Ultraviolet and Heat Effects from Photographic Lights

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The advent of digital scanning cameras, or scan backs, required that museum artifacts be subjected to high levels of continuous light for fairly extended periods. Early scan backs could be used with ordinary tungsten halogen photo lights, but required higher light levels for longer durations than film photography. Although tungsten halogen lights have been used for museum photography for many years, there was little published data on the cumulative effects of exposure on museum objects. New light sources, less familiar for photographic applications, were also introduced— fluorescent, HMI[1] and most recently HID[2].

Most museum conservators and registrars familiar with tungsten lights consider them relatively benign; the heat produced, and its drying effect are the primary dangers. The ultraviolet component of light from tungsten sources is relatively low, usually given as an average of 70 μWatt/lumens, and this figure is often adopted as the maximum UV level to be tolerated in the museum environment. It's not always understood that 70 μWatt/lumens is typical only of incandescent sources. Tungsten halogen lamps, usually used for photography and increasingly for exhibition lighting, typically emit UV in the 100 to 150 μWatt/lumen range, up to twice the allowable level, although still fairly low.

Fluorescent lights produce little heat but have been viewed with suspicion because they use ultraviolet internally to excite the phosphors that produce the visible light; some do emit high levels of UV. The Osram fluorescent tubes used by most of the fluorescent photographic lighting manufacturers were tested in 2000 and shown to produce UV levels in the same range as tungsten and tungsten halogen.[3]

HMI lights were developed for the movie industry and are used in some commercial digital photography studios. They produce large amounts of daylight-balanced light along with high levels of ultra violet and infrared. A number of museums have them, but they should be used cautiously around anything liable to be affected by UV exposure, including people—the lamp packaging carries a health warning about UV exposure. They do produce brighter illumination than anything else, and could be useful for photographing really large paintings and interior spaces, but with due caution.

Ceramic HID lights are the newest technology to be adapted for photographic illumination. Like fluorescents, they are efficient and produce little heat. A 150 Watt lamp produces about as much light as a 750 Watt tungsten fixture. The UV component is low and can be virtually eliminated with a simple UV filter, such as a sheet of UF3 Plexiglas.

A recent series of tests, conducted at the Berkeley Art Museum and the studio of Better Light, Inc. attempted to measure the UV component and the heat emitted by a number of commonly used light sources. The lights tested were what were available, and are somewhat representative of those used in museum settings, but not comprehensive. Other manufacturers' products may be added to the list as they become available for testing.

[1] Hydragyrum Medium Arc-length Iodide
[2] High Intensity Discharge
[3] Light Exposure to Sensitive Artworks During Digital Photography. *Spectra*, Summer/Fall 2000, pdf at http://www.mcn.edu/spectra/index.htm

Four tungsten halogen lights were tested, each rated at 1000 Watts:

Lowel Tota lights, using double ended FHM lamps, are very commonly used for copy work because they're inexpensive and produce an even pattern of illumination.

Lowel DPI are open faced focusing reflector units with 1000 Watt FEL single post lamps.

Arri 1000 Fresnels, using EGT two pin lamps, are representative focusing Fresnel instruments. The design allows a certain amount of heat to escape upward, while projecting a focused beam of light toward the subject. Similar units are made by Mole Richardson, LTM, Desisti and others.

TTI copy lights are a proprietary design of Tarsia Technical Industries, available with that company's copy stands or as separate units. They incorporate dichroic reflectors that are transparent to infrared wavelengths, allowing most of the heat to escape through the back of the reflector, while the visible light is projected toward the subject. The unit tested had four 250 Watt lamps for a total of 1000 Watts in a fan cooled housing.

Two fluorescent fixtures were tested:

Balcar Quadlights, containing four 55 watt Osram tubes in a flat housing, with a mirror polished hood directing more of the light forward. Similar designs with two to six tubes are made by Lowel, Kaiser, and others.

North Light's 2X3 model uses sixteen of the same 55 watt Osram tubes (total 880 watts), but the housing incorporates a Plexiglas shield in front and is fan cooled, to keep the enclosed lamps at a constant optimum operating temperature (since fluorescents will shift in color and intensity with temperature change.)

Fixtures using 40 Watt double ended tubes, such as Kino-Flo or many homemade units, weren't available for testing at this time.

Only one HMI unit was tested, a 1200 SE unit by SunRay. The SunRay was by far the most powerful light tested and though it was tested at the same six foot distance as the other lights, probably wouldn't be used that close to any subject in the a studio situation.

One HID light was tested with three different lamps and with several types of diffusion or filters: Buhlite 150 Watt SoftCubes with 3000°K, 4200˚ K and 6500˚K double-ended lamps by different manufacturers. The lamp is manufactured by Buhl Industries.

Luminance reading in lux and foot candles were made with a Spectra Professional IV incident meter at the center of a target six feet from the face of a single light pointing straight at the target.

UV measurements were taken in the same way with an Elsec UV Monitor type 762.

Temperature measurements were made with a YSI Precision Thermistor with a resistance of 10,000 Ohms at 25˚ C embedded in a 3 cm square target of neutral gray plastic. Resistance readings at the beginning and end of a fifteen-minute exposure were recorded, from which very accurate temperature values could be calculated.

Ultraviolet Output of Continuous Light Sources for Photography

Measured at six foot distance

Museum allowable UV standard is 70 µWatt/Lumens or less

Tungsten Halogen

Type	Notes	Foot Candles	LUX	UV in µWatt/lumens
Lowel Tota 1000 watt		221	2379	80
Lowel DP 1000 watt	Mid focus	763	8214	100
Arri Fresnel 1000 watt	Full flood setting	458	4931	85
TTI copy lights 1000W	4 lamp array dichroic reflectors fan cooled	300	3230	45

Fluorescent

Type	Notes	Foot Candles	LUX	UV in µWatt/lumens
Balcar Quadlite 200 watt	4 Osram 55 Watt bare tubes	148	1595	40
Northlight 2X3 880 watt	16 Osram 55 watt tubes, fan cooled	240	2584	45
Northlight 2X3 880 watt	With Rosco acetate diffusion	164	1766	30
Northlight 2X3 880 watt	With UF3 Plexiglas	222	2390	3

HMI

Type	Notes	Foot Candles	LUX	UV in µWatt/lumens
SunRay 1200 Watt	Frosted glass lens	8260	88920	400

Ceramic HID

Type	Notes	Foot Candles	LUX	UV in µWatt/lumens
Buhl 150 Watt SoftCube	3000˚ Kelvin lamp, 50% stock diffusion	194	2089	70
Buhl 150 Watt SoftCube	4200˚ K lamp, 50% stock diffusion	201	2164	100
Buhl 150 Watt SoftCube	4200˚ K, 50% diffusion + UF3 Plexiglas	178	1916	1
Buhl 150 Watt SoftCube	6500˚ K bare	333	3585	100
Buhl 150 Watt SoftCube	6500˚ K 50% stock diffusion	183	1970	70
Buhl 150 Watt SoftCube	6500˚K opal Plexiglas	69	743	35

Tests conduced at The University of California Berkeley Art Museum and Better Light Studio, San Carlos, California, by Ben Blackwell, Larry Guyer, and Robin Myers October 2002.

UV measured with Elsec UV Monitor type 762.

Luminance in foot candles and lux measured with by Spectra Professional IV meter.

Temperature Effects of Photographic Lights

One light at 6 foot distance, temperature rise at subject after 15 minutes

	Tungsten			Fluorescent		HMI	HID	
	Lowel Tota 1000 W	**Arri Fresnel 1000 Watt**	**TTI 1000 Watt**	**Balcar Quadlight**	**North Light 2X3 (880W)**	**Sun Ray 1200 Watt**	**Buhl 150W 4200˚K**	**Buhl 150W 6500˚K**
Starting Temperature	20.04° C 68.72° F	20.22° C 68.40° F	19.22° C 66.60° F	20.04° C 68.07° F	20.59° C 69.09° F	20.08° C 68.09° F	20.04° C 68.58° F	20.32° C 68.07° F
End Temperature	23.78° C 74.80° F	24.86° C 76.75° F	19.35° C 66.83° F	20.32° C 68.07° F	20.59° C 69.09° F	27.00° C 80.59° F	20.20° C 68.79° F	20.44° C 68.36° F
Rise after 15 minutes	+3.74° C +6.08° F	+4.64° C +8.35° F	+0.13° C +0.23° F	+0.28°C +0.51° F	No Change	+6.92° C +12.5° F	+0.16° C +0.29° F	+0.12° C +0.21° F

Tested at Better Light Studios, San Carlos, California by Ben Blackwell, with Michael Collette, Larry Guyer, and Robin Meyers.
Temperatures calculated from resistance readings from a YSI 44006 thermistor with a resistance of 10K ohms at 25˚ C.

Test site is large air conditioned space so ambient temperatures were little affected by hot lights.
Effect on temperature will be greater in a smaller room without efficient air conditioning.

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