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|--|-----------------|-------------------|
|  Eskom | Standard | Technology |
|--|-----------------|-------------------|

Title: **APPLICATION DESIGN
STANDARD FOR
TELEPROTECTION SYSTEMS**

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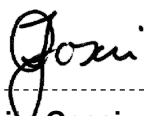
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Disclosure**

Compiled by



Tejin Gosai
Chief Engineer

Date: 09/12/2020

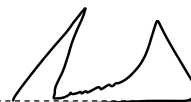
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Date: 09 December 2020

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1. Introduction

The purpose of this document is to provide an application design standard that could be used by the project engineers/ application engineers and planners to plan for teleprotection systems.

2. Supporting clauses

2.1 Scope

This document covers the most common application designs for Teleprotection systems used in Eskom.

2.1.1 Purpose

The purpose of the document is to ensure that the functional requirements for Teleprotection systems are included in the project designs.

2.1.2 Applicability

This document shall apply throughout Eskom Holdings Limited Divisions.

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] 240-90353855, Design Standard for Teleprotection Systems
- [2] 240-46264031, Fibre-Optic Design Standard – Part 2: Substations
- [3] 240-70733995, Optical Distribution Frame/Patch Panel

2.2.2 Informative

None.

2.3 Definitions

2.3.1 General

| Definition | Description |
|---------------------------|---|
| Coupling Equipment | This equipment is used for isolating and coupling Power Line Carrier signals, and is usually found in Transmission and Distribution substation yards and also in Power Station HV yards, and is connected to the High Voltage power line. The coupling equipment consists of the Line Trap and Line Matching Equipment. |
| dB | <p>The ratio of two powers, typically that at the output of a device/ component compared to that at the input to express the gain or loss in a component or system.</p> $X_{dB} = 10 \log_{10} \frac{P_{out}}{P_{in}}$ |

| Definition | Description |
|--------------------------------------|---|
| dBm | The absolute power level of a signal (Px) expressed in relation to a signal with a power level of 1 mW . $dBm = 10 \log_{10} \frac{Px}{1mW}$ (1mW into 600 Ω produces a voltage of 0.775V and = 0dBm) |
| Responsible employee (person) | An employee (person) who has been authorised in writing to be responsible for ensuring that the work on electrical apparatus covered by the Operating Regulations for High Voltage Systems can be carried out safely. |

2.3.2 Disclosure classification

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

2.4 Abbreviations

| Abbreviation | Description |
|--------------|--|
| 2W | 2 Wire |
| 4W | 4 Wire |
| ADSS | All Dielectric Self Supporting |
| CC | Coupling Capacitor |
| CCU | Carrier Combining Unit |
| CT | Current Transformer |
| CVT | Capacitive Voltage Transformer |
| HF | High Frequency |
| HV | High Voltage |
| LES | Lines Engineering Services |
| LME | Line Matching Equipment |
| LT | Line Trap |
| OPGW | Optical Ground Wire |
| ORHVS | Operating Regulations for High Voltage Systems |
| PE | Project Engineer |
| PLC | Power Line Carrier |
| Rx | Receive (Receiver) |
| SED | Substation Electric Diagram |
| TPE | Teleprotection Equipment (i.e. Microwave Teleprotection) |
| TU | Tuning Unit |
| Tx | Transmit (Transmitter) |

2.5 Roles and responsibilities

Not applicable.

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2.6 Process for monitoring

Not applicable.

2.7 Related/supporting documents

This document should be read in conjunction with 240-90353855, "Design Standard for Teleprotection Systems".

3. General

The Project Engineers must have a relatively good understanding of Teleprotection, PLC and Fibre Optic systems to follow the requirements below.

Note: It is important to note that if the Teleprotection systems are not included in the pre CRA or CRA phase of the project, to rectify the exclusion of the Teleprotection systems would cost substantial amounts as the requirements could influence or change the Substation HV yard, HV Lines and the Protection systems designs.

3.1 Application Guideline Requirements

- 1) Need to identify the type of projects as this would affect the designs of the Teleprotection systems. The different types of projects are:
 - a) New Substation Project
 - b) Refurbishment Substation Project
 - c) Substation Extension Project (New Lines Project)
 - d) Refurbishment Lines Project (Ground Wire Replacement with OPGW)
 - e) Line rearrangement Project (Shifting of Feeder bays)
 - f) New Protection Projects
 - g) Refurbishment of problematic Protection Projects
 - h) Teleprotection and PLC Refurbishment Projects
 - i) Aerial Fibre Optic (OPGW) Replacement Projects
 - j) Line Trap Replacement Project
- 2) For the above projects, the following documents need to be requested by the Project Engineer (PE) where applicable:
 - a) Planning Report – Primary Plant Planning Department
 - b) Substation and Lines Phasing Diagram – Substations
 - c) Substation User Requirement Specification (SURS) – Substations
 - d) Lines User Requirement Specification (LURS) – LES
 - e) Voltage Unbalanced Studies – LES
 - f) Substation Electric Diagram (SED) - Substations
 - g) Substation Foundation & Trench layout diagrams (for Fibre Optic systems) – Substations.

The following items lists the information and check lists required to ensure that all the areas for the Teleprotection systems are covered.

- a) Discuss with protection what protection schemes are being planned.
- b) Check with Eskom Telecommunications what telecommunication mediums are available or being planned. Check if the existing or planned telecommunications mediums will satisfy the protection requirements.

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- c) Check the requirements for Teleprotection systems.
- d) If a fibre optic cable is being planned, check the fibre optic design details and the possible date when installation will take place.
- e) For other telecommunications requirements, invite Eskom Telecoms to the project meetings to discuss their own technology.
- f) The document 240-90353855, "Design Standard for Teleprotection Systems" details the following:
 - 1) Teleprotection Philosophy for Transmission and Distribution.
 - 2) PLC design consideration.
 - 3) Line Trap phase allocation and lists the Line Parameters table to be completed by LES.
 - 4) Frequency allocation and lists the Parameters table to be completed by the PEs.
 - 5) Stand-alone teleprotection unit design consideration.
 - 6) Teleprotection – Protection contact base interface.
 - 7) Teleprotection interface cable.
 - 8) Current differential scheme telecommunications design.
 - 9) Matching and checking compatibility with new and existing Protection, Teleprotection and PLC equipment.
- g) Sample of the NSD 570 Proforma (Annex A) – To contact PTM&C Technology for the latest Proforma revision.
- h) Sample of the LME Proforma (Annex B) – To contact PTM&C Technology for the latest Proforma revision.
- i) Sample of the PLC ETL 6101/651 Proforma (Annex C) – To contact PTM&C Technology for the latest Proforma revision.
- j) Sample of the Line Trap Proforma – Actom (Annex D) – To contact PTM&C Technology for the latest Proforma revision.
- k) Sample of the Line Trap Proforma – High Voltage Technology (Annex E) – To contact PTM&C Technology for the latest Proforma revision.
- l) Sample of the Line Trap Proforma – Mega HVT (Annex F) – To contact PTM&C Technology for the latest Proforma revision.

From the above information and documents, a line diagram to plan for the Teleprotection and Fibre Optic System needs to be developed by the Project Engineer (PE) that encompasses the affected power network.

3.2 PLC System Requirements

3.2.1 PLC System

- a) Provide Technology with the following diagrams to determine the Line Trap positions on the phases of the line:
 - 1) Substation and Lines Phasing Diagram – Lines Engineering Services (LES)
 - 2) Voltage Unbalanced Studies – LES
 - 3) Line Parameters table from 240-90353855 - LES

- Technology will perform the propagation analysis and allocate the Line Traps to the most feasible line phases.
- b) Provide Technology with the following information to allocate the PLC frequencies:
 - 1) A line diagram that displays the Teleprotection, PLC and Fibre Optic System developed by the Project Engineer (PE).
 - 2) Frequency allocation Parameters table from 240-90353855 to be completed by the PEs.
 - c) If the PLC frequency cannot be allocated due to congestion, then an Artificial Busbar (additional Line Traps, CVTs, LMEs) would need to be built. Technology will be required to assist with the design and this will need consultation with Substation Engineering.
 - d) To determine the type of Line Trap required for the project, the following information is required, that is Line Voltage, Line Continuous Current, Fault Current, Line Trap Inductance, Creepage (insulators) and the Blocking Band (Frequency). Generally, the Line Voltage, Line Continuous Current, Fault Current, Line Trap Inductance and Creepage (insulators) would be similar to the corresponding circuit breaker parameters in the same feeder bay and obtained from Substations.
 - e) To determine whether a high pass or band pass LME is required depends on the PLC frequency allocated by Technology.

3.3 Teleprotection (Stand-alone) System Requirements

- a) Provide Technology with the following information:
 - 1) A line diagram that displays the Teleprotection, PLC and Fibre Optic System developed by the Project Engineer (PE).
- b) The line diagram will display which telecommunications medium is available for the stand-alone teleprotection unit that is either a fibre optic module or X.21 module.
- c) The stand-alone teleprotection unit address must be allocated.
- d) The signalling voltage from the protection panel must be provided to setup the stand-alone teleprotection unit correctly.

3.4 Fibre Optic System Requirements

- a) Enquire from Protection and Eskom Telecommunication what their requirements are.

Note: A new substation cannot be commissioned without telecommunications.

- b) Create a line diagram with the fibre links associated with each substation within the project. This will assist in identifying the number of fibre optic links that are available and what may be required.
- c) Ensure that you know what type of fibre optic cable is used in the link between the substations (OPGW, ADSS, ADLash™, etc).
- d) Teleprotection cannot work over ADLash™ fibre optic cables since these cable are experiencing high losses due to macrobending. Motivation should be made to replace these cables.
- e) Decide on the duct cable and patch panel requirements based on the configuration of the fibre optic link.
- f) Decide to which control room the fibre optic cable must be routed.
- g) Check if there is a requirement to connect control rooms with a fibre optic cable within the same substation area.
- h) Ensure that a fibre optic cabinet is installed in the control room for the patch panel.
- i) The PEs to provide the layout diagram and requirements for the Protection and Control fibre optic cable requirements within the substation. Technology can assist with the fibre optic cable design.

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 |
| Mfundiso Hina | Senior Manager – Eskom Telecommunications (Acting) |
| Maureen Mokone | Senior Manager – GIT (Acting) |
| Botse Sikhwitshi | Senior Manager – Group Security Senior Manager (Acting) |

5. Revisions

| Date | Rev | Compiler | Remarks |
|----------|-----|----------|--|
| Nov 2020 | 2 | T Gosai | Required to review due to document review date. Added Proformas in Annexes. |
| Feb 2016 | 1 | T Gosai | New document. |

6. Development team


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

- Vanessa Naidu
- Antonio Pereira
- Riyaz Gangat
- Mimi Tshikosi

7. Acknowledgements

Not applicable.

Annex A – Sample of NSD 570 Proforma

| | | | | |
|---|-------------------------------------|-----|--|--------------|
|  | PTM&C Equipment Proforma | | Unique Identifier | |
| | | | Record Identifier | NSD570 |
| | | | Document Type | Proforma |
| | | | Revision | 1 |
| | | | Effective Date | 01 June 2014 |
| | | | Group Technology (Engineering) - PTM & C | |
| | | | Date: | |
| From: | PTM & C Planning & Project Support | To: | Capital Expansion Central | |
| Project Engineer: | | | | |
| Tel: | | | | |
| Scheme name: | | | | |
| Project name: | | | | |
| Project / CC / WBS No.: | | | | |
| Region / O.U. | | | | |
| Substation: | | | | |
| Busbar Voltage: | | | | |
| Bay: | | | | |
| Station DC Voltage: | | | | |
| Contract No.: | 4600067973 | | | |
| Supplier: | ABB (Hitachi) (Pty) Ltd | | | |
| Revision: | | | | |
| Revision Control | First Issue | | | |

Please order the Microwave Teleprotection equipment listed below:


| | | | | |
|------------------------|------------|---|--|------|
| EQUIPMENT LABEL DETAIL | | This information must be included on the Purchase Order | | |
| STATION: | | DISTANT END: | | |
| Feeder No. | | HV Voltage | TPE DC Voltage | V DC |
| For Protection Main | | Protection Panel Delivery Date: | | |
| Item No. | SAP No. | Short Code | Description | QTY |
| 1 | 0000663307 | Combo 1 - TPE 48VDC/X.21 | NSD570 Module Rack which includes the Base Unit with 48V DC Power supply, 2 x PIA, 2 x Input/Output Cards, CPU - X.21 (RS-422/V.11) Interface Card. | |
| 2 | 0000663301 | Combo 2 - TPE 110VDC/X.21 | NSD570 Module Rack which includes the Base Unit with 110V DC Power supply, 2 x PIA, 2 x Input/Output Cards, CPU - X.21 (RS-422/V.11) Interface Card. | |
| 3 | 0000663304 | Combo 3 - TPE 220VDC/X.21 | NSD570 Module Rack which includes the Base Unit with 220V DC Power supply, 2 x PIA, 2 x Input/Output Cards, CPU - X.21 (RS-422/V.11) Interface Card. | |
| 4 | 0000663309 | Combo 4 - TPE 48VDC/FO 1310nm-30km | NSD570 Module Rack which includes the Base Unit with 48V DC Power supply, 2 x PIA, 2 x Input/Output Cards, CPU - X.21 (RS-422/V.11) Interface Card and 1310nm SM FO Driver. | |
| 5 | 0000663412 | Combo 5 - TPE 110VDC/FO 1310nm-30km | NSD570 Module Rack which includes the Base Unit with 110V DC Power supply, 2 x PIA, 2 x Input/Output Cards, CPU - X.21 (RS-422/V.11) Interface Card and 1310nm SM FO Driver. | |
| 6 | 0000663416 | Combo 6 - TPE 220VDC/FO 1310nm-30km | NSD570 Module Rack which includes the Base Unit with 220V DC Power supply, 2 x PIA, 2 x Input/Output Cards, CPU - X.21 (RS-422/V.11) Interface Card and 1310nm SM FO Driver. | |

Transport/Delivery is not included in the contract. Project Manager to arrange.

| | | | | |
|--------------|------|--|-----------|------|
| | Name | Designation | Signature | Date |
| Compiled by: | 0 | PTM&C Project Engineer | | |
| Accepted by: | | Discipline Custodian PTM&C Planning & Project Support Manager | | |
| Approved by: | | | | |
| Received by: | 0 | Project Manager | | |

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Annex B – Sample of LME Proforma

| | | | |
|---|---|---|---------------------------|
|  | PTM&C Equipment Proforma | Unique Identifier | 240-84597622 |
| | | Record Identifier | LME |
| | | Document Type | Proforma |
| | | Revision | 0 |
| | | Effective Date | 01 July 2014 |
| | | Group Technology (Engineering) - PTM & C | |
| | | Date: | |
| From: | PTM & C Planning & | To: | Capital Expansion Central |
| Project Engineer: | | Project Manager | |
| Tel: | | Tel: | |

| | |
|-----------------------|---------------|
| Scheme name: | |
| Project name: | |
| Project /CC/ WBS No.: | |
| Region / O.U. | |
| Substation: | |
| Busbar Voltage: | |
| Bay: | |
| Station DC Voltage: | |
| Contract No.: | 4600064123 |
| Supplier: | ABB (Pty) Ltd |
| Revision: | 0 |
| Revision Control: | 0 First Issue |


Please order the Line Matching Equipment listed below:

| Eskom Item No. | Code | SAP Number | Description | Line Trap Blocking range kHz | QTY |
|----------------|------|------------|------------------------------------|------------------------------|--------|
| 10 | XH | 0002900 | Line matching Equipment HP Filter. | 101 to 500 | |
| 20 | XB | 0004155 | Line matching Equipment BP Filter. | 48 to 78kHz | |
| | | | Value | | |
| | | | Coupling Capacitor ...4400.pF | | |
| | | | Lowest Carrier Frequency required: | xxx kHz | |
| | | | Line Impedance: 240 Ω / 320 Ω | xxx Ω | 156kHz |

| | | | | |
|--------------|------|--|-----------|------|
| | Name | Designation | Signature | Date |
| Compiled by: | | PTM&C Project Engineer | | |
| Accepted by: | | Discipline Custodian | | |
| Approved by: | | PTM&C Planning & Project Support Manager | | |
| Received by: | | Project Manager | | |

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Annex C – Sample of PLC Proforma

| | | | | | | | |
|--|---|---|--|--------------------|--------------|--------------|--|
|  | PTM&C Equipment Proforma | | Unique Identifier | | 240-84597622 | | |
| | | | Record Identifier | | PLC | | |
| | | | Document Type | | Proforma | | |
| | | | Revision | | 2 | | |
| | | | Effective Date | | 01 July 2014 | | |
| | | Group Technology (Engineering) - PTM & C | | | | | |
| | | | | Date: | | | |
| From: | | | | To: | | | |
| Project Engineer: | | | | Project Manager | | | |
| Tel: | | | | Tel: | | | |
| Scheme name: | | | | | | | |
| Project name: | | | | | | | |
| Project / CC / WBS No.: | | | | | | | |
| Region / O.U. | | | | | | | |
| Substation: | | | | | | | |
| Busbar Voltage: | | | | | | | |
| Bay: | | | | | | | |
| Station DC Voltage: | | | | | | | |
| Contract No.: | | 4600064993 | | | | | |
| Supplier: | | ABB (Pty) Ltd | | | | | |
| Revision: | | | | | | | |
| Revision Control | | First issue | | | | | |
| Please order the PowerLine Carrier equipment listed below: | | | | | | | |
| Distant end: | | | | | | Line number: | |
| A POWERLINE CARRIER CABINET | | | | | | | |
| Cabinet Label: | | TELEPROTECTION – | | | | Quantity: 1 | |
| Item | Material N | Item Description | | | | Quant | |
| 00640 KX-2 | 0554765 | Carrier Cabinet and wiring for 1 PLC. | | | | | |
| 00650 KX-3 | 0224028 | Carrier Cabinet and wiring for 2 PLC. | | | | | |
| B CARRIER COMBINING UNIT | | | | | | | |
| 00670 CCU-1 | 0554766 | PLC Carrier Combiner for phase to phase coupling | | | | | |
| 00680 CCU-3 | 0207814 | PLC Carrier Combiner for three phase coupling | | | | | |
| C UPPER SSB POWERLINE CARRIER SET | | | | | | | |
| | | | | Frequencies | | | |
| 00380 CX50-T | 0224011 | Power Line Carrier protection with 3 channel, 50 W 2 kHz | TX | kHz | RX | kHz | |
| 00430 CX100-T | 0224017 | Power Line Carrier protection with 3 channel, 100 W 2 kHz | TX | kHz | RX | kHz | |
| Please note that it is imperative that the frequencies are indicated on the order | | | | | | | |
| D LOWER SSB POWERLINE CARRIER SET (only required if two PLC's are required) | | | | | | | |
| 00380 CX50-T | 0224011 | Power Line Carrier protection with 3 channel, 50 W 2 kHz | TX | kHz | RX | kHz | |
| 00430 CX100-T | 0224017 | Power Line Carrier protection with 3 channel, 100 W 2 kHz | TX | kHz | RX | kHz | |
| D LOOSE MODULES / UNITS | | | | | | | |
| 00710 | 0224053 | Connector, HMI Cable RS232 to USB | | | | | |
| | | Name | Designation | Signature | Date | | |
| Compiled by: | | | PTM&C Project Engineer | | | | |
| Accepted by: | | | Discipline Custodian | | | | |
| Approved by: | | | PTM&C Planning & Project Support Manager | | | | |
| Received by: | | | Project Manager | | | | |

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Annex D – Sample of Line Trap Proforma - Actom

PTM&C Equipment Proforma

| | |
|---|--------------|
| Unique Identifier | 240-84597622 |
| Record Identifier | TLP - FO1 |
| Document Type | Proforma |
| Revision | 1 |
| Effective Date | 01 July 2014 |
| Group Technology (Engineering) - PTM & C | |

| | |
|--------------|--|
| Date: | |
|--------------|--|

| | | | |
|--------------------------|---|------------------------|----------------------------------|
| From: | PTM & C Planning & Project Support | To: | Capital Expansion Central |
| Project Engineer: | | Project Manager | |
| Tel: | | Tel: | |

| | |
|----------------------------|-----------------------------------|
| Scheme name: | |
| Project name: | |
| Project No.: | |
| Cost Centre: | |
| WBS/Internal Order: | |
| Region / O.U. | |
| Substation: | |
| Busbar Voltage: | |
| Bay: | |
| Station DC Voltage: | |
| Contract No.: | 4600067325 (Tx) & 4600067434 (GC) |
| Supplier: | Actom |

**Please order the equipment listed
below:**

| Line ITEM | Material No | Item Description | Blocking Band | Quantity |
|--------------|-------------|---|---------------|----------|
| | 4483 | U4: 132 kV, 2500A, 40 kA, 0,5 mH LT – (WITHOUT PI) | 48 - 78 kHz | |
| | 4483 | U4: 132 kV, 2500A, 40 kA, 0,5 mH LT – (WITHOUT PI) | 70 - 156 kHz | |
| | 4483 | U4: 132 kV, 2500A, 40 kA, 0,5 mH LT – (WITHOUT PI) | 101 - 500 kHz | |
| | 0558633 | S8H: 275 kV, 3150A, 50 kA, 0,5 mH LT - Heavy Creep (25mm/kV) | 48 - 78 kHz | |
| | 0558633 | S8H: 275 kV, 3150A, 50 kA, 0,5 mH LT - Heavy Creep (25mm/kV) | 70 - 156 kHz | |
| | 0558633 | S8H: 275 kV, 3150A, 50 kA, 0,5 mH LT - Heavy Creep (25mm/kV) | 101 - 500 kHz | |
| | 0558632 | S8HH: 275 kV, 3150A, 50 kA, 0,5 mH LT - Extra Heavy Creep (31mm/kV) | 48 - 78 kHz | |
| | 0558632 | S8HH: 275 kV, 3150A, 50 kA, 0,5 mH LT - Extra Heavy Creep (31mm/kV) | 70 - 156 kHz | |

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| Line ITEM | Material No | Item Description | Blocking Band | Quantity |
|-----------|-------------|--|---------------------|----------|
| | 0558632 | S8HH: 275 kV, 3150A, 50 kA, 0,5 mH LT - Extra Heavy Creep (31mm/kV) | 101 - 500 kHz | |
| | 0558631 | S9H: 275 kV, 3150A, 50 kA, 1,2 mH LT - Heavy Creep (25mm/kV) | 48 – 500 kHz | |
| | 0558630 | S9HH: 275 kV, 3150A, 50 kA, 1,2 mH LT - Extra Heavy Creep (31mm/kV) | 48 – 500 kHz | |
| | 0558629 | S10H: 275 kV, 4000A, 50 kA, 0,5 mH LT - Heavy Creep (25mm/kV) | 48 - 78 kHz | |
| | 0558629 | S10H: 275 kV, 4000A, 50 kA, 0,5 mH LT - Heavy Creep (25mm/kV) | 70 - 156 kHz | |
| | 0558629 | S10H: 275 kV, 4000A, 50 kA, 0,5 mH LT - Heavy Creep (25mm/kV) | 101 - 500 kHz | |
| | 0558628 | S10HH: 275 kV, 4000A, 50 kA, 0,5 mH LT - Extra Heavy Creep (31mm/kV) | 48 - 78 kHz | |
| | 0558628 | S10HH: 275 kV, 4000A, 50 kA, 0,5 mH LT - Extra Heavy Creep (31mm/kV) | 70 - 156 kHz | |
| | 0558628 | S10HH: 275 kV, 4000A, 50 kA, 0,5 mH LT - Extra Heavy Creep (31mm/kV) | 101 - 500 kHz | |
| | 0558823 | Q8H: 400 kV, 3150A, 50 kA, 1,2 mH LT - Heavy Creep (25mm/kV) | 48 – 500 kHz | |
| | 0558822 | Q8HH: 400 kV, 3150A, 50 kA, 1,2 mH LT - Extra Heavy Creep (31mm/kV) | 48 – 500 kHz | |
| | 0558627 | QB1H: 765 kV, 5000A, 50 kA, 0,5 mH LT - Heavy Creep (25mm/kV) | 48 - 78 kHz | |
| | 0558627 | QB1H: 765 kV, 5000A, 50 kA, 0,5 mH LT - Heavy Creep (25mm/kV) | 70 - 156 kHz | |
| | 0558627 | QB1H: 765 kV, 5000A, 50 kA, 0,5 mH LT - Heavy Creep (25mm/kV) | 101 - 500 kHz | |
| | 0558626 | QB1HH: 765 kV, 5000A, 50 kA, 0,5 mH LT – Extra Heavy Creep (31mm/kV) | 48 - 78 kHz | |
| | 0558626 | QB1HH: 765 kV, 5000A, 50 kA, 0,5 mH LT – Extra Heavy Creep (31mm/kV) | 70 - 156 kHz | |
| | 0558626 | QB1HH: 765 kV, 5000A, 50 kA, 0,5 mH LT – Extra Heavy Creep (31mm/kV) | 101 - 500 kHz | |
| | | Delivery destination: | 0 Substation | * |

| | Name | Designation | Signature | Date |
|---------------------|------|---|-----------|------|
| Compiled by: | | PTM&C Project Engineer | | |
| Accepted by: | | Discipline Custodian | | |
| Approved by: | | PTM&C Planning & Project Support Manager | | |
| Received by: | | Project Manager | | |

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Annex E – Sample of Line Trap Proforma - HVT

| | | | | | |
|---|--------------------------------|--|---|--------------|--|
|  | PTM&C Equipment Proforma | | Unique Identifier | 240-84597622 | |
| | | | Record Identifier | TLP - FO1 | |
| | | | Document Type | Proforma | |
| | | | Revision | 1 | |
| | | | Effective Date | 01 July 2014 | |
| | | | Group Technology (Engineering) - PTM & C | | |
| | | | | Date: | |
| From: | PTM & Planning Project Support | To: | Capital Expansion Central | | |
| Project Engineer: | | Project Manager | | | |
| Tel: | | Tel: | | | |
| | | | | | |
| Scheme name: | | | | | |
| Project name: | | | | | |
| Project No.: | | | | | |
| Cost Centre: | | | | | |
| WBS/Internal Order: | | | | | |
| Region / O.U. | | | | | |
| Substation: | | | | | |
| Busbar Voltage: | | | | | |
| Bay: | | | | | |
| Station DC Voltage: | | | | | |
| Contract No.: | | 4600066174 (Tx) & 4600066175 (Group Capital) | | | |
| Supplier: | | High Voltage Technologies (HVT) | | | |
| Please order the equipment listed below: | | | | | |
| | | | | | |


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| Line ITEM | Material No | Item Description | Blocking Band | Quantity |
|-----------|-------------|--|---------------|----------|
| | 667708 | U2: 132 kV, 2500A, 40 kA, 0,2 mH LT – (WITHOUT PI) | 80 – 108 kHz | |
| | 667708 | U2: 132 kV, 2500A, 40 kA, 0,2 mH LT – (WITHOUT PI) | 104 – 156 kHz | |
| | 667708 | U2: 132 kV, 2500A, 40 kA, 0,2 mH LT – (WITHOUT PI) | 125 – 204 kHz | |
| | 667708 | U2: 132 kV, 2500A, 40 kA, 0,2 mH LT – (WITHOUT PI) | 194 – 500 kHz | |
| | 0558639 | S3H: 275 kV, 2500A, 50 kA, 0,5 mH LT - Heavy Creep (25mm/kV) | 48 - 78 kHz | |
| | 0558639 | S3H: 275 kV, 2500A, 50 kA, 0,5 mH LT - Heavy Creep (25mm/kV) | 70 - 156 kHz | |
| | 0558639 | S3H: 275 kV, 2500A, 50 kA, 0,5 mH LT - Heavy Creep (25mm/kV) | 101 - 500 kHz | |
| | 0558638 | S3HH: 275 kV, 2500A, 50 kA, 0,5 mH LT - Extra Heavy Creep (31mm/kV) | 48 - 78 kHz | |
| | 0558638 | S3HH: 275 kV, 2500A, 50 kA, 0,5 mH LT - Extra Heavy Creep (31mm/kV) | 70 - 156 kHz | |
| | 0558638 | S3HH: 275 kV, 2500A, 50 kA, 0,5 mH LT - Extra Heavy Creep (31mm/kV) | 101 - 500 kHz | |
| | 0558836 | Q1H: 400 kV, 2500A, 50 kA, 0,5 mH LT - Heavy Creep (25mm/kV) | 48 - 78 kHz | |
| | 0558836 | Q1H: 400 kV, 2500A, 50 kA, 0,5 mH LT - Heavy Creep (25mm/kV) | 70 - 156 kHz | |
| | 0558836 | Q1H: 400 kV, 2500A, 50 kA, 0,5 mH LT - Heavy Creep (25mm/kV) | 101 - 500 kHz | |
| | 0558835 | Q1HH: 400 kV, 2500A, 50 kA, 0,5 mH LT - Extra Heavy Creep (31mm/kV) | 48 - 78 kHz | |
| | 0558835 | Q1HH: 400 kV, 2500A, 50 kA, 0,5 mH LT - Extra Heavy Creep (31mm/kV) | 70 - 156 kHz | |
| | 0558835 | Q1HH: 400 kV, 2500A, 50 kA, 0,5 mH LT - Extra Heavy Creep (31mm/kV) | 101 - 500 kHz | |
| | 0558834 | Q3H: 400 kV, 2500A, 50 kA, 1,2 mH LT - Heavy Creep (25mm/kV) | 48 – 500 kHz | |
| | 0558833 | Q3HH: 400 kV, 2500A, 50 kA, 1,2 mH LT - Extra Heavy Creepe (31mm/kV) | 48 – 500 kHz | |
| | 0558832 | Q6H: 400 kV, 3150A, 50 kA, 0,5 mH LT - Heavy Creep (25mm/kV) | 48 - 78 kHz | |
| | 0558832 | Q6H: 400 kV, 3150A, 50 kA, 0,5 mH LT - Heavy Creep (25mm/kV) | 70 - 156 kHz | |
| | 0558832 | Q6H: 400 kV, 3150A, 50 kA, 0,5 mH LT - Heavy Creep (25mm/kV) | 101 - 500 kHz | |
| | 0558831 | Q6HH: 400 kV, 3150A, 50 kA, 0,5 mH LT - Extra Heavy Creep (31mm/kV) | 48 - 78 kHz | |
| | 0558831 | Q6HH: 400 kV, 3150A, 50 kA, 0,5 mH LT - Extra Heavy Creep (31mm/kV) | 70 - 156 kHz | |
| | 0558831 | Q6HH: 400 kV, 3150A, 50 kA, 0,5 mH LT - Extra Heavy Creep (31mm/kV) | 101 - 500 kHz | |

| Line ITEM | Material No | Item Description | | Blocking Band | Quantity |
|--------------|-------------|--|--|---------------|----------|
| | 0558830 | Q7H: 400 kV, 3150A, 63 kA, 0,5 mH LT - Heavy Creep (25mm/kV) | | 48 - 78 kHz | |
| | 0558830 | Q7H: 400 kV, 3150A, 63 kA, 0,5 mH LT - Heavy Creep (25mm/kV) | | 70 - 156 kHz | |
| | 0558830 | Q7H: 400 kV, 3150A, 63 kA, 0,5 mH LT - Heavy Creep (25mm/kV) | | 101 - 500 kHz | |
| | 0558826 | Q7HH: 400 kV, 3150A, 63 kA, 0,5 mH LT - Extra Heavy Creep (31mm/kV) | | 48 - 78 kHz | |
| | 0558826 | Q7HH: 400 kV, 3150A, 63 kA, 0,5 mH LT - Extra Heavy Creep (31mm/kV) | | 70 - 156 kHz | |
| | 0558826 | Q7HH: 400 kV, 3150A, 63 kA, 0,5 mH LT - Extra Heavy Creep (31mm/kV) | | 101 - 500 kHz | |
| | 0558816 | Q9H: 400 kV, 3150A, 63 kA, 1,2 mH LT - Heavy Creep (25mm/kV) | | 48 - 500 kHz | |
| | 0558645 | Q9HH: 400 kV, 3150A, 63 kA, 1,2 mH LT - Extra Heavy Creep (31mm/kV) | | 48 - 500 kHz | |
| | 0558644 | Q10H: 400 kV, 4000A, 63 kA, 0,5 mH LT - Heavy Creep (25mm/kV) | | 48 - 78 kHz | |
| | 0558644 | Q10H: 400 kV, 4000A, 63 kA, 0,5 mH LT - Heavy Creep (25mm/kV) | | 70 - 156 kHz | |
| | 0558644 | Q10H: 400 kV, 4000A, 63 kA, 0,5 mH LT - Heavy Creep (25mm/kV) | | 101 - 500 kHz | |
| | 0558643 | Q10HH: 400 kV, 4000A, 63 kA, 0,5 mH LT - Extra Heavy Creep (31mm/kV) | | 48 - 78 kHz | |
| | 0558643 | Q10HH: 400 kV, 4000A, 63 kA, 0,5 mH LT - Extra Heavy Creep (31mm/kV) | | 70 - 156 kHz | |
| | 0558643 | Q10HH: 400 kV, 4000A, 63 kA, 0,5 mH LT - Extra Heavy Creep (31mm/kV) | | 101 - 500 kHz | |
| | | Delivery destination: | 0 | Substation | * |
| | | Name | Designation | Signature | Date |
| Compiled by: | | 0 | PTM&C Project Engineer | | |
| Accepted by: | | | Discipline Custodian | | |
| Approved by: | | | PTM&C Planning & Project Support Manager | | |
| Received by: | | 0 | Project Manager | | |

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Annex F – Sample of Line Trap Proforma – Mega HVT

|  | PTM&C Equipment Proforma | | Unique Identifier | 240-84597622 |
|---|-------------------------------------|---|--|--------------|
| | | | Record Identifier | TLP - FO1 |
| | | | Document Type | Proforma |
| | | | Revision | 1 |
| | | | Effective Date | 01 July 2014 |
| | | | Group Technology (Engineering) - PTM & C | |
| | | | Date: | |
| From: | PTM & C Planning & Project Support | To: | Capital Expansion Central | |
| Project Engineer: | | Project Manager | | |
| Tel: | | Tel: | | |
| Scheme name: | | | | |
| Project name: | | | | |
| Project No.: | | | | |
| Cost Centre: | | | | |
| WBS/Internal Order: | | | | |
| Region / O.U. | | | | |
| Substation: | | | | |
| Busbar Voltage: | | | | |
| Bay: | | | | |
| Station DC Voltage: | | | | |
| Contract No.: 4600066985 | | | | |
| Supplier: Mega HVT | | | | |
| Please order the equipment listed below: | | | | |
| Line ITEM | Material | Item Description | Blocking Bar | Quantity |
| 17528 | | U5HH: 132 kV POST INSULATORS – EXTRA HEAVY CREEPAGE (31mm/kV) - Line Traps U1 to U4 | | |
| 11055 | | S1H: 275 kV, 2500A, 50 kA, 0,2 mH LT - Heavy Creep (25mm/kV) | 80 – 108 kHz | |
| 11055 | | S1H: 275 kV, 2500A, 50 kA, 0,2 mH LT - Heavy Creep (25mm/kV) | 104 – 156 kHz | |
| 11055 | | S1H: 275 kV, 2500A, 50 kA, 0,2 mH LT - Heavy Creep (25mm/kV) | 125 – 204 kHz | |
| 11055 | | S1H: 275 kV, 2500A, 50 kA, 0,2 mH LT - Heavy Creep (25mm/kV) | 194 – 500 kHz | |
| 0558642 | | S1HH: 275 kV, 2500A, 50 kA, 0,2 mH LT - Extra Heavy Creep (31mm/kV) | 80 – 108 kHz | |
| 0558642 | | S1HH: 275 kV, 2500A, 50 kA, 0,2 mH LT - Extra Heavy Creep (31mm/kV) | 104 – 156 kHz | |
| 0558642 | | S1HH: 275 kV, 2500A, 50 kA, 0,2 mH LT - Extra Heavy Creep (31mm/kV) | 125 – 204 kHz | |
| 0558642 | | S1HH: 275 kV, 2500A, 50 kA, 0,2 mH LT - Extra Heavy Creep (31mm/kV) | 194 – 500 kHz | |
| 0558637 | | S5H: 275 kV, 2500A, 50 kA, 1,2 mH LT - Heavy Creep (25mm/kV) | 48 – 500 kHz | |
| 0558636 | | S5HH: 275 kV, 2500A, 50 kA, 1,2 mH LT - Extra Heavy Creep (31mm/kV) | 48 – 500 kHz | |
| Delivery destination: | | | 0 Substation | * |
| Name | | Designation | Signature | Date |
| Compiled by: | | PTM&C Project Engineer | | |
| Accepted by: | | Discipline Custodian | | |
| Approved by: | | PTM&C Planning & Project Support Manager | | |
| Received by: | | Project Manager | | |

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