

# **Response to EU Proposal on Ecodesign and Energy Efficiency as they relate to Entertainment Lighting**

*Association of Lighting Designers, UK  
25th January 2018*

Dear Ms Mautone,

This letter is a response to the request for comments on the EU's Ecodesign and Energy Efficiency of Light Sources proposals, an effect of which would be to ban the supply of tungsten-halogen light sources which are heavily used in entertainment lighting.

## **1. Sender: The Association of Lighting Designers**

This letter is from the Association of Lighting Designers in the UK. The Association is almost sixty years old; it was founded by some of the pioneers in the field of entertainment lighting design. Its membership now comprises people working across all areas of entertainment lighting, predominantly UK-based but with members from all over the world. ALD members work to create the lighting for live performances - theatre plays, musicals, opera, dance, concerts and other events up to and including Olympic Opening and Closing Ceremonies - around the world. Further information about the ALD and its membership can be found online at [www.ald.org.uk](http://www.ald.org.uk).

This letter is sent on behalf of these members, who are deeply concerned about the potential loss of the ability to use tungsten halogen as a light source. Their concerns can be summarised as:

- the loss of the ability to use long-established, well proven and reliable tungsten-based entertainment lighting fixtures.
- the waste that would be caused by having to scrap all of these fixtures.

- the high cost of having to replace all of those lighting fixtures and much of the control infrastructure (dimming, control, wiring) which supports their use.

- the high environmental impact of the creation of those new fixtures.

- and the loss of a versatile and beautiful light source which offers excellent colour rendering and highly versatile performance - an important tool for those working in this field who care deeply about the quality of light. Alternative light sources are measurably and demonstrably less good and less subtle than existing tungsten fixtures, in areas such as colour spectrum and the ability to dim smoothly and evenly.

## **2. Background: Entertainment Lighting**

To provide some background, lighting designers for performance are not 'illumination engineers,' calculating light levels to provide even illumination for specific tasks or specific working areas. Rather they use light to control and shape the visual environment for live performances - as the 'glue' that binds all of the different elements of a production together. They create the atmosphere and mood of the show, shifting that atmosphere to help tell the story of the show, precisely controlling what is visible to audience members and what is not at any moment in the show. While of course they do ensure that the performers are illuminated, they use precise control of light to manipulate their appearance on stage. The playwright Edward Bond once described the work the late lighting designer Andy Phillips created for Bond's play *Lear*: "He told me he lit the whites of their eyes," Bond said. Later in the play *Lear* has his eyes taken out. "I wondered what Phillips would do... he seemed to concentrate light on the hands. Uncannily, I became aware of *Lear's* fingernails."

While lighting designers can and will happily turn to any source that can emit light if it fits their needs or the needs of a particular production, the primary tool of the entertainment lighting designer for more than sixty years has been precisely controllable spotlights designed for entertainment lighting use, fitted with tungsten and, later, tungsten halogen light sources.

Depending on the size of the theatre and the scale of the production, the lighting rig for a show might consist of tens or hundreds of such entertainment lighting fixtures. It will typically include precisely controllable spotlights able to project a controllable and shapeable beam of light; each spotlight will be precisely set to one particular area of the stage, coloured using a colour filter, and connected to a dimmer so that its level can be individually adjusted. There may also be some less precisely controllable fixtures for lighting sky cloths or similar; these, too, will be connected to dimmers to allow precise control of their levels. The level of each fixture in the rig will be individually adjusted moment by moment during the course of the show, in order to create the desired lighting 'pictures'.

### **3. Strengths of Tungsten Light Sources for Entertainment Lighting**

Though now complemented by a wide variety of other light sources, including discharge arc lamps and LED sources, tungsten halogen spotlights became and remain a principle tool in this application because:

- they are a very good source of light with a wide, even colour spectrum that is free from abrupt spectral discontinuities: they make things, particularly living things like humans, look good.
- they are easy to manipulate: the technology to dim them is well understood and widely available, available as part of the installation in most theatres and easy to provide on a temporary basis if not.
- they are a familiar tool, with technical staff comfortable with their set-up and use.
- they are widely available: almost all theatres and other performance spaces will have a stock of equipment of this type, and rental companies offer ready access to such equipment if additional stock is required or no in-house equipment is available.
- they are relatively low-tech - easy to install, easy to maintain, rugged.

- because of that, theatre spotlights have a long working life: even in quite major theatres, lighting fixtures dating back to the 1960s can still be found in daily use, continuing to serve their original function rather than being reduced to scrap metal and glass.

- alongside those long-lasting fixtures, the technology has continued to improve, for example with a newer generation of fixtures taking advantage of technology such as dichroic glass reflectors to improve the efficiency (light output per watt of power) of spotlights such that a modern 575W spotlight can offer the same light output as earlier 1000W spotlights.

#### **4. Power Consumption of Entertainment Lighting**

With regard to the EU's intention to reduce the use of power, which is of course a laudable goal, it would be easy to construe the description above of 'tens or hundreds of spotlights' and '575W or 1000W spotlights' as suggesting that entertainment lighting is a heavy user of power, and an inefficient user because of its use of tungsten halogen as key source.

That is not the case, however. The power consumption of entertainment lighting is dramatically lower than a simple 'connected load' calculation (connected load of equipment x operating time) would suggest, because:

- entertainment lighting is predominantly used only during a performance. A typical performance might only last for two hours, and be performed only once or, occasionally, twice during a day. The rest of the time the show lighting rig will be off.

- during the creation of a new show, the lighting will be operating for a longer period, but these creation periods are also usually relatively short - typically just a few days - relative to the show's performance period.

- entertainment lighting uses a rig of lights to change the appearance of the performance space moment by moment by using different lights at different levels at different times. A rig of spotlights will never all be on at the same time, and the lights that are on at any given moment will almost always be dimmed down, very rarely at full power. A key study of lighting

in performance carried out for the Seattle Rep in 2011-2012 showed that the peak active load at any given moment of the show averaged about 30% of the total connected load, while the overall power used during a performance varied between 30% and just 7% of the possible total power consumption (ie. of the total connected load multiplied by the length of the performance). Details of this study can be found online here: <http://www.lightingandsoundamerica.com/reprint/EnvironmentStageLight.pdf>

- taking into account all of those factors, stage lighting uses a relatively small percentage of the total power consumed by an average theatre. A survey carried out by the Mayor of London's office in 2008 suggests that show power use by lighting, sound and scenic automation motors was just 9% of the total power consumed by an average theatre in London's West End. This report can be found online here: [https://www.london.gov.uk/sites/default/files/green\\_theatre\\_summary.pdf](https://www.london.gov.uk/sites/default/files/green_theatre_summary.pdf)

In other words, though it is easy to perceive tungsten halogen as an 'enemy' of energy efficiency, this is not really the case in its application in entertainment lighting, where it is used quite differently from 'general lighting' applications.

## **5. Alternative Light Sources**

It is of course possible to argue that replacing a 700W tungsten source with a comparable 200W LED source would lead to reductions in power consumption (assuming that a like-for-like fixture in terms of light output and quality could be found). However, we believe that the overall impact of making such a change would be hugely problematic environmentally and in its impact on venues, without providing the overall energy savings that would be expected:

- LED sources tend to be less bright than tungsten equivalents. For a tungsten spotlight operating at 50%, the LED equivalent might have to operate at 70%. The power use of the LED fixture would 40% of the tungsten equivalent rather than the expected 28%. The Association of Lighting Designers is beginning further work researching the actual relative power consumptions of different types of fixtures in like-for-like applications.

- LED sources are never truly 'off' during a show, even when not emitting light, since their control electronics have to remain

active. An 'inactive' LED fixture might draw 10-20W of power, whereas an 'inactive' tungsten fixture draws effectively no power. This overall use has to be factored into any comparison of energy use between different fixture types.

- LED sources use power in a more complex way than tungsten lighting fixtures, meaning that a power factor correction needs to be applied to their power use to calculate the power that has to be supplied to them by the electricity generating company.

- much of what is considered 'waste' from tungsten sources is heat. But of course in cooler periods of the year this contributes to the heating in the building, and will be compensated for by thermostats in the building's heating system. On one of the first productions to use LED lighting fixtures in the West End, the actors could not feel the accustomed 'heat' in the beams of light they were standing in. They felt cold, and so asked for the theatre's heating to be turned up, therefore increasing the building's power consumption and negating the savings on energy from using LED fixtures.

In other words, the power saving of switching to LED fixtures will not be as great as expected. At the same time, switching to LED fixtures requires the acquisition of these new LED fixtures. The issues associated with this are:

- high purchase price. For the industry standard spotlight, the ETC Source Four, which is now available in tungsten and LED versions, the list purchase price of the tungsten version is UK£503, while the directly equivalent LED model (the Source Four LED Series 2 Lustr) is UK£2181. In other words, if you have to purchase a new fixture, the LED version is 430% more expensive than the tungsten version. While much cheaper LED fixtures are available they lack the subtlety (ie. they have poorer colour range, poorer colour rendering, poorer fade quality with obvious stepping of changes in light level as they fade up or down, poorer manufacturing quality and poorer reliability) that entertainment lighting applications demand. Manufacturers of lighting fixtures note that large quantities of tungsten lighting fixtures (and associated support equipment such as dimmers) are still being made and sold because there

is demand for them, because of their particular qualities, but also just because they are much more affordable.

- in many cases theatres, particularly smaller theatres and other venues such as clubs, schools, churches, local halls, pubs and others, are not purchasing new equipment at all. They are continuing to use their existing products, just replacing the light bulbs (at a cost of typically £13 per bulb, with the failed lightbulbs containing materials that are non hazardous and recyclable) when they do fail. That is all they can afford to do (and in some case, even replacing the light bulbs is a financial struggle). Responses to a survey on the effect of a possible ban of tungsten halogen light bulbs being carried out by the Association of Lighting Designers suggests that this is a major area of concern for many venues - particularly smaller theatres, amateur theatres and schools. Many note that being forced to purchase new fixtures if the supply of tungsten light bulbs ended would be impossible, and would ultimately force the venues to close, with a resulting loss of jobs.

- respondents to the same survey also note that even if they were to start to budget to move to replace their tungsten fixtures, to do so within a two year timeline, as would be required if the supply of tungsten bulbs were to be banned from 2020 as proposed, would be unfeasible.

- in larger theatres or on existing shows, the complexity arises from having to replace old equipment with new equipment while maintaining the look of existing shows and without disrupting the performance schedule of the shows. That might be on a single long-running show (such as, say, *The Phantom of the Opera* or *Les Misérables* in London), where both cost and available time to make such changes would be challenging. It would be a particular issue in opera houses and similar venues where shows play in repertoire - ie. when a production may not be seen for several years but will then return to the stage. In addition to finding the time and resources to install new lighting equipment, further time and resources would have to be found to each time a show from the repertoire returned to the stage to re-create the lighting using the new lighting equipment.

- replacing tungsten fixtures would lead to the scrapping of large quantities of otherwise perfectly serviceable lighting fixtures, which would lead to the creation of large amounts of waste material. Manufacturers estimate that there are five to ten million lighting fixtures of this type currently in active service across the 28 EU states.

- replacing tungsten fixtures with LED fixtures does not just involve the cost of replacing the fixture itself, but also altering or replacing existing building infrastructure, particularly the dimming systems since these will often no longer be required and, in fact, may cause damage to LED fixtures. In many cases the existing lighting control consoles will not be suitable for control of LED fixtures, particularly colour-changing LED fixtures, and will also have to be replaced. The cost of such infrastructure replacement will, again, be very high (prohibitively high in many cases) and will again lead to a considerable amount of waste.

- greater complexity. Tungsten lighting fixtures have very few failure points - usually if a fixture fails, you just replace the light bulb (and because the fixtures are dimmed bulb failures are relatively rare because the bulb is always treated 'gently' and rarely run at full: the operating life of bulbs in theatre spotlights typically exceeds the manufacturer's stated lamp life by some margin, tiny reductions in output level bring about large increases in operating life). LED fixtures, by contrast, are relatively high tech products containing LED electronics and control electronics, these often also requiring ancillaries such as cooling fans. There are many possible failure points. A failure requires electronic diagnostic servicing and repair techniques and skills to be available; these would not be available in many theatres, particularly smaller venue. Failures may ultimately require a fixture to be scrapped, so generating more waste material. It feels unlikely that LED fixtures will have the many-decade operating life that tungsten fixtures have succeeded in achieving.

- non-lighting issues: tungsten fixtures are generally convection cooled. They make no noise. LED fixtures are often fan cooled. They make a constant background noise. A small noise per fixture, but a bigger noise when multiple fixtures are in use. This means that a background noise is introduced to a performance venue, which can be distracting from a

performance and will be unacceptable in many cases where acoustic performance is critical (particularly theatres for opera and drama, and in orchestral concert halls).

- and all for a light source that is ultimately less 'good' in terms of the quality of light it generates. Electronic Theatre Controls, Inc (ETC), a leading manufacturer of lighting fixtures for the entertainment industry, now makes and sells both the industry-standard tungsten lighting fixture (the Source Four) and what is generally acknowledged by entertainment lighting designers to be the LED lighting fixture with the best spectral light quality and fade quality (the Source Four LED Series 2 Lustr). The company notes that it has spent a great deal of effort over the last two years evaluating the various colour rendering standards with the goal of trying to match the black body curve of tungsten sources, treating that as the 'gold standard' for a light source. The company admits that it cannot find a recipe of either discrete coloured LEDs or phosphor-converted white LED sources that can truly duplicate the spectral output of a tungsten source, which lighting designers still demand.

- plus in practical terms, manufacturers suggest that even current and a coming generation of LED performance lighting fixtures will be unable to meet the efficiency goals proposed by the EU (220lumens/watt in white light). Based on current development trends, it seems that even if the budget was available and the schedule was available to replace the tungsten fixtures with fixtures meeting the proposed EU requirements, such fixtures will not actually be available by 2020.

## **6. Intent and Timeframe**

We should make it clear that we understand that the intent is not to outlaw the use of tungsten halogen sources in September 2020, but rather to prevent the supply of new tungsten halogen light sources from that time. It would seem that the EU's expectation is that lamps would still be available in the supply chain for a period after September 2020, and that there is therefore an expectation that there would be no need to have made a switch to more efficient sources by September 2020 - ie. that more time would be available for performance venues to budget for an implement any required changes.

However, given the relatively limited market for specialist light bulbs for entertainment lighting, we suspect that having these regulations in place with a September 2020 start date would have the effect of discouraging manufacturers from making these sources even prior to that date. Even without these regulations in place, some of these specialist lamps are already made in relatively short batches and there are already sometimes stock shortages. With this regulation in place we would expect stock availability to fall rapidly from September 2020.

In addition, making the change to an LED based rig, particularly changing the support infrastructure (replacing dimming and control systems) is a considerable undertaking that could not be undertaken while a venue was active. It would have to happen in a scheduled closed period, if such a period is available. Such a closed period may happen just once a year, so if these regulations were in place venues would need to make the change prior to September 2020 so that they did not become 'stranded' with a tungsten lighting rig for which they could no longer purchase replacement tungsten light bulbs

## **7. Ongoing Adoption of New Technology**

It is worth noting here that entertainment lighting practitioners are not afraid of new technology. Shows, particularly larger productions with bigger budgets, are adopting LED sources alongside tungsten and other sources for the advantages they bring, particularly the fixture's ability to change to different colours during a performance. Larger shows have, for the last two decades, adopted automated lighting fixtures whose movement can be controlled by computer. These fixtures have generally used discharge 'arc' lamps, which are always on at full when in use, dimmed using mechanical dimmers built into the lights. While these fixtures are efficient in terms of lumen per watt, they become less so when used in theatre-style applications where they are running at low output or even no output for periods of time. These fixtures are now being replaced very rapidly by a new generation of LED moving light fixtures where the LED is dimmed and so power consumption is proportional to light output level. Productions that have the budget to do so are happy to make this change because the overall running costs of the new LED fixtures (power

consumption, the removal of the need to replace the arc lamp at regular intervals) are dramatically lower than the older arc fixtures, and in many cases the light quality is an improvement over that from the arc sources.

Similarly, many venues are working to replace parts of their lighting systems where the improved energy performance of LED fixtures does outweigh the cost and difficulties involved in installing new fixtures - notably for houselight and worklight systems which are on at high levels for extended periods of time.

In other words, performances venues and productions that have suitable finances available are prepared to invest in something if it represents an improvement over what went before, and entertainment lighting practitioners are happy to use and recommend such equipment as long as it performs to an acceptable standard.

It is also worth noting that the entertainment industry as a whole is working hard to understand how its work affects the environment and to reduce its environmental impact, through organisations such as SIPA, the Sustainability in Production Alliance.

## **8. The Challenge, Moving Forward**

The challenge here, as we perceive it, is balancing the demands of the wide variety of users of entertainment lighting fixtures, with their widely disparate budgets and facilities. But to summarise:

- there is no current low-energy (LED or other) light source that matches the light 'quality' - spectral content, colour rendering, controllability, smooth dimming - of a tungsten halogen source.

- alternative light sources that match the EU's proposed lumen-per-watt values in a form suitable for entertainment lighting (ie. precisely controllable spotlights) are not yet available, and manufacturers suggest they are unlikely to be available by 2020.

- purchasing new LED lighting fixtures is expensive. Even if the budgets for replacing existing lighting rigs with comparable-

quality low-energy alternatives were available to arts organisations (which they generally are not), organising those budgets within the next two years would generally be impossible.

- a few companies are offering drop-in replacement LED sources for very specific models of tungsten halogen entertainment spotlights. However, these products are only of use with these very particular models of spotlight rather than being available for more general use, and are currently only available in 110Volt form, so not suitable for use in Europe. At least one manufacturer has abandoned development of a 230Volt equivalent as being technically unachievable.

- as regulations tighten and, in turn, demand for tungsten lamps falls, manufacturers are likely to reduce the range of tungsten bulbs they manufacture and/or dramatically increase the cost of those bulbs. Even without regulations in place, entertainment lighting is likely to be herded into using new technologies because of this.

- given the relatively low actual power use of tungsten sources in use in performance, and the relatively high amounts of waste material that would be generated by scrapping existing lighting fixtures, we wonder if it would be more sensible to allow this to happen gradually and 'naturally', driven by market forces (as, in fact is already happening), rather than trying to force it into happening over the next two years.

## **9. Framing An Exemption For Entertainment Lighting**

Given all of the above, we would like to propose an exemption that would allow the continued use of tungsten halogen light sources for entertainment lighting. We understand that the complication is ensuring that an exemption made for one area can not be abused to allow continued use in other areas.

The question therefore becomes how to frame the exemption for entertainment lighting. This is challenging because of the widely varied nature of entertainment lighting. However, possibilities that we can see include:

- continuing to allow the use of tungsten halogen bulbs in entertainment lighting fixtures. A definition of this application

already exists in “Safety Standard EN60598-2-17: Luminaires.”, and also with reference to professional products as defined in EN61000-3-2.

- continuing to allow the use of tungsten halogen bulbs of particular lamp types or lamp base types which are used largely or only for entertainment lighting purposes. This would include, for example, lamp base types G9.5, GX9.5, G39, GX16D, GY16, G22, P28, P40, PGJX-50, lamp types CP23, CP24, CP29, CP39, CP40, CP41, CP42, CP43, CP51, CP52, CP53 (plus their type-T equivalents, including T11, T12, T14, T17), CP60, CP61, CP62, CP70, CP71, CP72, CP73, CP75, CP77, EHD, EHF, EJG, FNN, FFP, FFR, FFS, GKV, HPL, HPL750, HPL575-XL, HPL750-XL, QXL. The Association of Lighting Designers is working on a more definitive version of this list. It is worth noting that some of these lamp types are already out of production and so no longer available. However, continuing to allow their use would at least make it permissible for manufactures to create new batches of these lamps if there was sufficient demand. We note that the current proposals include an exemption for the R7 linear lamp type, citing that no LED replacement is available. We believe this also to be the case for many of the lamp types utilised by entertainment lighting fixtures, often because the nature of LED sources precludes the ability to design them into a source that would work within the optical system of existing entertainment lighting fixtures.

- continuing to allow the use of tungsten halogen bulbs with a defined initial lumen output that falls within the range used by entertainment lighting, but which would exclude lamps normally used for domestic or architectural lighting purposes. The Association of Lighting Designers is working to identify a suitable value, but would expect it to be in the range of 10,000 lumens initial output.

- continuing to allow the use of tungsten halogen bulbs in entertainment applications where the lighting fixtures are connected to professional lighting dimmers, such that their levels can be controlled as part of the show.

- continuing to allow the use of tungsten halogen bulbs in entertainment applications where either the dimmers or the lighting fixtures are controlled by an entertainment lighting

control system and/or using an entertainment lighting control protocol (including, but not limited to, 0-10V analogue, DMX512, E1.31 sACN, Art-Net, RDM, ETCNet, ShowNet, Pathport and other specialist entertainment lighting control protocols).

- we note also that there appears to be an intent for a partial exemption for light sources designed for 'image capture and image projection'. Many theatrical spotlights can be used for image projection, but it is unclear whether this exemption applies to spotlights used in this way in live performance.

- we note also that there is an existing exemption for video projectors, suggesting an understanding that not all lighting is functional. This description applies equally to the use of entertainment lighting equipment.

## **10. Conclusion**

Ultimately, as noted above, with or without regulations in place, the limit to the ongoing life of tungsten halogen sources is likely to be how long manufacturers continue to supply such light bulbs: some are already out of production. However, having an exemption in place would allow at the very least a niche market to continue to exist, just as exists for, say, the supply of Polaroid film even in the face of the overwhelming move to digital photography, for particular applications or by lighting designers or lighting artists who feel, as many do, that the particular qualities of tungsten were still essential and irreplaceable.

An appendix to this document includes thoughts on this subject from a wide range of Association of Lighting Designer members, ranging from leading international lighting designers to those running tiny amateur theatres. The quotes show a universal desire to continue to be able to use tungsten halogen sources, whether on artistic or practical/cost grounds.

We would therefore respectfully ask that, while continuing to pursue your laudable ambitions to reduce power consumption, you give consideration to allowing the continued use of tungsten halogen light sources in the field of entertainment and performance lighting.

We are happy to answer questions or provide additional information if required.

Thank you for your time and consideration.

Yours sincerely,

A handwritten signature in black ink that reads "Johanna Town". The signature is written in a cursive style with a large initial 'J' and a stylized 'T'.

Johanna Town  
Chair, Association of Lighting Designers  
on behalf of the ALD membership.

*[ENDS]*