NEWS

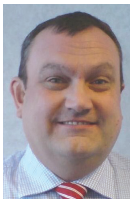
Welcome to the new-look Electrical Review where we will continue to provide you with the news, technology, comment and features you have come to expect, but in an updated design and on upgraded paper stock. If there are areas you would like to see covered in more depth or you would like to submit an article for consideration, we would be delighted to hear from you.

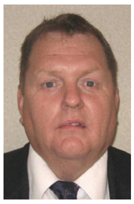
This issue features a special section on electrical flashover/arc flash, a subject which has previously received relatively little coverage in the UK engineering press but has been the root of many discussions with Electrical Review's readers. In the lead article of the section Mike Frain raises awareness of the dangers of flashover and the empirical research carried out in the US to predict the level of harm to electrical workers and bystanders: Many electrical staff routinely work on live high power equipment, carrying out tasks such as fault finding and diagnostic testing, without fully understanding the consequences of what will happen to them should an electrical flashover occur.

In the US the scale of the problem has been recognised by regulatory bodies and has resulted in the introduction of code 70E by the National Fire Protection Association (NFPA). Ross Kennedy believes this only addresses risk mitigation during the incident but does not address how to reduce the risk of the incident occuring. It is immediately clear from the editorials in this section that UK engineers and managers responsible for putting people to work on high power electrical systems can learn a great deal from US research on electrical flashover.

Elinore Mackay
Editor

PEOPLE


Steve Lea


Steve Malecki


Alan Denny

An aggressive plan to increase its share of the smart home and intelligent building technology market in the UK has been unveiled by ABB. At the heart of the plan is the launch of two new initiatives into the UK market to help boost awareness of the technology and the many benefits that it can bring. The first of these is the creation of an intelligent building team, which will provide customer service and sales support for ABB's range of open platform KNX/EIB products. Headed by **James Haigh**, general manager for ABB's low voltage products business in the UK, the six-strong team will provide support for both installers and key decision-makers involved in specifying the technology. It will primarily focus on the residential and commercial markets, which are estimated to be the two main growth sectors for smart building control technology up to 2012.

Balfour Kilpatrick, the multi services and power systems business of Balfour Beatty, announces the appointment of **Steve Lea** as area manager for Balfour Kilpatrick's South West operations, including the Bristol and Cardiff areas. Lea will report to West Region director Gordon Galletly.

Balfour Kilpatrick's East Region operations have been further strengthened with the appointment of **Steve Malecki**, area manager for the Leeds office. Malecki will report to Phil McGuire, regional director.

LEM SA, manufacturer of isolated current and voltage measurement components, has appointed **Alan Denny** as the new business development manager for its battery monitoring division. Denny brings LEM an extensive experience in the power electronics market. His professional career has included various technical and operational management positions and more recently he has worked as managing director for Europe & the Middle East and Africa with PK Electronics and was managing director with NDSL. Paul Van Iseghem, CEO of LEM said, "Alan brings outstanding credentials to LEM and will be a vital member of our team. His experience in the battery monitoring market will be invaluable as we continue to develop cutting-edge components that meet the needs of the most demanding applications." Based at LEM's headquarters in Geneva, Denny will focus on driving the business forward by developing a global network of channel partners who will integrate the LEM components into their own battery management systems.

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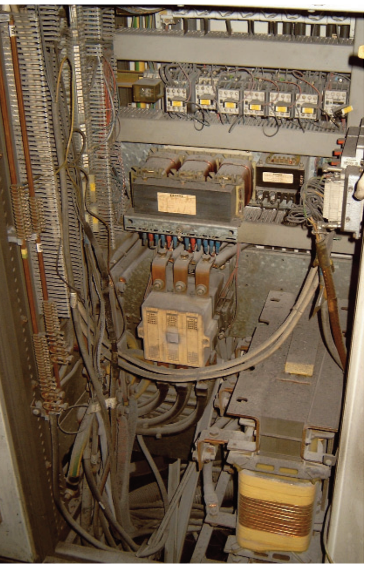
MIKE FRAIN LOOKS AT THE DANGERS OF LIVE TESTING AND FAULT FINDING IN INDUSTRIAL AND COMMERCIAL LOW VOLTAGE ELECTRICAL INSTALLATIONS

Electrical flashover Live proximity work in INDUSTRY



Example of a control panel showing mixed control and power circuits with bare copper busbars

IN ADVISING industrial and commercial companies on electrical safety rules and procedures, I make enquiries to every delegate on training courses about their own experiences. A good percentage have said that they have experienced electrical flashover (arc flash) and I have yet to meet anybody who has never received an electric shock. Most of us know it takes a very small amount of current flow through the body to cause death. Where death has not occurred this is due simply to the fortuitous nature of the current path in missing vital organs. What is required therefore to survive an electric shock from mains voltage is luck!

When someone is killed or injured by electricity what first comes to mind is electrocution but electric shock is not the only hazard. There are several hundred serious burn victims each year as a result of electrical flashover and is a source of long-term injuries and sometimes a slow and painful death. Many electrical staff routinely work on live high power equipment, carrying out tasks such as fault finding and diagnostic testing without fully understanding the consequences of what will happen to them should an electrical flashover occur. This article is written to highlight the dangers from electrical flashover and recent research to better understand its effects.

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LIVE WORKING

Live working is defined as "work on or near conductors that are accessible and live or charged". This is anywhere a worker is exposed to energised conductors, terminals, busbars or contacts and that often includes the removal of fuses and links. In industrial and commercial environments this usually means live diagnostic testing, faultfinding, non-invasive inspections such as thermal imaging and some tests in accordance with BS7671 Wiring Regulations. Even if it is intended to carry out work on dead conductors, an assumption should be made that they are still live until proven dead.

Whilst live connection work is routinely undertaken by utility distribution network operators (DNOs), any work that requires the connection and disconnection of live conductors and components in most industrial and commercial premises would be extremely difficult to justify.

Live working should never be accepted as the norm and Regulation 14 of the Electricity at Work Regulations 1989 makes clear three conditions must be met for live working to be permitted. These conditions are:

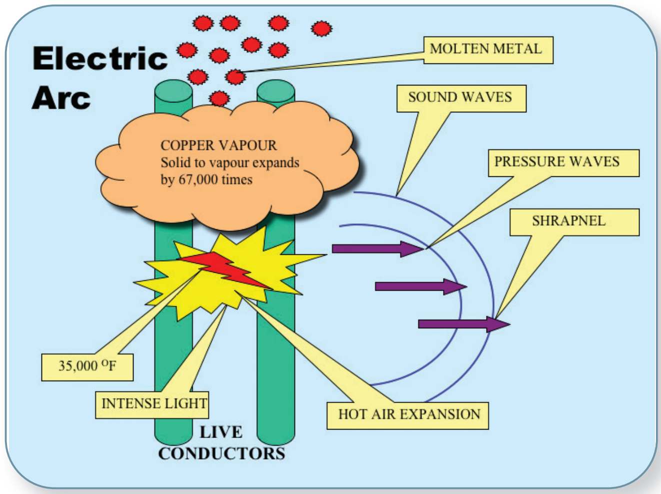
1. It is unreasonable in all the circumstances for the conductor to be dead
2. It is reasonable in all the circumstances for that person to be at work on or near that conductor while it is live
3. Suitable precautions (including where necessary, the provision of personal protective equipment) have been taken to prevent injury

If live working can be justified through the rigorous tests of reasonableness in conditions one and two, judgements must be made about suitable precautions against electric shock and the effects of electrical flashover to satisfy the requirements of condition three

ELECTRICAL FLASHOVER

Electrical flashover is usually caused by inadvertent contact between an energised conductor such as a busbar with another conductor or an earthed surface. This is often the result of incorrect use of test probes, faulty or poorly specified instruments or dropped tools and can be made more likely when the equipment is subject to condensation, dust or corrosion. The magnetic field from the resultant fault current will cause the conductors to separate or the tool to be blown back producing an arc, which ionises the air, making a conducting plasma fireball. Electric arcs produce some of the highest temperatures known to occur on earth and can be up to 35,000 degrees Fahrenheit, which is four times the surface temperature of the sun. This is enough to immediately vaporise all known materials and this sudden release of thermal energy at the point of the fault can cause severe burns to the skin, internal burns to throat and lungs due to inhaling vaporised metal or heated air, ignition of clothing, blindness from the resulting ultraviolet light and even death. The effects of the flashover can radiate several metres away from the point of the arc, injuring other people that might be nearby.

When an electrical flashover occurs, conductors can vaporise expanding to thousands of times their original volume and the



high release of thermal energy superheats and rapidly expands the surrounding air. The result can create a pressure wave called arc blast, which is literally an explosion. During this violent event, molten metal particles, destroyed equipment and related components will be ejected as shrapnel at speeds of up to 700 miles per hour.

LOW VOLTAGE POWER SOURCES

European statistics demonstrate that serious electrical accidents resulting from fault arcs occur mainly in low voltage power installations. Fault levels in many industrial and commercial networks can be surprisingly high and can lead to larger and more catastrophic flashover events. This does not necessarily mean you are safe working on systems that have lower prospective short circuit currents as at lower levels, overcurrent devices can operate more slowly allowing the arc to last longer producing a high overall amount of energy at the point of flashover.

The electrical utility industry adopts a rigorous task based approach to risk assessment of live working on low voltage systems and yet the fault energy in many cases is actually lower than can be found in some medium sized manufacturing plants. There are many instances of electrical installations that incorporate low voltage distribution transformer sizes of between 2MVA and 3 MVA as well as having generators and large motors that will contribute to total fault energy. At least one UK utility company (DNO) uses protective measures to cover 7,000A to 10,000A of arc current. In industrial processes and some commercial premises the amount energy that can be generated in an arc can be much higher than this, low voltage fault levels of 40,000A are quite common which will raise the level of arc energy.

NORTH AMERICAN RESEARCH

Experience shows many employers have no idea of the destructive nature of such fault energy should an incident be initiated by an employee. The difficulty has been that until recently there has been limited knowledge available to predict the amount of harm to a worker whose screwdriver or test probes slip whilst working in an energised control panel. Recent studies particularly in the United States have started to address this and there are now methods of calculating the amount of harm to workers and bystanders. This has enabled the North Americans to specify relevant work place precautions from flashover or arc flash hazard as it is commonly referred to. There are two US standards that apply to arc flash; NFPA70E-Standard for Electrical Safety in the Workplace and IEEE 1584- Guide for Performing Arc Flash Calculations.

As a very brief summary, the basis of the calculations relies on input data such as; fault level, voltage, gap between conductors, enclosure type, working distance, method of earthing and protective device characteristics. From this data, the amount of thermal energy from an arc can be determined that can reach a surface such as a person's skin. A figure of 1.2cals/cm2 is considered to be the energy required to produce the onset of a secondary degree burn and this is used as a benchmark for the need and type of PPE such as flame retardant clothing and the Flash Protection Boundary. The Flash Protection Boundary is defined as "An approach limit at a distance from exposed live parts within which a person could receive a second degree burn if an electrical arc flash were to occur." The IEEE 1584 calculation methods have been derived from actual laboratory experiments involving the simulation of electrical flashover events. There is ongoing research in the US into the arc flash hazard and a further $6million has been allocated this year. However, the effect of arc blast, which accounts for the pressure wave and shrapnel from a flashover, is still relatively unknown.

NEXT STEPS

You should make sure that you have written – and up to date – safe working practices to for people who carry out any work on or near low voltage electrical systems. The HSE guidance note HSG85 Electricity at Work – Safe Working Practices is an excellently written and valuable resource in this respect. It clearly sets out decision-making flowcharts on whether to work live or dead and also gives some guidance on live working procedures.

The ability to calculate flash protection boundaries will enable managers to arrive at better-informed judgements before allowing live proximity work to proceed in the first place and provide an ability to apply quantitative techniques to risk control. There is software available but only trained individuals should undertake arc flash calculations, as any study should take account of variables due to system configuration for example.

Finally, if you have influence over the design of electrical systems then a goal will be to eliminate the need to work live at all in maintaining those systems. Some of the measures that can be employed are the segregation of power and control circuits, safe control voltages and currents, finger safe shrouding of terminals and built in test facilities.

Mike Frain FIET MCMI is MD of Electrical Safety (UK), advising industrial and commercial organisations on electrical safety procedures. He has held senior management positions in contracting, utilities and facilities maintenance companies having direct responsibility for putting people to work on a full range of complex and large power electrical systems.

FURTHER READING

- ***HSR25 Memorandum of Guidance on the Electricity at Work Regulations 1989 (HSE books)***
- ***HSG85 Electricity at Work - Safe Working Practices (HSE books)***
- ***INDG163REV2 Five Steps to Risk Assessment (HSE books)***
- ***INDG 354 Safety in Electrical Testing at Work (HSE books)***
- ***GS38 Electrical Test Equipment for use by Electricians (HSE books)***
- ***Guidance on Safe Isolation Procedures for Low Voltage Installations (Electrical Safety Council)***