Eskom	Work Instruction	Technology

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Content

Figures

Tables

1. Introduction

All projects in Eskom conform to the approved standard Eskom project life cycle model in order to govern and standardise project approval, management, and the investment process as shown in figure 1 below.

This document defines a standardised process for all substation projects initiated in the Transmission Division.

Figure 1: Standard Eskom project life cycle model

2. Supporting clauses

2.1 Scope

2.1.1 Purpose

The purpose of this document is to set out the Substation engineering CoE department's process that is followed pertaining to a substation project.

2.1.2 Applicability

This document applies to all substation projects initiated by Transmission Asset management execution or Transmission grid planning department.

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] 32-1155: Standard Project Life Cycle Model

[2] 240-53114026: Project Engineering Change Management

[3] 240-53113685: Design Review Procedure

[4] 240-76628703: Wires Project Life Cycle Model and Work Package

[5] 240-64014170: Wires Business Project Life Cycle Governance Guideline

[6] 240-606480018: Terms of Reference for Design Review Teams presiding over Power Delivery Infrastructure Designs in Eskom

[7] 32-601: Procedure for issuing quotations to transmission customers

[8] ISO 9001, Quality Management Systems - Requirements.

2.2.2 Informative

None

2.3 Definitions

2.3.1 General

Definition	Description
Substation design leader	Substation design leader is the delegated engineer/technologist responsible to coordinate the Centre of excellence specific activities for the particular package/plant , system/asset such as civil, electrical etc.
Substation engineering works scheduler	Substation engineering works scheduler is the delegated engineer/technologist responsible to schedule and prioritise the Centre of excellence projects.

2.3.2 Disclosure classification

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

2.4 Abbreviations

Abbreviation	Description
AIS	Air-insulated switchgear
CCC	Completion Compliance Certificate
CoE	Centre of Excellence
CRA	Concept Release Approval
DRA	Definition Release Approval
DRM	Design Review Meeting
DRT	Design Review Team
ERA	Execution Release Approval
FRA	Finalisation release approval
GIS	Gas-insulated switchgear
HIS	Highly integrated switchgear
HOA	Handover approval
HVAC	Heating, ventilation, and air conditioning
LES	Lines Engineering Services
LIDAR	Light Detection And Ranging
PDE	Power Delivery Engineering
PTM & C	Protection, Teleprotection, Metering and Control
SLDG	Substation Layout Design Guide
URS	User Requirement Document. A document prepared by Transmission Technology department which provides high level information about what needs to be done in a given project.

2.5 Roles and responsibilities

Role	Description
Design Review Team	The team member's responsibilities include the following: • Ensuring that an appropriate and complete design process has been followed • Ensuring that an appropriate design is being proposed and value engineering principles are being applied, as well as checking compliance with organisational strategies • Reviewing the viability of the design • Ensuring that all design input has been adequately considered; in particular, ensuring that the engineering design or design change has been adequately reviewed with regard to interface issues between various disciplines, contractors, etc. • Ensuring that all review cycles have been complied with • Making recommendations regarding engineering change approval
Substation Engineering Personnel	All Substation Engineering personnel shall comply with this work instruction

2.6 Process for monitoring

This document shall be reviewed as required to ensure that the information contained within it is relevant and up to date.

2.7 Related/supporting documents

This document shall supersede all other specific documents pertaining to the guideline of a project at Substation Engineering.

3. Substation Engineering design process

All substation related projects introduced to Substation Engineering undergo three phases, with approval required at the end of both the concept and detail design phases.

In addition to the three phases, Substation Engineering is also involved in the pre-project planning phase as mapped out in detail on Annex A1 flowchart.

3.1 Pre-project planning process

The pre-project planning process is mapped out for a typical greenfield or extension project in Annex A1 flowchart, indicating inputs to Substation Engineering, Substation Engineering design processes, technical interfaces and lastly Substation Engineering outputs. The inputs to the pre-planning process include:

- Work request
- Scope of project

- Site layout drawing with proposed sites(if applicable)
- LIDAR survey from Line Engineering Services
- Preliminary geotech report
- Environmental management plan
- Line servitudes (if available)

The Integration engineer would request a pre-planning design from substation engineering works scheduler via a works request form, and a contractual document known as a completion compliance certificate would be compiled between Integration and Substation Engineering. The outputs from Substation Engineering at this early stage would be the compilation of a Completion Compliance Certificate (if required) and Task schedule.

3.1.1 Design Alternatives

- Review and analyse scope of project for clarity, adequacy, etc
- Define Electrical and Civil station sizing requirements
- Compile site footprint
- Comparison of site options
- Recommendation of preferred site

3.1.2 Specialised Studies

The following specialised studies are to be carried out if applicable:

- Geotechnical desktop study for identified sites
- Scope definition geotechnical study
- Terrace geometric design
- Flood analysis
- Storm water study

3.1.3 Design Review and Baseline

Review and approve preferred site taking into account compliance with scope, specialised studies and baseline the documents that describe the design. Note: There is no formal design review for this phase.

The Design Report which includes the typical Station Electric Diagram, typical Key Plan, terrace geometric designs, flood analysis and storm water study form part of the pre-planning report.

The Pre-planning process is completed and the CCC (if required) needs to be signed by all relevant parties as completion of the works request on actual dates.

3.2 Concept design process

The concept design process is mapped out in Annex A2 flowchart, indicating inputs to Substation Engineering, project management activities, Substation Engineering design processes, technical interfaces and lastly Substation Engineering outputs. The inputs to the concept design process include:

- Work request
- URS
- Planning/Engineering report
- Site location and size drawing (If applicable)

- Line servitudes (On condition of Line engineering involvement)
- Survey data (On condition project is an extension or greenfields project)
- Investment Committee approval – WBS Number

The Integration engineer would request a concept design from substation engineering works scheduler via a works request form, and a contractual document known as a completion compliance certificate would be compiled between Integration and Substation Engineering. The outputs from Substation Engineering at this stage would be the compilation of a Completion Compliance Certificate and Task schedule.

3.2.1 Design Alternatives

- Review and analyse user requirements for clarity, adequacy, feasibility, etc of scope
- Determine design requirements, i.e. translate into design scope and engineering, design and technical requirements.
- Identify all stakeholders e.g. system operator, the grid, secondary plant, line design, etc
- Obtain stakeholder acceptance that their needs and expectations have been adequately captured and expressed correctly.
- Formulate concept design options, i.e. conceptualise possible feasible design solutions (options/alternatives) taking into account space constraints, future expansion, power line servitudes, executability, AIS, GIS and HIS, specialised studies, governance and technical documents, etc. This will take the form of a station electric and key plan.

3.2.2 Technical Assessment of Design Alternatives

Assess the merit of each alternative solution typically by means of a weighted score against the following aspects, which should be considered in order to discriminate between alternative concept designs:

- Level to which the requirements are met,
- Level to which the design criteria are met,
- Level to which stakeholder values (strategic objectives) are met
- Estimated project and life cycle cost,
- Estimated construction time frames
- Risks associated with the alternative
- Maturity of technology.

A recommendation should be provided based on the above and the alternatives should be ranked in order of preference. Any alternatives that are deemed too risky should be clearly marked as not technically acceptable for further consideration.

3.2.3 Choose Design Alternative

Choose Design Alternative: Based on the results of the technical assessments, trade studies are performed to determine the cost-effectiveness of each alternative. The preferred alternative is selected with due consideration of the technical risks and technology maturity.

3.2.4 Design Review and Baseline

Review and approve concept design taking into account compliance with URS, stakeholder requirements, processes, laws, regulations, codes, standards, philosophies, rules and practices and baseline the documents that describe the design.

3.2.5 Output to the concept design process

The Design Report which includes the Station Electric Diagram, Key Plan, terrace design and access road route and the final geotechnical scope definition report.

The Design Report together with the Station Electric Diagram, Key Plan and terrace design and access road route as well as the final geotechnical scope definition report form the concept design package. It is presented to the Substation Engineering design review team, which upon support from this panel is presented to the Power Delivery Engineering Review Team. At this stage the Concept Design is approved and forms part of the submission to project management for Definition Release Approval via an Integration engineer.

The concept design process is completed and the CCC (if required) needs to be signed by all relevant parties as completion of the works request on actual dates.

3.3 Detail design process

The detailed design process is mapped out in Annex A3 flowchart. The inputs at the start of the detailed design process include approved:

- Works Request
- Concept Design report
- Final Site Co-ordinates (Applicable to Greenfield projects)
- Final Site Survey (Applicable to Greenfield projects)
- Gate Approval – DRA from Investment Committee

Similar to concept, an Integration engineer will request a detailed design from Substation Engineering, and establish a completion compliance agreement between the two departments.

Apply standard designs already developed. Any adjustments to the standard design can also be made. If there are no standard designs then new standard designs must be created.

3.3.1 Specialised Studies

The following specialised studies are to be carried out if applicable:

- Lighting Design
- Earthing Design
- Lightning Protection
- HVAC Design
- Geotechnical studies, which are reviewed against the necessary specifications, and if acceptable approved.
- Geometrical designs.
- Terrace design

3.3.2 Substation Design Integration

Table 1 below captures the interdisciplinary interfaces between the civil and electrical disciplines.

The key plan and electrical bay layouts which is produced by the electrical department, once completed, is handed over to the civil department for the geometric design, the foundation and trench, civil bay layouts, terrace and road design and lighting design to be completed. The building layouts will be used to produce the HVAC designs. The electrical designer will inform the civil designer via an email to start with the relevant civil design as depicted in table 1. The electrical drawings for handover will be stored in the appropriate project file subfolder on hyperwave.

Table 1: Flow of outputs and inputs between electrical and civil department

Electrical deliverables	Flow of Interface	Civil deliverables
Key Plan		Geometric design (Greenfield projects) Foundation and Trench Steelwork Marking Plan Terrace and Road Lighting
Electrical bay layouts		Civil bay layouts

- Input from Lines Engineering Services for voltage unbalanced systems, where reactive compensation is required and approval of tower acceptance forms (if applicable).
- Input from PTMC for line trap phasing(if applicable)

3.3.3 Design Review and Baseline

Review and approve detail design taking into account compliance with URS, stakeholder requirements, processes, laws, regulations, codes, standards, philosophies, rules and practices and baseline the documents that describe the design.

This final design package compromises of (See Annex B – DRA process):

- Electrical
- Civil
- AC reticulation, lighting and HVAC
- Waybill
- Proformas
- Design Report

The CCC (if required) is then signed off on actual completion and issuing of the design. The above lists all possible iterations of drawings or documents required on a project and some may not always be needed on specific projects.

3.3.4 Technical Input to Tender Documentation

- Develop a procurement strategy and identify work packages for the detail design, manufacturing, construction, installation and commissioning activities.
- Develop a technical specification, containing the works information or scope of work, depending on the type of contract and procurement strategy.
- Once the technical specification is incorporated into the tender documentation, a design review is performed to ensure compliance to the design and, if successful, the Acquisition Requirements Baseline is established.
- Assist with the resolution of any queries of a technical nature, thereby facilitating the reception of accurate bids on the issued tenders.

3.4 Execution design process

The Execution Design Process is mapped out in Annex A4 flowchart. The inputs to substation engineering at the start of the Execution Design Process include approved:

- Works request
- Detailed design report
- Technical Tender documents

A CCC may be compiled between Integration and substation engineers agreeing on necessary deliverables.

The following typical process is then followed:

- Technical tender evaluations are done culminating in a report.
- Final equipment verification is confirmed with purchase orders for the project.

3.4.1 Technical Assurance of Construction

Provide technical input to the Project Quality Management Strategy, Construction Plan, Construction Quality Plan and Quality Control Plan as well as participation in engineering oversight activities. Site reports are compiled. It further entails resolving of technical information requests, change requests, and the reviewing of the Construction Pack for completeness. Non-conformances during construction are issued and resolved.

3.4.2 Technical Assurance of Commissioning

This process ensures the provision of engineering input and support during Commissioning. Inspections and analysis to verify that the equipment is installed and plant is constructed according to the design is performed. The operating diagram is produced during this phase. Marked up drawings are issued by the Integration engineer to the design engineers for validation. Once commissioning is complete, the As-commissioned baseline is established.

3.4.3 Project Finalisation

Provide oversight over the validation of the plant against the stakeholder requirements for final handover to Project Management.

4. Transmission Customer Projects

All Transmission customer projects shall follow the procedure as outlined in [7].

During the issuing of the indicative cost estimate, by default, the project enters the concept stage in terms of the Eskom Project Life Cycle Model (PLCM). Substation engineering department's outputs at this stage is a high level scope of work if requested by the power delivery integration engineer.

Once the customer accepts the indicative cost estimate, by default, the project enters the detail stage in terms of the Eskom project life cycle model (PLCM). Substation engineering department's outputs at this stage of the project is as documented in 3.2 and 3.3 above. The duration for Substation engineering outputs is 60 working days if the project value is less than 35 million rands and negotiable if the project value is greater than 35 million rands.

Once the customer accepts the budget quotation, the project enters the execution stage in terms of the Eskom project life cycle model (PLCM). Substation engineering department's outputs at this stage of the project is as documented in 3.4 above.

5. Project engineering change management

An engineering project change request shall be submitted to Substation Engineering by PDE Integration Department. The change request shall be noted and registered. The request shall then be directed to the relevant lead designer for review. The impact of the requested changes on scope, time and resources will be assessed. Timelines and deliverables will be renegotiated and contracted accordingly. The scope of work as per requested changes will be implemented and follow the normal design process, including design reviews. All project engineering changes shall be managed in accordance with [2].

6. Authorization

This document has been seen and accepted by:

Name and surname	Designation
Rukesh Ramnarain	Chief Engineer Substation Engineering
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7. Revisions

Date	Rev	Compiler	Remarks
March 2016	4	R. Ramnarain	Pre-project planning process updated Concept design process updated Detail design process updated Substation Design Integration added Execution design process updated Project Engineering change management subsection updated
May 2015	3	R. Ramnarain	Compiler, and supported by Responsibility changed. Project Engineering change management section added. Transmission Customer Projects section added. Annex A revised. Annex B revised.
June 2014	2	D. Delly	Next Review Date changed to June 2019. Compiler and Functional Responsibility changed.
Nov 2012	1	N. Harilal	Final Document for Authorisation and Publication.
Aug 2012	0.0	N. Harilal	First draft.

8. Development team

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

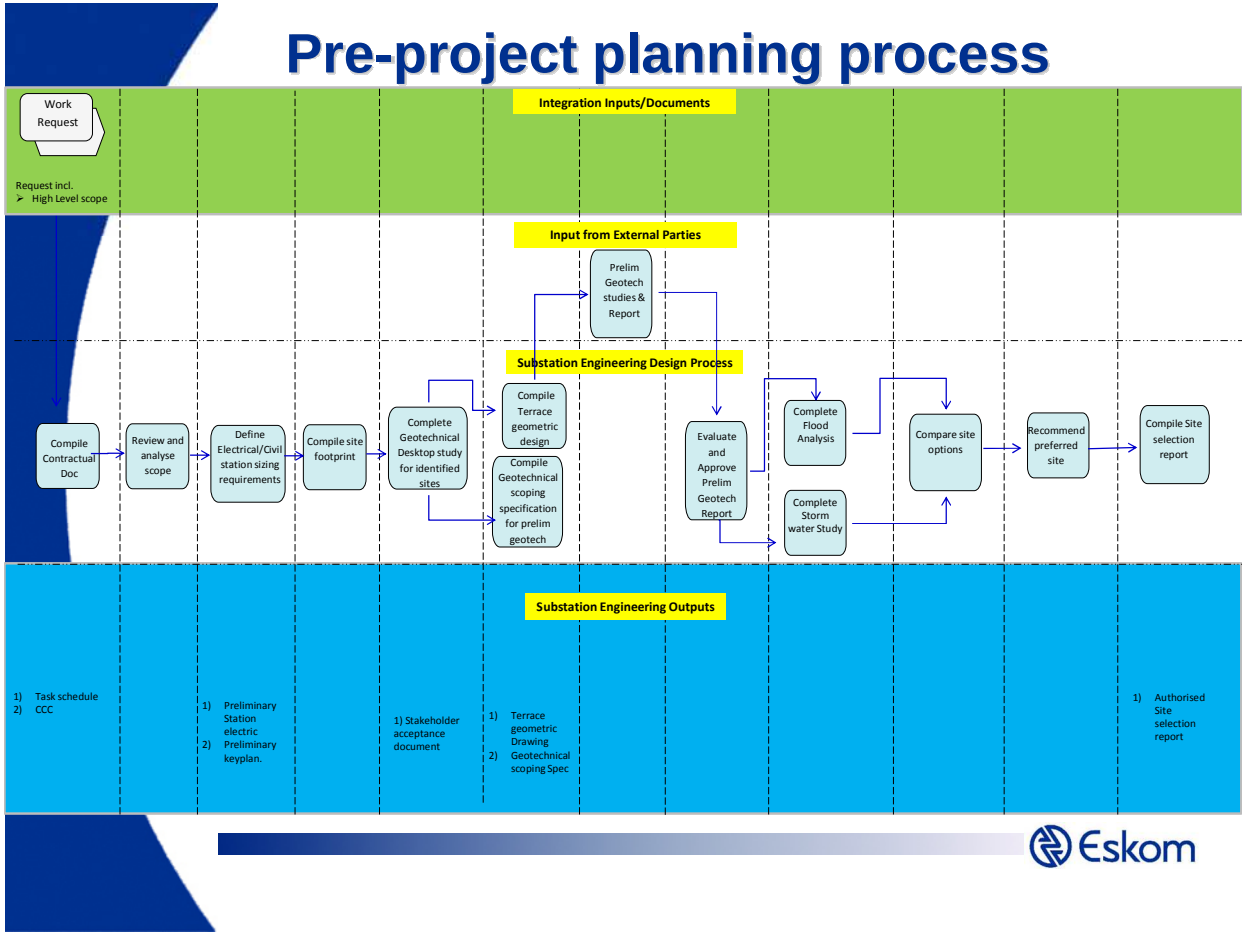
Group Technology Division, Power Delivery, Substation Engineering Staff

9. Acknowledgements

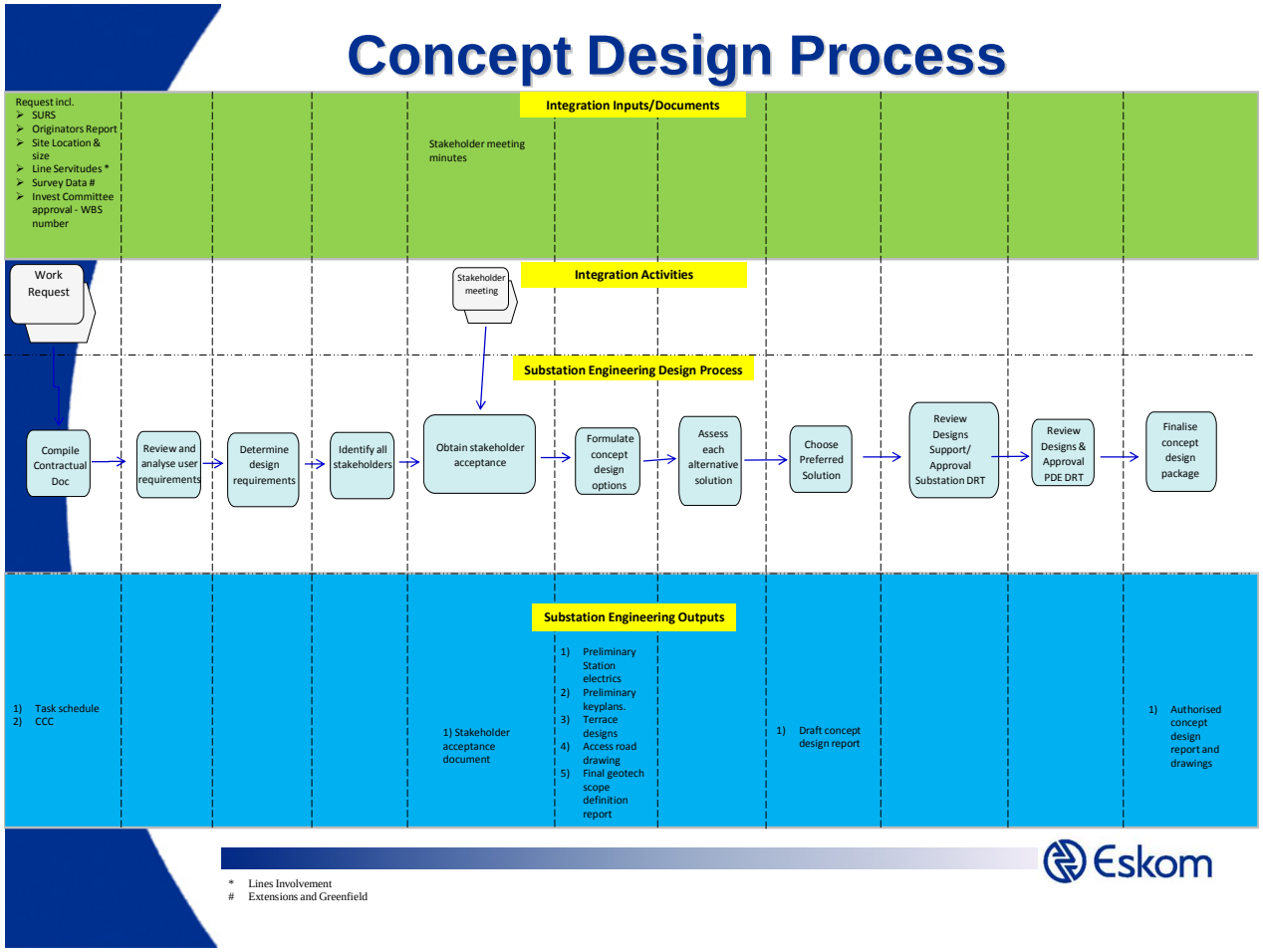
Group Technology Division, Power Delivery, Substation Engineering Staff

Annex A – Design Process flowcharts

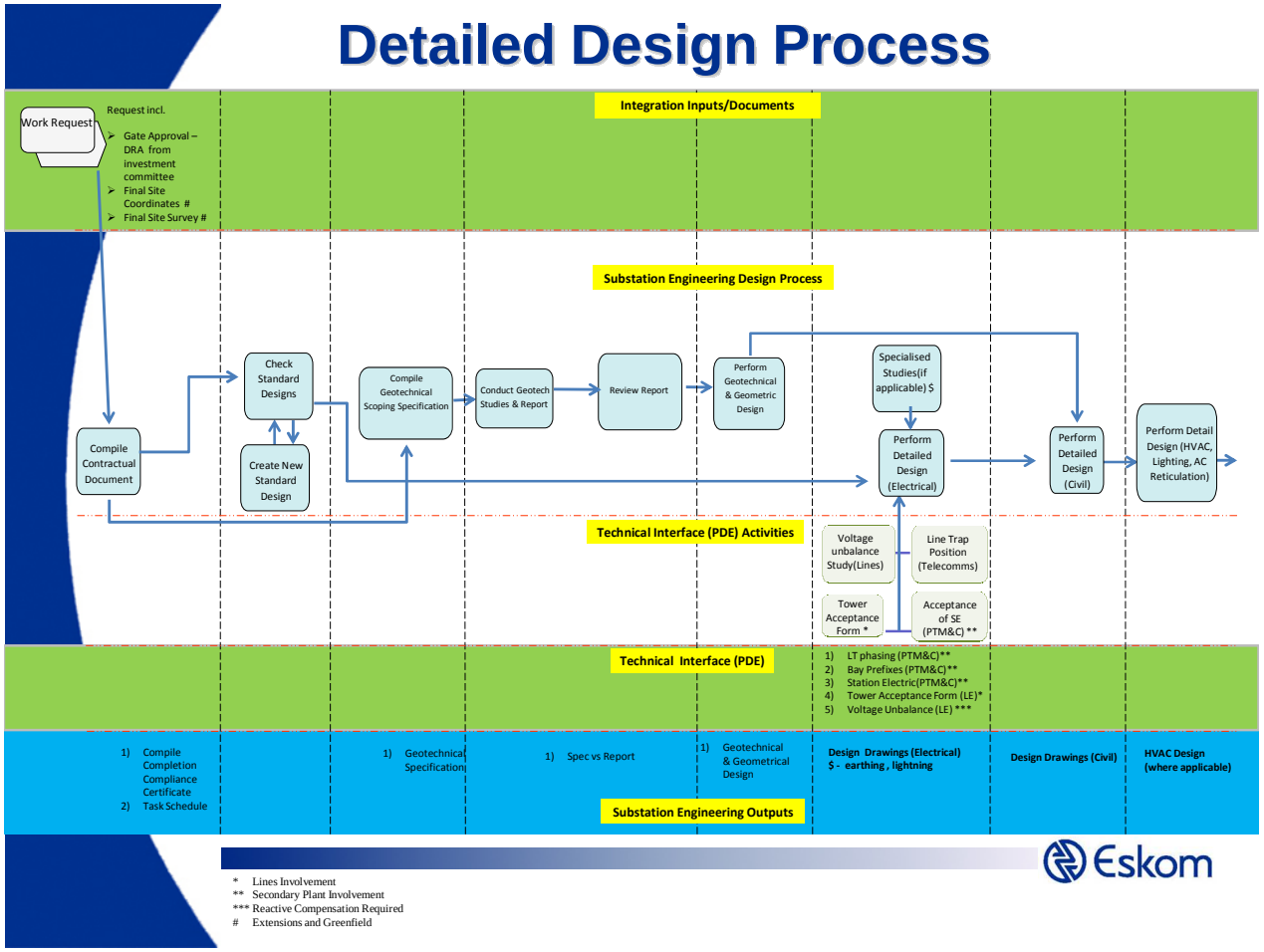
1) Pre-Project planning process flowchart



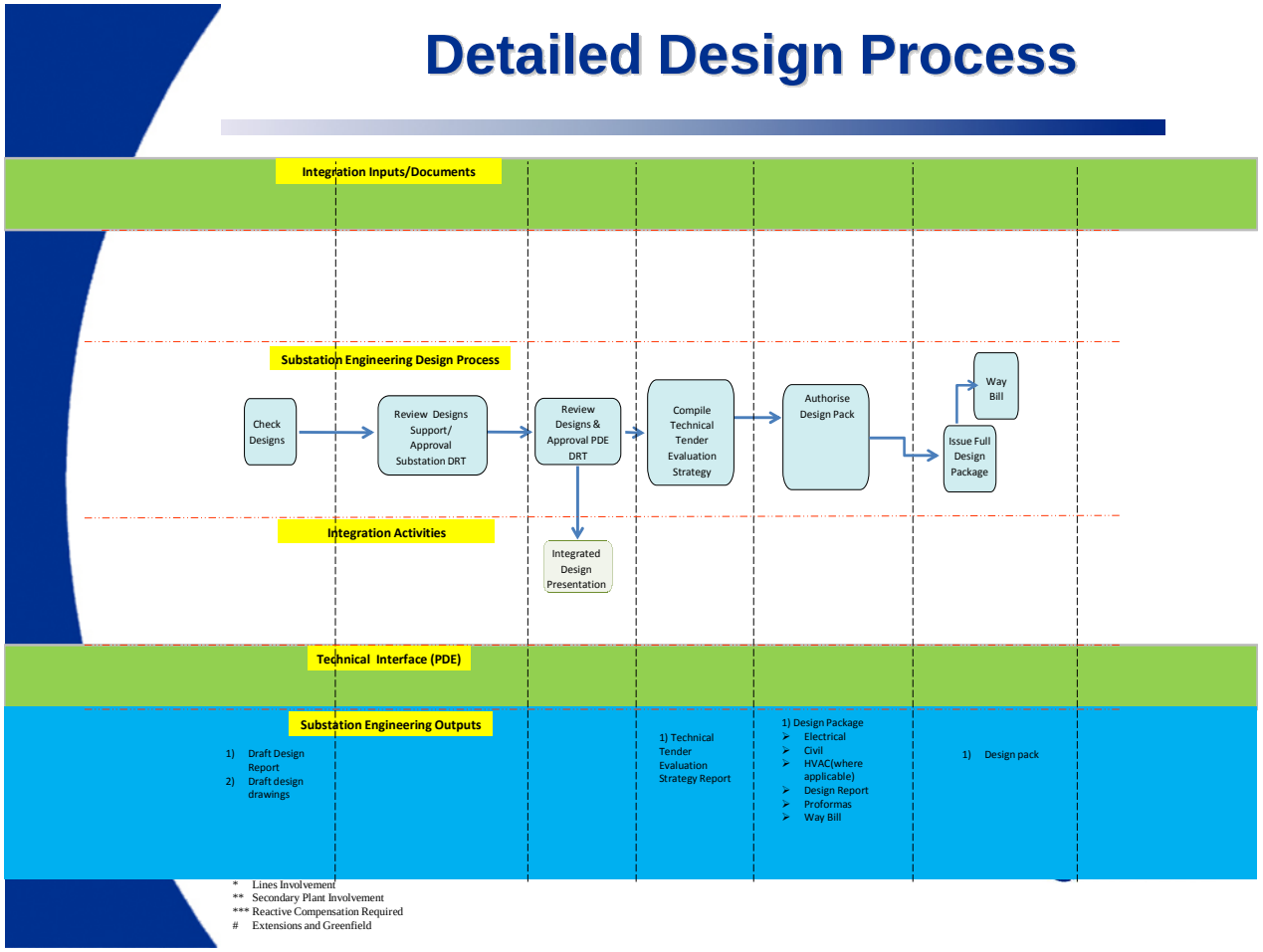
2) Concept design process flowchart



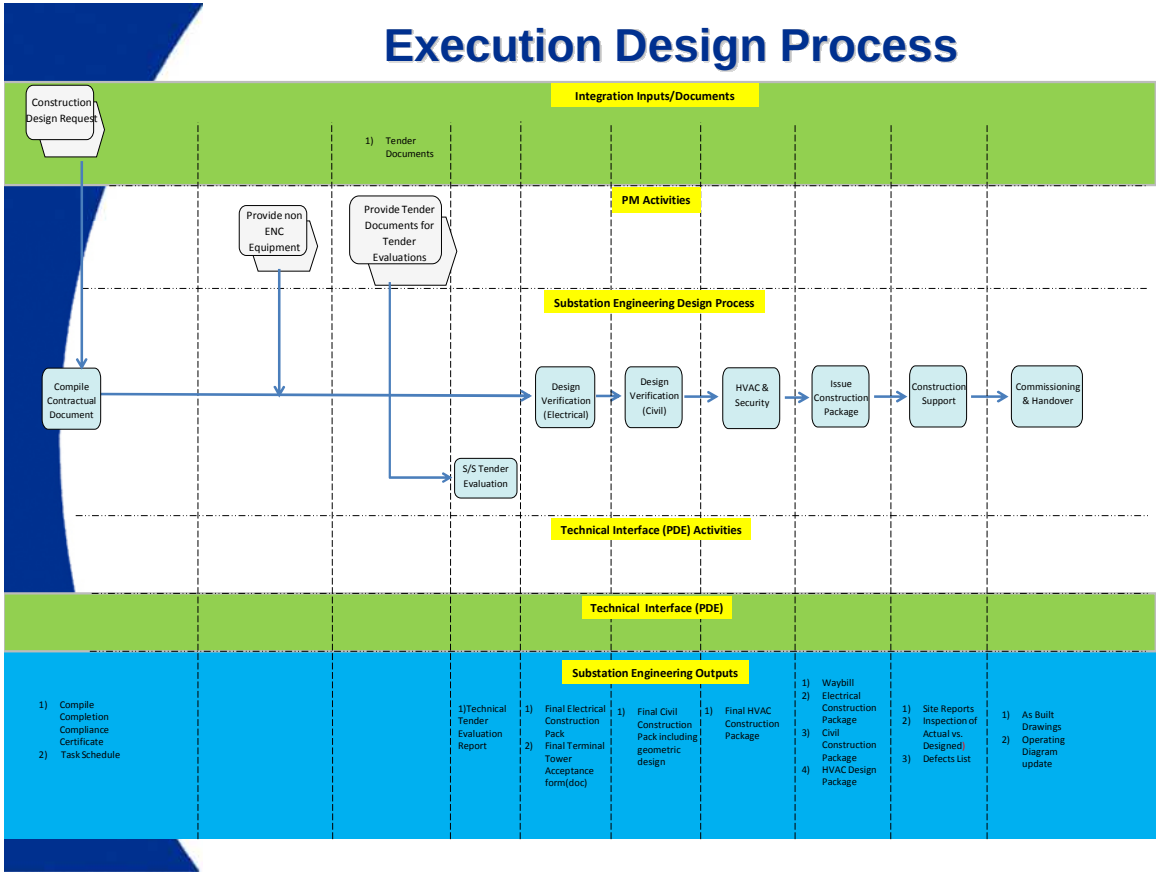
3) Detailed Design Process flowchart



Detailed Design Process



4) Execution design Process flowchart



Annex B – Substation Engineering Outputs

A list of all Substation Engineering outputs per project

Substation Engineering Outputs: Pre-Project Planning Process			
1			Completion Compliance Certificate
2			Task Schedule
3			Geotechnical desktop study report
4			Preliminary Geotechnical scope definition report
5			Terrace geometric design drawings
6			Flood analysis report
7			Storm water management plan report
8			Design Report
Substation Engineering Outputs : CRA Process			
9			Completion Compliance Certificate
10			Task Schedule for all phases of the project
11			SLD Options(if applicable)
12			Option Comparison(if applicable)
13			Formulate Preferred Option(if applicable)
14			Draft SE Preferred Option
15			Draft KP Preferred Option
16			Draft terrace design and access road route(if applicable)
17			Draft Concept Design Report
	17.1		SE
	17.2		KP
	17.3		Terrace design and access road route(if applicable)
18			Geotechnical scope definition report
19			SS Presentation
20			Design Review
21			Populate Actuals CCC for CRA
22			Issue authorised design package
Substation Engineering Outputs : DRA Process			
23			Compliance Certificate(if required)
24			Geotechnical Specification
25			Geotechnical Specification vs Report
26			Geotechnical and Geometrical Design

27			Design Package Electrical (Electrical)
	27.1		Station Electric
	27.2		Key Plan
	27.3		Earthmat
	27.4		Electrical Bay layouts
	27.5		Busbar Layout
	27.6		Overhead Earthwire Layout
	27.7		Operational Floodlighting
	27.8		Security and Lighting layout
28			Acceptance Documents
	28.1		Terminal Tower Acceptance
29			Design Package (Civil)
	29.1		Terrace Design
	29.2		Site Contour Plan
	29.3		Drainage Drawing
	29.4		Access Roads
	29.5		Building General Arrangement
	29.6		Building Electrical Reticulation
	29.7		Transformer and Reactor Plinths
	29.8		Level Schedule
	29.9		Fire Protection
	29.10		Barrier Fence Layout
	29.11		Buildings Access Storage Yard, Consumable Store, Workshop
	29.12		Foundation and Trench
	29.13		Steelwork Marking Plan
	29.14		Safety and Security Fence Drawings
30			HVAC Design
	30.1		Drawings
		30.1.1	Control Building
		30.1.2	Workshop Building
		30.1.3	Cladded stores
		30.1.4	Consumable stores

		30.1.5	Access Control
		30.1.6	Cable Route layout
		30.1.7	Borehole and pressure pump layout
	30.2		Design documents
		30.2.1	HVAC Specification
31			Equipment Proformas
	31.1		Major and Spec
	31.2		Minor and Spec
	31.3		Safety Labels and Spec
	31.4		Labels and Spec
32			SS Presentation Documents
33			Design Package
	33.1		Electrical
	33.2		Civil
	33.3		HVAC
	33.4		Design Report
	33.5		Technical Tender Evaluation Strategy Report
	33.6		Waybill
34			Populate Actuals CCC for DRA
35			Issue Design Pack
Substation Engineering Outputs : ERA Process			
36			Compile Completion Compliance Certificate
37			Technical Tender Evaluation Report
38			Final Electrical Construction Pack
39			Final Terminal Tower Acceptance form (doc)
40			Final Civil Construction Pack including geometric design
41			Final HVAC Construction Package
42			Waybill
43			Site Reports
44			Inspection of Actual versus Designed
45			Defects List
46			Operating Diagram