

Title: **SCOPE OF WORK TEMPLATE  
FOR TELEPROTECTION  
PROJECTS**

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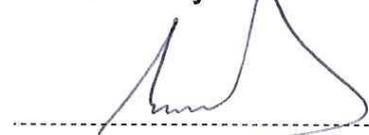


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## **Executive Summary**

The document provides a scope of work for Teleprotection and Power Line Carrier (PLC) projects for both Eskom Transmission and Distribution.

## **1. Introduction**

This is a scope of work template to be used by Project Planning and Application Engineers within PTM&C for Teleprotection and Power Line Carrier projects. It shall be used for the sending and receiving ends of Transmission and Distribution lines.

## **2. Supporting clauses**

### **2.1 Scope**

This document covers the contractor requirements for the Teleprotection and Power Line Carrier work carried out during a project.

#### **2.1.1 Purpose**

This document will provide the PTM&C planner with the tools to write a high level scope of work and the PTM&C applications engineer the tools to write the detailed scope of work.

#### **2.1.2 Applicability**

This document is applicable to the PTM&C Planning and Application engineers respectively.

## **2.2 Normative/informative references**

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

### **2.2.1 Normative**

- [1] ISO 9001, Quality Management Systems.
- [2] 240-75975613: Standard for the Installation of Power Telecommunications Equipment.
- [3] 240-91461878: Teleprotection Trip Testing
- [4] 240-96651735: Power Line Carrier and Associated Coupling Equipment: Commissioning and Major Maintenance Procedure.
- [5] TPC 41-89: Secondary Plant Line Trap Maintenance
- [6] TPC 41-84: PLC System Coupling Device Maintenance
- [7] 240-141828918: Design Standard For Teleprotection Systems
- [8] 240-103057370: Application Design Standard for Teleprotection Systems

### **2.2.2 Informative**

None

## **2.3 Definitions**

### **2.3.1 General**

None

### **2.3.2 Disclosure classification**

**Controlled disclosure:** controlled disclosure to external parties (either enforced by law, or discretionary).

## 2.4 Abbreviations

Abbreviation	Description
12/18 Z Cable	12/18 Z Teleprotection Cable; armoured.
BVX 4 ECV	4 core x 4mm <sup>2</sup> , stranded copper, armoured, PVC insulated power cable.
EA	Engineering Assistant at the station.
IDF	Intermediate Distribution Frame.
LME	Line Matching Equipment.
LT	Line Trap.
ODF	Optical Distribution Frame.
PLC	Power Line Carrier
RG 12 AU	75 Ω coaxial cable; armoured.
TPE	Teleprotection Equipment.
TPH 10 AX	10 pair x 0.5mm, Telephone, armoured PVC, APL, cable.
TVH 25 AX	25 pair x 0.5mm, Telephone, armoured PVC, APL, cable
X.21 Cable	6 pair Data cable, Armoured with each pair individually screened.

## 2.5 Roles and responsibilities

It is the responsibility of PTM&C to follow the guidelines outlined in this document.

## 2.6 Process for monitoring

The document will be monitored for relevance during the project lifecycle.

## 2.7 Related/supporting documents

Not applicable.

## 3. Document content

The generic scope of work for teleprotection between two or more substations should adhere to the Design Standard For Teleprotection Systems 240-90353855 as well as the Application Design Standard for Teleprotection Systems 240-103057370.

**Note:** The generic scope of work applies to approximately 80% of the projects. If there are other project requirements not fully covered by this scope of work, then PTM&C Technology Design shall be consulted to assist with the additional scope of work.

### 3.1 Introduction

There is a project to build or refurbish the protection/teleprotection system/s at XXX substation on XXX kV feeder/s no/s. X, X, X, and X ; this/these feeder bay/s is/are required to interface with feeder no/s. X, X and X at XXX substation and feeder no/s. X, X and X at XXX substation (add more if necessary). The existing protection and teleprotection information at the local and remote ends of the affected feeders are captured in Tables 1 and 2 respectively.

**Table 1: Existing Protection and Teleprotection Information at Local Station**

Local Station Name: XXXXXXXXX									
Item no.	kV	Feeder No.	Feeder Name	M1 Prot. Scheme Type, eg. Phase 1, 2 or 3	M1 Teleprot. Equip.	M1 Teleprot Comms Medium	M2 Prot. Scheme Type, eg. Phase 1, 2 or 3	M2 Teleprot. Equip.	M2 Teleprot. Comms Medium
1.									
2.									
3.									
4.									
5.									
6.									

\*add or delete rows if necessary.

**Table 2: Existing Protection and Teleprotection Information at Remote Stations**

Remote Station Name: XXXXXXXXX									
Item no.	kV	Feeder No.	Feeder Name	M1 Prot. Scheme Type, eg. Phase 1, 2 or 3	M1 Teleprot. Equip.	M1 Teleprot Comms Medium	M2 Prot. Scheme Type, eg. Phase 1, 2 or 3	M2 Teleprot. Equip.	M2 Teleprot. Comms Medium
1.									
2.									
Remote Station Name: XXXXXXXXX									
3.									
4.									
Remote Station Name: XXXXXXXXX									
5.									
6.									

\* add or delete rows if necessary.

### 3.1.1 Description of Work

This chapter comprises of a description of the protection, teleprotection and/or PLC work which is being done at the local and remote Substations. This is captured in tables 3 and 4.

The equipment which is to be installed is/are:

- a) List all the different equipment to be refurbished/replaced (Line Traps/LMEs/PLCs/Teleprotection Equipment).

All work must be done in accordance with the standards and specifications listed in this document.

**Table 3: New Protection and Teleprotection Information at Local Station**

Local Station Name: XXXXXXXXX									
Item no.	kV	Feeder No.	Feeder Name	M1 Prot. Scheme Type, eg. Phase 1, 2 or 3	M1 Teleprot. Equip.	M1 Teleprot Comms Medium	M2 Prot. Scheme Type, eg. Phase 1, 2 or 3	M2 Teleprot. Equip.	M2 Teleprot. Comms Medium
1.									
2.									
3.									
4.									
5.									
6.									

\* add or delete rows if necessary.

**Table 4: New Protection and Teleprotection Information at the Remote Stations**

Remote Station Name: XXXXXXXXX									
Item no.	kV	Feeder No.	Feeder Name	M1 Prot. Scheme Type, eg. Phase 1, 2 or 3	M1 Teleprot. Equip.	M1 Teleprot Comms Medium	M2 Prot. Scheme Type, eg. Phase 1, 2 or 3	M2 Teleprot. Equip.	M2 Teleprot. Comms Medium
1.									
2.									
Remote Station Name: XXXXXXXXX									
3.									
4.									
Remote Station Name: XXXXXXXXX									
5.									
6.									

\* add or delete rows if necessary.

### 3.1.2 Drawings and Diagrams

The contractor must ensure that they are in possession of the latest drawings which the project manager will source from the PTM&C Applications Engineer.

**Table 5: Drawings, Diagrams and Table Information required**

<b>Standards Required</b>	240-75975613: Standard for the Installation of Power Telecommunications Equipment .
<b>Drawings Required</b>	Substation XXX kV Drawing Reference Control Room Layout.
	Substation XXX kV (make, type of) Teleprotection Unit System Cabling Diagram Feeder 1
	Substation XXX kV (make, type of) Teleprotection Unit System Cabling Diagram Feeder 2
	Substation XXX kV (make, type of) PLC Cabling Diagram Feeder 1
	Substation XXX kV (make, type of) PLC Cabling Diagram Feeder 2
	Substation and Line Phasing Diagram (should be provided by Substation department)
<b>Annexures</b>	Annex A – LME Installation Diagram Annex B - Teleprotection Commissioning Completion Certificate
	Annex C - Power Line Carrier Inspection Sheet
	Annex D - Power Line Carrier Commissioning and Inspection Sheet
	Annex E - BILL OF MATERIAL
	Annex F - Checklist for requesting PLC transmit and receive frequencies from PTM&C Telecomms (T&S)
	Annex G - Teleprotection Trip Testing Sign-Off Document
	Annex H: Line Parameters for Line Trap Phase Location

### 3.2 Materials Required

### 3.3 Scope of Work

The contractor shall supply, install, terminate and test the teleprotection units and/or Line Traps and/or LME and/or PLC equipment mentioned in this document and will conform to the Standards and Specifications listed in this document.

#### 3.3.1 HV YARD

##### 3.3.1.1 Line Details

XXX kV Feeder Number: XXX

Feeder Name: XXX

##### 3.3.1.2 Line Traps (Delete section if not applicable)

Voltage rating (kV): XXX

Current rating (A): XXX

Fault Current Rating (kA): XXX

Inductance Rating (mH): XXX

Blocking Band (kHz): XXX

Creepage (mm/kV): XXX

For a 132kV line trap, a CC or CVT or insulators will be required. The CC and CVT is specified by Substations department and the 132kV insulator will be ordered with the Line Trap from the same supplier or supplier to ensure compatibility between Line Trap and CC or CVT.

The one/two XXX kV line traps are installed on the XXX (colour) and XXX (colour) phases.

The installation of the line traps shall be done by Eskom or Contractor.

### **3.3.1.3 Line Matching Equipment (Delete section if not applicable)**

Type: Band Pass/ High Pass (choose one)

LME Order Number XXX

- a) The contractor must install the LMEs on the Phases as shown on the Carrier System Cabling Diagram XXX and sheet 1.
- b) The contractor must install a  $75\Omega$  coaxial cable for each LME to be connected to the Power Line Carrier terminal equipment.
- c) The contractor must note that the breather holes of the LMEs must not be used for the coaxial cable glands.
- d) The contractor must number the coaxial cables at both ends as shown on drawing XXX.
- e) The contractor must install the 10 mm diameter copper rod from the HF terminal of the CVT to the LME as shown in Annexure A - LME Installation Diagram. The copper rod must be brazed and **NOT** crimped.

### **3.3.2 Carrier Room**

#### **3.3.2.1 Power Line Carrier (PLC) (Delete section if not applicable)**

##### **PLC Link 1**

##### **Local Substation Details**

Substation: XXX

Feeder: XXX

Feeder Number: XXX

PLC Direction: XXX line number XXX

PLC Label description :TELEPROTECTION – XXX

PLC Order Number: XXX

PLC Frequencies: Tx: XXXkHz, Rx: XXXkHz

PLC Type: XXX (e.g. ETL) XXX (e.g. 600)

PLC Frequency Type: 2 kHz/4 kHz (choose 1)

Functionality: Main 1/ Main 2 Teleprotection (choose 1)

Other Requirements: Teleprotection only/ Teleprotection with Speech and Data/ Teleprotection with Data/ Teleprotection Wide band (choose 1). If Data is used, specify bandwidth: 9.6 kbps/19.2 kbps, etc.

CCU Type: No CCU required/ CCU-2/ CCU-3 (choose 1)

##### **Remote Substation Details**

Substation: XXX

Feeder Name: XXX

Feeder Number: XXX

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PLC Direction: XXX line number XXX

PLC Label description :TELEPROTECTION – XXX

PLC Order Number: XXX

PLC Frequencies: Tx: XXXkHz, Rx: XXXkHz

PLC Type: XXX (e.g. ETL) XXX (e.g. 600)

PLC Frequency Type: 2 kHz/4 kHz (choose 1)

Functionality: Main 1/ Main 2 Teleprotection (choose 1)

Other Requirements: Teleprotection only/ Teleprotection with Speech and Data/ Teleprotection with Data/ Teleprotection Wide band (choose 1). If Data is used, specify bandwidth: 9.6 kbps/19.2 kbps, etc.

CCU Type: No CCU required/ CCU-2/ CCU-3 (choose 1)

**PLC Link 2** XXX (delete section if not applicable, if more PLC links are required, copy section))

**Local Substation Details**

Substation: XXX

Feeder Name: XXX

Feeder Number: XXX

PLC Direction: XXX line number XXX

PLC Label description :TELEPROTECTION – XXX

PLC Order Number: XXX

PLC Frequencies: Tx: XXXkHz, Rx: XXXkHz

PLC Type: XXX (e.g. ETL) XXX (e.g. 600)

PLC Frequency Type: 2 kHz/4 kHz (choose 1)

Functionality: Main 1/ Main 2 Teleprotection (choose 1)

Other Requirements: Teleprotection only/ Teleprotection with Speech and Data/ Teleprotection with Data/ Teleprotection Wide band (choose 1). If Data is used, specify bandwidth: 9.6 kbps/19.2 kbps, etc.

CCU Type: No CCU required/ CCU-2/ CCU-3 (choose 1)

**Remote Substation Details**

Substation: XXX

Feeder Name: XXX

Feeder Number: XXX

PLC Direction: XXX line number XXX

PLC Label description :TELEPROTECTION – XXX

PLC Order Number: XXX

PLC Frequencies: Tx: XXXkHz, Rx: XXXkHz

PLC Type: XXX (e.g. ETL) XXX (e.g. 600)

PLC Frequency Type: 2 kHz/4 kHz (choose 1)

Functionality: Main 1/ Main 2 Teleprotection (choose 1)

Other Requirements: Teleprotection only/ Teleprotection with Speech and Data/ Teleprotection with Data/ Teleprotection Wide band (choose 1). If Data is used, specify bandwidth: 9.6 kbps/19.2 kbps, etc.

CCU Type: No CCU required/ CCU-2/ CCU-3 (choose 1)

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- a) The Carrier cabinet and carrier set with the above mentioned frequencies will be installed in position TP XXX as shown on the attached Control Room Layout, XXX and must be installed as per 240-75975613 "Standard for the Installation of Power Telecommunications Equipment".
- b) The contractor must install cables as shown on the attached drawing XXX ETL 600 Carrier System Cabling Diagram XXXkV Feeder XXX.
- c) The coaxial cables must be numbered and glanded at both ends with sufficient slack for the carrier technician to fit the coaxial connector.
- d) The contractor must gland, terminate and number the 10 pair telephone cable in the carrier cabinet and to the IDF as shown in sheet No. XXX of XXX.
- e) The contractor must terminate the 18Z at the Carrier Cabinet end only. The cable must be glanded and lugged and there must be sufficient slack at the Protection Panel.
- f) The contractor must terminate, gland and number the BVX 4 ECV DC cable at the cabinet. An Eskom technician must be present when the supply cables are terminated at the 50VDC board.
- g) The contractor must terminate, gland and number the 220 V AC Norse cable to the 220V plug at the bottom of the cabinet. An Eskom technician must be present when this cable is terminated at the 220VAC board.

**3.3.2.2 Teleprotection Equipment (TPE)** (delete section if not applicable)

**Teleprotection Link 1** (delete section if not applicable, if more Teleprotection links are required, copy section)

**Substation 1 Details**

Substation: XXX

Feeder Name: XXX

Feeder Number: XXX

TPE Order Number: XXX

TPE Direction: XXX, Line No: XXX

TPE Type: NSD 570

TPE Position: Installed in the XXX Protection Panel or XXX Teleprotection Panel.

**Remote Substation Details**

Substation: XXX

Feeder Name: XXX

Feeder Number: XXX

TPE Order Number: XXX

TPE Direction: XXX, Line No: XXX

TPE Type: NSD 570

TPE Position: Installed in the XXX Protection Panel or XXX Teleprotection Panel.

- a) The Stringing and Cabling Contractor cabling the XXX 1 Protection Panel/ Teleprotection Panel (choose 1) will install the 6 pair X.21 Data cable between the Protection Panel and the BME. (delete section if not applicable)
- b) The fibre optic cable installation between the Protection Panel/ Teleprotection Panel (choose 1) and the Fibre Optic Cabinet will be detailed in the XXX, document reference XXX Fibre Optic Gantry to Substation Control Room Scope of Work Guideline. (delete section if not applicable)

### **3.4 Testing**

- a) All teleprotection equipment must be tested in accordance with the latest revision of Eskom's standard, 240-91461878: Teleprotection Trip Testing.
- b) All PLC and Coupling equipment must be tested in accordance with the latest revision of the following Eskom standards,
  - 1) 240-96651735: Power Line Carrier and Associated Coupling Equipment: Commissioning and Major Maintenance Procedure.
  - 2) TPC 41-89: Secondary Plant Line Trap Maintenance
  - 3) TPC 41-84: PLC System Coupling Device Maintenance
- c) If a contractor is tasked to provide the testing and commissioning of the Teleprotection, PLC and coupling equipment, then the contractor must submit a list of test equipment available together with their current calibration test certificates. All testing must be witnessed by Eskom. The contractor must arrange with the Project Manager when testing is to be done. The contractor shall comply to all Eskom's SHEQ (Safety, Health, Environment and Quality) requirements as stipulated by the Project Manager and/or Transmission Grid and/or Distribution Region (choose the applicable ones).

### **3.5 Documentation**

The commissioning and test results must be provided to the Eskom Project Engineer and/or Transmission and/or Distribution Eskom representative and/or the Eskom Project Manager on completion of this work:

- a) Test results as per the following Eskom standards for Commissioning and Testing,
  - 1) 240-91461878: Teleprotection Trip Testing
  - 2) 240-96651735: Power Line Carrier and Associated Coupling Equipment: Commissioning and Major Maintenance Procedure.
  - 3) TPC 41-89: Secondary Plant Line Trap Maintenance
  - 4) TPC 41-84: PLC System Coupling Device Maintenance
- b) Updated drawings showing the cable routing through the yard and to the Station, cable lengths and the layout in the control room.
- c) Full technical specification of all cables installed.
- d) A dated and signed hardcopy of results and specifications must be provided.
- e) The sign off sheet (Annex C) shall be completed by the Eskom Technician or Contractor and submitted.
- f) A PDF dated and signed soft copy of results and specifications must be provided. This should read: A signed hard copy as well as a soft copy in PDF format of all test results as well as supplied cable and material specifications shall be provided.

### **3.6 General**

- a) The successful contractor will be issued with a detailed scope of work.
- b) All new 18 Z teleprotection cables must be glanded and lugged with sufficient slack for the carrier technician to install and terminate.
- c) Gland all cables at both ends. Refer to document, 240-75975613: Standard for the Installation of Power Telecommunications Equipment.

**Notes:**

- 1) Armour glands must be used for all armoured cables.

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- 2) Compression glands for all unarmoured cables
- d) Where possible, all cables inside the cabinet must be tied back neatly or installed in the cable trunking provided in the cabinet.
- e) All cables, including existing coaxial cables, must be numbered at both ends as shown on the relevant drawings, attached to this scope of work. The drawings will be supplied to the successful contractor.
- f) All conductors of the telephone cables must be fanned out neatly.
- g) All conductors to be terminated, must be fitted with the appropriate “spade lugs”. Terminations to the Kröne tagblocks do not require lugs.
- h) On completion of all work, the contractor must ensure that the carrier cabinets, floors and trenches are cleaned of all wire cuttings, cable sheaths and other debris and placed in a location, identified by the station EA for disposal.
- i) The contractor must comply with Eskom’s waste disposal policy.
- j) All chequer plates must be cut and refitted by the contractor, after installation.
- k) The cable ends of all un-terminated cables must be sealed to prevent the ingress of moisture and water.
- l) The installation of the Teleprotection, PLC and coupling equipment, set out in this document, must be done by Eskom and/or Contractor.
- m) If a contractor is chosen for the installation, then the contractor must comply to all the Safety, Health, Environment and Quality requirements as stipulated by Eskom (Project Manager and/or Commercial and/or Grid/Region).
  - 1) The successful Contractor must complete the **Operating Regulations for High Voltage Systems (HV Regulations) Course**, and must be assessed and approved by the Grid or Regions or SHEQ where the work is to be performed.
  - 2) Power Telecomms must be included in the assessment of any new contractor.
  - 3) The Successful contractor must be on site when the power line carriers are being commissioned to assist with the cables and glanding of cables.
  - 4) The successful tenderer must ensure that there are two teams who will do the installation work.

#### 4. Authorization

This document has been seen and accepted by:

Name and surname	Designation
Lenah Mothata	Senior Manager – Grids
Barry Clayton	Chief Engineer – Secondary Plant, Works Planning and Centralized Services
Sikelela Mkhabela	Senior Manager – DX
Prudence Madiba	Senior Manager – GX
Isabel Fick	Senior Manager – Eskom Telecommunications
Maureen Mokone	Senior Manager – GIT
Lloyd Chego	Senior Manager – Group Security

## 5. Revisions

Date	Rev	Compiler	Remarks
July 2019	1	R.Gangat	Original document.

## **6. Development team**

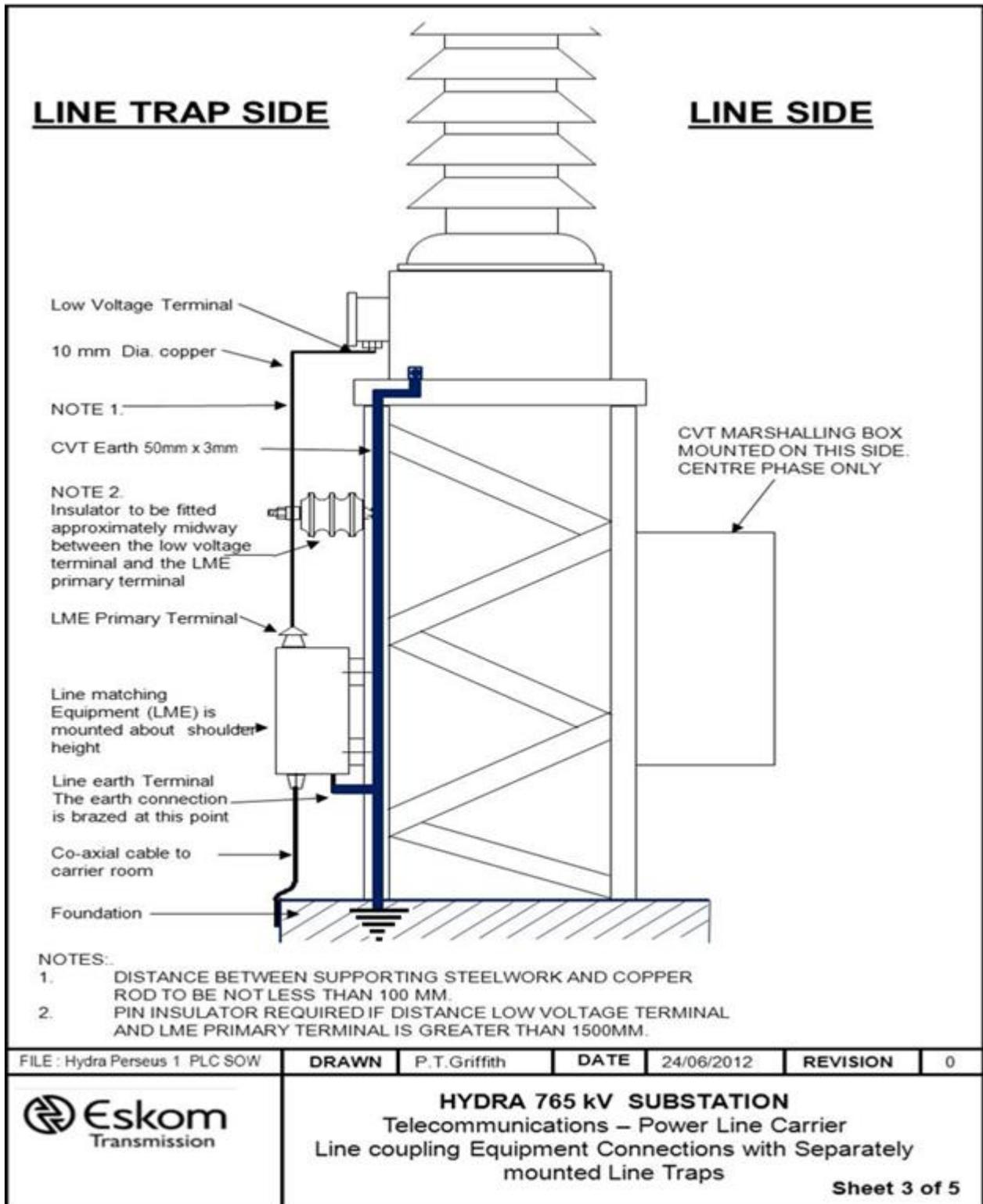
The following people were involved in the development of this document:

- T. Gosai

## **7. Acknowledgements**

- A. Pereira (Tony)
- A. Van Der Poel

**Annex A – LME Installation Diagram**



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**Annex B – Teleprotection Commissioning Completion Certificate**

	Reference	Rev																								
	Annex A	1																								
Teleprotection Commissioning Completion Certificate.																										
Station Name	Distant Station Name																									
Grid	Line number.																									
Date Commissioning Completed																										
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 80%;">Equipment Commissioned according to Accepted Standards and Guidelines</th> <th style="width: 20%;">Yes / No</th> </tr> </thead> <tbody> <tr> <td>240-96651735: Power Line Carrier and Associated Coupling Equipment: Commissioning and Major Maintenance Procedure.</td> <td style="text-align: center;">[   ]</td> </tr> <tr> <td>TPC41-84: Coupling Equipment Commissioned according to Procedure PLC System Coupling Device Maintenance</td> <td style="text-align: center;">[   ]</td> </tr> <tr> <td>Power Line Carrier Commissioned according to Manufacturers Design Documentation.</td> <td style="text-align: center;">[   ]</td> </tr> <tr> <td>240-91461878: Teleprotection Trip Testing</td> <td style="text-align: center;">[   ]</td> </tr> <tr> <td>All circuits and alarms commissioned and tested with relevant Control centres</td> <td style="text-align: center;">[   ]</td> </tr> <tr> <td>All information filled in correctly and the equipment installed as per the Scope Of Work (SOW) for the Power Line Carrier and Associated Teleprotection Equipment supplied.</td> <td style="text-align: center;">[   ]</td> </tr> <tr> <td>Power Line Carrier and Associated Teleprotection Equipment commissioned and ready to be returned to commercial operation.</td> <td style="text-align: center;">[   ]</td> </tr> <tr> <td>8. Have you received the test result certificate from Eskom Telecommunications Regional Commissioning Technician for the new 64KBits Radio Teleprotection Circuit. The Bit Error Ratio (BER) must be &lt; 10<sup>-6</sup>, after being tested for 1hr.</td> <td style="text-align: center;">[   ]</td> </tr> <tr> <td>9. Is the Cabinet installation done by the Contractor done as per 240-75975613 “Standard for the Installation of Power Telecommunications Equipment”.</td> <td style="text-align: center;">[   ]</td> </tr> <tr> <td>10. All fibre optic terminations done and tested and equipment end to end tested according to the <a href="#">document reference XXX</a> Fibre Optic Gantry to Substation Control Room Scope of Work Guideline.</td> <td style="text-align: center;">[   ]</td> </tr> <tr> <td>11. X.21 cable terminated and tested between the BME and the Teleprotection Equipment and end to end tests completed”.</td> <td style="text-align: center;">[   ]</td> </tr> </tbody> </table>			Equipment Commissioned according to Accepted Standards and Guidelines	Yes / No	240-96651735: Power Line Carrier and Associated Coupling Equipment: Commissioning and Major Maintenance Procedure.	[   ]	TPC41-84: Coupling Equipment Commissioned according to Procedure PLC System Coupling Device Maintenance	[   ]	Power Line Carrier Commissioned according to Manufacturers Design Documentation.	[   ]	240-91461878: Teleprotection Trip Testing	[   ]	All circuits and alarms commissioned and tested with relevant Control centres	[   ]	All information filled in correctly and the equipment installed as per the Scope Of Work (SOW) for the Power Line Carrier and Associated Teleprotection Equipment supplied.	[   ]	Power Line Carrier and Associated Teleprotection Equipment commissioned and ready to be returned to commercial operation.	[   ]	8. Have you received the test result certificate from Eskom Telecommunications Regional Commissioning Technician for the new 64KBits Radio Teleprotection Circuit. The Bit Error Ratio (BER) must be < 10 <sup>-6</sup> , after being tested for 1hr.	[   ]	9. Is the Cabinet installation done by the Contractor done as per 240-75975613 “Standard for the Installation of Power Telecommunications Equipment”.	[   ]	10. All fibre optic terminations done and tested and equipment end to end tested according to the <a href="#">document reference XXX</a> Fibre Optic Gantry to Substation Control Room Scope of Work Guideline.	[   ]	11. X.21 cable terminated and tested between the BME and the Teleprotection Equipment and end to end tests completed”.	[   ]
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8. Have you received the test result certificate from Eskom Telecommunications Regional Commissioning Technician for the new 64KBits Radio Teleprotection Circuit. The Bit Error Ratio (BER) must be < 10 <sup>-6</sup> , after being tested for 1hr.	[   ]																									
9. Is the Cabinet installation done by the Contractor done as per 240-75975613 “Standard for the Installation of Power Telecommunications Equipment”.	[   ]																									
10. All fibre optic terminations done and tested and equipment end to end tested according to the <a href="#">document reference XXX</a> Fibre Optic Gantry to Substation Control Room Scope of Work Guideline.	[   ]																									
11. X.21 cable terminated and tested between the BME and the Teleprotection Equipment and end to end tests completed”.	[   ]																									
Teleprotection Equipment Commissioned by: _____ Grid Representative: _____ (Commissioning Technician)																										
_____ Signature	_____ Signature																									
_____ Print name	_____ Print Name																									

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Tx/Eng./Power Telecomms/Technology.  
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Annex C – Power Line Carrier Inspection Sheet

Powerline Carrier Inspection Sheet.(To be completed by the Contractor and the carrier Technician).

Contractor:..... Installer:.....(Print)

Signed:..... Date:.....

Line Details

Station: Direction:

Line Voltage: kV Feeder No: Line No:

Microwave Teleprotection Details: Make:..... Serial No:.....

- 1. Teleprotection unit installed in Teleprotection Cabinet or  Protection Panel
- 2. Cables glanded and installed correctly as per drawing
- 3. Cables numbered correctly as per drawing

Powerline Carrier Details:

Upper SSB

Type:	<input type="text"/>	Serial No:	<input type="text"/>
Tx Freq	<input type="text"/> kHz	Rx Freq	<input type="text"/> kHz

Lower SSB

Type:	<input type="text"/>	Serial No:	<input type="text"/>
Tx Freq	<input type="text"/> kHz	Rx Freq	<input type="text"/> kHz

- 1. Check that all equipment is supplied as per order.
- 2. Mount, Install and earth the cabinet as per Eskom Standard 240-75975613
- 3. Install telephone cables to IDF as per drawing.
- 4. Install DC cables correctly.
- 5. Gland cables correctly to the gland plate.
- 6. Boot cable ends correctly.
- 7. Number all cables corresponding to the drawings.
- 8. Terminate cables correctly as shown on drawings.
- 9. Label cabinet correctly.
- 10. Mark up drawing found in the scope of work.
- 11. Check that rodent and vermin prevention measures are in place.
- 12. Ensure correct CCU is installed.


LME Detail: Make:..... Serial No:.....

- 1. Separate coaxial cables from each LME to carrier room.
- 2. 10 mm<sup>2</sup> un-insulated copper rod installed between the LME and CVT.
- 3. Support for the copper rod where CVT is mounted very high.
- 4. LME mounted ± 1.5 m from the ground.
- 5. LME mounted on station side of structure.
- 6. LME earthed with 50 x 3 mm flat copper or 2 x 10 mm copper rods.
- 7. Cables glanded and numbered See Note 1


Note 1: DO NOT Drill holes in the LME or use the Breather holes for the Coaxial Cables

---

**Defects** (Record and report defects found with the panel immediately)


Eskom representative: (Carrier Technician)

**Print Name:**..... **Signed:**..... **Date:**.....

## Annex D – Power Line Carrier Commissioning and Inspection Sheet

### Powerline Carrier and Coupling Equipment Commissioning and Inspection Sheet

(This document is adapted from the document 240-96651735: “Power Line Carrier and Associated Coupling Equipment: Commissioning and Major Maintenance Procedure”)

To be completed by the PLC Technician.

**Technician :** .....(Print) **Date:**.....

**Signed:**.....

#### 1. Line Details

Station: ..... Direction: .....

Line Voltage: ..... kV Feeder No: ..... Line No: .....

Conductor Configuration:	Single	Twin	Trip	Quad	Hex

Tower Type

Flat Horizontal		Vertical	
Giraffe		Double circuit	
Delta,		Inverted Delta	
Cross rope Horizontal		Other (Specify)	

Detail

#### 2. Line Trap Details

Record the following details:

1. Line phasing Looking towards the line
2. Line Trap Make
3. Line Trap Type
4. Serial Number
5. Phases on which the LTs are installed
6. Inductance
7. Continuous Current
8. Fault Current

.....-Ø	.....-Ø	.....-Ø
mH	mH	mH
Amps	Amps	Amps
kA	kA	kA

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9. Blocking Band	kHz	kHz	kHz
10. Creepage (Heavy/Very Heavy – 25/31 mm/kV)			
11. LTs installed on correct phases as per station electric drawing at both ends.			
12. Correct LTs, surge arresters and tuning units installed			
13. LTs, CCs/CVTs are correctly installed and earthed as per design guide.			
14. Haefely LT cross arms drilled to let moisture escape.			

**3. Tuning Unit Details**

1. Inductance	mH	mH	mH
2. Continuous Current	Amps	Amps	Amps
3. Fault Current	kA	kA	kA
4. Blocking Band	kHz	kHz	kHz

**4. CVT Details**

1. Make			
2. Serial Number			
3. Total Capacitance			
4. CVTs/CC are installed on the line side of the Line Traps.			
5. No earth on CVT/cc LV connection point except uncoupled phase.			

**5. LME Details**

	.....-Ø	.....-Ø	.....-Ø
1. Make			
2. Serial Number			
3. Type (e.g. A9-BS)			
4. High pass or band pass.			
5. Strappings of the LMEs			
6. Correct LME installed as per application.			
7. Separate coaxial cables from each LME to carrier room.			
8. 10 mm <sup>2</sup> un-insulated copper rod installed between the LME and CVT.			
9. Support for the copper rod where CVT is mounted very high.			
10. LME mounted ± 1.5 m from the ground.			
11. LME mounted on station side of structure. (Shortest distance to the CVT terminal)			
12. LME earthed with 50 x 3 mm flat copper or 10 mm <sup>2</sup> round copper.			
13. For 3 phase coupling, the output of the LME to the CCU input X4, is reversed.			

6. Coaxial Cable Details

- 1. Numbers (As per drawings)
- 2. Correct Coaxes (75Ω) Installed
- 3. Connection of coaxes to CCUs correct
- 4. Coax Armouring earthed at both ends.

R	<input type="text"/>	W	<input type="text"/>	B	<input type="text"/>
					<input type="text"/>
					<input type="text"/>
					<input type="text"/>

7. Carrier Combining Details

- 1. Coupling Arrangement:.....
- 2. CCU make:..
- 3. Couple and mark the correct coaxial cables to the inputs of CCU.
- 4. Ensure correct CCU is installed.
- 5. Ensure CCU is securely fixed and correctly earthed.

<input type="text"/>
<input type="text"/>
<input type="text"/>
<input type="text"/>

8. Powerline Carrier Details:

Upper SSB

- SSB No:
- Tx Freq
- Rx Freq
- Modem (NSK 5/other)
- Line Protection

<input type="text"/>
<input type="text"/>
<input type="text"/>
<input type="text"/>

- Type:
- Order No:
- Serial no:
- Power

<input type="text"/>
<input type="text"/>
<input type="text"/>
<input type="text"/>

Channel 1: Channel 2: Channel 3:  
 .....  
 .....

Lower SSB

- SSB No:
- Tx Freq
- Rx Freq
- Modem (NSK 5/Other)
- Line Protection

<input type="text"/>
<input type="text"/>
<input type="text"/>
<input type="text"/>

- Type:
- Order No:
- Serial no:
- Power

<input type="text"/>
<input type="text"/>
<input type="text"/>
<input type="text"/>

Channel 1: Channel 2: Channel 3:  
 .....  
 .....

The following must be checked:

- 1. Check that all equipment is supplied as per order.
- 2. Ensure the cable numbers correspond with the drawings.
- 3. Ensure that the cables are terminated correctly and mark up drawings.
- 4. Ensure that the cabinet is correctly labelled.
- 5. Check that rodent and vermin prevention measures are in place.
- 6. Check that the coax inputs are fitted with gas discharge tubes.

<input type="text"/>

**PLC INSPECTION, ALIGNMENT AND TESTING**

A. Tested when Line is Dead!

1. Cabinets, gland plates, racking etc. correctly earthed.
2. Protection, speech and alarm cables correctly wired and marked.
3. PLC cabinet and frame correctly labelled.
4. Alarms operating on PLCs (and alarm annunciator where applicable)
5. Alarms tested to all control centres
6. Local TPE & PIA levels performed and correctly strapped.
7. End to end levels correct.
8. Equalisation performed.
9. PLC Serial/ order No, programming and alignment details recorded in alignment schedule


**Note:** Trip testing in conjunction with Protection/Test department in accordance with 240-91461878: Teleprotection Trip Testing.

B. Tested when Line is Alive!

1. Pilots measured?
2. Noise measured in PLC operating frequency band?
3. Hybrid balance rechecked?
4. Equalisation rechecked? (only if speech functions used)


**END TO END RESULTS OVER THE PLC BANDWIDTH.**

Upper SSB No. ....			
Freq.	Insertion Loss (dB)	Return Loss (dB)r	Loss
Hz			

Lower SSB No. ....			
Freq.	Insertion Loss (dB)	Return Loss (dB)r	Loss
Hz			

---

**MICROWAVE TELEPROTECTION INSPECTION AND TESTING**

1. Teleprotection unit installed in Teleprotection Cabinet	<input type="text"/>	Protection Panel	<input type="text"/>
2. Teleprotection equipment Serial No.	<input type="text"/>	Order No:	<input type="text"/>
3. Teleprotection Supply Voltage (50, 110 or 220 Vdc)	<input type="text"/>	Address	<input type="text"/>
4. Teleprotection unit correctly earthed.			<input type="text"/>
5. Cables glanded and numbered correctly as per drawing			<input type="text"/>
6. Alarms operating on TPE (and alarm annunciator where applicable)			<input type="text"/>
7. Alarms tested to all control centres			<input type="text"/>
8. Local TPE & PIA correctly strapped.			<input type="text"/>
9. PFA tests done on the data channel for bit error rate.			<input type="text"/>

Remarks:

SCOPE OF WORK TEMPLATE FOR TELEPROTECTION PROJECTS

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POWERLINE CARRIER COMMISSIONING SHEET 240-96651735				Technician Name (Print)			Sign.							
Station:	..... SS		Distant Station	..... SS			Line No	.....	Date					
Freq. (kHz)	Line Trap Blocking (Ohms)			LME CHARACTERISTICS						End to End tests		Noise(dBm/u) 24Hz		Freq. (kHz)
				Insertion loss (dB)			Return loss (dB)			Insertion loss(dB)	Return loss (dB)	Before Energising	After Energising	
	-∅	-∅	-∅	-∅	-∅	-∅	-∅	-∅	-∅					
20														20
40														40
60														60
80														80
100														100
120														120
140														140
160														160
180														180
200														200
220														220
240														240
260														260
280														280
300														300
320														320

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**Annex E – Bill of Materials**

Item	Description	Measurement	Qty	Unit Price	Total Price
1	Preliminary and General (including site establishment at ..... access, etc.)	Sum	0		
2	Preliminary and General (including site establishment at ..... access, etc.)	Sum	0		
3	Survey, XXX Station (on site verifications of the Scope of Work, and finalising of cabinets, cable, materials, etc.)	Sum	0		
4	Dismantling and Removal of Equipment. (delete section if not applicable)				
4.1	Removal of existing Carrier panel (PLC) from the West Control Room	ea	0		
4.2	Removal of existing Microwave Teleprotection Equipment (TPE).	ea	0		
4.3	Removal of existing Line Matching Equipment (LME).	ea	0		
4.4	Removal of existing IDF	ea	0		
4.5	Removal of Capacitor Voltage Transformers including Steelwork	ea	0		
4.6	Removal of Coupling Capacitor. including Steelwork	ea	0		
4.7	Removal of Line Traps including Steelwork	ea	0		
4.8	Removal of Standard Equipment Cabinet	ea	0		
2	Erection of Equipment (delete section if not applicable)				
5.1	Install Carrier Cabinets a shown on the attached drawings	ea	0		
5.2	Install NSD 570 (Usually installed in the Protection Panel)	ea	0		
5.3	Install Line Matching Equipment LME as shown in the attached sketches	ea	0		
5.4	Install IDF	ea	0		
5.5	Installation of Capacitor Voltage Transformers including Steelwork	ea	0		
5.6	Installation of Line Traps including Steelwork	ea	0		
5.7	Installation of Line Traps including Steelwork	ea	0		

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Item	Description	Measurement	Qty	Unit Price	Total Price
5.8	Installation of Standard Equipment Cabinets	ea	0		
6	Disconnect and remove existing Cables. (delete section if not applicable)				
6.1	Disconnect and Remove Existing Power Cables BVX 4 ECV.	m	0		
6.2	Disconnect and Remove Existing Telephony Cables TPH 10 AX	m	0		
6.3	Disconnect and Remove Existing Telephony Cables TPH 25 AX	m	0		
6.4	Disconnect and Remove Existing Coaxial Cables RG 21 AU	m	0		
6.5	Disconnect and Remove Existing Teleprotection Cables 12 Z	m	0		
6.6	Disconnect and Remove Existing Teleprotection Cables 18 Z	m	0		
6.7	Disconnect and Remove Existing Norse Cables 2.5 mm	m	0		
7	Install new Cables. (delete section if not applicable)				
7.1	Install new Power Cables BVX 4 ECV.	10 m	0		
7.1.1	Install glands for new Power Cables BVX 4 ECV.	ea	0		
7.1.2	Terminate new Power Cables BVX 4 ECV.	lot	0		
7.2	Install new Telephony Cables TPH 10 AX	..... m	0		
7.2.1	Supply and Install glands for new Telephony Cables TPH 10 AX.	ea	0		
7.2.2	Terminate new Telephony Cables TPH 10 AX.	lot	0		
7.3	Install new Telephony Cables TPH 25 AX	lot	0		
7.3.1	Supply and Install glands for new Telephony Cables TPH 25 AX.	ea	0		
7.3.2	Terminate new Telephony Cables TPH 25 AX.	lot	0		
7.4	Install new X.21 Data Cables 6 pair data Cable	m	0		
7.4.1	I Supply and Install glands for new X.21 Data Cables 6 pair data Cable	ea	0		

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SCOPE OF WORK TEMPLATE FOR TELEPROTECTION PROJECTS

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Item	Description	Measurement	Qty	Unit Price	Total Price
7.4.2	Terminate new X.21 Data Cables 6 pair data Cable	lot	0		
7.5	Install new Coaxial Cables RG 21 AU	±..... m	0		
7.5.1	Supply and Install glands for new Coaxial Cables RG 21 AU	ea	4		
7.5.2	Terminate new Coaxial Cables RG 21 AU	lot	0		
7.6	Install new Teleprotection Cables 12 Z	m	0		
7.6.1	Supply and Install glands for new Teleprotection Cables 12 Z	ea	0		
7.6.2	Terminate new Teleprotection Cables 12 Z	lot	0		
7.7	Install new Teleprotection Cables 18 Z	±..... m	0		
7.7.1	Supply and Install glands for new Teleprotection Cables 18 Z	ea	0		
7.7.2	Terminate new Teleprotection Cables 18 Z PLC End Only	lot	0		
7.8	Install new Norse Cables 2.5 mm between panels	.....m	0		
7.8.1	Supply and Install glands for new Norse Cables 2.5 mm	ea	0		
7.8.2	Terminate new Norse Cables 2.5 mm Per end	lot	0		
8	Numbering of all cables as per drawings and specifications	lot	0		
9	As-built documentation returned - hard copies only	lot	0		
10	Other - please specify	lot	0		

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**Annex F – Checklist for requesting PLC transmit and receive frequencies from PTM&C Telecomms (T&S)**

Checklist of Required Information when requesting PLC Frequencies			
No	Item	Comments	Check Y/N
1	Powerline Network diagram	A diagram showing the power network topology.	
2	Project Execution Plan	In order to save costs, PLCs can be juggled around to accommodate the project execution plan.	
3	Teleprotection plan for new project	To determine the new requirement	
4	As-built PLC frequency allocations at local and remote substations	Photographs of all Carrier Panels at local and Remote Substations	
5			
6			

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## Annex G – Teleprotection Trip Testing Sign-Off Document

TELEPROTECTION TRIP TESTING and FAULT FINDING Unique Identifier: 41-133  
 Revision: 2  
 Page: 7 of 9

### Annexure A: Teleprotection Trip Testing Sign-Off Document

	Teleprotection Trip Testing Sign-Off Document	Reference Annex A	Rev 1
Station: _____ Distant Station: _____ Region: _____ Date: ____/____/____ Project/ Job/ WO number _____			
1 Functional test (End-to-End Trip test) successful? (Y/ N/ n/a)			
1.1 Main 1 Permissive[ ] Direct Transfer Trip[ ] Directional E/F [ ]			
1.2 Main 2 Permissive[ ] Direct Transfer Trip[ ] Directional E/F [ ]			
Comments: _____ _____			
2 Teleprotection transmission time (only record <u>if</u> available from HMI or protection injection test set)			
2.1 Transmission time: from <u>HMI</u> (ETL500/600, DIP5000, NSD570 and later only) M1 _____ ms TPE Type _____ M2 _____ ms. TPE Type _____			
2.2 Transmission time: Local loop – TPE looped local, tested from protection panel M1 _____ ms TPE Type _____ M2 _____ ms. TPE Type _____			
and/or			
2.3 Transmission time: Protection GPS aided end-to-end measurement (if GPS available) M1 _____ ms TPE Type _____ M2 _____ ms. TPE Type _____			
and/or			
2.4 Transmission time: Protection relay "Echo" . (Only if echo setting activated) M1 _____ ms TPE Type _____ M2 _____ ms. TPE Type _____			
Comments: _____ _____			
Test and inspection performed by: (TELECOMMS PERSONNEL)		End to End Trip testing performed by: (PROTECTION PERSONNEL)	
_____ Signature		_____ Signature	
_____ Print name		_____ Print Name	

- I. Regional Secondary plant Manager.
- II. Tx/Eng./Power Telecomms/Technology. (Ali A Pereira/ T Gosai)
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## Annex H – Line Parameters for Line Trap Phase Location

The location of the line traps on the particular phases of a feeder bay is determined by the PLC propagation software program (utilises modal propagation). The table below shall be populated by the relevant Lines department.

**Table: Line Parameters**

Tower Type(s)	
Line Length (km)	
Line Voltage (kV)	
Phase Conductors (Type)	
Earth Conductors (Type)	
Number of Phase Conductors in Bundle	
Bundle Spacing (mm)	
Attachment Position (Horizontal (x) & Vertical (y)) for all 3 Phase Conductors (Red/White/Blue) (m)	
Attachment Position (Horizontal (x) & Vertical (y)) for all Earth Conductors (m)	
Sag Phase Conductors (if available) (m)	
Sag Earth Conductors (if available) (m)	
Number of Transpositions	
Transposition locations (km)	
Transposition Swap sequences	
Phasing drawing displaying the Line Phasing which corresponds to the substation phasing diagrams at both ends of the line. (Should be provided by Substations department)	