

Electrical safety for entertainers



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Introduction

Who is this leaflet aimed at?

If you are an entertainer who uses electrical equipment for sound, lighting or other effects, this leaflet is for you. Others who use electrical equipment in the course of their work, such as wardrobe or scenic artists, may also find this guidance useful. It sets out basic measures you can take to help control the electrical risks from use of such equipment.

This revised version brings the content up to date and includes:

- changes to legislation and links to further guidance;
- updates to reflect current working practices, equipment and terminology.

For other guidance on the law, see HSE's website at www.hse.gov.uk.

Electricity can kill

Entertainers have been injured and even killed from electric shocks while performing or practising. Make sure your next performance is not your last.

Even a very small electric current flowing through your body can kill you. For example, 50 mA (a 40 W light bulb only takes about 150 mA) can cause pain, paralysis of chest muscles and, after a few seconds, upset the heartbeat and cause death (see Figure 1).

The higher the current, the quicker and more dangerous are the effects.

Risks

Faulty, damaged or incorrectly used equipment can injure you. If you damage electrical equipment, for example a cable, then bare live wires may be exposed.

Apparatus may be wrongly connected so that the outside metal parts become live.

The risk of injury is increased if you are holding an instrument or microphone, as you may not be able to let go if it becomes electrified (live).

Even equipment which does not have a mains power supply itself can be dangerous. For example, on some systems audio equipment such as loudspeakers may have terminals at dangerous voltages.

Electrical equipment that overheats can cause fire (see the advice on this under 'Extension leads and plugs' and 'Ventilation' later in the leaflet).

Precautions

Good-quality, well-maintained equipment, which is properly used, helps ensure safety. To achieve this, maintenance, inspection, testing and repairs should only be carried out by someone who has suitable skills, knowledge and experience.

Do not rely on other people's equipment being in a safe condition or properly connected. Check before you use it.

Do not connect or use incompatible items of equipment.

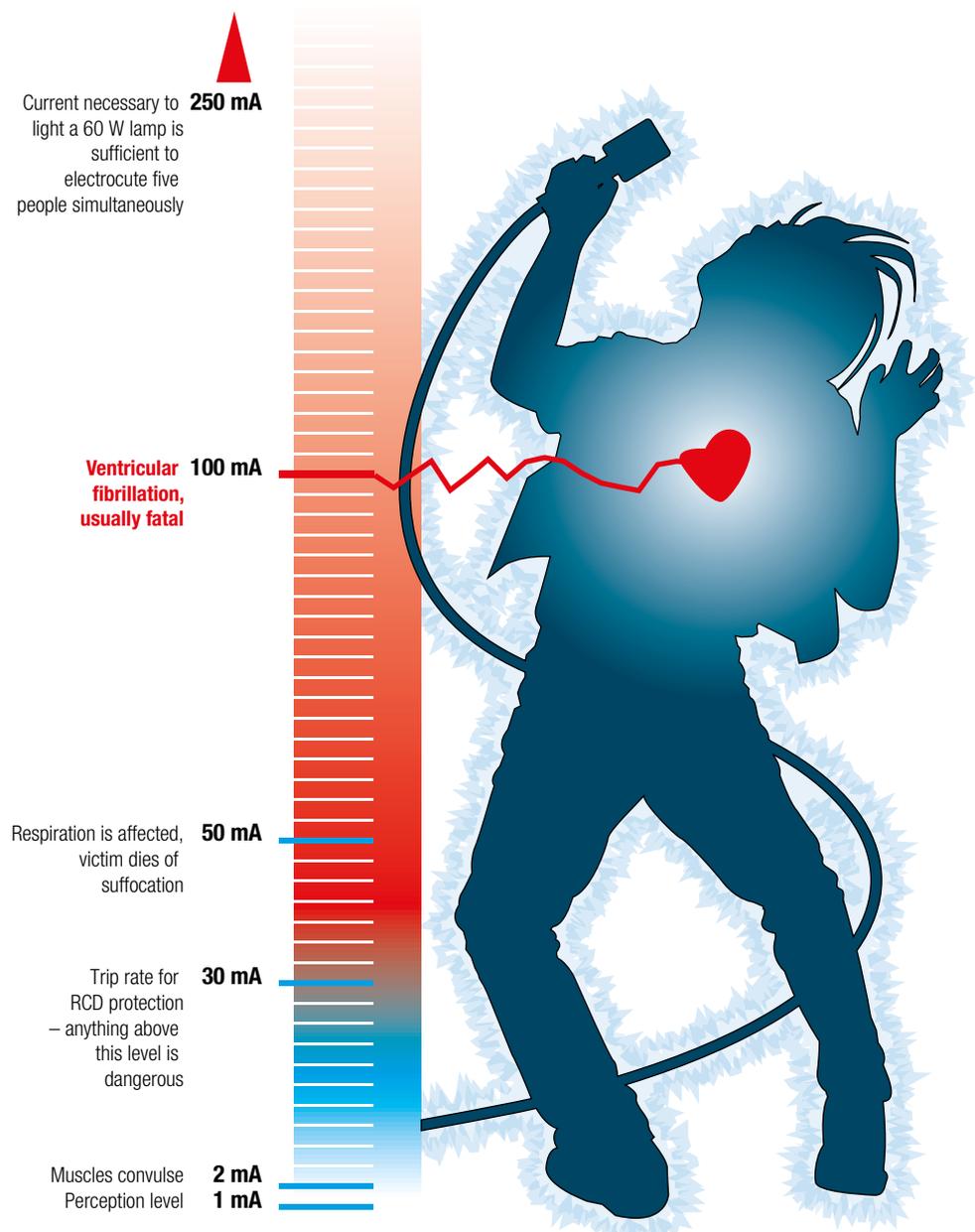


Figure 1 Relative magnitude and effect of electric current

Residual current devices (RCDs)

Use a residual current device (RCD) on the power supply to instruments, audio equipment and any other equipment which you or your colleagues may handle.

RCDs are relatively inexpensive and widely available from electrical goods retailers. They should be used because they:

- detect very small leakages of current to earth;
- automatically and quickly cut off the electricity supply.

The sockets you use, particularly for audio equipment, should be protected by RCDs suitable for personal protection. These are commonly referred to as 30 mA devices, with a disconnection time of no greater than 40 ms. The best place for an RCD is at the distribution board or at the socket outlet itself (see Figure 2).

You should check with the person responsible for the premises whether the relevant circuits from the main distribution board are RCD protected. If these are not already provided, or if the person is unsure about whether this protection is in place, you can use an RCD-fitted plug or RCD adapter.

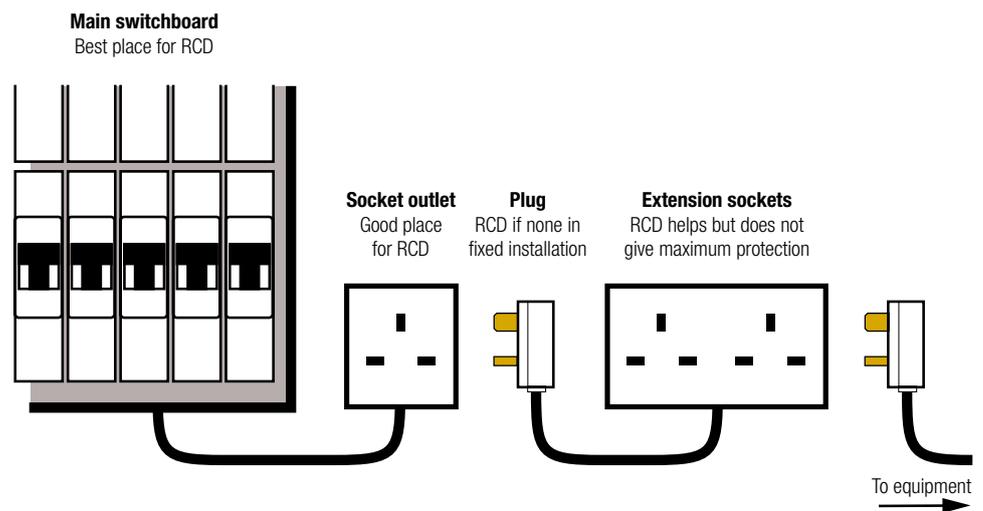


Figure 2 Where should the RCD be?

Remember

- It is important that you always keep your equipment in good condition.
- An RCD is a back-up to protect you if something goes wrong.
- If the RCD trips it is a sign that there is a fault that could be dangerous. Do not ignore this warning. Have it checked and get the fault fixed by someone competent to do so.
- Never bypass the RCD so that you can carry on using equipment which may be faulty, and possibly dangerous.
- It is best to limit the number of items of equipment supplied from one RCD to no more than six.

Sound equipment

Earth connections

Lack of good earth connections and poorly maintained equipment can cause electrical safety problems with sound equipment. Any item of equipment which is mains-powered should either be double-insulated  (see Figure 3) or correctly fitted with a protective (safety) earth.

If you are in any doubt about the connections of equipment, consult a competent person. Remember that an audio expert might not be an expert in electrical safety.

Single items of equipment, if properly maintained, usually present few problems. However, if a number of items are connected together, it is possible that cable screens (the braided metal protective layer of the cable), together with protective earths, form loops resulting in 'mains hum' on the system.

If this happens, don't remove protective earth connections. Removal of earths is one of the common causes of entertainers receiving electric shocks, some of which have been fatal. Good-quality sound equipment should not cause hum, although in some cases you may need to disconnect the screen at one end (only) of interconnecting audio cables.

When obtaining new equipment, discuss your needs with the supplier. Some equipment has a facility for disconnecting the 'signal' earth from the safety earth without affecting safety.

Where possible, powering all the sound equipment from the same socket or distribution panel will go a long way to reducing interference.

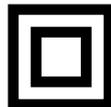


Figure 3 Double-insulated symbol

Electricity supply

Sometimes it may be necessary to site a mixing desk at some distance from the power amplifiers, interlinked by multi-core signal cables. Microphones etc may have their own power supply (not phantom-powered from the mixing desk). If this is not done, the risk of mains hum will be increased and people may be tempted to remove the earths from the equipment.

Connections

Amplifier terminals and the wiring and connections to loudspeakers may carry dangerous voltages. It is essential that wiring with adequate insulation is used, and that any connectors should be safe for use at the appropriate voltage and current.

Extension leads and plugs

Extension leads frequently cause electrical accidents, sometimes due to incorrect connection. Take care with the connections, particularly if a different plug has to be fitted.

The live, neutral and earth wires must be connected correctly (see Figure 4). If they are not, the apparatus may work but be lethal, perhaps in a way which would not be detected by a protective device such as a fuse or RCD.

If a lead or plug is damaged, replace it with a new one or repair it.

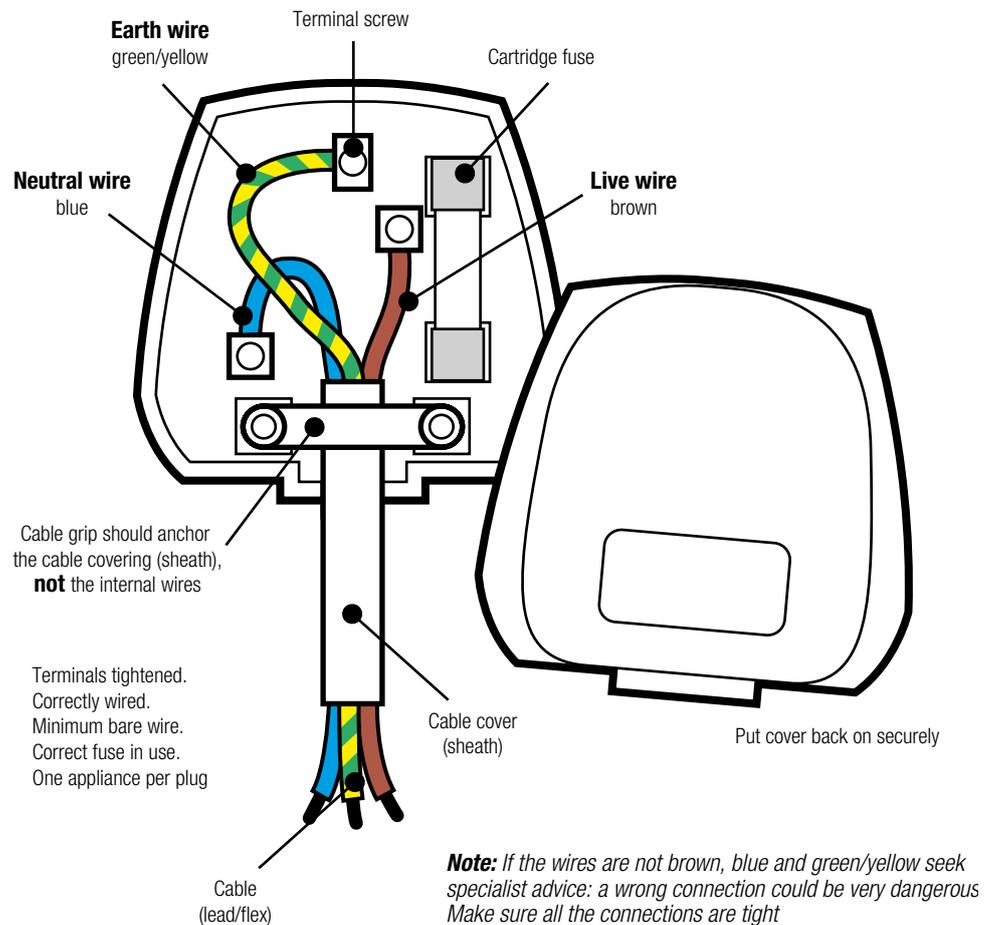


Figure 4 Plugs: points to watch

Only fully extended extension leads are capable of carrying the full current capacity of the cable without overheating. So fully unwind cable drums or coils to avoid the risk of fire. Also, do not use multiple adapters plugged into wall sockets, as they can easily get overloaded.

Ventilation

Make sure your amplifiers are properly ventilated. High-power amplifiers can get very hot if the ventilation around them is blocked, for example by stacking other equipment on or near them. This could cause a fire. Most amplifiers are fitted with thermal protection devices as a precaution against fire and if this protection operates it will shut the system down (possibly during a performance).

Fuses

If your equipment is fitted with 13 A (square-pin) plugs, make sure that the correct fuse is fitted. The rating plate on the equipment or the instruction book will tell you how much electrical power the equipment needs.

Under no circumstances should you bypass the fuse or replace it by wire, silver paper, or a nail, all of which are dangerous.

Inspection and testing

Portable electrical equipment can be damaged as it is moved from place to place. Make sure all electrical apparatus, including extension boxes and cables, is regularly checked by the user. As a general guide, user checks should include a visual inspection of the equipment, preferably before using it at a new location or when it is taken out of service for storage.

If there is damage to any electrical part or if the equipment causes an RCD to trip, it should be taken out of service at once and replaced, or repaired by a competent person.

Typical routine checks for portable apparatus are shown in the checklist at the back of this leaflet.

Regular electrical tests by a competent person may also be appropriate. These will detect the faults that cannot be seen at inspection, such as lack of continuous earth. Electrical testing every month would be reasonable until a suitable interval can be determined by risk assessment.

While there is no requirement to have one in law, a suitable log is useful as a management tool for monitoring and reviewing the effectiveness of a maintenance plan. Dutyholders with large amounts of equipment may also find it useful to label equipment to indicate when it was tested and that the test was satisfactory, ie it has been passed as safe.

Repairs should only be made by someone who is competent to do so.

Further advice on in-service inspection and testing can be found in the HSE publication *Maintaining portable and transportable electrical equipment* (HSG107)¹ and an Institution of Engineering and Technology (IET) code of practice.²

110–125 V American equipment

If you have American equipment designed to work only on supply voltages of 110 to 125 V, you will need a transformer to change the voltage. Incorrect use of such equipment can be dangerous and so you should consult a competent person, such as an electrician, about the selection and use of transformers.

Do not use a single-winding auto transformer as it can be incorrectly connected or can fail to danger (the electricity is still connected) without any indication. The first sign may be when you get an electric shock.

One item of equipment can be safely supplied from a safety isolating transformer which has been manufactured to comply with the British Standard BS EN 61558 (or IEC742). Only one item of equipment should be connected to any one transformer.

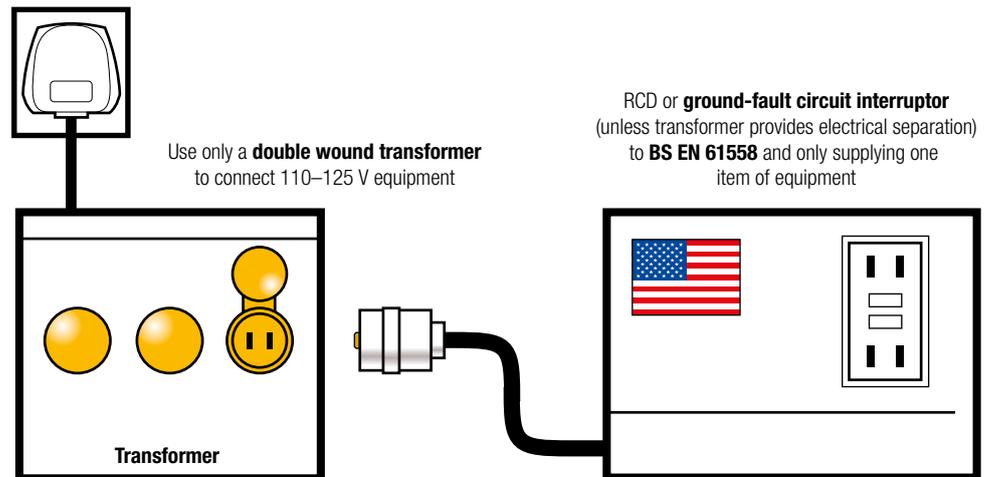


Figure 5 110–125 Volt American equipment

If a number of items of equipment are powered from the same transformer, or if the output of the transformer is connected to long cables (eg across the stage), then you should use a double-wound isolating transformer, with one side of the secondary earthed and an RCD (known in America as a ground fault circuit interruptor) connected into the transformer secondary circuit.

Do not use RCDs designed for UK installations on the output of transformer providing a 110 V supply as they are not generally designed to operate at such low voltages. The operating voltage should be marked on the RCD, but if in doubt consult a competent person.

Transformer output(s) should have suitable excess current protection (fuses or preferably circuit breakers) and, where a protective conductor is needed, it should be efficiently connected to an effective earth. The earthing conductor should be at least as large as the phase and neutral conductors of the primary circuit, and may be connected to the earthing conductor of the 230 V mains supply.

Do not use two 120 V lamps in series on a 230 V supply unless both of the light fittings are designed for 230 V operation. It is important that you do not use standard 230 V plugs on lower-voltage equipment. Accidentally connecting such equipment to 230 V mains could be dangerous. If in doubt, ask a competent person which plug you should use.

Lighting

Supports

Unless lighting is specifically intended for use at low level and protected against inadvertent damage, rig lighting bars and equipment should be out of reach of performers and the audience.

If cables to lights are run overhead, support them along their length (preferably by a catenary wire or on truss) unless the cable is the type which has its own strain wire. Take the strain off the flexible cable of suspended light fittings by supporting them with support wires or other suitable devices (see Figure 6).

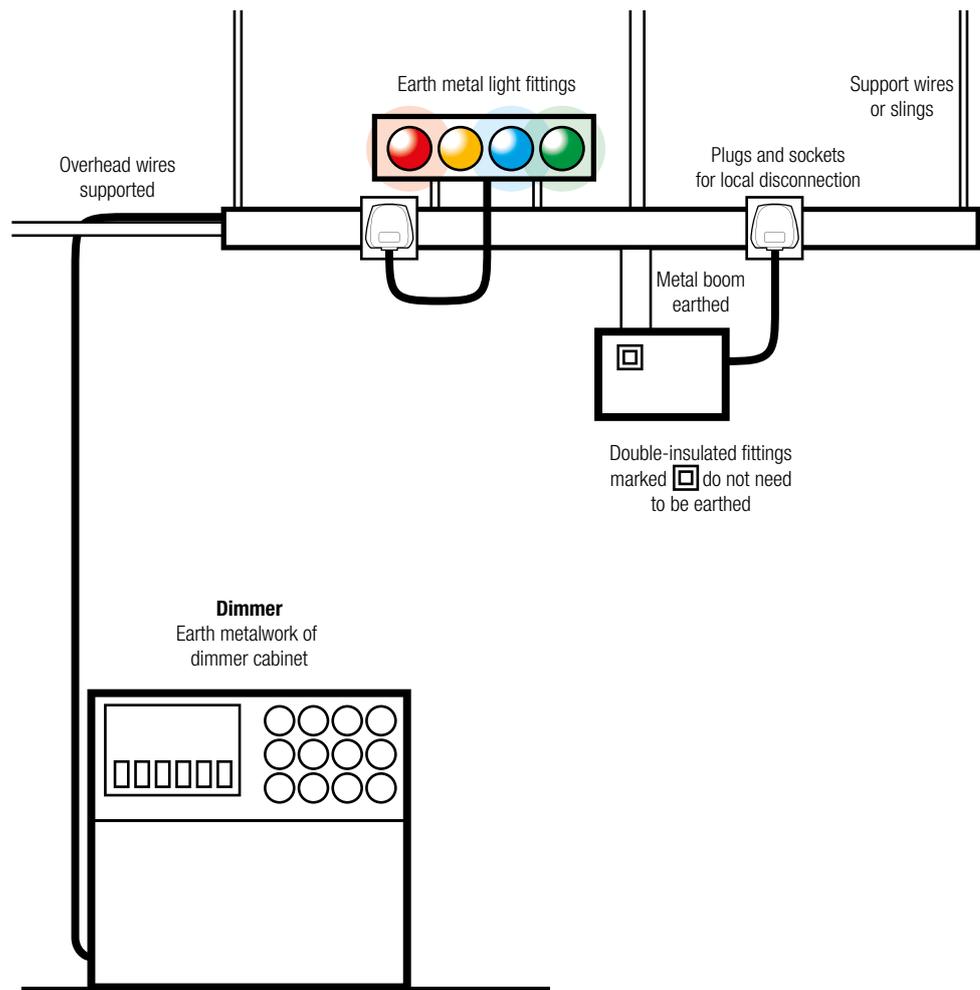


Figure 6 Indoor lighting: points to watch

Circuit separation and RCDs

If possible, you should take the electrical supply for lighting from sockets which are protected by a different RCD for that used by the audio equipment. This avoids problems that may occur with RCDs on lighting circuits. The audio equipment needs reliable RCD protection.

RCDs may not always be appropriate for lighting circuits. Some types of dimmer controls have a relatively high electrical leakage which may cause unwanted tripping when a number of units are fed from one RCD. Other dimmers produce a direct current which can prevent some types of RCD operating correctly. Some manufacturers offer RCD protection as an option on the supply side to the dimmer equipment.

It might be tempting to put an RCD on the secondary (output) side of a dimmer to give additional protection to a lighting rig, particularly where it is positioned at low level. However, some RCDs which contain electronic components do not operate satisfactorily at voltages much lower than 230 V so the additional protection may be ineffective. If you are in doubt, check with the equipment manufacturer (or supplier) and the RCD manufacturer.

Remember that RCDs should be used for circuits supplying outdoor lighting.

Three-phase supplies

Older lighting installations were typically connected to two or three phases of the electrical supply, using separate dimmers on different phases to avoid confusion. In these situations, only a single phase should be connected to any one boom.

Modern proprietary equipment, such as specifically designed three-phase dimmer units are available. Such equipment should be CE marked to show compliance with the Essential Health and Safety Requirements of the Electrical Equipment (Safety) Regulations 1994 (also known as the Low Voltage Directive).³

Connections

If you have lighting on a bar or boom, connect the individual lights to the boom by plug and socket. For indoor lighting these can be the 'old type' 15 A or 5 A three (round) pin types which are often used and quite satisfactory for lighting.

Commonly, the industrial type of blue and red connectors are now used for many lighting circuits, often called Ceeform or Commando plugs. These are available in ratings from 16 A up to 125 A and can be used outdoors, which the round-pin 15 A types are not designed for.

These industrial plugs and sockets are manufactured to BS EN 60309 and provide better protection against damp and rain. They should be used for all new installations where possible.

The metalwork of individual lights and the bar or boom should be adequately connected to the protective earth conductor.

Plugs and sockets to BS EN 60309 (previously BS 4343) provide better protection against damp and rain, and are ideal for use at outdoor locations. Since they are a tougher design than the specialist 15 A designs, they should be used for all new installations.

Cables

Power cables from the lighting booms to the dimmer cabinet or control cubicle are often multi-core. You should ensure that such cables are suitably flexible and protect against abrasion or other mechanical damage.

If there is any risk of the cables getting hot from the lights, they should be of a type which is sheathed in or protected by heat-resisting material.

- Make sure flexible cables are properly secured in a cable grip at the plug or other termination.
- All plugs and sockets should be adequate in terms of voltage and current ratings and they should be in good condition; the protective earth connection is particularly important.
- Ensure all circuits have their own phase, neutral and protective conductors which should all be the same size.

Earthing

A dimmer can act as a marshalling point for cables to a lighting boom. All the exterior metalwork of the dimmer should be adequately earthed. There can sometimes be separate connections for outgoing earth wires for lights.

Alternatively, you can rely on the earth connection of the outgoing plugs and sockets. There should be no provision in dimmers for 'lifting' (ie disconnecting) earths.

Special effects

Some lasers, strobes and other high-intensity lighting use high voltages internally so it is particularly important to ensure they are in good condition and properly earthed if necessary. Setting up such equipment is a job normally carried out by specialists.

References

1 *Maintaining portable and transportable electrical equipment* HSG107
(Third edition) HSE Books 2013 www.hse.gov.uk/pubns/books/hsg107.htm

2 *IET Code of practice for in-service inspection and testing of electrical equipment*
Institution of Engineering and Technology www.theiet.org

3 *Essential Health and Safety Requirements of the Electrical Equipment (Safety) Regulations 1994 (the Low Voltage Directive)* www.legislation.gov.uk

Further reading

The health and safety toolbox: How to control risks at work HSG268
HSE Books 2013 www.hse.gov.uk/pubns/books/hsg268.htm

The Electricity at Work Regulations 1989. Guidance on Regulations HSR25
(Third edition) HSE Books 2015 www.hse.gov.uk/pubns/books/hsr25.htm

Electrical safety and you: A brief guide Leaflet INDG231(rev1) HSE Books 2012
www.hse.gov.uk/pubns/indg231.htm

Electrical safety at places of entertainment General Guidance Note GS50
HSE Books 2013 www.hse.gov.uk/pubns/gs50.htm

Checklist for portable appliances

Listed below are typical routine electrical checks for portable apparatus. This checklist is only intended as a guide; certain apparatus may need different or additional inspections and tests. The checks should be carried out by a suitably competent person.

Note: Non-electrical checks are outside the scope of this leaflet.

Equipment:		
Make	Model	Serial number
User inspection: With equipment disconnected		
<i>Item</i>	<i>What to look for</i>	<i>Pass condition</i>
1 Mains plug	Check for broken casing, and cable properly clamped	No cracks in plug casing. No damage allowing contact with plug internal connections. Cable clamped securely by outer sheath, no inner insulation visible
2 Mains lead	Check for cuts, splits and crush damage	No inner (coloured brown, blue or green/ yellow) insulation visible; no bulges in cable, no kinks or twists or taped up joints
3(a) Equipment connector (or)	Check for broken casing on equipment and cable connectors. Check cable clamp	No cracks in plug or socket casing. No damage allowing contact with plug or socket internal connections. Cable clamped securely by outer sheath, no inner insulation visible
3(b) Equipment cable entry	Check grommet or clamp still there. Check cable clamp	No sharp edges on contact with cable. Cable clamped securely. No inner insulation visible
4 Mains on/off switch, voltage selector switch, fuse holders etc	Check for broken insulation	No cracked insulation, no loose parts, no parts missing
5 Equipment housing	Check for general condition. Check for loose parts inside	No holes (large enough to put a finger in) close to mains cable or switches. No rattles when you tilt it a quarter of a turn

Further information

For information about health and safety, or to report inconsistencies or inaccuracies in this guidance, visit www.hse.gov.uk/. You can view HSE guidance online and order priced publications from the website. HSE priced publications are also available from bookshops.

British Standards can be obtained in PDF or hard copy formats from BSI: <http://shop.bsigroup.com> or by contacting BSI Customer Services for hard copies only Tel: 0845 086 9001 email: cservices@bsigroup.com.

This guidance is issued by the Health and Safety Executive. Following the guidance is not compulsory, unless specifically stated, and you are free to take other action. But if you do follow the guidance you will normally be doing enough to comply with the law. Health and safety inspectors seek to secure compliance with the law and may refer to this guidance.

This leaflet is available at: www.hse.gov.uk/pubns/indg247.htm.

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