SUBSTATION EXPLOSION
BARRY GASS
ACTOM PROTECTION & CONTROL
SUBSTATION EXPLOSION
INTRODUCTION

An authorised person closed an 11kV Oil Circuit Breaker (OCB) onto a fault at a substation.
The OCB exploded and the force of the blast blew off the substation doors, seriously damaging the building.
The authorised person broke his right arm, when the door behind which he was standing was blown open.
The fire that followed destroyed all the equipment within the substation. *
One of the cables feeding a Mini Substation (MSS) developed a fault and the OCB tripped.
The electromechanical relay protecting the cable did not flag.
No cause was found for the OCB to trip, so it was decided to close the breaker.
## HAZARD IDENTIFICATION AND RISK ASSESSMENT

### TASK TO BE PERFORMED:

- New hazard identified: YES, NO
- Does Risk Assessment already exist? YES, NO
- Risk Assessment Name & No:

### HAZARDS

<table>
<thead>
<tr>
<th>ELECTRICITY</th>
<th>NOISE</th>
<th>PEOPLE ABOVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIRE / HEAT</td>
<td>DUST</td>
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</tr>
<tr>
<td>MACHINERY</td>
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<td>SLIP AND FALL</td>
<td>WEATHER</td>
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</tbody>
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### OTHERS:

**WHAT ACTION DID YOU TAKE TO ELIMINATE / CONTROL THE HAZARDS IDENTIFIED?**

(Elaboration: Substitution / Isolation / Engineering / Administration / PPE)

1: 
2: 
3: 
4: 

### COMPLETE THE FOLLOWING QUESTIONS

- **P** = Which PPE do you need for this specific task?

- **A** = Did you inspect your work area? List your concerns.

- **E** = Are you using the correct tools for this task? List the tools.

- **T** = Did you lock out? (Are you sure it’s safe / who were involved?)

- **S** = Did you discuss the risk assessment / do you have to revise / compile a new risk assessment? What should be added?

### Signature:

Name(s): 

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**Constable 11437**
NO ELECTRICAL CLOSING
LANYARD APPLIED
TAKE 5
FLASH SUIT

HAZARD IDENTIFICATION AND RISK ASSESSMENT

<table>
<thead>
<tr>
<th>Responsible Person:</th>
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<tr>
<td>Date:</td>
<td>Time:</td>
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<tr>
<td>DEPARTMENT:</td>
<td>SECTION:</td>
</tr>
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<td>OPERATION:</td>
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OTHERS:

**WHAT ACTION DID YOU TAKE TO ELIMINATE / CONTROL THE HAZARDS IDENTIFIED?**

Elimination / Substitution / Isolation / Engineering / Administration / PPE

1:
2:
3:
4:

**COMPLETE THE FOLLOWING QUESTIONS**

For more detailed info check cover page

P = Which PPE do you need for this specific task?
A = Did you inspect your work area? List your concerns.
R = Are you using the correct tools for this task? List the tools.
T = Did you lock out? (Are you sure its safe / who were involved?)
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Name(s): Signature:
As an added precaution, the authorised person decided to wear a flash suit.

Another electrician, who was present, stood further away, as he was not wearing a flash suit.
The explosion blew off the main central doors of the substation, through a metal link fence, ending up about 20 metres away.
The authorised person broke his right arm, when the door behind which he was standing was blown open.
The fire that followed destroyed all the equipment within the substation.
The OCB was closed onto a fault and did not trip, due to mechanical failure.

The oil vapourised and the OCB exploded.
SPLIT TANK
SUBSTATION EXPLOSION
CONTRIBUTING FACTORS

• The age of the OCB.

• Lack of maintenance.

• The electromechanical relay did not flag, indicating the original cause of the fault.
SUBSTATION EXPLOSION
CONTRIBUTING FACTORS

The risk assessment only took into account the danger of arc flash and not the power released by the OCB exploding.
The OCB was closed onto a fault.

The electromechanical relay sent a trip signal to the circuit breaker, but it failed to trip, probably due to lack of maintenance.

As the breaker was an OCB, it was more susceptible to fire and explosion.
SUBSTATION EXPLOSION
ACTION

All existing circuit breakers to be fitted with remote operating devices, to allow operation outside the substation.
All general risk assessments must be reviewed, especially where OCBs are presently used, to include strategies to mitigate the risk of explosions.
• Controls must be put in place and applied.

• Procedures to be revised accordingly and all operating staff (authorised persons) trained on them.
SUBSTATION EXPLOSION
ACTION

- Regular maintenance to be carried out on all switchgear.

- A maintenance schedule to be compiled and complied with.
Old OCBs to be replaced with new Vacuum Circuit Breakers (VCBs) or Sulphur Hexafluoride (SF6) breakers.

A replacement schedule to be compiled and monitored.
SUBSTATION EXPLOSION ACTION

- All circuit breakers to be trip tested once a year.

- Relays to be secondary injected and calibrated every two years.
A mini-risk assessment (Take 5) must be carried out at the work site, over and above the existing general risk assessment.

The risk changes at each work site, although the task remains the same.
Medium/High Voltage (MV/HV) operating training must be conducted and reviewed every two years (refresher courses conducted).
Employer shall provide:

- Information
- Instruction
- Training
- Supervision
Full flash suits must be worn when racking in or out a circuit breaker, spring charging and any other local operations,
including tests for zero potential and live electrical phasing.
Personnel to stand away from any open door and in such a position that they cannot be injured by the blast from an explosion or from doors being blown open.
Batteries and battery chargers to be maintained and calibrated.
Batteries to be load tested on entry into substation, if load test facilities exist.
MANUAL BATTERY TEST MAX 5 SECS

BATTERY VOLTAGE

CHARGER CURRENT

Voltage Gauge: 30 V

Current Gauge: 2 A
The question is - how many times can you close a circuit breaker after a fault?
There is no definitive answer to this question, as there are so many variables:
• How old is the breaker?

• When was the breaker last maintained?

• How many times has the breaker tripped on fault since the last maintenance was carried out?
What protection scheme is installed on the circuit breaker?

When was it last tested?
What is the insulating medium?

If it is an OCB, what is the condition of the oil?
The insulating properties of the oil and its flash point are reduced after a fault current passes through it.
It is a misconception, that, if the circuit breaker or MSS is vacuum or SF6, an explosion will not occur during operation.
In fact, if the integrity of the SF6 or vacuum is lost, the operator is opening/closing the circuit breaker/MSS in air and a flashover could ensue.
When operating with SF6 filled equipment, the authorised person must always check the SF6 gas level on the gas pressure gauge (if one exists).
The flash suit provides protection for arc flash and will give the operator little physical protection against the force of a blast; therefore, remote tripping must always be the first option, before resorting to PPE.
When looking at flash suits, it is important that the correct type and cal rating is selected (a low voltage flash suit, for example, is not suitable for use on Medium or High Voltage).
All other staff in, or working in the vicinity, should move away to a reasonable distance whilst operating is being carried out.
It is also important to call the relevant Control Centre when entering substations, so that they do not operate switchgear remotely, via Supervisory Control And Data Acquisitions (SCADA), whilst the operator is in the substation.
Nowadays, circuit breakers can be designed to have arc spaces in the switchgear, so that the breaker must be opened, closed, racked in or out with the door closed and any explosion contained in the chamber.
Protection systems have also become more sophisticated and faster.
However, the clearance time is still dependent on the actual circuit breaker tripping time.

If the fault is not cleared quick enough then SUBSTATION EXPLOSION GENERAL
REMEMBER

NO OPERATING CONDITION OR LOSS OF SUPPLY CAN EVER JUSTIFY ENDANGERING THE LIFE OF ANYONE
THANK YOU

- Barry Gass
- Training Manager
- ACTOM Protection and Control
- Tel: 011 820 5299
- Cell: 083 251 4755
- Email: barry.gass@actom.co.za
- Fax: 011 820 5387