



Operation and maintenance of oil-filled HV combined-fuse switches

In April 2014, EnergySafety published Guidelines for the safe management of high voltage electrical installations. The purpose of the document was to provide advice to 'responsible persons' for premises with high voltage (HV) electrical installations.

The following information adds to these guidelines and provides further advice to operators and 'responsible persons' for installations with HV equipment. It must be read in conjunction with the guidelines. While it focuses on oil-filled HV switchgear, the importance of knowing your assets and ensuring they are being maintained and operated within their original design conditions cannot be overstated.

Background

Although electrical switchgear is generally reliable and performs well, failures, when they occur, may be catastrophic. Problems can arise due to poor selection or incorrect settings of protection equipment, lack of adequate maintenance or operation of the switchgear outside its design limits. While the switchgear may have been originally adequate for the load and fault current at the time of its installation, over time, expansion in plant and machinery may push it closer to, or even outside, its limits. This may cause the electrical equipment to be unable to cope with the resulting electrical and thermal stress and lead to catastrophic failure. Failure of oil-filled switchgear and/or oil immersed HRC fuses may result in arc flash and/or burning oil, leading to serious injury, death or major property damage.

Many oil-insulated HV switches are owned and operated by private owners, with unknown histories of preventative maintenance. Many such switches are likely to have up to 40 years of service. The switches may no longer be manufactured and, in some cases, spare parts may be difficult to obtain or unavailable.

Audit of existing assets

Those responsible for HV assets should keep an up-to-date record of all components of the electrical distribution system at their premises. This includes:

- drawings of the electrical distribution system, including electrical switchgear, its locations and fault levels at all relevant points;
- details of equipment such as manufacturer, model, serial number, year of manufacture, date of installation, voltage, current and short-circuit ratings and details of the operating mechanism;
- details of maintenance performed on all HV switches;
- any modifications carried out;
- up-to-date protection settings and high rupture capacity (HRC) fuse size selections; and
- an engineering review of the electrical distribution system to confirm that equipment is not being pushed outside its original design parameters, especially in cases where additional plant and machinery have imposed increasing electricity demand over the years.

Restricted operation of oil-filled hv combined-fuse switches

HV switches must be operated only by competent persons authorised by the responsible person and, where required, by the network operator. Switching operators shall only operate switchgear for which they have been trained (refer to Section 4 of the Guidelines for more details).

EnergySafety recently issued Inspector's Order No. 02-2015 restricting certain work practices on ALL oil-filled combined-fuse switches. The Order requires that:

1. Where a fuse has or may have operated in a HV oil-insulated combined-fuse switch:

- no person shall commence any electrical work on it, including operation of the switching or earthing mechanisms or opening the lid, until it is first completely isolated from the electricity supply;
- owners and operators of any such switch shall not permit any person to commence any electrical work on it, including operation of the switching or earthing mechanism or opening the lid, until it is completely isolated from all sources of electricity; and
- switches worked upon must remain isolated until all work is completed and the tank lid closed.

2. Where no fuse has operated but routine maintenance is to be carried out on HV oil-insulated combined-fuse switches:

- the switch mechanism may be switched off and earthed but no person shall open the tank lid until the switch unit is first completely isolated from the electricity supply;
- owners and operators of any such switch shall not permit any person to open the tank lid until the switch unit is completely isolated from all sources of electricity; and
- switches worked upon must remain isolated until all work is completed and the tank lid closed.

3. Normal switching operations may proceed as and when required, provided there is no evidence of fuse operation.

The HV switches affected by this Order include ALL oil-insulated models designed to permit fuse changes while parts at the bottom of the tank remain energised. Some of the known brands are:

- Long & Crawford Ltd.
- GEC Alstom T & D Switchgear Ltd.
- Hawker Siddeley Switchgear Ltd.
- W Lucy & Co Ltd.
- Merlin Gerin Ltd.
- Reyrolle Switchgear Ltd.
- Whipp & Bourne Ltd.

Post-fault operation of oil-filled HV combined-fuse switches

All HV fuse operations should be fully investigated. Any operation of a HV fuse implies a fault has occurred or a near-overload has persisted, indicating that it may be dangerous to open the switch involved unless it is first isolated. Fuse replacements should only be conducted once the equipment has been completely isolated and only after the cause of the failure has been identified. Do not replace any fuse until the cause of the fault is known and has been addressed.

The choice of fuse in a fuse-switch combination for a transformer protection application must satisfy specific criteria. Switchgear manufacturers supply a list of fuses suitable for their equipment (brand, types and ratings) for each type of application. Where these recommendations are not followed, the electrical protection may be inadequate, or safety compromised for particular operating conditions or faults. If fuses are incorrectly selected, they may trip for normal operating loads.

HRC fuse elements can be damaged through mishandling during transportation or deteriorate with age while in service. When replacing HRC fuses, low resistance testing or ductor testing of the fuses should be undertaken to ensure the resistance range is within manufacturer's specifications and all three phase fuses have matched fuse characteristics.

HRC fuses can shatter if the fuse cartridge overheats while attempting to clear a low level fault current or overload current, near to its minimum breaking current. The striker pin, designed to trip the switchgear, may fail to operate.

Operators of HV oil-insulated switchgear must have operating procedures which ensure operators do not switch or access fuse chambers if there is the possibility of a shattered fuse inside and they are exposed live parts inside the oil tank.

A big risk to switching operators occurs if a switch-fuse unit is single-phasing. Single-phasing may indicate the striker pin or the switchgear tripping mechanism has failed or the fuse has shattered. In such cases, the switching and earthing mechanisms must not be operated until the unit has been isolated from all sources of electricity.

The same level of risk occurs if two fuses have operated and the switchgear has not tripped. The combined-fuse switch should not be operated. In any event, accessing the fuse chamber should not be undertaken unless the switchgear has been completely isolated.

Maintenance of oil-filled HV switches

All switchgear should be maintained routinely and in accordance with the manufacturers' instructions. Prior to starting any work on the equipment, the switch has to be isolated and earthed.

Typical maintenance should include, but not limited to:

- cleaning of the internal mechanism, contacts and the whole of the interior of the oil tank;
- removing all foreign material (if any) from the tank;
- replacing the existing insulating oil with new;
- refurbishing or replacing contacts as appropriate;
- replacing seals and gaskets;
- adjusting mechanisms;
- testing the low resistance of the HRC fuses; and
- where fitted, testing electrical protection periodically and, where necessary, after a fault operation.

In many cases, sufficient technical expertise may not be available in-house to carry out the maintenance. Whoever is contracted to carry out maintenance work on the switchgear must demonstrate that he or she is conversant with the particular type, model or brand of equipment involved.

Inspection and maintenance should be carried out immediately following any operation of a HV fuse.

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