

## Company Directive

### POLICY DOCUMENT: TP20

#### Relating to Protection Class Communication Links

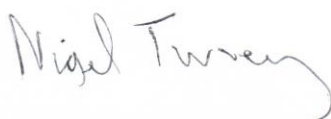
##### Policy Summary

This policy document contains the standard requirements for the protection class **Communication Links**, **Communication Bearers** and **Communication Channels**.

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**Implementation Date:** September 2019

**Approved by**



**Nigel Turvey**  
DSO and Future Networks Manager

**Date:** 25<sup>th</sup> September 2019

<b>Target Staff Group</b>	All staff involved with the specification, construction, operation, maintenance and removal of protection class Communication Links and associated protection systems
<b>Impact of Change</b>	Amber – All relevant staff shall comply with the requirements of this document
<b>Planned Assurance checks</b>	Six months after the issue of the document the policy Authors will check the next 5 protection class communication links to be commissioned to ensure compliance with this document

*All references to Western Power Distribution or WPD must be read as National Grid Electricity Distribution or NGED*

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## IMPLEMENTATION PLAN

### Introduction

POL: TP20 specifies the requirements for protection class **Communication Links**, **Communication Bearers** and **Communication Channels**.

### Main Changes

This is a new document

### Impact of Changes

POL: TP20 specifies the requirements for protection class **Communication Links**, **Communication Bearers** and **Communication Channels** used for unit protection, protection intertripping and protection class operational intertripping. The target group shall ensure the requirements of this document are applied in full.

<b>Target Staff Group</b>	All staff involved with the specification, construction, operation, maintenance and removal of protection class Communication Links and associated protection systems
<b>Impact of Change</b>	Amber – All relevant staff shall comply with the requirements of this document

### Implementation Requirements

Managers shall ensure that all their staff with the target group are familiar with and follow the requirements of this document.

### Implementation Timescale

This document shall be implemented on issue for new and significantly modified protection systems and protection class **Communication Links**, **Communication Bearers** and **Communication Channels**.

## REVISION HISTORY

Document Revision and Review Table		
Date	Comments	Name
September 2019	<ul style="list-style-type: none"><li>• New document</li></ul>	Andy Hood / Andrew Baker

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## 1.0 INTRODUCTION

This document specifies requirements for protection class **Communication Links**, **Communication Bearers** and **Communication Channels** utilised by Western Power Distribution WPD). This document is based on [ENATS 48-6-7](#) Communication Services for Tele-protection Systems and [ENATS 48-6-9](#) Communications Bearers for the provision of Tele-protection Channels.

**Communication Links** are provided for the data exchange between each pair of protection relays (intertripping relays or other protection relays). **Telecommunications Operators (TO's)** including WPD Telecoms shall not provide automatic fail over systems that automatically switch to an alternative link should the normal link fail. This is because some protection systems (e.g. unit protection systems) could mal-operate and initiate a trip if the associated **Communication Link** is switched. WPD provides back-up protection systems and/or triangulated intertripping/unit protection to deal with **Communication Link** faults.

Where there is any significant difficulty in applying these requirements the author shall be contacted who will review the situation and determine if a variation is appropriate.

## 2.0 SCOPE

This document is applicable to **Communication Links**, **Communication Bearers** and **Communication Channels** provided for protection intertripping, operational intertripping and for unit protection.

The start / end point of each **Communication Link** is deemed to be the terminals of the associated intertrip relay or unit protection relay, as applicable. Unless otherwise agreed the **TO** is responsible for providing the equipment (e.g. cable etc.) between multiplexers and WPD's protection relays.

## 3.0 DEFINITIONS

The following definitions apply for the purposes of this document:

### 3.1 Communication Link

The total system (mechanism and equipment) used to convey information between two points. It may comprise one or more types of communication bearer and provide one or more communication channels together with interfacing equipment located within Western Power Distributions' installations.

### 3.2 **Communication Bearer**

The physical entity which propagates the communication signals. It may comprise part, or all of, the **Communication Link**.

### 3.3 **Communication Channel**

The part of a **Communication Link** or Service dedicated to conveying the information (in both directions) for a prescribed protection function. One **Communication Link** may support more than one channel by the use of time division, frequency division or wavelength division multiplexing techniques.

### 3.4 **Differential delay**

Differential delay is caused by delay asymmetry in the go and return path of a particular channel. It is defined as the difference between the absolute values of go and return path propagation delay.

### 3.5 **Directly Connected Fibre Optic Link**

A point to point (i.e. protection relay to protection relay) inter-substation passive fibre link owned or operated on behalf of Western Power Distribution, such as Optical Ground Wire (OPGW), Optical Phase conductor (OPPC), Fibre Wrap, Underground Fibre Cable and All Dielectric Self Supporting (ADSS) cable.

### 3.6 **Optical Loss Margin**

The difference between the installed fibre optic link 'end to end' loss and the optical budget

### 3.7 **Optical Budget**

The difference between the guaranteed minimum transmitter optical output (i.e. the power launched into the core of 1 metre of the specified fibre) and the guaranteed minimum receive power which will enable the receiver to operate at the specified bit error rate over the specified temp range, expressed in decibels (dB).

### 3.8 **Optical Connector Insertion Loss**

The optical loss across a pair of mated connectors expressed in decibels (dB).

### 3.9 **Pulse Code Modulation (PCM)**

A technique used to digitise analogue information for transmission on a multiplexed digital **Communication Link**.

### 3.10 **Telecommunications Operator (TO)**

Provider of telecommunication services to Western Power Distribution

## 4.0 POLICY

A **Communication Link** and its associated **Communication Bearers** and **Communication Channels** convey (i.e. send and return) information between WPD protection relays. Since more than one communication bearer may be used in series to provide a single **Communication Link** or channel some of the end to end requirements, e.g. propagation delay and **Differential Delay**, are only achieved by limiting the maximum number of **Communication Bearers** used in series. Requirements for **Communication Bearers** are specified in ENATS 48-6-9.

### 4.1 Delivery Medium and Equipment Interfaces

4.1.1 The preferred service delivery medium is all dielectric optical fibre, however twisted copper pair cable or approved WPD Telecoms owned radio based technologies may also be used where the cost of fibre is prohibitive.

4.1.2 Where Line Isolation Units (LIU) form an integral part of the service delivery, the specified characteristics for the circuit should be inclusive of the LIU's.

#### 4.1.3 Voice Frequency Communication Links and Communication Bearers

Voice frequency **Communication Links** and **Communication Bearers** shall be four-wire twisted pair in accordance with EE SPEC: 78 and capable of full duplex transmission to ITU-T G712. The nominal characteristic impedance shall be 600 Ohms (balanced).

#### 4.1.4 Digital Communication Links and Communication Bearers

New or substantially modified equipment (protection relays and telecommunication equipment) shall be capable of providing a N x 64 Kbits/s digital service to IEEE C37.94.

Legacy equipment, i.e. installed prior to the issue of this document, may also provide a N x 64Kbits/s ITU-T G704 digital service via an ITU-T G703 interface or a N x 64Kbits/s ITU-T G704 digital service via an ITU-T X21 interface.

#### 4.1.5 Directly Connected Fibre Optic Links

Where directly connected fibre optic links are provided these shall be single mode fibres compliant with ITU-T G652. At least 2 additional spare direct fibres shall be allocated to WPD for each **Communication Link** that may be used to replace the original fibre should this fail.

## 4.2 Communication Link Parameters and Characteristics

**Communication Links** are allocated a category based on the type of application. All unit protection schemes (e.g. current differential etc.) require Category 1 **Communication Links** whereas protection intertripping and operational intertripping schemes require Category 3 **Communication Links**. Class 2 **Communication Links** are not normally specified by Western Power Distribution but information on these is also provided for completeness.

### 4.2.1 Signalling Speed

Digitally presented **Communication Links** shall be capable of full duplex operation at the declared wire speed (rate of data transfer).

### 4.2.2 Power Supplies

All equipment comprising part of the **Communication Link**, including line isolation units, shall be designed to operate from a nominal 48 V D.C. or 24V D.C battery system that satisfies the requirements of EE SPEC: 104. The equipment shall provide isolation from the incoming D.C. supply and its internally derived voltage rails. Mains independent operation shall be provided for at least 72 hours in the event of a complete mains failure.

### 4.2.3 Earthing

The equipment zero volt line and the equipment protective earth shall be segregated. The network termination equipment shall, therefore, be provided with separate zero volt and earth terminals. If segregation cannot be achieved, the equipment supplier / manufacturer shall state the recommended earthing practice.

### 4.2.4 Propagation Delay

**Communication Links**, **Communication Bearers** and **Communication Channels** shall be routed such that the propagation delay time incurred is as small as possible. The “end to end” delay must remain consistent with the measured end to end delay recorded during commissioning of the service. In practice small incremental variations within the operational maximum allowable end to end delays and **Differential Delays** are manageable if the incremental changes in characteristics do not occur more than once every five minutes.

The propagation delay for Category 1 **Communication Links** shall remain stable during the normal operational life of the channel. Any planned changes to the propagation delay shall be discussed and agreed with the asset owner of the associated protection scheme (e.g. the relevant Major Projects Manager) prior to being implemented as switching these links could inadvertently cause the associated protection systems to trip.



The maximum allowable **Communication Link** end to end delay is:

- Category 1 Service: 6 milliseconds
- Category 2 Service: 10 milliseconds
- Category 3 Service: 30 milliseconds

#### 4.2.5 Differential delay

The go and return path for a particular **Communication Channel** shall be routed together in the same physical media in order to minimise the Differential Delay.

The **Differential Delay** shall be less than or equal to:

- Category 1 Service: 400 microseconds
- Category 2 Service: 10 milliseconds
- Category 3 Service: 30 milliseconds

#### 4.2.6 Alarm Signalling

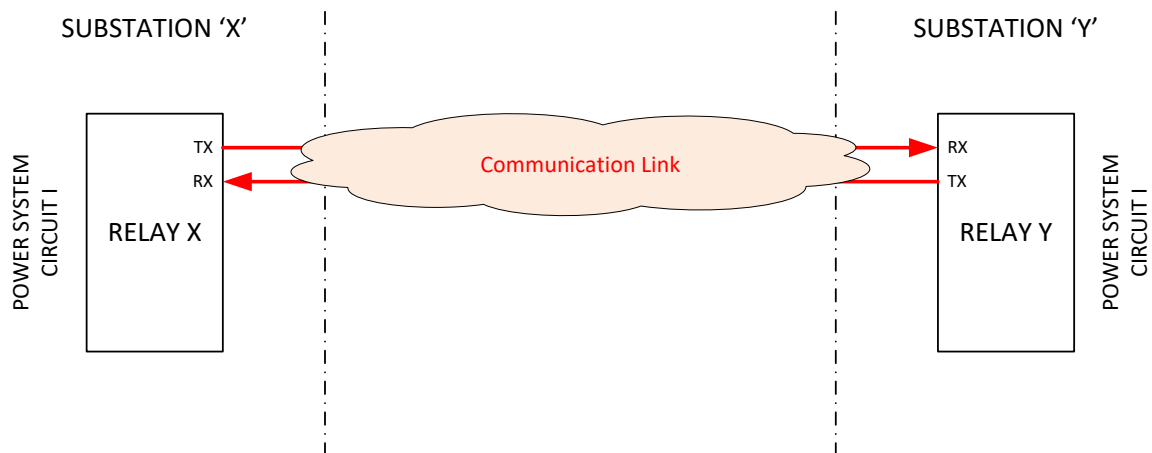
Where a N x 64 kbit digital channel contributes to, or is derived from, a higher order ITU-T G703 bit rate, indication of upstream failure shall be signalled downstream by a method compliant with ITU-T G703.

#### 4.2.7 Communication Link and Communication Bearer Separation

**Communication Links** and **Communication Bearers** contribute towards demand security, generation security, network integrity and system integrity as defined in WPD System Design (SD) Policy, e.g. POL: SD2, POL:SD3, POL:SD4 and POL:SD11. **Communication Links** and **Communication Bearers** shall be separated where this is needed to meet these requirements. For the purpose of these requirements failure of single item of communication equipment or the failure of a single **Communication Link** (e.g. a common mode failure) shall be considered in the same way as an outage of a primary system circuit such as an overhead line, cable or transformer.

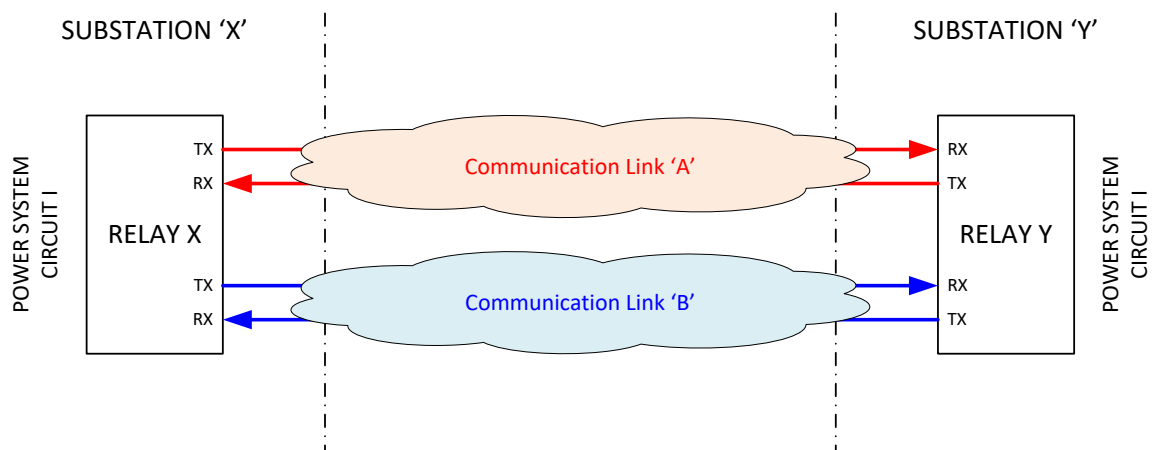
Where separation is required between two or more **Communication Links** and/or **Communication Bearers** any associated communication cables shall, as far as possible, be physically separated to prevent more than one cable being damaged by a single event (e.g. inadvertent excavation). Where communication cables are installed outside the perimeter of WPD substations a minimum separation of 1m is required between the relevant communication cables.

A series of examples are provided in Figure 1, 2, 3 and 4. The same principles should be applied to alternative arrangements.



*Note: As only a single **Communication Link** is required there are no segregation requirements*

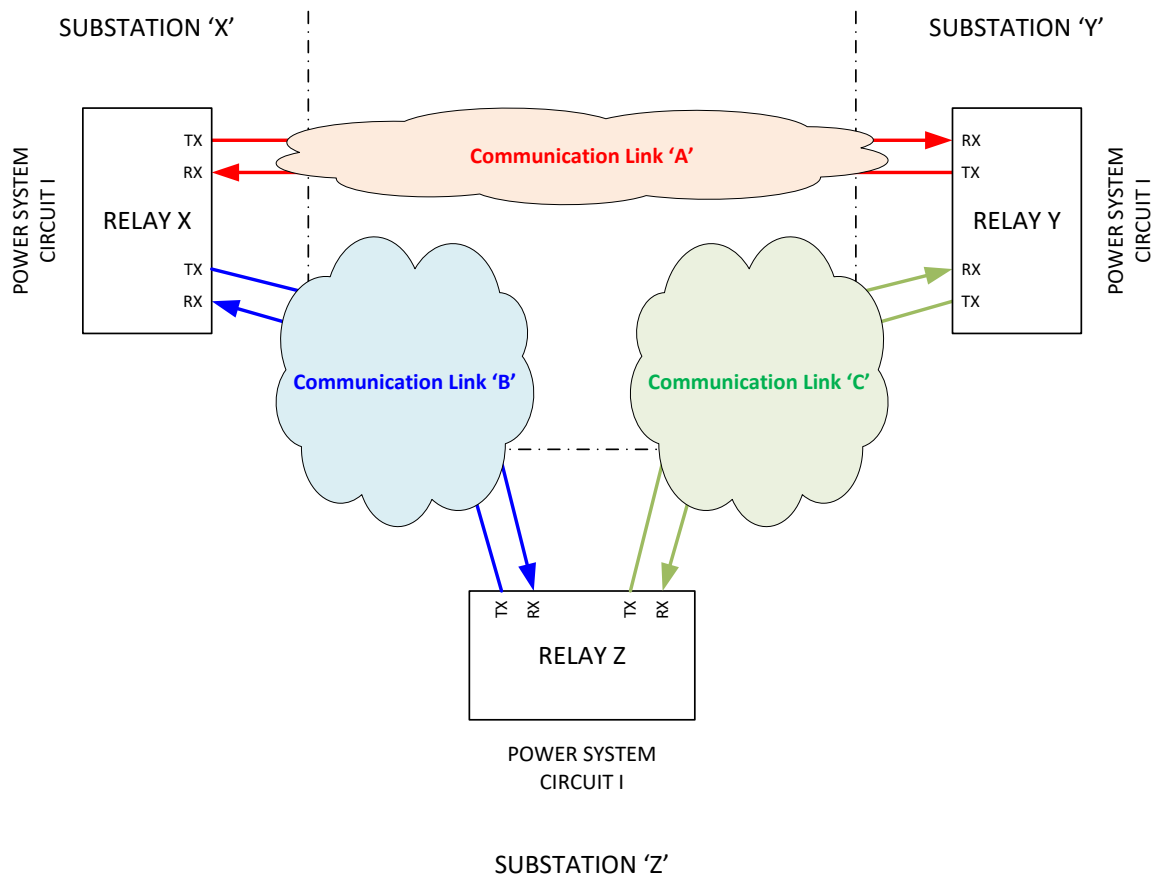
**Figure 1 Segregation Requirements - Single Communication Circuit**



*Notes: No single failure (e.g. D.C. power supply fuse, motherboard, multiplexer card, radio antenna, optical fibre, **Communication Bearer** etc.) should result in the concurrent failure of both **Communication Links**.*

*Where the communication media for link A and Link B consist of fibre optic cable or four wire twisted pair cable they shall be segregated from each other by at least 1m (where installed outside the perimeter of WPD substation/s).*

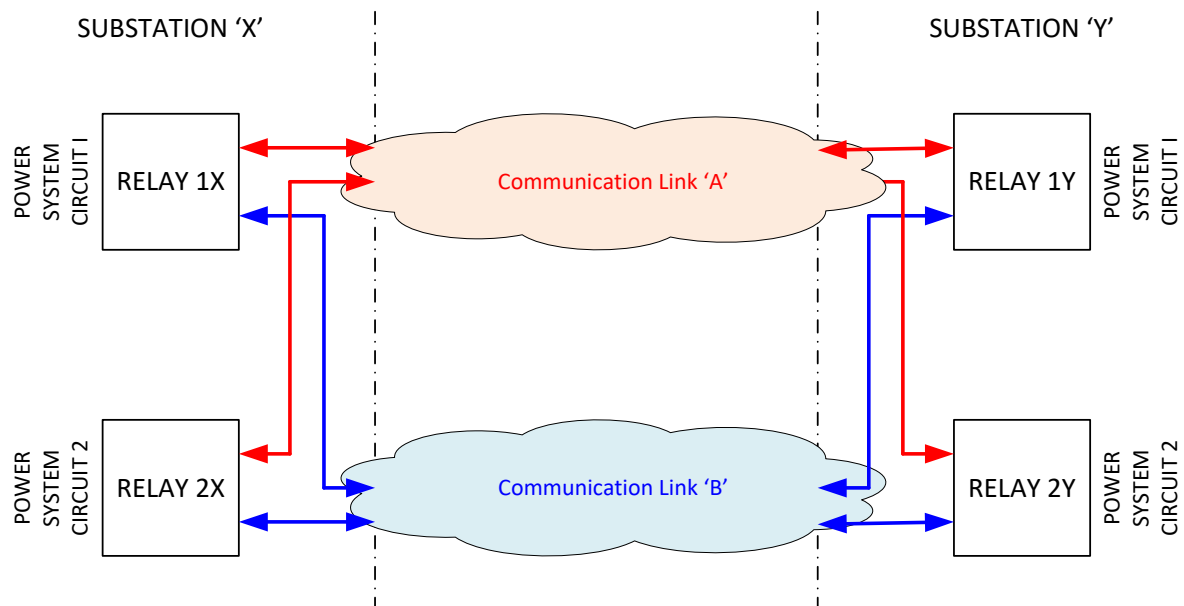
**Figure 2 Segregation Requirements – A Single Protection System with Dual Communication Links**



*Notes: No single failure (e.g. D.C. power supply fuse, motherboard, multiplexer card, radio antenna, optical fibre, **Communication Bearer** etc.) should result in the concurrent failure of two or more **Communication Links**.*

*Where the communication media for link A, Link B and/or Link C consist of fibre optic cable or four wire twisted pair cable they shall be segregated from each other by at least 1m (where installed outside the perimeter of WPD substations).*

**Figure 3 Segregation Requirements – A Single Protection System with Triangulated Communication Links**



*Notes: No single failure (e.g. D.C. power supply fuse, motherboard, multiplexer card, radio antenna, optical fibre, **Communication Bearer** etc.) should result in the concurrent failure of both **Communication Links**.*

*Where the communication media for link A and Link B consist of fibre optic cable or four wire twisted pair cable they shall be segregated by at least 1m (where installed outside the perimeter of WPD substations).*

**Figure 4 Segregation Requirements – Protection Systems Associated with Multiple Power Circuits**

#### 4.2.8 Re-Routing

Automatic **Communication Link**, **Communication Bearer** or **Communication Channel** switching shall not be employed. Where manual re-routing is proposed by the **TO** they shall contact the asset owner the protection asset owner (e.g. the relevant Major Projects Manager) to discuss and agree the details. WPD may need to take precautions before re-routing is carried out to prevent protection mal-operations. Re-routing may only be carried out with the asset owner's permission.

The new route shall meet the **Propagation Delay** and **Differential Delay** requirements specified in 4.2.4 and 4.2.5. The separation requirements in 4.2.7 may be relaxed temporarily where re-routing is required due to a circuit failure as long as the segregation is re-established once the failure has been rectified.

Furthermore, when switching a **Communication Link**, **Communication Bearer** or **Communication Channel** both the go and return paths for each **Communication Channel** shall be switched out prior to being switched in on an alternative path.

#### 4.2.9 Jitter

The maximum communication channel output jitter (for a digital channel) shall comply with the network limits defined in ITU-T G.823.

### 4.3 **Performance Requirements**

#### 4.3.1 Voice Frequency Communication Links

The channel shall perform in accordance with ITU-T G712.

#### 4.3.2 Digital Channels

The channel's overall error performance characteristics shall be in accordance with ITU-T G821 and the parameters shall meet the following requirements:

- Long term bit error ratio<sup>[1]</sup>: <10<sup>-8</sup>
- Number of degraded minutes<sup>[2]</sup>: <1.5%
- Number of severely eroded seconds<sup>[2]</sup>: <0.06%
- Number of eroded seconds<sup>[2]</sup>: <1.2%

*Notes:*

<sup>[1]</sup> The long term bit error shall be evaluated over a minimum period of 24 hours after excluding one second periods where the bit error rate is worse than 10<sup>-3</sup>.

<sup>[2]</sup> These performance requirements shall be derived from averaged data over at least a one month period.

#### 4.3.3 Directly Connected Fibre Optic Links

Directly connected fibre optic **Communication Links** shall meet the requirements of ITU-T G652. The Loss Margin shall be greater than 4dB.

For links longer than 100 Metres, the installed end to end loss is calculated as follows:

$$\text{End to End Loss} = (A_f \times L) + (A_s \times N_s) + (A_c \times N_c)$$

Where,

- L = Total length in km of the optical path
- A<sub>f</sub> = Fibre attenuation at the utilised wavelength - dB/km
- N<sub>s</sub> = Number of splices in the link
- N<sub>c</sub> = Number of connector pairs
- A<sub>c</sub> = Maximum insertion loss for a connector pair - dB
- A<sub>s</sub> = Maximum allowable splice loss.

#### 4.3.4 Channel Service Availability

The overall availability of any **Communication Link** shall not be less than 99.95%.

The difference between the total number of severely errored seconds and the total amount of unavailable time expressed as a percentage of total time shall not be greater than 0.002%

There shall, as far as possible, be no correlation between any disturbances in WPD's electricity network due to fault conditions, or otherwise, and any breaks or error events in the communication channel. Consequently, best endeavours shall be employed to prevent mal-operation of protective devices, insulation breakdown or the mal-operation of electronic equipment which comprises part of the **Communication Link**, during power network faults.

In accordance with 4.2.2 mains independent operation shall be provided for at least 72 hours in the event of a complete mains failure.

#### 4.3.5 Communication Link Restoration Times

Breaks in transmission shall be restored to a normal operational condition within 5 hours of a fault being detected or notified, as applicable, in 95% of cases for Category 1 Links and in 80% of cases for Category 2 and 3 Links.

The **TO** shall notify WPD's Control Centre of the likely time to clear the fault within 2 hours of it being detected / notified. The **TO** shall also notify WPD's Control Centre when the fault is cleared.

### 4.4 **Communication Link Test Requirements**

#### 4.4.1 Equipment Type Tests

Network terminal equipment installed within WPD's substations shall meet the requirements of [ENA EATS 48-5](#).

Compliance with the **Propagation Delay** and steady state **Differential Delay** requirements of 4.2.4 and 4.2.5 shall be demonstrated for **Communication Links** of all types.

#### 4.4.2 Voice Frequency Communication Link and Communication Bearer Acceptance Tests

For voice frequency **Communication Channels**, satisfactory compliance with ITU-T G712 for **PCM** channels shall be demonstrated for the following:

- Attenuation/Frequency distortion.
- Group delay distortion with frequency.
- Inter-channel and go-to-return crosstalk.
- Stability of loss.

- Compliance with the propagation delay and steady state **Differential Delay** requirements specified in 4.2.4 and 4.2.5.

#### 4.4.3 Digital Communication Channels

Each digital **Communication Channel** shall be monitored for at least 15 minutes to establish the long term bit error ratio. During this period, unavailable seconds, degraded minutes, severely errored seconds and error free seconds shall also be monitored to establish that the performance requirements specified in 4.3.2 can be met.

The monitoring equipment shall be connected at the 64 k/bits level and to the same channel as that to be used for the protection. The connection interface shall be identical to the type used for the protection equipment.

#### 4.4.4 Directly Connected Fibre Optic Channels

Each directly connected fibre optic channel shall be tested to ensure the requirements of 4.3.3 are satisfied.

## **APPENDIX A**

### **SUPERSEDED DOCUMENTATION**

This is a new document and no document is superseded by its issue.

## **APPENDIX B**

### **RECORD OF RESPONSE DURING CONSULTATION**

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## **APPENDIX C**

### **ANCILLARY DOCUMENTATION**

ENATS 48-6-7 Communication Services for Tele-protection Systems.

ENATS 48-6-9 Communications Bearers for the provision of Tele-protection Channels.

ENATS 48-5 Environmental Test Requirements for Protection Control Equipment and Systems.

POL: SD2 132kV Network Design.

POL: SD3 66kV and 33kV Network Design.

POL: SD4 11kV and 6.6kV Network Design.

POL: SD11 System Design Requirements for Load Management Schemes.

## **APPENDIX D**

### **KEY WORDS**

Protection, Communication, Links, Channels, Bearers. Channels, Propagation Delay, Differential Delay, Intertripping, Unit protection