QMS Work Instruction
Electrical Work on Site

Power Conversion, Control and Data
Renewables and Industry

1 Competence

Only persons who because of their training and experience have adequate knowledge of electricity should be considered competent to carry out installation, commissioning, testing and fault finding on electrical systems. Where their technical knowledge and experience is not considered to be sufficient to enable them to do the work safely, they must be supervised by a competent person who has such knowledge and experience.

2 Planning

Plan ahead, recklessness with electricity can lead to injury, death and criminal charges.

Consider the following and review the plan if circumstances change.

1. Work to be done
2. Hazards of the system
3. Your ability and experience
4. Precautions to be taken
5. The system of work to be employed.

3 Risk assessment and permit to work

Before starting work, a risk assessment must be carried out and suitable control measures put in place, especially when live working is required.

Any permit to work systems at the Client site must be complied with at all times.

4 Dead working

All electrical work on electrical equipment must be carried out with the equipment dead unless the conditions for live working are satisfied.

4.1 Isolation

Ensure that equipment that is made dead cannot be inadvertently re-energised or dangerously charged by locking off isolators and removing fuses. If a fuse has been removed make sure it or a similar one can not be re-inserted by taking it away or locking the cabinet until work is complete.

4.2 Post notices

Put a notice or label at the place of disconnection indicating that someone is working on the isolated system. If several people are working on a job place “DANGER - LIVE” notices on equipment close to the place of work which is still live. All labels and notices MUST be removed when they no longer apply. They should have a space for the name of the person using it and date.

4.3 Prove dead

Before starting work prove that conductors are dead at the point of work, the test instrument should be proved immediately before and immediately after testing the conductor. Where possible use a separate live supply to prove the test instrument after proving dead, for instance a 13A socket. When testing for confirmation of a dead circuit, always assume conductors are live until they are proved dead. In the case of three phase systems, prove all supply conductors are dead. The use of multimeters which can be set to the wrong function are allowed for competent persons, but not recommended for proving dead. All instruments used for checking circuits should be maintained and inspected frequently.

4.4 Earthing

Earthing of circuit conductors is essential for high voltage apparatus (>650V) and stored energy equipment. The earthing conductors and their connections should be suitable for the energy which may flow in the event of a failure of the previous precautions. Earthing low voltage circuits is desirable if there is a risk of someone else being able to re-energise the conductors.

Adjacent Parts

When a circuit or equipment to be worked on has been made dead it may still be necessary to protect against inadvertent contact with other live parts nearby. This should preferably be done by the erection of physical barriers and/or the use of temporary insulation. There must be adequate working space and adequate lighting. There should be adequate head room, no tripping hazards and no obstructions which could restrict a persons movements. At least 1m clear working space is recommended from parts live at 400V. The space should be at least 1.5m if there are live parts on both sides.

Extra precautions for high voltage / high power work

Arcing across an air gap (arc flash) is a significant risk for equipment operating at voltages above 650V or at lower voltages where the available short circuit power is such as to give risk of a serious burns injury or in extreme cases death. In these situations it is not necessary to touch live parts in order to suffer a burn or a shock. In these situations earthing of conductors at the point of disconnection of supply is essential and additional earths may be required at the point of work. The system of locking off while work is in progress should use safety locks which have unique keys. Precautions should be backed up by following a customers disciplined written permit to work system.

Live working

To work on or near live conductors the following three statements MUST apply:

1. It must be unreasonable for the circuit to be dead.
2. It must be reasonable in all circumstances to work on or near the equipment whilst it is live.
3. Suitable precautions must be taken to prevent injury.

Live working includes live testing.

Live circuits should only be worked upon if the work cannot be carried out dead, it is likely that this will apply to some forms of electrical testing and commissioning. Once testing is complete any repairs to faults or modifications to circuits should be carried out dead. If the conditions for live working are satisfied minor changes to control circuits of 110V ac and below, fed from control supplies, are permitted following the guidelines below.

Competence

Live working must only be carried out by people adequately trained and experienced in the type of live work being undertaken. They must understand the task and be able to recognise any deterioration in the state of the equipment or departures from agreed procedures. They should have the self discipline to recognise their own limitations and must seek assistance with work which may be outside of their area of competence.

Precautions before starting live work

If any of the following conditions are not satisfied it is likely that it is unreasonable to work live.

Suitable tools and test equipment

Ensure that suitable properly insulated tools are available and used. They should have insulation which is robust enough to be proof against mechanical damage. These tools should be inspected frequently by a suitably competent person. They should be destroyed if the insulation is damaged.

Ensure that test instruments should have insulated probes and fused leads (see guidance note GS38).

Temporary barriers

Installing temporary insulation or protective barriers where necessary to avoid the possibility of anyone touching parts at dangerously different potentials at the same time.

Adequate working area

Ensure that the working space is adequate with sufficient head room, no tripping hazards and no obstructions which could restrict a persons movements. At least 1m clear working space is recommended from parts live at 400V. The space should be at least 1.5m if there are live parts on both sides.

Ensure the work area has adequate lighting.

If work is carried out near rather than on live equipment ensure that appropriate and adequate safety clearances are established and maintained.

Control of access

Determine how to control the area to ensure that those who are not competent to work on live systems are not permitted into the area. If the person undertaking the work is continuously present while danger exists from live conductors, and the area is small enough to be under his constant supervision and control, then further precautions to control access may not be necessary. If, however, the area is too large for the person to exercise effective surveillance, or he is not continuously present, then effective control will need to be secured by other means. These may be the provision of lockable enclosures or barriers, red striped tape and warning notices indicating the presence of live conductors. If necessary ask the customer to provide barriers. Ensure that all unauthorised persons are kept out of the barriered or restricted areas.

Adequate Information

Ensure that adequate information is available to the person carrying out the work about the live conductors involved, the associated electrical system and the foreseeable risks.

Accompanying person

HSE advice is that if an accompanying person would substantially contribute towards the implementation of safe working practice then he should be present. Implementing safe working practices encompasses being able to carry out the work safely and preventing unauthorised access. If an accompanying person is required that person must be able to recognise danger, isolate the supply and give first aid. If there is a risk of electrical shock, evidence shows that prompt disconnection of supply and first aid is a significant factor in survival. If a control panel does not meet EN60204, the company does not allow lone working whilst the panel is live. As a guide panels with insulated conductors, shrouded terminals and segregated power and control circuits generally meet EN60204.

Precautions during live working

Switching on isolators

When switching on isolators on high energy supplies, particularly above 200A, make sure that the control cabinet door is closed. Faulty components can result in arc flash and explosions of molten metal, which can cause serious injury. Doors containing high power incoming switches or circuit breakers should be kept closed at all times except during initial commissioning or diagnostic activities.

Personal protective equipment (PPE)

The wearing of safety rated protective spectacles is compulsory when, on behalf of the company, individuals are attending machinery or operating in an industrial environment.

Good working practices

Horizontal surfaces and projections inside control cabinets should not be used for temporary storage of tools and other equipment. Make sure that tools and other equipment are never placed where they might fall on to live busbars or other equipment.

Ensure that all equipment is completely covered before activities such as drilling or filing on metal components to prevent future short circuits and failure of equipment due to ingress of swarf.

Mobile phones and radio equipment

Do not use mobile phones or walkie-talkie radios close to open control cabinets containing drives or other electronic equipment. Such equipment may mal-function which could cause a hazard.

Test instruments

Failure of a test instrument when measuring high power circuits could result in serious injury due to arch flash and explosion. Prior to measurement, test equipment and associated leads must be subject to a visual inspection. Damaged test equipment or test leads must be marked and not be used under any circumstances.

All test instruments should be in accordance with HSE guidance note GS38, key points from this guidance are:

Test probes:

- Should have finger barriers or be shaped to prevent accidental hand contact with live conductors under test.
- Should be insulated leaving an exposed metal tip not exceeding 4mm measured across any surface of the tip. Where practicable this should be reduced to 2mm or less, or spring loaded retractable screened probes should be used.
- Should have suitable high breaking capacity (hbc / hrc) fuse or fuses, with a low current rating (usually not exceeding 500 mA) or a current limiting resistor and fuse.

Leads:

- Adequately insulated
- Coloured so one lead can easily be distinguished from the other
- Flexible and of suitable capacity for the duty expected of them
- Sheathed to protect against mechanical damage.
- Do not have accessible exposed conductors, other than the probe tips and do not have live conductors accessible to a persons finger if a lead becomes detached from a probe, indicator or instrument when in use.

References

- Opus Design Services PL007 Electrical Safety Policy
- Guidance Note: Electricity at Work Regulations 1989, HSE: HSR25.
- Electricity at work Safe Working Practices, HSE: HSG85.
- Guidance Note Electrical test equipment for use on low voltage electrical systems, HSE: GS38.