Understanding Light Intensity Specifications for Flashing Signal Lights

GENERAL

The purpose of this reference section is to promote understanding of light intensity specifications for flashing signal lights.

The term "Effective Intensity" or "Candela Effective" is used by signal engineers to describe a flashing signal light which has the same signaling effectiveness as an equivalent steady burning light.

The method of calculating the Effective Intensity of flashing signal lights discussed herein has been taken from the IES Guide for "Calculating The Effective Intensity of Flashing Signal Lights, Section 4.3 Condenser–Discharge Lights" and is used by agencies of the Federal Government to specify strobe beacon Light requirements.

XENON STROBE FORMULAS

Electrical Relationships

P = Power in watts
J = Joules (Also known as wattseconds)
F = Flashes per second (flash frequency)
C = Capacitance in microfarads
V = Voltage in kilovolts

Basic Electrical Formulas

$$J = \frac{CV^2}{2}$$

$$P = J \times F$$

PHOTOMETRIC RELATIONSHIPS

I_{eff} = Effective intensity (Also known as candela effective)
HCPS = Horizontal Candlepower seconds
BCPS = Beam Candlepower seconds
M = Lens or reflector amplification factor
= Efficiency of flashtube in lumen seconds/watt seconds
Q = Light output of flashtube in lumen seconds (empirically derived for helix flashtubes)
Lb = Foot–Lamberts background illuminance
d = Distance in feet that a light intensity can be seen

BASIC PHOTOMETRIC FORMULAS

$Q = J \times$ Lumen Seconds

$$HCPS = \frac{Q}{10}$$

$BCPS = M \times HCPS$(candela)

$I_{eff} = 5 \times BCPS$ (candela)

$I_{eff} = (6.37Lb + 18.60)d^2 \times 10^{-7}$ (candela)

$$d = \sqrt{\frac{I_{eff}}{\sqrt{(6.37Lb + 18.60)\ 10^{-7}}}}$$

PEAK CANDLEPOWER, CANDELA SECONDS AND CANDELA EFFECTIVE

When comparing two different warning lights, the first question usually asked is how bright are these lights and how do they compare to one another? This can be a complicated question when one is comparing very different light sources such as rotating incandescent lights and xenon strobe lights. Let's briefly discuss three different commonly specified "intensity" ratings:

1) PEAK CANDELA or PEAK CANDLEPOWER –This quantity is the maximum light intensity generated by a flashing light during its light pulse. It indicates NOTHING ABOUT HOW BRIGHT THE LIGHT APPEARS TO THE HUMAN EYE. Peak candela alone **cannot** be used to directly compare two warning lights. In addition there is **no** set multiplication factor for converting peak candela, a unit of luminous intensity, to either candela seconds or effective candela, both units of luminous energy. Tomar Electronics Inc. strongly discourages the use of peak candela ratings when comparing warning lights.

2 CANDELA SECONDS or CANDLEPOWER SECONDS – This quantity is the actual light energy contained in a pulse of light. Candela seconds is used by the Society of Automotive Engineers and the California Highway Patrol to specify the minimum requirements for light output from a flashing light because flash energy has been shown to be a relatively accurate and fair way of comparing radically different types of lights such as incandescent rotators and xenon strobe lights. Candela seconds is merely a relative measure of how bright a flash of light will appear to a human eye. A light with a higher candela second rating will appear brighter than a light with a lower candela second rating even if the lower rated light has a much higher peak candela rating.

3) CANDELA EFFECTIVE or EFFECTIVE CANDLEPOWER – Candela effective is based on candela seconds and attempts to equate the brightness of a flashing light source to the brightness of a steady burning source. If a flashing light has a candela effective rating of 100 then it will be visible at the same distance as a 100 candela steady burning source. The National Bureau of Standards, the FAA, and the Illuminating Engineering Society use candela effective in specifying intensities of flashing light source because this rating is the most meaningful when it becomes necessary to predict the visible range of flashing warning lights versus steady burning light sources.

Tomar Electronics uses only candela effective as measured using the technique outlined in the **IES GUIDE FOR CALCULATING THE EFFECTIVE INTENSITY OF FLASHING SIGNAL LIGHTS** using visible light only. We recommend only the use of candela effective or candela seconds when comparing any two flashing warning lights.

LENS PLASTIC TYPE AND COLOR

TOMAR uses only the finest optical grade plastics available. All lenses are molded from GE LEXAN® which is listed in the AAMVA publication entitled "Listing of Acceptable Plastics for Optical Lenses and Reflectors Used on Motor Vehicles" and meet SAE Color Specification J578d.

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