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# RESPOND

## Updated Policies

29 June 2018

## VERSION HISTORY

| Version | Date | Author | Status | Comments |
|---|---|---|---|---|
| V0.1 | 25 June 2018 | John Lucas/ Paul Marshall | Draft | |
| V1.0 | 29 June 2018 | John Lucas/ Ben Ingham | Final | Updated following review |

# CONTENTS

# GLOSSARY OF TERMS AND ABBREVIATIONS

| Abbreviation/Term | Definition |
|---|---|
| **AP** | **Adaptive Protection** is the use of adjustable protection settings that can be changed in real time |
| **ADE** | **The Association of Decentralised Energy** is a leading industry advocate of an integrated approach to delivering energy services using combined heat and power and district heating. Previously known as the Combined Heat and Power Association (CHPA) |
| **CB** | **A circuit breaker** is a device that interrupts the flow of current in an electric circuit |
| **CCCM** | **Common Connection Charging Methodology** is a section within DCUSA that covers charging for new connections to the distribution system |
| **CHP** | **Combined heat and power** is the simultaneous generation of usable heat and power (usually electricity) in a single process |
| **CRMS** | **Control Room Management System** |
| **CT** | A **current transformer** is a transformer designed to scale down large primary currents to smaller values for the purpose of measurement and protection |
| **DCUSA** | **Distribution Connection and Use of System Agreement** is a multi-party contract between licensed distributors, suppliers and generators |
| **DG** | **Distributed generation** is generation connected to the distribution network |
| **DNO** | A **distribution network operator** is the owner and/or operator of an electricity distribution system and associated assets |
| **FLAT** | The **Fault Level Assessment Tool** is intelligent software which assesses near real time fault current peaks on the network and decides to enable or disable the mitigation technologies |
| **Fault current** | Actual current which flows during a fault |
| **FCL service** | The **Fault Current Limiting service** is a distributed generation and/or industrial and commercial customer-provided response to reduce overall fault current on the distribution network |
| **Fault level** | Prospective maximum current which will flow during a fault |
| **FlexDGrid** | A Second Tier LCN Fund fault level mitigation project run by Western Power Distribution |
| **HAZOP** | A **hazard and operability** study is a structured and systematic technique for system examination and risk management |
| **HV** | **High voltage** is the 11,000/6,600 volt network |
| **I&C** | **Industrial and commercial** customers are non-domestic |

| Abbreviation/Term | Definition |
|---|---|
| | customers |
| **IPSA+** | **Interactive Power Systems Analysis Plus** software is used to model and assess network power flows, voltage profiles, fault levels, stability and harmonics |
| **Is-limiter** | A fault current mitigation technology |
| **LCN Fund** | **Low Carbon Networks Fund** |
| **LCNI** | **Low Carbon Networks and Innovation** |
| **Near real time** | A measure of the frequency of the calculation by the Fault Level Assessment Tool. For Respond this will be every five minutes |
| **NMS** | **Network management system** |
| **NTC** | **National Terms for Connection** is a document containing the standard terms for connection to the electricity distribution system |
| **Primary substation** | A point on the network where the voltage changes from 33kV to 11kV or 6.6kV |
| **Protection relay** | Device that analyses power system voltages and currents to detect faults and sends signals to circuit breakers to open |
| **RTU** | A **remote terminal unit** is the interface between the substation equipment and the **NMS** |
| **SDRC** | **Successful delivery reward criteria** are key milestones to be delivered throughout the project |
| **Substation** | A point on the network where voltage transformation occurs |
| **Switchgear** | Device for opening and closing electrical circuits (including circuit breakers) |
| **TRIAD** | A National Grid charging system that allows large electricity users to reduce energy charges by reducing consumption during peak demand periods |

# 1 INTRODUCTION

The purpose of this document is to fulfil the requirement associated with the Respond successful delivery reward criteria (SDRC) **9.1.5 – Publish updated fault level management, planning, design, protection setting and maintenance policies.**

### Background

The project investigated three techniques to provide additional fault level capacity on the network namely:

- The retrofitting of Adaptive Protection (AP) to existing substation equipment to re-sequence the operation of circuit breakers
- The installation of Is-limiters to detect and interrupt fault current before it reaches peak value
- The purchase of a Fault Current Limiting service (FCL service) from a customer which requires them to operate their equipment to reduce fault level under certain defined circumstances.

Adaptive Protection and Is-limiters were installed and trialled successfully by the team during the project albeit on networks where the fault level did not exceed the ratings of existing equipment. Although the project team went to great efforts to identify suitable customers to take part in the trial of an FCL service they were unable to engage with any of them and therefore this element of the project was not trialled.

To achieve the SDRC a desktop review of Electricity North West's technical library was undertaken by the project team to identify all of the documents that may be impacted by the introduction of the new techniques. Following the initial review a more comprehensive analysis of the relevant documents was carried out to identify the changes required on the basis that the techniques will be adopted for use within the company. However, it should be noted that before these new techniques can be adopted into business as usual, there is a project requirement for robust safety cases to be developed for each of the techniques (SDRC 9.3.8) and these are due to be published in September 2018.

Consequently, it has not been possible to formally update the relevant policies as the process requires them to be submitted to a technical policy panel for approval and this would, by necessity, require a review of the relevant safety case for each of the techniques before the company could adopt them into business as usual.

In order to satisfy the requirements of the SDRC, we have adopted a pro-active approach and prepared proposed changes to policy that will be required to accommodate the new techniques. These changes have been documented as either additions to the existing text or an additional appendix to be included in an existing document.

The output of the review of the technical library is summarised in the table below.

*Figure 1.1: Technical library review*

| Policy Reference | Title | Change required |
|---|---|---|
| EPD 220 | Fault Level Management | Appendices for Adaptive Protection and Is-limiters |
| EPD 301 | Inspection and Maintenance of Electrical Plant and Substation Security. | Section detailing maintenance period for Is-limiters |
| EPD350 | Protection for 132kV, 33kV and 11/6.6kV systems. | Appendix detailing Adaptive Protection settings and reference to manufacturer settings for Is-limiters |
| CP 258 | Connections for Industrial and Commercial Customers. | No revision required |
| CP 259 | Generation connected to the Electricity North West Distribution Network. | Include an appendix for Adaptive Protection and Is-limiters on 11/6.6kV systems |
| CP 279 | Distribution System Design – General Requirements. | No revision required |
| CP 280 | Distribution System Design. – 132kV Network. | No revision required |
| CP 281 | Distribution System Design – 33kV Network. | No revision required |
| CP 282 | Distribution System Design – HV Network. | Include an appendix for Adaptive Protection on the 11(6.6)kV system |
| CP 306 | Plant Maintenance Procedures. | Include Is-limiter maintenance requirements |
| CP 373 | Protection Settings for 33kV and 11/6.6kV Systems. | Include an appendix of Adaptive Protection and Is-limiter setting requirements |
| CP 608 | Switchgear and Switching. | Operational instructions required for Adaptive Protection and Is-limiters |
| CP820 | Charging Conditions for Reinforcement and Replacement of Electricity North West's Electricity Distribution System. | Update charging policy to reflect the changes proposed in DCUSA (SDRC 9.3.5) |

# 2 MODIFICATIONS TO EPD 220 APPENDIX A

EPD220 details Electricity North West's approach to the management of fault levels on the network. Below are the proposed modifications to Appendices A and B of this document following the findings of the Respond project.

**APPENDIX A**

**Adaptive Protection**

### A1. Adaptive Protection description

The Adaptive Protection (AP) scheme utilises additional protection equipment which is installed in existing primary substations. The additional protection equipment consists of a numeric protection relay which is set to trip circuit breaker(s) upstream of a faulted feeder to reconfigure the network prior to the feeder protection operating to clear the fault. Tripping of the upstream circuit breaker(s) increases the source impedance thereby reducing the fault current. The AP relay offers two stages of operation. In general the HV systems are operated in radial or closed ring configurations and a different approach is required for each.

A full description of the AP for radial and ring circuits can be found in Appendices F and G of EPD 350.

### A2. Criteria of application of Adaptive Protection

Adaptive Protection will only be employed in 11(6.6)kV networks when the following conditions are met:

1. The maximum prospective fault flow is within the peak make and break fault ratings of the bus section circuit breaker

2. The maximum prospective fault flow is within the peak make and break ratings of the transformer circuit breakers

3. The maximum prospective peak (asymmetrical) fault current flow that will be seen with AP protection installed and working is within the instantaneous fault withstand rating and thermal rating of the substation busbars and all circuit breakers, including the feeder circuit breakers

4. The maximum prospective peak (asymmetrical) fault current flow that will be seen with AP protection installed and working is within the instantaneous fault withstand rating and thermal rating of the feeder cables and/or overhead line

5. It should be possible to reduce the fault current to within ratings by upstream switching in the event that circuit breaker DC supplies are lost within the substation

6. The maximum prospective fault current is within the rating of existing customer switchgear on any feeder or the fault level at a customers' site is equal to or less than the design fault level.

- Section 4.3.3 "Fault Levels in Excess of Declared Values" should be read in conjunction with the following:

Where Adaptive Protection is applied, Stage 1 operation ensures that through fault current at 100ms after fault initiation is less than the short time rating of the equipment.

- Section 4.5.1 "Operating Margins" should be read in conjunction with the following:

Where appropriate, Adaptive Protection may be applied to limit through fault current at 100ms after fault initiation to less than 100% of the assigned rating of the equipment.

## APPENDIX B

## Is-limiters

### B1. Is-limiter description

An Is-limiter is a combination of an extremely fast acting switch, which can conduct a high current but has a low switching capacity, and a fuse with a high breaking capacity mounted in parallel. In order to achieve the desired short opening time, a small explosive charge is used as a stored energy mechanism to interrupt the switch (main conductor). When the main conductor has opened, the current still flows through the parallel fuse which limits the current to within 0.6ms and then finally interrupts it at the next voltage zero.

A full description of the Is-limiters connected in series with a transformer incomer circuit breaker or in parallel with the bus section circuit breaker can be found in Appendices F and G of EPD 350.

### B2. Criteria of application of Is-limiters

Details will be added when the Is-limiter safety case report is complete.

- Section 4.3.3 “Fault Levels in Excess of Declared Values” should be read in conjunction with the following:

Where Is-limiters are installed, the total operating time is typically between 5 and 10ms, thereby limiting the peak prospective current to less than the assigned rating of the equipment.

- Section 4.5.1 “Operating Margins” should be read in conjunction with the following:

Where appropriate, Is-limiters may be installed to limit prospective short circuit current to less than the assigned rating of the equipment.

# 3 MODIFICATIONS TO EPD 301: INSPECTION AND MAINTENANCE OF ELECTRICAL PLANT AND SUBSTATION SECURITY

## APPENDIX M

## Is-limiters

### Inspection and maintenance of Is-limiters

When Is-limiters are installed as a fault current mitigation measure, the following paragraphs should be taken into account.

- In Section 5.2 “Additional Security Inspections”, the following amendment is proposed:

  *“…as laid down in Appendix A and M.”* instead of *“…as laid down in Appendix A.”*

- In Section 9.2 “Inspection and Maintenance Intervals” the following amendment is proposed:

  “… *shown in Appendices A to M*…” instead of “… *shown in Appendices A to K*…”

- Appendix G “Grid and Primary Substations – Inspection and Maintenance Intervals” should be read in conjunction with the information detailed in Figure 3.1.

*Figure 3.1: Is-limiter further information*

| | Period in Months | Notes |
|---|---|---|
| Is-limiter switchboard | 48 | Inspections as detailed in section 7.2 of ABB Is-limiter instruction manual BA 323/04 E. |
| Is-limiter tripping device and interlocks | 12 | The Is-limiter electronics are tested in conjunction with a proprietary test insert. Refer to sections 7.2.1 and 7.3 of ABB Is-limiter instruction manual BA 323/04 E. |
| Is-limiter inserts | 96 | Inserts installed in active Is-limiters must be returned to the ABB factory for refurbishment within eight years. |
| | 144 | Inserts in storage must be returned to the ABB factory for refurbishment within 12 years. |

# 4 EPD 350: PROTECTION FOR 132KV, 33KV AND 11/6.6KV SYSTEMS

## APPENDIX F

## Adaptive Protection on 11/6.6kV systems

### F1. Adaptive Protection description

The Adaptive Protection (AP) scheme utilises new protection equipment which is installed in the existing primary substations where there is an issue with fault level exceeding design ratings of equipment.

The AP equipment consists of a numeric protection relay which, on detecting a feeder fault, trips circuit breaker(s) upstream of the faulted feeder to reconfigure the network prior to the feeder protection operating to clear the fault. Tripping of the upstream circuit breaker(s) increases the source impedance thereby reducing the fault current. *Note: Adaptive Protection cannot be applied where feeders are equipped with unit protection.*

- Section 4.3 “Grading Margin and Reset Times” should be read in conjunction with the following:

In order to limit the phase fault current which the feeder circuit breaker is required to interrupt, conventional protection sequential coordination is deliberately reversed. The AP relay offers two stages of operation with the first stage tripping the bus section circuit breaker before the feeder protection operates. If the bus section circuit breaker fails to trip within 200ms then the second stage operates to trip one of the two transformers’ 11(6.6)kV circuit breaker, again before the feeder protection operates.

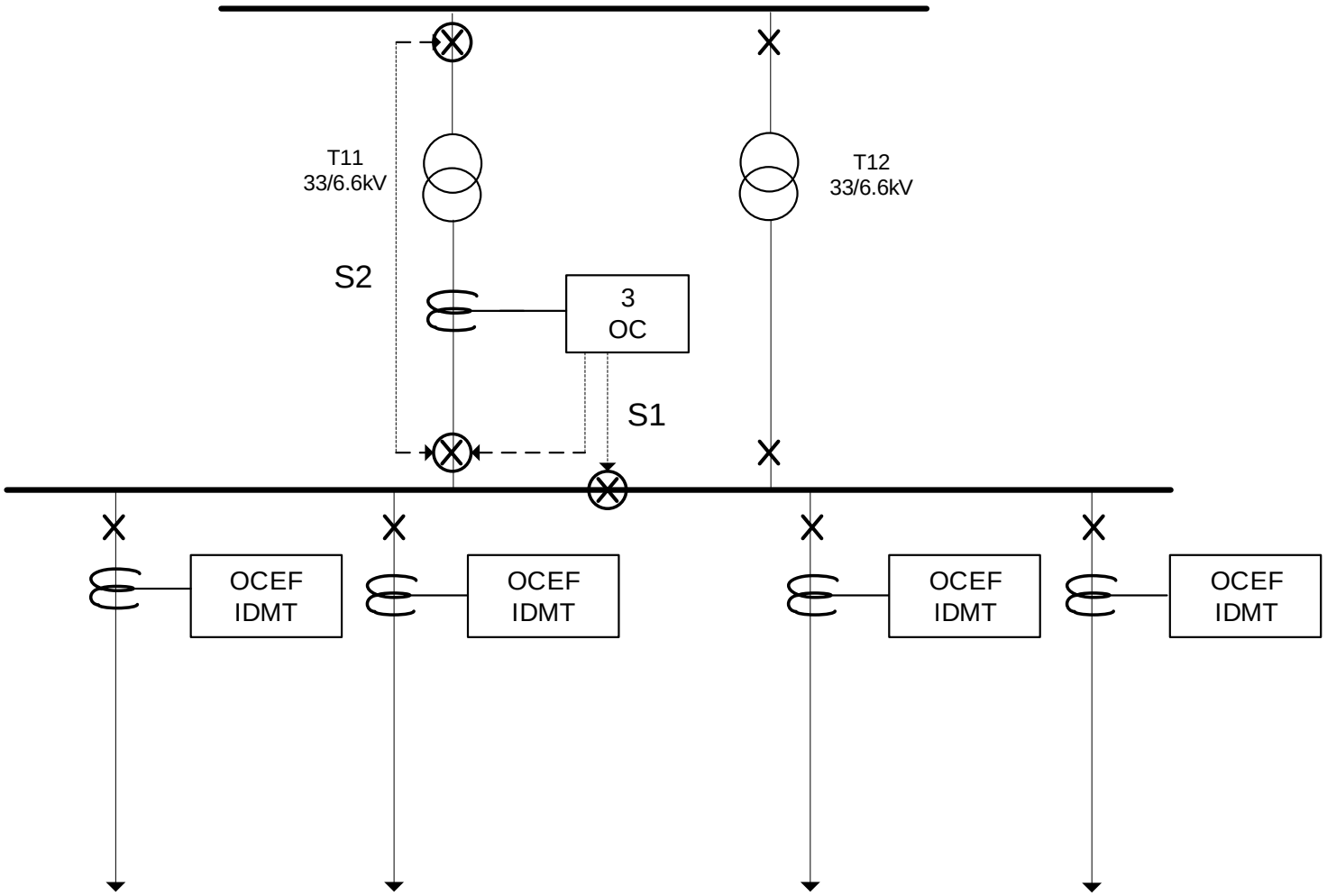
### F2. Adaptive Protection – 11/6.6kV radial feeders

A set of interposing current transformers (CTs) are installed on the low voltage (LV) side of the two primary transformers and their output is fed into a single AP relay. If the current setting threshold is exceeded the AP relay issues an instantaneous trip signal to the 11(6.6)kV bus section circuit breaker. Each section of busbar is then only supplied by one transformer and the fault contribution from the upstream network is reduced, resulting in less fault current flowing to a fault in the downstream network. If the Stage 1 action fails, then Stage 2 of the Adaptive Protection relay trips one of the two transformers’ 11(6.6)kV circuit breaker and also the associated transformer 33kV circuit breaker where required by the network configuration

The current setting is selected to operate for multiphase faults on the 11(6.6)kV system and avoid tripping for single phase to earth faults or load. Adaptive Protection operates without delay and in advance of the existing feeder protection relays so that existing relay settings are not required to be altered.

The operation is illustrated in Figure F1.

*Figure F1. Key diagram for Adaptive Protection – radial feeders*



## F3. Adaptive Protection – closed ring

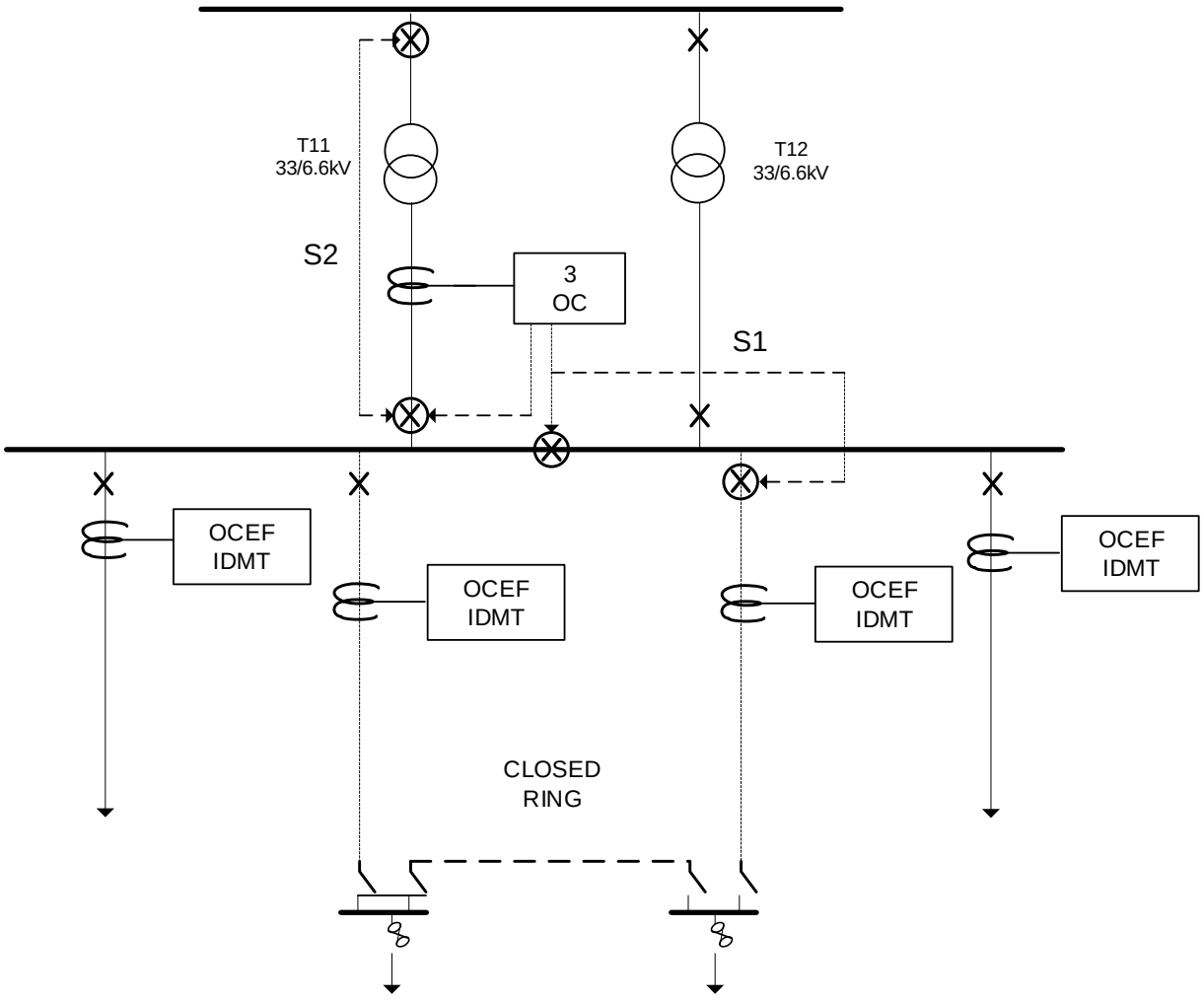
A set of interposing CTs are installed on the LV side of the two primary transformers and their output is fed into an AP relay. If the current setting threshold is exceeded, the AP issues an instantaneous trip signal to the bus section circuit breaker and one of the closed ring feeder circuit breakers. Each bus section is then only supplied by one transformer and the fault contribution from the upstream network is reduced, resulting in less fault current flowing to a fault in the downstream network. If the Stage 1 action fails, then Stage 2 of the Adaptive Protection relay action trips one of the two transformers' 11(6.6)kV circuit breaker and also the associated transformer 33kV circuit breaker where required by the network configuration.

The current setting is selected to operate for multiphase faults on the 11(or 6.6)kV system and avoid tripping for single phase to earth faults or load.

Adaptive Protection operates without delay and in advance of the existing feeder protection relays so that existing relay settings are not altered by the installation of Adaptive Protection.

The operation is illustrated in Figure F2.

*Figure F2. Key diagram for Adaptive Protection – closed ring*



## APPENDIX G

## Is-limiter

### G1. Is-limiter description

An Is-limiter is a combination of an extremely fast acting switch, which can conduct a high current but has a low switching capacity, and a fuse with a high breaking capacity mounted in parallel. In order to achieve the desired short opening time a small explosive charge is used as a stored energy mechanism to interrupt the switch (main conductor). When the main conductor has opened, the current still flows through the parallel fuse which limits the current to within 0.6ms (ie during the first quarter cycle before the short circuit current reaches its full value) and then finally interrupts it at the next voltage zero.

- Section 4.1.2.2 “Recording of Settings” should be read in conjunction with the following:

The Is-limiter settings are specific to the network conditions and shall be provided by the equipment manufacturer.

### G2. Is-limiter in series with a transformer incomer 11(6.6)kV circuit breaker – Type A

For Type A installations, the Is-limiter is installed in series with a transformer 11(6.6)kV circuit breaker.

The Is-limiter is provided with an associated series circuit breaker as shown in Figure G1.

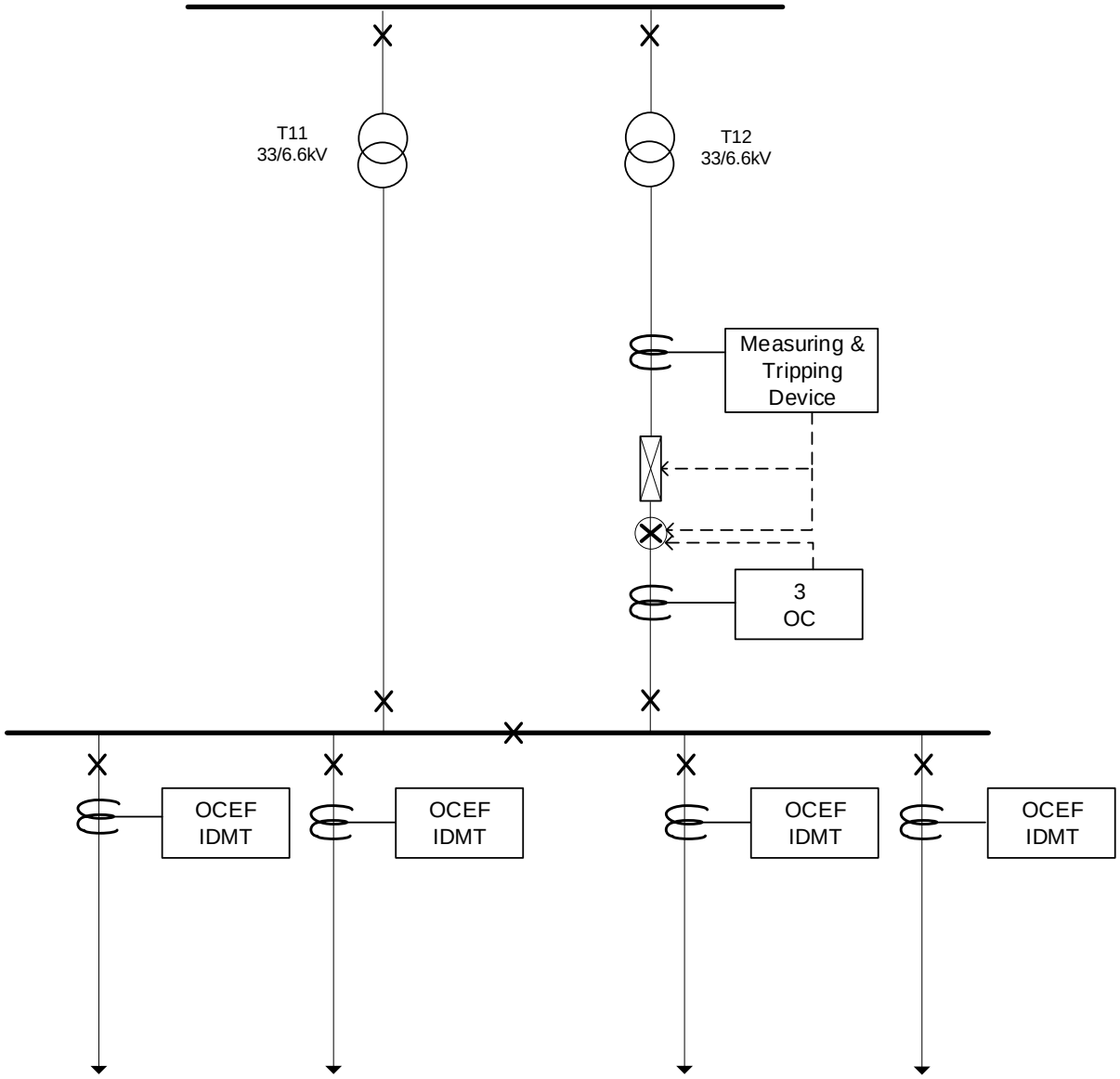
The current flowing through the Is-limiter is monitored by an electronic measuring and tripping device. A trip occurs as soon as an impermissibly high short-circuit current begins to flow. In order to determine whether tripping of the Is-limiter is necessary, the instantaneous current and rate of rise of current across the Is-limiter are constantly measured and evaluated.

The Is-limiter series circuit breaker is normally tripped by the Is-limiter but it also has its own CTs and protection relay. This relay trips the Is-limiter series circuit breaker if it detects a phase current above the current setting threshold (the earth fault element is not enabled) and it performs this trip almost instantaneously (minimum time delay setting of 20ms), which in reality means it will issue a trip command in about 40ms.

If the Is-limiter operates correctly it will interrupt the fault current in the faulted phase(s) and trip the series circuit breaker before the Is-limiter series circuit breaker protection relay can respond.

Following an Is-limiter trip, the insert(s) that have operated must be replaced before it can be restored to the service position.

*Figure G1: Key diagram for Is-limiter installation – Type A*




**G3. Is-limiter in parallel with bus section 11(6.6)kV circuit breaker – Type B**

For Type B installations, the Is-limiter is installed in parallel with the bus section 11(6.6)kV circuit breaker.

The Is-limiter is provided with an associated series circuit breaker and the combination is connected to a circuit breaker on each of the 11(6.6)kV busbar sections as shown in Figure G2.

The current flowing through the Is-limiter is monitored by an electronic measuring and tripping device. A trip occurs as soon as an impermissibly high short-circuit current begins to flow. In order to determine whether tripping of the Is-limiter is necessary, the instantaneous current and rate of rise of current through the Is-limiter are constantly measured and evaluated.

The Is-limiter series circuit breaker is normally tripped by the Is-limiter but it also has its own CTs and protection relay. This relay trips the Is-limiter series circuit breaker if it detects a phase current above the current setting threshold (the earth fault element is not enabled) and

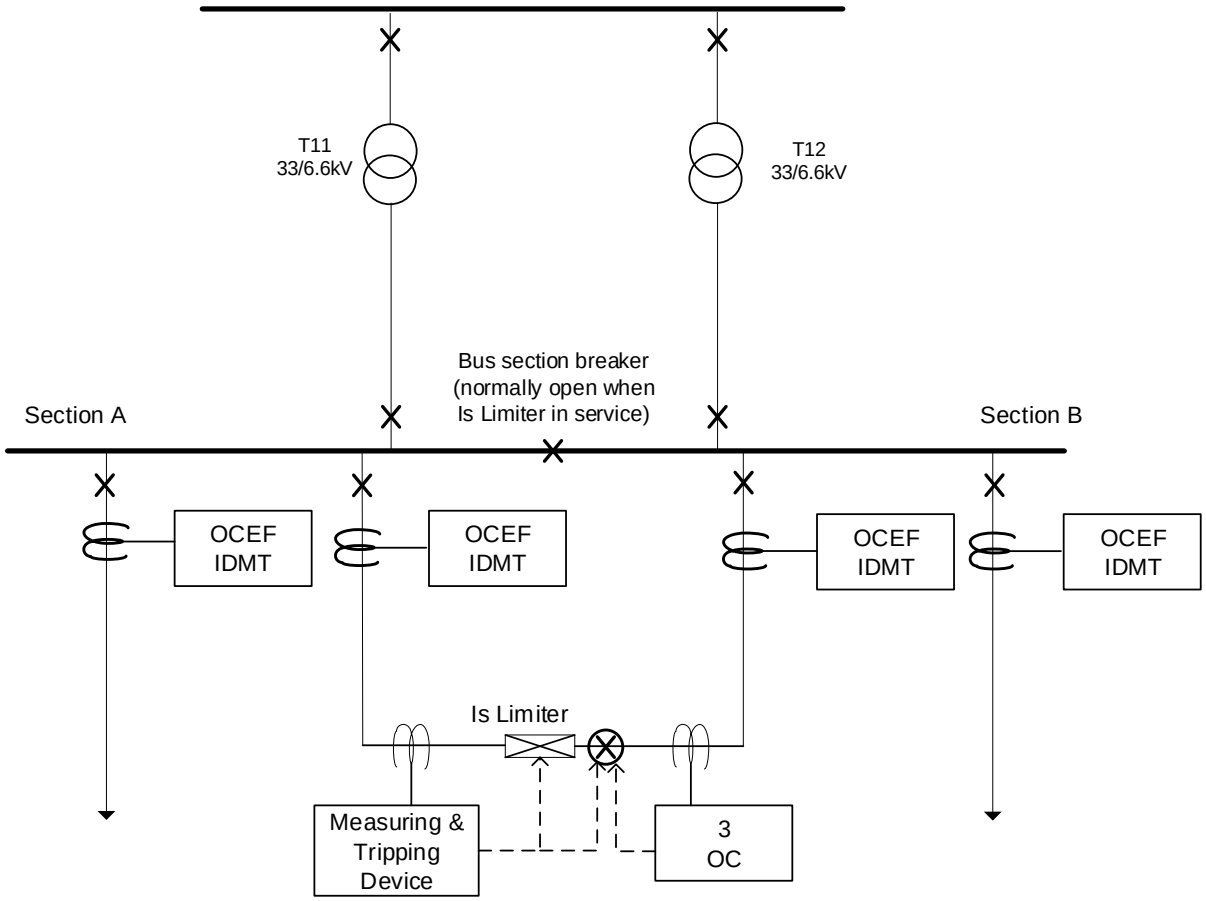
it performs this trip almost instantaneously (minimum time delay setting of 20ms), which in reality means it will issue a trip command in about 40ms.

If the Is-limiter operates correctly, it will interrupt the fault current in the faulted phase/s and trip the series circuit breaker before the Is-limiter series circuit breaker dedicated protection relay can respond.

When the Is-limiter is in service, the bus section 11(6.6)kV circuit breaker is open so that any transformer fault current flowing from one section of busbar to the other section will pass through the Is-limiter.

Following an Is-limiter trip, the insert(s) that have operated must be replaced before it can be restored to the service position.

*Figure G2. Key diagram for Is-limiter installation – Type B*



# 5 CP 259: GENERATION CONNECTED TO THE ELECTRICITY NORTH WEST DISTRIBUTION NETWORK

**APPENDIX F**

**Adaptive Protection and Is-limiters on 11(6.6)kV systems**

- Section 8.4.8.5 “Network Fault Levels” should be read in conjunction with the following:

Other fault level mitigation techniques such as Adaptive Protection and Is-limiters may also be considered.

# 6 CP 282 (ISSUE 3): DISTRIBUTION SYSTEM DESIGN – HV NETWORK

**APPENDIX B**

**Considerations when Adaptive Protection is applied on 11(6.6)kV systems**

- Section 4.2.5 “Customer Security” should be read in conjunction with the following:

  Where Adaptive Protection is installed, unit protection shall not be applied.

- Section 4.7 “Protection” should be read in conjunction with the following:

  Where Adaptive Protection is installed, unit protection shall not be applied.

*Note: For description of the Adaptive Protection scheme, please refer to Appendix F of EPD 350.*

# 7 CP306: PLANT MAINTENANCE PROCEDURES

**PROCEDURE FM5/1XX**

**Issued XXXXX**

**ABB Is-limiter in a primary substation**

This work is to be carried out in accordance with the requirements of the policy and philosophy sections of this code of practice.

Maintenance should be undertaken in accordance with the requirements of section 7 of the manufacturer's instruction manual BA 323/04 E.

If there are known potential defects then, as work proceeds, ensure that:

- Either the defects do not exist or
- The defects existed in the past but have been rectified or
- The defects are rectified during this maintenance.

This work is to be carried out in compliance with the requirements of the Distribution Switchgear, General Procedure FM5/001.

**Notes:**

- Maintenance feedback checksheet to be completed to identify condition of equipment AS FOUND and AS LEFT
- Maintenance activities are carried out at frequencies stated in the CP 309 Appendix D and in accordance with the manufacturer's recommendations.

| | | PROCEDURE |
|---|---|---|
| **1.** | **ENTRY TO SUBSTATIONS**<br>Entry to substations shall be carried out in accordance with Procedure FM1/001. | FM1/001 |
| **2.** | **VANDALISM AND TRESPASS**<br>Observe the requirements of Procedure FM1/002. | FM1/002 |
| **3.** | **SAFETY DOCUMENTATION**<br>**THIS PROCEDURE SHOULD BE CARRIED OUT UNDER THE ELECTRICITY NORTH WEST ELECTRICITY DISTRIBUTION SAFETY RULES AND ASSOCIATED CODES OF PRACTICE AND WILL REQUIRE THE ISSUE OF AT LEAST ONE SAFETY DOCUMENT.** | |
| **4** | **CONDITION DATA CAPTURE**<br>Perform a non-intrusive Partial Discharge (PD) assessment of the Is-limiter and the housing using UltraTEV. or Ultrasonic PD activity. Record the UltraTEV indication status for each component surveyed in the Maintenance Feedback Checksheet.<br>Undertake visual checks of the Is-limiter for signs of corrosion and distortion or damage. | FM1/004 |

| | | PROCEDURE |
|---|---|---|
| **5** | **PROGRAMMED MAINTENANCE**<br>**All work on the isolated Is-limiter and the housing exterior must be carried out under a Limitation of Access.** | |
| **5.1** | Use Partial Discharge Monitor (Ultrasonic) to check busbar and feeder spouts. | FM4/011 |
| **5.2** | Carry out inspection and maintenance in accordance with section 7 of the ABB Instruction Manual BA 323/04 E. | |

After removal, inserts should be returned to the ABB factory for refurbishment.

# 8 CP 373 (ISSUE 2): PROTECTION SETTINGS FOR 33KV AND 11/6.6KV SYSTEMS

**APPENDIX A**

**Adaptive Protection and Is-limiters on 11(6.6)kV systems at primary substations**

- Section 10 “Protection Setting for Primary Transformers” should be read in conjunction with the following subsections:

**A1. Adaptive Protection on low voltage side of primary transformers**

The Adaptive Protection overcurrent relay installed on the low voltage side of primary transformers shall be non-directional.

The current setting is dependent upon the source impedance and shall be calculated by the network designer.

*Note: For a description of the Adaptive Protection scheme, please refer to Appendix F of EPD 350.*

**A2. Is-limiters**

Is-limiter settings are specific to the network conditions. The settings shall be determined by the Is-limiter manufacturer.

*Note: For a description of the Is-limiter scheme, please refer to Appendix G of EPD 350.*

# 9 CP608: ADAPTIVE PROTECTION OPERATIONAL INSTRUCTION

| SUBJECT:- SWITCHGEAR /SWITCHING | PROCEDURE: OPXX |
|---|---|
| SUBJECT HEADING:- OPERATIONAL PROCEDURES FOR ADAPTIVE PROTECTION IN THE RESPOND PROJECT | ISSUE:- 1 |
| | DATE : |

**Introduction**

The Adaptive Protection (AP) scheme utilises new protection equipment which is installed in the existing primary substations where there is an issue with fault level exceeding design ratings of equipment.

The AP equipment consists of a numeric protection relay which on detecting a feeder fault, trips circuit breaker(s) upstream of the faulted feeder to reconfigure the network prior to the feeder protection operating to clear the fault. Tripping of the upstream circuit breaker(s) increases the source impedance thereby reducing the fault current. *Note: Adaptive Protection cannot be applied where feeders are equipped with unit protection*.

A set of interposing current transformers (CTs) are installed on the LV side of the two primary transformers and their output is fed into a single AP relay. If the current setting threshold is exceeded the AP relay issues an instantaneous trip signal to the 11(6.6)kV bus section circuit breaker. Each section of busbar is then only supplied by one transformer and the fault contribution from the upstream network is reduced, resulting in less fault current flowing to a fault in the downstream network. If the Stage 1 action fails, then Stage 2 of the AP relay trips one of the 11(6.6)kV transformer circuit breakers and also the associated transformer 33kV circuit breaker where required by the network configuration.

The current setting is selected to operate for multiphase faults on the 11(6.6)kV system and avoid tripping for single phase to earth faults or load. Adaptive Protection operates without delay and in advance of the existing feeder protection relays so that existing relay settings are not required to be altered.

The following operational procedures have been written on the assumption that the fault level could be exceeded for some or all of the time.

**Remote control of Adaptive Protection**

Adaptive Protection can be switched IN/OUT via the CRMS. However, at primary substations where there is an issue with fault levels exceeding design ratings of equipment, the AP will be permanently enabled.

**Local control of Adaptive Protection**

Every substation equipped with Adaptive Protection will have an Adaptive Protection marshalling cabinet. Switching the selector switch to DISABLED will switch OUT the Adaptive Protection. To switch IN the Adaptive Protection the selector switch should be turned to ENABLED.

Note that the operation of the disabled/enabled switch sends a change of state signal to the CRMS.

**HV system parallels**

The Adaptive Protection can be left switched ‘IN’ for HV primary parallels but the paralleling criteria in CP 608 must still be followed. If the criteria requires the operation of the Txx, Tyy

or a bus section 11(6.6)kV circuit breaker (CB) at a primary substation with Adaptive Protection, the procedures in section 6, 7 or 8 should be followed.

**HV network faults**

The Adaptive Protection should be 'IN' and allowed to open its CB prior to the fault being cleared by the controlling CB on the relevant circuit. Once the fault has been disconnected by automatic switching, the CB controlled by the Adaptive Protection can be reclosed to restore system security.

**To open Txx, Tyy or bus section 11(6.6)kV CBs**

The following procedure should be adopted:

- **Open** Txx , Tyy or bus section 11(6.6)kV CB (fault level is now reduced)

Note that opening Txx, Tyy or bus section CBs will send an alarm to the control room stating that the Adaptive Protection is disabled.

**Work on Txx, Tyy or bus section 11(6.6)kV CBs**

- Follow procedure in Section 6
- Set selector switch on Adaptive Protection control panel to DISABLED, fix safety lock and post caution notice
- Remove the following fuses/links on the Adaptive Protection control panel to isolate the interposing CTs , fix caution notice/ caution notice tape.

  STAGE1 BUS SECT CB OPEN – FUSE AND LINK

  STAGE 2 T1X LV CB OPEN – FUSE AND LINK

  STAGE 2 T1X HV CB OPEN – FUSE AND LINK

*Note: Stage 2 preferably trips un-teed 33kV transformer circuits thus it could be Txx or Tyy depending on site 33kV topology.*

- Complete isolation and earthing in accordance with established procedures.

**To restore Txx, Tyy or bus section 11(6.6)kV CBs to normal service**

- Ensure CB is in service position
- Ensure Adaptive Protection relay is not indicating it is in a trip state
- Replace fuses/links removed in section 7(iii)
- Set selector switch on Adaptive Protection control panel to ENABLED
- Confirm that Adaptive Protection indicates 'IN' on the CRMS
- Immediately CLOSE Txx, Tyy, or bus section 11(6.6)kV CB.

# 10 CP608: Is-LIMITER INSTALLED IN PARALLEL OPERATIONAL INSTRUCTION

| SUBJECT:- SWITCHGEAR /SWITCHING | PROCEDURE: OPXX |
|---|---|
| SUBJECT HEADING: OPERATIONAL PROCEDURES FOR IS-LIMITER INSTALLED IN PARALLEL WITH BUS SECTION 11(6.6)KV CIRCUIT BREAKER | ISSUE:- 1 |
| | DATE : |

**Introduction**

The Is-limiter is a device that is capable of detecting and limiting a fault current before it reaches the first peak, ie in less than one millisecond and therefore allows the fault to be cleared by its controlling circuit breaker. The electronics in the device use the rate of rise of current to determine the peak fault current in conjunction with a current threshold value and if both of these are greater than a pre-defined setting, the electronics trigger the device to operate.

The operation of any one of the Is-limiter inserts fitted to each phase of the Is-limiter truck causes the series connected Is-limiter circuit breaker to trip.

The Is-limiter insert consists of a charge which operates to interrupt the main current carrying path and diverts the current through a fuse element which then operates to reduce the fault level on the network. After an Is-limiter insert has operated it must be changed for a new one.

The Is-limiter operates for the following faults:

- phase to phase
- phase to phase to phase
- phase to phase to earth
- phase to phase to phase to earth.

It should be noted that the settings of the Is-limiter are such that it does not operate for single phase to earth faults.

The Is-limiter and its circuit breaker are housed in a freestanding container unit and access is only available to specifically authorised persons. Spare inserts will be kept in the container unit and shall only be changed by a suitably trained and authorised person.

The following operational procedures have been written on the assumption that the fault level could be exceeded for some or all of the time.

*Figure 8.1: Insert holder and insert*

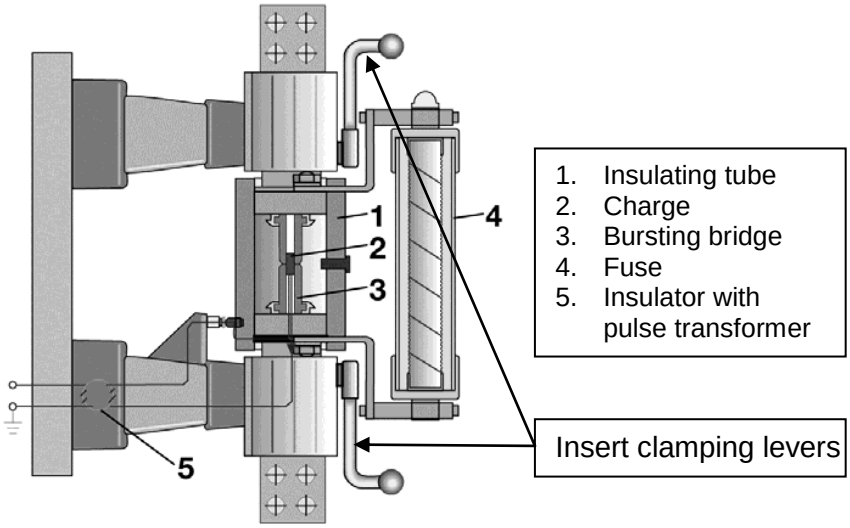
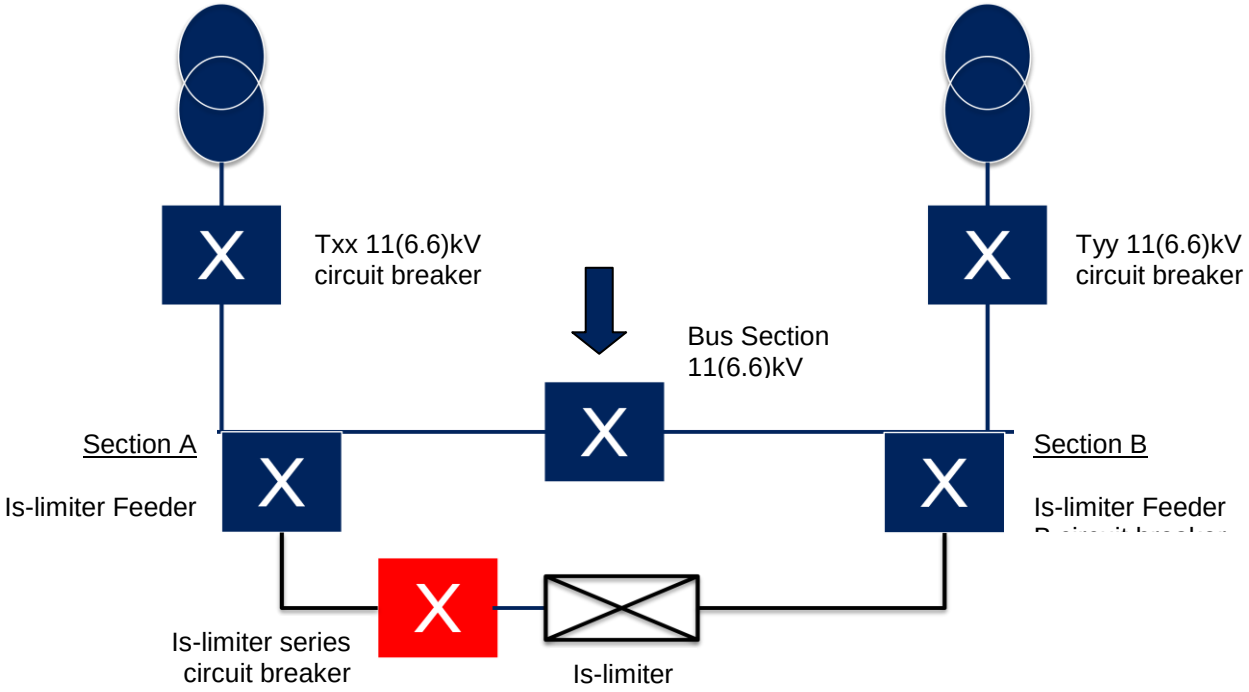



*Figure 8.2: View of an Is-limiter truck withdrawn from service*

*(Note that Is-limiter inserts may have only one fuse barrel)*

**System normal**

An Is-limiter installed at a primary substation is connected in parallel with the 11(6.6)kV bus section circuit breaker which is normally open. The Is-limiter must also be enabled to ON by the software in the CRMS.




X = **NEW CIRCUIT BREAKER**

**PLEASE NOTE THAT THE IS-LIMITER AND SERIES CB ARE HOUSED IN SEPARATE CONTAINER UNIT WHICH IS LABELLED**

**XX XX SUBSTATION**

**Is-LIMITER & SERIES CB SWITCHROOM**

**XXXXXX**

### System faults

A fault on the network when the fault level is above the pre-determined limit will cause the Is-limiter to operate and the Is-limiter series circuit breaker to open.

After the **fault has been cleared** the following actions should be taken by the control engineer.

- Confirm that the Is-limiter series CB is OPEN
- OPEN Is-limiter Feeder A 11(6.6)kV CB
- OPEN Is-limiter Feeder B 11(6.6)kV CB
- Switch OUT Is-limiter by telecontrol to disable further Is-limiter operations
- Arrange for Is-limiter inserts to be replaced.

### Is-limiter faults or device mal-operation

Should there be any concerns or associated alarms as to the functional state or health of the Is-limiter, Is-limiter series circuit breaker or if the system status indication is not believed (DBI) then the following action should be taken:

- OPEN Is-limiter Feeder A 11(6.6)kV CB
- OPEN Is-limiter Feeder B 11(6.6)kV CB.

If Section A (or B) Is-limiter Feeder A (or B) 11(6.6)kV CB trips then:

- OPEN the remaining Is-limiter 11(6.6)kV CB to de-energise the Is-limiter
- Switch out Is-limiter by telecontrol.

### Planned transformer outages

For a planned outage of a transformer

- Confirm all transformers are in service and carrying load
- Switch Is-limiter out by telecontrol to disable operation
- CLOSE bus section 11(6.6)kV CB
- OPEN Is-limiter Feeder A 11(6.6)kV CB
- OPEN Is-limiter Feeder B 11(6.6)kV CB
- Continue with the transformer outage in accordance with established procedures.

To restore Is-limiter

- Confirm Is-limiter series CB is CLOSED
- Confirm all transformers are in normal service
- CLOSE Is-limiter Feeder A 11(6.6)kV CB
- CLOSE Is-limiter Feeder B 11(6.6)kV CB
- Open bus section 11(6.6)kV CB
- Switch in Is-limiter by telecontrol to enable operation
- Confirm all transformers are sharing load.

### Planned bus section outage

- Confirm that bus section CB is OPEN.
- Continue with bus section outage in accordance with established procedures.

### 11(6.6)kV system parallels

11(6.6)kV system parallels shall be made in accordance with CP608 section 9.

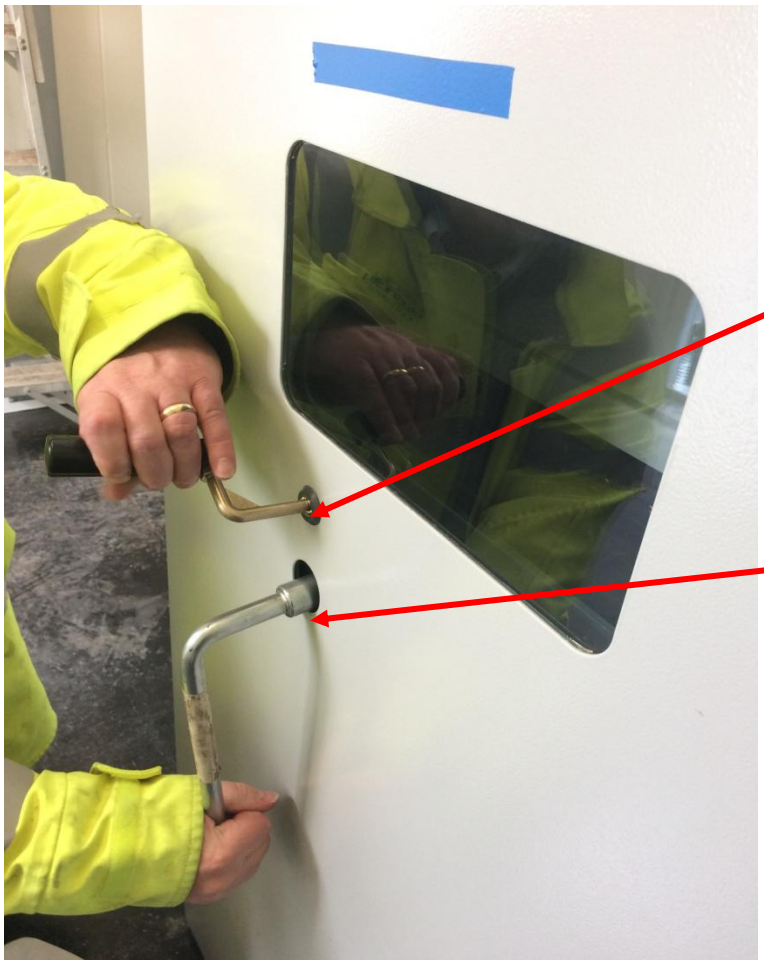
### $I_S$-limiter insert replacement

Access to the Is-limiter container is limited to suitably trained and authorised persons.

Is-limiter replacement procedure is as follows:

- Confirm all transformers are in service and carrying load
- Confirm Is-limiter series CB is OPEN
- OPEN Is-limiter feeder A 11(6.6)kV CB
- OPEN Is-limiter feeder B 11(6.6)kV CB
- Isolate Is-limiter series CB, apply safety lock and caution notice
- Isolate Is-limiter (see photo for operating details)
- Open Is-limiter door using key and apply safety lock and caution notice to busbar and feeder shutters
- Replace Is-limiter insert (note that Is-limiter insert replacement shall only be undertaken by a suitably trained and authorised person
- Remove safety locks and caution notices from busbar and feeder shutters
- Close and lock Is-limiter door using key
- Return Is-limiter to normal service location
- Restore Is-limiter CB to normal service location
- CLOSE Is-limiter series CB
- CLOSE Is-limiter feeder A 11(6.6)kV CB
- CLOSE Is-limiter feeder B 11(6.6)kV CB.

*Figure 8.3: Is-limiter door panel*



# 11 CP608: Is-LIMITER INSTALLED IN SERIES OPERATIONAL INSTRUCTION

| SUBJECT:- SWITCHGEAR /SWITCHING | PROCEDURE: OPXX |
|---|---|
| SUBJECT HEADING: OPERATIONAL PROCEDURES FOR IS-LIMITER INSTALLED IN SERIES WITH A TRANSFORMER INCOMER 11(6.6)KV CIRCUIT BREAKER | ISSUE:- 1 |
| | DATE : |

**Introduction**

The Is-limiter is a device that is capable of detecting and limiting a fault current before it reaches the first peak, ie in less than one millisecond and therefore allows the fault to be cleared by its controlling circuit breaker (CB). The electronics in the device use the rate of rise of current to determine the peak fault current in conjunction with a current threshold value and if both of these are greater than a pre-defined setting, the electronics trigger the device to operate.

The operation of any one of the Is-limiter inserts causes the Is-limiter series CB to trip.

The Is-limiter insert consists of a charge which operates to interrupt the main current carrying path and diverts the current through a fuse element which then operates to reduce the fault level on the network. After an Is-limiter insert has operated, it must be changed for a new one.

The Is-limiter operates for the following faults:

- phase to phase
- phase to phase to phase
- phase to phase to earth
- phase to phase to phase to earth

It should be noted that the settings of the Is-limiter are such that it does not operate for single phase to earth faults.

The Is-limiter and its Is-limiter series CB (ABB UniGear ZS1) are housed in a freestanding container unit (Txx transformer Is-limiter container).

Spare inserts for the Is-limiter will be kept in a box in the Txx transformer Is-limiter container and shall only be changed by a suitably trained and authorised person.

*Figure 9.1: Insert holder and insert*

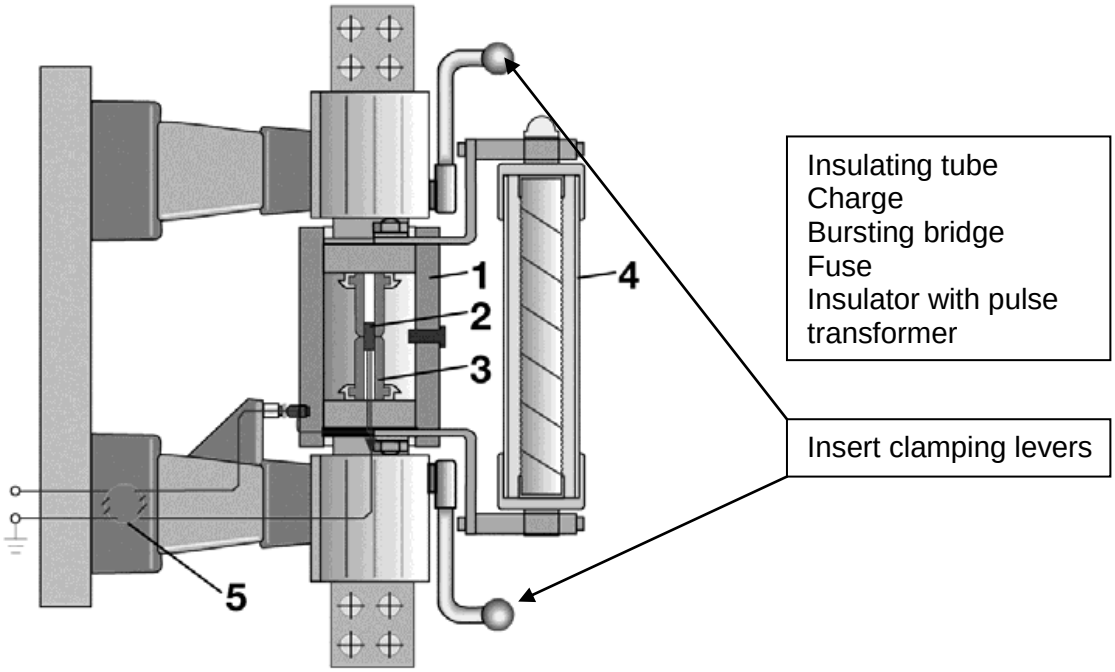
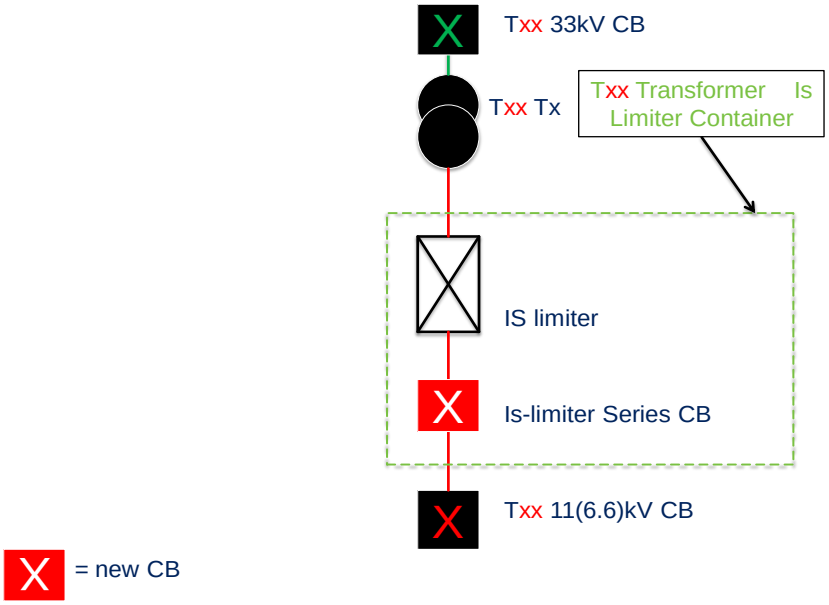



*Figure 9.2: View of an Is-limiter truck withdrawn from service (Note that Is-limiter inserts may have only one fuse barrel)*

### System normal

An Is-limiter and Is-limiter series CB installed at a primary substation are connected in series in between the Txx transformer and Txx 11(6.6)kV CB.




### Network faults causing the Is-limiter to operate

A fault on the network when the fault level is above the pre-determined limit will cause the Is-limiter to operate and the Is-limiter series CB to open.

After the **fault has been cleared** the following actions should be taken by the control engineer.

- Confirm that the Is-limiter series CB is OPEN
- Confirm that Tyy transformer has picked up all of the load
- Arrange for Is-limiter inserts to be changed.

### Is-limiter faults or device mal-operation

Should there be any concerns or any associated alarms as to the functional state or health of the Is-limiter then the following action should be taken:

- Confirm load (if any) on Txx transformer to help with investigation
- OPEN Txx 11(6.6)kV CB via telecontrol using normal operational transformer de-loading techniques
- OPEN Txx 33kV CB via telecontrol.

### Planned transformer outages

For a planned outage of Txx

- Confirm all transformers are in service and carrying load
- OPEN Txx 11(6.6)kV CB via telecontrol using normal operational transformer deloading techniques
- OPEN Txx 33kV CB via telecontrol
- Isolate Txx 33kV and Txx 11(6.6)kV CB, VT, tap change supplies, pumps, fans, NER supplies etc in accordance with standard operational procedures

- Earth via Txx 33kV and Txx 11(6.6)kV CB in accordance with standard operational procedures.

To restore Txx to normal service~:

- Confirm Txx 33kV, Txx 11(6.6)kV CB and VT are in normal service position and all auxiliary supplies are restored to normal
- Confirm Is-limiter series CB is CLOSED
- CLOSE Txx 33kV CB via telecontrol using normal operational transformer re-energisation techniques
- CLOSE Txx 11(6.6)kV CB via telecontrol using normal operational transformer re-energisation techniques
- Confirm Txx transformer is carrying load.

For a planned outage of the other transformer Tyy (ie not in series with Is-limiter):

- Confirm all transformers are in service and carrying load
- OPEN the Tyy11(6.6)kV CB via telecontrol using normal operational transformer deloading techniques
- OPEN the Tyy 33kV CB via telecontrol.

To restore other transformer Tyy to normal service:

- Restore the transformer Tyy on outage to normal service using normal operational transformer re-energisation and re-loading techniques
- Confirm the transformer Tyy is carrying load.

**11(6.6)kV system parallels**

11(6.6)kV system parallels shall be made in accordance with CP 608 section 9 and any requirements of this document.

**Is-limiter insert replacement**

Access to the Txx transformer Is-limiter container is limited to suitably trained and authorised persons.

Is-limiter insert replacement procedure is as follows:

- Confirm all other transformers are in service and carrying load
- OPEN Txx 11(6.6)kV CB via telecontrol using normal operational transformer de-loading techniques
- OPEN Txx 33kV CB via telecontrol using normal operational transformer de-loading techniques
- Confirm Is-limiter series CB is OPEN
- Isolate Is-limiter series CB safety lock and CN
- Isolate Is-limiter (see photo for operating details)
- Open Is-limiter door using key then apply safety lock and CN to busbar and feeder shutters
- Replace Is-limiter inserts (note that Is-limiter insert replacement shall only be undertaken by a suitably trained and authorised person)
- Remove safety locks and caution notices from busbar and feeder shutters
- Close and lock Is-limiter door using key
- Restore Is-limiter into service location
- Restore Is-limiter CB to service location
- CLOSE Is-limiter series CB via telecontrol
- CLOSE Txx 33kV CB via telecontrol using normal operational transformer re-loading techniques

- CLOSE Txx 11(6.6)kV CB via telecontrol using normal operational transformer re-loading techniques
- Confirm Txx transformer is carrying load.

*Figure 9.3: Is-limiter door panel*