RESEARCH INTO THE EFFECTS AND IMPLICATIONS OF INCREASED CFL USE

March 2010

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Introduction:

The following report is a short preliminary survey study presenting an overview of the effects and implications of increased use of Compact Fluorescent Lamps (CFLs), soon to be mandated by the *Energy Independence and Security Act of 2007.* This study was partially funded by a seed money grant from the Illuminating Engineering Society.

The main purpose of the study is to determine if more research is required before the ban on ordinary incandescent lamps takes effect. If it is determined that it would be in the best interest of the country to conduct further studies, then the ban and the restrictions placed on the incandescent lamp should be withdrawn and held in abeyance, until a solid basis can be determined as to what the best course of action be taken to meet the spirit of the act. All funding by the several government entities promoting the use of CFLs should also cease until there is careful evaluation of relevant CFLs characteristics and comparison with incandescent lamps.

We assembled an experienced interdisciplinary team, fully capable of delivering proposed investigation and research.

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MAIN CONCERNS RE: CFL USE

Setting

The *Energy Independence and Security Act of 2007* (and its counterparts around the World) will institute efficiency standards for general service incandescent lamps that will effectively fully phase them out of manufacture and availability by 2012 – 2014. The compact fluorescent lamp (CFL) is looked upon as a logical replacement.

Crisis

CFLs are not the superior replacement for incandescent lamps, neither in conservation or aesthetics. Nor is the CFL an equivalent light source technology. As an indicator of lamp efficiency, *lumens-per-watt* has been extensively used as a comparative metric to promote the energy advantages of light sources. However, this is flawed because no meaningful conclusions can come from measuring and quantifying an individual type of light source on its own. Lumens-per-watt does not capture any qualitative characteristics, nor does it express the actual performance level of any light source used in practical applications. Most importantly, it does not represent the actual illuminating and spectral properties of a given light source. *Lumens-per-watt* is simply an idealized quantifier obtained in laboratory measurement, which is often used isolated from other light source characteristics and out of context with the lighting applications under which people live and work. What is really needed is an incandescent lamp with today's lumen output but with longer life.

Realities

Generally, there are no bad light sources, only bad applications. There are some very laudable characteristics of the CFL, yet the selection of any light source remains inseparable from the luminaire that houses it, along with the space in which both are installed and lighting requirements that need to be satisfied. In the pursuit of more *useful* lumens-per-watt metric, one must match the luminaire to the space being illuminated. The lamp, the fixture and the room: all three must work in concert and for the true benefits of end-users. If the CFL should be used for lighting a particular space, or an object within that space, the fixture must be designed to work with that lamp, and that fixture with the room. It is a symbiotic relationship. A CFL cannot be simply installed in an incandescent fixture and then expected to produce a visual appearance that is more than washed out, foggy and dingy. The whole fixture must be replaced -- light source and luminaire -- and this is never an inexpensive proposition.

Conclusion

“It is wrong to assume that banning the incandescent lamp is an energy- and ecologically-conscious action. We have not solved all our lighting problems by finding a highly efficient source. There is presently no lighting technology that can replace certain types and uses of incandescent lamps.” [ref, IALD]

This study challenges current political consensus and decision to phase out incandescent lamps and switch to CFLs on the assumption that significant energy savings will be achieved without seriously compromising any of the relevant functional and illuminating requirements in target applications. Moreover, and more importantly, the study points out that there is a need to carefully investigate and elucidate some of the important safety concerns that may arise from a prolonged exposure and widespread use of CFLs, of which levels of electromagnetic fields measured around these appliances are illustrated in more detail. (N.B. an initial measurement of approximately 50 DB from a 13W CFL)

Methodology

The simple analysis presented below highlights the fact that the intended ban of incandescent lamps places perhaps too many restrictions on the functional habitability of most spaces we encounter every day. This is demonstrated, in part, by showing how well the lumens from these light sources (incandescent and CFL) match the lighting task at hand. The presented analysis uses *coefficient of utilization* (CU), expressed as a function of *room cavity ratio* (RCR), as CU is probably the most widely published data, available for practically all commercial lighting fixtures. Generally, CU gives a rough estimation of the lumens incident to a working plane relative to the total lumens emitted by the lamps within the fixture. Therefore, CU can be used to evaluate the overall suitability of different light sources and fixtures for a performance-based comparison, because it fully captures the end result in-situ. These results clearly demonstrate that lumens-per-watt measure, as a singular indicator which is but one factor separated from actual practice, cannot be used for the correct analysis and assessment. There are far too many other variables that cannot be ignored.

Results

We surveyed the published CUs of one commercial luminaire manufacturer, comparing 47 incandescent downlights to 25 CFL downlights. The CUs are calculated for common room reflectances of 80% ceiling, 50% walls and 20% floor:

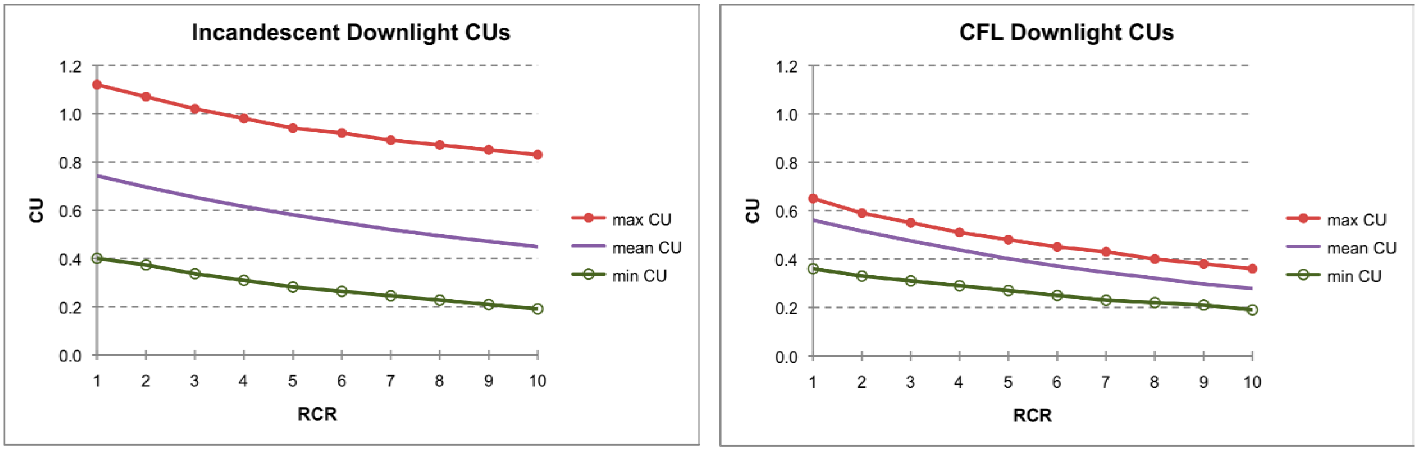


Figure 1. Comparison of CU values for incandescent and CFL based light fixtures.

It can be observed from Fig. 1 that across all considered fixtures the utilization capability of incandescent is nearly twice that of CFLs, where the minimum utilization of both incandescent and CFLs is identical. On average, incandescent's capability to deliver useful lumens is greater than CFL's across all room types.

The greater disparity between the max-min CU curves in the incandescent plot proves the versatility of these sources. By observing the spread of data for each lamp type, it can be seen that the variety of compositional lighting effects that can be achieved with CFLs is limited. This is simply because their source size is so much larger than the filament of the incandescent. In essence, the lumens-per-watt metric of equivalency is flawed (potential savings of electric energy in some CFL applications may be up to twice time lower if they need to provide the same illuminance levels as their incandescent counterparts), which is the inherent failure of the advertised equivalency. Subsequent plots sustained these findings (see Figure 1). In other words, these preliminary and general results require further and more detailed study.

Resolution

This report is not an extensive review of all relevant aspects of replacing incandescent- with CFL light sources in all applications; rather it is an initial foray. Nevertheless, by using the common tools employed in daily lighting practice, we demonstrate the fallacy that simply replacing CFL for incandescent light source will yield equal results and conserve energy. Incandescent lamps definitely produce fewer lumens-per-watt than CFLs, but they still use energy for lighting more efficiently and light objects discernibly better in many applications.

Lumens-per-watt is simply not a reliable factor in determining either the suitability or sustainability of a light source. Perhaps, for lighting the corridor of an office building, CFLs might be fine. However, for lighting a make-up counter in the theater, or an intimate dining area in a restaurant, of for any other visible task/activity where good color recognition is important, CFLs will not work. The light source, the distribution of light and the location of a lighting fixture must always be considered together, as the selection of a light source can never be disconnected from its end use, or where it is to be employed.

We assert that selection and use of any light source (including CFLs) is ultimately justified in its end use application. Banning a light source, however, is not a logical step when there are many unknowns that need to be addressed. The following is a short list of main concerns related to the expected incandescent-CFL switch, not in order of importance, which should be thoroughly researched at once. There is also a long list of merchandizing pitfalls that require the re-education of many of the personnel at point of sale locations for the purchase of the CFLs. This is absolutely necessary because of the passage of the Energy Independence and Security Act of 2007. The CFLs will soon become all pervasive and the recent measurements and compilation of information provided below discuss and illustrate some of the most important aspects of their use.

CONCERNS

- Electromagnetic Fields (EMF) - The replacement of incandescent lamps, the most common lamp used in virtually every household in America, with CFLs will introduce a prolonged exposure to EMFs. Everyone will be exposed to them. Not enough is known about the consequences of continuous "bombardment" of these fields, even if they are at low intensities. The EMF emitters are all-pervasive in everyone's life today, but not in the unremitting manner they will be present if we add CFL lighting to the list of propagating devices (a random survey of NYC streets had EMF readings between 5mG and 100mG at several street corners). Infants and young children are at the greatest risk, and in some of the darkest scenarios we may be dooming the next generation to illnesses that would never occur because of incandescent lighting. There is virtually no data, study or report related to accurate quantification and assessment of negative EMF effects of CFLs. From the medical report in this paper we see that, "Results of several epidemiological studies showed a moderate association between exposure to magnetic fields above 3-4 mG and occurrence of childhood leukemia. This risk doubled above the 3-4 mG level (0.3-0.4 μT). Caution is required regarding efforts to extrapolate spot readings of EMFs to long-term exposure for the purpose of estimating health risks". Were any of the possible health concerns pointed out to the legislators who approved this act? The data presented in Fig. 2 and later in this document points to many such hazards that may come from CFLs.

ID number	Manuf.	Wattage	dimmed ?	6" (mG) Magnetic	12" (mG) Magnetic	18" (mG) Magnetic	24" (mG) Magnetic	30" (mG) Magnetic	36" (mG) Magnetic	42" Magnetic	48" Magnetic	SPD READ?	SPD distance	24" FC READING
9	GE	26	FULL	100+	8	10	7	6	6	3.5	~2	Y	24"	60
			DIM	100+	22	8	6	6	6	5	3	Y	24"	40

Figure 2. Preliminary EMF measurements for one CFL available on the market.

- Currently, there is no metric to correctly describe the quality of light produced by CFLs. Correlated Color Temperature (CCT) and Color Rendering Index (CRI) are not adequate, as they do not show the rendering of skin tones. Furthermore, lamps with identical CCTs and CRIs render color differently from manufacturer to manufacturer. All CFLs are spectrally deficient when it comes to properly rendering most skin tones. Since these light sources are meant to serve people, this should be of major concern.

- CFLs should be recycled, but there is no uniform Federal law or otherwise advised method for this process. Most of these lamps will end up in landfills, although such disposal is unlawful in some states. Fact: 1 gram of mercury, corresponding to the content of about 200-500 CFLs, will pollute a 2 acre pond.

- The disposal of accidentally broken lamps is a further problem which remains unresolved (they should not be vacuumed). After breaking a single CFL, mercury concentrations in air can more than 300 times bigger than allowed limit [http://www.maine.gov/dep/rwm/homeowner/cflreport.htm]; the recommendation is to use glass jar with a gum-sealed metal cover for their disposal.

- Most CFLs are packaged in plastic, which is an environmental issue. Furthermore, manufacturing and production processes for CFLs are also significantly more carbon intensive than manufacturing of incandescent lamps.

- There are many limitations to the proper installation of CFL light sources. Size of CFL light sources will usually limit optical control otherwise available for incandescent light sources. Most recessed lighting fixtures for incandescent lamps will have to be replaced or eliminated if CFLs are to be used instead; in such cases, savings due to lower CFL energy demand are seriously compromised by additional installation and work costs. Current residential lighting equipment, which universally works for any incandescent lamp, is not appropriate for many CFLs. Dimmers that are in use for incandescent lamps will not work with CFLs, as the majority of CFLs are not dimmable. Many dimmable CFLs do not work with incandescent dimmers, and even dimmers that are made for CFLs are brand specific (will not work on other brands of CFL).

- All dimmers made to control 'dimmable' CFLs do not work with all CFLs that are labeled to be dimmable. Some lamps dim half-way, and some lamps do not dim at all. Lamps and dimmers must be matched, which is a nearly impossible task. And even when matched, CFLs do not dim acceptably. This fact is further exacerbated by the reality that most purveyors of the lamps and dimmers do not understand this problem. Most existing dimmer installations would have to be replaced, which is effectively preventing use of CFLs in various end use applications, for example bedrooms.

- Use of any dimmer on a CFL will increase EMF by up to 10 times the initial value.

- Further on that problem – when a CFL is dimmed, the Spectral Power Distribution (SPD) changes, with most of the red spectrum being dropped, leaving green and blue as the dominant colors. This renders everyone in the room horribly, and one would be hard pressed to find a living or dining room lit with predominantly green-blue light as visually pleasing. This is illustrated in more detail further in this report.

- The general requirements for electrical characteristics of CFLs with rated powers less than 25 W (i.e. CFLs which will be used for the replacement of standard incandescent lamps in households and similar lighting applications) do not specify their operating power factors and are limited only to the control of the emission of 3rd and 5th harmonics [BS/EN 61000-3-2]. As a consequence, practically all manufactured CFLs with powers less than 25 W operate with true power factor of around 0.6 capacitive (i.e. significantly lower than unity power factor of incandescent lamps), and introduce relatively high current total harmonic distortion (THD), usually exceeding 100% (incandescent lamps have no harmonic emission). A wholesale replacement of incandescent lamps with CFLs will therefore influence substantial changes in flaws of active and reactive powers, and will introduce additional voltage harmonic distortion, possibly above the prescribed limits. For example, one study related to an isolated island supply system where CFLs are used to replace incandescent lamps (because of the expected energy savings) resulted in voltage THD values exceeding 30%. This is a main point of concern, as the related negative effects of increased CFL use in residential and commercial load sectors (where there are other non-linear power electronic loads) are not properly investigated; furthermore, the use of expensive active filters may be needed in order to prevent circuit resonance problems.

- CFLs utilize self-oscillating electronic circuits, with operating frequencies usually in the range from few tens kHz to several tens kHz. In this frequency range, there will be intensified interactions between the individual devices (e.g. CFLs and SMPS'– switch-mode power supplies), which will form low-impedance paths influencing each other depending on their operating conditions and modes of operation. This suggests that standard harmonic analysis (in the range up to 2-3 kHz) cannot be used for the full and precise assessment of CFLs characteristics, and that further research in this area is needed.

- It is not clear from the lighting equivalencies advertised for CFLs what their actual energy saving effects is. There is an obvious and important discrepancy between the advertised values (4 times more efficient than incandescent) and the Lighting

Research Center's values (3 times more efficient). Until there are accurate and validated published data, there will be a general danger of misuse and misrepresentation of the effectiveness of the CFLs and their contribution to the environment. It is only logical to ask for the re-evaluation of the current incandescent ban until this is fully clarified.

- Manufacturer's lamp life claims are based on analytical calculations or mathematical premises, not on a valid research study, or actual use survey. In the recent DOE CALiPER testing study [Broderick, IES Conf], the light outputs of some of the tested lamps dropped for more than 50% within the first 1,000 hours (manufacturers claim lifetime between 6,000 and 10,000 hours), and their measured efficacy was smaller than what was declared by the manufacturers (usually between 45 and 65 lumens-per-watt) – the actual measured values were often around 30 lumens-per-watt or lower.

The above is just a miniscule list of issues surrounding the legislation to ban incandescent lamps. An immediate partial remedy would be to lift the ban, ask for clarification of related issues and meanwhile let the market and the users determine how to light their homes, places of worship and businesses.

ADDITIONAL CONCERNS

Electrical/Man-made light has become an all-pervasive element in cities since the beginning of the 20th Century. City dwellers never see true darkness or the true brightness of a starry night sky. What they are subjected to, for the most part, is the hideous yellow-orange smog of sodium vapor illumination coming from various exterior and public lighting systems. We live in a "blade-runner world" at night – visually deprived of the way we normally perceive our world. This 'deprivation' will soon be mandated to enter the formerly guarded privacy of our homes, where we use incandescent lamp, a light source with continuous output spectrum similar to that of the Sun. It is obvious that all of the consequences of the new mandate to ban incandescent lamps and replace them with some other, high-frequency operated light sources with a discontinuous output spectrum have not been thoroughly thought through. Perhaps, now is the time to start thinking.

To further compound this unfortunate situation, our lighting will now add a plethora of artificially generated frequencies throughout the electromagnetic field (EMF). It seems, as more and more frequencies are being added exponentially each year with no question or gauntlet posed, that the need to analyze the impact that these fields may inflict on our lives is only more urgent.

The numbers of everyday appliances that we live and work with have also multiplied significantly. TV sets, computers, cordless phones, intercom systems, microwave ovens, satellite and radio signals, microwave ovens and induction cookers, ad-infinitem. Soon there will be another potentially harmful source added to virtually every home in this country – the compact fluorescent lamp (CFL). Household wiring may help transport EMFs throughout the entire building structure.

It is important to note that the effects of electromagnetic radiation are usually cumulative. Therefore, even extremely low EMF exposure may, over prolonged periods of time, result in severe health consequences. Illnesses to which EMFs are, or may have been a contributing factor includes: Electromagnetic Sensitivity Syndrome, Chronic Fatigue Immune Dysfunction Syndrome, AIDS, Gulf War Syndrome, Electromagnetic Pulse, Amyotrophic Lateral Sclerosis, Alzheimer's Disease and various forms of Cancer (Brain, Leukemia, Lymphoma, Melanoma, Breast, etc).

People who have pacemakers are warned not to wear iPods in their shirt pockets. They are also cautioned to keep a distance from microwave ovens. There are other heart related devices that these same cautions apply to. Warnings are posted at airport security screening devices that warn against use with heart related devices.

B – Residential Applications:

The following is a list of some of the potential problems in substituting CFLs for the standard incandescent lamps.

Costs:

Initial cost of lamps and the re-installation electrical work that will be required-

CFLs may not be compatible with photocells, timers, and other relay-operated devices. Who bears the cost of their replacement and disposal?-

The amount of energy consumed in these retrofit installations has not been taken into account-

Misleading claims made about the efficacy of the compact fluorescent lamps-

Most CFLs have power in the UV spectrum, not good for skin, light health, or artwork.

Low power Factor of CFLs used in residential applications (around 0.6 capacitive) has not been included in any of the cost analysis. This will impact on the utilities supply of electricity. With 'smart meters' lighting bills will almost double. Power factor for incandescent lamps is 1.0, no change in cost-

Misleading claims made about the life of the lamp. Installation location and "on – off" switching frequency significantly shorten their life. Operating position (base-up or base-down) also plays a big role in performance and lamp life.

Incompatibility may occur with many existing fixtures-

Existing dimmer installations will not work with the CFLs-

Potential interference with other household devices, e.g. TVs, cordless phones, intercoms, medical devices, etc.-

The complex disposal procedure required for recycling lamps and clean-up if a lamp is broken. We might require a ‘deposit law.’ Disposal of an incandescent lamp is simple. With a CFL one must consider the glass, the mercury, the plastic base and the electronic circuit board-

Will the further development of Light Emitting Diode (LED) sources make CFLs obsolete in the next decade? Will we have to renovate all over again?-

C - Lighting Quality Degradation:

Poor color rendering of skin tones-

CFLs will not dim to the lighting level required for mood even with CFL compatible dimmers-

Change in spectral power distribution of the CFL when dimmed. Color rendering of skin tones goes from poor to hideous-

Many decorative lamp styles are not available in CFLs which may require replacement of fixtures-

Colors of interior finishes and furniture will change with CFLs. These changes may not be acceptable-

Lighting of art works may be significantly degraded.

Appropriate photometric distribution curves may not be possible because of scale of the light source to properly light many spaces.

Many people find reading difficult under the light from CFLs-

Electromagnetic Field Measurement Trials (Compact Fluorescent Lamps)

Electromagnetic Field (EMF) tests were conducted on a makeshift testing platform with three medium base sockets. Each compact fluorescent lamp (CFL) was screwed into on socket and tested individually. A *TriField Meter* model 100XE was used to measure the EMF of the lamps, dimmers and surrounding area of the testing room. The TriField meter measures magnetic (ranges 0-100 with extra sensitivity from 0-3), electric and radio/microwave. A handheld spectrometer was used to get a basic identification of the Spectral Power Distribution (SPD) of each light source. The custom socket mounting board consists of three porcelain medium base sockets run in parallel, and is plugged into the wall socket. Voltage from the wall socket was measured at 117-118 volts.

EMF readings were taken at 6”, 12”, 18”, 24”, 30”, 36”, 42”, 48”, from center of the lamp (see Figure 3). Future readings should be taken in multi-directions (see Figure 4).

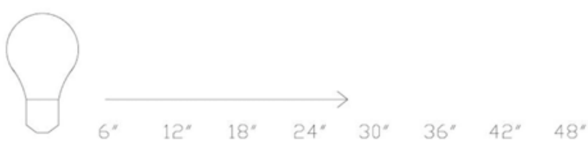


Figure 3. Measurement technique

Figure 4. Future readings

In EMF trials one and two, a metal tape rule was used to demarcate the measurement locations. The metal tape rule was influencing the EMF readings by propagating the signal. A new wooden dowel was used in subsequent measurements to mark location points. EMF trials one and two are not included in the information in this report (see Figure 5).

Basic procedure for the measurement process began with a reading of the standing EMF of the room, using the TriField meter. Measurements were taken in the center of the room, and at each corner (noted in the trials as NE, NW, SE, SW). Readings were also taken near any other equipment in the room that might be giving off a signal. On the third and fourth trials, notes were taken about which lamps gave skin a “splotchy” look. There were some initial notes taken on whether the EMF recordings were affected by the rotation of the lamp (either measuring in-line with the two glass posts of the spiral, or out of alignment). This seemed to make no difference at all, and so this notation was abandoned.

One CFL at a time was screwed into the mounting base and allowed to warm up to its full light output. The EMF was measured at each distance from the lamp and marked down on the chart. As can be seen in the measurements included, there was sometimes an *increase* in measured intensity of EMF with increased distance from the lamp. This happened more often when using the metal ruler; however there were still some instances of increased intensity using the wooden dowel.

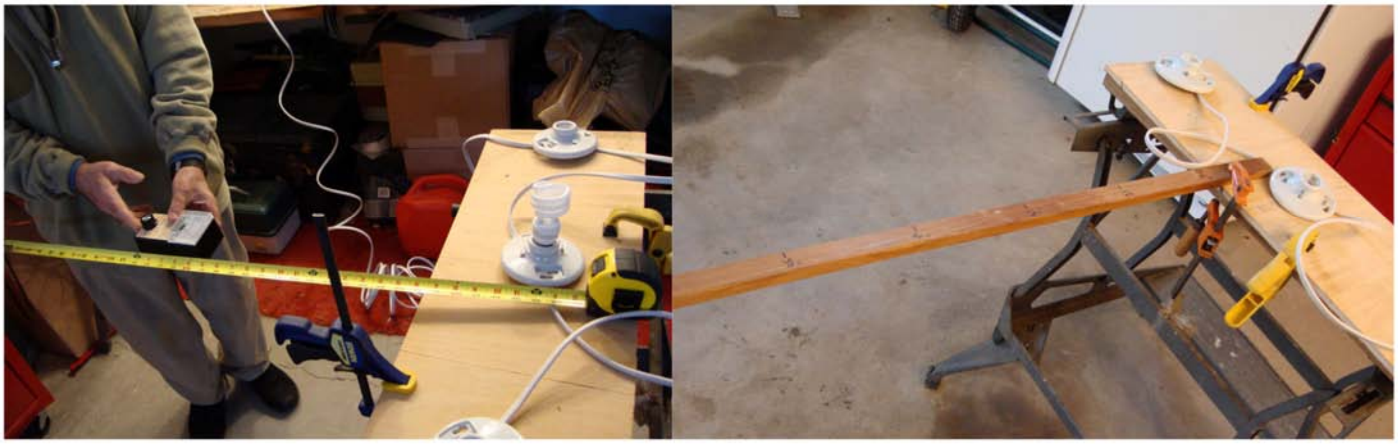


Figure 5. Measurement apparatus (metal rule on left, wooden rule on right)

LAMPS TO BE USED FOR EMF MEASUREMENTS

Lamp Inventory | 3-Jan-10

ID number	Manuf.	Wattage	Equivalent Wattage	Measured Equiv. Watt	Dimmable?	CCT	Lumens	Claimed Life	Manuf. Locations	Lamp Shape	Quantity	NOTES
1	Bright Effects	7	40		No	6500	330	8000	China	T Lamp	1	
#007741 (LBP7T10)												
2	Bright Effects	13	60		No	3500	900	8000	China	Spiral	1	
#296888 (LBP13T/35K(E))												
3	Sylvania	24	100		Yes	2700	1500	8000	China	Spiral	1	
CF24EL/TWIST/827/DIM/BL												
4	Ottlite	25	100		No	daylight	n/a	8000	China	Spiral	1	
#25ED12R (fcc id: N3WCORCTL1M1) (13W E243260)												
5	Bright Effects	26	100		n/a	3500	1750	8000	China	Spiral	1	box says no dim lamp says dimmable
#296883 (BE26T3/BW)												
6	GE	26	90		No	2700	1300	10000	China	R40	1	
FLE26/2/R40XL/CD												
7	Sylvania	40	150		No	2700	2600	6000	China	Spiral	1	
CF40EL/TWIST/827/RP												
8	Bright Effects	65	300		No	2700	3900	6000	China	Lg Spiral	1	
#046931 (L65TN)												
9	GE	26	90		Yes	2700	1300	6000	China	R40	1	
FLE26/2DVR40SWCD												
10	Philips	16	65		Yes		630	8000	Poland	R30	1	
MEDIUM BASE EL/4 BR30												
R (room)	Sylvania	23	100		No	2700	1600	10000	China	Spiral	15	LAMPS to be used for room fc measurements
Incand	GE	100				soft white						LAMPS to be used for room fc measurements

See above for Lamp ID numbers (1-10) as well as the identification numbers given by the manufacturer. The lamps labeled "R (room)" are a set of 15 CFLs used for footcandle measurements, installed as replacements for the 14 (5 year old) incandescent lamps in the ceiling of the measuring room. Also of note: Lamp #5 (Bright Effects 26W) came in a package that warns *not* to use the lamp with a dimmer. However the lamp itself has a printed reminder that it *is* for use with dimmers. This lamp is included in the dimmer trials (trials 5 & 6). This preliminary study considered only a small sample of lamps; more will be measured if this proposal is successful.

Figure 6. Selection of lamps used in testing

EMF TRIAL 3 _ Jan 09,2010
EMF testing - all 9-Jan-10
Lamps in the ceiling at the time are original 5 year incandescent

9:00am start - CENTER -no magnetic, no electrical readings, radio waves measured at .01
NW corner - no electric, radio .01, no magnetic (near electric box)
NE corner - no elecric, radio .01, no magnetic
SE corner - no elecric, radio .01, no magnetic
SW corner - no electric, radio .01, no magnetic

using new wooden ruler stick
NOTE: metal seems to carry the signal
All measurements from center of lamp
~ Voltage 117V out of strip

All measurements crudely taken to get a general idea of emf further study is recommended

ID number	Manuf.	Wattage	6" (mG) Magnetic	12" (mG) Magnetic	18" (mG) Magnetic	24" (mG) Magnetic	30" (mG) Magnetic	36" (mG) Magnetic	42" Magnetic	48" Magnetic	line up with posts
1	Bright Effects	7	5.5	1.6	0.5	0	0	0	0	0	n/a
2	Bright Effects	13	5	4	0.6	0	0	0	0	0	n/a
3	Sylvania	24	10	4	2	0.1	0	0	0	0	n/a
4	Ottlite	25	4	4	3	0.1	0	0	0	0	yes
5	Bright Effects	26	10	5	1.6	0	0	0	0	0	no
6	GE	26	13	7	3.5	0.3	0	0	0	0	n/a
7	Sylvania	40	15	4.5	3	0.3	0	0	0	0	n/a
8	Bright Effects	65	5	4	4	5	3	0	0	0	n/a
9	GE	26	100+	15	2	0.6	0.2	0	0	0	n/a

EMF Trial 3. Measuring new CFL lamps (1-9)

EMF TRIAL 4 _ Jan 13,2010

EMF testing - all | 13-Jan-10

Lamps in the ceiling at the time are original 5 year incandescent

10:45am start -

NW corner - no electric, radio .01, no magnetic (near electric box)
NE corner - no elecric, radio .01, no magnetic
SE corner - no elecric, radio .01, no magnetic
SW corner - lighting installation set up here

All measurements taken after burning lamps for1 hour

using new wooden ruler stick

NOTE: metal seems to carry the signal

All measurements from center of lamp

~ Voltage 117V out of strip

All measurements crudely taken to get a general idea of emf further study is recommended

ID number	Manuf.	Wattage	6" (mG) Magnetic	12" (mG) Magnetic	18" (mG) Magnetic	24" (mG) Magnetic	30" (mG) Magnetic	36" (mG) Magnetic	42" Magnetic	48" Magnetic	meas. at
1	Bright Effects	7	5	2	0.5	0.1	0	0	0	0	
2	Bright Effects	13	4.75	3	0.75	0	0	0	0	0	10:45am
3	Sylvania	24	9	4.25	2.25	0.2	0	0	0	0	
4	Ottlite	25	3.5	4	1.5	0.75	0.5	0.25	0	0	
5	Bright Effects	26	12	7	3	0.5	0	0	0	0	11:50am
6	GE	26	13	6.5	3.25	0.3	0	0	0	0	
7	Sylvania	40	17.5	4.75	1.8	0.4	0	0	0	0	
8	Bright Effects	65	5	4	4	4	3	0	0	0	12:45am
9	GE	26	100+	8	1.5	0.4	0.1	0	0	0	

EMF Trial 4. Measuring new CFL lamps (1-9)

Measurement set-up also included two dimmers for use with CFLs. Lutron "Diva" dimmers for Philips CFLs were used, one standard and one with custom modifications by Lutron to make it calibrated to 36 volts. Lutron provided the first "Diva" dimmer (for Philips CFLs) as no hardware stores in the area (Home Depot, Lowes, local family-run businesses) carried any dimmers specified for use with compact fluorescent lamps. The first Lutron "Diva" dimmer had very little effect on the CFL (see Trial 5). It dimmed the lamps barely 20%. This dimmer was used in Trial 5, and is referenced in Trial 6 as the "old" dimmer. The "new" dimmer (used in Trial 6) is a *second* "Diva" dimmer sent from Lutron headquarters. This "new" dimmer has custom modifications that calibrate it to 36 volts. We do not know what the "old" Lutron dimmer was calibrated to.

Once the dimmers were attached to the testing board, the three dimmable CFLs were tested individually for quality of dimming and for EMF. In the charts, "full" means that the dimmer was switched on to 100% power. "Dim ½" means the dimmer was set to approximately half-way down its path, to what should be called 50% dim. The word "dim" in the charts means that the dimmer was switched on, but the dimmer was at 0%. Finally, "straight (no dim)" means that the lamp was plugged directly into the wall socket, with no dimmer attached at all.

Home Depot online has only two CFL dimmers available; the Lutron "Diva" and the Lutron "Skylark". Neither dimmer was available in the local Home Depot. In these trials, the Lutron dimmer did not work on any of the other commercially available lamps (GE, Sylvania, Bright Effects). Even the dimmer that was customized by Lutron did not seem to have a strong dimming effect on the lamps.

EMF TRIAL 5 _ Jan 13,2010

Dimmer Testing | 13-Jan-10

DIMMER SPECIFIES FOR PHILIPS DIMMABLE CFL - DOES NOT DIM WELL ON OUR SYLVANIA OR BRIGHT EFFECTS OR GE LAMPS

using new wooden ruler stick

All measurements from center of lamp

NOTE: metal seems to carry the signal

Measured ~ Voltage 117V out of strip

All measurements crudely taken to get a general idea of emf further study is recommended

ID number	Manuf.	Wattage	dimmed ?	6" (mG) Magnetic	12" (mG) Magnetic	18" (mG) Magnetic	24" (mG) Magnetic	30" (mG) Magnetic	36" (mG) Magnetic	42" Magnetic	48" Magnetic	SPD READ?	SPD distance	24" FC READING
3	Sylvania	24	FULL	90	16	8	7	6.5	6	6	5	Y	24"	26
			DIM	11	11	8	7	6.5	6	5	3.5	Y	24"	21
5	Bright Effects	26	FULL	12	10		7		6		4	Y	24"	33
			DIM	22	20	14	11	9	7	4	2.5	Y	24"	30
9	GE	26	FULL	100+	8	10	7	6	6	3.5	~2	Y	24"	60
			DIM	100+	22	8	6	6	6	5	3	Y	24"	40
DIMMER	Lutron		FULL	100+										
			DIM	50										

DIMMER EMF Trial 5. Three dimmable lamps

Currently, there are no allowed limits or reference values with which to compare the EMF of these lamps.

EMF TRIAL 6 _ Jan 21,2010

Dimmer Testing 21-Jan-10

* Ceiling lights off for these measurements
sunny day

using new wooden ruler stick

All measurements from center of lamp

NEW dimmer from Lutron : exactly the same dimmer as last time, but this one has hand written label on it saying " CAL 36 V".
Dimmer **still** specifies for Philips CFLs only.

* need to know difference between dimmers (old and new)

* measured from top of EMF meter

NOTE: metal seems to carry the signal

Measurec ~ Voltage 118V out of strip

All measurements crudely taken to get a general idea of emf further study is recommended

ID number	Manuf.	Wattage	warm up time	dim ?	6" (mG) Magnetic	12" (mG) Magnetic	18" (mG) Magnetic	24" (mG) Magnetic	30" (mG) Magnetic	36" (mG) Magnetic	42" Magnetic	48" Magnetic	SPD READ?	SPD distance	NEW dim 24" FC READING	with OLD dimmer ! 24" FC READING	GE 100W incand. with NEW dimmer ! 24" FC READING	GE 100W incand. with OLD dimmer ! 24" FC READING
3	Sylvania	24	20 min	FULL	15	11	7	6	5	4.8	3.8	2.5	Y	24"	29	30	41	40
				dim 1/2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	26.5	29	8.6	19
				DIM	30	7.5	7	7	6	5	4.5	3.25	Y	24"	14	26	3.3	6
				straight (no dim)	10	4	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	29.8			
													Y	24"				
5	Bright Effects	26	5-10 min	FULL	11	10	10	8	6	4	3	1.6	n/a	n/a		n/a	n/a	n/a
			DID NOT DIM	DIM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Y	24"		n/a	n/a	n/a
				straight (no dim)	6	5	1.8	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
													Y	24"				
9	GE	26	10 min	FULL	100+	13	6	5	5	4	3	2.5	n/a	n/a		n/a	n/a	n/a
				DIM	100+	25	14	6	5	4.8	4	3	Y	24"		n/a	n/a	n/a
				straight (no dim)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10	Philips	16	10 min	FULL	50	12	10	10	8	5.5	3.5	1.8	Y	24"	50	45	n/a	n/a
				DIM	75	11	6.5	6	6	5	4	3	Y	24"	9	14	n/a	n/a
DIMMER at 6"	Lutron (with custom CAL 36 V)			FULL	75													
				DIM	35													
				OFF	1													
DIMMER at 6"	Lutron old dimmer			FULL	35													
				DIM	10													
				OFF	3													

10:00am start - CENTER -no magnetic, no electrical readings, radio waves measured at .01
NW corner - no electric, radio .01, no magnetic (near electric box)
NE corner - no elecric, radio .01, no magnetic
SE corner - no elecric, radio .01, no magnetic
SW corner - no electric, radio .01, no magnetic
near computer : 8 mg / near ceiling heater : 3 mg
near garage door opener : 10 mg when operating but .2 when static

DIMMER EMF Trial 6. Four dimmable lamps

There were no dimmable Philips CFL lamps available in the area, but Lutron was able to supply a 16W (65W replacement) dimmable R30 CFL (in plastic package). This lamp was also measured for quality of dimming and for EMF.

EMF TRIAL 7 _ Jan 22,2010
Dimmer Testing 22-Jan-10

* Ceiling lights off for these measurements
sunny day

using new wooden ruler stick
All measurements from center of lamp

NEW dimmer from Lutron : exactly the same dimmer as last time, but this one has hand written label on it saying " CAL 36 V".
Dimmer specifies for Philips CFLs only.

* measured from top of EMF meter

NOTE: metal seems to carry the signal
Measurec ~ Voltage 118V out of strip

All measurements crudely taken
to get a general idea of emf
further study is recommended

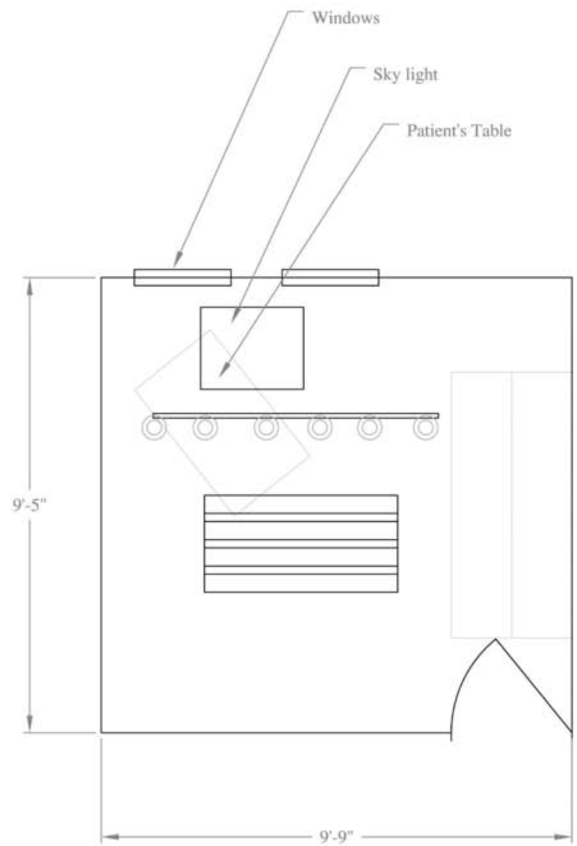
ID number	Manuf.	Wattage	warm up time	dim ?	6" (mG) Magnetic	12" (mG) Magnetic	18" (mG) Magnetic	24" (mG) Magnetic	30" (mG) Magnetic	36" (mG) Magnetic	42" Magnetic	48" Magnetic	SPD READ?	SPD distance	NEW dim 24" FC READING	with OLD dimmer ! 24" FC READING
10	Philips	16	10 min	FULL	50	12	10	10	8	5.5	3.5	1.8	Y	24"	50	45
				DIM	75	11	6.5	6	6	5	4	3	Y	24"	9	14
															4/5th dim	2/3rd dim

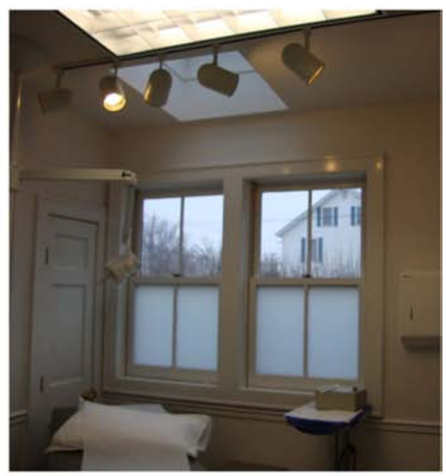
DIMMER EMF Trial 7. Philips dimmable CFL

Philips dimmable lamp on maximum output

Philips dimmable lamp on minimum output

EMF MEASUREMENTS AT DOCTOR GREGORY'S OFFICE, NY





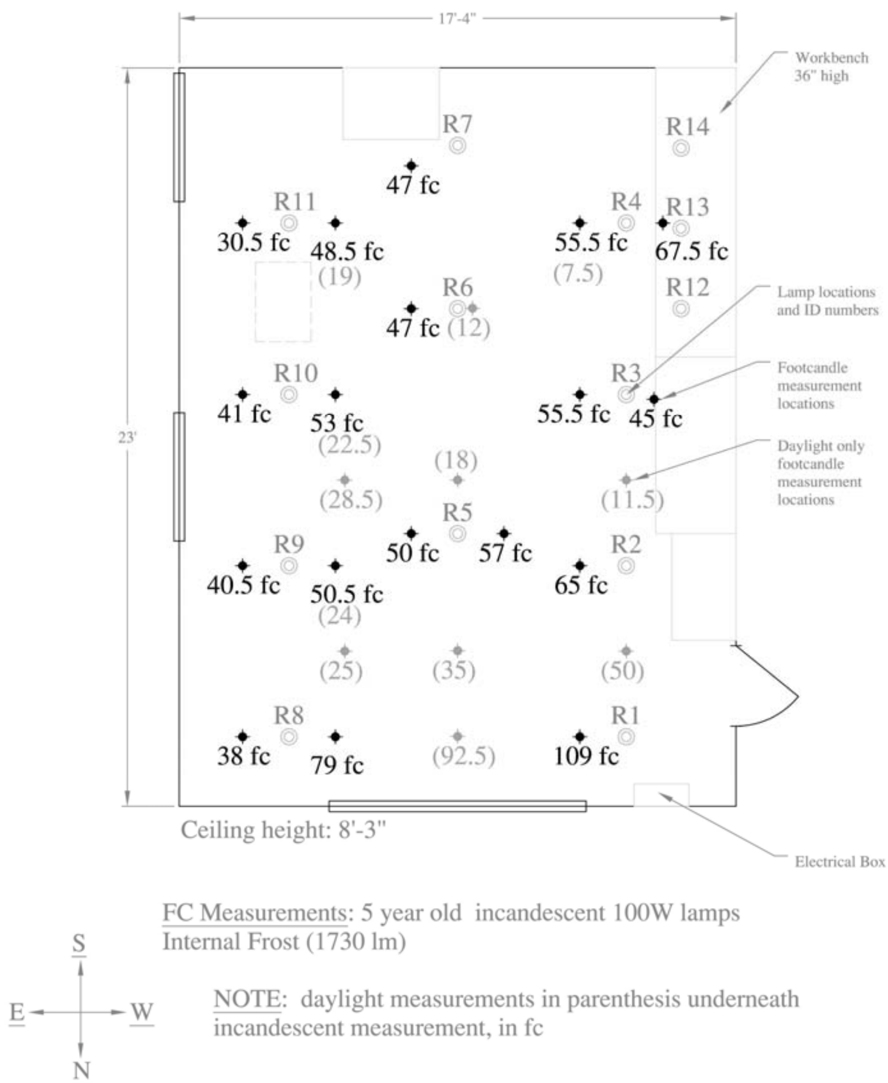
EMF Measurements: Measured 1.5 mG across the room evenly, and 1.2 mG on the patient's table

EMF Measurements: 6 CFL spiral lamps, base up & (3) 4' long linear fluorescent lamps in 2x4 troffer

DATE: 01-13-2010
TIME: 2 pm
WEATHER: bright cloudy
LOCATION: Dr. Gregory's Office Chatham NY

SCALE: 1/2"=1'-0"
NOTES: All measurements taken in milligauss (mG), at 30" above floor level, with the exception of the one measurement taken on the patients table at 36" height. All CFL lamps are base up and turned on. All linear fluorescent lamps are on. Appeared to be a warm color temperature

A separate series of experiments were carried out using the existing grid of lamps on the ceiling of the testing room. Footcandle measurements of the effects of three sets of lamps were taken using a Konica Minolta T10 illuminance meter. Lamps used were: 5 year old incandescent 100W Internal Frost lamps (1730 lm), new 23W (100W replacement) Sylvania CFL spiral lamps, and new incandescent 100W Soft White lamps (1600 lm). A delta of 1.08 was applied to the Soft White (1600 lm) lamp measurements to compare them with the 1730 lm IF lamps.

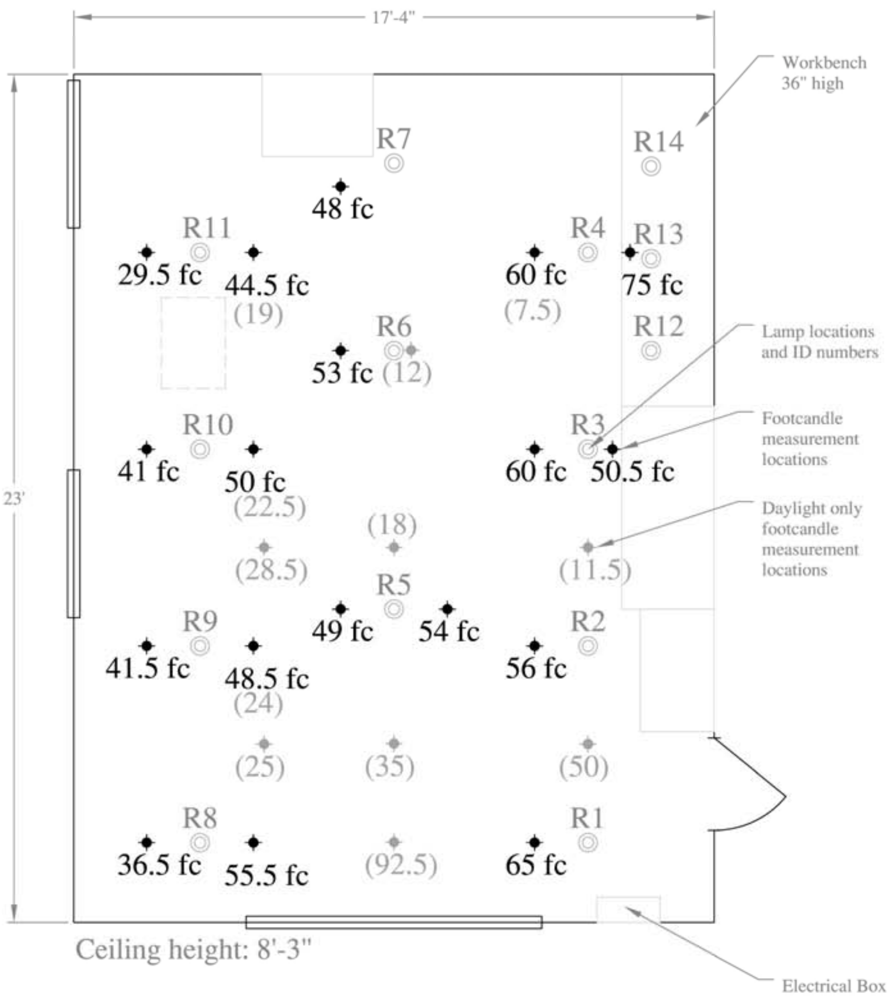


DATE: 01-03-2010
TIME: 11am
WEATHER: bright cloudy snowstorm

SCALE: 3/8"=1'-0"
NOTES: All measurements taken in footcandles, at 29" above floor level, with the exception of the one measurement taken on the workbench at 36" height. All lamps are base up.

Image of 5 year old Incandescent Internal Frost 100W

Image of 5 year old Incandescent Internal Frost 100W



FC Measurements: new 23W (100W replacement) Sylvania CFL Spiral

NOTE: daylight measurements in parenthesis underneath incandescent measurement, in fc

DATE: 01-03-2010

TIME: 1 pm

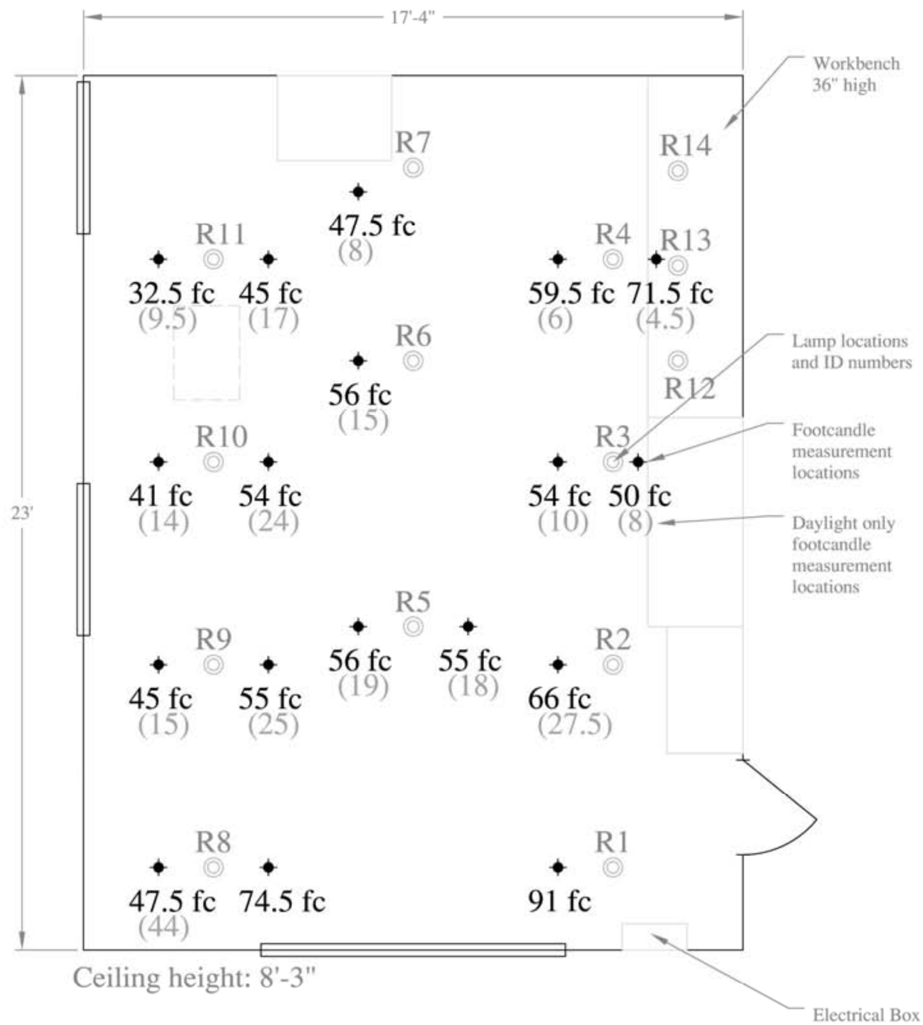
WEATHER: bright cloudy snowstorm

SCALE: 3/8"=1'-0"

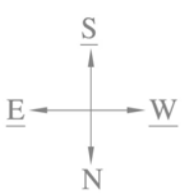
NOTES: All measurements taken in footcandles, at 29" above floor level, with the exception of the one measurement taken on the workbench at 36" height. All lamps are base up. Of 15 original new CFLs, one was dead before installation. CFLs took long time to heat up

Image of new 23W Sylvania CFL Spirals (100W replacement)

Image of new 23W Sylvania CFL Spirals (100W replacement)



FC Measurements: new incandescent 100W lamps Soft White (1600 lm) - *includes* Δ 1.08 to compare to IF incand. lamps



NOTE: daylight measurements in parenthesis underneath incandescent measurement, in fc

DATE: 01-08-2010

TIME: Noon

WEATHER: bright cloudy snowstorm

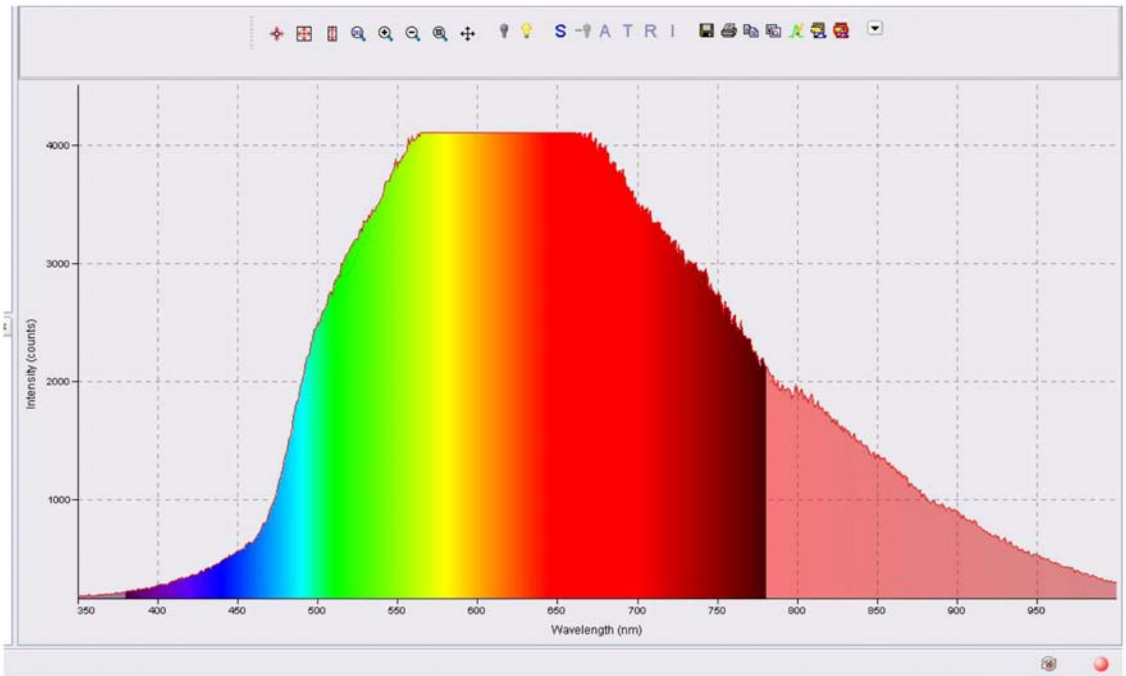
SCALE: 3/8"=1'-0"

NOTES: All measurements taken in footcandles, at 29" above floor level, with the exception of the one measurement taken on the workbench at 36" height. All lamps are base up. Of 15 original new lamps, one lamp died spontaneously, minutes after turning on

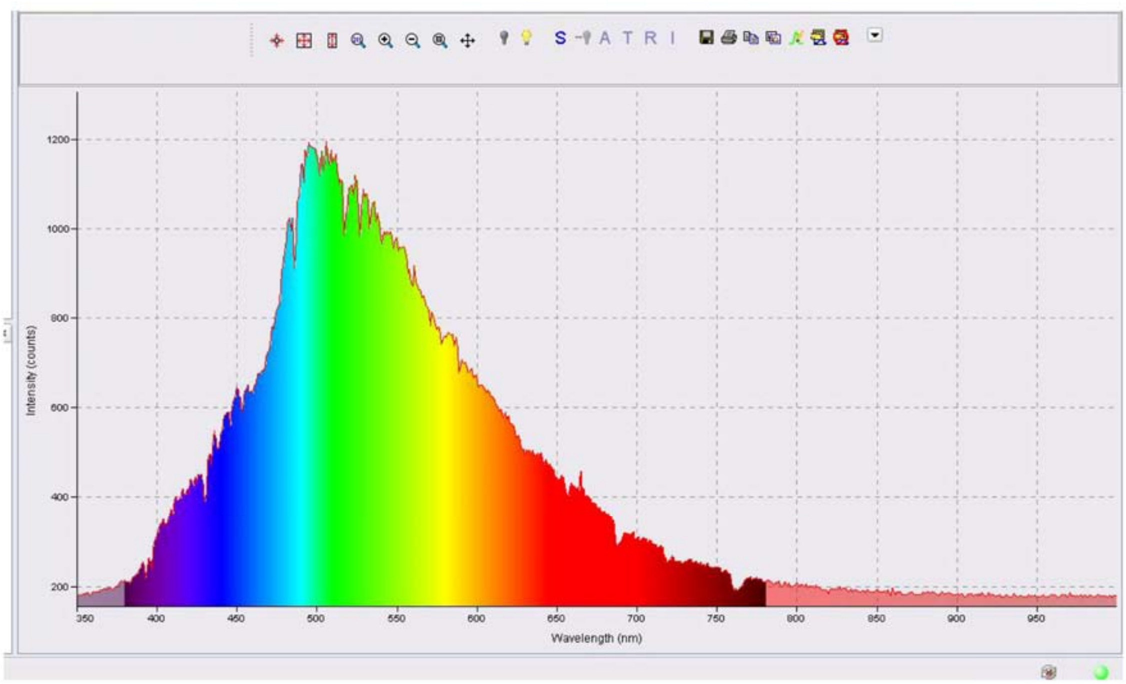
Image of new Incandescent Soft White 100W

Image of new Incandescent Soft White 100W

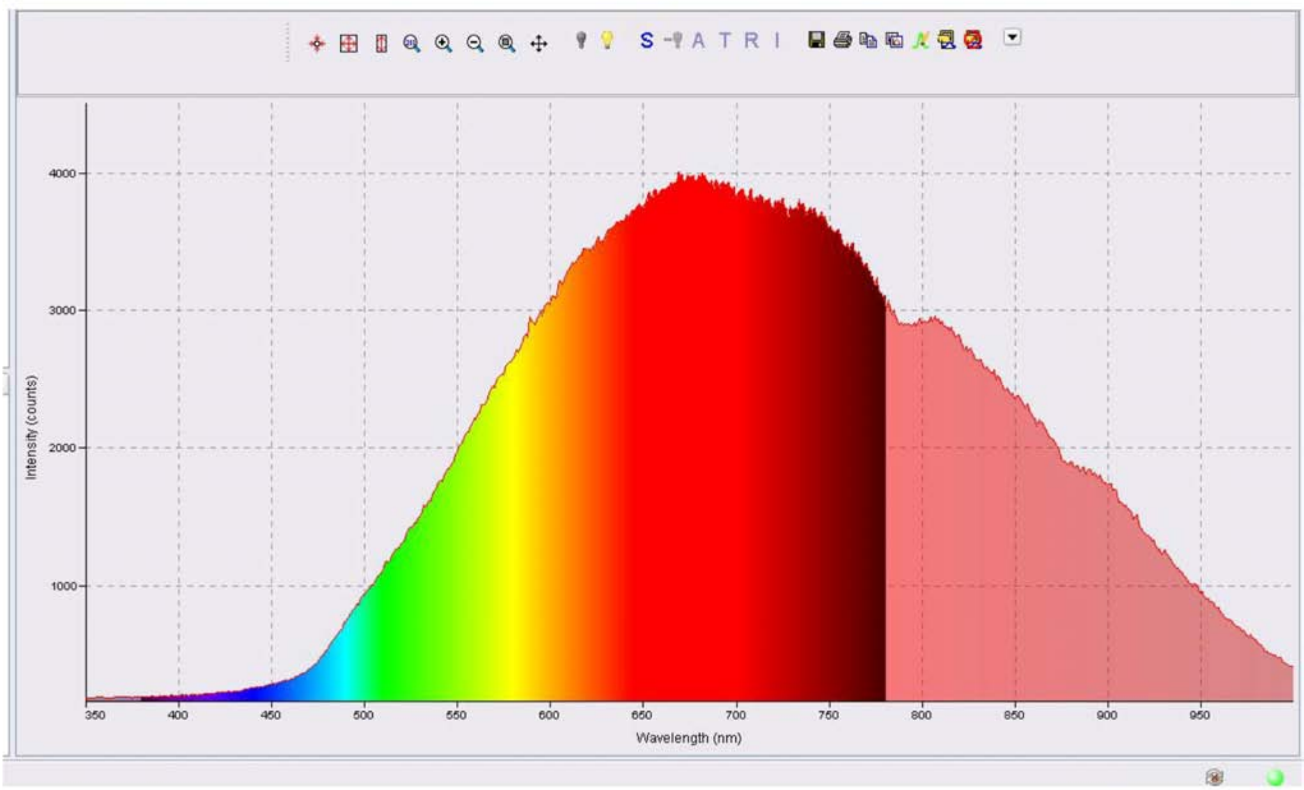
A sophisticated spectrometer, Ocean Optics “Red Tide” digital spectrometer, was used to gain understanding of the color rendering implications of dimming CFLs. Below are several comparisons of daylight, candle light, incandescent, and dimming CFLs on “full” meaning at 100%, and at “dim” meaning at 0%. All dimming CFLs use the “new” Lutron “Diva” custom modified dimmer, calibrated to 36 volts. The dimmer notes that it is for Philips CFLs. Through Lutron, we were able to obtain one Philips dimmable lamp (#10).



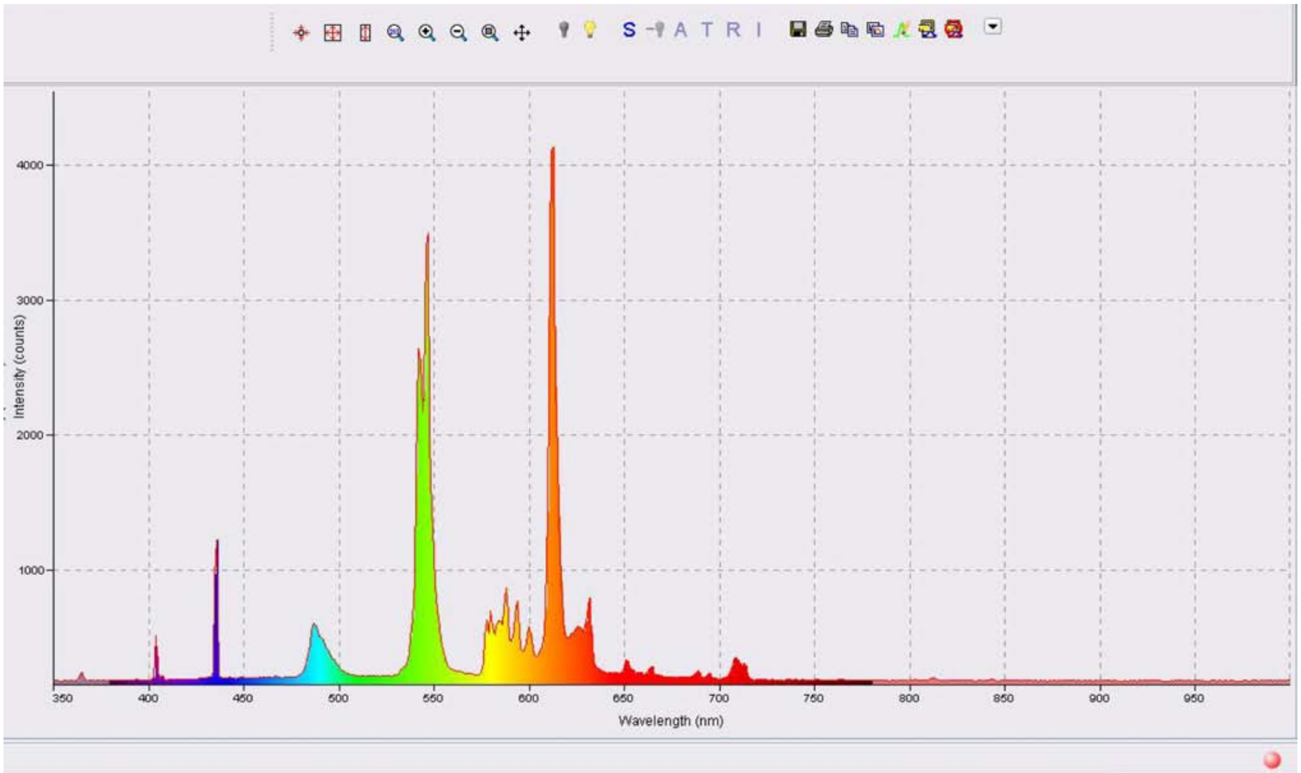
Incandescent Lamp



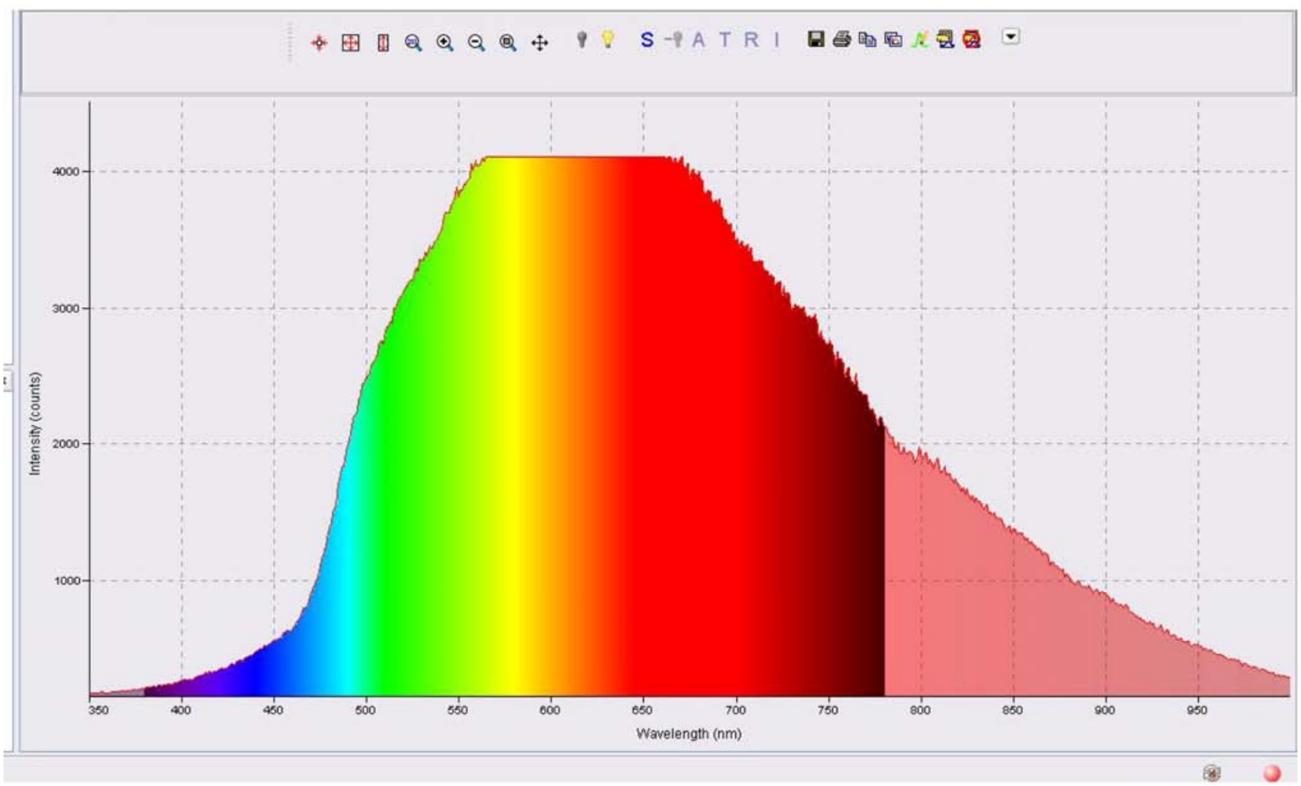
DAYLIGHT (at 3X scale)



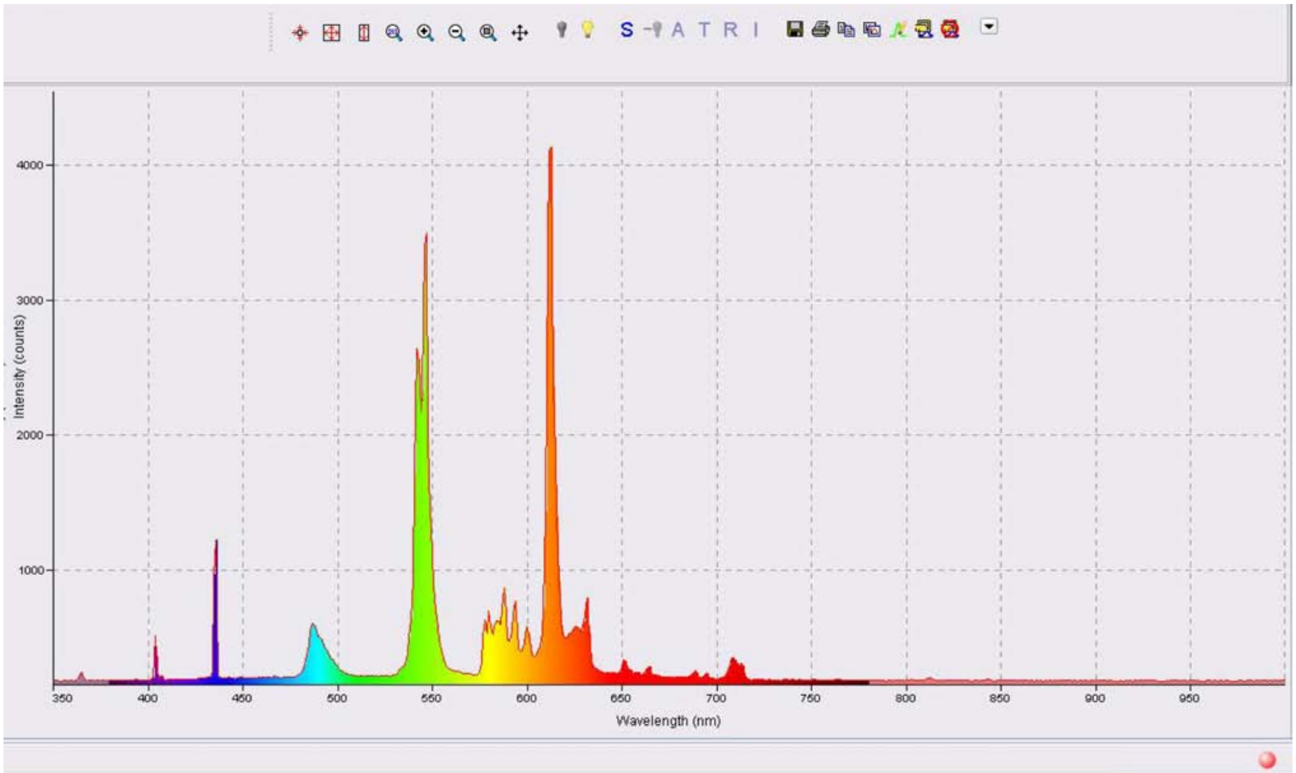
Candle flame as seen in photos above



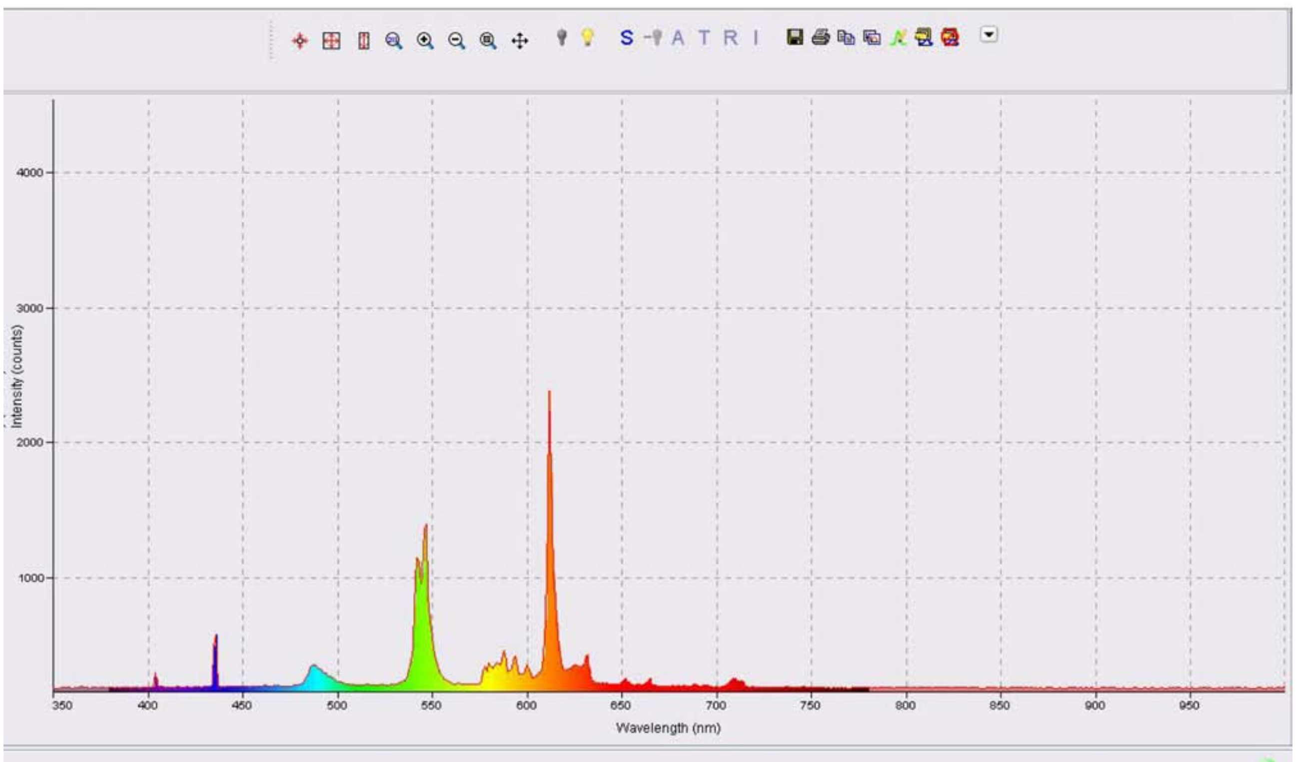
LAMP #3 Sylvania 24W (100W replacement) _ FULL



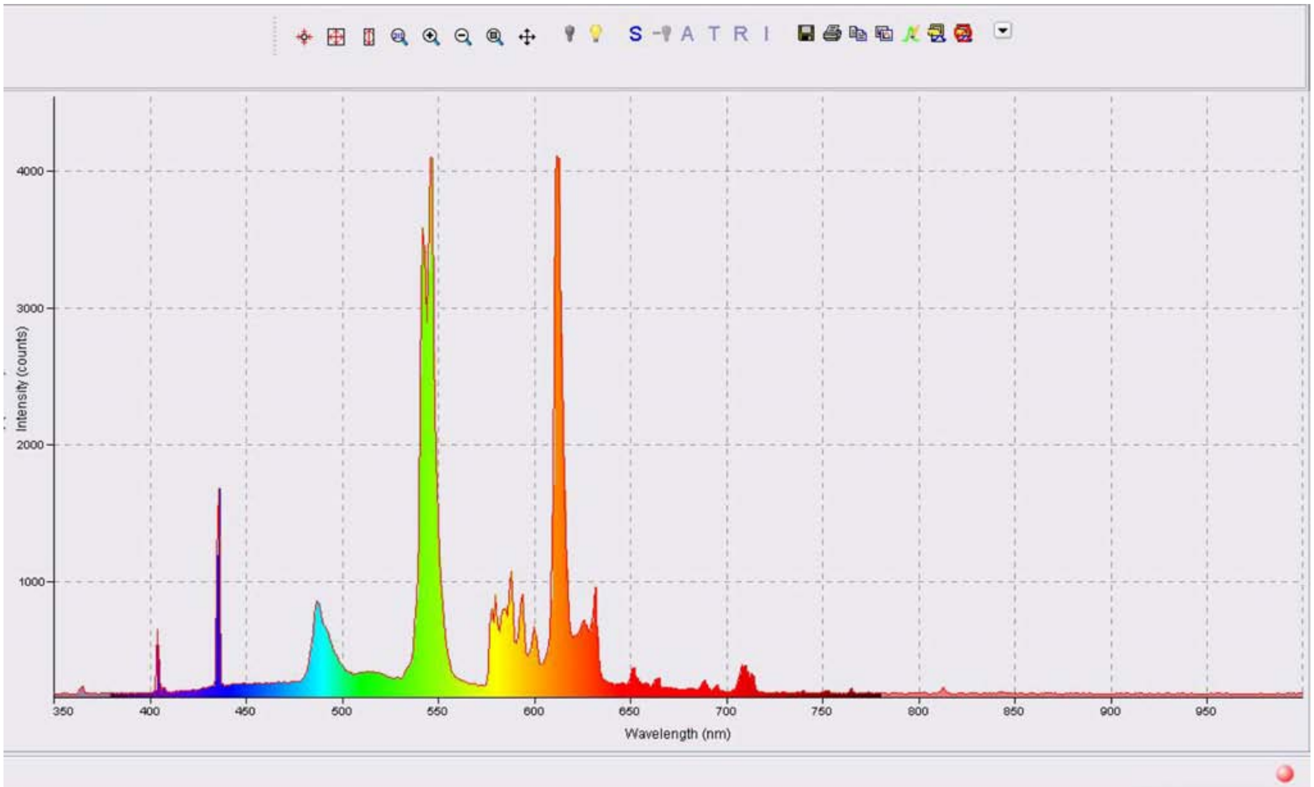
Soft White GE Incandescent 100W



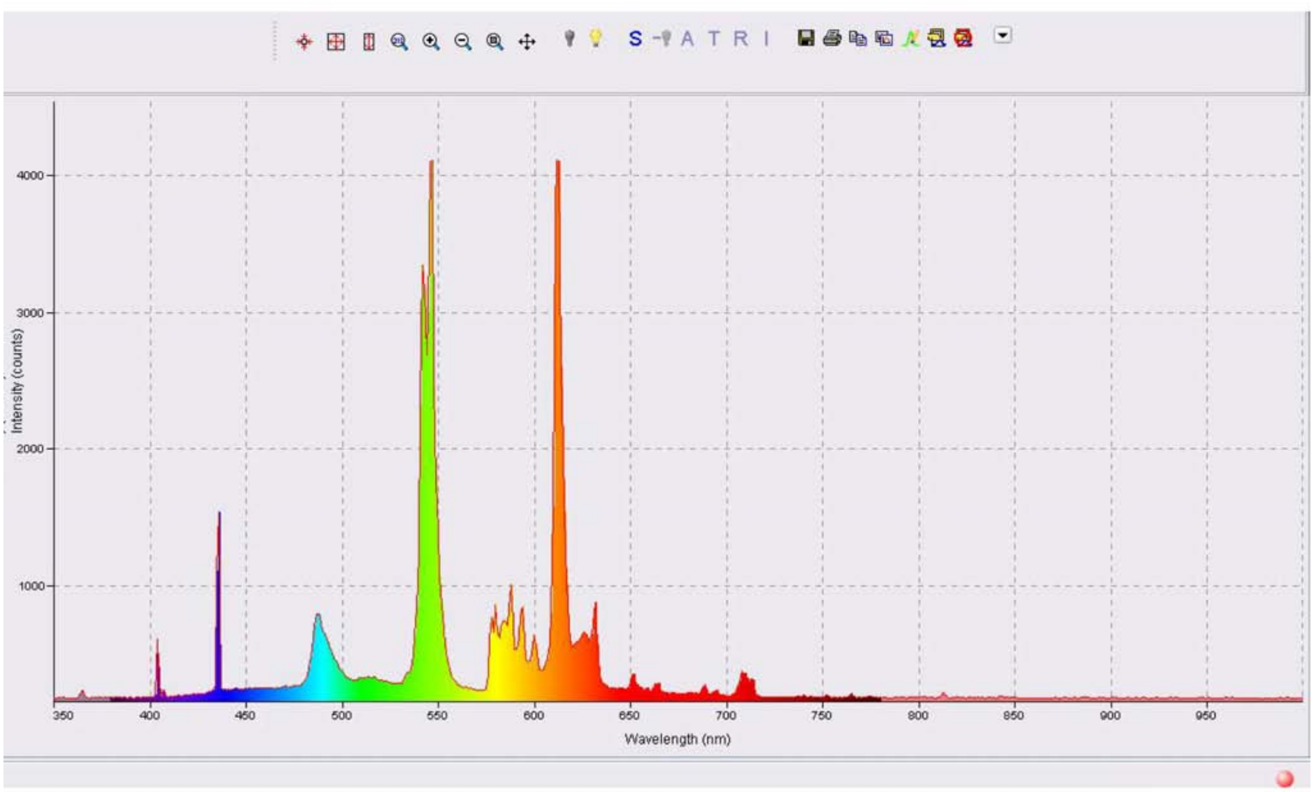
LAMP #3 Sylvania 24W (100W replacement) _ FULL



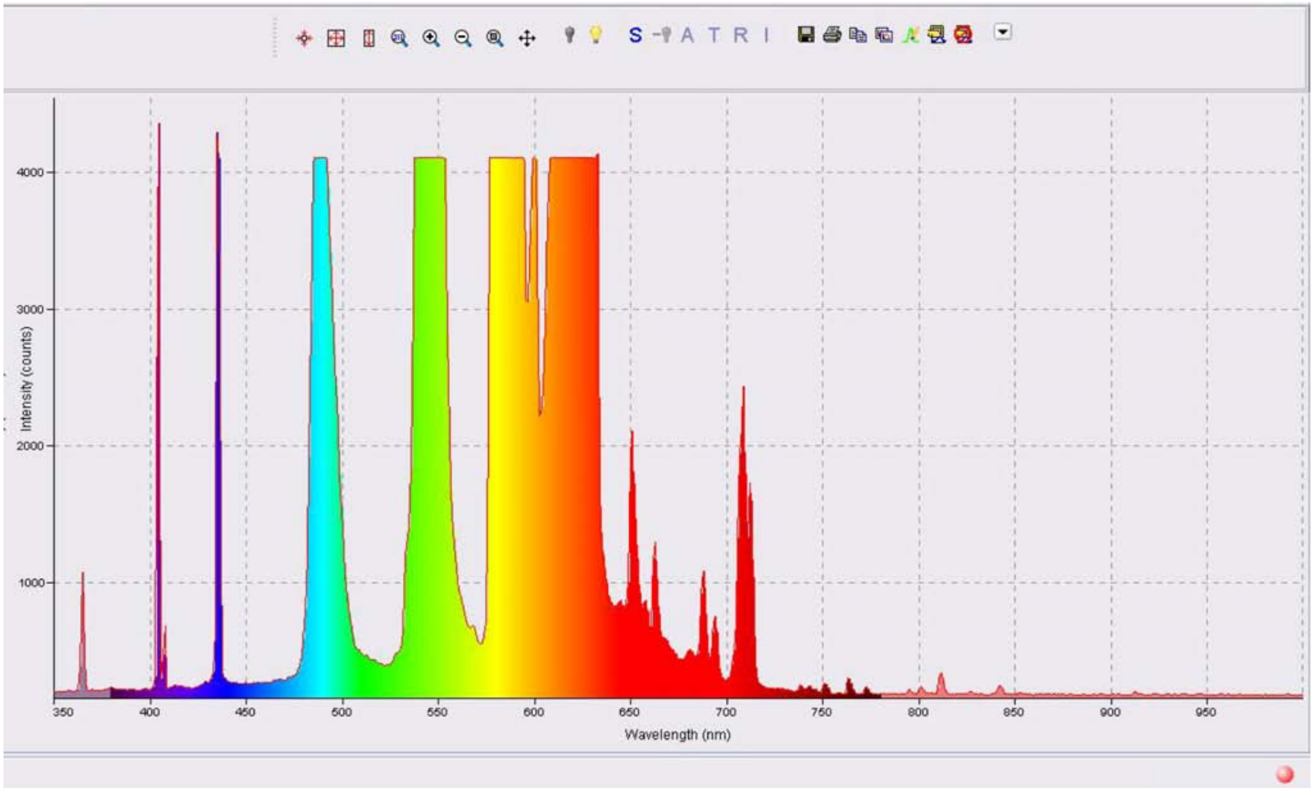
LAMP #3 Sylvania 24W (100W replacement) _ DIM



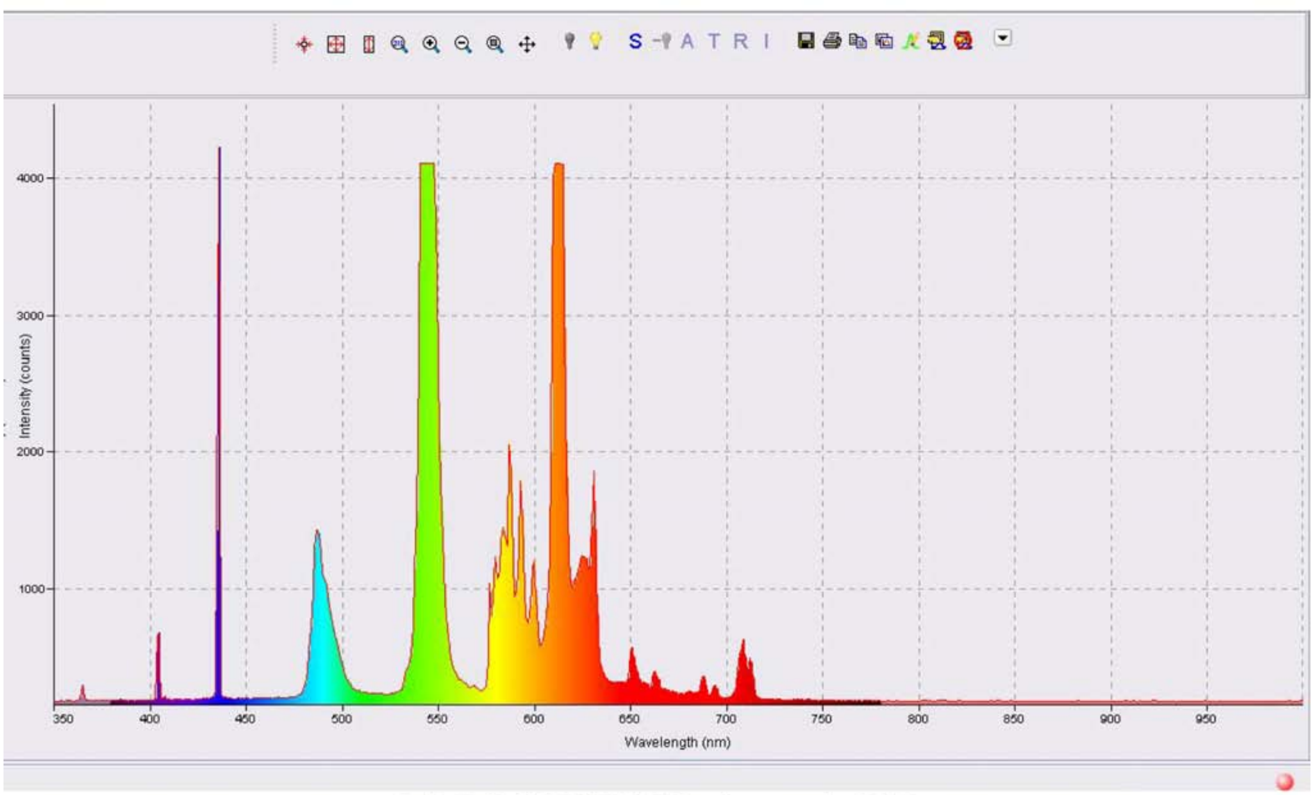
LAMP #5 Bright Effects 26W (100W replacement) _ FULL



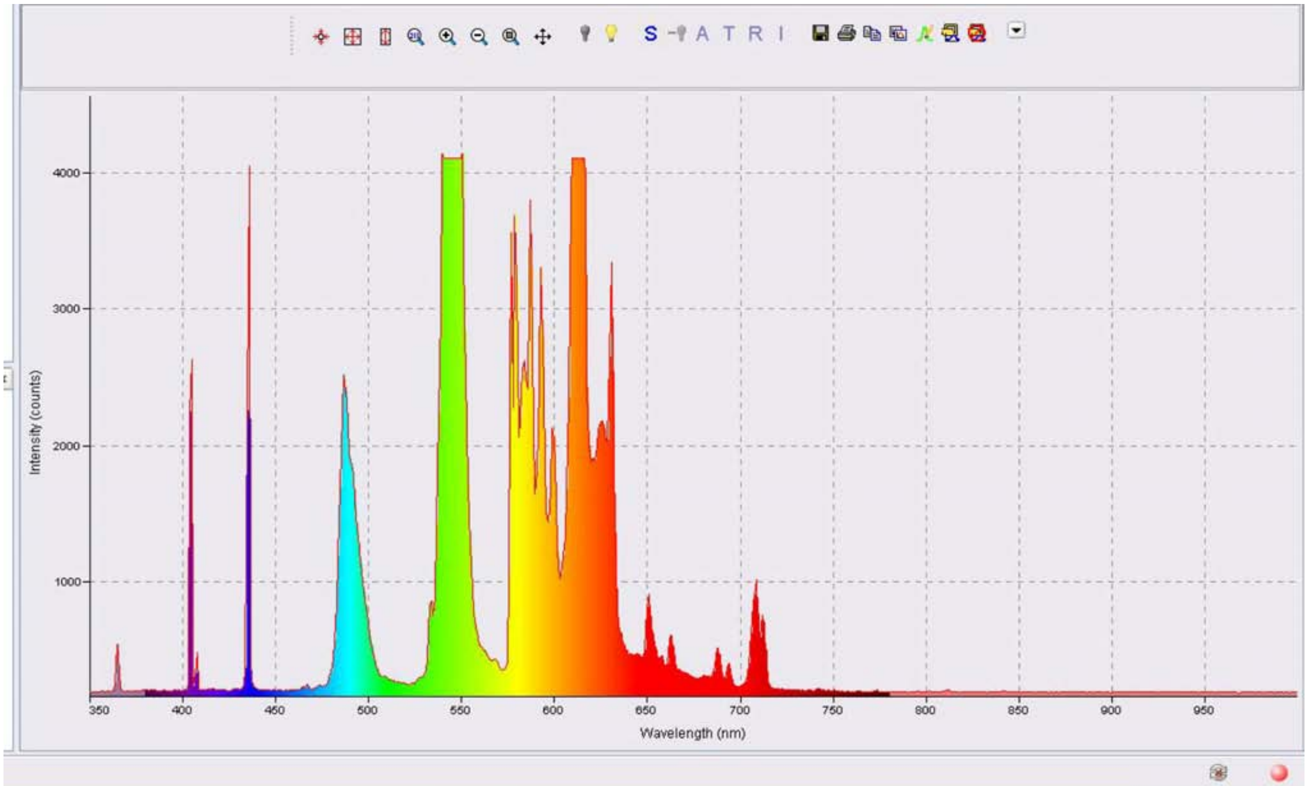
LAMP #5 Bright Effects 26W (100W replacement) _ DIM



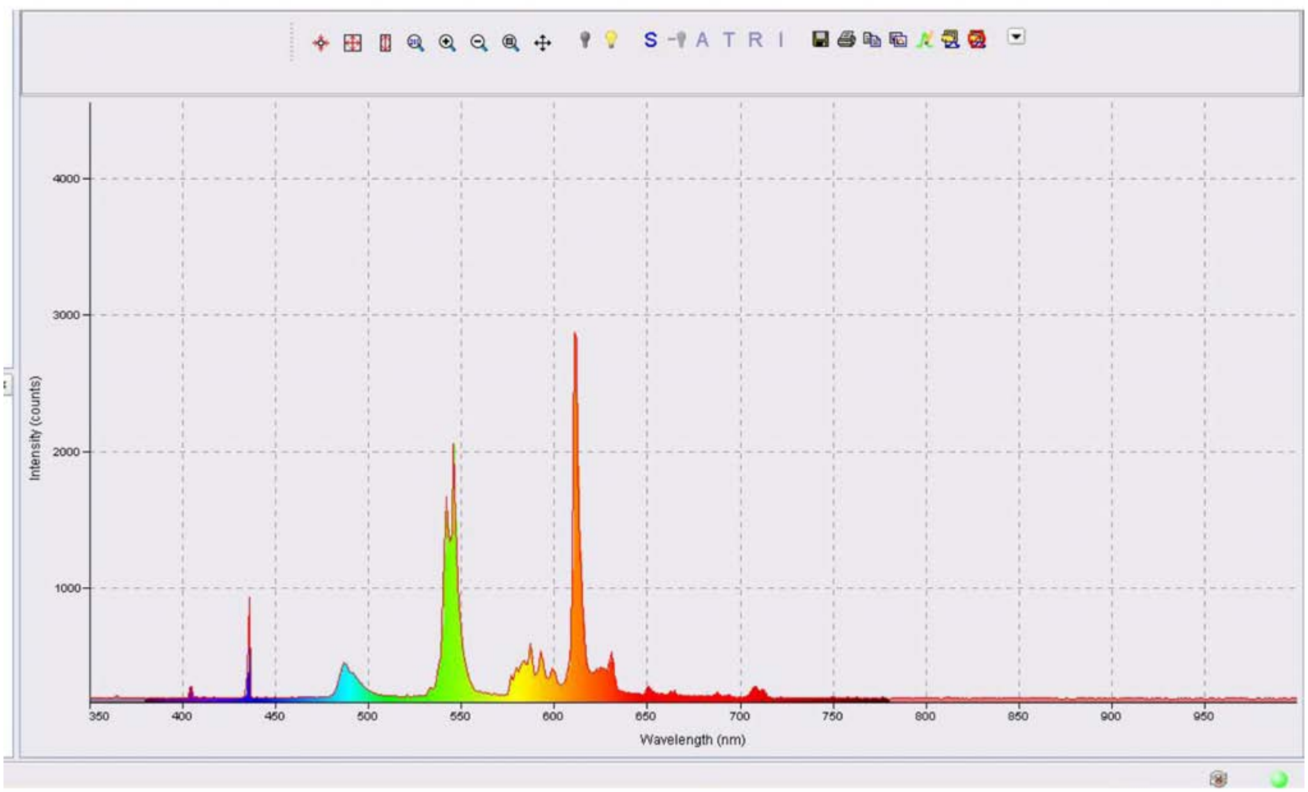
LAMP #9 GE 26W (90W replacement) _ FULL



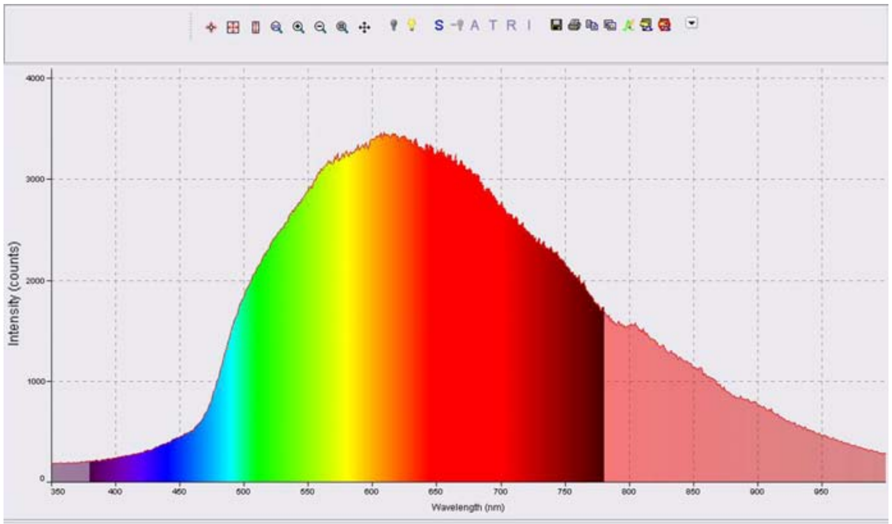
LAMP #9 GE 26W (90W replacement) _ DIM



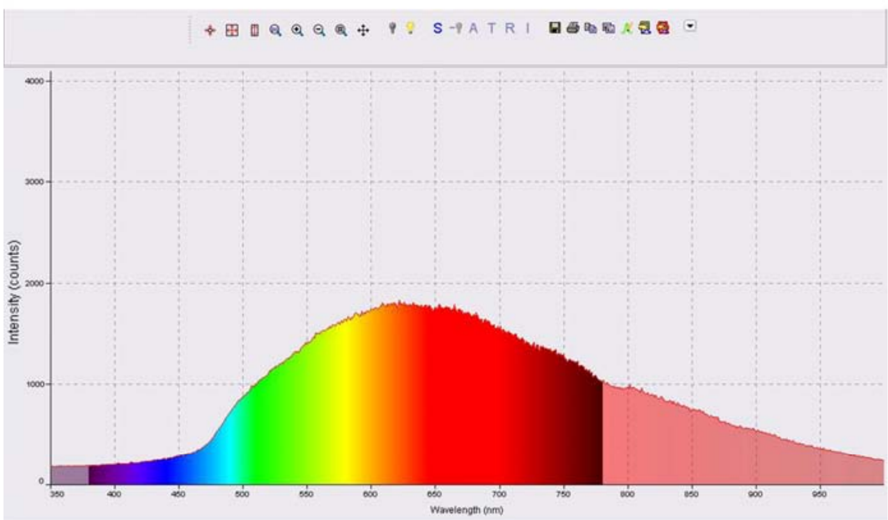
LAMP #10 Philips 16W (65W replacement) _ FULL



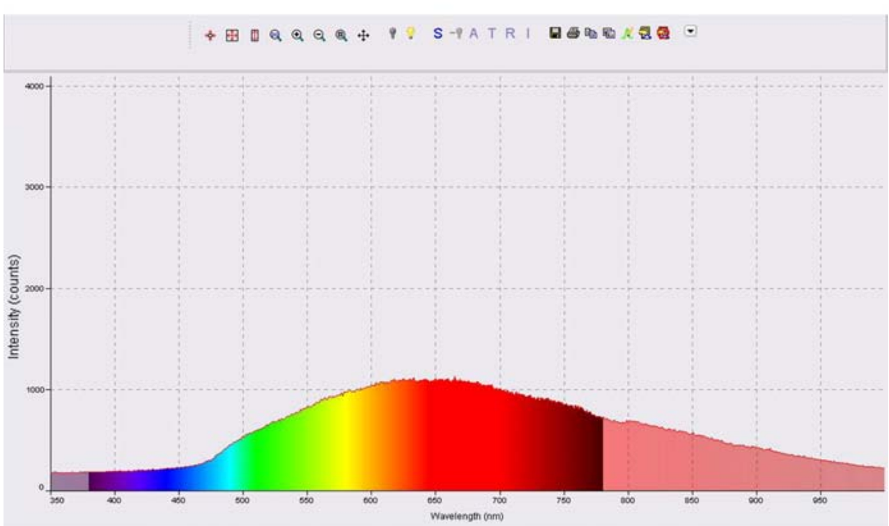
LAMP #10 Philips 16W (65W replacement) _ DIM



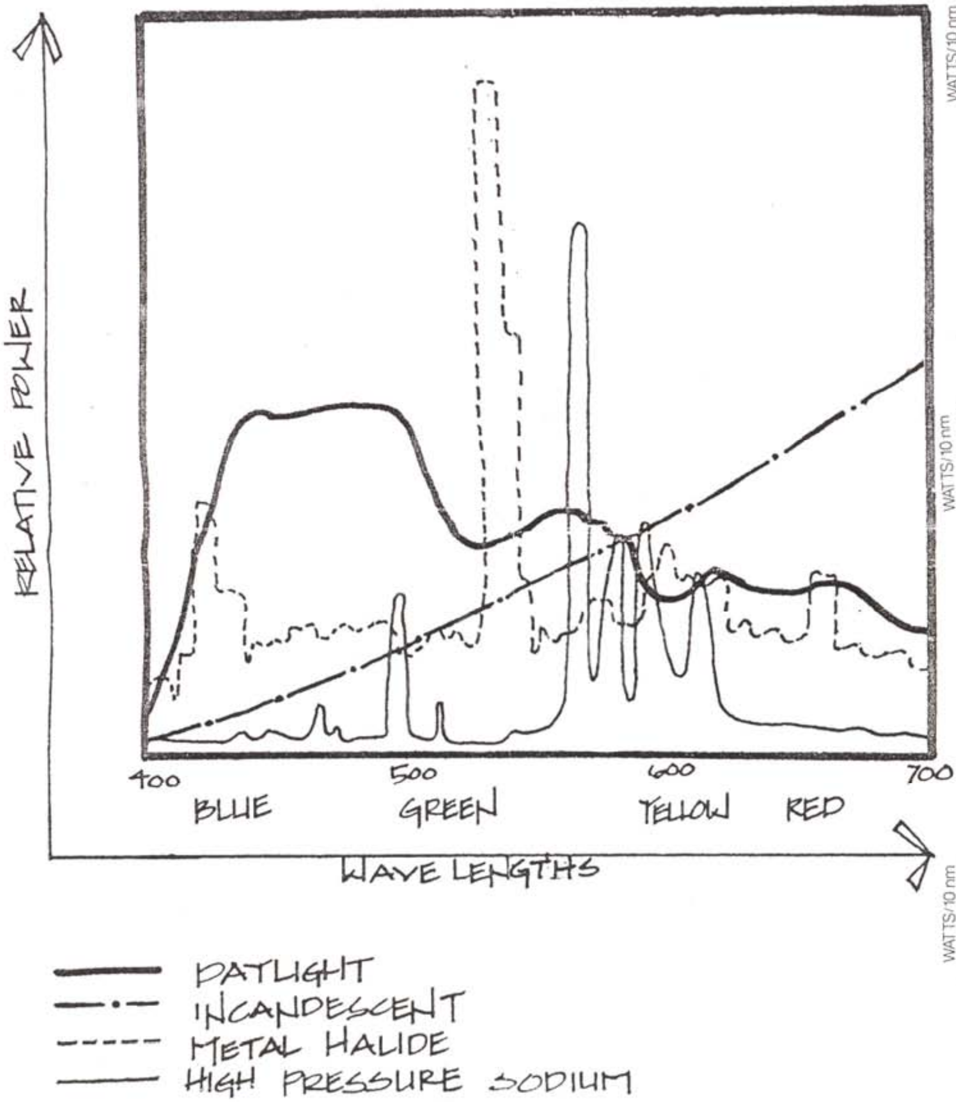
LAMP # R12 GE soft white 100W _ FULL (100%DIM)

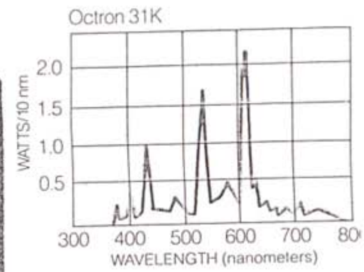


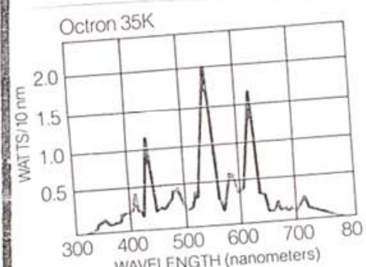
LAMP # R12 GE soft white 100W _ MED (50%DIM)

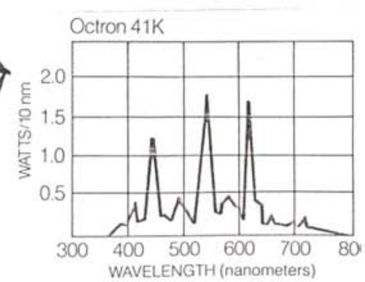


LAMP # R12 GE soft white 100W _ LOW (30%DIM)


RELATIVE POWER
400
500
600
700
BLUE
GREEN
YELLOW
RED
WAVE LENGTHS
DAYLIGHT
INCANDESCENT
METAL HALIDE
HIGH PRESSURE SODIUM


Octron 31K
WATTS/10 nm
2.0
1.5
1.0
0.5
300
400
500
600
700
WAVELENGTH (nanometers)


Octron 35K
WATTS/10 nm
2.0
1.5
1.0
0.5
300
400
500
600
700
80
WAVELENGTH (nanometers)


Octron 41K
WATTS/10 nm
2.0
1.5
1.0
0.5
300
400
500
600
700
WAVELENGTH (nanometers)

MEDICAL REPORT

Effects on Human Beings from Exposure to Electromagnetic Fields (EMF):

Health Implications of Emissions from Compact Fluorescent Lighting

Philip W. Brickner, MD, Richard L. Vincent, Scott Bucher and Heather Auto

St. Vincent's Hospital—New York

ABSTRACT

The purpose of this analysis is to recognize the scientific evidence that exists regarding health effects from human exposure to electromagnetic fields (EMF), with a specific focus on compact fluorescent light sources (CFLs). Human beings are regularly exposed to a natural cycle of background magnetic radiation produced by the Earth and by solar winds. The rise and fall of these magnetic fields creates biological effects, such as circadian rhythms in humans. EMF exposure (both electric and magnetic) induces electric fields and currents inside the body. These electric fields and the density of currents are of particular interest because they relate to the stimulation of excitable tissue such as nerve and muscle.

As a result of the introduction of a multiplicity of electronic devices, there now exists an increased number of sources for human exposure to a variety of EMF fields. However there are insufficient biodata to predict effects on human health. This paucity of data includes EMFs in the extremely low frequency (ELF) range (50 to 60 Hz) that are emitted by CFL sources. Because of imminent regulations requiring replacement of

incandescent light sources that emit no EMFs, with EMF-emitting CFLs, another source of EMF exposure will arise. This is a concern, because humans live in close proximity to light sources, and the health consequences have not been studied.

Substantial information exists about the consequences of EMF exposure from power lines, mobile phones and digital music players covering a wide range of frequencies and magnetic field strength measured in kHz and Tesla units; however, in this analysis we have limited our examination to human exposures within the ELF range of radio frequency (60 Hz) and magnetic flux as measured in Tesla or Gauss associated with compact fluorescent lighting systems. The topics of photosensitivity, childhood leukemia, Alzheimer's disease, pregnancy and circadian disruption have been reviewed. The best evidence from published data relates to possible links between cancer and electromagnetic fields that flow from power lines.

From the studies examined, the question of whether human EMF exposure in the ELF fields that flow from CFLs can cause harm to human health is not resolved.

INTRODUCTION

Human beings are regularly exposed to a natural cycle of background magnetic radiation produced by the Earth and by solar winds. The rise and fall of these magnetic fields creates biological effects, such as circadian rhythms in humans (1, pg. 66). EMF exposure (both electric and magnetic) induces electric fields and currents inside the body. These electric fields and the density of currents are of particular interest because they relate to the stimulation of excitable tissue such as nerve and muscle. The purpose of this analysis is to recognize the scientific evidence that exists regarding health effects from human exposure to electromagnetic fields (EMFs). In particular the focus is on the range of EMFs relevant to emissions measured from compact fluorescent lamp systems (CFLs).

Primary references for this study include Levitt's Electromagnetic Fields (1), the SCENIHR's Report Health Effects of Exposure to EMF (2) and Light Sensitivity (3), and WHO Environmental Health Criteria 238. (4) Additional, medical databases such as PubMed were searched for relevant information.

CHARACTERISTICS OF ELECTRIC AND MAGNETIC FIELDS

Electric and magnetic fields (EMF) are invisible forces surrounding any unshielded electrical device. Electric fields are generated by voltage. As voltage increases, so does the strength of the field. Volts per meter (V/m) or kilovolts per meter (kV/m) are the units used to measure the strength of the electric field. One kV= 1000 V. These fields are weakened by wire insulation, trees, buildings and human skin and other forms of shielding.

While some degree of association exists between health effects and magnetic fields, no similar associations have been found for electric fields; therefore, the focus of attention for biological effects is centered on magnetic fields.

Magnetic fields result from the flow of current through a wire or in electrical devices. For magnetic fields, the greater the current flow, the greater the strength of the field. As distance increases from the source, there is a rapid decrease in field strength. Gauss (G) or Teslas (T) are units that indicate the magnetic flux density (strength) of the magnetic field. Gauss units are used primarily in the US and Tesla units are the internationally accepted term. Most EMF exposures are reported in fractions of Gauss or Tesla (in microtesla or milligauss). A milligauss is 1/1000 of a gauss. A microtesla (μT) is 1/1,000,000 of a tesla. To convert from microtesla (μT) milligauss (mG) multiply by 10. 1(μT) = 10 mG; 0.1(μT) = 1 mG.

A characteristic of a magnetic field is its unimpeded flow through most materials (including human tissue) and therefore these fields are difficult to screen out or limit. International guidelines have been developed that are designed to limit EMF exposure based on magnetic fields, because an association may possibly exist between cancer risk and increased magnetic field exposure (5, 6).

COMPACT FLUORESCENT LAMPS (CFL) AND ELF

Compact fluorescent lighting systems operate between 60 Hz and 100 Hz, depending on the ballast. CFLs can also operate in the high frequency range from 30-60kHz (3). According to SCENIRH (3, pg. 15), ELF fields are associated with devices that operate in the 50 Hz or 60 Hz range used by European (50 Hz) and US (60 Hz) electric systems. CFLs fall within the ELF category of EMF. There is a paucity of published information on ELF emissions for the range of commercially available CFLs (3, pg. 15). Research is being conducted in Switzerland to characterize ELFs from energy efficient lamps (CFLs) (7), and in the US (8), but no conclusions are available as to the results of these studies.

HEALTH EFFECTS

FROM EMF AND EXTREMELY LOW FREQUENCY FIELDS (ELF)

Health effects from EMFs are being studied by consumer protection agencies and electric power providers (2, 4-6, 9) . Their purpose is to build a consensus of knowledge about potential risks to humans from radio frequency and electromagnetic field exposure and to understand the implications of the question: 'Do electric power and magnetic fields (power-frequency EMF 50 or 60 hertz Hz) adversely affect human health?' These issues are complex and published studies to date do not provide straightforward answers (6, pg 2). Concerns analyzed in a wide range of research studies that are focused on human health effects include: photosensitivity, childhood and adult leukemias, Alzheimer's disease, and possible circadian disruption (6, 10). As to pregnancy, "there is no safe time for either strong intense bursts or low-level continuous doses of EMFs during the months of pregnancy" (1, pg. 156).

Early studies (11) were focused on electric fields; however, in the mid-1980s the focus shifted from electric to magnetic fields within homes and their possible role in the development of childhood leukemia and brain cancer(12, 13). United States researchers at state and federal levels began to expand these studies to consider occupational exposures with a range of health endpoints, including miscarriage, adult cancers, cardiovascular disease, and neurodegenerative illness (6).

In conjunction with the authorization of the U.S. National Energy Policy Act in 1992, the National Institute of Environmental Health Science (NIEHS), National Institutes of Health (NIH) and the US Department of Energy (DOE) launched the Electric and Magnetic Fields Research and Public Information Dissemination (EMF RAPID) program in 1993. This was a six year effort to investigate what scientific evidence of potential risk, if any, exists to human health from extremely low frequency (ELF) exposure.

EMF Rapid reported to Congress in 1999 that the overall scientific evidence of risk from ELF exposure was weak. The evidence did not show a consistent pattern of biological effects from such exposure, either from laboratory studies with animals or at the cellular level. However, and to the contrary, examination of *epidemiological* studies of disease incidence in human populations revealed a fairly consistent pattern that associated EMF exposure with childhood leukemia and chronic lymphocytic leukemia in adults. Further studies by the World Health Organization (WHO) since 1999 have shown a continued association of EMF exposure with childhood leukemia, but these later analyses do not support an EMF link to adult leukemias (6, pg. 3).

WHO (14) has noted the following key points:

- *A wide range of environmental influences causes biological effects. 'Biological effect' does not equal 'health hazard'. Further research is needed to identify and measure whether or not a health hazard exists from ELF EMF exposure (4).*

- *At low frequencies, human exposure to external electric and magnetic fields induces small circulating currents within the body. In virtually all ordinary environments, the levels of induced currents inside the body are too small to produce obvious effects.*

- *The main biologic effect of radiofrequency electromagnetic field exposure is heating of body tissues (4, pg. 103).*

- *There is no doubt that short-term exposure to very high levels of electromagnetic fields (in the 100 kHz range) can be harmful to health(4, pg. 11). Current public concern focuses on possible long-term health effects caused by exposure to electromagnetic field at levels below those required to trigger acute biological responses.*

- *WHO's International EMF Project (15) was launched to provide scientifically sound and objective answers to public concerns about possible hazards of exposure to low level electromagnetic fields.*

- *The focus of international research is on the investigation of possible links between cancer and electromagnetic fields, at power line and radio frequency (50 Hz to 60Hz). EPRI's EMF Health Assessment and RF Safety program (16) includes studies in progress that address many of WHO's highest priority research recommendations (17).*

- *To date there is no evidence to conclude that exposure to low level electromagnetic fields is harmful to human health.*

DEVELOPMENT OF EMF EXPOSURE LIMITS

In the 1990s several national and international experts participated in panels to evaluate the risks of EMF exposure (9, 18). Their efforts narrowed to only one concern—childhood leukemia. Results of several epidemiological studies showed a moderate association between exposure to magnetic fields above 3-4 mG and occurrence of childhood leukemia. This risk doubled above the 3-4 mG level (0.3-0.4 μT). Caution is required regarding efforts to extrapolate spot readings of EMFs to long-term exposure for the purpose of estimating health risks (19).

As a consequence of this information, the International Agency on Research on Cancer (IARC) has listed EMFs as a potential source of carcinogenesis (IARC category 2B—a "possible" human carcinogen), although no firm causal link has been established (9). As a precaution, several international groups, the World Health Organization (WHO), the International Commission on Nonionizing Radiation Protection (ICNIRP), and the European Union's advisory group the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR), (2, 3, 5, 15, and 18) have issued reviews and guidelines to limit human exposure at a level not to exceed 0.4 μT (4 mG). According to ICNIRP 'these guidelines are based on short-term, immediate health effects such as stimulation of peripheral nerves and muscles, shocks and burns caused by touching conducting objects, and elevated tissue temperatures resulting from absorption of energy during exposure'. The guidelines are based on short-term, immediate health effects. Induction of cancer, including brain tumors, from long-term EMF exposure was not considered to be established. Further, ICNIRP concluded that available data are insufficient to provide a basis for setting exposure restrictions, although epidemiological research has provided suggestive, but unconvincing, evidence of an association between possible carcinogenic effects and exposure at levels of 50/60 Hz magnetic flux densities (20, pg. 496).

The mechanisms for potential human biological degradation from long-term EMF exposure are not well understood, compared to mechanisms established for exposure to other agents, such as ultraviolet radiation (UV). Following UV exposure, for example, human systems provide cellular repair. The American Council of Governmental

Industrial Hygienists (ACGIH) has developed a series of threshold limits for UV exposure, a level not be exceeded within a given time period.

However, for ELF and for EMFs in general, a threshold limit for biological repair mechanisms respond is not established.

HEALTH IMPACTS FROM CFL EXPOSURE

SCENIHR examined health impacts associated with CFL exposure, and the following indented text is adapted from the SCENIHR report (3).

> SCENIHR has performed a wide examination of the relevant available information describing correlations between the properties of fluorescent tubes and the appearance of symptoms because such tubes display very similar properties to those of energy saving lamps. The data found for fluorescent tubes was then extrapolated to situations where compact fluorescent lamps may be used. A wide range of symptoms have been claimed to be aggravated by the use of energy-saving lamps (and CFLs in particular). However, suitable direct data on the relationship between energy saving lamps and any of these conditions have not been identified, possibly related to the fact that the widespread introduction of such bulbs is a relatively recent development.
>
> It has been observed that some single-envelope CFLs emit UVB and traces of UVC radiation. Under extreme conditions (i.e. prolonged exposures at distances

<20 cm) these CFLs may lead to UV exposures approaching the current workplace limit set to protect workers from skin and retinal damage.

The use of double-envelope energy saving bulbs or similar technology would largely or entirely mitigate both the risk of workplace UV emissions in extreme conditions and the risk of aggravating the symptoms of light-sensitive individuals.

CONCLUSION

Human health impacts from ELF exposure have not been established. Nor have they been disproved. It is particularly a concern that health consequences that flow from a vastly increased ELF exposure from <u>mandated use of CFLs</u>, have not been fully considered.

CONCLUSION:

The title "CONCLUSION" might not be appropriate for this report. To truly reach a conclusion, or take definitive action on the consequences of an increased use of CFLs would require more work. This report, after all, is just an exploratory review of the subject. It does however point out with considerable certainty, that more work is urgently needed. There is simply too much risk in issuing an uninformed mandatory decision to ban incandescent lamps; from health repercussions to changes in electrical characteristics and power supply system operation, as well as through a significant intrusion on the quality of life of almost every residence in the country. Why take this risk? Do politics trump science and practice experience? Please revisit the fears expressed in the last paragraph of the medical section.

As stated previously, a temporary action that should be immediately taken is to lift the "ban" on incandescent lamps and reconsider all promotion of the use of Compact Fluorescent Lamps. Then, as a start, we should have a trial to check the effectiveness and acceptability of "The Ban", as well as some of the other untested proposals for lighting power density restrictions that are being considered.

We propose the following simple test that may actually provide an effective method for determining whether the legislation will actually serve people:

- Initiate a field study aimed at satisfying the proposed power limits in all public buildings, from museums and hospitals to the White House, and the homes of all elected officials.
- As this will include replacing all incandescent lamps with CFLs, it would be easy to directly ascertain the effects of the proposed legislation/ban.
- Assure that all of these measures to comply with specified power limits in residential units are done and paid for solely by the occupants, i.e. that occupants may freely decide on the use of specific equipment and devices
- At the end of sufficiently long period (e.g. 18 months) check whether the incandescent lighting had not been reinstalled, and perform a detailed survey with all users to determine their overall satisfaction with the initial, intermediate and resulting lighting.
- This will help to identify specific target applications for different light sources, as they will be selected by end-users, based on their needs and requirements.
- In parallel with this field study, initiate and perform detailed research related to determining quantitative and qualitative characteristics of CFLs and other alternative light sources (e.g. LED light sources), as well as the comparative analysis of their relevant aspects and most important effects of use.

Based on the data collected from the above field/labs studies, the Energy Independence and Security Act of 2007 and current lighting related energy legislation still in Congress may be amended, if necessary, to conform to the results of the studies. We expect that the current and proposed legislation would be rewritten in favor of a new act, which will be based on the result of a thoughtful process that could yield a set of proven recommendations that will better serve our nation's needs by maximizing both human health, environmental satisfaction and energy efficiency. In the end, the most energy effective solution for residences may be achieved using incandescent lamps with a combination of occupancy sensors and dimmers.

APPENDIX

Formulas for Unit Conversion Charts

I've found the following formulas convenient when reading research papers or published tables showing the results of electromagnetic field studies done in different countries, or with different instruments. The conversion charts are set up with Decibel-milliwatts (dBm) as the anchor point, shown in whole units for convenience. The next two columns relate to electric fields (kV/m & V/m). After that, the next six columns are power levels. And the final four columns are concerned with magnetic fields. The calculations in the charts all revolve around Watts per square meter (W/m^2). So to find the other values if you know W/m^2, here are the formulas I used to get them:

$V/m = \sqrt{W/m^2 \times 377}$ Volts per meter = the square root of the product of Watts per square meter times 377

kV/m = V/m /1,000 Kilo-volts per meter = Volts per meter divided by 1,000

$mW/cm^2 = W/m^2 / 10$ Milli-Watts per square centimeter = Watts per square meter divided by 10

$uW/m^2 = W/m^2 \times 1{,}000{,}000$ Micro-Watts per square meter = Watts per square meter times one million

$uW/cm^2 = W/m^2 / .01$ Micro-Watts per square centimeter = Watts per square meter divided by .01

$nW/cm^2 = W/m^2 / .000{,}01$ Nano-Watts per square centimeter = Watts per square meter divided by .000,01

$pW/cm^2 = W/m^2 / .000{,}000{,}01$ Pico-Watts per square centimeter = Watts per square meter divided by .000,000,01

$A/m = \sqrt{W/m^2 / 377}$ Amps per meter = the square root of the product of Watts per square meter divided by 377

$mG = W/m^2 / 23.9$ Milli-Gauss = Watts per square meter divided by 23.9

$uT = W/m^2 / 239$ Micro-Teslas = Watts per square meter divided by 239

$nT = W/m^2 / 239{,}000$ Nano-Teslas = Watts per square meter divided by 239,000

Some other useful conversion formulas are :

$mG = (A/m)^2 \times 15.774059$

$A/m = \sqrt{mG / 15.774059}$

$nT = mG \times 100$

$mG = nT / 100$

$A/m = \sqrt{nT / 1{,}577.4059}$

$nT = (A/m)^2 \times 1{,}577.4059$

$V/m = W/m^2 / A/m$

$V/m = (mW/cm^2 \times 10) / A/m$

$A/m = W/m^2 / V/m$

$A/m = (mW/cm^2 \times 10) / V/m$

And some useful predictive (but possibly inaccurate*) conversions between electric, magnetic, and power units:

$V/m = \sqrt{nT \times 90{,}103}$

$V/m = \sqrt{mG \times 9{,}010.3}$

$nT = (V/m)^2 / 90{,}103$

$mG = (V/m)^2 / 9{,}010.3$

$W/m^2 = (V/m)^2 / 377$

$mW/cm^2 = (V/m)^2 / 3{,}770$

$W/m^2 = (A/m)^2 \times 377$

$mW/cm^2 = (A/m)^2 \times 37.7$

*These may not perfectly correlate with measured field readings, depending on wiring configurations and other conditions.

Also, in the conversion tables, you'll find some numbers abbreviated with an exponential notation. For instance, 2.41E-07 is really 2.41 times 10 to the negative seventh power, or 0.000000241. And 7.63E+08 is really 7.63 times ten to the eighth power, or 763,000,000.0. Just count the digits between the decimal points and you'll get the idea!

Bob Dahse / GeoPathfinder.com rev.01/15/2007

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