Eskom	Scope of Work	Transmission

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Compiled by	Reviewed by	Authorised by
……..	……..	……
Bertie Jacobs	**Sibonelo Nzama**	**Faith Mokhonoana**
Chief Technologist	**Middle Manager: SCH Cluster**	**Senior Manager**
Line Engineering	**Line Engineering**	**Line Engineering**
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1. INTRODUCTION

Eskom has invested in a transmission (132 kV – 765 kV) overhead power line training facility that will be used for training in the line construction space as well as other activities such as product testing etc. The training will cover both theoretical and practical aspects of line construction from the survey of a line to stringing and regulation of conductors. The objective and goal of the training centre is to issue trainees, upon successful completion, with an “Overhead Linesman Trade Certificate”. The target audience will be the line contractors (site foreman/supervisor and above) and Eskom employees such as the site team, the grids, power line engineers and project management.

The overall aim of the training facility is to:

- Fast track all aspects of construction learning, skills transfer and to create a pool of expertise that Eskom and power line construction companies can source.
- Maintain high safety standards and reduce fatalities during construction.
- To promote a more efficient construction rate with fewer incident delays.
- Improve competence in line construction.
- Improve the quality of workmanship on newly commissioned Eskom overhead power lines.
- To demonstrate new technologies and construction practices.

2. TRAINING FACILITY OVERVIEW

The constructed infrastructure at the Eskom Academy of Learning (EAL) is meant to assist with the practical training of all powerline construction aspects. Figure 1 illustrates an overview of the existing practical training infrastructure.

At the facility, there is a foundation section designated for the training of certain foundation construction activities. The section currently has two open excavations for conventional foundations, steel and reinforcement for the relevant foundation, slump test apparatus and concrete cubes moulds. A separate guy anchor foundation is installed in this section for proof load testing. The engineering lab has a fully equipped concrete laboratory with concrete cube curing baths and strength testing equipment. A micropile rig is also available for training.

Adjacent to the foundation section is the designated area for the practical training of tower assembly and erection. There are three towers positioned in this area with permanent foundations, a self-supporting structure (518J) and the cross-rope structures for the 400 kV (529A) and 765 kV (705C). These towers can be assembled, erected and dismantled repetitively using the different methods. This section also has various hardware and insulators for dressing of the towers,

The 1 km non-energised 400 kV power line was constructed for the main purpose of conductor stringing and, regulation, hardware, and line accessories installation training. The line was designed to simulate various field conditions. The line has seven different structures as shown in Figure 1 and currently has three different phase conductors and bundle configurations (3 x Tern, 2 x Bersfort and 4 x IEC560), two different earth conductors (19/2.7 steelware and Horse), hardware assemblies and both glass and composite insulators. The area parallel to the line is reserved for survey duplication of the line and setting out of the existing towers.

The engineering lab also has full scale samples of overhead line hardware assemblies, vibration dampers and other components, to assist with the theoretical training. The lab will also be used to provide information on different geology experienced during power line construction.
Other features include a site office area, similar to what is used on actual construction sites, complete with offices, small boardroom, kitchen and other amenities.

Figure 1: General outlay of EAL training facility

3. SERVICES REQUIRED (SCOPE OF WORK)

Eskom Transmission requires the following services:

- Development of theoretical training modules with assessments
- Practical training modules with assessments
- Provision of facilitators to facilitate both theoretical, practical training and assessments
- Training of Eskom facilitators on the facilitation of the theoretical and practical training ad how to carryout assessments

N:B: All training will be done at the Eskom Academy of Learning in Midrand, Johannesburg.

A training framework was developed by Eskom Transmission Line Engineering Services (LES) which is in Annexure A. This covers all the required (but not limited to) topics and modules that need to be developed.

Since it is a framework, not all information is populated like figures, photos and some text, however it does provide a good overview of what is required.

It is envisaged that the training will take the form of both theoretical as well as practical training. During the theoretical training, which will typically be classroom based, all key concepts and theory will be conveyed to the students with the required assessments where and as necessary. This theory will form the foundation for all the modules that is needed for the practical execution.

The practical training modules must include the details of the “how to” for each construction activity as well as the correct implementation and safe operation of all tools and equipment to be used for the relevant training modules. The necessary assessments where and as required need to be created in order to confirm the student’s competency in mastering the relevant subject.

The following high level modules need to be covered.

- Project/job planning
- Site establishment
- Line survey
- Foundation installation
- Tower assembly
- Tower erection
- Tower dressing
- Stringing and regulating
- Installation of vibration dampers, bird guards, aircraft warning spheres etc.
- As-built documentation

4. RFI OBJECTIVES

Service providers are required to respond with a **strategy/letter/information** indicating their ability to meet the objectives 1 – 7 below.

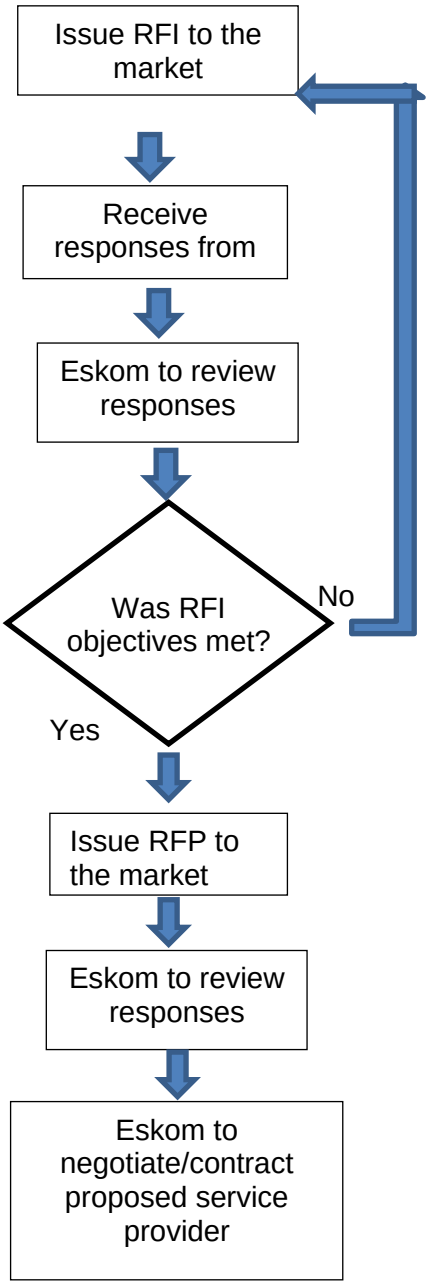
1. Provide an overhead line construction curriculum covering voltages from 132 kV to 765 kV lines for both theoretical and practical modules in accordance with the framework in Annexure A. They must also provide the facilitators to provide this theoretical and practical training making use of the EAL full scale practical infrastructure as described.
2. Train Eskom employed staff to become facilitators in both theoretical and practical training as described above.
3. Provide training, support and facilitation for a period of five years (or as determined by Eskom later) in accordance with the developed curriculum by them.
4. Be already accredited with Quality Council for Trade Occupations (QCTO).
5. Make use of the EAL training module templates for final submission of all training material.
6. Provide a budget cost and timeframe (considering the EAL template requirements as stated above) for the provision of all mentioned services required.

7. Respond, complete and return the Requirements Schedule in Annexure B together with information for all 6 points above.

5. HIGH LEVEL PROCESS FLOW

The following flow chart provides an overview of the process that will be followed.

As this is a RFI process with indicative cost and time frame, it cannot be used to enter into a contract with any prospective service provider. Hence, another process like Request for Proposal (RFP) or similar type of enquiry will be issued at a later stage.

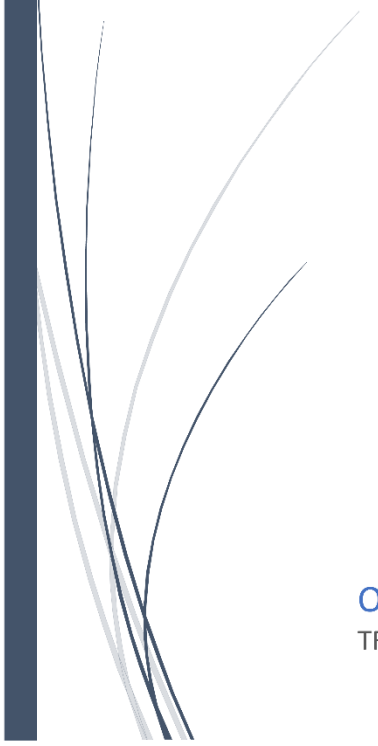


ANNEXURE A

Training Framework

Transmission Line Simulator
Eskom Academy of Learning

Training Modules Table of Contents



Overhead Lines SCOT – Training Care Group
TRANSMISSION

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1. Introduction

This manual outlines the activities and methodologies (including sequences) used to build competence on the construction of an overhead transmission line.

It must be noted that the table is a guideline and the actual learning material can be developed in any sequence as long as it covers each topic.

The target audience for this training is all professionals and workmen who construct high voltage (HV) transmission (construction companies and especially new companies that need to build competence through the incubation program.)

2. Specifications and Reference

3. Definitions and Abbreviations

Term	Definition

Term	Abbreviation
Safe Work Procedure	SWP
Fall Arrest Anchor	FAA

4. Background

4.1 Design

Eskom provides the detailed design of power lines and develop a line specification for all 132 kV, 220 kV, 275 kV, 400 kV and 765 kV voltage projects.

4.2 Construction

- Each section in the documents should cover the following voltage levels 132 kV, 220 kV, 275 kV, 400 kV and 765 kV level.
- Each activity should be broken down per voltage if the methodology varies per voltage level.
- Each activity should be broken down per tower type, self-supporting, guy vee, cross rope and poles.
- Eskom outsources all construction activities.
- For each section list the required qualifications and experience / skills.
- Include pictures or drawings to clarify processes.
- Where applicable include Prototyping before manufacturing.

5. Job planning

- Job planning – Sequence of events, how to avoid delays and which teams are required first.
- Resources requirements – type of skill, how many teams, authorised personnel, how big are the teams.
- Method statements and SWPs – understanding the scope, safety and preferred method.
- Inventory of required information (drawings, standards, specifications, installation manuals, etc).
- Work Schedule – timelines and continuity.

6. Site establishment

- Indicating key personnel and staffing for project and site organograms, cover key project and construction management personnel including project managers, site manager, SHEQ personnel and temporary works engineer.
- Provide system and documentation for materials management.
- The sub sections of this section must be inclusive of everything used on site. Below is a guideline of some key components. Please include handling and storage of ***all items*** on site be used in construction on site e.g., steelwork, insulators, hardware conductor etc.
- Where applicable include Prototyping before manufacturing.

6.1 Basic rigging course of how to download and upload material and equipment

- Identify and choose correct type of slings, ropes etc to be used for the different types of free-issue material and other equipment. Students must learn how to choose the suitable strength class of rigging equipment, the correct type (example nylon slings vs steel slings) when and where to use what.
- Learn crane signals
- How to determine mass of object to be loaded in case not clearly indicated
- Consult with rigging suppliers as to detail course content

Figure 1:

6.2 Insulators handling, storage and transportation

- The contractor must maintain a full inventory of all components received (insulators, rings etc.) including all documentation (goods received, test reports, inspection reports etc.)
- Provide documentation regarding handling, storage and transportation according to supplier guidelines.
- Do a full assembly mock-up of all assemblies on the ground, verify and sign off that all are in order before installation.
- Correct handling methodology of insulators (glass and composite) needs to be covered.

Figure 2:

6.3 Conductor and groundwire handling, storage and transportation

- Maintain a full inventory of all components received including all documentation (goods received, test reports, inspection reports etc.)
- Provide documentation regarding handling, storage and transportation according to supplier guidelines.
- Students will be required to compile a short SWP highlighting the methodology and risks associated with each step of material handling. Indication is required how they will mitigate against the risks identified.
- A practical exercise is required where students lift a conductor drum (can be empty) using the correct spreader bar and slings from an elevated platform (a truck or simulated truck) to the ground.
- Repeat above for simulating uploading drum from site camp to tower location.
- Conductor drum storage, there are very specific best practices that should be adhered to with regards to surface material, surface gradient, placement position, chocking of drums, drainage, spacing of drums, regular rotation and any other special additional requirements depending on site conditions and expected period of storage etc.

Figure 3:

6.4 OPGW and OPGW hardware handling, storage and transportation

- The contractor must Maintain a full inventory of all components received including all documentation (goods received, test reports, inspection reports etc.)
- Provide documentation regarding handling, storage and transportation according to supplier guidelines.
- Students will be required to compile a short SWP highlighting the methodology and risks associated with each step of handling and downloading/uploading of the drums. Indication is required how they will mitigate against the risks identified.
- A practical exercise is required where students lift a OPGW drum (can be empty) using the correct spreader bar and slings from an elevated platform (a truck or simulated truck) to the ground.
- Repeat above for simulating uploading drum from site camp to tower location.

Figure 4:

6.5 Tower steel and accessories handling, storage and transportation

- Prototyping before mass manufacturing.
- Maintain a full inventory of all components received (including bolts, nuts, washer etc.) including all documentation (goods received, test reports, inspection reports etc.)
- Provide documentation regarding handling, storage and transportation according to supplier guidelines.
- Students will be required to compile a short SWP highlighting the methodology and risks associated with each step of handling and downloading/uploading of the steel bundles. Indication is required how they will mitigate against the risks identified.
- A practical exercise is required where students off load correctly packed steel bundles using the correct slings and required rigging equipment from an elevated platform (a truck or simulated truck) to the ground.
- Repeat above for simulating uploading steel bundles from site camp to tower location.
- Correct storage of material at tower position to be covered.

Figure 5:

6.6 Hardware handling, storage and transportation

- Prototyping before manufacturing.
- Maintain a full inventory of all components received including all documentation (goods received, test reports, inspection reports etc.)

- Provide documentation regarding handling, storage and transportation according to supplier guidelines.

Figure 6:

7. Surveying, pegging and plumbness

- List of survey equipment per tower type.

Figure 7:

7.1 Surveyor Responsibilities

Figure 8:

7.2 Control pegs

Figure 9:

7.3 Bend Point Pegs

Figure 10:

7.4 Line Poles and Tower offsets

Figure 11:

7.5 Setting out Procedures

Figure 12:

7.5.1 Centre-Point Pegs and Associated Pegs

Tools Required

- Survey Grade Gps
- Total station

- Hammer
- Iron Pegs
- Wooden/steel poles
- Paint
- Peg cap
- Tripod
- Measuring tape

Figure 13:

7.6 Setting out procedure for self-supporting tower

- Calculation of leg extensions and body extensions for ordering

Figure 14:

7.7 Setting out procedure for cross rope tower

Figure 15:

7.8 Setting out procedure for guyed vee tower

Figure 16:

7.9 4.6 Setting out procedure for pole

Figure 17:

8. Construction activities

8.1 Geotechnical investigations

- Elaborate on the evaluation and determination of the foundation material.
- Highlight all the risks and the treatments of risks that may be encountered during geotechnical investigations.

- Dolomitic studies and investigations?
- Under-mining investigations?
- Etc.

Figure 18:

8.2 Foundation activities

- Highlight all the risks and the treatments of risks that may be encountered during foundation activities.
- Add a flowchart for typical foundation construction.

Figure 19:

8.2.1 Foundation Loads interpretation

Foundation loads interpretation. Focus on how to interpret the tower loads and transfer to foundations.

8.2.2 Foundation components

- Overview of the different types of foundation components (within the conventional foundations for self-supporting and guyed and piles).
- Detail the basic function of each component (e.g. different rebar, cleats, stub, why second pad?, earthing, spacer for micropiles, different pile diameter, drill bits etc).
- How to read tower foundation drawings including stub and link drawings with examples.
- Highlight the difference in the drawings for different foundation types and the importance of certain details (e.g. the column slopes for the cross-rope structure masts foundation and the bearing plate orientation of the guyed-V mast foundation etc).
- Detail the tools required for the construction.

Practical:

- Review a conventional foundation drawing for a self-supporting structure and ensure that all the correct material and tools required are on-site.

8.2.3 Excavations, soil nominations, placing of rebar and shuttering

- Detail the “how to” for:

- Excavating and the different the methods of obtaining the correct stub/leg extension required.
- The layout for the soil nomination test pits for the different tower types.
- To create the rebar cage, what is lap length, rebar spacing, cover to concrete etc.
- Size and seal formwork.

- Detail of how to for micropiles and other piles (similar to above).
  - Examples but not limited to micro-pile and driven pile options.

Practical:

- Use the drawing with the open excavation and all foundation material, setup the conventional foundation according to the drawing.
- Walk along the line to look at different completed foundation types.

Figure 20:

8.2.4 Slump test, pouring of concrete, concrete vibration and curing

- List all the equipment and tool required for the heading activities and their function.
- What should be checked on the delivery note from the concrete truck.

Practical:

- Practical slump tests to be practiced by students.
- What are tolerances for the slump test.
- What does this mean? Can it be corrected?

- How should concrete vibration be done? What is under and over vibration? What will it look like on site?
- The method for curing of the foundation
- How to make concrete cubes, how many, how to label and why
- Method of curing, overview of why

Practical:

- Make and label cubes.

Figure 21:

8.2.5 Cube crushing tests

- Method of cube crushing, why and when

Practical:

- Witness a cube crushing, did it pass or fail? If it failed what is the next step?

Figure 22:

8.2.6 Earthing

Example of special consideration e.g. earthing system of the power line 1 and 2, include safety earthing to make stringing and regulation safe near other energized power lines.

Figure 23:

8.2.7 Soil compaction

- In-situ compaction tests must be done for every backfilling operation.
- Method.
- How to test compaction effort.
- Include soil erosion mitigations i.e., Berms, gabions etc.

Practical:

- DCP test

Figure 24:

8.2.8 Proof and ultimate load testing

- Why, how and when?
- Off-line testing of guy anchors to determine soil parameters
- On-line pull tests
- Detail the test components step up and location relative to the foundation, include pics and function.
- What are the sensitive apparatus?
- Test method.

- Test sheets.

Practical:

- As a team setup a test for the guy anchor foundation perform the test and record the results.

Figure 25:

8.2.9 Temporary foundations

- Design of different types of temporary foundations, calculations, checks and installation.

Figure 26:

8.3 Towers assembly and erection

Each activity should be broken down per voltage if the methodology varies be voltage level.

- Calculation of leg extensions and body extensions for ordering
- Method used.
- Equipment ratings.
- Overview of different types of towers used on Eskom Grid.
- Confirming correct drawings are on site.
- Tower drawing training indicating the different number of drawings associated with each section, transverse view, longitudinal view, how to interpret steel cuts and bending, interpreting different views, latest revisions, identifying member numbers etc.
- Training on bolts – sizes, length requirements, grip length, direction etc.
- Reference to contractor's SWP and risk mitigation.

Figure 27:

8.3.1 Installing normal bolts and step bolt on all towers

- Do practical installation on two pieces of members choosing correct length of bolt(s).
- Students to be trained on the correct orientation of FAA.
- Basics of punching and painting to be covered theoretically and practical using the correct type of punch. Samples need to be physically punched and checked for correctness.

Figure 28:

8.3.2 Self-supporting assembly

Practical:

- As a team assemble a self-supporting structure.

Figure 29:

8.3.3 Guy rope basics

- Cover the theory of different types of guy rope end-fittings (crimped vs pre-formed).
- Cover the correct chamfering of link plates to be used with the different guy ropes (See Trmscaac 6.0).
- Have physical examples of each type available to cover all possible combinations.
- Cover the theory of how to correctly tension a guy rope.
- Use small rig to illustrate and practice the correct methodology of tensioning of guy ropes using load cells.
- Do practically the installation of pre-formed guy wire fittings.
- Do practically the installation of crimped type guy wire fittings.

Figure 30:

8.3.4 Guyed vee and guy anchors assembly

- Describe the method used to cut, install and tension guy wires.

Figure 31:

8.3.5 Cross rope and guy anchors assembly

- Describe the method used to cut, install and tension guy wires.

Figure 32:

8.3.6 Pole and guy anchors assembly

- Describe the method used to cut, install and tension guy wires.

Figure 33:

8.3.7 Self-supporting erection

- Detail the different methods and the how to.
- Include different erection methods e.g., gin-pole or crane.
- Include details of the skilled riggers and structural experts required for loading calculations to ensure that safe procedures are followed at site.

Practical:

- As a team erect the structure using the different methods.

Figure 34:

8.3.8 Guyed vee erection

- Include different erection methods e.g., gin-pole or crane.
- Include details of the skilled riggers and structural experts required for loading calculations to ensure that safe procedures are followed at site

Figure 35:

8.3.9 Cross rope erection

- Include different erection methods e.g., gin-pole or crane.
- Include details of the skilled riggers and structural experts required for loading calculations to ensure that safe procedures are followed at site

Practical:

- As a team erect the structure using the different methods

Figure 36:

8.3.10 Single mast tower erection

- Erection of lattice single mast towers such as 704, etc.

Figure 37:

8.3.11 Pole erection

- Include details of the skilled riggers and structural experts required for loading calculations to ensure that safe procedures are followed at site. Aligning with the holdup bolts

Figure 38:

8.4 Installing fall arrester

- Include method statement for installing and for uninstalling the fall arrest system.

Figure 39:

8.5 Back staying

Figure 40:

8.6 Dressing, Stringing and Regulating

- Provide a list of the required equipment including dimensions, ratings and safe working loads of the equipment.

Figure 41:

8.6.1 Dressing conductor

Figure 42:

8.6.2 Dressing earthwire

Figure 43:

8.6.3 Dressing OPGW

Figure 44:

8.6.4 OPGW Joint boxes

Figure 45:

8.6.5 Stringing pilot wire

Figure 46:

8.6.6 Stringing conductor

- Include a section covering long spans.

Figure 47:

8.6.7 Regulating earthwire

Figure 48:

8.6.8 Regulating OPGW

Figure 49:

8.7 Crossings

- Include
  - Method used.
  - Equipment ratings.
  - Pictures or drawings to clarify processes.

Figure 50:

8.7.1 Line to line crossings – dead crossing

Figure 51:

8.7.2 Line to line crossings – live crossing

Figure 52:

8.7.3 Line to railways – dead crossing

Figure 53:

8.7.4 Line to railways – live crossing

Figure 54:

8.7.5 Line to roads

Figure 55:

8.7.6 Line to highways

Figure 56:

8.8 Installing anti-vandal measures

- What are the different types.
- When should they be installed.
- Method of how to for each type.
- Where to install them.
- This should have happened before erection for guyed structures.

Practical:

- Walk along the line and view the different anti-vandal fastener measures and connections on the different tower types. Are they correct?

Figure 57:

8.9 Installation of anti-climb device

Figure 58:

8.10 Installation of line surge arresters

Figure 59:

8.11 Installation of bird perch diverters (bird guards)

- Bird guards
- Bird flappers
- Bird diverters

Figure 60:

8.12 Installation of aerial warning spheres

Figure 61:

8.13 Installation of spacers/spacer dampers

- Bolted
- Preformed

Figure 62:

8.14 Installation of vibration dampers

Figure 63:

8.15 Installation of tower labels

Figure 64:

Figure 65:

8.16 Rehabilitation

Figure 66:

Figure 67:

8.17 As-built documentation

This documentation should include a complete file including all final tower positions, foundation and geotechnical reports, tower types, tower footing measurements, line impedance measurement, incident reports, inspection reports and airborne laser scan (if specified) and infra-red scan if specified.

Figure 68:

ANNEXURE B

Requirements schedule

Enquiry No.:_____ **Tenderer's name:** _____

Development of Transmission overhead line construction training curriculum

Ref.	Description	Response (Yes/ No)
1.	**Company details**	
1.1	Provide your company profile	
2.	**Experience in training material development**	
2.1	Have you previously developed training material for overhead power line construction? 132 kV to 765 kV	If Yes provide details
2.2	Have you facilitated practical overhead power line construction training? 132 kV to 765 kV	If Yes provide details
2.3	Has your company executed this kind of work/services in partnership, with a subcontracting agreement, or as JV or as corsotium (Y/N)	If Yes, please provide details how the partner and the roles your company played and the role the partner played.
2.4	What are the source(s) of your curriculum content?	Is it books, courses, own experience etc? Provide details.
2.5	Number of facilitators available to perform training?	Number available
2.6	Provide us with a copy of a book or evidence sample of similar work that you have performed (where applicable)	
3.	**Facilitator and curriculum accreditation**	
3.1	Is your company and/or facilitators accredited with the Quality Council for Trade Occupations (QCTO)?	Yes or No. Provide evidence

3.2	Are you accredited with any other body, institution, organisation etc?	If Yes provide details
4.	**References**	
4.1	Provide feedback and/or references from past customers/clients.	Provide letters of recommendation and/or details.
5.	**Additional Information**	
5.1	Different proposal covering all above subjects are welcome (Where alternative proposal is available please indicate that your proposal is an alternative)	
5.2	Provide the indicative total cost for the program/course of this magnitude. - Provide detail cost structure. (rate based or activity based) *N:B All training will take place at the Eskom Academy of Learning*	