electricity north west

Bringing energy to your door

Electricity Policy Document 321

Issue 4 May 2023

Policy for Automatic Reclosing of 33/11/6.6kV Overhead Lines

Amendment Summary

ISSUE NO. DATE	DESCRIPTION
Issue 4 **May 2023**	Document updated to latest template New definition for FLISR added Updated a sentence on SEF in section 4.3 Updated reference to CP14 to become CP314 in section 4.3 Replaced the use of ARS with FLISR in section 6 Updated documents referenced from CP14 to CP314 Added a new description of the document based on above changes Prepared by: Simon Rushton Approved by: Policy Approval Panel and signed on its behalf by Steve Cox, DSO Director

Contents

1 Introduction 4

2 Scope 4

3 Definitions 4

4 Pole Mounted Equipment for 6.6 and 11kV Systems 5

4.1 Reclosing Equipment 5

4.2 Location on the System 5

4.3 Recloser Settings 6

4.4 Auto-Sectionalising Links (ASL) 7

4.5 General Policy for Pole Mounted Equipment 7

5 Ground Mounted Equipment on Predominantly Overhead Systems at 6.6 and 11kV 8

5.1 Existing Reclosing Schemes 8

5.2 New and Converted Reclosing Schemes 9

6 Telecontrol Delayed Auto-Reclose (TDAR) 10

7 33kV Auto-Reclose Schemes 11

8 Documents Referenced 11

9 Keywords 12

Appendix A – Location of Auto-Reclosers 13

Appendix B – Use of Auto-Reclose on a Network 14

Appendix C – Fitting of Automatic Sectionalising Links 15

1 Introduction

This policy document lays down the basic protection and auto-reclosing requirements for the control of overhead lines operating at 6.6kV, 11kV and 33kV. The requirements for 6.6kV and 11kV are based on Industry recommendations encompassed in ACE Reports 11 and 54 for reclosing at these voltage levels. The 33kV requirements are a Electricity North West Limited based design.

Auto-reclosing facilities should be applied to overhead lines in accordance with Electricity North West Limited' policy on System Design outlined in EPDs 281 and 282.

2 Scope

This document covers auto-reclosing requirements for 6.6kV, 11kV and 33kV overhead lines, including the requirements for ground mounted circuit breakers with auto-reclosing facilities. The policy for delayed automatic reclosing (DAR) at 132kV is covered in CP338.

This policy shall be applied retrospectively to those auto-reclose schemes utilising OYT reclosers with downstream ground mounted transformer protection.

3 Definitions

Automatic Recloser	Pole mounted circuit breaker which can trip and reclose onto the network a number of times dependent on settings. The type of protection curve for each trip, no of trips/recloses, dead times and reclaim time are all variable settings for the modern recloser.
Automatic Sectionaliser	Pole mounted equipment which opens automatically after sensing a set number of pulses of fault current. The opening is carried out during the dead time of its associated upstream auto-recloser.
Automatic Sectionalising	The process by which a network is automatically re-configured following a fault. A distribution automation scheme will automatically open certain switches during the dead time of the circuit, before re-energising the feeder breaker.
Automatic Sectionalising Links (ASL)	Links which fit in standard single phase drop out expulsion fuse mounts, designed to open after detecting set numbers of pulses of fault current. These work in the same way as sectionalisers, opening during the dead time of the associated upstream auto-reclosers.
Distribution Automation	A scheme where certain switches on a 11 or 6.6kV feeder have been fitted with actuators and linked to an automation system, so that, under fault conditions, the

	network can automatically reconfigure itself to restore supplies. The automation scheme is linked into telecontrol at the associated Primary substation and may also be used for remote switching.
FLISR	Fault Localisation, Isolation and Supply Restoration – an automated NMS control system algorithm that when triggered by the relevant events and protection alarms will attempt location and isolation of a fault and supply restoration of de-energised customers by operating remotely controllable switching devices.
Telecontrol Delayed Auto-Reclose (TDAR)	This is an optional auto-reclose function of the 11/6.6kV Automatic Restoration System (ARS) used by the Control Room Management System to restore transient trips on overhead lines.

May 23

4 Pole Mounted Equipment for 6.6 and 11kV Systems

Electricity North West Limited will only use auto-reclosers that meet specification ES315.

4.1 Reclosing Equipment

The preferred pole mounted equipment is the GVR auto-recloser utilising the Polarr relay. The GVR is rated for fault making and breaking duty at up to 12kA (228 MVA at 11kV and 137 MVA at 6.6kV). The Polarr relay incorporates instantaneous and IDMT protection for overcurrent and earth faults, as well as SEF with definite time protection. The type of protection curve and timings are selectable for each trip and it also includes a sequence co-ordination facility which is useful for limiting the total number of interruptions on the circuit.

Previous pole mounted equipment to be found on the network are the Reyrolle OYT High Speed Automatic Recloser, the OYS Automatic Sectionaliser and the ESR Automatic Recloser. The OYT recloser is fully rated for fault making and fault breaking duties up to 100 MVA at 11kV or 75MVA at 6.6kV. The OYS sectionaliser is not designed for fault breaking duties, and is, therefore, required to open within the dead time of an associated recloser located nearer the source of supply. The OYS is however fully rated for fault making duties up to 100MVA at 11kV or 75MVA at 6.6kV. The standard normal current rating of both the OYT and OYS is 200A.

The OYT recloser should only be used where there is no downstream protection covering ground mounted transformers i.e. HV switch-fuse units, IDMT relays or direct acting trips.

The Reyrolle ESR recloser has had reliability problems and there is a program to replace those units, which have faulty relays, with GVRs. Those units with a modified relay (marked by a red spot) are to be sent for refurbishment and converted by Reyrolle to a down pole box arrangement to allow further use on the system. The standard normal current rating of the ESR is 400A and it is fully rated for fault making and breaking duty at up to 6kA. Where the fault level is above this a GVR should be used.

4.2 Location on the System

Where, to meet the requirements of EPD282, pole mounted auto-reclosing equipment is selected the recloser should be installed as close as possible to the feeding source, bearing in mind the fault capacity ratings given

above, with further reclosers or sectionalising equipment, as required, installed at suitable down stream point(s) on the feeder. The process for selection of the appropriate recloser for the location is also shown in the decision tree in Appendix A.

Where the fault level on a predominantly overhead section of a feeder exceeds the values given above or where for other reasons a pole mounted recloser is considered unsuitable, consideration should be given to providing automatic reclosing facilities on the ground mounted CB at the feeding substation. Section 5 of this EPD covers the requirements for applying auto-reclosing to ground mounted circuit breakers.

In general auto-reclosing equipment should be applied to "solid" (unfused) overhead systems. Where auto-reclosing is applied on a main line, then all transformers on that line will be isolatable by a set of solid links. All spur lines will also be isolatable at the tee off position and the remainder of the spur operated as a solid overhead system. There are two exceptions to this; firstly, the inclusion of a switch-fuse unit installed to protect a ground mounted substation; and secondly the fusing of a PMT where there is a ground mounted take-off. The main reason for this is to give suitable protection to the low voltage terminal zone of the transformer. The design requirements and fuse protection for overhead lines are detailed in EPD282 and CP331 respectively. This application of auto-reclosing is also shown in a decision tree in Appendix B.

4.3 Recloser Settings

The modern auto-recloser has selectable instantaneous or IDMT curves and can be set as a single trip non-reclosing protection. A setting for the auto-recloser will need to be determined based on the system in which it is to be installed, existing ground and pole mounted equipment on the network and fault level.

The maximum number of trips to lockout is four. The final trip should always be an IDMT trip. The preferred setting is two instantaneous trips followed by two IDMT trips. The number of instantaneous trips can be varied but the final trip must always be IDMT. The first instantaneous trip shall have a definite time delay of 200ms. This is to allow enough time for downstream protection to operate. Sensitive earth fault (SEF) should be set at the first relay covering the overhead line feeder and should be capable of being remotely switched out. Sensitive earth fault may also be set where there is no possibility of system parallels causing trips or where there is currently no SEF protection for the feeder. Where further pole and ground mounted equipment is installed downstream grading shall be achieved in all cases through the selection of trips, time delays or inverse time grading. The modern auto-recloser has the ability to prevent unnecessary tripping where a series of reclosers is installed. This is achieved through the use of sequence co-ordination, which works by counting fault pulses and advancing the upstream recloser through its sequence without tripping. This shall be used wherever possible to ensure minimal system disruption. May 23

Discrimination between OYT auto-reclosers, OYS sectionalisers and ASLs is only achieved by selecting the number of trips to lock-out. On certain auto-reclosers, the reclosing coil is energised from the line voltage. It is necessary, therefore, to ensure that this equipment is installed with the closing coil connected to the normal feed side of the line. Since the OYT recloser will sometimes be installed on single phase lines, it is important to note that its closing coil is connected between the incoming terminals of the centre and right hand phases of the unit, when viewed from the incoming side of the line.

In designing a scheme for the installation of auto-reclosing equipment the following points should be borne in mind:

- The amount of equipment to be installed on a circuit should take into account the need for protection to grade along the line, with the source circuit breaker and achieve suitable levels of discrimination. This may also require a change of the source protection. The design should also include the need to minimise unnecessary customer interruptions.

- The provision of normal line isolating switches and "D" links should be treated as a separate consideration although it may well be that the location of these items will fall naturally at positions near to the recloser or sectionaliser.

- All necessary precautions must be taken for the protection of the system against lightning. Reference to CP314 should be made early in the design stage. The GVR recloser should be ordered with the approved surge arrester brackets to enable fitting of the arresters on the tank. May 23

- Where an automatic recloser is installed in an interconnector between two systems, or in a ring main, it is necessary to ensure that all isolators in the interconnector, or the ring, are of the ganged type.

- Where the inclusion of auto-reclosers and sectionalisers still leave long lengths of teed circuits to be patrolled following lock-outs caused by persistent faults, particularly where these circuits traverse difficult terrain with consequent long restoration times, consideration should be given to the inclusion of overhead line fault passage indicators at strategic points on the network. Overhead line fault passage indicators should be selected from the currently approved types.

4.4 Auto-Sectionalising Links (ASL)

Where further sectionalising of a circuit is required, use can be made of ASLs. These work by opening during the dead time of an associated recloser, after counting a set number of pulses of fault current above a certain level. The application of ASLs described below is also shown diagrammatically in a decision tree in Appendix C.

Where ASLs are to be fitted as a replacement for existing drop out fuses or links as part of the CHL improvement project, it is acceptable to use the existing mounting steelwork i.e. there is no need to fit a trip-all-phases mount.

Where ASLs are to be fitted as part of an overhead line refurbishment or automation/remote control scheme, then more comprehensive network study is required. For single phase lines, there is no requirement to install trip-all-phase mounts. For three-phase lines, consideration shall be given to the level and nature of three-phase motor load downstream of the links. This shall include the rating of motor load, protection against single phasing, its functionality i.e. is it part of a continuous manufacturing process or critical in its role. In general, it is recommended that trip-all-phase mounts are fitted on all these lines but consideration may be given to using existing steelwork depending on the above factors.

There are many ratings of ASL available and these can be obtained in 1, 2 or 3 shot versions. In order to standardise as much as possible, it is intended to use only 2 shot ASLs of 25, 63 100, and 200A rating. ASLs should be selected such that their ratings are between 2 and 3 times the aggregate full load current of all the downstream connected transformers. The lower limit of 2 times is more critical in order to prevent spurious operation of the ASL and link selection should err on the upper side of this limit.

4.5 General Policy for Pole Mounted Equipment

When equipment is mounted on poles, the tank and all other steelwork should be earthed in accordance with CP332 and as detailed in CP430.

Facilities must be provided to permit the maintenance of pole mounted equipment to be carried out in accordance with Live Line Instructions approved for use within the Company.

An approved design of insulated operating rod, as described in CP884, must always be used when manually operating pole mounted equipment, e.g. after lock-out, manual tripping or closing, operation of earth fault relay shorting switch.

Points of isolation for 6.6 and 11kV overhead lines are defined in CP606 section A6. The opening of an auto-recloser or sectionaliser must not be regarded as constituting a point of isolation within the terms of Electricity North West Limited' Distribution Safety Rules.

Dead times and reclaim times shall generally be in accordance with Sections 5.2.5 and 5.2.6 respectively.

5 Ground Mounted Equipment on Predominantly Overhead Systems at 6.6 and 11kV

Where auto-reclosing facilities are required and where pole mounted equipment is not adopted due to fault level values or other reasons, consideration should be given to providing reclosing on ground mounted CBs.

In this connection it is imperative to ensure that the ground mounted CB is fully capable of the required make/break duties imposed upon it by the reclosing cycle. Procedure S23 of CP606 lays down the requirements to be met for ground mounted CBs before use on reclosing duties.

5.1 Existing Reclosing Schemes

ACE Report No 11 recommended four basic auto-reclosing schemes. These four schemes all cover ground mounted CBs and the choice of scheme depends largely on the type of closing mechanism employed by the CB and whether or not remote alarms are required. The recommended schemes, covering single shot and repetitive single shot reclosing, are R1, R2, R3, and R4.

ACE Report No 54 recommended and detailed five improved protection and auto-reclosing schemes for 11kV distribution networks. The following schemes are provided for information, the common ones in use in Electricity North West Limited being R9 and R10.

Scheme R6 Electro-mechanical Repetitive Single Auto-Recloser Scheme for circuit breaker with motor wound spring closing mechanism. This is basically the R2 scheme.

Scheme R7 Electro-mechanical repetitive single auto-reclose scheme for a circuit breaker with motor wound or solenoid closing mechanism, with lockout and alarm facilities. This scheme is basically the R4 scheme but with certain modifications to permit conversion to R8.

Scheme R8 Electro-mechanical repetitive multiple auto-reclose scheme for a circuit breaker with motor wound or solenoid closing mechanism, with lockout and alarm facilities. This scheme comprises the relay assembly of R7 but with an additive relay to convert the scheme from repetitive single auto-reclose to repetitive multiple auto-reclose operation.

Scheme R9 Reyrolle type TDA53 solid state integral protection /sequencing auto-reclose scheme. This scheme is basically a repetitive multiple reclose scheme with considerable flexibility in protection setting.

Scheme R10 GEC type SDND solid state protection and auto-reclose scheme. Similar to the R9 scheme, but with a different relay.

5.2 New and Converted Reclosing Schemes

Circuits controlled by automatic reclosing ground mounted circuit breakers require the installation of an auto-reclosing relay and instantaneous overcurrent and earth fault relay in addition to the standard IDMT overcurrent and earth fault relay. Where a new installation is being installed, or an existing non-reclose circuit breaker is being fitted with auto-reclose, a modern microprocessor based auto-reclose relay will be installed in conjunction with a modern overcurrent and earth fault relay. As an alternative, it is possible to provide auto-reclose facilities through the use of the telecontrol system. However, it should be stressed that the preferred method is a complete hard-wired scheme as described above. Where considering a modern ground mounted auto-reclose scheme it should combine the functionality of the R8 scheme with the ability to co-ordinate and discriminate with modern pole mounted auto-reclosing equipment. Whilst it is not practicable to give standard current and time settings for the various main and ancillary relays used in a reclosing scheme, the following is a guide to the settings required.

5.2.1 Instantaneous OC and EF Relay

This relay should wherever possible have applied current settings capable of detecting phase and earth faults in the protected zone i.e. up to the remote end of the feeder or branch or the take over point of a pole mounted auto-recloser. To assist with these requirements the relay selected from current standard types for instantaneous tripping of a feeder equipped with an auto-reclosing feature has a low transient overreach and a high drop off/pick up ratio. A problem which may prevent achievement of this requirement is relay stability during the re-energisation of summated transformer loads; a typical overcurrent element setting for the purpose would be approximately three times the summated ratings of the distribution transformers connected to the protected line.

It should be noted that auto-reclosing is only initiated from the instantaneous protection. Therefore, if a fault is cleared by other protective equipment on the ground mounted circuit breaker, a lock-out trip will be given to the controlling circuitry.

5.2.2 IDMT OC and EF Relay

Operation of this relay will not initiate a reclosing sequence. The current setting applied to this relay must be capable of detecting phase and earth faults within the protected zone and, wherever possible, provide back-up protection to any downstream protection equipment.

In addition to these conditions of current setting, this relay must also have a time setting suitable for discriminating with outlying downstream protection, such as pole mounted reclosers, HV switch-fuses or circuit breaker IDMT units.

5.2.3 Sensitive Earth Fault Relay

Where a sensitive earth fault relay is installed, its prime function is to detect a broken conductor condition. Operation of the sensitive earth fault protection will, therefore, prevent operation of the auto-reclose scheme. SEF settings shall be in accordance with EPD373.

5.2.4 Bus-zone Protection

Bus-zone protection is not normally applied to the 11/6.6kV bus bars. In the rare cases, where bus-zone protection is applied at these voltage levels, the operation of this protection should prevent operation of the auto-reclose scheme.

5.2.5 Dead Time

The dead time setting of an auto-reclose scheme classifies the scheme as either “high speed” or “slow speed” reclosing. High speed reclosing gives line re-energisation after a dead time of up to 1s, whilst slow speed reclosing indicates a dead time in excess of 1s. In practice the longer the dead time, the more likelihood there is of a successful reclosure following a transient fault.

In the case of lines supplying domestic and commercial premises, advantage can be taken of the slow speed reclosing scheme, since supply interruption periods in the order of 15s to 20s normally cause no serious problems in these types of premises. In the case of supplies to industrial premises, however, some reduction in dead time setting can be advantageous to the customer, in that a high speed scheme will often allow induction motors to “coast through” the interruption period and thus retain in service any continuous processing machinery. The dead time setting can therefore depend on the type of load being supplied and in the case of industrial premises the manufacturing process employed. A standard dead time is quoted but with the option that this may be altered if considered advantageous to particular circumstances.

The standard dead time will be 5s.

5.2.6 Reclaim Time

This is the time following a successful reclosure in which the auto-reclose equipment fully resets to provide a subsequent full reclosing cycle. In order to reduce the chance of a lockout during lightning the time should be kept short.

The standard reclaim time will be 15s.

5.2.7 Private Generation

Where private generation is connected to the network, its protection requirements, in particular protection resetting times, should be in accordance with CP602. This is to ensure that healthy supply conditions have existed for a continuous period, before the generator attempts to synchronise to the system, i.e. to prevent re-synchronising during an auto-reclose sequence.

5.2.8 Lock-out

The number of shots to lock-out must be assessed from the type of controlling circuit breaker, system fault level and circuit breaker rating as laid down in CP606 Procedure S23.

6 Telecontrol Delayed Auto-Reclose (TDAR)

TDAR is an optional function of FLISR and is capable of restoring transient faults on overhead lines. When TDAR is applied to an 11/6.6kV primary circuit breaker it will attempt to reclose the tripping device after a specified dead time. The number of recloses is configurable while associated trips can be set as either IDMT **or** Instantaneous, but not a combination of the two. The standard TDAR setting is typically one reclose with a dead time and reclaim time of 15 seconds. May 23

All 11/6.6kV circuits that contains an overhead span and does not have a hardwired auto-reclose scheme configured at the Primary shall be configured with TDAR. Exceptions to this are when a circuit is configured with unit protection (i.e. a translay ring) or the primary breaker has an operational restriction that inhibits automation.

If the primary circuit breaker has a hand charged spring mechanism, then only one automatic control function can be applied, i.e. TDAR or FLISR. This is due to limitations with having to manually recharge the mechanism after one reclose. An assessment shall be made by the network performance team as to which automatic control function is most suitable for all hand charged spring circuits that supply a section of overhead line. May 23

Reference to CP284 Automatic Restoration Section 9 shall be made when considering the application of FLISR or TDAR to a circuit.

7 33kV Auto-Reclose Schemes

Where there is an overhead line section within a feeder auto-reclose may be applied to the feeding circuit breaker. This will be achieved through a suitable auto-reclose relay. Reclosing shall only be initiated from the main protection and not from back-up. Any 33kV to lower voltage transformer LV circuit breaker will not be fitted with auto-reclose.

The relay will be set for single shot reclose only. Where intertripping facilities are installed then auto-reclose shall be inhibited for a permanent intertrip receive or for busbar protection operation. Where intertripping is not available and a fault thrower is used on the remote end of the feeder, a single reclose will, nevertheless, be allowed. The preferred settings to be used will be similar to those used for 132kV auto-reclosing, a dead time of 10s and a reclaim time of 15s.

Points of isolation for 33kV overhead lines are defined in CP606 section A6. The opening of an auto-recloser or sectionaliser must not be regarded as constituting a point of isolation within the terms of Electricity North West Limited' Distribution Safety Rules.

8 Documents Referenced

DOCUMENTS REFERENCED	
ACE Report No 11 (1966)	Report on Standardisation of Auto-Reclosing Facilities on Distribution Switchgear
ACE Report No 54 (1977)	Auto-Reclosing Schemes for 11kV Distribution Networks
EPD281	Distribution System Design — 33kV Network
EPD282	Distribution System Design — 11/6.6kV Network
EPD373	Earth Fault Protection for HV Overhead Lines
CP314	Lightning Protection of HV Overhead Lines

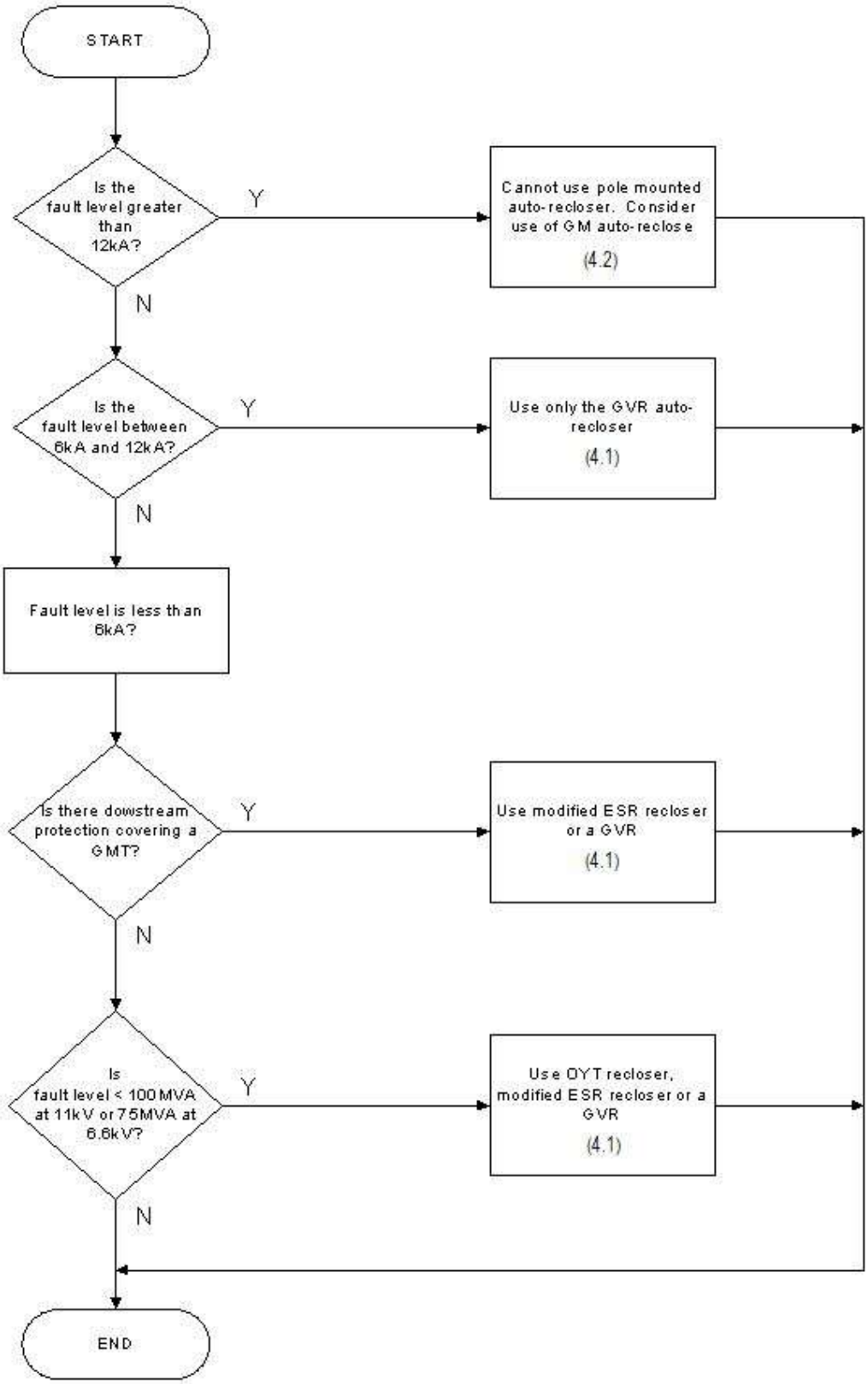
May 23

CP284	ARS 11/6.6kV Network Design Considerations
CP331	Fusing of Distribution Network
CP332	LV Service Supplies and the Application of Protective Multiple Earthing
CP338	132kV Protection
CP430	Overhead Linesman's Manual
CP602	Private Generation in Electricity North West Limited
CP606 Procedure S23	HV Fault Restoration -Reclosing of Switchgear
CP884	Portable Ancillary Electrical Equipment
ES315	Specification for Pole Mounted Equipment

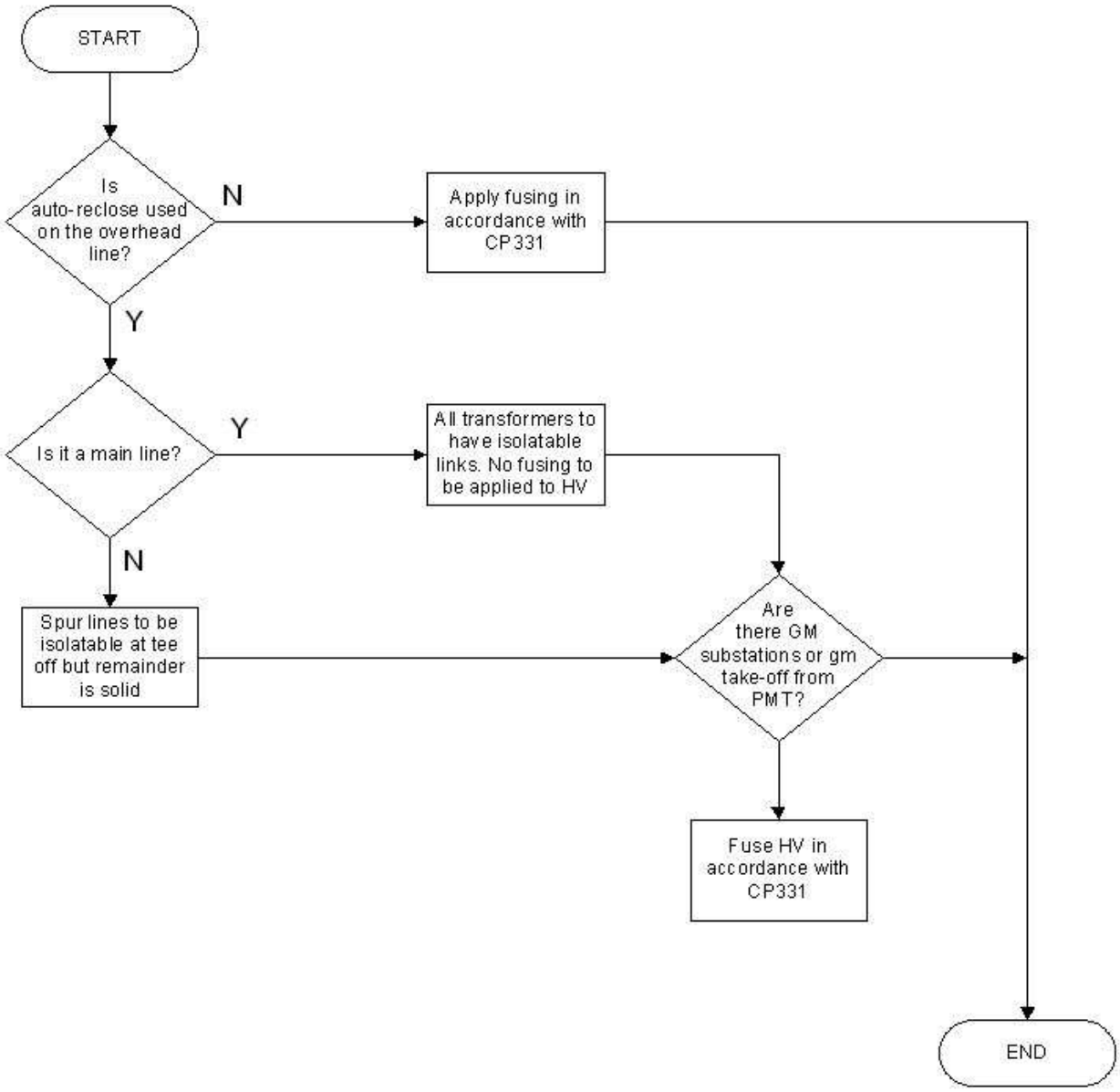
9 Keywords

Auto-reclose; protection; relay; fuse; overhead; circuit breaker; DAR; SEF

Appendix A – Location of Auto-Reclosers



Appendix B – Use of Auto-Reclose on a Network



Appendix C – Fitting of Automatic Sectionalising Links