DEVELOPMENT OF NETWORK PLANNING STANDARDS FOR USE BY ESKOM DISTRIBUTION

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1. INTRODUCTION

This paper is about identifying the needs for, the compilation of and the introduction of Network planning standards in Eskom Distribution. A short description of Eskom and its objectives is given below to provide a context for the reader. Eskom Distribution is responsible for all networks operated at 132kV and below.

Eskom is a large utility that generates approximately half the electricity consumed in Africa and 95% of the electricity consumed in South Africa. It’s 19 power stations have an installed generating capacity of 42 000 megawatts and its total network delivering electricity to its 3 159 000 customers, comprises 289 722 km of power lines. [1]

Eskom is self-financing and run on the business principles of long-term viability and continuous improvement for the benefit of its customers. It is committed to being the world’s lowest cost electricity producer and has a compact with its customers to continually reduce the real price of electricity in order to assist energy intensive industries to improve their competitive positions and attract foreign investment.

Its financial plan is to recover the real cost of supply and obtain a real return on its assets.

Eskom has a responsible attitude towards socio-economic improvement and provides an environment for upliftment and development of its employees and society in general.

It has a very close link to the government and has ten commitments to the government’s RDP (Reconstruction and Development Programme) initiative, listed in its 1997 Annual Report [2]. Its major thrust over the past decade has been an electrification programme. This programme is continuing and it aims to bring electricity to 250 000 homes per annum over the next 5 years. The portion of these in rural areas will increase year on year.

The distribution business functions within a framework of clearly defined processes.

<table>
<thead>
<tr>
<th>Process</th>
<th>Process name</th>
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<tbody>
<tr>
<td>A</td>
<td>Integrated business planning</td>
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<tr>
<td>B</td>
<td>Customer relationship process</td>
</tr>
<tr>
<td>C</td>
<td>Deliver a capable network</td>
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<tr>
<td>D</td>
<td>Purchase and deliver electricity</td>
</tr>
<tr>
<td>E</td>
<td>Field services</td>
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<tr>
<td>F</td>
<td>Product development</td>
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</table>

It is absolutely essential that the management of these processes is focussed on satisfying the diverse customer needs and meeting business objectives. Network planning plays a vital role in this objective.

Its function is an integral part of the “Deliver a capable network” process.

An objective of Network Planning is to provide sustainable and cost effective networks in support of the regional development objectives. It plays a vital role in achieving business objectives since capital expenditure and network performance is influenced the minute a network planner begins to formulate a network solution.

Experience has shown that standards are required for Eskom Distribution to achieve its business objectives and defend its decisions, even on a legal basis if necessary. They provide a baseline from which to measure business performance through carefully selected indicators. The Network Planning environment in Eskom has not had a set of formal standards to work to in the past.

2. STANDARDS PRODUCTION IN ESKOM

Eskom has an organisation Distribution Technology (DT) whose has the responsibility for ensuring that the business has the required standards. The Distribution Technology manager uses the Technical Steering Committee of Distribution, TESCOD to assist in achieving this objective. TESCOD is focussed on technical development and the production standards and work practices. The production of work practices and standards is triggered by feedback from the business and from new business initiatives e.g. the electrification programme. A “Future Network Vision” is being developed at present to assist in mapping out the future technical needs for the network. TESCOD approved study committees and work groups perform the actual identification of needs, production of relevant standards and implementation, based on the various triggers.
The Future Network Vision will define the focus areas of the study committees for the next five years.

The “Deliver a capable network” process uses regional technology and change control forums (TFCC’s) and a national forum, managed by DT to identify issues of national interest to be fed to the study committees. The study committees also receive and debate issues of national interest based on information received from their regional members. The regional members are encouraged to share the respective study committee work with the regional TFCC’s.

3. THE NEED FOR PLANNING STANDARDS

3.1 Background

Network planning in Eskom Distribution has historically been accepted as the Network Planning Engineer’s responsibility. The planning engineer’s initiative and knowledge base played a big role in the effectiveness of the plans. The Planner’s knowledge base came from limited training courses e.g. power system analysis software courses, reading material in the form of Eskom developed training manuals e.g. the Distribution and Transmission planning guides, and interaction with other more experienced planners. The longer the planner stayed in this field of engineering the more he learnt and the more familiar he became with the loads and their growth. Unfortunately many factors have resulted in the total years of planning experience in Eskom being eroded. There is now a need to be able to train network planners in the key areas of network planning and to provide them with a standard framework on which to base and report on their plans. In the past there was little restriction on capital expenditure. Planning reports were not standardised within the regions. The approval of planning proposals and the subsequent release of capital was also not well co-ordinated with the business planning. Historical trends and past design practices were used predominantly in the development of future network plans and projects. The load growths and load nodes were fairly consistent.

The Business has changed significantly over the past decade. Eskom’s compact with its customers to reduce the real price of electricity and the electrification programme has meant that capital has to be spent wisely to ensure business sustainability. International economic trends in a global market are far less predictable. Periods of growth and recession are shorter and more frequent. This all means that business planning, and especially network planning in a utility, cannot be based on history alone and there is a need for network planners to have access to better information, training and direction. They need a framework on which to base their plans so that they can contribute to the achievement of business objectives as reflected by appropriate business measurement indicators. Bonuses are paid according to performance against indicators.

Network planning standards are seen as a means to provide network planners with the necessary frameworks.

A decision was taken by TESCOD in July 2000 to produce standards for the network-planning environment with the driving forces being:

- a common way of presenting decision making information for the use by managers
- a means to ensure that minimum network & environmental requirements are stated and complied with
- a basis from which to investigate network problems and encourage improvement
- the perception that the best way to ensure that the capital available is well spent is to ensure that a solution is sought for appropriate reasons and that the proposed solution is optimal.

A national set of planning standards is needed to achieve this and ensure that networks plans are in line with business objectives, and that capital is fairly allocated. Planners and Eskom need to justify their decisions in the face of adverse stakeholder reaction.

3.2 Present initiatives and future plans

The Planning Study Committee (PSC) was tasked by TESCOD to initiate a programme to produce appropriate standards for the use by network planners. A planning standards working group (PSWG) was formed and this group listed all the initiatives underway at the time. The initiatives were prioritised according the the direction given by the PSC. It is interesting to note that the initiatives taking place at the time were driven by a young Engineer and co-author of this paper, Clinton Carter Brown. Experience in the field of standards production has shown that most successful initiatives are driven initially by an individual whose mind is set on finding solutions to age old problems in a particular field.

The present set of initiatives is shown in Table 1 below.

<table>
<thead>
<tr>
<th>Initiative</th>
<th>Description</th>
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<tbody>
<tr>
<td>1. Planning Study Committee (PSC)</td>
<td>Tasked by TESCOD to initiate a programme to produce appropriate standards for the use by network planners.</td>
</tr>
<tr>
<td>2. Planning Standards Working Group (PSWG)</td>
<td>Formed to produce network planning standards.</td>
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<tr>
<td>3. Network Development Planning (NDP) Process</td>
<td>Used to identify future load needs within an acceptable cost and time frame.</td>
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The initial work started by Clinton Carter Brown focussed on items 4, 7, 10, and 21. When TESCOD tasked the PSC to produce standards the priorities changed. The PSWG were asked to produce as a priority a standard format for the presentation of network development plans (NDP) to management. There was no standard methodology and report format covering the NDP work process.

Network development planning (NDP) is a process that is designed to ensure that Eskom networks will accommodate the future load needs within an acceptable cost and time frame. The process feeds the business planning process by identifying capital projects, for the next 2 to 5 years that will need to be completed if the load forecasted becomes a reality.

Network development planning became a part of the Eskom Distribution business when a formal capital...
investment process [3] was introduced in about 1995. It is performed in all regions. The people doing the work are enthusiastic and they have gained valuable experience over the past few years. The NDP’s are compiled by the Regional Network Planning Departments and approved at the Regional Planning Review Forums. The Distribution Executive responsible for the planning of capital expenditure reviews the approach followed, the assumptions made and the general conclusions reached to ensure that the capital available is most effectively spread between the regions. For this to be done effectively it is essential to have NDP’s with similar characteristics for each region and reports presented in a standard format. The compilation of an NDP requires a lot of information from different sources, network analysis, selection of solutions, evaluation of solutions and a decision on the most appropriate solution. There is far too much information to be presented to management in a concise manner. An NDP report therefore has two elements: (1) the storage of all the working information [4], retrievable for future reference and (2) a comprehensive but concise report for the presentation to management [5].

At present there are some significant differences between the Regional approaches to NDP’s. These are as follows:

- Some regions produce Sub Transmission (33 to 132kV) and Reticulation (up to 33kV) NDPs separately
- Some do them as one using the same resources
- Some produce an integrated NDP with reticulation and sub transmission resources working as a team
- Some build the NDP by considering the feeders and working up to substation and transmission levels
- Some have lots of NDP’s (30) and some have few (3)
- Some produce a very comprehensive report and others a short form report for management review

Many of the differences can be attributed to past practices in the regions and the fact the all regions have significantly different loads to cater for. The challenge was to produce a standard that catered for the needs of management and planning.

NDP’s propose network solutions, but managers can only adjudicate a network solution if the philosophy behind the solution is known. It was decided that a national set of network planning philosophies was needed to ensure that all NDP’s have a common basis that is in line with the business objectives. This thinking became the trigger for a standard containing the important network planning philosophies. It essentially gives the planner the building blocks that can be manipulated to find appropriate network strengthening and expansion solutions. The building blocks include standard network voltages, voltages levels, fault levels, and network configurations.

The above has described the immediate priorities of the PSWG.

<table>
<thead>
<tr>
<th>Standards Projects for PSWG</th>
<th>Priority</th>
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</thead>
<tbody>
<tr>
<td>1 NDP data storage archiving</td>
<td>2002</td>
</tr>
<tr>
<td>2 NDP Standard report format</td>
<td>2002</td>
</tr>
<tr>
<td>3 Network Planning philosophies and criteria</td>
<td>2002</td>
</tr>
<tr>
<td>4 Guideline for voltage drop apportionment</td>
<td>2002</td>
</tr>
<tr>
<td>5 Planning options and selection(alternative comparison)</td>
<td>2002</td>
</tr>
<tr>
<td>6 Project prioritisation</td>
<td>2002</td>
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<tr>
<td>7 Motor starting</td>
<td>2002</td>
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<tr>
<td>8 Electrification Technology selector</td>
<td>2002</td>
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<tr>
<td>9 RENI modifications and link to RM</td>
<td>2002</td>
</tr>
<tr>
<td>10 Guidelines for modeling reticulation systems</td>
<td>2003</td>
</tr>
<tr>
<td>11 QOS and performance (including minimum fault levels etc)</td>
<td>2003</td>
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<tr>
<td>12 Unbalance calculation methods and assumptions</td>
<td>2003</td>
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<tr>
<td>13 Planning for contingencies - Methodology</td>
<td>2003</td>
</tr>
<tr>
<td>14 Harmonic Studies</td>
<td>2003</td>
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<tr>
<td>15 calculation of LV losses per GW 12/01</td>
<td>2003</td>
</tr>
<tr>
<td>16 Reliability</td>
<td>2003</td>
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<tr>
<td>17 PSA parameters</td>
<td>2003</td>
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<tr>
<td>18 Standards implementation</td>
<td>2003</td>
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<tr>
<td>19 Geo-based load forecasting</td>
<td>2004</td>
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<tr>
<td>20 Asset utilisation</td>
<td>2004</td>
</tr>
<tr>
<td>21 Series caps</td>
<td>2004</td>
</tr>
<tr>
<td>22 Financial Evaluation Model</td>
<td>Ongoing</td>
</tr>
</tbody>
</table>

The future work of the PSWG is also recorded in Table 1. This work programme changes as priority work is identified. The PSWG therefore actually works on a rolling plan where work on all initiatives is continually performed however priority projects receive more focus than others. The more work that is performed on standards the more evident it is that network planning affects virtually every business process. For example, the responsibility for network control and optimisation falls under the Electricity Delivery process but their ability to meet business targets depends greatly on the planning solutions implemented. Key members of Electricity Delivery have recently been included in the PSWG’s activities. The relationship been Customer Services and Planning also needs to be nurtured so that networks can be matched to contracted performance levels and load forecasting can be improved.

The production of standards invariably identifies gaps in knowledge. There is always a need to close these gaps and research often plays a big role.

3.3 Research to enhance network planning

Research projects are raised in Eskom through the submission of short documents, called one pagers. The one pagers are reviewed by research steering committees
What is an NDP / Definition of NDP areas

The work on the planning standards has resulted in the identification of research in the following main areas.

- Reliability studies: It is necessary to establish what tools are available, what data they need to produce a fair result, and whether the result obtained is in fact tangible and usable. Some of this research is nearing completion but the results were not available at the time of writing this paper. The approach taken to assist planners in the interim has been to offer guidelines for lines and substations. It the planner cannot meet the guideline then this is a prompt for further investigation. These guidelines are part of the Eskom standard on, Network Planning Philosophies and Minimum Criteria. [6]

- Load forecasting: There is no standardised approach to load forecasting in Eskom. Research is needed to establish the most appropriate load forecasting techniques for the diverse loads that Eskom services. A task team under the PSWG has been formed to tackle this issue. It is expected that research one pagers will result from the work of this task team.

- Power system analysis: There are many aspects of power system analysis (PSA) that need to be researched. E.g. what parameters are required and how accurate do they need to be i.e. how sensitive is the PSA result to various parameters. This research is in progress at present.

- Parameters. What fault levels should be targeted to ensure that quality of supply criteria can be met for different loads? There is also the question of unbalance and what levels are acceptable. Research projects have been raised in these fields.

It is expected that many more areas of research will be identified as the production of planning standards progresses.

4. OVERCOMING THE BARRIERS IN THE PRODUCTION OF PLANNING STANDARDS

In general there are always significant barriers to overcome in the production of standards. The production of planning standards is no exception. In fact since the network-planning environment has not worked according to documented standards in the past some of the more common barriers are more significant. There is always a perception that the introduction of standards will remove and constrain the autonomy previously enjoyed.

Some of the barriers experienced are discussed below.

Barrier : Regional differences, demographics, load mixes.
What is an NDP / Definition of NDP areas

Explanation: South Africa is a diverse country covering a huge geographical area. The Eskom Regions have many demographic, load and geographical differences to cope with. They define their NDP areas differently and think about the time frame differently due to these differences.

Barrier: Folklore, past ways, comfort zones and frameworks
Explanation: These are a reality in a large business that has existed for a long time. Experiences passed down over generations become beliefs and are difficult to overcome. Only scientific fact presented in a convincing way can overcome them.

Barrier: Information, Methods and Techniques
Explanation: Information is now more accessible than ever before. It is however not presented in a structured form that is useful and easy to use by busy planning engineers. It is difficult to present new methods and techniques without addressing the information management issue.

Barrier: Integration
Explanation: The role of network planning is seen differently by different process function within Eskom. It was necessary to involve e.g. Electricity Delivery Network Optimisation, Plant, and Customer Services, in discussions to ensure that, from management downwards, that everyone understood their roles in ensuring that the networks are capable.

Barrier: Knowledge on statistics in engineering
Explanation: Up until fairly recently most engineering methods have been based on deterministic techniques. Engineers are not that familiar with statistics and statistics in general seem to frighten engineers.

Barrier: Not invented here syndrome
Explanation: The implementation of any technique or method is always easier in the environment where it was born. This is human nature and needs to be addressed in the creation of any standard.

Barrier: Training material. What should standards contain?
Description: Standards are expected to be concise and easy to use. This is a key success factor in their future implementation. However the background to a particular clause also needs to be captured for future reference and training material. There is always a debate as to what is included in the standard and what is not. The Eskom approach has been to initially capture everything and then decide how to handle the information.

Barrier: No international network at this stage.
Explanation: A question often asked is; “How are other utilities approaching this”? There does not appear be easy access to what the various utilities around the world are doing in the field of planning standards. A network needs to be established where such information can be easily shared. The competitive nature of utilities may be a barrier to such an initiative. A purpose of this paper is to initiate international contact and information sharing.

Barrier: Expertise to write planning standards
Description: The writing of standards is a skill on its own. Finding people suitably experienced and qualified to
write planning standards for a particular utility is a challenging task.

All these barriers are a reality and the planning fraternity in Eskom had to be convinced that the standards that were being produced were useful and in fact necessary. This was a long process that required perseverance. The turning point was in fact when a senior planning manager and a group of younger engineers, who had gained some respect from the more senior engineers, showed their support for the creation of standards. The planning fraternity is now very much involved in the decisions on what to create and the compilation process.

5. EXPECTED BENEFITS

A summary of the many benefits that will result from the successful introduction of planning standards is presented below:

1. Capital expenditure planning is expected to improve as the source of the expenditure is being optimised through the use of appropriate standards.
2. The designed network performance levels are expected to improve due to a more integrated approach to planning and a framework that enables managers to understand and put the planning solutions into perspective.
3. Planning training methods, based on standards and research, will be developed to offer continuous improvement in knowledge to planners and managers. This should improve a variety of business operations.
4. The standards and the various workgroups will provide forums for continual sharing of information at local, national and international levels.
5. Research will be focussed on the needs of the planning engineers. The outputs of research are therefore likely to be applied thus improving the return on this investment.

6. CONCLUDING REMARKS

The Eskom Distribution programme to produce planning standards started in 2000 and is now starting to produce some results. It is expected that the programme will continue for at least another 3 years before it goes into maintenance mode. The program has been a catalyst for regional network planning engineers to synergise their efforts and regional cooperation is growing continuously. Young engineers are gaining valuable experience participating in workgroups with more senior engineers. It is expected that the program will continue to identify research and training needs.

REFERENCES

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2. Eskom,1997, Annual Report
4. Eskom Standard, Distribution Group Standard For Storage and Archiving of Network Development Plan Engineering Files, SCSASACP1
5. Eskom Standard, Distribution Group Standard for Compiling Network Development Plans, SCSASAC07