

PLASA / EEEEC:

Ecodesign Lighting:

Non-Exempt Specialist Lamps for Entertainment Lighting

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Introduction

This document has been prepared in response to a spreadsheet supplied by the UK's Department of Business, Energy and Industrial Strategy which attempted to show that LED replacement lamps were available for many of the lamp base types the entertainment lighting industry is continuing to seek exemptions for, as outlined in the submission made by Pearle on behalf of the European Entertainment Ecodesign Coalition (EEEC) and in the related explanation document produced by the EEEEC:

https://www.plasa.org/wp-content/uploads/2018/10/Stage-and-Studio-Lighting-amendments-Ecodesign-Proposal-Joint-Statement_18102018.pdf

This document attempts to demonstrate why the LED replacement lamps proposed by BEIS would not make suitable replacements for entertainment lighting equipment.

The general points to note, and areas where LED sources often fail for entertainment lighting applications, are:

- Entertainment lighting uses light sources at a range of intensities to achieve the desired lighting 'picture' on stage. Tungsten-halogen fixtures are traditionally controlled using specialist phase-control (thyristor) dimmers. Many drop-in replacement LED sources do not function well or at all with such dimmers. Some may be damaged by them. Even if suitable LED drop-in replacements are available that work physically and optically with existing fixtures, they are useless for this purpose if they cannot be dimmed smoothly and evenly, with no visible steps, flicker or other artefacts, from zero output to full output. (Specialist LED entertainment lighting fixtures use direct control from an entertainment lighting protocol such as DMX512 to overcome this; such control will not be available for drop-in LED replacement sources).
- Entertainment lighting fixtures almost all involve an optical design using reflectors and lenses designed around tungsten light sources. Drop-in replacement LED sources may not interact correctly with those optical systems and in many cases may not actually physically fit within the lighting fixture.
- The reflector design means that light is often reflected back through the light source within the fixture assuming it to be largely transparent, and tungsten and arc fixtures are. This will not be the case with drop-in LED replacements.

- LED drop-in replacements may not be robust enough to survive in convection-cooled lighting fixtures.

It would be possible to design specialist drop-in replacement light sources for entertainment lighting fixtures, but the market demand for such sources is probably not large enough - ie. the single most popular entertainment lighting fixture (the ETC Source Four range) has sold only around 4million units over its 25 year history, and this is a huge number in comparison to other entertainment lighting fixtures. The Source Four's manufacturer has been attempting to create a drop-in replacement white LED source for this fixture (the S4WRD), but they concede that it is really best for architectural lighting applications where the light source is on for extended periods of time at full rather than subtle theatrical applications, and they have so far failed to create a version that operates on a 240V power supply.

Given that no suitable drop-in LED replacement light sources are available, maintaining the supply of tungsten lamps allows existing fixtures to continue to be used, rather than having to replace the fixtures (which would then become scrap) and also the entire control infrastructure.

G6.35

Typical entertainment use:

Capsule lamp used in set practicals, set dressing or tiny lighting fixtures.

Example replacement quoted:

https://www.amazon.co.uk/Klarlight-Bi-pin-Halogen-Incandescent-Replacement/dp/B073PY7636/ref=pd_rhf_se_s_cp_0_1?encoding=UTF8&pd_rd_i=B073PY7636&pd_rd_r=fc32509f-cd00-40f3-b507-5463c6a1a4e0&pd_rd_w=vNcbi&pd_rd_wg=LivVA&psc=1&refRID=J9P3TZS1RQ1C07QM87N1

Issue for Entertainment Lighting Use:

May not be dimmable using phase control dimmers as generally used in entertainment lighting; may not function correctly (even at full output) on such dimmers. Dimming - good quality, smooth, step-free dimming - is a requirement for all entertainment lighting applications.

No 'red shift' (colour moves warmer) during a fade, which is desirable in some entertainment lighting applications: white light tungsten sources, though often described as single colour or white light sources, actually offer an enormous range of colour depending on what level they are dimmed to.

GES/E40/K39D AT LOW VOLTAGE

Typical entertainment use:

Low voltage Beamlights, Svoboda battens.

Example replacement quoted:

<https://www.lightrabbit.co.uk/bulbs-led/e40-led-bulbs.html>

Issue for Entertainment Lighting Use:

These LED lamps would not work within the physical, optical electrical design of specialist entertainment lighting fixtures using GES E40 lamp bases such as the Beamlight fixtures and the Svoboda batten:



These fixtures use low-voltage (24V) crown-silver tungsten lamps either run from a transformer or, in the case of the Svoboda batten, wired in series within the lighting fixture. The optical design of the lamp combined with the physical design of the fixture gives an intense, near-parallel beam of light that is unmatched by

any other lighting fixture. The proposed alternatives would not physically fit into the Svoboda batten, and would not provide the correct optical performance in either fixture type.

In addition, the examples illustrated may not be dimmable using phase control dimmers as generally used in entertainment lighting; may not function correctly (even at full output) on such dimmers, and even if they could be dimmed would not exhibit 'red shift' (colour moves warmer) during a fade, which is desirable in many entertainment lighting applications.

While some LED fixtures are available that claim to replicate the properties of these fixture types, none exactly match them, and all are several orders of magnitude more expensive to purchase than these fixtures or (for existing owners of these fixtures) the lamps required to keep them running.

Note that we are not requesting a general exemption for GES/E40 lamp bases, but rather an exemption for this application when used at low voltage. The request for exemption for K39d is for the same type of application; in general, Beamlights up to 500W use a low voltage GES lamp, larger Beamlights (typically 1000W) use K39d lamp bases.

Many of these lamps were actually created for marine applications and so may be exempt under marine exemptions. However, the new regulations stipulate that exemptions only apply when exempt products are used in the applications

they were created for, so such products would not be exempt if used in entertainment lighting.

Lighting fixtures of these types are still in widespread use in theatres and opera houses in the UK and across Europe, are still being manufactured, and are still being specified for and installed on brand new shows.

We note that in the current discussions about regulating lighting in Australia/New Zealand, an exemption is included for this type of crown-silvered lamps, recognising their special optical parameters (*E3 Equipment Energy Efficiency Decision Regulation Impact Statement: Lighting*, p118):

https://ris.pmc.gov.au/sites/default/files/posts/2018/05/lighting_decision_ris.pdf

G12

Typical entertainment use:

Low-wattage discharge lamps for film use.

Example replacement quoted:

<https://www.lightrabbit.co.uk/bulbs-led/g12-led-bulbs.html>

Issue for Entertainment Lighting Use:



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These replacements would not work within the optical design of existing fixtures which use a reflector and lens system. In addition, these replacements would unlikely to survive the heat when used in a convection-cooled fixture not designed with LED control electronics in mind.

GX5.3

Typical entertainment use:

'Birdie'-type low voltage miniature lighting fixtures.

Example replacement quoted:

https://www.amazon.co.uk/Bonlux-Spotlight-Reflector-Replacement-Recessed/dp/B07DKDHC3J/ref=sr_1_4?s=lighting&ie=UTF8&qid=1539986936&sr=1-4&refinements=p_n_feature_three_browse-bin%3A443506031/

Issue for Entertainment Lighting Use:

May not be dimmable using phase control dimmers as generally used in entertainment lighting; may not function correctly (even at full output) on such dimmers. Dimming - good quality, smooth, step-free dimming - is a requirement for all entertainment lighting applications.

No 'red shift' (colour moves warmer) during a fade, which is desirable in some entertainment lighting applications.

GX51

Typical entertainment use:

High output (18kW+) open-faced reflector lamps for the film industry, eg ArriMax 18/12:



https://www.arri.com/fileadmin/media/arri.com/downloads/Lighting/Lighting_Products/Product_Information/Daylight_HMI_Lampheads/M-Series/2018_08-24b_M-Series_Tech_Specs_Poster_online.pdf

Example replacement quoted:

None proposed - claimed not found. LED Replacements unlikely to be found because of high light output, and optical/thermal design issues with creating a drop-in replacement that would function in this optical/physical design, and because of relatively limited demand.

GX6.35

Typical entertainment use:

Compact, high-output, portable film/tv light sources, eg. Redhead.



Example replacement quoted:

https://www.amazon.co.uk/G6-35-GX6-35-Illumination-Connectors-Replacement-Dimmable/dp/B077D685JV/ref=sr_1_11?s=lighting&ie=UTF8&qid=1539987225&sr=1-11&refinements=p_n_feature_three_browse-bin%3A443509031/

Issue for Entertainment Lighting Use:

May not work within the reflector-based optical system of a lighting fixture designed for a tungsten light source. May not survive the operating environment of a fixture designed for a tungsten light source where light/heat output is re-directed through the light source by the reflector system. May reduce the output of the fixture that was designed around the assumption that reflected light would pass back through a largely transparent tungsten lamp.

May not be dimmable using phase control dimmers as generally used in entertainment lighting; may not function correctly (even at full output) on such dimmers.

Par1

Typical entertainment use:

Integrated reflector/lens spotlight systems (Pars)

Example replacement quoted:

<https://www.astounded.com/buy/lighting-sfx/stage-band-lighting/led-par-cans/>

(but note that these are replacement lighting fixtures, not replacement lamps)

Issue for Entertainment Lighting Use:

May not be dimmable using phase control dimmers as generally used in entertainment lighting; may not function correctly (even at full output) on such dimmers. Dimming - good quality, smooth, step-free dimming - is a requirement for all entertainment lighting applications.

No 'red shift' (colour moves warmer) during a fade, which is desirable in some entertainment lighting applications.

No or poor choice of beam angles (including non-symmetrical beam shapes), whereas Par lamps are available in a number of beam angles.

Of the example replacement complete fixtures shown: poor colour rendering. Multi-coloured shadows rather than monochromatic shadows (shadow is as important a part of lighting design as light). Poor light output. Potentially noisy cooling systems. No ability to interface with existing entertainment lighting control systems (ie. no interface for control by DMX, Art-Net, E1.31 sACN or equivalent entertainment lighting control protocols). Higher maintenance requirements. Shorter expected working life - no user-serviceable parts, so effectively a disposable (and probably largely non-recyclable) item, which is not very eco-friendly.

R7

Typical entertainment use:

Floodlights, particularly asymmetrical floodlights for sky cloth lighting.



Example replacement quoted:

<http://www.strictlyleds.co.uk/led-light-bulbs/r7s-led>

Issue for Entertainment Lighting Use:

There is confusion within the EU documents as to whether they are attempting to exempt R7 lamps with an output of less than or equal to 2700 lumens, as they have written, or greater than 2700 lumens, as they have suggested in various discussions.

The implication is that they are seeking to exempt lamps for which no drop-in LED replacement is available and ban lamps for which drop-in LED replacements are available.

However, drop-in replacements are available in the less than or equal to 2700 lumen output range, eg. the Philips CorePro LED Linear D 14-120W:

http://www.lighting.philips.com/main/prof/led-lamps-and-tubes/led-capsules-and-specials/corepro-ledlinear-mv/929001353602_EU/product

But no drop-in replacements are available at greater than 2700 lumen output.

Nor are any likely to be available generally, or for the specific requirements of entertainment lighting. These requirements have been well presented by Dr.

David Bertenshaw, the former R&D Director of Strand Lighting in a period from the late 1960s to the late 1990s, in a response to the EU's public survey:

https://ec.europa.eu/info/law/better-regulation/initiatives/ares-2018-476175/feedback/F14861_en?p_id=310970

In short, he presents that the standards for the R7 Lampholder (IEC60061 sheets 7004-92-3 and 7005-53A-5) would not allow it to reliably or safely retain a heavy, high-output LED replacement, particularly with the shock-loads a fixture being handled into position, as entertainment lighting fixtures often repeatedly are, would encounter. He also argues that the very asymmetric optical design of many such entertainment fixtures such as the ADB ACP1000 illustrated above (designed to allow even illumination of a sky cloth from top or bottom) would be disrupted by a larger, less transparent LED light source, and that such a light source may not survive such a convection-cooled operating environment.

All of this is in addition to the now-familiar issues:

May not be dimmable using phase control dimmers as generally used in entertainment lighting; may not function correctly (even at full output) on such dimmers.

No 'red shift' (colour moves warmer) during a fade, which is desirable in some entertainment lighting applications.

While LED floodlight fixtures are widely available, and in fact in many cases are the first item of such technology many theatres adopt (because while entertainment lighting generally uses less electricity than expected because the lighting rig is only used for short periods of time, all the lights are rarely on at the same time, and are usually on dimmed to less than full power, sky cloth lighting is a big user of electricity and LEDs used for this purpose give a quick pay-back on investment), those fixtures are often problematic

because they do not offer this level of asymmetric light distribution, often have other issues, particularly poor fading at the very bottom end of the fade range, and are an order of magnitude more expensive than existing R7-based fixtures and especially just the R7 lamps needed to make those fixtures operate.

However, there is a massive stock of R7-based equipment in use, and to force its rapid replacement (particularly when many LED replacements lack the fade subtlety of the tungsten equipment and are also an order of magnitude more expensive than the existing tungsten equipment) will be problematic. The lower running costs of LED fixtures means that as suitable products become available at a suitable price, this area will sort itself out relatively quickly without the 'strong hand' of regulation attempting to force the change in an unrealistic timescale (which may result in the forced adoption of ultimately unsuitable equipment which would then in turn need to be wastefully replaced).

We also note that the same Australian study referenced above will provide exemption for all R7 lamps because of the problem of obtaining retrofit LED lamps (E3 Equipment Energy Efficiency Decision Regulation Impact Statement: Lighting, p117).

Conclusion

Entertainment lighting requires precise control over light, both in terms of the optical design of fixtures, and the ability to control those fixtures. Lighting 'pictures' on stage, in concerts or for films are composed by precisely balancing the levels of a multitude of light sources. Changes during live performance are made by crossfading between different lighting states. Such changes might be

quick, even instantaneous, might be slow, but must always occur without any distracting 'artefacts' - steppiness, jumpiness or, particular, abrupt transitions to or from zero output.

Many LED sources cannot achieve such fades at all. Most cannot achieve it when controlled from the type of phase-control dimmers that are standard in entertainment lighting. And in many cases such replacement light sources would not either physically fit within existing lighting fixtures or work within their optical design.

Specialist lighting fixtures designed for entertainment lighting overcome many of these issues and are being adopted by many venues and productions as time and budget allow.

Generic drop-in LED replacement lamps do not work for entertainment lighting for the reasons outlined above. Yet the market is not large enough to encourage anyone to develop specialist drop-in LED replacement lamps, and those few who have tried have failed on cost or performance grounds.

It is for this reason that we continue to argue for exemption for these tungsten lamps that are still in widespread use in entertainment lighting.

Suitable complete specialist LED replacement fixtures are available now in some, but not all, cases. They are, however, an order of magnitude more expensive (3-10 times) than existing tungsten lighting fixtures, or more once

the cost of replacing the complete dimming/control infrastructure in existing venues is considered. This is unaffordable particularly by smaller theatres in the very short (1-3 year) term, particularly because given the use profile of entertainment lighting fixtures (only used during a few hours a day of performance, never with all lights on together, rarely with any of the lights operating at full power; the power consumption of an entertainment lighting rig during performance is typically only 15-25% of the power consumption the total connected load would suggest) they are unlikely to see payback in terms of energy saving for many years. By which point their LED fixtures may have failed or required expensive repair, whereas many tungsten fixtures in use are decades old and still performing fine with just the occasional change of lamp.

If you require any further information about any of this or need to see examples of the kinds of lighting fixtures discussed here, please do get in touch.

[ENDS]