SAPP GENERATION PLANNING CRITERIA

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1. INTRODUCTION

The objective of the system planning criteria is to ensure that the criteria specified are adhered to during the inter-utility planning process. System planning is to ensure the development of a reliable, efficient, and economical system for the transmission of electricity from generators to load centres. The Generation Planning Criteria sets out the standards that are applied in the planning time period. Each utility has its own generation planning criteria. The standards highlighted in this document set the minimum standards expected at the SAPP level but utilities may choose to apply more stringent criteria. Reliable operation of the interconnected system requires that all members comply with these minimum criteria. This criteria is also intended to be used as a guideline for developing more specific and definitive criteria by each member.

2. OBJECTIVES

The objective of Power Supply Planning is to aim at a least cost planning to serve the demand at a specified level of reliability. The purpose is to facilitate joint planning and coordination of the generation and transmission network of the individual utilities so as to provide for increased operating efficiency and continuing service reliability. Common criteria and procedures must be used in the planning and operation of the interconnected system for cost effective, adequate and reliable power supply.

The Generation planning Criteria specifies the minimum technical and design criteria and principles to be used in the planning in the medium to long term. Compliance with this criteria is considered essential to a well planned and operated electric systems.

3. THE PLANNING PROCESS

The planning horizon of the SAPP Interconnected system is twenty (20) years. It addresses the peak demand forecast and the expected generation additions over the planning horizon to meet the reserve margins

4. RESPONSIBILITIES

SAPP in conjunction with the members shall identify the scope and specify the data required for reliability analysis. Each member shall provide accurate and appropriate equipment, power system data and load data for simulation purposes.

5. GENERATION PLANNING CRITERIA

5.1 DEMAND AND ENERGY FORECASTS

Each member shall submit to SAPP a 20-year forecast for peak demand energy requirements. The forecasts shall be in accordance with generally recognised methodologies and also in accordance with the following principles.

a) Each member shall select its own load forecasting methodology and establish its own load forecast.

b) Each member shall forecast load based on expected weather conditions

c) The method used, factors considered and assumptions made shall be submitted together with the forecast

d) Economic, technological, sociological, demographic and any other significant factors shall be considered in producing the forecast

e) The base , high and low scenarios shall be submitted

f) The SAPP forecast shall be the total of the member forecasts

5.2 RELIABILITY CRITERIA

The Reserve Capacity Obligation of a Member for any given period shall be equal to 10.6 % of the Annual System Peak Obligation of such Member when the generating plant is thermal and 7.6 % when the generating plant is hydro. A weighed average shall apply to Members who have a mixed system. Appendix 1 highlights how the reserve capacity obligation is determined in SAPP.

During the entire planning period, the SAPP system shall maintain adequate reliability of supply.

5.3 SECURITY CRITERIA

The minimum level of internal generation shall have as a long term objective, capacity equal to or greater than 100% of demand. Internal generation shall be committed when existing reserve levels drop below that specified in the reliability criteria.

5.4 GENERATION RESERVE REQUIREMENTS

The system shall be designed to withstand the more probable contingencies without widespread system failure and instability, maintaining power quality within specified voltage and frequency fluctuation ranges and maintaining voltage and thermal loadings within operating limits. The frequency range shall be between 49.85 and 50.15 Hz.

This criterion requires and provides for the sharing of reserve generating capacity as a means of reducing capacity requirements of each member and providing reliable electric service to customers due to equitable purchase, sale and exchange of generating capacity among members.

SAPP OPERATING RESERVES FOR 2011					
Utility Name	Largest Generator [MW]	Maximum Demand [MW]	Spinning Reserve [MW] e	Quick Reserve [MW] f	Operating Reserve [MW] g = e + f
ESKOM	900	36664	518.9	518.9	1037.7
ZESA	220	1469	47.8	47.8	95.6
ZESCO	180	1500	42.2	42.2	84.5
BPC	33	553	10.7	10.7	21.4
EdM	24	501	8.8	8.8	17.6
NAMPOWER	80	564	17.7	17.7	35.4
SNEL	62	1081	20.5	20.5	41.0
LEC	24	121	4.8	4.8	9.6
SEC	10	204	3.6	3.6	7.2
TOTAL	1533	42657	675	675	1350

5.5 GENERATION PLANNING DESIGN FEATURES

a) In order to maintain a balanced design of the power system, excessive concentration of generating capacity in one unit, at one location or in one area shall be avoided.

b) Auxiliary power sources shall be provided in each major generating station to provide for the safe shutdown of all units in the event of loss of external power.

c) Each members shall have a unit capable of black start so as to restart other units in the members' area.

d) Boiler controls and other essential automation of major generating units shall be designed to withstand voltage dips caused by system short circuits

5.6 SYSTEM PLANNING STEPS

The following steps, typical of power system planning studies, accomplish that:

- Gather the necessary data to support the steps listed below
- Establish the planning criteria that govern generation and transmission expansion planning
- Define the existing generation and transmission systems
- Prepare an overall load forecast for SAPP based on the individual load forecasts of all the SAPP utilities
- Determine the cost and availability of power plant fuels
- Determine options for generation and transmission expansion
- Develop scenarios to assist in evaluating important issues

- Establish and analyze the Base Case generation and transmission expansion plans
- Perform all generation production simulation and optimization.
- Evaluate the environmental impacts of the Base Case
- Evaluate the financing aspects and strategies of the Base Case
- Compare the costs and other characteristics of the Base and Alternative Cases

5.7 RELIABILITY CRITERIA FOR LONG TERM PLANNING PURPOSES

SAPP shall formulate long-term plans for development of the Transmission System on the basis of the justifiable redundancy.

A system cannot be made 100% reliable, as planned and forced outages of components will occur and multiple outages are always possible, despite having a very low probability of occurrence. The appropriate degree of reliability depends on the probability of loss of supply and the probable amount of load not supplied when an outage does occur.

6. CONTIGENCY CRITERIA FOR LONG TERM PLANNING PURPOSES

6.1 A system meeting the N-1 (or N-2 when and where would this apply?) contingency criterion must comply with all relevant voltage limits and the applicable current limits, under all credible system conditions.

6.2 For contingencies under various loading conditions it shall be assumed that appropriate, normally used generating plant is in service to meet the load and provide spinning reserve. For the more probable N-1 network contingency, the most unfavourable generation pattern within these limitations shall be assumed, while for the less probable N-2 network contingency an average pattern shall be used.

6.3 The generation assumptions for the N-1 and N-2 network contingencies do not affect the final justification to proceed with investments, but merely define what is meant by the statement that the system has been designed to meet an N-1 or N-2 contingency.

7. GENERATION INTEGRATION

With all connecting lines healthy it shall be possible to transmit the total output of the power station to the system for any system load condition unless under contingency conditions.

Integration of power stations

(1) When the integration of power stations is planned, the following network redundancy criteria shall apply:

Power stations of less than 1 000 MW

- With all connecting lines in service, it shall be possible to transmit the total output of the power station to the system for any system load condition. If the local area depends on the power station for voltage support, the connection shall be made with a minimum of two lines.
- Transient stability shall be maintained following a successfully cleared single-phase fault.
- If only a single line is used, it shall have the capability of being switched to alternative busbars and be able to go onto bypass at each end of the line.

Power stations of more than 1 000 MW

- With one connecting line out of service (N-1), it shall be possible to transmit the total output of the power station to the system for any system load condition.
- With the two most onerous line outages (N-2), it shall be possible to transmit the total output of the power station less its smallest unit to the system.
- Smallest unit installed at the power station shall only include units that are directly connected to the transmission system and are centrally dispatched.

(2) Transient stability shall be retained for the following conditions:

- A three-phase line or busbar fault, cleared in normal protection times, with the system healthy and the most onerous power station loading condition; or
- A single-phase fault cleared in “bus strip” times, with the system healthy and the most onerous power station loading condition; or
- A single-phase fault, cleared in normal protection times, with any one line out of service and the power station loaded to average availability.

(2) The cost of ensuring transient stability shall be carried by the generator if the optimum solution, as determined by the System Operator, results in unit or power station equipment being installed.

(3) Busbar layouts shall allow for selection to alternative busbars. In addition, feeders must have the ability to go onto bypass.

(4) The busbar layout shall ensure that no more than 1 000 MW of generation is lost as a result of a single contingency.

(5) To enable the System Operator to successfully integrate new power stations, detailed information is required per unit and power station.

(6) When the integration of a nuclear facility or off-site power supply to a nuclear facility is planned, the levels of redundancy and/or reliability of the transmission system and off-site power supply requirements specified in its nuclear operating license or by the National Nuclear Regulator within the country shall apply.

8. GENERATION EXPANSION PLANNING PROCESS

The generation expansion planning process follows development of the load forecast. The main steps involved are:

- Add plants identified by the utility
- Maintain SAPP required reserve margins
- Add "generic" plants to maintain reserve margins as necessary
- Limit over-building – adding generation far in excess of reserve margin requirements
- Establish transmission system transfer limits among utilities so that they can be imposed as constraints in the production simulation and optimization analysis
- Maintain transfer limits taking into account normal operation and contingency conditions using steady state, stability, and voltage collapse models.
- Conduct production simulation analysis of the Base Case
- Conduct production simulation analysis of scenarios based on the Base Case

The diagram below shows the generation planning process.

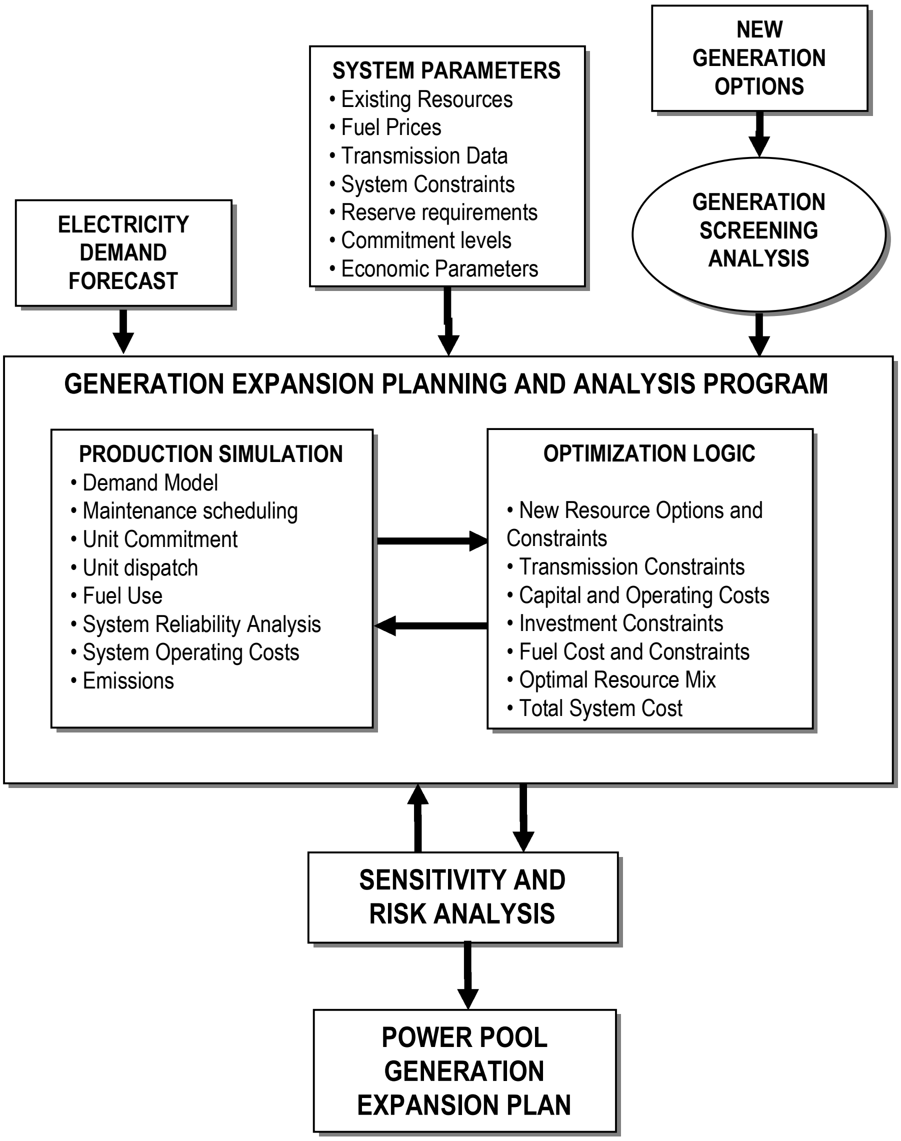

Diagram 1: Generation Planning Process

Screening analysis identifies clearly inferior and clearly superior alternatives and the economic range of service, whether peaking, mid-range or base-load, that the resource option would be expected to serve over its life. The limitation of screening analysis is that the calculations are made outside of the context of existing system operation, and so analysis is only used to rank options and eliminate clearly uneconomical options.

Determine the least cost generation expansion plan using the system optimization algorithm. The optimization uses a constraint of maintaining minimum reserve margin as specified by SAPP.

Both production simulation and optimization account for the impact of reliability by assigning a cost when the system is unable to meet load (unserved energy).

For the generation expansion plans, calculate annual costs and reliability measures, including:

- Generation capital, O&M, and fuel costs and the costs associated with unserved energy

- Reliability statistics such as: reserve margins, loss of load hours, and expected unserved energy
- Emissions-related statistics

9. RELIABILITY APPORACH IN OPTIMISATION ANALYSIS

The traditional reliability approach in optimization analysis is to use reliability criteria as constraints in long-range generation expansion planning and to optimize an economic objective (e.g., minimizing total discounted system costs) subject to a specified reliability criterion (e.g., reserve margin, LOLH, or LOLP). This approach to expansion planning does not, however, allow reliability vs. cost trade-offs. That is, it does not take into consideration the trade-offs between economic factors and different levels of reliability inherent in capacity expansion planning.

The approach is to minimize the total discounted cost including all costs. "All costs" means the direct costs of the generation and transmission systems (generation and transmission capital, fuel, and operation and maintenance costs), plus the cost of ENS.

The rationale for is that it would produce the lowest overall cost solution. Furthermore a least cost approach incorporating the cost of ENS is consistent with the planning approaches of several of the SAPP utilities

The optimization program adds new generating resources to lower the overall levelized system costs including the ENS cost. At some optimal point, adding another generating unit adds more costs than the benefit of reduction in ENS and its costs, and the overall costs rise.

When another criterion such as reserve margin is also applied, in some circumstances it could be the limiting factor. It could require more generation or transmission than the least-cost optimum. In that the resource plan would not achieve the ideal least-cost balance of cost and reliability.

10. ECONOMIC JUSTIFICATION CRITERIA

When evaluating different options, generation and transmission projects should be selected based on the least cost option. Utility specific criteria will take precedence depending on the availability of funding.