will also be lower. This should be taken into consideration when designing a fixture.
- The amalgam tip temperature can be increased by insulating the tips with amalgam tip covers available from OSRAM SYLVANIA. Use of the amalgam tip covers is recommended for cold temperature applications.
- The range of high lumen output can also be shifted to lower ambient temperatures by increasing the heat retaining characteristics of the lighting fixture. Small fixture volume, low fixture surface area, use of low thermal conductivity materials or multiple wall construction, etc. will increase the temperature difference between amalgam and ambient temperatures, shifting the lumen vs. ambient temperature curve to lower temperatures. Conversely, open, increased fixture volume, high surface area fixtures shift the curve to higher ambient temperatures. Orienting the lamp with amalgam tip down and avoiding reflection of light back onto the lamp also allows operation in higher ambient temperatures.

![Figure 19: System Power and Relative Lumen Output vs. Amalgam Temperature for ICETRON 70](image-url)
3.7.3 Effect Of Ambient Temperature On System Performance

For a given system and fixture, the ambient temperature will determine the system’s temperatures: amalgam tip, ballast, bulb wall, and magnetic toroid will affect system performance and/or system life.

In general, a one degree increase in ambient temperature will result in a one degree increase in the system components’ temperatures. It is important to design the fixture for the system used, in order to satisfy the different thermal requirements of the ICETRON QUICKTRONIC® systems. Refer to section 4.4 for more details.

The following charts show the system temperatures versus the ambient temperature with the corresponding system power and relative light output. The actual temperatures recorded will depend on the fixture design: housing dimension, heat sinking efficiency, reflector geometry and size, use of passive or active amalgam heating, etc. However, the relationship between ambient and system temperatures variations will remain roughly one to one.
Figure 22: 70W ICETRON® lamp/100W QUICKTRONIC® ballast

Figure 23: 100W ICETRON lamp/100W QUICKTRONIC ballast

Figure 24: 100W ICETRON lamp/150W QUICKTRONIC ballast
3.8 EMI CHARACTERISTICS

3.8.1 EMI/RFI Characteristics

Electronic devices often contain power supplies that can generate electromagnetic interference (EMI/RFI). The interference may either be conducted through the power supply wiring or radiated through air. The ICETRON QUICKTRONIC system contains filter circuitry within the ballast that limits the amount of electromagnetic interference to comply with Federal Communications Commission’s (FCC) limits for commercial lighting products (FCC CFR 47, Part 18, non-consumer rating).

3.8.2 EMI/RFI Performance

Figure 26 shows the conducted electromagnetic interference for the ICETRON QUICKTRONIC systems. ICETRON QUICKTRONIC systems comply with the FCC limits which are: 1) conducted: maximum 1000 microvolt in the 0.45 MHz to 1.6 MHz range, and maximum 3000 microvolts in the 1.6 MHz to 30 MHz range 2) radiated field strength limit at 30 meters: maximum 30 microvolts per meter in the 30 MHz to 88 MHz range, maximum of 50 microvolts per meter in the 88 MHz to 216 MHz range, and maximum 70 microvolts per meter in the 216 MHz to 1000 MHz range.

Figure 26: EMI QT1x150ICE/UNV-T with 20 meter remote cable in conduit
3.9 SHOCK AND VIBRATION

The ICETRON® lamp is designed to tolerate shock and vibration that would be expected in typical applications such as post top, bridge, roadway underpass or tunnel lighting. ICETRON lamps have been tested under the following conditions with no damage:

Shock – Lamps subjected to three (3) one-half sine wave shocks of 10 ms duration at 20 g.

Table 11: Vibration Parameters

The vibration parameters were adapted from ANSI C136.31-2001, American National Standard for Roadway Lighting Equipment – Luminaire Vibration, Section 5, luminaire vibration test.

<table>
<thead>
<tr>
<th>Start Freq.</th>
<th>Amplitude</th>
<th>End Freq.</th>
<th>Amplitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Hz</td>
<td>1.5 G</td>
<td>7.07107 Hz</td>
<td>3.5 G</td>
</tr>
<tr>
<td>10 Hz</td>
<td>3.5 G</td>
<td>30 Hz</td>
<td>3.5 G</td>
</tr>
</tbody>
</table>

Sweep between 5 Hz and 30 Hz at 0.861654 Min/sweep (linear)
Duration: 100,000 cycles at 100%
Total test time: 1:36:30

Care should be taken when mounting the ballast to minimize vibration.

3.10 SYSTEM PROTECTION

3.10.1 Lamp Fails to Light

If the ICETRON lamp should fail to light within 10 seconds the ballast will shut down (providing protection for the system components). To reset the ballast, the input voltage to the ballast must be turned off for a minimum of 10 seconds, then reapply input voltage.

3.10.2 Replacing a Failed Lamp

Before replacing a lamp, power to the ballast must be turned off. If a user mistakenly unplugs a lamp from an energized ballast, the ballast will automatically shut down. If an operational lamp is re-connected to the ballast, the ballast will automatically reset and provide power to the lamp.

3.11 INRUSH CURRENT

When a lighting system is energized, a momentary surge of current occurs, called “inrush”. This current must be limited so that it does not harm auxiliary lighting controls (mechanical switches, contacts, relays, etc.). All ICETRON QUICKTRONIC® systems limit the ballast inrush current to less than 5 amperes.

3.12 ELECTRICAL FUSING

All ICETRON QUICKTRONIC systems contain inherent electrical protection. Although there is no need to externally fuse the ballast, should code or regulation require it, a 4 amperes slow blow fuse is recommended.

3.13 SOUND RATING

ICETRON QUICKTRONIC ballasts are sound rated A (up to 75% quieter than magnetic types) and are acceptable for most applications.
4.1 THERMAL ISSUES

The following thermal issues need to be addressed when designing a fixture for ICETRON® QUICKTRONIC® systems.

1. The ballast is a complex piece of electronic equipment that is sensitive to temperature. Elevated temperatures above its maximum design temperature rating \( T_{c \text{ max}} = 70°C/158°F \) for the 150W ballast and \( T_{c \text{ max}} = 65°C/149°F \) for the 100W ICETRON QUICKTRONIC ballast will reduce the life expectancy of the electronic components inside the ballast. A temperature test point is identified on the ballast label so that fixture designs may be evaluated to ensure that the ballast will not overheat. Further instructions for ballast thermal measurements is described in section 4.3.1 and 4.4.1. Failure to follow the guidelines may result in system shutting down due to an internal thermal breaker and activating a non-resettable indicator, the thermal dot \( (T_{\text{dot}}) \) located on the side of the ballast. Activation of the thermal dot and exceeding the \( T_{c \text{ max}} \) of 70°C/65°C will reduce system life and void the warranty. The system may shut down due to excessive temperature and then restart only when the ballast has had sufficient time to cool and the input voltage to the ballast is recycled.

2. Light output from the ICETRON QUICKTRONIC system is strongly influenced by the amalgam tip temperature. Follow the suggested guidelines in section 4 to ensure that the lamp will provide the optimum amount of light for your application.

3. The connector used to join the lamp to the ballast has a maximum temperature rating of 221°F (105°C). Keep connector away from lamp.

4. Although the lamp is not as sensitive to heat as the ballast, proper heat sinking can improve the performance of the lamp.

See section 4.4 for thermal testing and analysis guidelines.

4.2 EMI ISSUES

The ICETRON system operates at radio frequencies (250 kHz). Therefore it is important to suppress electromagnetic interference (EMI) to acceptable levels. Steps may be taken to ensure that EMI radiated from the system and EMI conducted into the power lines is minimal. See sections 3.8 and 4.3.3 for details.

4.3 LAMP/BALLAST MOUNTING

Due to their long life, ICETRON QUICKTRONIC system components are intended to be permanently attached to the lighting fixture. Several precautions should be taken when considering the system mounting configuration.

4.3.1 Ballast

The fixture must be configured such that the temperature at the test point on the ballast label \( (T_{c \text{ max}}) \) does not exceed 158°F (70°C) for the 150W ballast and 149°F (65°C) for the 100W ICETRON QUICKTRONIC ballast when the fixture is operated at the expected maximum ambient temperature. Applications in which the ballast case temperature exceeds this maximum void all warranties. The following are guidelines to help the designer achieve maximum cooling of the ballast. Note: Type 1 ballast must also be protected from exposure to rain and other elements.

- If possible, mount the ballast in its own compartment, thermally isolated from the compartment that houses the lamp. This will prevent the lamp from heating the ballast and this also helps prevent the lamp from communicating electrical noise to the ballast input wires.
- Mount the ballast below the lamp so that heat rising from the lamp is not directed toward the ballast.
- Mount the ballast on metal surfaces that will be cooled by the outside air.
- If the ballast must be mounted in the same compartment as the lamp itself, then consider the following guidelines:
  - Mount the ballast behind the lamp reflector. The lamp reflector will reflect much of the infrared energy away from the ballast.
  - Do not mount the ballast on the same metal substrate used to heat sink the lamp.
  - If the ballast is to be mounted to a surface, make sure the bottom of the ballast and the mounting surface are in intimate contact for good heat transfer. The mounting surface must be flat. Do not mount the ballast on a warped surface.
  - Four (4) mounting screws are required for proper grounding and heat sinking to a manufacturer’s fixture. A serrated head or captive star washer screw is required for proper grounding. For example; a Serrated Hex Washer Head Slotted Sheet Metal Screw No. 10. McMaster p/n 900063A242 or equivalent is acceptable.
• Fixture volume including ballast compartment should be no smaller than about 50 liters.
• If no appropriate cool metal surfaces are available, consider mounting the ballast away from all hot metal surfaces and attach a black, aluminum heat sink with cooling fins to the bottom of the ballast.
• Ballast and lamp induction core weight (several pounds) should be considered when designing the method of fixture attachment to ceiling grid, etc. These components should be mounted so that vibration is reduced as much as possible.

4.3.1.1 Fixture/Outdoor Requirements

**Input:** Input line power should be disconnected from the ballast when the fixture is being serviced.

**Rain:** The ICETRON® QUICKTRONIC® ballast is rated as TYPE 1—Outdoor ballast and must be protected from any exposure to moisture and water.

**Fixtures:** Fixture manufacturers need to design the fixture to prevent exposure to rain. A properly designed fixture needs to have adequate sealing and may consider mounting the ballast upside down to avoid exposure to water accumulation inside the fixture.

4.3.2 Lamp

The following lamp considerations should be taken into account when designing a fixture:

1. The luminous output of the lamp depends strongly on the amalgam tip temperature. To obtain at least 90% of maximum light output, the amalgam temperature must be between 122°F and 257°F (50°C – 125°C) for the ICETRON 100 and between 131°F and 257°F (55°C to 125°C) for the ICETRON 70 and ICETRON 150. Depending on the size and openness of the lamp compartment, the amalgam tip may need additional thermal coupling to make sure that its temperature range corresponds to the ambient temperature range to which the fixture will be exposed. The following factors can influence amalgam tip temperature:
   • Lamp orientation. If the lamp is operated vertically (with amalgam tip down as specified) the tip will tend to run cooler because of internal gaseous convection currents, and hence the allowable fixture ambient temperature range will be slightly higher. If the lamp is operated horizontally, the tip will run a little warmer and the allowable fixture ambient temperature range will be slightly lower.
   • Fixture openness. If the lamp is mounted in a sealed fixture, the amalgam tip temperature will be higher than if it is mounted in an open fixture.
   • Close proximity to other sources of heat, e.g., other lamps and/or ballasts in a multi-lamp fixture. These sources of heat may cause amalgam tip temperature to be higher.
   • Reflector design. Amalgam tip temperature will be higher in fixtures that direct radiation back onto the lamp.

   The fixture designer may need to take measures to heat or cool the amalgam tip. Suggestions for doing so may be found in section 4.4 “Thermal Testing Procedure.”

2. The lamp connector should not be positioned close to the lamp or in any location where its temperature will exceed 221°F (105°C) at maximum ambient temperature.

3. The lamp should be mounted firmly to a heat sinking structure. The temperature at the feet must not exceed 212°F (100°C) at the maximum fixture ambient temperature.

4. Position the lamp so as to achieve the optimum lumen output considering amalgam tip positioning, temperature and ambient heating (see section 3.7.2).

5. The lamp is attached to the ballast via mating plug-in connectors. The total wire length after mating is approximately two feet. Caution: the wire and the mating connectors should not be altered. These wires should be routed within the fixture so as to comply with regulatory agency approvals (UL, NEC, etc.).

6. Any input lead or the output connector must be kept a minimum of 4 inches away from the ICETRON lamp or must be Teflon® coated (or other similarly approved material that is able to withstand UV radiation of 1 microwatt per square centimeter for the life of the fixture).

4.3.3 Remote Operation

The ICETRON lamp (1) and ballast (2) can be remote mounted from each other using the specified remote mounting cabling (see Figure 27). The ICETRON QUICKTRONIC ballast will operate a lamp with a special high voltage cable (3) in conduit up to 66 feet (20 meters) long as specified below. Only this cable is approved for operation with the ICETRON QUICKTRONIC system. Use of an unapproved cable voids the warranty.
The following materials are approved for the remote cable up to 66 feet (20 meters):

a. Wire: 18 AWG wire (19/30) MIL-W-16878E (type EE), UL1180, 200°C, 1000 Volt, stranded silver-plated copper, extruded TFE TEFILON, wire must be twisted pair, manufacturer: Anixter.

b. Conduit: 3/8" flexible steel conduit UG380; manufacturer: Liquatite. (note: Conduit must be electrically connected to earth ground.)

c. Receptacle (4): Mini-fit, jr., Molex part number 39-01-2025 to be used with crimp, female molex part number 39-00-0059 or 39-00-0060.

d. Plug (5): Mini-fit, jr., Molex part number 39-00-0061 or 39-00-0062.

The ICETRON® QUICKTRONIC® system complies with Federal Communications Commission (FCC) limits. An improperly installed extension cable can cause increased EMI/RFI. The OEM is solely responsible for ensuring that the ICETRON system with remote mounting properly suppresses both conducted and radiated emissions and meets the FCC limits.

For further information please contact your OSRAM SYLVANIA Commercial Engineer.

4.3.4 Other Considerations

The following considerations are important in achieving optimal fixture performance:

1. To keep EMI conducted in the power lines to a minimum, keep the ballast input wires (power supply lines to the ballast) as far away as possible from the ballast output wires (supply to the lamp) and any part of the lamp.

2. To assure maximum safety and to further suppress EMI, make sure that the ballast case and the lamp mounting brackets are electrically grounded. Four serrated head mounting screws or captive star washers or equivalent are required to ensure proper ground connection of the ballast. The serrated head screw or equivalent must cut through the paint on the ballast and fixture surface for good metal to metal contact to earth ground. All four mounting screws must be used for the proper heat transfer from the ballast to the fixture. See Section 4.3.1 for details.

3. Painting the fixture with a high emissive paint will permit the fixture to dissipate heat more effectively through thermal radiation.

4. Heat is transferred better through spot welds than through surface to surface contact. Use as many spot welds as possible.

4.4 THERMAL TESTING AND ANALYSIS

4.4.1 Temperature Measurement Points

There are two temperature indicating points on the ballast:

One spot, called the $T_{c\text{ Max}}$, is located on the ballast label. This point must not exceed 70°C for the 150W and 65°C for the 100W under any conditions or the warranty will be voided. This is the location where all temperature measurements must be taken.

A second temperature indicator is the $T_{dot}$ (which is located on the side of the ballast to the lower right of the input connector)—a thermal-sensitive material that will change to a black color when the $T_{dot}$ exceeds 77°C for the 150W and exceeds 71°C for the 100W. This point is used only for warranty purposes and should not be used for thermal measurements.
The maximum ballast case temperature should be measured using a fine wire thermocouple and temperature meter. The thermocouple should be attached (using a high temperature resistant glue) to the test point, $T_c \text{ Max}$ on the ballast label. Critical lamp and ballast temperatures can be measured by attaching thermocouples using suitable tape or thermally conductive cement. If the thermocouple is attached by means other than cement, a thermally conductive paste should be applied to ensure that thermocouple and measurement point are at an equal temperature. Allow at least four hours (for a typical fixture) for temperatures to stabilize before recording data. The temperature measurement points on the lamp and ballast are shown below.

![Measurement Points on ICETRON® Lamp](image1)

* Maximum Bulb Wall Temperature is 302°F (150°C).

4.4.2 Thermal Testing Procedure

The procedure for measuring critical temperature points for the ICETRON QUICKTRONIC® system is as follows:

1. Connect thermocouples to the lamp test points and the ballast test point (see figures 28 and 29). Allow enough slack in the thermocouple wires to permit measurements when the fixture is mounted as it would be in the field. Refer to section 4.4.1 for further instructions on mounting thermocouples.

2. Mount the ICETRON QUICKTRONIC system into the fixture.

3. Assemble the fixture into its complete form, i.e., the way the fixture will be used in the field. Orient and mount the fixture as in a typical application.

4. Apply power to the system and allow the fixture to thermally equilibrate (approximately four hours).

5. Measure the temperature at the ballast test point “$T_c \text{ Max}$” which is located on the ballast label ($T_{ballast}$).

6. Measure the amalgam tip temperature ($T_{amal}$).

7. Measure the room temperature ($T_{room}$).

8. Measure the temperature at the mounting foot of the lamp ($T_{foot}$).

9. Measure the temperature at the bulb wall ($T_{bulb}$).

4.4.3 Thermal Analysis

There are two primary factors that place limits on the range of operating ambient temperature. These factors are the amalgam temperature range and the maximum ballast case temperature ($T_c \text{ Max}$).

1. First, calculate the lower and upper limits of operating ambient temperature based on the measured amalgam temperature. The formulas are:

   - For the ICETRON 150:
     \[ T_a = T_{room} - T_{amal} + 55 \]
     \[ T_b = T_{room} - T_{amal} + 125 \]

   - For the ICETRON 100:
     \[ T_a = T_{room} - T_{amal} + 50 \]
     \[ T_b = T_{room} - T_{amal} + 125 \]

   - For the ICETRON 70:
     \[ T_a = T_{room} - T_{amal} + 55 \]
     \[ T_b = T_{room} - T_{amal} + 125 \]

   where all temperatures are in degrees C.
2. Next, calculate the maximum ambient temperatures allowed for various parts of the system.

\[
\begin{align*}
T_{\text{max/ballast}} &= T_{\text{room}} - T_{\text{ballast}} + 70 \, \text{(for 150W ballast)} \\
T_{\text{max/ballast}} &= T_{\text{room}} - T_{\text{ballast}} + 65 \, \text{(for 100W ballast)} \\
T_{\text{max/foot}} &= T_{\text{room}} - T_{\text{foot}} + 100 \\
T_{\text{max/bulb}} &= T_{\text{room}} - T_{\text{bulb}} + 150 \\
\text{Set } T_{\text{max}} &= \text{(lowest of } T_{\text{max/ballast}}, T_{\text{max/foot}} \text{ and } T_{\text{max/bulb)}}
\end{align*}
\]

(All temperatures in degrees C)

3. Determining the operating ambient temperatures.

- The lowest temperature in which the fixture will operate properly is \( T_a \). This is the ambient temperature that corresponds to the lower limit of the amalgam temperature range for 90% of peak light output. The fixture may be operated in lower ambient temperatures, down to -40°F (-40°C) (see Section 3.7.1 for details), with no adverse affect on the life of the system, but the light output will be reduced and lamp color may shift.

- The highest allowable temperature in which the fixture may be operated is \( T_{\text{max}} \). This will correspond to one of the maximum temperatures allowed at the various test points. Operating the fixture with ambient temperatures higher than \( T_{\text{max}} \) will result in shortened life of the system and possibly even thermal shutdown of the ballast. If the ballast becomes too hot, an internal thermal breaker will activate and the ballast will shut down. Two procedures must happen in order for the ballast to reset and operate properly after thermal shutdown:
  1. The ballast must cool below the setpoint of the thermal breaker.
  2. The power to the ballast must be cycled off for a minimum of 10 seconds and then re-energized.

- \( T_b \) is the ambient temperature that corresponds to the higher limit of the amalgam temperature range for 90% of peak light output. \( T_b \) may be higher than \( T_{\text{max}} \), but again, the system must not be operated above \( T_{\text{max}} \).

4a. Correcting thermal problems — Two problems may occur:

- The maximum allowable temperature, \( T_{\text{max}} \), is too low for the fixture’s particular application. To correct this problem, follow the guidelines for proper lamp and ballast mounting. If all the guidelines have been followed and the maximum allowable temperature is still too low, then more aggressive cooling options may need to be investigated.

- The temperature limits, \( T_a \) and \( T_b \), corresponding to the ambient temperature limits for at least 90% peak light output are too high, or too low. For example, \( T_b \) could be much higher than \( T_{\text{max}} \), thus preventing the fixture from taking advantage of the amalgam’s full temperature range. This means that the amalgam tip is too cold for any given fixture ambient temperature. Whether or not action must be taken to adjust the amalgam temperature range is a judgment call of the designer. Figure 30 shows the amalgam temperature as a function of fixture ambient temperature. Figure 30 also shows the effect of heating or cooling the amalgam tip on operating ambient temperature range. Cooling shifts the range up and heating shifts the range down (see Figure 30). For every degree the ambient temperature changes, the temperatures internal to the fixture change by one degree. So, according to the graph, to shift the entire range by \( \Delta T \) degrees, you must apply heating (or cooling) to the amalgam tip so that at any given fixture ambient temperature, the amalgam temperature changes by an amount \(-\Delta T\).

4b. Techniques to passively heat the amalgam tip are:

1. Insulate the lamp compartment so that the local lamp environment runs hotter. However, to prevent the ferrites from overheating you should make sure you have good heat sinking at the lamp’s mounting feet.
2. Reduce the dimensions of the lamp compartment or seal the lamp compartment to eliminate cooling from outside air.
3. Install amalgam tip covers (foam plug) on both amalgam tip and exhaust tip. Installation of an amalgam tip cover on the exhaust tip is also required in order not to create a competing cold spot for mercury vapor pressure. Amalgam tip covers can be ordered from OSRAM SYLVANIA; the part number is 22093.
4. Parts of the lamp that generate heat are the glass bulb and the ferrite coupling cores. Take advantage of these heat sources by conducting heat from them to the amalgam tip. Some examples are:
   - Install a thin aluminum tube about the length of the amalgam tube itself over the amalgam tip so that the end of the tube is located close to the heat producing glass bulb. You can increase or decrease heating by moving the aluminum tube closer or farther away from the bulb respectively. If the use of an adhesive is necessary, use a transparent silicone adhesive.
4.5 FIXTURE EFFICIENCY CONSIDERATIONS

4.5.1 Calculating Fixture Efficiency

Fixture efficiency is calculated by measuring the total luminous flux from the fixture and dividing by the total flux from the lamp alone. The measurements are (normally) made on seasoned lamps at an ambient temperature of 77°F (25°C). However, the light output of ICETRON® lamps varies somewhat with the temperature of the amalgam.

To get a valid measurement of fixture efficiency, one of the following methods must be used:

1. The amalgam tip temperature can be controlled at a constant temperature for both bare lamp and fixture readings. This will ensure that the actual lumen output of the lamp is constant regardless of ambient temperature.

Or:

2. A correction factor can be applied to both bare lamp and fixture measurements to normalize the output to the estimated peak value. In this case, there is no need to control the amalgam tip temperature.

4.5.1.1 Controlled Amalgam Tip Temperature

If extensive measurements are planned, an amalgam tip heater and temperature controller can be constructed. The heater can consist of a section of heating tape applied around the tube with a thermocouple cemented to the tube adjacent to the amalgam to monitor tip temperature.

Alternately, an aluminum rod can be drilled to fit over the amalgam tip. This rod can be heated by heat tape or by a small cartridge heater. The thermocouple can be attached directly to the aluminum in this case. Thermally conductive paste must be used between heater and the amalgam tip. A temperature controller should set power level to the heater. The recommended set-point temperature is 65°C for the 100W and 70°C for 70W and 150W which should result in near peak light output. The system should be powered on and allowed to reach a stable operating condition. This typically requires about 4 hours from a cold state.

* CAUTION — vibration may induce tip breakage!

Figure 30: Amalgam temperature as a function of fixture ambient temperature
4.5.1.2 Peak Output Correction Factor

The light output of an ICETRON® lamp operating at thermal equilibrium is determined by the mercury vapor pressure. The mercury vapor pressure, in turn, is determined by the temperature of the main amalgam. The total light output will typically be within 10% of maximum for tip temperatures in the range of 131°F to 257°F (55°C to 125°C) for the 70W and 150W, and 122°F to 257°F (50°C to 125°C) for the 100W. However, when a cold lamp is first turned on, the lumen output will rapidly increase to an intermediate peak which is about 3% lower than maximum. The peak light intensity (Lp) of a bare lamp can be measured from any reference point.

The system must reach thermal equilibrium before photometric measurements are made. This typically requires about four hours. The system has reached thermal equilibrium when there is no further change in system power or light output. Stabilized light intensity (Ls) of the lamp is measured from the same reference point used for measuring (Lp). The ratio Lp/Ls then provides a correction factor to normalize output to the peak reading. The total luminous flux of the bare lamp (ΦL) must be measured on a thermally stabilized system. The corrected total luminous flux of the bare ICETRON lamp is therefore:

\[
\Phi_{Lc} = \Phi_L * \frac{L_p}{L_s}
\]

The same procedure can be used when an ICETRON QUICKTRONIC® system is mounted in a fixture where FP is the peak light intensity and F_s is stabilized light intensity measured from the same reference point. The total luminous flux of the fixture (FF) must also be measured on a thermally stabilized system and corrected as with the bare lamp.

\[
\Phi_{Fc} = \Phi_F * \frac{F_p}{F_s} \quad \text{so} \quad \text{Fixture Efficiency is} \quad \Phi_{Fc} / \Phi_{Lc}
\]

4.5.2 Reflector Design Suggestions

In contrast with the current general tendency to reduce the tube diameter of conventional fluorescent lamps (T12 \rightarrow T8 \rightarrow T5), the ICETRON lamp requires a larger diameter discharge tube. For the 70W, 100W and 150W ICETRON lamps, a tube diameter of 54 mm (T17) is optimal; for higher lamp power ratings even greater diameters will be needed. Because smaller diameters elevate the lamp voltage (VL), and the empirically determined ferrite core loss relationship, Pcore \sim VL^{2.5}, losses in the coupler cores of the ICETRON lamp would increase unacceptably with diminishing tube diameter.

In a fixture intended for high-bay or street lighting, it is important to direct as much light as possible downwards. Therefore a reflector is incorporated within the fixture to redirect light that is emitted from the upper surface of the lamp so that it travels in a downward direction. Several fixture designs incorporate reflectors to direct light where it is needed and reduce stray light. If the lamp has a large diameter, and if a small fixture or small reflector is used, a considerable fraction of the light incident upon the reflector is generally reflected (“redirected”) back toward the lamp. The light is then scattered and/or partially absorbed. This decreases fixture efficiency. However, it is possible to avoid this difficulty by following the principles described in section 4.5.3.

4.5.3 The Reflection Principle

Consider a light ray emanating tangentially from a point E on the lamp surface (tube radius R) and striking the reflector at point D. If that ray is not reflected back upon itself and this condition can be satisfied for all other points of the reflector contour (r=R), then it is possible to suppress the light loss due to scattering and absorption. This can be realized because all other rays (originating from any lamp surface point between E and E’) bypass the lamp to the right after reflection from point D. This is illustrated in figure 31 between the solid and dashed lines. Some rays may be reflected a second time (D’). These conditions are fulfilled when all parts of the reflector curve are perpendicular to the respective tangent lines exemplified here by ED in the figure. This leads to the following mathematical definition (in differential form) of the reflector contour:

\[
d\varphi = \frac{(1/R^2 - 1/r^2)^{1/2}}{\pi} x \, dr
\]

The reflector curve can be determined by mathematical integration of Equation (1). The result is

\[
\varphi = \varphi_0 + \left((r/R)^2 - 1 \right)^{1/2} + \text{across } (R/r)
\]

The reflector curve (r=R) shown in Figure 31 is calculated from \( \varphi = 0 \) and the positive bracketed factor, \(+\ldots\). It is a spiral contour that issues radially from the lamp surface and unfolds clockwise. A counterclockwise opening spiral with the negative bracketed factor, \(-\ldots\), is equivalent, and the curves may start at any angle \( \varphi = 0 \).

Because all parts of this special reflector fulfill the non-redirected condition, any part (or parts) of the reflector can be utilized as a reflector surface, depending on the requirements of the lighting application. This reflector also suppresses temperature rise of the lamp surface.
4.5.4 Application to the ICETRON System

Instead of a single tube the ICETRON® lamp incorporates two tubes parallel to each other (see Figure 32). Illumination losses in this implementation can result from the light of one tube being scattered and partly absorbed by the other, as well as from light being retro reflected onto the lamps by the reflector.

The reflector (see Figure 32) shows an integrated reflector system needed to satisfy the non-redirected conditions. It displays the basic reflector parts 1 and 2 that are identical with $\phi (r/R)$ of reflector design 1 (Figure 31). Part 3 is the mirror image of part 2 about the x-axis. Parts 4, 5, and 6 are the mirror about the y-axis. The reflector parts 2, 3, 5, 6 are only needed to avoid the absorption of light that the light that two tubes emit towards each other.

Figure 31: Reflector Design 1

Figure 32: Reflector Design 2
4.6 MULTIPLE LAMPS

Although it may be advantageous to design ICETRON® system fixtures with multiple lamps/ballasts, the following guidelines should be followed. The maximum allowable ballast case temperature, $T_{c_{\text{Max}}}$ is 158°F (70°C) for the 150W and 149°F (65°C) for the 100W. Ballasts should be positioned such that this case temperature maximum is not exceeded. Thermal characteristics of the lamp such as proper amalgam tip temperature, bulb wall temperature, and thermal coupling of induction cores with fixture are important in maintaining sufficient light output and reliability. Routing the input leads to the ballasts away from the ballast/lamp output leads (as well as limiting the length of the ballast/lamp output leads) provides the lowest possible level of EMI/RFI.

4.7 TROUBLESHOOTING

ICETRON systems should be installed and operated in compliance with the National Electric Code (NEC), Underwriters Laboratories Inc. (UL) requirements, and all applicable codes and regulations. As it is possible to come in contact with potentially hazardous voltages, only qualified personnel should perform system installation or troubleshooting. The ballast can become electrically unsafe and fail to meet FCC compliance if the cover is removed. All installation, inspection, and maintenance of lighting fixtures should be done with the power to the fixture turned off.

The following should be used to guide qualified personnel in the troubleshooting and correcting of the most commonly encountered problems in typical lighting systems:

- **Lamp does not light.**
  Check to see if there is power to the ballast. If so, is the ballast or lamp at fault? Swap known good components to determine if the lamp or ballast has reached its end of life. Other possible causes: Has input voltage to the ballast been switched off for more than 10 seconds, resetting the ballast, after lamp was replaced? Are the lamp and ballast wire connectors properly mated? Is the input line voltage within specified limits? Are in-line fuses or other devices at fault?
  See section 3.7.2 Effects of ambient temperature on system performance

- **Lamp starts slowly, flickers, or fails prematurely.**
  Is the lamp at fault? Swap with a known good lamp to determine if the lamp has reached its end of life. Other possible causes: Are ambient conditions within specified limits? Is the input line voltage within specified limits? Are fixture and system components properly grounded? Are the lamp and ballast wire connectors properly mated? Is the lamp the correct type to be compatible with the ballast? (Compatible lamp types should be listed on the ballast label.) Is the ballast at fault? (Swap with a known good ballast to determine if the ballast is defective.) Is fixture rated for TYPE 1?

- **Lamp lights and operates for a while, then shuts off.**
  Is the ambient temperature of the ballast too hot? Ballast case temperature should be below 158°F (70°C) for the 150W and 149°F (65°C) for the 100W. Other possible causes: Is the lamp the correct type to be compatible with the ballast? (Compatible lamp types should be listed on the ballast label.) Is the ballast at fault? (Swap with a known good ballast to determine if the ballast is defective.)

- **Excessive noise.**
  Are any of the lighting fixture components loose? Are ballast case and lamp secured tightly to fixture? Other possible causes: Is the ballast at fault? (Swap with a known good ballast to determine if the ballast is defective.)

- **Interference.**
  Is a radio or antenna close to lamps? Move the radio or antenna away as much as practically possible from lamps. If problem persists, separate branch circuits may be required for the radio equipment and lighting fixtures.

- **Other possible causes:** Are fixture and system components properly electrically grounded? Are the ballast input and output leads separated as much as practically possible? Is the ballast at fault? (Swap with a known good ballast to determine if the ballast is defective.) Is the TYPE 1 outdoor rated ballast protected from exposure to moisture and water?
4.8 ICETRON FIXTURE DESIGN CHECKLIST

The following items must be strictly adhered to in order to achieve an acceptable ICETRON® system fixture design. Applications that do not meet these criteria will not be covered by warranty.

4.8.1 Lamp

✓ Lamp is firmly attached to fixture via the four mounting holes.
✓ Lamp is attached to fixture by mounting feet only.
✓ Amalgam tip temperature for 90% of maximum light output is within the specified range. For more details see section 4.4.
✓ For vertical (non-horizontal) lamp operation, the amalgam tip is positioned downward.
✓ Bulb wall temperature does not exceed 302°F (150°C). For more details, see section 4.4.
✓ Temperature at mounting base of lamp does not exceed 212°F (100°C). Lamp induction cores have good thermal coupling to the fixture.
✓ Wire and mating plug-in connectors between lamp and ballast have not been altered in any way.
✓ Wire and mating plug-in connectors must be kept at least 4 inches away from any lamp surface.
✓ The lamp connector should not be positioned close to the lamp or in any location where its temperature will exceed 219°F (104°C) at maximum ambient temperature.

4.8.2 Ballast

✓ Ambient temperature of the ballast is kept as low as possible.
✓ Dissipation of heat is enhanced by using the metallic lighting fixture as a heat-sink for the ballast enclosure and the lamp induction cores.
✓ The bottom of the ballast (largest surface area possible) is mounted flat against a large metallic surface of the fixture.
✓ Test point temperature of the ballast (Tc Max) does not exceed 158°F (70°C) for the 150W, 149°F (65°C) for the 100W. For more details, see section 4.4.
✓ Ballast is protected from exposure to rain and other elements that could damage the ballast.
✓ Grounding through four (4) serrated head or captive star washer mounting screws, or equivalent, are required for proper grounding. The serrated head screws must cut through the paint on the ballast flange and fixture surface for good metal to metal contact.
✓ Ballast input leads and ballast/lamp output leads are separated as much as physically possible to minimize EMI.
✓ TYPE 1 outdoor rated ballast is protected from exposure to moisture and water.

4.8.3 Fixture

✓ Wire and mating plug-in connectors are routed within the fixture so as to comply with regulatory agency approvals.
✓ Fixture is grounded.
✓ High emissive surfaces for heat transfer (recommended).
✓ Suitably sealed for outdoor application.
✓ Provides proper ballast protection from exposure to water.
4.9 APPLICATIONS

Long service life and high CRI make ICETRON® QUICKTRONIC® systems an ideal choice for big box retail applications.

ICETRON QUICKTRONIC systems provide long service life for difficult to service applications such as lighting over stairs and escalators.

The low starting temperature (as low as -40°F) makes the ICETRON QUICKTRONIC system a practical solution for lighting freezers.

ICETRON QUICKTRONIC systems offer the elevated lumen output needed to meet the ambient light requirements of mall atriums and office lobbies with high ceilings.
Street lighting applications call for long service life and high efficacy, and ICETRON QUICKTRONIC systems deliver both, along with excellent CRI.

In high-bay warehouse applications, the long service life and high LPW of ICETRON QUICKTRONIC systems yield cost effective, low maintenance lighting.

The excellent color characteristics, long service life and high efficacy of ICETRON® QUICKTRONIC® systems make them an ideal choice for airport check-in areas and other public spaces.

ICETRON QUICKTRONIC systems are a perfect fit for sign and tunnel applications that require long service life and high efficacy.

The long service life of the ICETRON QUICKTRONIC system makes it an excellent choice for parking garages where security and sense of safety are important.
5.1 GLOSSARY

ACGIH: The American Conference of Governmental Industrial Hygienists. They have established Threshold Limit Values (TLVs) for chemical substances and physical agents that are generally used in the U.S. and are widely accepted overseas.

Amperes (Amps): The unit of measure for electrical current flow.

Ambient Temperature: The air temperature in a general environment (room temperature).

ANSI (American National Standards Institute): The regulatory body charged with developing standards for performance, safety, etc. for various products.

Audible Noise (Sound): All fluorescent lamp ballasts produce some acoustic noise and are sound rated.

Average Rated Life (system): ICETRON® QUICKTRONIC® ballasts are designed to have an average rated life of 100,000 hours at 158°F (70°C) for 150W ballast, and 149°F (65°C) for 100W ballast. Because the lamp has no electrodes to wear out, the system life is essentially determined by the life of the ballast. Note: the lamp has 63% lumen maintenance at 100,000 hours. To maximize system life, the ballast case temperature should be kept as low as possible. It is also important to maintain effective dissipation of heat using the metallic lighting fixture as a heat sink for the ballast enclosure.

Ballast: A current or power regulating device used to control discharge lamps.

Ballast Basics: Ballasts have three primary functions: 1) start the lamp, 2) control operation of the lamp once it has started, 3) control the shape of the line current waveform. These high frequency electronic ballasts operate lamps more efficiently and eliminate the hum and visible flicker normally associated with magnetic ballasts.

Ballast Factor (BF): Relative light output of a commercial ballast as compared to a reference ballast [e.g., BF of 0.90 would yield 90% of a lamp’s rated lumens].

Candelas (cd): The unit of measure quantifying the luminous intensity (candlepower) of a light source in a specific direction; any given light source may exhibit different luminous intensities, depending upon the direction considered.

Color rendering index (CRI): Measure of the degree of color shift that objects undergo when illuminated by a light source as compared with the color of those same objects when illuminated by a reference source, e.g., a tungsten filament of comparable color temperature. A CRI of 100 corresponds to negligible color shift.

Color Temperature: The absolute temperature in degrees Kelvin at which a black body emits radiant energy most closely matching the color perceived from a given light source.

Color Temperature: The unit of measure quantify the rate of energy release per second or Hz.

Frequency (Hz): The number of times per second that an alternating current system reverses from positive to negative and back to positive, expressed in cycles per second or Hz.

Fusing: ICETRON QUICKTRONIC ballasts contain an internal electrical fuse. Although there is no need to externally fuse the ballast, should code or regulation require one, 4-amp slow blow fuses are recommended.

Grounding: The ICETRON QUICKTRONIC ballast case and metallic fixture must always be grounded. The grounding helps assure safety, proper lamp starting, and acceptable EMI/RFI performance.

Hertz (Hz): Measure of frequency; 60 cycles per second = 60 Hz.

Illuminating Engineering Society of North America (IESNA): Professional society that advances knowledge and disseminates information in the lighting industry.

Inrush Current: When a lighting system is energized, a momentary surge of current occurs called “inrush”. This may damage auxiliary lighting controls such as mechanical switches and contacts. ICETRON QUICKTRONIC ballasts contain current limiting circuitry, and have a maximum inrush current of less than 5 amps.

Institute Of Electrical and Electronic Engineers (IEEE): Organization of engineers that establishes standards for safety and performance for the electrical and electronics industries.

Integrating Sphere: A spherical photometer that enables total luminous flux to be determined by a single measurement. Measures indirect luminance of the inner sphere surface.

International Electrotechnical Commission (IEC): The international standards setting organization. The equivalent in the United States is ANSI.
**K-Factor:** A parameter that quantifies the effect of non-linear equipment, such as lighting ballasts, on an electrical system. Lighting systems should be designed so that the transformer rating is sufficient for the ballasts used (typically K-Factor < 4). ICETRON® QUICKTRONIC® ballasts meet this specification.

**Light Level:** Light output from a system is a function of rated lamp lumens, ballast factor, fixture efficiency, and ambient temperature. All of these factors must be considered when designing or retrofitting a lighting system.

**Low Temperature Starting:** The ICETRON QUICKTRONIC system has the capability to start the lamp at temperatures as low as -40°F (-40°C) for the 150W and 100W lamp, and -13°F (-25°C) for the 70W lamp. Enclosed fixtures are recommended because the lamp has reduced light output at cooler ambient temperatures.

**Lumen Maintenance:** Light output at a particular point in lamp life. Expressed as a percent of initial lumen (100 hour lumen) output.

**Luminous Efficacy (lm/W):** Total lumenous flux emitted by lamps divided by the total lamp or system power input, expressed in lumens per watt.

**Luminous Intensity:** Luminous flux per unit solid angle in a certain direction from the light source. Expressed in candelas.

**Maximum Case Temperature:** ICETRON QUICKTRONIC ballasts have a maximum allowable case temperature of 158°F (70°C) for 150W ballast, and 149°F (65°C) for 100W ballast. Applications in which the case temperature is allowed to exceed this maximum void the manufacturer’s warranty.

**Mortality:** Lamp life rated as the average life of a group of lamps operated under ballast-controlled laboratory conditions. Average rated system life is defined when about 50% of the systems in a large test group have failed while 50% remain lighted.

**Phosphor:** Material used to coat the inside surface of fluorescent lamps; this controls color and the amount of visible light produced.

**Polychlorinated Biphenyls (PCBs):** A material formerly used in ballast capacitors but now considered hazardous and disposal is regulated. ICETRON QUICKTRONIC ballasts do not contain PCBs.

**Power Factor (PF):** The ratio of real power (watts) consumed to apparent power (Volts X Amps). The higher the power factor, the less current required to produce a given amount of usable power.

**Radio Frequency Interference (RFI):** Electrical noise that is generated by various types of equipment and may be radiated through the air.

**Safety:** ICETRON QUICKTRONIC ballasts should be installed and operated in compliance with the National Electric Code (NEC), Underwriters Laboratories Inc. (UL) requirements, and all applicable codes and regulations. Because it is possible to come in contact with potentially hazardous voltages, only qualified personnel should perform ballast installation. The lamp should not be taken apart. All installation, inspection, and maintenance of lighting fixtures should be done with the power to the fixture turned off.

**Spectral Power Distribution (SPD):** Graph of continuous and/or banded power density given off by fluorescent lamps, display from ultraviolet to infrared wavelengths. The area under the curve represents lamp total power output.

**System Warranty:** The ICETRON QUICKTRONIC system is covered by a comprehensive system warranty (consult QUICK 60+® warranty bulletin for additional details).

**Total Harmonic Distortion (THD):** The presence and extent of a current or voltage waveform at multiples of the fundamental frequency. Excessive THD (defined by ANSI as greater than 32%) may cause adverse effects to the electrical system. ICETRON QUICKTRONIC ballasts operate at less than 10% THD.

**Transformer Rating:** K-factor rating quantifies how much harmonic distortion a transformer can safely handle. The higher the transformer K-factor rating, the more harmonic distortion a transformer can safely handle.

**Transit Protection:** ICETRON QUICKTRONIC ballasts meet ANSI 62.41 Category A. This helps to ensure isolation from electrical disturbances such as power line transients, and temporary line voltage dropouts, surges and sags.

**Type 1 Outdoor Ballast:** Must be operated within overall electrical enclosure to be protected from exposure to water.

**Type 2 Outdoor Ballast:** Must be operated within overall enclosure to be protected from exposure to water.

**Volt (V):** Unit of measurement for the electrical potential between two points.

**Watt (W):** Unit of measurement for actual power consumed.