

**RISK ASSESSMENT FOR OVERHEAD LINE FEEDER CIRCUITS IN GAS-INSULATED SWITCHGEAR (GIS) SUBSTATIONS****PURPOSE AND SCOPE**

This document provides guidance on risk assessment for the use of delayed auto-reclose (DAR) on overhead line circuits where part of a gas-insulated switchgear (GIS) substation falls within the line protection zone.

**PART 1 –PROCEDURAL****1 INTRODUCTION**

Where an overhead line circuit terminates at a substation with gas-insulated switchgear (GIS), it is usual for a length of GIS to fall within the line protection zone. In such cases, an internal fault within the GIS would normally result in a trip and delayed auto-reclose (DAR) operation, in the same way as a fault on the overhead line. In contrast to the overhead line, however, the application of DAR to GIS is of no benefit. The insulation system of the GIS is largely non-self restoring and the auto-reclose operation is likely to result in re-application of the fault. This in turn increases the risk of burn-through of the GIS enclosure due to internal arcing.

Due to the increased risk of enclosure burn-through, consideration should be given to inhibiting the DAR. Inhibition of the DAR does, however, entail significant costs and may be avoided where the risks of doing so can be demonstrated to be acceptable by site-specific risk assessment.

GIS enclosures are required to withstand internal arcing as follows [1]:

- a) For the duration of the main protection fault clearance time: No external effect other than possible operation of the pressure relief device
- b) For the duration of the back-up or circuit-breaker fail protection fault clearance time: The resulting effect to be limited to operation of the pressure relief device or the appearance of a hole, provided there is no ejection of fragmented parts

It follows that where the GIS is subjected to DAR, the probable re-application of a fault and consequent longer duration of internal arcing must be taken into account.

Normally, a fault will be cleared within the fault clearance time of the main protection of 140 ms at 400 kV and 160 ms at 275 kV [2]. The auto-reclose operation will then re-energise the circuit from one end initially. Where re-energisation results in re-application of a fault, the circuit will be cleared within 80 ms either from the unit protection or from the 'switch onto fault' facility of the distance protection. Where a GIS enclosure cannot withstand internal arcing for the total duration of the main protection fault clearance time for the first and second applications of the fault, the use of DAR will not be acceptable.

Where the enclosure can withstand internal arcing for the total duration of the main protection fault clearance time for the two applications of the fault, the risk of burn-through is associated with the scenario where a successful fault clearance and automatic re-closure is followed by failure of both main protections or circuit-breaker failure since either of these will result in a longer fault clearance time.

Where both main protections fail to clear the re-applied fault, it will be cleared by back-up protection, typically in a time within the range 0.5 to 1.0 s. If a circuit-breaker fails, the fault will be cleared by back trip of adjacent circuit-breakers, typically in a time of up to 300 ms. It is credible that an enclosure would fail to withstand internal arcing for the combined duration of main protection and back-up or circuit-breaker fail protection fault clearance times.

Burn-through of the enclosure under the above conditions is the subject of the risk assessment described in the next section. Generic values for quantities that may be used in risk assessments are given.

Note that if the initial fault is cleared by back-up or circuit-breaker fail protection, automatic re-closure will not occur. It should also be noted that where a fault within GIS is cleared by back-up or circuit-breaker fail protection, there is still a risk of enclosure burn-through when not subjected to a re-close operation.

## 2 METHODOLOGY

The methodology to be adopted in deciding whether a section of GIS falling within an overhead line protection zone may be subjected to DAR is shown in Figure 1.

It should first be established whether the GIS enclosure can withstand internal arcing for the total duration of the main protection fault clearance time for the first and second applications of the fault, with no external effect other than possible operation of the pressure relief device. Information on internal arcing behaviour will be provided by the supplier at the time of type registration. Where the enclosure cannot meet the above condition, it will not be acceptable to subject the GIS to automatic re-closure. The DAR must be inhibited or not used at all in such cases.

Where the enclosure can withstand internal arcing for the total duration of the main protection fault clearance time for the two applications of the fault, the acceptability of subjecting the GIS to DAR may be based on a site-specific risk assessment. In performing the risk assessment, the following simplifying and pessimistic assumptions can be made:

- a) On re-closing, the arc will restrike and cause a second fault at the same point in the enclosure as the first
- b) The enclosure will burn through unless the second fault is cleared by the main protection.

Two scenarios will be considered for risk assessment. The first of these considers the area around the switchgear, such as within the switchhouse of an indoor substation, while the second is concerned with long lengths of GIS, such as cross-site connections.

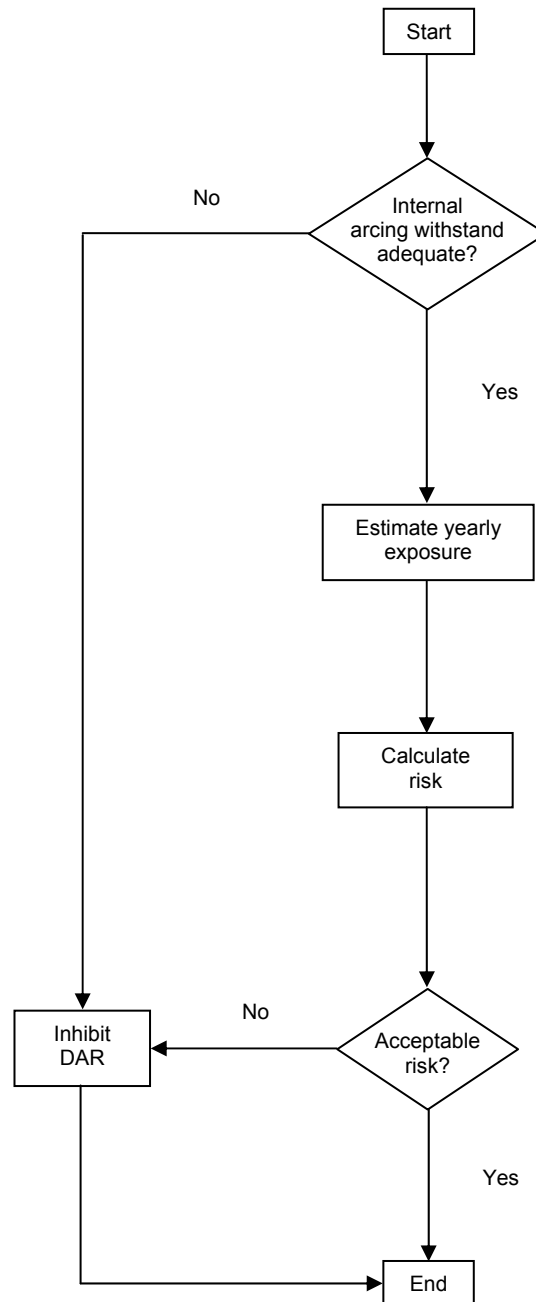


Figure 1 - Flow Chart For Risk Assessment