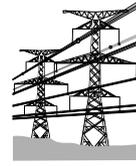




HIGH VOLTAGE TRAINING



SUBSTATION ACCIDENT: A CASE STUDY

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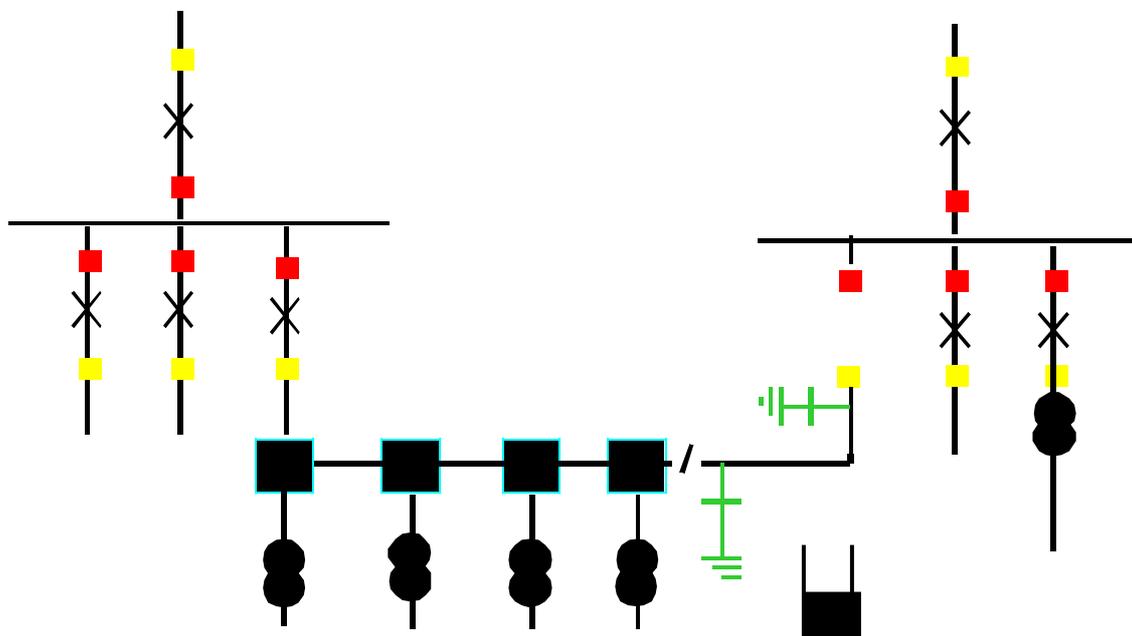
Introduction

An Authorised Person received an electric shock and was badly burned when testing for voltage, at the back of an isolated 11kV circuit breaker, in a substation. The Authorised Person died three days later in hospital from the injuries he sustained in the accident. His assistant survived the incident, escaping with burns to his hands, face and upper body.

This paper is a case study and looks at the incident, causes and what could/should have been done to prevent the accident.

Sequence of Events

An Authorised Person had to isolate an 11kV cable, in order to cut in a new mini substation (MSS), between a substation (S/S) and a MSS. He had already Switched, Isolated, Tested and Earthed the cable on both sides correctly.



A risk assessment had been conducted and a work permit issued, in accordance with the company's rules and regulations.

Definition of Work Permit: Written authorisation for work to be carried out on electrical mains or apparatus.

The circuit breaker (CB) had integral earthing and had been tested and placed in the earth position, locked off and a danger tag applied. During the course of the work, the Authorised Person had to remove the back cover of the panel (cable end box), in order to disconnect the 11kV cable.

The Authorised Person chose to identify the correct back cover to be removed by counting the number of breakers in from the **LEFT** hand side.

He walked around the back of the panel, from the right and counted the breakers from the **RIGHT** hand side, instead of the left. The Authorised Person also checked the label on the back of the panel to confirm that he was at the correct breaker. Unfortunately, this cover was a removable cover and had been incorrectly replaced on the wrong panel from a previous job that had been done.

As the cable was earthed at the MSS and the circuit breaker at the front of the panel by integral earthing, the Authorised Person decided that it was not necessary to wear a flash suit when removing the back cover and testing.

He removed the back cover and decided, as an extra safety precaution, to safety test the conductors before removing the tape from the conductors. He decided to use a live tester to penetrate the insulation before removing the tape for safety. However, instead of using an approved medium/high voltage live tester, as required in terms of the company's regulations, he picked up a low voltage multimeter to test for the presence of voltage.

He also enlisted the help of his assistant to hold the multimeter, whilst he tested the conductors. The assistant was not wearing any special PPE (flash suit). On penetrating the tape, there was an explosion, causing third degree burns to 80% of his body and his assistant sustained burns to his hands, face and upper body.

Cause of the Incident and Injury

- The cover on the back of the panel had been replaced on the wrong panel the last time that work had been carried out.
- The Authorised Person counted from the wrong side, when he went around the back of the switchgear.
- The Authorised Person used the wrong tester to test that the cable was dead.
- The Authorised Person was not wearing a flash suit whilst testing that the cable was dead.
- The Authorised Person allowed his assistant to work too close to the cable, without wearing adequate PPE (flash suit).

Root Cause

The wrong cover plate was removed, exposing the workers to live 11kV conductors. He counted from the wrong side and used a low voltage multimeter to test the live 11kV cable.

Contributing Factors

- The Authorised Person had not taken all the risks into account when conducting the risk assessment, nor had he explained the dangers and hazards of the task to his assistant.
- He did not follow the correct safety rules and operating regulations.
- He was not fully concentrating on the job in hand.
- He was late in performing the planned switching operations and was pressurised by other staff, waiting for him to finish, so that they could work on the cable.
- No flash suit was worn.

Conclusions

In the ensuing investigation, it was found that the Authorised Person's mind was not on the job, as he had had an argument with his wife, before leaving for work that morning and was late in isolating the cable. He was pressurised by staff, waiting to work on the cable and did not follow the correct procedure, in order to get the work done. He rushed the job and picked up the wrong tester (low voltage multimeter) to test the 11kV cable. He failed to wear a flash suit and did not make sure that his assistant was safe, by allowing him to work too close to the back of the panel without the required PPE.

Remedial Action

- All existing circuit breaker panels, in all substations, to be checked to make sure that they are labelled correctly and in the correct manner, in terms of the company's regulations, i.e. panels should be labelled on the front, back and top of the panel and where possible, on non-removable covers.
- A standard operating procedure (SOP) needed to be compiled, stating the correct safe procedure to remove the back cover and test the cable, before removing the tape.
- Training needed to be provided, on the above SOP, to all staff required to remove such covers.
- It was decided that an insulated rod or pole should be held on the front of the panel, that would be visible from the rear of the panel, as well as the other identifying method used in this incident.
- It was also decided that, if it were required to test 11kV conductors in a similar situation, before the tape is removed, they shall be tested using a proximity tester.
- The tester should be fixed onto an approved insulating rod of the correct voltage rating, maintaining safety clearance and an approved flash suit shall be worn.
- All conductors are to be discharged, using an approved single pole discharge device, before attempting to remove the tape, after confirming that they are dead.
- All panels are to be painted different colours to indicate their function i.e. **RED** for a Ring and **BLUE** for an Incomer (this can also assist with identification).
- In order to maintain safety, it is essential that a risk assessment exists for each task.
- A risk assessment (Take 5) must be carried out at all work sites, over and above the general risk assessment, as the risk changes at each work site, although the task remains the same.
- Risk assessments to be reviewed to ensure that they cover all areas (include Hierachy of Control), training to be conducted.
- It is a misconception that PPE is the first line of defence, in fact it is the last! Therefore, staff are to be trained on Hierachy of Control to ensure safety of personnel.

Hierarchy of Control

Most effective means of control	Elimination
	Substitution
	Separation
	Administrative Control
Least effective means of control	Personal Protective Equipment (PPE)

Elimination	Whenever possible, eliminate the hazard. Eliminating the hazard eliminates the risk.
Substitution	When eliminating a hazard is not practical, consider substituting a less hazardous alternative. For example, you might replace a noisy machine with a quieter one.
Separation	Isolate the hazard with mechanisms such as isolation and lock out, machine guards, barricades or interlock.
Administrative Control	Develop controls such as safe work procedures and improving operator skills (training).
Personal Protective Equipment (PPE)	This is the least effective risk control. The use of PPE alone is not adequate and must be supported by one of the controls above.

- All safety rules and operating procedures to be reviewed, updated and monitored regularly.
- Enforce discipline at the work site.
- Ensure compliance with rules and regulations.
- It is essential to comply with the OHSAct and to follow company safety rules and operating procedures. This is not only a legal requirement, but can also prevent damage to equipment, prevent injury to personnel and save lives.
- Full flash suits must be worn when testing for zero potential and during all MV/HV operations and other staff to stand away, in such a position that they cannot be injured by an explosion.
- Training MV/HV Operating must be conducted and reviewed every two years (refresher courses conducted).

General

You should always consider what can go wrong and what will be the consequences. In this situation, what voltage am I testing and what safety precautions do I need to take?

Always use a reasonable man approach; always ask yourself - would I let my 16 year old son or daughter do the job? If the answer is no, then why should I do it, or ask someone else to do it. It must be remembered that for every action there is a reaction.

No operating condition or urgency of service can ever justify endangering the life of anyone.

Remember - Safety before Production, NOT Production before Safety! There is no substitute for safety.

Abbreviations Used

MSS = Mini Substation.
S/S = Substation
PPE = Personal Protective Equipment.
CB = Circuit Breaker
MV = Medium Voltage
HV = High Voltage
SOP = Standard Operating Procedure
OHSAct = Occupational Health and Safety Act

Definitions

LIVE TESTER: A tester designed to make physical contact with the conductor under test, in order to determine if the conductor is live or dead.

PROXIMITY TESTER: A tester designed not to make physical contact with the conductor under test, to determine if it is live or dead (generally only used above 6.6kV and on overhead lines).

INTEGRAL EARTHING: Method of earthing, built into the equipment, as part of the manufacture of the equipment.

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