ELECTRICAL EQUIPMENT

Risk Control Guide

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Risk Control Guide

Introduction

This Risk Control Guide provides good practice for the arrangement, testing and maintenance of electrical equipment to minimise fire losses and accident prevention. It is applicable for equipment with voltages up to 1,000V AC. This includes secondary voltage where the primary voltage is higher than 1,000 V AC.

This Guide is based on United Kingdom regulation and practice. References are from UK sources.

Building owners and operators have a duty to maintain electrical equipment in a safe condition. In the UK this is governed by the “Electricity at Work Regulations 1989”.

From standard electrical terminology (and terminology used in this guide) “fixed electrical installations” relates to wiring, switchgear and electrical equipment that is permanently fixed and can only be moved if fixings are removed, e.g. transformers, motors, compressors, heaters, lights, etc.

Further information and guidance is available at:

http://www.hse.gov.uk/pUbns/priced/hsr25.pdf - Guidance on “The (UK) Electricity at Work Regulations”

Electrical Fires

Electrical equipment is a common fire ignition source. Poor connections or faulty equipment can overheat, smoulder and spark, igniting combustible elements of electrical equipment and wiring. If other combustible materials are nearby the fire may spread. Even with limited fire spread, loss of critical power supplies can lead to extended interruption to business operations.

Electrical fires can be caused by faulty electrical equipment:

BATTERY CHARGING

ELECTRICAL SWITCH-GEAR

LIGHTING

EXTENSION LEADS
PORTABLE APPLIANCES
PROXIMITY TO
COMBUSTIBLE MATERIALS

INAPPROPRIATE WIRING
OUT OF DATE WIRING
INAPPROPRIATE VOLTAGE
FOR USE INTENDED

Fixed Electrical Installations - Physical Controls

Key recommendations for fixed electrical installations:

- ☐ Oil filled transformers should be located outdoors, away from buildings. Bunding or containment should be provided around oil filled transformers. External transformer compounds should be clear of rubbish and vegetation, not directly adjacent to combustible construction. Indoor transformers should be within non-combustible blast wall cut-off rooms with fully sealed penetrations (1-hour rated cut-off room if the building is sprinkler protected; at least 2-hour rated if the building is unprotected), adjacent to non-combustible construction. Alternatively indoor transformers should be dry cast resin type, or filled with an approved (non/less-flammable) fluid e.g.©Midel 7131 transformer fluid.

- ☐ Electrical switch rooms should be cut-off rooms and fire-rated. Any wall, floor or ceiling penetrations should be sealed with material of a similar fire rating to the barrier penetrated. Fire detection should be provided within the rooms. Fixed fire protection should be considered for rooms with oil filled switchgear.

- ☐ Cable runs should be properly supported, ideally in cable trays. Rope, cord or plastic zip ties must not be used to secure cables and cable trays should not be overloaded. In sprinklered buildings, sprinkler protection should be extended beneath multiple layers of cable trays, or very wide trays.

- ☐ Cable penetrations through construction should be fully fire stopped with fire rated or intumescent materials which (as minimum) match the fire rating of the construction being penetrated. This includes cable tunnels and beneath raised floors.

- ☐ Electrical equipment such as fork-lift battery chargers should be located in dedicated areas, ideally cut-off rooms of fire rated construction, provided with permanent ventilation and as a minimum, fire detection.

- ☐ For fork-lift battery chargers in non-cut-off rooms, locate these against a masonry or other non-combustible wall and maintain a clear space of not less than 1.5 metres around charging stations and items being charged, delineated with prominent painted floor markings or barrier rails.

- ☐ Battery charging units should be mounted on permanent metallic stands or wall-brackets (not on wooden pallets) and brackets provided to hold charging cables off the floor and prevent damage.

- ☐ Access to electrical rooms should be controlled, with doors and gates locked.

- ☐ Electrical rooms should be kept cool, clean and tidy. They should be kept free of any storage and housekeeping should be maintained to a high standard.

- ☐ Electrical equipment and panels in open areas should be wall mounted on non-combustible materials, extending at least 1.5 metre above and well separated from combustible storage, with a minimum 1 metre separation maintained free of combustible material.

Fixed Electrical Installations - Frequency of Testing & Records

As electrical installations deteriorate with use and over time, every electrical installation should be periodically tested and inspected to identify electrical faults that could result in harm or fire.

Electrical installation condition reports (or periodic inspections) are recommended 5 yearly for commercial, residential and educational premises and 3 yearly for industrial facilities. Electrical testing and inspection should also be carried out on change of occupancy.

Property owners are recommended to ensure the fixed electrical installations are tested and inspected prior to new tenants moving in and upon a change of use of the premises. It is important to ensure no damage, harm or overloading has occurred.

These inspections should be carried out by qualified electricians and include checks on:

- the adequacy of earthing and bonding,
- the suitability of switches and circuit breakers,
- the serviceability of switches, sockets and lighting fittings,
- suitability of type of wiring system and sockets and their condition, also making sure that suitable Residual Current Devices (RCDs) are provided,
- the presence of adequate identification and notices,
- the extent of any wear and tear, damage or other deterioration.

Full guidance for electrical installation condition reports in the UK is provided in BS 7671: Requirements for Electrical Installations. BS 7671 may be purchased at:https://shop.bsigroup.com/ProductDetail/?pid=000000000030292893

In support of regulations and as best practice, appropriate maintenance programmes should be in place including:

☐ Fixed Wiring Inspections completed at adequate frequencies. Full records should be available for review, along with records to show that Code 1 & 2 defects (as defined in UK regulations – see Note) have been rectified.

Note: UK regulations: IET Wiring Regulations / BS 7671

- Code 1 defects: require immediate attention.
- Code 2 defects: require urgent action.
- Code 3 defects: improvements are recommended.
- F category defects: further investigation is needed as soon as possible.

☐ Infra-red Thermographic Surveys of all major electrical switchgear, major cable runs and key equipment such as circuit-breakers, conductors and connections. These should be carried out annually and full records maintained available for review, along with records to show that defects have been rectified.

Note: Thermographic surveys of the fixed electrical installation are recommended to identify hot spots and monitor the condition of electrical installations for commercial and industrial facilities.

- ☐ Power Factor Correction it is recommended units should be checked for overheating using thermography or thermometers on a quarterly basis.

- ☐ Power Transformer Test and Inspection for oil insulated units, oil samples should be analysed 3 – 5 yearly for less critical transformers and annually for critical installations where there is a significant fire exposure. Mineral oil analysis to include checks for moisture content, pH, dielectric strength and dissolved gases. Test certificates should be available for review. Load inspections and testing of protection systems and devices, must be completed as a minimum in line with the original equipment manufacturers recommendation.

- ☐ Mains Circuit Breakers mechanically exercised annually and subjected to secondary current injection testing every 3-5 years.

- ☐ Emergency Lighting Tests completed monthly, 6 monthly and three yearly in line with BS 5266:Part 1.

- ☐ Lightning Protection complete inspection and testing of the installed system in line with manufacturers guidance. If no guidance on test frequency is available this should be completed at least annually.

Electrical installations should be inspected and fully tested following flood or water damage prior to use.

High Intensity Discharge (HID) Lighting and other Lighting

Lighting technology is moving away from the use of HID (High Intensity Discharge) lights in industrial and commercial facilities, with LED lighting now becoming prevalent. But past popularity of HID lighting means many HID lighting installations remain in service. Scratches, water contact, or excessive pressure can cause HID lamps to break and if a suitable shroud or shield is not present, extremely hot glass fragments and lamp parts will be released, presenting a fire ignition hazard to nearby combustible materials.

HID lighting controls:

- ☐ High Intensity Discharge (HID) lights should be fitted with containment barriers. Tempered or borosilicate glass barriers are preferred as normal glass could shatter. Only retrofit lamp containment barriers if the action does not invalidate the approved standard for the fixture assembly.

- ☐ Alternatively, fit a shroud to protect the arc tube where a lamp containment barrier is not possible e.g. in the case of open fixtures. The ANSI electrical safety code designates O rating usually for shrouded lamps suitable for use with open fixtures.

- ☐ Where HID lamps are operated continuously night and day it is recommended that they are turned off for 15 minutes each week. If there are problems with the lamp it will not re-ignite after the “cycle-off” period and should be replaced.

- ☐ Where installed in warehouses and storage areas, HID lamps should be positioned over aisles and not directly above combustible stock.

- ☐ Lamps should preferably be changed after 70% of their rated life-span. Lamp replacement should be undertaken by a competent electrician, ensuring that the correct lamp type and rating appropriate for the fitting is used.

General lighting control:

- ☐ Regularly inspect lighting installations. Any failing fluorescent tubes should be replaced and safety starters provided on all fluorescent lights.
- ☐ Ensure frequency of re-lamping is done as per manufacturer recommendations.
- ☐ Ensure lighting cables and hot elements are clear of combustible building construction and materials.

Residual Current Devices

Residual Current Devices (RCDs) or Earth Leakage Circuit Breakers (ELCBs) are electro-mechanical devices designed to switch off electric current in the event of an electrical fault. They can detect very small faults before they become dangerous and are an excellent additional protection against electric shock and electrical fires. RCDs work by measuring indirectly the leakage current from the live conductors to earth. They are not designed to detect overcurrent and are not replacements for fuses or other overcurrent-tripping devices. RCDs are also known as Residual Current Circuit Breakers (RCCBs).

RCDs are available in many forms and ratings. If the tripping current of an RCD is 30 milliamperes (0.03 Amps) or less, then the RCD will give some protection from fatal electric shock and protection from fire. RCDs with a higher tripping current than this will still offer some protection from fire, but less protection from fatal electric shock.

RCD protection is recommended for all electrical power circuits in new installations, unless there is an overriding consideration such as high integrity supplies for freezers, lighting, welfare of livestock etc. Also, RCD protection should be provided for all electrical outlets likely to be used to supply outdoor equipment.

RCDs should be tested using a test button, which simulates an earth leakage fault, at regular intervals, e.g. every 3 months.

ELCBs are safety devices used in electrical installations with high earth impedance to prevent shock. They detect small stray voltages on the metal enclosures of electrical equipment, and interrupt the circuit if a dangerous voltage is detected. Once widely used, most recent installations now use RCDs, which instead detect leakage current directly.

Electrical Equipment in Hazardous Areas

Ignition from electrical (or mechanical) equipment in an explosive atmosphere (i.e. those atmospheres containing flammable gases and vapours, or combustible dusts) can lead to destructive blast effects and fire, causing both harm to people and property damage.

ATEX is the name commonly given to the two European Directives for controlling explosive atmospheres. These are the legal requirements for controlling explosive atmospheres and the suitability of equipment and protective systems used in them.

In the UK, the regulations relating to minimum requirements for improving the health and safety protection of workers potentially at risk from explosive atmospheres are implemented in The Dangerous Substances and Explosive Atmospheres Regulations (DSEAR).

In DSEAR Hazardous Areas are defined as "any place in which an explosive atmosphere may occur in quantities such as to require special precautions to protect the safety of workers".

Hazardous areas for flammable gases and vapours are classified into zones based on an assessment of the frequency of the occurrence and duration of an explosive gas atmosphere, as follows:

- Zone 0: An area in which an explosive gas or vapour atmosphere is present continuously or for long periods,
- Zone 1: An area in which an explosive gas or vapour atmosphere is likely to occur in normal operation,
- Zone 2: An area in which an explosive gas or vapour atmosphere is not likely to occur in normal operation and, if it occurs, will only exist for a short time.

A similar set of classifications exist for environments where explosible dusts may be present.

All fixed and portable electrical equipment used in a "hazardous area" must be of a suitable type, for example, intrinsically safe, flameproof, increased-safety or encapsulated. The wrong type of electrical equipment may lead to an ignition.

Further information and guidance is available at:

http://www.riscauthority.co.uk/free-document-library/RISCAuthority-Library_detail.rc30-electrical-equipment-in-flammable-and-explosive-gaseous-atmospheres.html - RC30 Electrical Equipment in Flammable and Explosive Atmospheres

http://www.riscauthority.co.uk/free-document-library/RISCAuthority-Library_detail.rc12-recommendations-for-the-prevention-and-control-of-dust-explosions.html - RC12 Recommendations for the Prevention and Control of Dust Explosions

http://www.hse.gov.uk/fireandexplosion/dsear-regulations.htm - UK Health & Safety Executive (HSE) DSEAR Regulations

Detailed guidance on specifications for complex hazardous areas classification can be found in the Energy Institute (EI) “Model code of safe practice Part 15: Area classification for installations handling flammable fluids”, which may be purchased at:

http://publishing.energyinst.org/topics/hazardous-area-classification/ei-model-code-of-safe-practice-part-15-area-classification-for-installations-handling-flammable-fluids

Transient Over-voltages

Most businesses are dependent, to a greater or lesser extent, upon electronic or electronically controlled equipment and damage or outage, even for short periods, may have a major impact upon business continuity, customer service, or even market position.

Transient over-voltages are very short duration increases in voltage that can damage electronic, computer and telecommunications equipment, interrupt electronic system operation, cause data-loss or corruption, reduce electrical electronic equipment life, or even lead to equipment overheating to the point of ignition and fire.

Transient over-voltages, may be transient spikes or transient surges. Transient spikes contain very high voltage levels and very little current whereas transient surges contain both high voltage and high current. These are usually caused by switching problems or by electrical faults (contact with earth or short circuit), or by atmospheric electrical discharges (lightning), either direct or indirect via power cables.

When assessing the risk of disturbance from lightning, it is important to consider both the likelihood of an occurrence and its potential impact. Whilst traditional structural lightning protection may prevent damage to buildings, it will not protect electronic equipment against transient surges or spikes.

BS EN 62305:2012 Protection Against Lightning standard provides a useful reference on risk assessment for both direct lightning strikes and transient over-voltages. Guidance is also provided on the protection of electronically stored data.

BS EN 62305 may be purchased at:

https://shop.bsigroup.com/SearchResults/?q=BS%20EN%2062305

For vulnerable facilities, detailed overvoltage risk assessments should be carried out by competent technical specialists, who should also provide a protection plan.

Most electrical lines are equipped with security measures to avoid short-circuits and electrical shocks to people. Almost every electric board contains protectors such as automatic circuit breakers and RCDs. However these devises will not protect against the consequences of transient over-voltages, since their reaction-time is much slower than the voltage peak that appears.

Typical protection strategies use Surge Protective Devices. These respond in nanoseconds to voltage peaks and are able to drive lightning current (main or secondary) to earth, safeguarding the connected equipment. However, it should be noted that these devices do

nothing to protect a structure against direct lightning strikes. Surge protection must be installed in conjunction with structural lightning protection.

Secondary light duty transient over-voltage protectors may be installed at individual workstations or computer cabinets, where inbuilt protection is assessed as inadequate. These protectors will give added protection against externally derived interference and will also protect against transient over-voltages created within a building.

Further information and guidance is available at:

http://www.riscauthority.co.uk/free-document-library/RISCAuthority-Library_detail.rc3-recs-for-loss-prevention-in-electronic-equipment-part-6.html - RC3 - Recs for loss prevention in electronic equipment - Part 6 (Guidance measures to protect electronic equipment installations from disturbances arising from power supply variations, electromagnetic radiation, electrostatic discharge, and electrical interference transmitted through power and communication lines)

Portable Electrical Equipment

All electrical equipment on a site must be included by the electrical test and inspection system, including portable appliances. This includes any equipment brought onto a site by employees or others, such as phone chargers, toasters, kettles, radios and electric heaters. However, employees should normally be prohibited, or as a minimum discouraged, from bringing their own portable equipment to the workplace. In hotels, portable appliances brought in by hotel guests are not required to be tested.

Portable appliance testing is mandatory in the UK (Electricity at Work Regulations) and some other countries.

All new portable electrical appliances should be subject to an initial visual check for damage.

Most electrical safety defects can be found by visual examination, which is an essential part of the examination, but some types of defect can only be found by testing.

Multiple extension leads should be avoided and it should be ensured that extension leads are not overloaded.

Further information and guidance, including scope and frequency of examination for portable appliances, can be found at:

http://www.hse.gov.uk/pubns/priced/hsg107.pdf - Maintaining portable electrical equipment

Electrical Maintenance Safety

Safe maintenance precautions for work involving electrical systems are essential to avoid harm to personnel and equipment damage.

BS EN 50110-1 defines “essential requirements (the five safety rules)” for ensuring that electrical installations are properly isolated for the duration of the work:

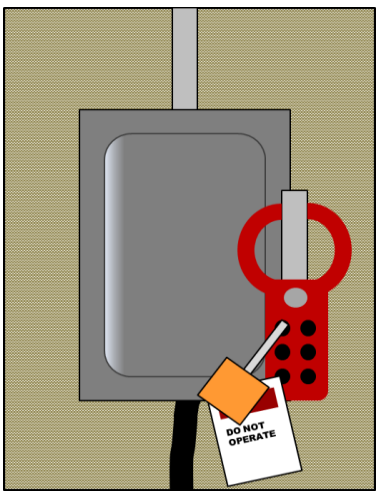
1. disconnect completely,
2. secure against re-connection,
3. verify that the installation is dead,
4. carry out earthing and short-circuiting,
5. provide protection against adjacent live parts.

This requires clear identification of the work location and the electrical installations that require isolation.

To implement good safety practice for electrical maintenance in commercial and industrial environments:

- Use a suitable permit to work systems with “lockout-tagout” (see below). There should be a system for monitoring or auditing the permits.
- Ensure that circuits are properly identified against electrical line drawings.
- Regularly inspect protective equipment, with records kept.
- Ensure that those working on electrical equipment are competent to do so, and maintain records of training and certifications.
- Ensure there is adequate working space, means of access and lighting in the area where the electrical equipment is being worked-on.
- Maintain comprehensive electrical maintenance records.
- Only undertake work on live equipment when there is no alternative and a safety review has been completed.

“Lockout-tagout” is used across industries as a safe method of working on hazardous equipment.



Folding scissors clamp for “lockout-tagout”

Correct application of “lockout-tagout” ensures that dangerous equipment is properly isolated and not able to be re-started prior to the completion of maintenance or servicing work. It requires that hazardous energy sources be "isolated and rendered inoperative" before work is started on the equipment that is being maintained. When the isolated power source is locked, a tag is placed on the lock identifying the worker who has fitted it, indicating that the power source should not be turned on. The worker then holds the key for the lock ensuring that only he or she can start the machine. This prevents accidental start-up of equipment while work is being completed. Typically, the power source is locked using a padlock and lockable hasp.

When two or more people are working on different parts of a larger overall system, the locked-out device is secured in the isolated position with a hasp that has multiple padlock holes capable of holding it closed. Each person applies their own padlock to the hasp. The locked-out equipment cannot be activated until all workers have signed off on their portion of the project and removed their padlock from the hasp.

The key and for each worker should be unique, i.e. no two keys or locks should ever be the same. A person's lock and tag must not be removed by anyone other than the individual who fitted the lock and tag.

Further information and guidance on electrical safety can be found at:

http://www.hse.gov.uk/electricity/index.htm - Electrical safety at work

http://www.hse.gov.uk/pubns/priced/hsg85.pdf - Electricity at work, Safe working practices

http://www.electricalsafetyfirst.org.uk/mediafile/100117573/Best-Practice-Guide-2.pdf - Guidance on the management of electrical safety and safe isolation procedures for low voltage installations

