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Stellenbosch Municipality

Refurbishment Criteria

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1 INTRODUCTION

Major portions of the electrical networks within Stellenbosch Local Municipality have been in service for many years and are approaching or have exceeded their design life. Such networks may begin to exhibit degradation in reliability performance, reduced safety margins, functional inadequacy, obsolescence or general deterioration. The industry is starting to recognise these problems and Stellenbosch Local Municipality have started programs to extend the useful life of these networks.

To obtain maximum benefit from available networks, it is advantageous that a systematic, formal life extension (refurbishment) program be developed and carried out on a timely basis.

2 INTERGRATED REFURBISHMENT PLANNING

It is important for system planners to have a long-term vision and definite plan to establish a power system through a process of evolution that will comply with the following:

- Utilisation of the most economical technologies of the day,
- Minimisation of system losses,
- Limiting the impact on the environment,
- Compliance to reliability and quality requirements of the customers, and
- Developing systems that can be maintained and operated with the least possible amount of effort and cost.

Refurbishment planning forms a key part of this long-term vision. Ideally the refurbishment plan must be carefully integrated with the strategic network expansion plan.

3 REFURBISHMENT PLANNING PROCESS AND OUTPUTS

The refurbishment planning process followed by NETGroup normally produces the following key outputs:

- Visual or full technical audits on the relevant networks depending on the requirement,
- An easy to use Asset Condition Assessment program with captured nameplate data and photos of all electrical equipment in commercially available software,
- Development of age profiles of electric equipment per category,
- A complete prioritisation exercise on the relevant network with the aim of phasing the refurbishment related capital expenditure,
- Development of a detailed short-term refurbishment capital expenditure program together with a more general long-term capital program, and
- Documentation of the audits and recommendations.

4 INFLUENCING FACTORS

In the development of a refurbishment plan the following influencing factors are taken into account:

- Changes and improvement of the technology employed,
- External conditions that the equipment has been exposed to,
- Quality and durability of the materials used,
- Level of maintenance carried out on the equipment,
- Normal loading and stress levels that the equipment has been exposed to, and
- Quality of the original design.

5 METHODOLOGY

Figure 5-1 shows the process flow employed by NETGroup during a typical refurbishment plan. More detail on the methodology for each step as conducted for the Stellenbosch networks is provided in the relevant paragraphs hereafter.

5.1 Definition of Required Outputs

It is necessary to define the required outputs of the exercise at the onset of the process. The following are typical results that management would need for decision making:

- Refurbishment Capital programs with project descriptions,
- Equipment age profiles and summarised replacement values, and
- Full prioritisation of electrical networks in terms of refurbishment needs.

5.2 Definition of Methodology

Once the required outputs have been defined it is necessary to define the methodology that must be followed to achieve the required outputs. The methodology must define the following steps of the project:

- Technical audits requirements,
- Prioritisation of primary electrical equipment within the networks, and
- Refurbishment project requirements e.g. description, size and phasing.

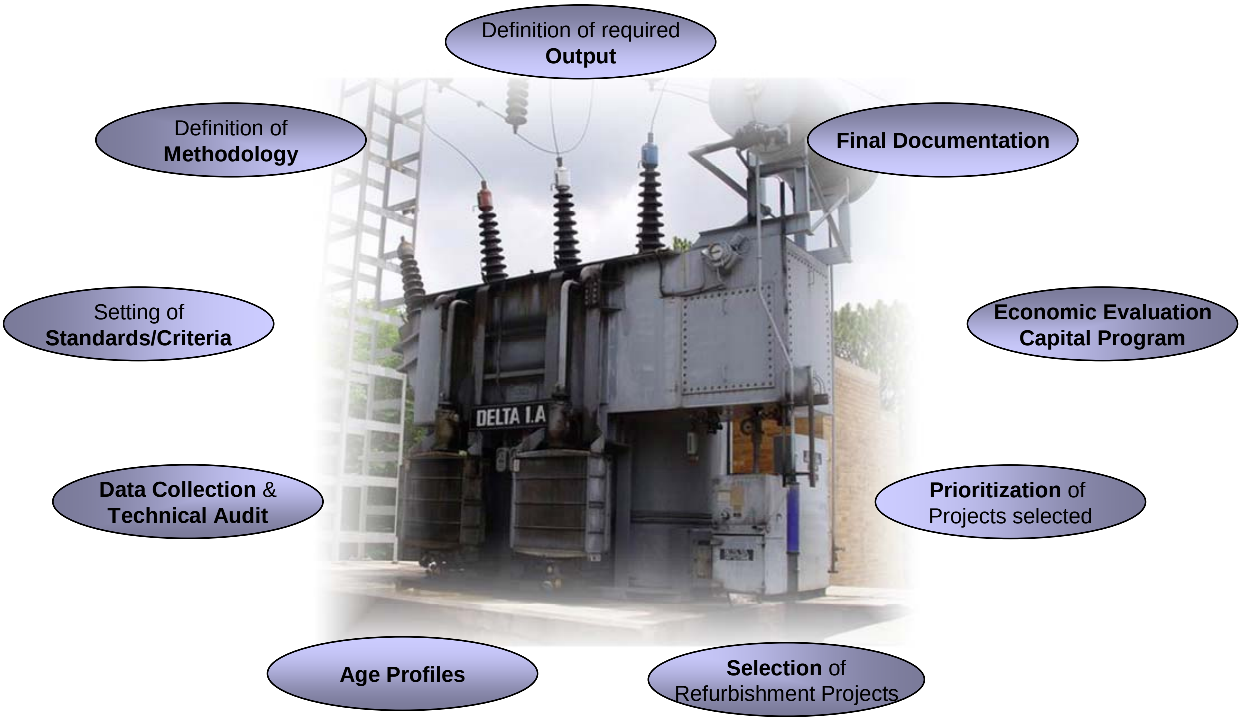

Figure 5-1: Refurbishment Planning Process Flow Chart

5.3 Setting of Standards and Criteria

A refurbishment exercise mainly evaluates the current installation in terms of design, current performance and maintainability. It is consequently necessary to state the standard specification that the installation must conform to. Applicable standards for power systems that can be classified into the following categories:

- Standards for electrical clearances,
- Basic technical standards specifying the electrical equipment,
- Minimum standards for civil works,
- Important also are simple criteria for selecting refurbishment projects. In other words some simple rules of thumb are set to give guidance on whether a project should be selected as a refurbishment project or not. Typical criteria used is:
  - Poor performance of plant that affects quality of supply and power system reliability which cannot be rectified by normal maintenance,
  - Deterioration of the condition of the plant to the extent that it cannot be rectified by normal maintenance,
  - Obsolete equipment to the extent that expertise and spares cannot be found for normal maintenance,
  - Inadequate designs where the installation no longer complies with current design requirements of the part of the system concerned,
  - Unsafe operating conditions where human life is endangered or where major damage to the power system is possible,

- Critical theft incidence occurring,
- Operating costs high in relation to replacement costs, and
- Installations that pose a threat to the environment.

The Table be below shown the basic Equipment that was reviewed and its associated Attribute Criteria and assigned weight.

Equipment	Attributes	Criteria	Weight
Capacitors	Condition	Damaged	35
		Good	0
	Connection box condition	Damaged	13
		Good	0
	Earthing	Damaged	33
		Good	0
	Foundation	Damaged	13
		Good	0
	Oil leak	No	0
		Yes	39
	Spares available	Yes	0
		Limited	15
		Not Available	30
	Structure	Damaged	13
		Good	0
		Rust	8
Civils	Access – During rains	Difficult	6
		Easy	0
		Muddy	4
	Access – Erosion	Limited	4
		None	0
		Severe	7
	Access – Surface layer	Normal	0
		Poor	9
	Building – Battery condition	Damaged	20
		Fair	8
		Good	0
		Poor	16
	Building – Cable trench covers	Asbestos	11
		Damaged	18
		Good	0
	Building – Ceiling	Fair	10

Equipment	Attributes	Criteria	Weight
		Good	0
		Repair	20
		Replace	30
	Building – Fire doors	Fair	5
		Good	0
		Repair	10
		Replace	15
	Building – Panel earthing	Damaged	6
		Good	0
		Not present	10
	Building – Roof	Damaged	14
		Good	0
	Building – Steel doors	Damaged	8
		Good	0
		Rust	5
	Building – Wooden doors	Damaged	8
		Good	0
	Drainage – Erosion on platform	Heavy Erosion	10
		Light Erosion	6
		No Erosion	0
	Drainage – Storm water	No	6
		Yes	0
	Drainage – Table wet season	High	6
		Low	4
		Normal	0
	Fence – Perimeter	Damaged	12
		Good	0
		Not Present	20
	Fence – Yard	Damaged	12
		Good	0
		Not Present	20
	Lighting – Entrance security	Limited	5
		None	8
		Yes	0
	Lighting – Transformer	Limited	5
		None	8
		Yes	0
	Lighting – Yard	Limited	5
		None	8

Equipment	Attributes	Criteria	Weight
		Yes	0
		Replace	8
Current Transformer	Connection box condition	Damaged	13
		Good	0
	Earthing	Damaged	33
		Good	0
	Foundation	Damaged	13
		Good	0
	Insulator	Damaged	46
		Good	0
	Oil leak	No	0
		Yes	39
	Oil level	Low	52
		Normal	0
	Spares available	Yes	0
		Limited	15
		Not available	30
	Structure	Damaged	13
		Good	0
		Rust	8
Indoor Breaker	Cable terminal box	Damaged	28
		Good	0
	Fault level	<0.7	0
		<1.2>0.7	42
		>1.2	70
	Gas leak	No	0
		Yes	42
	Oil leak	No	0
		Yes	42
	Panel condition	Damaged	35
		Fair	10
		Good	0
		Poor	20
	Spares available	Yes	0
		Limited	0
		Not available	0
	Switching operation	Failure occurred	0
		Impossible	0
		Normal	0

Equipment	Attributes	Criteria	Weight
Isolator	Contact condition	Damaged	48
		Good	0
	Earth switch condition	Damaged	30
		Good	0
	Earthing	Damaged	30
		Good	0
	Foundation	Damaged	12
		Good	0
	Insulator	Damaged	42
		Good	0
	Operating mechanism	Damaged	60
		Good	0
	Spares available	Yes	0
		Limited	15
		Not available	30
	Structure	Damaged	12
		Good	0
		Rust	7
Outdoor Breaker	Earthing	Damaged	40
		Good	0
	Fault level	<0.7	0
		<1.2>0.7	48
		>1.2	80
	Foundation	Damaged	16
		Good	0
	Gas leak	No	0
		Yes	48
	Insulator	Damaged	56
		Good	0
	Oil leak	No	0
		Yes	48
	Oil level	Low	64
		Normal	0
	Spares available	Yes	0
		Limited	15
		Not available	30
	Structure	Damaged	16
		Good	0
		Rust	10

Equipment	Attributes	Criteria	Weight
	Switching operation	Failure occurred	20
		Impossible	35
		Normal	0
Surge Arrestor	Earthing	Damaged	30
		Good	0
	Foundation	Damaged	12
		Good	0
	Insulator	Damaged	42
		Good	0
	Spares available	Yes	0
		Limited	15
		Not available	30
	Structure	Damaged	12
		Good	0
		Rust	7
Transformer	Bushing condition	Damaged	70
		Good	0
	Cooling device condition	Damaged	50
		Good	0
	Earthing	Damaged	50
		Good	0
	Expansion vent	Damaged	80
		Good	0
	Instrument condition	Damaged	50
		Good	0
	NEC condition	Damaged	60
		Fair	36
		Good	0
	Normal loading	<0.5	0
		<1.2>0.5	48
		>1.2	80
	Oil leak – Main tank	Large oil leak present	60
		Little	36
		No	0
	Oil level – Main tank	Low	80
		Normal	0
	TC Oil leak	Large oil leak present	60
		Little	36
		No	0

Equipment	Attributes	Criteria	Weight
	Plinth condition	Damaged	50
		Good	0
	Unusual sound	No	0
		Yes	80
	Vibration	No vibration	0
		Unusual vibration	80
Voltage Transformer	Connection box condition	Damaged	10
		Good	0
	Earthing	Damaged	25
		Good	0
	Foundation	Damaged	10
		Good	0
	Insulator	Damaged	35
		Good	0
	Oil leak	No	0
		Yes	30
	Oil level	Low	40
		Normal	0
	Spares available	Yes	0
		Limited	15
		Not available	30
	Structure	Damaged	10
		Good	0
		Rust	6

Table 5-1: Equipment Set-up

5.4 Data collection and Technical Audit

Once the study set-up has been done, the next step is to obtain installation information through discussions with personnel, the review of equipment related records and physical site inspections. The following Table provides a list of substations that was included in this project.

STELLENBOSCH		
Station Name	Station Voltage	Date Inspected
Begraafplaas Switching Station	11/11kV	08/05/2006
Bison Board Switching Station	11/11kV	08/05/2006
Blakes Estate Switching Station	11/11kV	08/05/2006
Boord Switching Station	11/11kV	09/05/2006
Bosman Switching Station	11/11kV	09/05/2006
Braak Switching Station	11/11kV	08/05/2006
Cascade Switching Station	11/11kV	10/05/2006
Cloetesville Substation	66/11kV	10/05/2006
Coetzenburg Switching Station	11/11kV	09/05/2006
Curry Switching Station	11/11kV	10/05/2006
Dalsig Oos Switching Station	11/11kV	09/05/2006
Denneoord Switching Station	11/11kV	09/05/2006
Devon Valley Switching Station	11/11kV	08/05/2006
Distell Switching Station	11/11kV	08/05/2006
Helshoogte Switching Station	11/11kV	09/05/2006
Hofman Switching Station	11/11kV	10/05/2006
Jan Marais Substation	66/11kV	09/05/2006
Karendal Station	11/11kV	09/05/2006
Kayamandi Switching Station	11/11kV	10/05/2006
Kerk Switching Station	11/11kV	09/05/2006
Krige Switching Station	11/11kV	09/05/2006
Kromrivier Switching Station	11/11kV	09/05/2006
La Colline Switching Station	11/11kV	09/05/2006
Langstraat Suid Switching Station	11/11kV	10/05/2006
Lower Drop Switching Station	11/11kV	08/05/2006
Main Substation	66/11kV	08/05/2006
Marais Park Switching Station	11/11kV	09/05/2006
Markotter Substation	66/11kV	10/05/2006
Merriman Z Switching Station	11/11kV	11/05/2006
Papegaairand Switching Station	11/11kV	10/05/2006
Paradyskloof Switching Station	11/11kV	09/05/2006
Polkadraai Switching Station	11/11kV	08/05/2006

STELLENBOSCH		
Station Name	Station Voltage	Date Inspected
Rowan Switching Station	11/11kV	09/05/2006
SDR Kliniek Switching Station	11/11kV	09/05/2006
Sonneblom Switching Station	11/11kV	09/05/2006
Stadsaal Switching Station	11/11kV	11/05/2006
Stone Switching Station	11/11kV	09/05/2006
Suidwal Switching Station	11/11kV	10/05/2006
Tegno Park Switching Station	11/11kV	09/05/2006
Tennant Switching Station	11/11kV	10/05/2006
Tindal Switching Station	11/11kV	09/05/2006
Tortelduif Switching Station	11/11kV	08/05/2006
Uniepark Switching Station	11/11kV	09/05/2006
University Substation	66/11kV	09/05/2006
Welgevonden Switching Station	11/11kV	10/05/2006

Table 5-2: Stellenbosch Substations visited

FRANSCHOEK		
Station Name	Station Voltage	Date Inspected
Franschoek Substation	66/11kV	11/05/2006
Groendal Switching Station	11/11kV	11/05/2006
Hugenote Switching Station	11/11kV	11/05/2006
Monument Switching Station	11/11kV	11/05/2006

Table 5-3: Franschoek Substations visited

The data capturing exercise is necessary for instances where existing information systems are incomplete or where the reliability of information is suspect. The second and more important reason for data capturing is to establish the existing condition of the equipment to the best of the information available. Important is to ensure that valuable new information must be absorbed into a refurbishment program where the data can be easily accessed and maintained. This normally allows for:

- A systematic review of substations and related networks that may have reached or exceeded their original design life,
- Identify systems, structures and equipment approaching wear-out or becoming obsolete,
- Prioritise replacement, refurbishment, and follow-up tasks, and
- Support the development of a capital program that will ensure adequate network refurbishment.

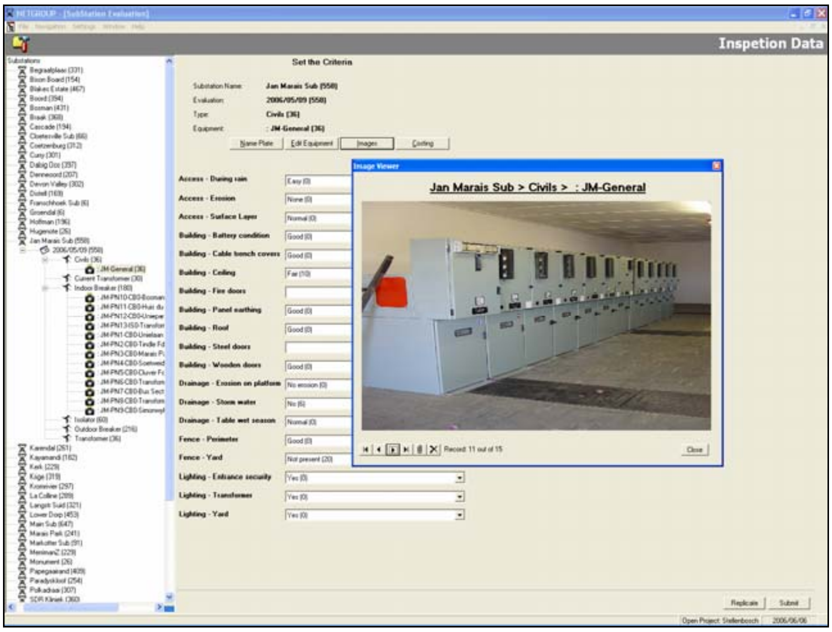

Figure 5-2: Asset Condition Assessment program

The technical audit basically comprises of an exercise where basic information of the installations are obtained and evaluated on site at the hand of a tick sheet. A second phase involves the evaluation of this basic information by a design engineer to provide a technical perspective of the state, suitability of the design and maintainability of the equipment.

It must be noted that a preparation exercise to exhaust readily available information prior to the site visit is valuable and it enhances the quality of the technical audit extensively. Sources of such information are single line diagrams, facility records, performance records and discussions with operations and maintenance personnel on the performance of the power system and typical problem areas.

5.5 Age profiles

Although age in itself does not provide any conclusive information on the state of equipment or the need to refurbish or to replace, it does provide a good overview of the extent of the task at hand. Age can be used for the longer term planning or the strategic planning phase of the exercise.

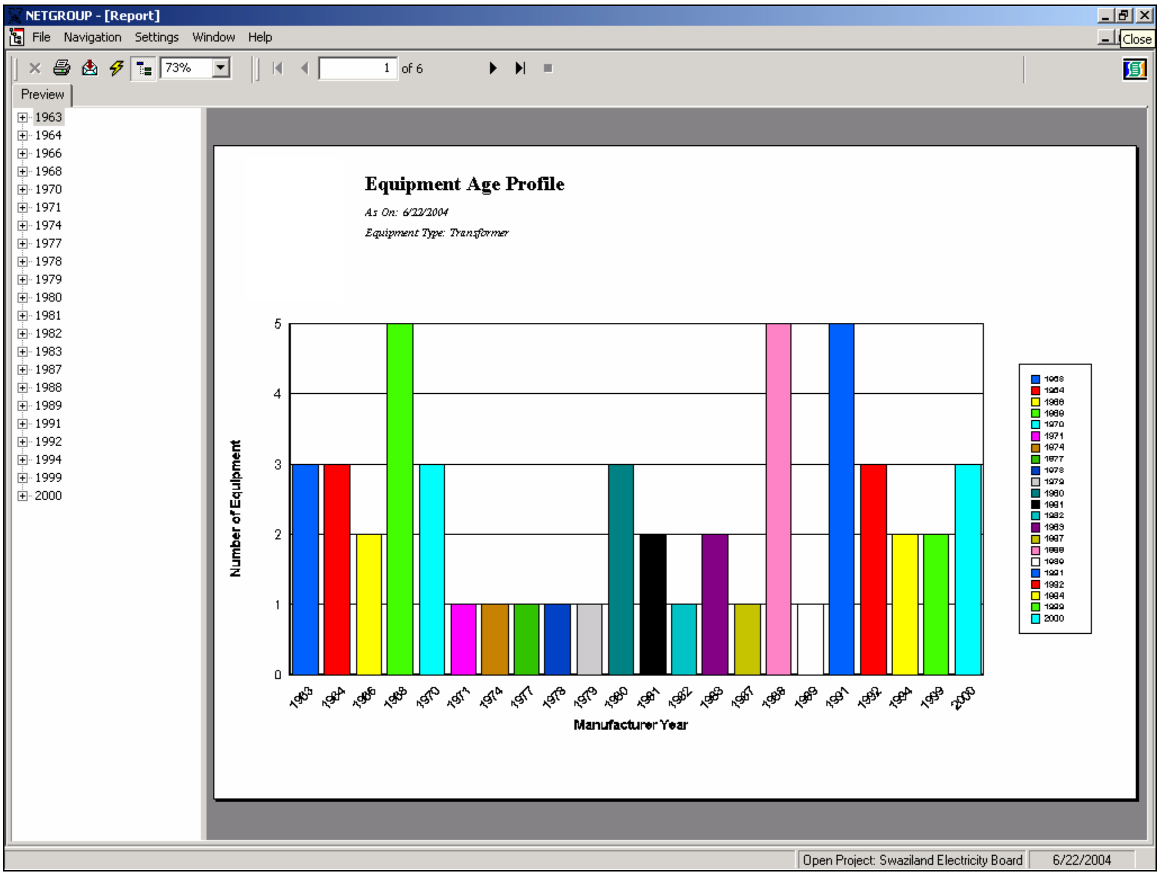

Figure 5-3: Equipment Age Profile - Transformers

Age profiles are used to highlight the following aspects:

- It provides excellent insight into the perceived state of the network,
- Identify per equipment category the expected replacement cost of assets older than a certain age,
- List and phase equipment to be refurbished or replaced in order to maintain an age of less than a specified value, and
- At what rate equipment age will increase if the current replacement or refurbishment rates are adhered to for the next 20 years.

5.6 Selection process

Based on the criteria as summarised in paragraph 5.3 and with the technical audit results available suitable refurbishment projects are selected.

The following aspects are important to note:

- The selection of projects should rather be liberal than conservative. The prioritisation process and budget constraints will eliminate projects that prove to be less important in the end,
- Selection should be based on technical facts whenever possible and not on hear say. Take measurements of samples whenever possible,

- Consider complete substations and lines instead of various individual projects per substation or line due to the amount of detail that can result, and
- Following the technical audit exercise, trends for the study area that comply with the selection criteria can be identified. These trends can then be used as a further guide in the selection process.

5.7 Prioritization exercise

With the projects as selected in paragraph 5.6 available it is necessary to prioritise these projects before a detailed costing exercise is attempted. A prioritisation matrix needs to be compiled to be able to prioritise the selected projects. Typical indices of such a matrix are:

- Legal implications,
- Importance of customers,
- Importance of plant,
- Performance,
- Environmental aspects, and
- Future configuration of network.

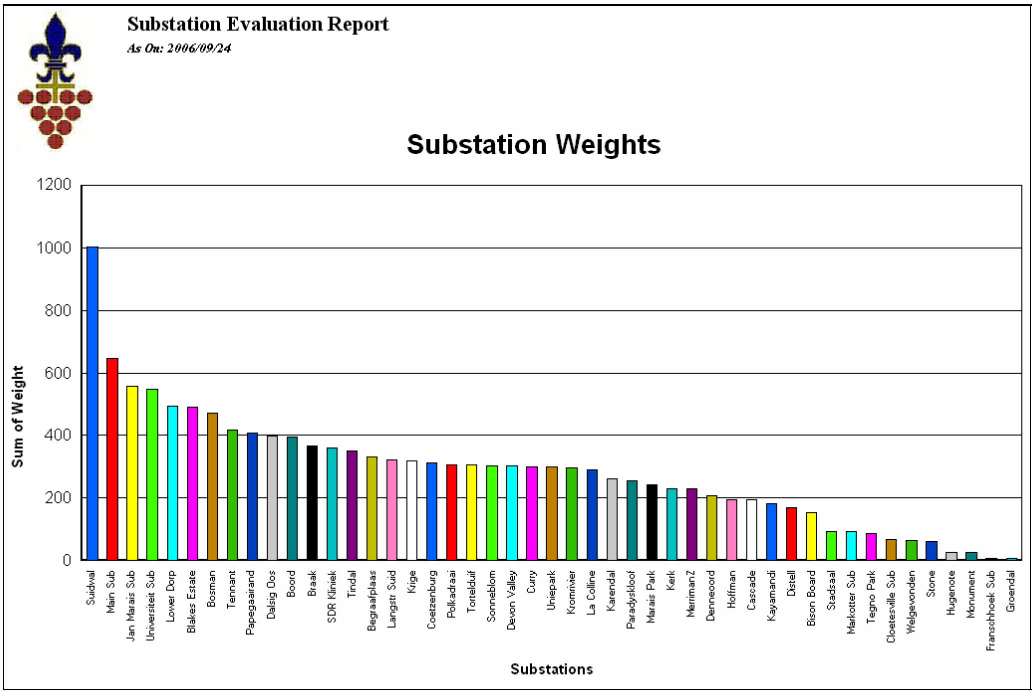

Figure 5-4: Prioritisation model

These indices can be weighted in order to increase the relative importance of specific indices. Projects with life threatening and legal implications are normally of the highest priority.

5.8 Economic Evaluation and Capital Programs

Once the priority projects have been identified it is necessary to cost them to a sufficient level of detail. Low priority projects can be dropped at this stage if deemed as unimportant after a more thorough prioritisation exercise.

Short-term and long-term capital programs are now compiled to include all of the prioritised projects and phasing is done in order to address top priority projects during the first couple of years.

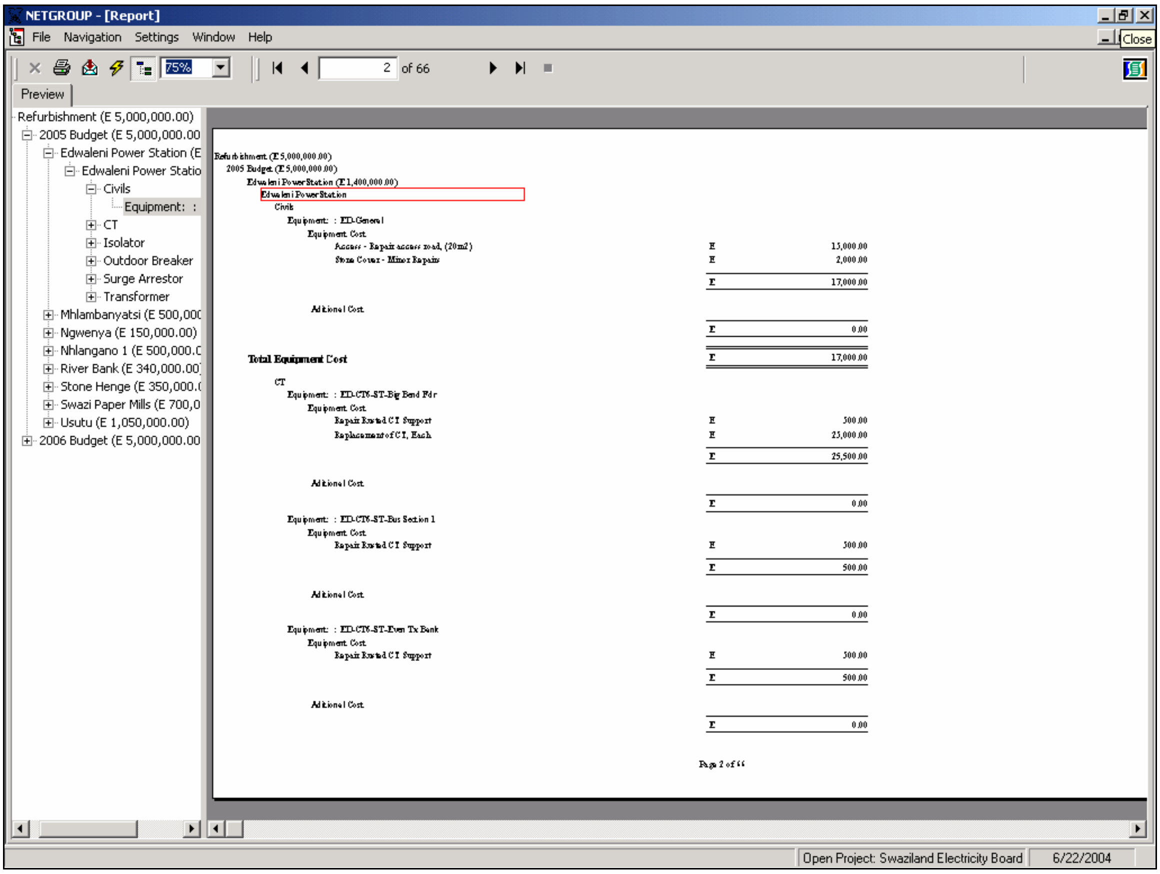

Figure 5-5: Capital Program

The level of refurbishment and replacement are monitored with economical analysis. The basis of the economical analysis is to relate capital expenditure to demand savings and to calculate internal rate of return and nett present values from the resulting cash flow simulation. The income from refurbishment expenditure materialises due to the following:

- Savings due to lower operational and maintenance cost.
- Savings due to lower network losses.
- Savings due to less damage from equipment failure.
- Savings due to less power failures and the reduction of loss of sales.

5.9 Final documentation

The recommendations and the results as defined in the first step are properly generated and included in the report. Results like the data capturing exercise, equipment ageing, substation scores, the prioritisation exercise and capital program are also included as software modules and delivered as a working system rather than a specific end result. A different scenario can easily be generated with such tools and will hopefully be more useful than a stagnant final report.