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|  | Guideline | Technology |
|---|------------------|-------------------|

Title: **FIBRE OPTIC GANTRY TO
SUBSTATION CONTROL ROOM
SCOPE OF WORK GUIDELINE**

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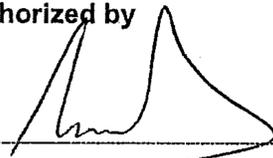
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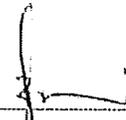
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1. Introduction

There is a requirement to provide a guideline to Project Planning and Application Engineers within PTM&C for the fibre optic scope of work from the gantry to the control room on Transmission and Distribution projects.

2. Supporting clauses

2.1 Scope

This document covers the contractor requirements for fibre optic work carried out during a project between the gantry and control room.

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 Planner and Applications engineer.

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] 240-70732888, Fibre Optic System Acceptance Testing Standard
- [3] 240-70733995, Optical Distribution Frame / Patch Panel
- [4] 240-46264031, Fibre Optic Design Standard – Part 2: Substations
- [5] 240-46263618, Labelling of Fibre Optic Cables

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 |
|--------------|--------------------------------|
| ADLash™ | All Dielectric Lashed cable |
| ADSS | All Dielectric Self Supporting |

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| Abbreviation | Description |
|--------------|---|
| Dx | Distribution |
| HDD | Heavy Duty Duct |
| HDPE | High Density Polyethylene |
| HV | High Voltage |
| OPGW | Overhead ground wire with optical fibre |
| TNC | Traffic Node Cabinet |
| Tx | Transmission |

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 gantry to control room fibre optic cabling and accessory installation should follow the guidelines below.

Note: The generic scope of work should apply 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

A new XXXkV line will be built between Station A and Station B and a XX core OPGW will be strung between the two stations.

3.1.1 Description of Work

- a) An OPGW will be installed on the new XXX kV Line which is built at XXX kV line between Station A and Station B
- b) The contractor will be required to terminate the fibre in the control rooms at both ends of the line.
- c) At Station A, new single mode HDD cable will be installed between the Station B feeder gantry and the existing Traffic Node Cabinet, No. XX located in the control room.
- d) At Station B, new single mode HDD cable will be installed between the new Stations A feeder gantry and the existing Traffic Node Cabinet, No. XX located in the control room.

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

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 1: Drawings and Diagrams required

| |
|--|
| Fibre Optic Cable Trenches |
| |
| Station A Control Room Panel Layout. |
| Station B Control Room Panel Layout. |
| Single mode Fibre Optic Layout in Station A Yard |
| Single mode Fibre Optic Layout in Station B Yard |
| Station A Traffic Node Cabinet Layout, No. XX |
| Station B Traffic Node Cabinet Layout, No. XX |
| Detail of the Yard Trench |
| Station A Yard Foundation, Trench and Earthmat Layout XXXX |
| Station B Yard Foundation, Trench and Earthmat Layout XXXX |

3.2 Materials Required

- a) The 48 core HDD fibre optic cables required between the gantry and the TNC cabinets at Station A and Station B will comply with the NRS Specification 066-2002.
- b) The contractor installing the OPGW on the Station A – Station B XXX kV line shall provide the stainless steel joint boxes and the down lead clamps for the OPGW to be fastened to the gantry columns at both stations.
- c) The 40mm diameter, outside diameter, stainless steel pipe. (2m)
- d) The 48 way Optical Distribution Frame, (Patch Panel) is part of the OPGW contract and shall conform to the specification for ODFs, 240-70733995.
- e) The 32mm, outside diameter, HDPE pipe shall be class 6 or similar. The HDPE pipe is required to protect the duct cable in the HV Yard.
- f) See Table in Annex B for Bill of Material.

3.3 Scope of Work

The Contractor shall supply, install, terminate and test the fibre optic cables mentioned in this document and will conform to the Standards and Specifications mentioned in this document.

- a) At Station A, the single mode HDD cable shall be installed between the control room, and the Station B, XXXkV gantry. The most common case is if there is no loop-in on the line, then the single mode cable shall be 48 cores. If there is a loop-in on the line, then there shall be 2 single mode 24 core cables with two 24 way patch panels. However when there are loop ins or other requirements, then Technology need to be informed to ensure the most practical design is used. The estimated length of the HDD cable is 200m and the length shall be confirmed by the contractor.
- b) At Station B, the single mode HDD cable shall be installed between the control room, and the new Station A, XXX kV gantry. The most common case is if there is no loop-in on the line, then the single mode cable shall be 48 cores. If there is a loop-in on the line, then there shall be 2 single mode 24 core cables with two 24 way patch panels. However when there are loop ins or other requirements, then Technology need to be informed to ensure the most practical design is used. The estimated length of the HDD cable is 200m and the length shall be confirmed by the contractor.

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- c) The 40mm, outside diameter, stainless steel pipes shall be installed as shown in figure 1, of the Fibre Optic Design Standard, 240-46264031. The clamps fastening the pipes must be stainless steel as well.
- d) On the gantry, the OPGW and Duct cable joint box shall be installed approximately 1.5m above ground. The loop created by the OPGW and duct cable shall be as per figure 2 in Annex A.
- e) At Station A, the existing Fibre Optic Cabinet is installed in position XX as shown on drawing no. XXX/XXXX. The ODF, (patch panel) will be installed in the TNC in the position shown in Diagram X.
- f) At Station B, the existing Fibre Optic Cabinet is installed in position X as shown on drawing no. XXX/XXXX. The ODF, (patch panel) will be installed in the TNC in the position shown in Diagram X.
- g) The contractor shall contact the project manager for instructions on where the ODFs (patch panels) will be installed.
- h) The contractor must note that trenching shall be required between the gantry and the nearest trenches for the cables and HDPE pipes from their respective gantries to the nearest trench. Marked up drawings shall be requested from the Project Manager.
- i) The Gantry point fibre connections and terminations shall be done in accordance with paragraph 4.3.2 of the Fibre Optic design standard, 240-46264031.
- j) All single HDD cables shall be installed in individual HDPE pipes.
- k) Single length cables shall be installed for its full length in accordance with the standard, 240-46264031.
- l) At the entry of the control rooms at Station A and Station B, the HDPE pipes must extend into the building.
- m) Two metres of the HDD cable shall be left in the TNC, after the cables have been terminated, two metres of fibre optic duct cable must be left within the Traffic Node Cabinets in each control room, in accordance with specification 240-46264031.
- n) Colour coding shall be completed in accordance with Eskom's standard, 240-46264031.
- o) The labelling and numbering of the cables shall be in accordance with Eskom's Labelling of Fibre Optic Cable standard 240-46263618.

3.4 Testing

- a) All splices must be tested in accordance with the latest revision of Eskom Fibre Acceptance Testing Standard, 240-70732888.
- b) The contractor must submit a list of test gear available together with their current calibration test certificates.

Note: That all testing must be witnessed by Eskom. The contractor must arrange with the Project Manager when testing is to be done.

3.5 Documentation

The final documentation must be approved by an Eskom representative and handed over to the Eskom Project manager on completion of this work:

- a) Test results as per the Fibre Optic cable System Acceptance Testing Procedure 240-70732888.
- b) Updated drawings showing the cable routing through the yard and to the Station, with as built cable lengths and the layout in the control room
- c) Full technical specification of all cables installed.

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- d) A dated and signed hardcopy of results and specifications must be provided to the Project Manager.
- e) The sign off sheet (Annex C) shall be completed by an Eskom Fibre Technician and submitted to the Project Manager.
- f) A PDF dated and signed soft copy of results and specifications must be provided to the Project Manager. 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 to the Eskom Project Manager.

3.6 General

- a) All lengths of the HDD fibre optic cables are estimated and it is the responsibility of the successful contractor to confirm all measurements.
- b) All splicing shall be done by the contractor.
- c) The minimum bending radius of each cable as specified by the manufacturer shall be maintained as mentioned in the Installation standard 240-46264031.
- d) The names and proof of course certification of persons doing splicing must be supplied.
- e) The successful contractor must ensure that he is in possession of all documents mentioned in this Scope of Work and understands the contents thereof.

4. Authorization

This document has been seen and accepted by:

| Name and surname | Designation |
|-------------------|--|
| Danie du Plessis | Senior Manager – Grids |
| Sikelela Mkhabela | Senior Manager - DX |
| Prudence Madiba | Senior Manager – GX |
| Alison Maseko | Senior Manager - Eskom Telecommunications (Acting) |
| Paul Grobler | Chief Engineer - TX |
| Sean Martiz | Senior Manager - GIT |

5. Revisions

| Date | Rev | Compiler | Remarks |
|------------|-----|----------|--------------|
| March 2016 | 1 | V Naidu | New Document |

6. Development team

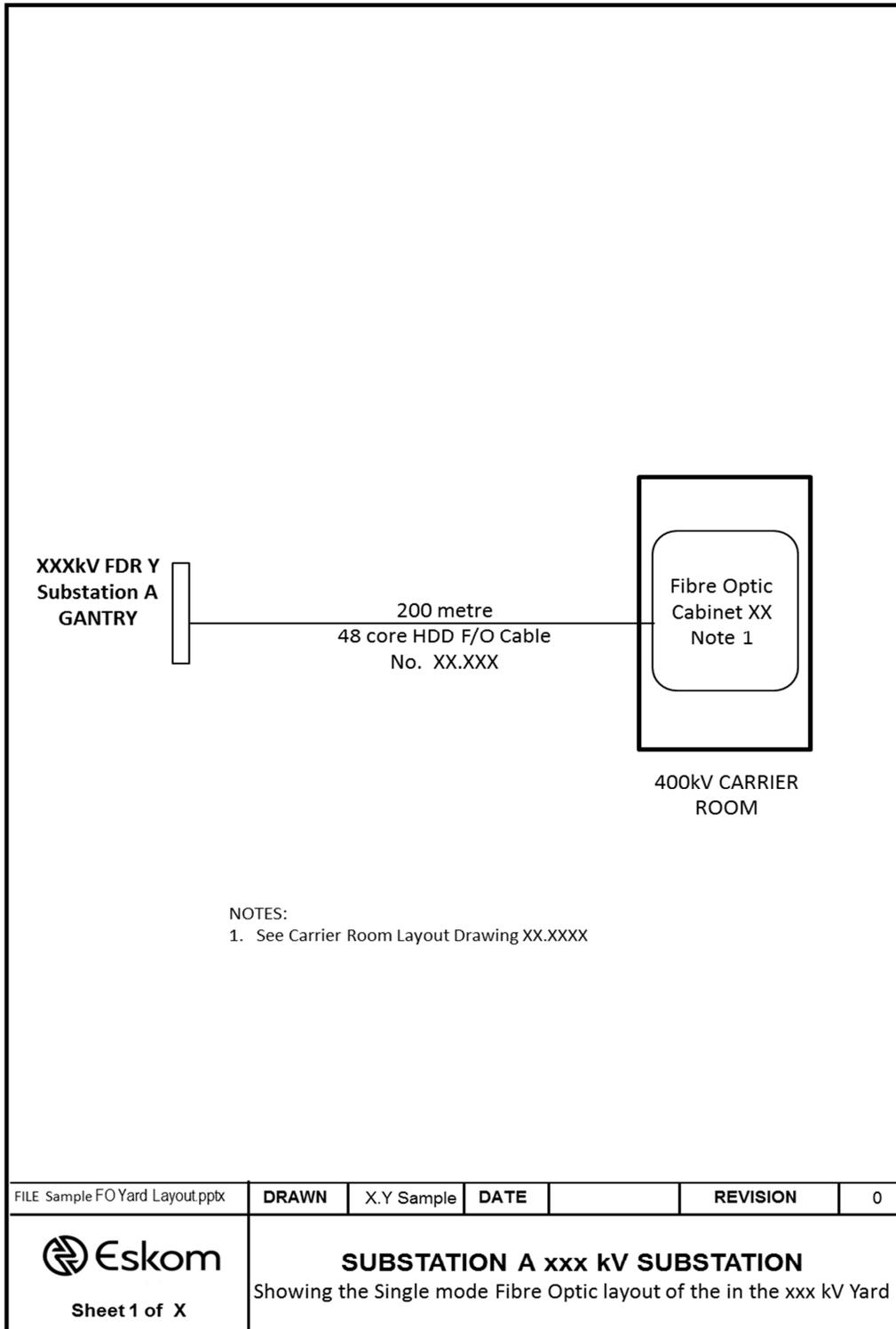
The following people were involved in the development of this document:

- Tejin Gosai
- Antonio Pereira
- Paddy Griffith

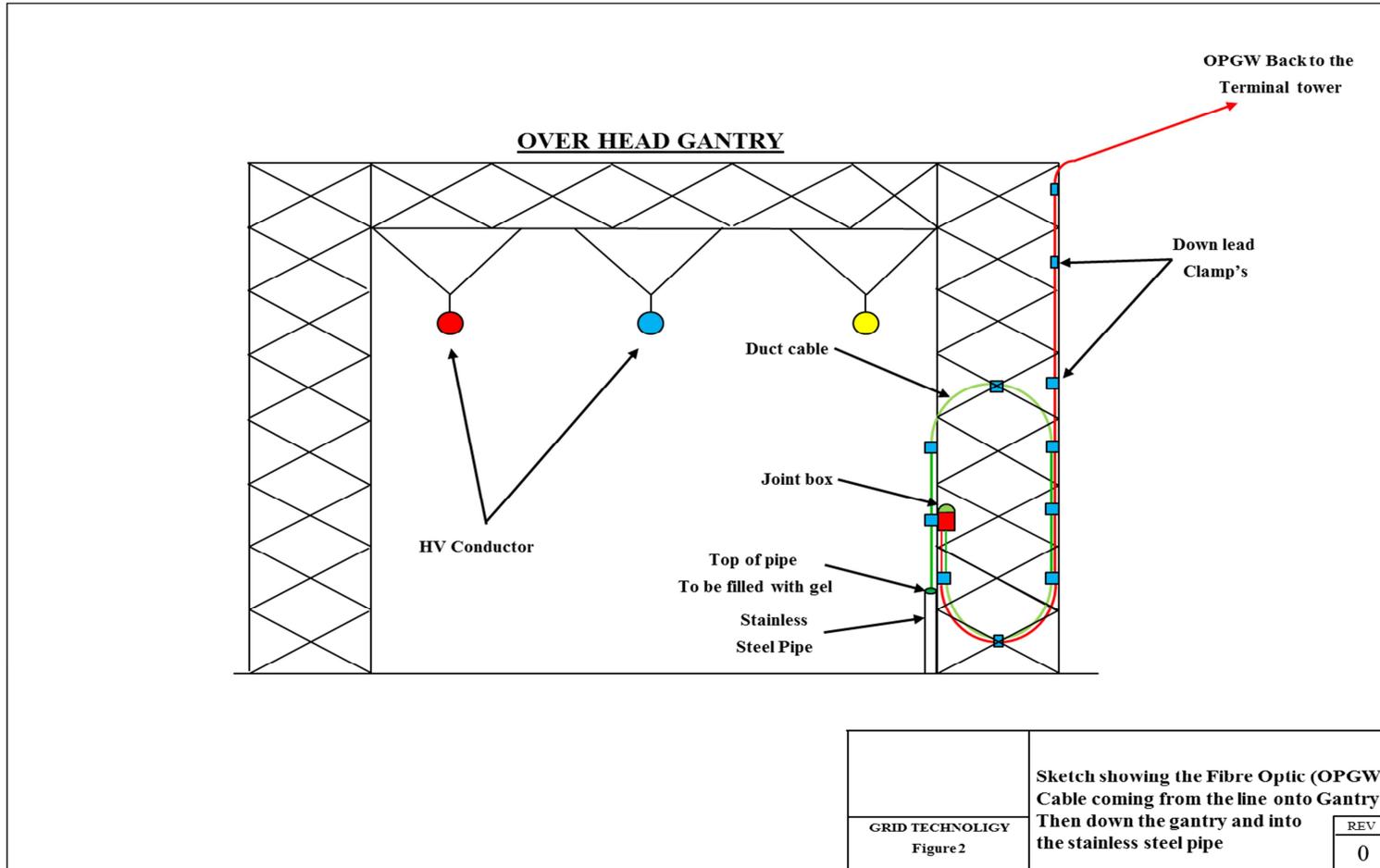
7. Acknowledgements

Paddy Griffith is acknowledged for the initial scope of work document created which is what this document is based on.

Annex A – Sample Drawings Required

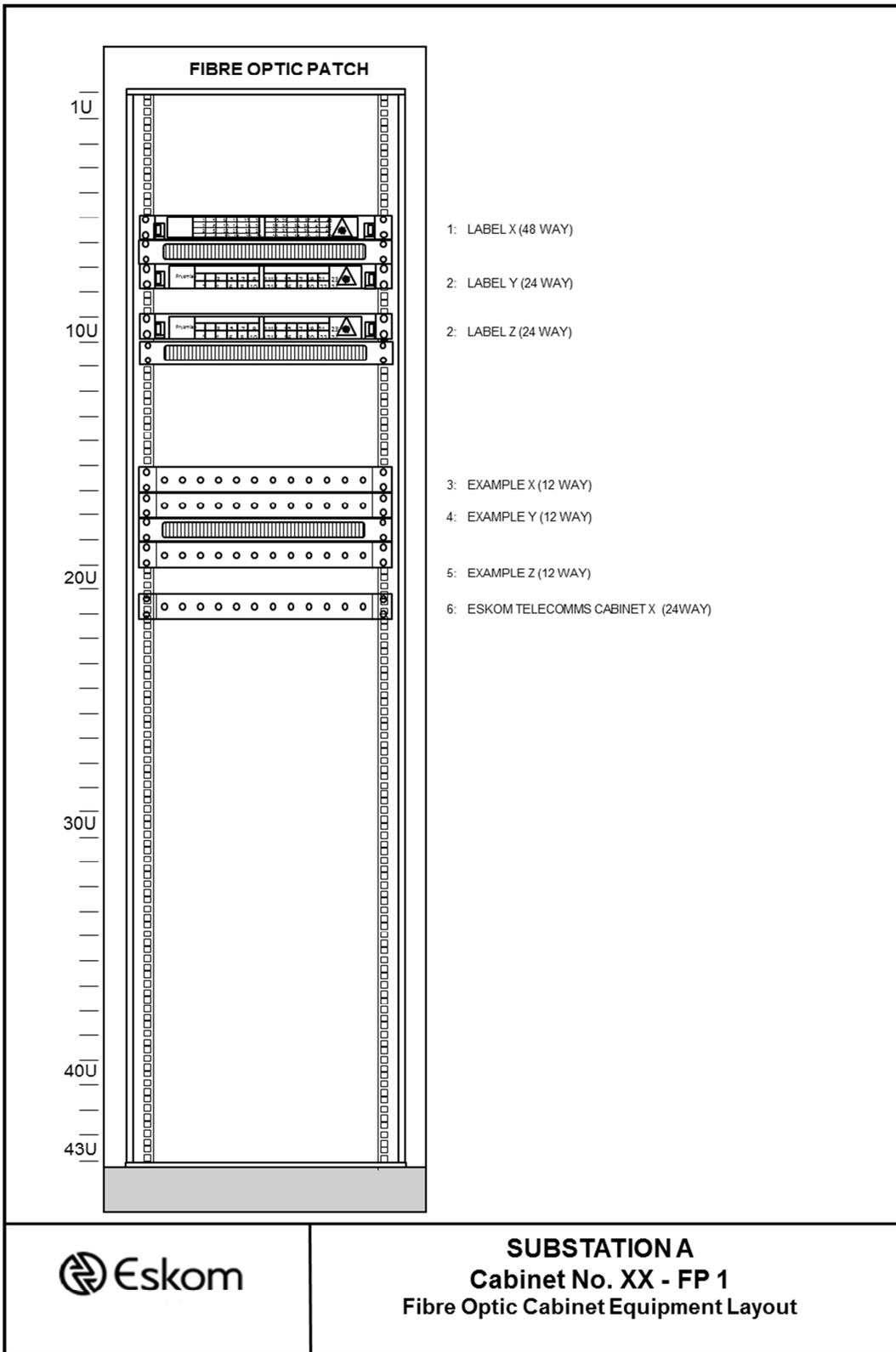


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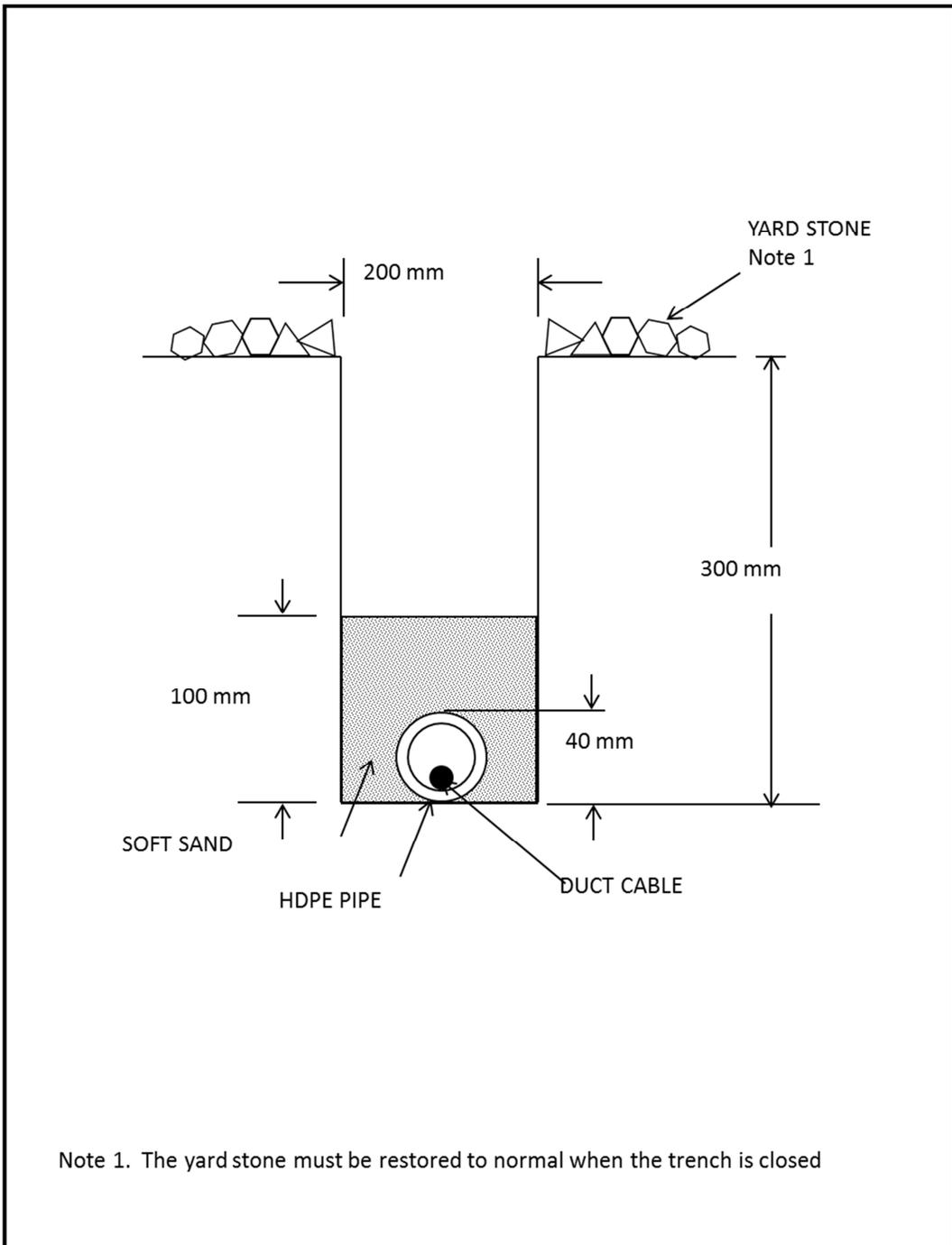
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SUBSTATION A
Cabinet No. XX - FP 1
Fibre Optic Cabinet Equipment Layout

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Note 1. The yard stone must be restored to normal when the trench is closed

| | | | | | | |
|---------------------------------|-------|------------|------|--|----------|---|
| FILE Sample FO Yard Layout.pptx | DRAWN | X Y Sample | DATE | | REVISION | 0 |
|---------------------------------|-------|------------|------|--|----------|---|

| | |
|--|--|
| | Substation A |
| | Showing the detail of the Yard trench |
| | Sheet X of Y |

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Annex B – Sample Bill of Materials

| Item | Description | Measurement | Qty | Unit Price | Total Price |
|------|---|-------------|-----|------------|-------------|
| 1.1 | Preliminary and General (including site establishment at Station A, access, etc.) | sum | 1 | | |
| 1.2 | Preliminary and General (including site establishment at Station B, access, etc.) | sum | 1 | | |
| 2.1 | Survey, Station A (on site verifications of the Scope of Work, and finalising of cabinets, cable, materials, etc) | sum | 1 | | |
| 2.2 | Survey, Station B (on site verifications of the Scope of Work, and finalising of cabinets, cable, materials, etc.) | sum | 1 | | |
| 3.1 | Supply, install, terminate and test 48 core single mode (9/125µm) metal free Heavy Duty Duct (HDD) cable, between the Fibre Optic Cabinet at Station A and the Station B Feeder Bay and terminate both ends (All lengths mentioned must be confirmed by the contractor) | 100m | 1 | | |
| 3.2 | Supply, install, terminate and test 48 core single mode (9/125µm) metal free Heavy Duty Duct (HDD) cable, between the Fibre Optic Cabinet at Station B and the Station A Feeder Bay and terminate both ends (All lengths mentioned must be confirmed by the tendering contractor) | 100m | 1 | | |
| 4 | Trenching required for the cables and HDPE Pipes from the gantries to trench. (Trenching to be confirmed by the tendering contractor) | ±15 m | | | |
| 5.1 | Class 6 HDPE, 32 mm, outside diameter, pipes at Station A. Contractor to confirm lengths | 100 m | | | |
| 5.2 | Class 6 HDPE, 32 mm, outside diameter, pipes at Station B. Contractor to confirm lengths | 100 m | | | |
| 6 | 19" rack-mount 48-way single mode fibre patch panel complete with SC-APC mid-couplers & pigtails- supply and install | each | 2 | | |
| 7 | Splice protectors Single mode | each | 96 | | |
| 10 | No 0 compression glands | each | 2 | | |
| 13 | Splicing of OPGW single mode fibre cores to Duct fibre cores at substation gantries | ea | 96 | | |
| 14 | Splicing of Single mode Duct fibre cores onto pigtails and insertion of pigtails into mid-couplers | ea | 96 | | |
| 15 | Final OTDR testing for all single mode fibre cores from end to end as per specification | ea | 48 | | |
| 16 | Final end to end power budget measurements of OPGW fibre cores as per specification | ea | 48 | | |
| 17 | As-built documentation including of test results as per specification - soft and hard copies | lot | 2 | | |
| 18 | Marking of all cables, patch panels, mid-couplers and pig tails as per specification | lot | 1 | | |
| 19 | 40 mm stainless steel pipe required for the HDD cable at the gantry | ea | 2 | | |
| 20 | Other - please specify | | | | |

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Annex C – - Quality Acceptance Sign Off Sheet

| | |
|-------------------|--|
| PROJECT | |
| SUBSTATION NAME | |
| PATCH PANEL LABEL | |

| ITEM | DESCRIPTION | NO | YES |
|------|--|----|-----|
| 1 | Large gland to accommodate full cable diameter into cabinet | | |
| 2 | 2m plus slack in cabinet. | | |
| 3 | Entry to patch panel correctly terminated. | | |
| 4 | Transportation tube correctly installed | | |
| 5 | Correct splicing organiser for the patch panel | | |
| 6 | No insulation tape used In the organiser | | |
| 7 | No macro bending on fibre or pig tails | | |
| 8 | Compatible grooves for splicing protectors | | |
| 9 | Neat pig tales | | |
| 10 | Numbered pig tales | | |
| 11 | Mid couplers grooves facing down | | |
| 12 | Mid couplers tight | | |
| 13 | Mid couplers protected with dust cover | | |
| 14 | Patch panel mounted correctly with cage bolt and nut inside | | |
| 15 | Patch panel mounted an adjustable bracket | | |
| 16 | Patch panel re-cessed in such away that when the patch cords are inserted in the mid couplers the patch cords, are not t in the way of other equipment and closing door. | | |
| 17 | Patch panel and cable labelled correctly with fibre distance and distant station. | | |
| 18 | Patch panel and site clean | | |
| 19 | Cabinet mounting – must be bolted down | | |
| 20 | Cabinet Earthing – according to Standard | | |

Accepted by Eskom:

Technician Name: _____

Date: _____

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