# Luminescence Analysis of Fluorescent Lamps driven by IceCap 660

© Jin Kim (clamrade)

9/20/2002

Reef enthusiasts generally agree that Metal-Halide (MH) lamps are great but, at the same time, are not suitable for many aquatic applications. For example, MH lamps need to be placed at least several inches above the water surface, which wasn't feasible in my new 50G reef. So, while I was looking for an alternative, I was glad to come across an opportunity to evaluate Model 660 electronic fluorescent lamp ballast from IceCap, Inc. IceCap has been marketing its line of fluorescent ballasts as energy efficient and reliable for reef use. However, the real appeal was in their alleged ability to drive a normal-output (NO) fluorescent lamp to produce as much light as a very-high-output (VHO) lamp. Conceptually, such appeared feasible, but I was naturally somewhat skeptical without seeing quantitative data supporting the claim. The obvious benefit would be reduced lamp costs, which is evident in Table 1: the price difference between specialty VHO "reef" lamps and ordinary "daylight" NO lamps is even greater for 4' long lamps.

The objective of the test was to compare the luminescence intensities and spectra of various NO and VHO lamps driven by an IceCap 660 to verify the above claim. For this end, both NO and VHO versions of Coralife Trichromatic 6500K Daylight lamp were tested – not necessarily due to my fondness of these products in particular but rather due to their availability as both NO and VHO. Furthermore, I wished to examine the suitability of several generic GE and Philips "daylight" lamps to reef applications by comparing to the Coralife lamps specifically marketed for reef use. Specifications of lamps tested are summarized in Table 1: all lamps were 3' long rapid-start type.

| Common Name | Price | Part Number | Kelvin Rating* | Initial / Average Lumens* | Output Power @ 160 hrs | Power Drop from 5 hrs | Photon Flux @ ~160 hrs |
|---|---|---|---|---|---|---|---|
| GE Daylight | $10 | F30T12 /D/RS | 6250K | 1900/1650 | 108 % | 3 % | 108 % |
| Philips Daylight | $10 | F30T12 /D/RS | 6500K | 1950/1700 | 100 % | 14 % | 100 % |
| Philips Ultralume | $10 | F30T12 /50U/RS | 5000K | 2380/2140 | 116 % | 10 % | 119 % |
| GE Chroma50 | $10 | F30T12 /C50/RS | 5000K | 1650/1350 | 96 % | 11 % | 102 % |
| Coralife NO | $16 | | 6500K | | 124 % | 7 % | 125 % |
| Coralife VHO | $25 | | 6500K | | 100 % | 6 % | 100 % |
| Coralife ActinicVHO | $25 | | | | 122 % | 3 % | 102 % |

Table 1: Summary of fluorescent lamp specifications and measurements: *Manufacturer specified data

The spectra were taken between 330nm and 830nm with 2nm resolution using a calibrated optical spectrum analyzer (OSA), while the luminescence intensities were measured with a light meter of a known spectral responsivity. The total optical output power of a 3' fluorescent lamp is difficult to measure since such would require the collection and measurement of the output in all directions, perhaps with an uncommonly large "integrating sphere." Thus, the optical powers of various lamps (after ~ 160 hours of use) are represented as relative to the Coralife VHO "reference" lamp. For example, 90% relative intensity means that the light output power of that particular lamp is 90% of that of the Coralife

VHO. An adjacent column tabulates the photon flux, which is a fair way to compare lamps of different spectral characteristics. This is because "blue photons" are more energetic than "red photons," and thus, the Actinic lamp in Table 1 is substantially higher in output power relative to the Coralife VHO but not so in photon flux. In fact, this photon flux, together with the spectral data, may be a better figure of merit for reef applications, considering photosynthesis presumably involves discrete photons.

Measurements were performed after 5 hours of use and again after 160 hours of use. Each lamp was operated 10 hours per day to realistically simulate the actual usage in reef applications. The error bar for intensity measurement is approximately 2%, which was estimated by comparing repeated measurements.

The spectra of various lamps after 160 hours of use are represented by Figures 1-4. Each spectrum is normalized against the total output power: thus, relative intensity comparisons among the various spectra in Figures 1-4 are valid. In Figure 1, the spectra of sunlight at 0m, 5m, and 10m depth of seawater are plotted as well, and their relative intensities are also accurate. However, a comparison of the solar spectral intensity to the fluorescent lamp spectral intensity as shown in these figures is invalid. "AM1.5" was assume to be the solar spectrum at sea-level.

The results are surprising. Comparing the spectra of the NO and VHO Trichromatic Coralife lamps in Figure 1, it is quite obvious that the VHO lamp is not simply a high output version of the NO lamp. In fact, the NO lamp appears to be a tri-phosphor lamp while the VHO is closer to a generic "daylight" lamp. This difference is again evident in the relative luminescence intensity of the two lamps in Table 1. The NO lamp is actually 25% brighter than the VHO!

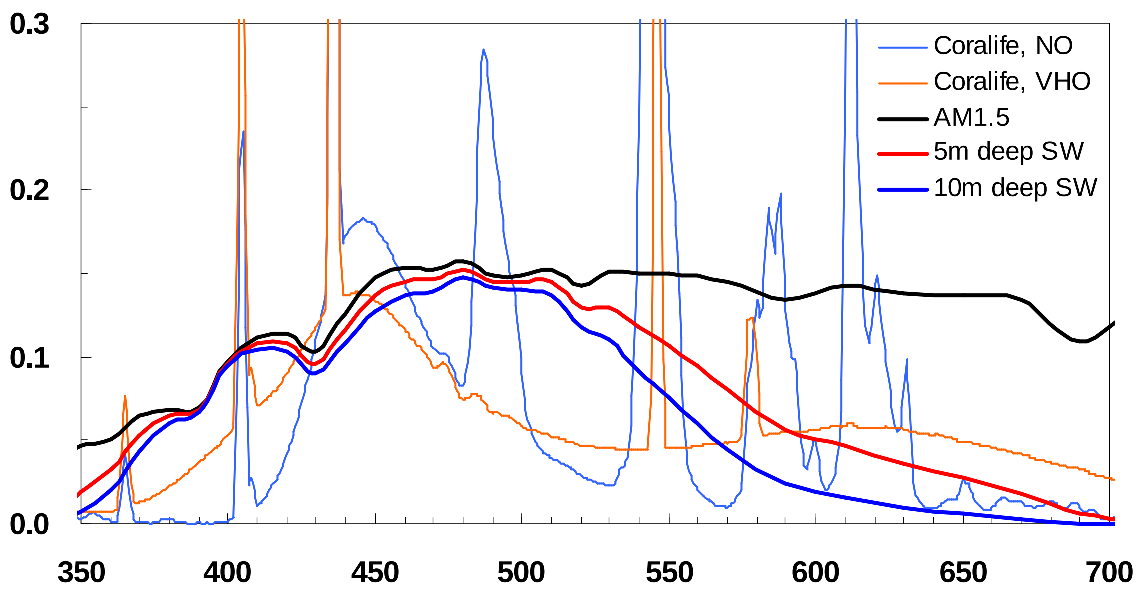


Figure 1: Normalized spectra of Coralife lamps and of sunlight

Figure 2 shows the spectra of the two tri-phosphor lamps and the actinic lamp. Except for the slight emphasis between 430-500nm, the Coralife NO and Philips Ultralume are nearly identical. Of course, the difference can be easily made up with Actinic supplementation, which is what most reefers tend to do regardless of the type of full-spectrum lamp used. As evident in Table 1, the power output levels of the two lamps are also very similar.

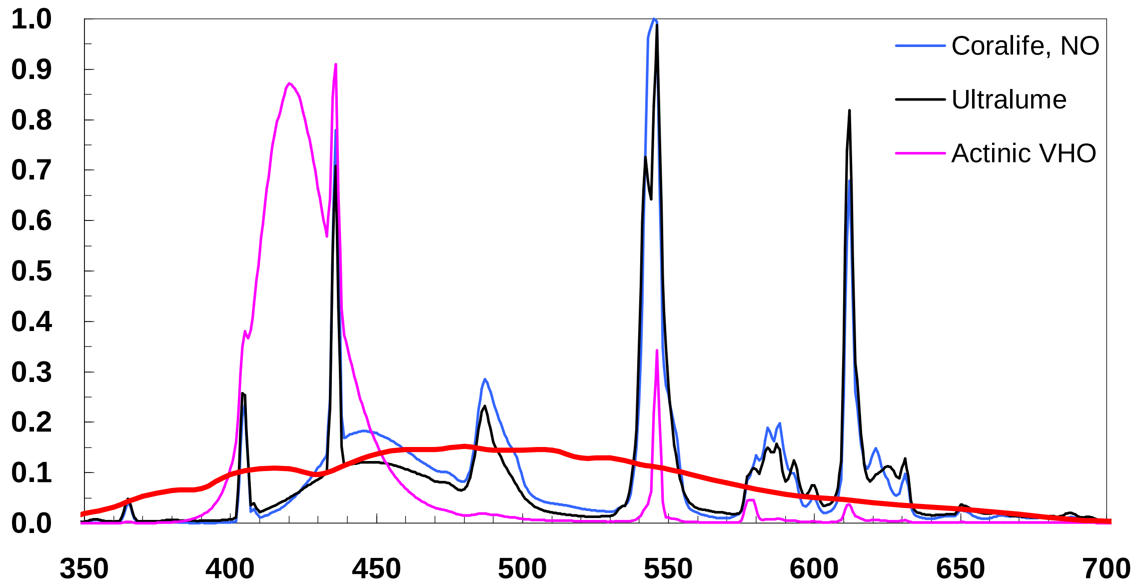


Figure 2: Normalized spectra of Coralife NO, Philips Ultralume, and Actinic VHO

Figure 3 shows the spectra of the common “daylight” lamps. We can see that the Philips and GE daylight lamps are nearly identical in both the spectrum and intensity. Compared to these two, the more expensive Coralife VHO holds a small advantage in spectral characteristics but not in output power. This, again, is easily corrected by Actinic supplementation. The GE Chroma50, with a Kelvin rating of only 5000K, appears inadequate for reef applications. However, its flat spectrum best mimics the sunlight, contributing to its high color rendering index (CRI).

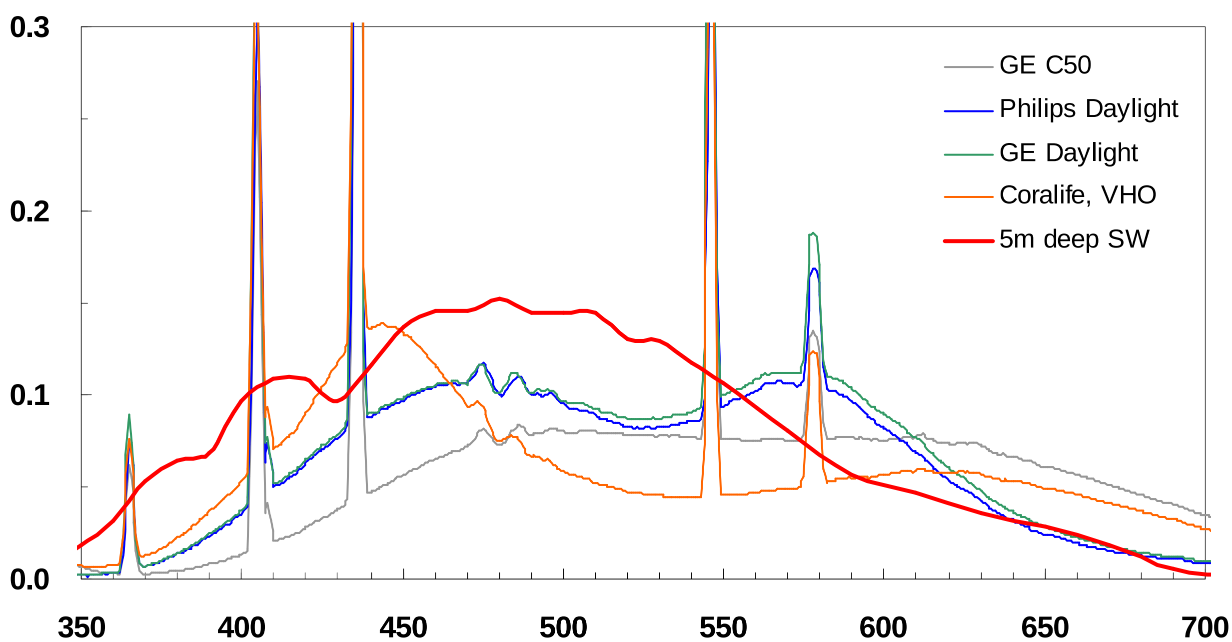


Figure 3: Normalized spectra of GE Chroma50, Philips Daylight, GE Daylight, and Coralife Tri-Chromatic VHO lamps

The conclusion from this objective study is that commonly available cheap "daylight" lamps from discount stores such as Home Depot can produce as much light output as more expensive VHO lamps specifically marketed for reef applications using an IceCap 660. While a true test of the suitability of these lamps for reef applications would be a side-by-side comparison of two reef aquariums differing only in the types of lamps used, such may be impossible. Much more realistic, but more subjective, would be a long-term study of these "cheap" lamps driven by IceCap 660, successfully sustaining multiple reef aquariums.

Over the course of one year, the aforementioned 50G reef aquarium was successfully sustained with such a setup. The lamp combination consisted of the Coralife NO, GE Daylight, Philips Daylight, and Coralife Actinic VHO lamps. The combined spectra of these four lamps are shown in Figure 4, compared with sunlight at 5-meter depth of seawater. Under this somewhat unnatural but still aesthetically pleasing light, all soft corals (Xenia, various button polyps, various star polyps, various leather corals, various LPS, Capricornis) and a maxima clam thrived, and the bubble anemone split half a dozen times. While one system is not sufficient to establish credibility for the IceCap ballasts, it does represent an existence proof.

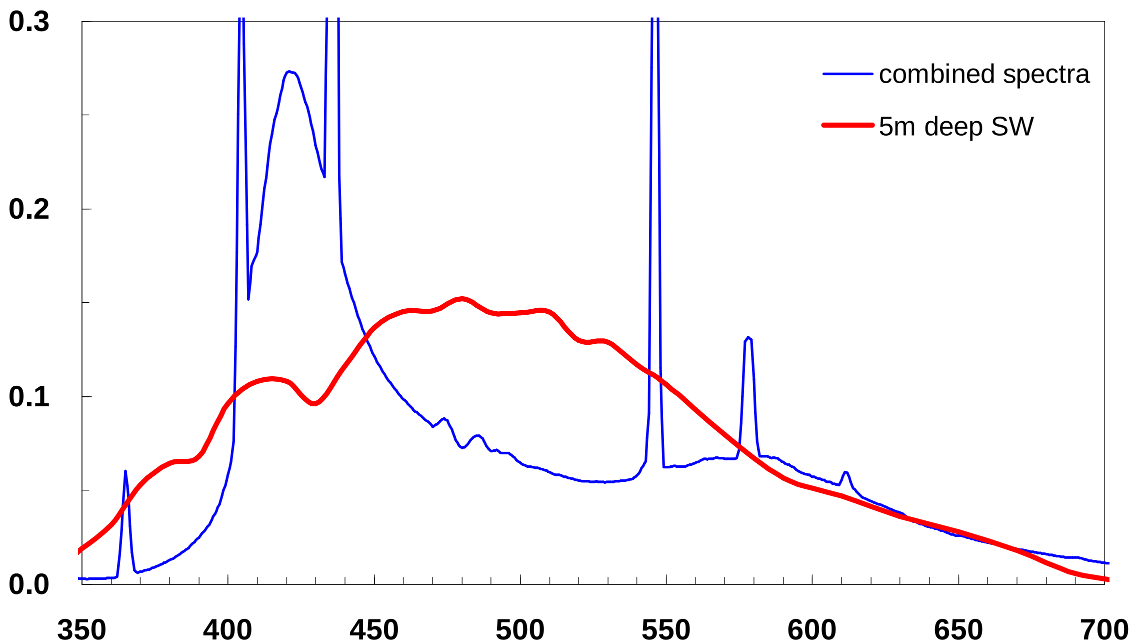


Figure 4: Combined average spectra of Philips Daylight, GE Daylight, Coralife Tri-Chromatic VHO, and Coralife Actinic VHO lamps

At the end of this first year, the lamps were replaced by two daylight NO lamps and two actinic NO lamps. This combination produced light that is even more unnaturally blue but yet still preferred by some. Under this light, a leather coral and the bubble anemone was observed changing color over the period of a few months. All specimens continued to thrive.

It is regrettable that the luminescence analysis could not be performed at the conclusion of the first year. However, it was noticed that although the spectrum of each lamp did not change noticeably during the initial 160 hours, the luminescence intensity did decrease by 5-15% depending on the lamp. This is expected of fluorescent lamps, as was observed for both the NO and VHO lamps, and is not expected to continue at a linear rate of decay. Considering that the new lamps did not appear dramatically brighter compared to the one-year old lamps, it is estimated that the luminescence intensity drop over one year is < 20%. Thus, it appears that the "normal" one-year lifespan of fluorescent lamps holds true for both VHO and NO lamps on an IceCap 660.

The IceCap 660 was provided by IceCap, Inc.