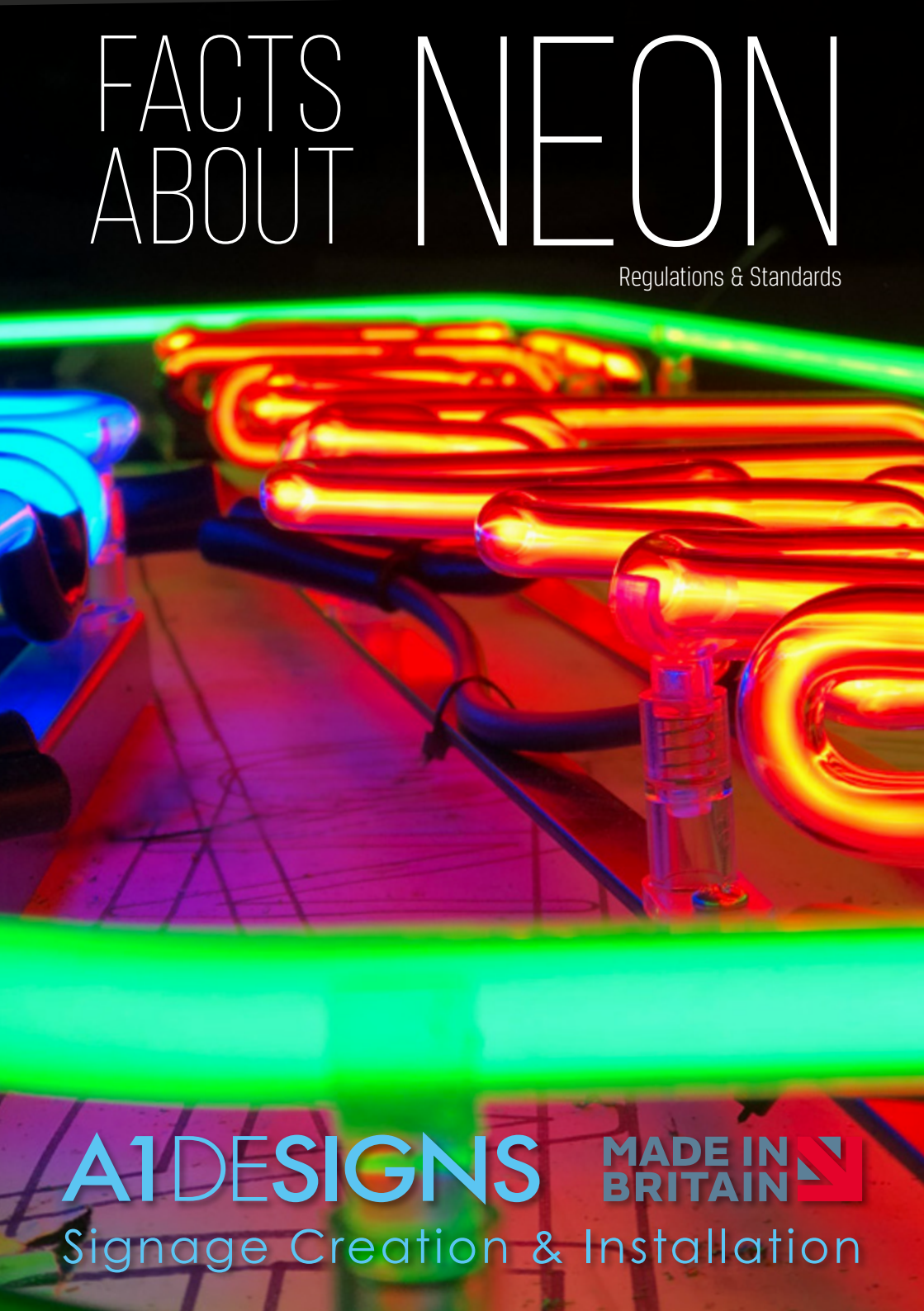
FACTS ABOUT NEON

Regulations & Standards



A1DESIGNS

MADE IN BRITAIN

Signage Creation & Installation

A1deSIGNS have been manufacturing a wide variety of signage for over 30 years. We have always manufactured our neon in-house.
Over recent years a lot of misinformation has been circulated about neon, as such we have put together this guide to help a wide variety of clients better understand the product along with the regulations and standards surrounding its use.

Our in-house capabilities:

NEON MANUFACTURE
Flashing, spelling, dimming and much more.

VINYL GRAPHICS
Window etch, lettering, vehicle graphics etc.

SIGN WRITING & GILDING
Traditional hand painted lettering and gold leaf.

COLD CATHODE LIGHTING
Bespoke straight or curved sections.

DIGITAL PRINTING
Up to 1600mm wide onto rolls.

CNC FLAT BED ROUTER
Wood, acrylics, composites etc.

UV BONDING OF ACRYLIC & GLASS
Cabinets, displays, cases etc.

MIG / TIG WELDING
Metal frames etc.

ACRYLIC FABRICATION
Letters, boxes etc.

METAL / COMPOSITE FABRICATION
Letters, trays, boxes.

AGEING OF MATERIALS
Wood, rusted steel, tarnished metals, patinating etc.

ELECTRICAL WIRING
PAT testing, light bulb wiring.

INSTALLATION CREW
PASMA, IPAF certified, CSCS, Sign making NVQ qualified, Safe Contractor.

LED LIGHTING / LIGHT BULBS / FAIRGROUND LIGHTS
As part of a project.

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Q. WHAT IS THE DIFFERENCE BETWEEN NEON AND LED NEON?

A. NEON IS ONLY EVER MADE FROM GLASS, LED NEON CONTAINS LEDs AND IS EITHER MADE FROM PLASTIC OR SILICON.

Neon is hand bent/crafted over a hot flame by someone that has been trained in the art of bending glass. Once the glass has been bent to a shape, an electrode (glass housing with metal shell inside), is heat welded onto each end of the hand bent tubes.

Once the section (hand bent shape with the electrodes attached), is complete, it is attached to a machine called a bombarder. This machine then vacuums the section down to negative atmospheres of pressure. Electricity is then passed through the tubes, causing them to heat up. The section gives off impurities whilst being heated up which are vacuumed out of the tube, the heating also activates the electrode shells.

Once the tube has reached temperature and the electrodes have been activated, the tube is allowed to cool and the gas is placed into the tube. The tube is then connected up to a transformer to be aged in, which helps to identify any potential failures within the tube. It is then blocked out, a process where each tube is hand painted on parts that are not needed to be seen, giving each letter or shape definition.

LED neon on the other hand, is cut from a solid piece of acrylic by a CNC router, this then has LEDs put in the rear which are soldered as required, it is capped off and then vinyl is applied to the sides.

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Q. DOES NEON GET VERY HOT TO THE TOUCH?

A. GENERALLY NO.

There are a couple of reasons a neon section (tube) would get hot. This can be either due to the existence of impurities in the tube (air usually), the electrodes having too much current passed through them due to incorrect calibration or if it's incorrectly installed.

The only other time that an electrode may be hot is on large diameter tubing running at a high current in the range of 150mA.

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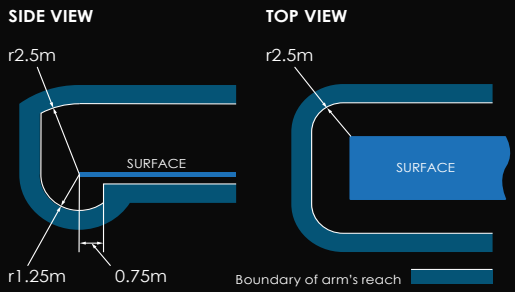
Q. CAN NEON BE AT TOUCHING HEIGHT?

A. YES - SAFETY REGULATIONS APPLY.

Neon can be at touching height, however, different regulations apply for the installation. Touching height (arm's reach) is defined in section 7 of the European Standard EN 50107 and is concerned with the protection against contact of active (live) parts.



Arm's reach is defined as the zone extending from any point on a surface that a person would stand or move about from which a person could reach out to. This would be a reach of 1.25m in front and below the surface and up to 2.5m above the surface that someone could occupy.

When a sign is within arm's reach the following must apply:

If the glass tubing is housed completely within a case, for example acrylic, no open circuit protection is required.

If the glass tubing can be touched then a mechanically protective enclosure according to IP2X and open circuit protection is required.

This can be a tray panel with the electrical connections in the rear, or the silicon caps fixed in place so as to require a tool to remove them. External metal parts must be earthed and all electrode connections must be protected by silicon caps.

Complete mechanical protection is achieved if the housing does not exhibit any opening with a diameter of more than 12mm even if a tube should break.

Electronic transformers come with open circuit protection by default, other transformer types require a simple change of an internal earth trip, or if being flashed or dimmed by a separate external earth trip.

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Q. WHAT IS THE LIFE EXPECTANCY OF NEON TUBES? IS THIS AFFECTED BY THEM BEING SWITCHED ON AND OFF?

A. IF INSTALLED CORRECTLY AROUND 40,000 HOURS. IT IS NOT AFFECTED BY BEING SWITCHED ON AND OFF.

The life expectancy of a tube pumped with pure neon depends on a few factors; whether the tube stays sealed and unbroken, whether there are enough ions remaining in the tube for it to strike and as long as it does not suffer an electrode breakdown. This can be many years. However, the argon pumped tubes can suffer from electrode erosion and have a useful life expectancy of over 40,000 hours. Tubes have been known to last a great deal longer than this.

In 2012 an article in the Daily Mail wrote about some neon tubes that were found in the USA that had been running constantly for 77 years. Fluorescent coated tubes do however suffer from a decrease in light output over time (lumen depreciation), LEDs also suffer from this as well, but are more greatly affected than neon by heat.

Switching neon on and off repeatedly will have a negligible effect on its life span.

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Q. DO NEON SIGNS EXPLODE?

A. NO THEY DO NOT.

Air pressure is 1013.25 millibars at sea level, a neon tube is manufactured under a vacuum and then filled to a maximum pressure of up to 25 millibars in small diameter tubes and around 5 millibars for larger diameter tubes.

Therefore a neon tube when broken technically implodes and sucks air into the tube, however this is not a spectacular event and does not result in the expulsion of glass everywhere.

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Q. NEON IS HIGH VOLTAGE, IS THAT NOT DANGEROUS?

A. WHEN INSTALLED CORRECTLY, IT IS NO MORE DANGEROUS THAN OTHER HOUSEHOLD APPLIANCES.

When installed correctly the voltage from a neon sign is insulated from being touched. If contact is made with a live connection, transformers generally have protection devices that switch the unit off. Neon is generally classed as high voltage (above 990v), but the current is low on a neon transformer, in the milliamp (mA) range usually around 18-20mA. The socket in your house although only 240v can be as high as 30amps 30,000mA of current. Voltage makes less of a difference in the case of an electric shock, whereas current makes a massive difference, for example static electricity is in the range of 25,000 - 35,000 Volts, but the current (measured in mJoules) is extremely low and not constant.

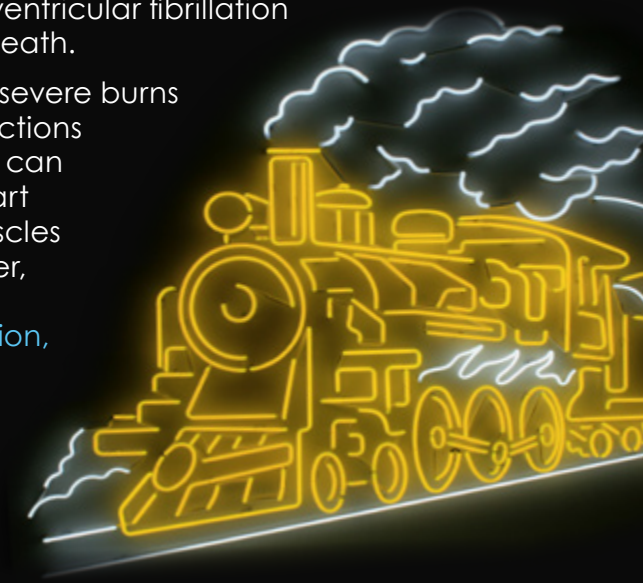
Current has the following effect on the body

At 20-75mA of current someone would receive a painful jolt and loss of muscle control.

At 75-100mA of current, ventricular fibrillation of the heart can occur (uncoordinated twitching of ventricles).

At 100-200mA of current, ventricular fibrillation occurs, often resulting in death.

At over 200mA of current, severe burns and severe muscle contractions occur and internal organs can be damaged and the heart can stop due to chest muscles applying pressure. However, this clamping effect can prevent ventricular fibrillation, greatly improving the chances of survival if the victim is removed from the electrical circuit.



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Q. IS THE GAS USED IN A NEON SIGN POISONOUS?

A. NO - NOT IN THE SMALL AMOUNT PRESENT IN A TUBE.

Neon signs contain either Neon gas or Argon gas, both of which are inert gases and as such have no reaction when inhaled in small quantities, they are present in the air we breathe daily.

The only thing that is harmful within an argon tube is the addition of a small amount of elemental mercury. Elemental mercury occurs widely in the environment, mercury causes damage when it is cumulatively absorbed into the body over time.

If a tube is broken it is recommended to air the room in which it is located, and clean up any mess created. The NHS website states that the small amount of mercury in the tube is extremely unlikely to cause problems for your health and provides extra precautionary advice for clean-up, this is the same advice as for fluorescent lamps.

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Q. NEON IS EXPENSIVE?

A. NO, NOT FOR A CUSTOM, HANDMADE PRODUCT.

Neon is a hand-made product that involves someone standing over a hot flame turning a glass tube until the glass becomes soft enough to be bent, each bend is individually heated and shaped, this is a difficult skill to master that takes years of practice.

Once the tube has been shaped it then has electrodes welded on to the glass, once electrodes have been welded to the glass section it is attached to a bombarder which then processes the glass by heating up to around 240°C whilst evacuating impurities given off by the glass.

Once the tube has achieved this temperature and the electrodes have been activated, the tube is then vacuumed down to negative atmospheres. Once the tube has cooled and a good vacuum is achieved the tube is filled with the chosen gas and removed from the bombarder. The tube is then aged in and black paint is applied to the parts of the glass that don't need to be seen and provide definition to the design. The glass can then be mounted as necessary.

When you consider the amount of time and expertise that goes into the manufacture of a neon sign, along with the life expectancy, it is not an expensive product.

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Q. WILL MY NEON SIGN CAUSE A FIRE?

A. NEON IS NO MORE LIKELY TO CAUSE A FIRE THAN ANY OTHER ELECTRICAL ITEM

We install and manufacture correctly, using parts that meet and are constructed to EU and UK safety regulations.

If there is a fault with a neon sign, it should be switched off and repairs carried out as necessary by a qualified technician, as you would with any electrical product before putting back in to use. This should be done before attempting to use the sign, as more problems may occur if the sign is used when faulty.

Neon signs imported from outside the EU can be sub standard in quality and safety.

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Q. CAN NEON BE USED OUTSIDE?

A. YES, NEON CAN BE USED OUTSIDE.

Externally suitable transformers are IP44 rated, but must be mounted correctly, some small electronic transformers are IP65 rated and can also be used outside except when over a certain voltage. Neon glass is perfectly fine in the Great British weather.

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Q. WHEN DOES A NEON SIGN NEED TO HAVE A FIRE-FIGHTER'S SWITCH?

A. ANY PERMANENT, NON-PORTABLE, HIGH VOLTAGE NEON SIGN OVER 100W (E.G MAX 8KV/18MA), WILL REQUIRE A FIRE-FIGHTERS SWITCH OR CONNECTING TO A FIRE CIRCUIT.

Fire-fighter switches are not always required. When considering the requirement, we need to look at the relevant regulations and these are found in the IET Electrical Regulations.

The IET Electrical Regulations 18th Edition States:-

537.4.2 - A Fire-fighter's switch shall be provided in the low voltage circuit supplying:

1. *Outdoor lighting installations operating at a voltage exceeding low voltage, and*
2. *Indoor discharge lighting installations operating at a voltage exceeding low voltage.*

For the purposes of this regulation, an installation in a covered market, arcade or shopping mall is considered to be an outdoor installation. A temporary installation in a permanent building used for exhibitions is considered not to be an exterior installation.

This requirement does not apply to a portable discharge luminaire or to a sign of a rating not exceeding 100w and fed from a readily accessible socket-outlet.

When considering this regulation we need to understand the definition of portable and the definition of what constitutes low voltage.

The definition of portable as outlined in the British Standard BS559:2009 Design & Construction of Signs is:-

3.1.5 Portable Sign - Small self contained sign which is supplied as a complete unit and is intended to be placed in position and, if illuminated, connected to a mains supply, usually by an unskilled person.

Note: A portable Illuminated sign is usually supplied with an integral lead for connecting to the mains supply and this often includes a mains plug.

The definition of low voltage as outlined in the British Standard BS559:2009: ▶

3.3.1 Low Voltage - nominal voltage normally exceeding extra-low voltage but not exceeding 1,000vAC. or 1,500vDC between conductors, or 600vAC. or 900vDC between conductors and earth.

From the above we can say the following:

- A "portable" luminaire (e.g. an art piece) can be of any wattage or voltage and does not require a fire-fighter's switch.
- A sign powered by multiple low voltage transformers (990v) does not require a fire-fighter's switch.
- A sign of less than 100w fed from a readily accessible socket does not require a fire-fighter's switch.
- A non-portable sign over 100w requires a fire-fighter's switch.

So what does 100w allow us to have? This is dependent on the amount of mA (Milliamps) being passed through the tubes and the voltage required for the installation.

When working out wattage there are two methods, one is the apparent power (expressed as Volt Ampere) and the other is the Real power (Watts).

Volt Ampere is worked out with the following equation from Ohm's Law

P(Watts) = V(Volts) x I(Amps)

However this is not the Real power in watts that is obtained, it is actually Volt-Ampere's which is not the same thing.

Real power is worked out by multiplying VA (Volta-Ampere) x Power Factor (cosϕ) which for wire wound transformers is 0.5, this results in a much lower wattage. With this in mind anything up to and including the following transformers should be able to be used, as their Real power is less than 100w when running:

Wire Wound Transformer:

6kV 25mA running at 95 watts.

8kV 18mA running at 95 watts.

Electronic Transformer:

8kV/ 20mA running at around 95% of full capacity. Less load uses less power. Installations should be individually checked when running, as cabling and other factors can affect the efficiency.

When a fire-fighter's switch is required the regulations state:

537.6.2 - Every exterior installation covered by regulation 537.6.1 in each single premises shall wherever practicable be controlled ▶

by a single fire-fighter's switch. Similarly, every internal installation covered by Regulation 537.6.1 in each single premises shall be controlled by a single fire-fighter's switch independent of the switch for any exterior installation.

537.6.3 Every fire-fighters switch provided for compliance with Regulation 537.6.1 shall comply with all the relevant requirements of the following items (i) to (iv) and any requirements of the local authority:

(i). For an exterior installation, the switch shall be outside the building and adjacent to the equipment, or alternatively a notice indicating the position of the switch shall be placed adjacent to the equipment and a notice shall be fixed near the switch so as to render it clearly distinguishable.

(ii). For an interior installation, the switch shall be in the main entrance to the building or in another position to be agreed with the local fire authority.

(iii). The switch shall be placed in a conspicuous position, reasonably accessible to fire-fighters and, except where otherwise agreed with the local fire authority, at not more than 2.75m from the ground or the standing beneath the switch.

(iv). Where more than one switch is installed on any one building, each switch shall be clearly marked to indicate the installation or part of the installation which it controls.

In short; internal and external neon signs should have separate fire-fighter switches, these should be ideally placed next to the sign that it controls or in the main entrance of the building, if not then a sign saying where the switch is should be provided along with a label for the switch. The switch should be no higher than 2.75m from the floor. Due to the age of the regulation and the fact is has not been updated for quite some time, It is also possible to connect into an alarm circuit that switches off when a fire is detected, this should be confirmed as acceptable by the local fire authority.

The reason fire-fighter switches are required is that when spraying water over high-voltage installations it allows the voltage to travel up the water being sprayed, it is a safety feature for the fire-fighters, should they ever be required. It is not the fact that a neon sign is more likely to cause a fire, as when installed correctly a neon sign is just as safe as any other electrical installation or appliance.

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Q. DOES NEON USE A LOT OF POWER?

A. NO, POWER CONSUMPTION IS LOW, LESS THAN YOUR WASHING MACHINE FOR THE SAME AMOUNT OF TIME.

The amount of power that is used by a neon sign is relative to the size of the sign, the diameter of the tubing and how many sections the neon is broken up into. Depending on required light output a single transformer can have a power requirement of between 0.2A @1-2.5kV and 0.93A @10kv for 18ma and 0.4A@1-2.5kV and 1.22A @10kv from 25mA transformers, this is the tube striking current that is required which drops dramatically once running.

To work out tube transformer requirements, a calibration process is carried out. To estimate the power requirements the process requires; measuring the linear length of tubing, allowing for the number of electrodes in the circuit and then choosing the correct mA output for the diameter of glass and electrodes being used.

The following is true when calibrating a neon sign:

The **thinner** the tube diameter the **less** meterage you can run.
The **thinner** the tube diameter the more **intense** the light is (brighter).

Electrode shells can only be run at certain milliamps, less mA can be passed through smaller diameter tubes as follows:

10mm	(25mA)
13mm	(50mA)
16mm	(80mA)
18mm	(150mA & 250mA)

External influences such as cable lengths can have an effect on power consumption, power consumption of wire wound transformers can be improved greatly (up to 40% reduction) with the use of capacitors.

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Q. DOES NEON COST A LOT TO RUN?

A. NO, COST IS LOW, LESS THAN YOUR WASHING MACHINE FOR THE SAME AMOUNT OF TIME.

When looking at the running cost of neon, you are needing to work out the kWh. This is done by working out the wattage (real wattage) being used by the transformer and converting that into kilowatts. Then multiply that figure by the number of hours the transformer will be running. This is then multiplied by your electricity cost per kWh.

If we take our 8kv/18mA wire wound transformer running at 95watts of power. The sign it powered was running for 10 hours a day for every single day of the year.

95 watts /1000 = 0.095kWh

0.095kWh x 10 hours per day = 0.950kWh

0.950kWh x 365 days = 346.75kWh over the year at 10 hours per day.

346.75kWh is then multiplied by the current cost for your electricity per kWh. The current average at the time of writing this is 14.37p/kWh.

346.75 x 14.37p = 4982.78p /100 = £49.82 for the year.

An example of a neon sign running on an 8kv transformer is shown below, the linear length of glass that can be run is dependent on the diameter of the tubing used and the number of sections of tubing there is, but as a rough guide an 8kv transformer can run 10.2m of electrical meterage in 10mm glass and 14.1m in 15mm glass.

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Q. HOW EFFICIENT IS NEON?

A. VERY, MORE SO THAN THE LED VERSION SPECIFIED BELOW

Neon is an efficient light source, especially when compared with fake LED versions. Efficacy of a light source is worked out by the amount of light given off for the amount of power being used or the ratio of luminous flux to power, this is measured in lumens per watt.

The light transmission value of opal LED acrylic is 35%, this means only 35% of the available light makes its way through the acrylic. So even when LEDs have a high efficacy, a large amount is lost due to absorption by the acrylic. If we take a 5050SMD LED strip in white 6500k with 60 LEDs per metre generally rated at around 1020lm/m depending where you read, you are only getting 357 Lumens/m transmitted through the acrylic, and the wattage is 14.4W/m which equates to 24.79 Lumens/Watt of power

The equivalent colour in neon is 6500k, a 15mm tube has a lumen output of 913lm/m @50mA and consumes 20W/m of glass allowing for electrodes. This equates to 45.65 Lumens/W.

This is obviously subject to specification variances of the various LEDs and the manufacturer of the acrylic along with the quality of the neon tubes after pumping. This also doesn't take into account that neon is a 360 degree light source which LED versions are not and the fact that the light is bounced off the side of the acrylic or rear which may affect light output.

Q. CAN NEON BE RECYCLED?

A. YES, NEON IS RECYCLED IN THE SAME WAY AS FLUORESCENT LAMPS.

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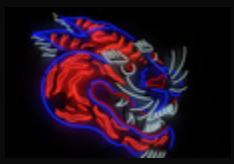

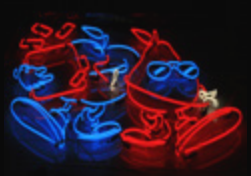

SOURCES

IET 17th Edition Electrical regulations

BS 559:2009 - Design & Construction of Signs

BS EN 50143:2009 - Sign and luminous-discharge-tube Installations operating from a no-load rated output voltage exceeding 1,000V but not exceeding 10,000V

BD EN 60598-2-14:2009 - Luminaires

Glostertube - Light output and energy consumption chart of cold cathode lamps.

SIET:- Neon Handbook

The Neon Engineers Notebook Second Edition - Morgan Crook & Jacob Fishman

Perspex Spectrum LED Block 1T77 Specification sheet

www.wholesaleledlights.co.uk

NHS Website: https://www.nhs.uk/common-health-questions/accidents-first-aid-and-treatments/can-a-broken-thermometer-or-light-bulb-cause-mercury-poisoning/

Daily Mail: https://www.dailymail.co.uk/news/article-2151843/Clifton-Cafeteria-Neon-light-left-77-years-discovered-Los-Angeles-restaurant-renovation.html

Ventricular fibrillation: https://www.thespruce.com/amperage-not-voltage-kills-1152476

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Compiled and written by
Andy Nash April 2020

MADE IN BRITAIN

A1DESIGNS

enquiries@a1designs.co.uk

020 8646 9886

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