Review of the Maximum Reserve Capacity Price 2007

FINAL REPORT

■ 09 November 2007

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1. Introduction

As part of the Government of Western Australia's commitment to establishing a wholesale Electricity Market within the South West Interconnected System, in 2004 the Government of Western Australia setup an Independent Market Operator (IMO) to administer and operate the Wholesale Market.

The Western Australian Electricity Market Rules (the market rules) require the Independent Market Operator to conduct a review of the Maximum Reserve Capacity Price each year. As part of this process Sinclair Knight Merz (SKM) has been commissioned to determine the following for the year 2007:

- capital cost (procurement, installation and commissioning, excluding land cost) of a generic, industry standard liquid fuelled 160 MW OCGT power station;
- fixed operation & maintenance costs of the above facility with capacity factor of 2 %. The cost shall be in 5 year periods covering 1 to 30 years;
- capital cost (procurement, installation and commissioning, excluding land cost) of a generic, industry standard 330 kV switchyard and overhead transmission line that facilitates the connection of the above mentioned power station to an existing transmission line;
- fixed operation & maintenance costs of this switchyard and overhead transmission line. The cost shall be in 5 year periods covering 1 to 50 years;
- assess the proposed the switchyard and the transmission line arrangements compliance with the requirements of Western Power's Technical Rules; and
- legal, approval, environmental, financing and design costs associated with term 'M' used in Wholesale Electricity Market Rule.

This report should be read in conjunction with the scope of work agreed between IMO and SKM which explains the objectives of this project in detail and is attached in Appendix A.

SKM

2. Generation Plant Capital Cost

Taking into account the review completed for the IMO as part of its Maximum Reserve Capacity Price Advisory Group, SKM estimated the capital cost (procurement, installation and commissioning, excluding land cost) of a generic, industry standard liquid fuelled 160 MW Open Cycle Gas Turbine (OCGT) power station. The estimate includes all components and costs associated with a complete gas turbine project.

2.1 Methodology

In order to establish capital costing for a generic 160 MW liquid fuelled OCGT plant, SKM undertook the following steps:

- development of a table of prices for a number of open cycle gas turbine plant using the latest version of Thermoflow GT Pro/Peace power station development software;
- normalisation of existing project data on recent similar sized plant developments, (removal of non-typical costs such as significant ground preparation, pilling, excessive environmental costs etc);
- correlation of the Thermoflow GT Pro/Peace derived cost data with the normalised reference data; and
- produced normalised estimates based on combined Thermoflow and existing project data to comprise costing for a generic 160 MW open cycle gas turbine plant.

2.2 Thermoflow GTPro / Peace Derived Costs

SKM has utilized a standard proprietary generating plant modelling software (Thermoflow GT Pro®/PEACE®) together with its in-house cost data to develop capital prices for a number of OCGT plants with output in the 160 MW range (exact plant capacities are dependent on the nearest matching gas turbine). Single turbines have been employed to reduce inconsistencies with capital costing and thus all of the plant models developed use a single gas turbine.

In developing the matrix of prices, SKM has utilised:

- its knowledge and experience of generation project development;
- its database of costs for power station capital and operating costs;
- its knowledge of the impact of the flow through of commodity price increases, labour costs etc on generation station capital costs and hence appropriate escalation indices; and
- its knowledge and experience in generation project costing, including typical allowances.

In developing the Thermoflow costs, SKM has assumed a standard green field site located in Western Power's South Western region and having no special geological, environmental, permitting or consenting peculiarities. In particular it has been assumed that there are no unusual requirements for ground preparation, such as piling or land remediation etc. As a location is not specified, SKM has also assumed ISO conditions (15 °C, 0 m elevation and 60 % RH) for plant operation.

2.3 Project Data Price Review

In developing the end cost estimate, SKM has also utilized information gathered from a number of recent projects that it has been involved with over the past four years. These projects have been in varying stages of the project development lifecycle and include projects in the initial feasibility study stage, project scope development stage, tendering to specification stage, front end engineering stage, construction stage, and project implementation management to identify 'real life' project cost data for generating plant of sizes similar to this study.

Capital cost of plant development in Australia has increased above that of CPI and to this end, CPI over the past few years does not provide an accurate proxy for the rates pf plant development escalation. SKM has developed and utilizes a number of escalation factors for varying aspects of a power plant and has applied these to bring the total capital estimate to June 2007 money terms. The reference project data has then been further revised to take out non-generic project costs such as costs relating to significant ground preparation work, unusual environmental consenting requirements etc. to produce a table of 'normalised' real life project costing data comparable to that produced by the Thermoflow modelling software. This has also taken into account escalation factors for cost items specific to the Western Australian industry (i.e. high labour rates).

These costs were normalised to ensure they covered the same cost items as the Thermoflow software (e.g. excluding connection costs, environmental consents, financing costs etc.) and any abnormal cost variations relating to unique or unusual project factors removed. Much of this data has been sourced from confidential projects and so cannot be directly presented in this report.

2.4 Development of the Generic OCGT Capital Cost Estimate

SKM has statistically compared and correlated the two sets of costing data to develop a generic OCGT capital cost estimate for a generic 160 MW liquid fuelled open cycle gas turbine plant. Where slight inaccuracies occurred, existing project data was normalized and then used to compensate for any cost inaccuracies of the modelling software. In this manner, the anonymity of the reference project data has been maintained.

2.5 Resultant 160 MW Generic OCGT Capital Cost Estimate

The following table provides a breakdown of the capital cost estimate for a 160 MW liquid fuelled generic OCGT plant covering main power island, balance of plant, buildings, workshop, primary and redundant SCADA and communications equipment. Costs are considered to be accurate to ±15 %.

- **Table 2-1 OCGT Capital Cost Estimate**

Item		$ AUD '000,000s
1	Main Plant Equipment	$65.2
2	Balance of Plant / Other Equipment	$2.3
3	Civil Works	$4.7
4	Mechanical Works	$5.4
5	Electrical Assembly & Wiring	$1.6
6	Buildings & Structures	$4.7
7	Engineering & Plant Startup	$4.9
8	Contractor's Soft & Miscellaneous Costs	$11.6
9	Owner's Soft & Miscellaneous Costs	$4.0
Total - Owner's Cost		$104.4

This equates to a capital cost of **AUD$652 / kW.**

2.6 Present System Employed by IMO

The IMO's current system for estimating the capital cost of an OCGT plant is documented in the *Wholesale Electricity Market Rules.* The rules state that the capital cost is estimated to be:

"…double the lowest quoted equipment price of the three open cycle gas turbines with capacities nearest to CAP, quoted in United States dollars per MW, contained in the most recent issue of Gas Turbine World Handbook, or a similar reputable international trade price, current as at [relevant year]."

SKM has performed the following steps:

- used most recent version (2006) of Gas turbine World Handbook for capital cost of gas turbines,
- selected lowest price ($/MW) generator, nearest to the capacity value selected for the different power outputs, and
- doubled the generator price to obtain capital cost of the power station.

Although the rules refer to gas turbine costs derived from Gas Turbine World Handbook publications, SKM has assumed this to mean the gas turbine plus generator combinations as listed in the "Simple Cycle Power Plants" tables rather than the turbine only costs listed in the "Mechanical Drive" tables. This price has been escalated to June 2007 monetary terms.

SKM followed this process using the latest currently available issue (2006) of Gas Turbine World Handbook and produced output for plant capacity of 160 MW.

- **Table 2-2 OCGT Capital Cost based on IMO's current system**

Unit	MW Output	US $	Au $/kW [1]	Esc. 2006/07[2]	'Double' Estimate (Au $/kW)
SGT5-2000E	157.0 MW	$181/kW	203.8	209.3	418.6
SGT5-2000E	163.0 MW	$180/kW	202.6	208.1	416.3
PG7241FA	171.7 MW	$180/kW	202.7	208.1	416.3

2.7 Comparison with GT World Derived Prices

SKM's current methodology for producing capital cost estimates indicates a higher cost than the results from the current IMO methodology. There is significant difference between the estimates, in the order of 70 %. Based on SKM's methodology for estimating capital cost of plant, the current IMO methodology as provided for in the market rules of doubling the published gas turbine price is of suspect reliability. It is insufficiently refined to capture all relevant price data, and more importantly does not factor in differential cost indices for high cost elements of the project (such as labour). This significant difference means that the IMO methodology may have been appropriate at its time of inception, but it is no longer applicable to current market conditions.

SKM therefore concludes that while the doubling of equipment price may have been a valid method to estimate total OCGT plant capital costs at the time of development of the methodology, analysis of recent differential inflation movements in the market for the various cost elements of an OCGT plant indicate that this is no longer the case. Future movements within the market may result in further diversion and increased inaccuracy of the methodology.

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[1] Based on exchange rate of USD$1 = AUD$1.1259 as provided by IMO.

[2] Australian Bureau of Statistics (June 2006 / June 07)

3. Generation Operation & Maintenance Costs

3.1 Assumptions and Estimated Maintenance Costs

At the request of the IMO, an OCGT plant, based on a single gas turbine capable of delivering a net 160 MW output fuelled predominantly with natural gas has been evaluated for a 30 year operating life. A fuel regime of 100 % running on distillate (light fuel oil) has been provided to allow independence from gas supply. SKM has developed a gas turbine operation and maintenance model based on these parameters using the net output and net heat rate produced by Thermoflow GT PRO® software. SKM has assumed an ambient temperature of 15 C, with a relative humidity of 60 % and an altitude of 0 m for the plant specification. The three turbines considered in this analysis are the:

- Alstöm 13E2;
- Siemens V94.2 (SGT5-200E); and
- General Electric GE9171E.

The running regime advised by the IMO is as described in Appendix A, repeated here for convenience:

- 2 % capacity factor;
- 4 hours running per start; 44 starts per annum for a 2 % capacity factor;
- no fast starts[3];
- one full time load trip to be assumed per annum; and
- 100 % running on liquid fuel (distillate).

3.1.1 Generator O&M Cost Escalation

A range of data sources have been drawn on (Table 3-1) to develop appropriate costs and price escalators for the OCGT plant fixed O&M costs data. These escalators have been applied to the cost data available to SKM that is not already couched in 2007 money terms.

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3 Given that there is no balancing market in the SWIS Wholesale Electricity Market, the Independent Market Operator has advised that there will be no requirement for fast starts in the operating regime and hence it is assumed that the plant will be dispatched with sufficient forward notice to avoid the need for fast starts.

▪ **Table 3-1 Gas Turbine Plant Fixed O&M Cost Data Indexation Sources**

Escalation Sources – Gas Turbine Fixed O & M	
Source	**Used for**
Australian Bureau of Statistics – Consumer Price Index	Market fee, gas connection fee, balance of plant, consent, legal, corporate overhead, engineering support, electrical, fire protection, rates
Australian Bureau of Statistics – Labour Price Index (WA)	Non operator blue collar labour elements 2005 - 2007
Industrial relation commission – Electrical Contractor Award	Contractor costs 2005 - 2006
SKM – OCGT Project Data (amalgam – 2007)	Insurance, plant operator labour, OCGT substation

These indices have been compounded for each cost element in proportion to the ratio of the make up costs for which the indices are applicable. The compound escalator for the gas turbine plant fixed O&M is determined at:

- **2005-2006**: 4.25 %
- **2006-2007**: 3.45 %

All costs are presented as mean values ± 10 %.

3.1.2 Expected fixed Maintenance Costs

The fixed O&M cost elements (±10 %) shown below in Table 3-2 have been developed from cost data derived from a range of sources including an amalgam of data from current and recent similar OCGT projects. These costs have been escalated, where appropriate, to June 2007 money terms. Plant insurance has been omitted from the figures however SKM estimates this at 0.5 % of replacement capex (June 2007).

▪ **Table 3-2 Generator fixed O&M costs**

Generator Fixed O & M cost breakdown	
O & M Cost Component	**$M pa**
Plant operator labour	0.420
OCGT Substation (connection to tie line)	0.21
Rates	0.053
Market Fee	0.053
Gas Connection (excludes amortised gas pipeline connection costs)	0.053
Balance of plant	0.106
Consent (EPA annual charges emissions tests)	0.027
Legal	0.022
Corporate Overhead	0.191
Travel	0.022
Subcontractors	0.271
Engineering Support	0.053
Security	0.108
Electrical (Including Control & Instrumentation)	0.105
Fire	0.053
Total	**1.56**

Five yearly variable and fixed OCGT O&M costs (mean values ± 10 %) are provided in Table 3-3 for each five year period of the 30 year operating life based on a 100 % liquid fuel (distillate) regime and 2 % capacity factor[4].

▪ **Table 3-3 Combined Generator O&M costs ($June 2007)**

Cumulative five yearly costs (Years) AUD'000s	1 to 5 $'000s	6 to 10 $'000s	11 to 15 $'000s	16 to 20 $'000s	21 to 25 $'000s	26 to 30 $'000s	1 to 30v
Fixed O&M @ 2 % CF	$7,800	$7,800	$7,800	$7,800	$7,800	$7,800	$46,800
Variable O&M @ 2 % CF	$630	$880	$23,560	$880	$17,860	$630	$44,440

[4] The assumption of the plant running on 100 % distillate represents a change to the assumptions used in the 2006 report. Running on distillate, which is considered a 'dirtier' fuel than gas results in increased O&M costs over costs arising when running primarily on gas. This is due to the requirement for more frequent inspections of the turbine and shorter time periods between turbine overhauls.

4. Transmission Connection Capital Costs Line

4.1 Options considered

As part of this project SKM has been asked to consider two switchyard connection options:

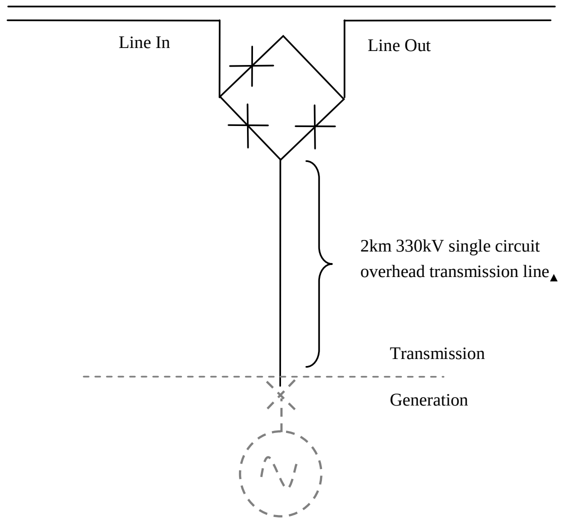
1) connecting the generator to an existing transmission line through a least cost 3 breaker mesh arrangement; and
2) connecting the generator to an existing transmission line through a 3 breaker mesh arrangement that is configured as a breaker and a half configuration switchyard.

4.2 Option 1

4.2.1 General Issues and Assumptions

The connection to the existing transmission line will be based on the most economical (i.e. least cost) solution with the 3 breaker mesh arrangement configuration switchyard being located under the existing transmission line. The general arrangement and the single line diagram of this switchyard can be seen in Appendix E. It has been assumed that the existing transmission line is double circuit. The generator will supply the switchyard via a 2 km long[5] 330 kV single circuit overhead line, this arrangement is shown in Figure 4-1. The assumed transmission line rating is 940 MVA. All transmission connection costs have been calculated from the isolator on the high voltage side of the generator transformer and therefore do not include any of the costs associated with the generator transformer and switchgear.

[5] It is recognised that transmission tie line lengths will vary and be project specific.



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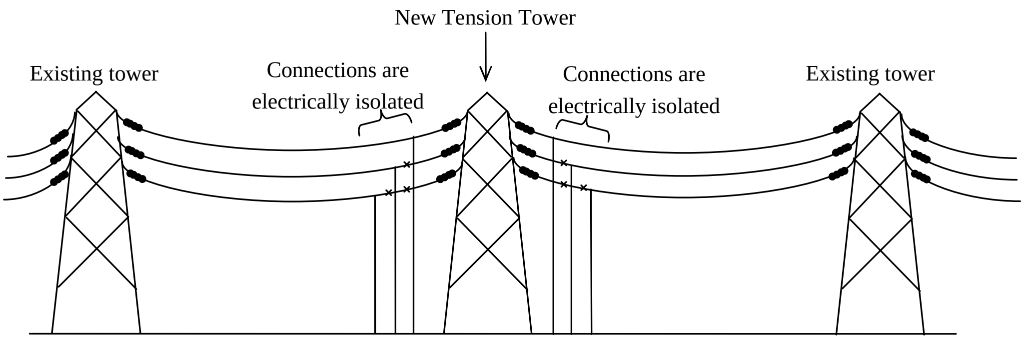
■ **Figure 4-1 Overall arrangement for Option 1**

The 2 km of transmission line connecting the generator to the switchyard considers 50% flat - 50% undulating land, 50 % rural – 50 % urban conditions, allowance for one road crossing per km, and with no unforeseen environmental or civil costs associated with the development. It is assumed that the existing transmission line will not require modification to allow for this connection with the exception of one new tension tower located at the switchyard to allow the point of connection. SKM has considered a single tension tower configuration, with the new tension tower being positioned between two existing towers as shown in Figure 4-2. Costs associated with any staging works have not been considered.



- **Figure 4-2 Elevation of connection point into the existing transmission line for Option 1**

The 3 breaker mesh connection not configured in a breaker and a half arrangement consists of 3 complete switch bays that connect directly onto the bus arrangement. This option is considered to be the least cost solution due to the reduced land occupied by the yard, reduced establishment costs, and support structure costs. However this arrangement limits the future expansion of the switchyard and thus the generating facility.

4.2.2 Option 1: Switchyards Capital Costs

The capital cost for the 3 breaker mesh arrangement discussed in option 1 is estimated at $5m ±15 % (excluding EPCM).

4.2.3 Option 1: Transmission Line Capital Costs

To accommodate the requirement of this option, SKM has developed costs for a 330 kV single circuit line of steel tower construction with 2 × Mango ACSR conductor. As the line is only 2km in length a 100 % allowance for short length factor has been applied to the line cost based on SKM recent experience on similar projects (note SKM's standard unit rates for transmission lines are based on a reference asset where the transmission line is constructed on a 100km length). The total cost for the 2 km of transmission line has been estimated at $1.2m ±15 % excluding EPCM.

4.2.4 Option 1: Combined Switchyard and Transmission Line Capital Costs

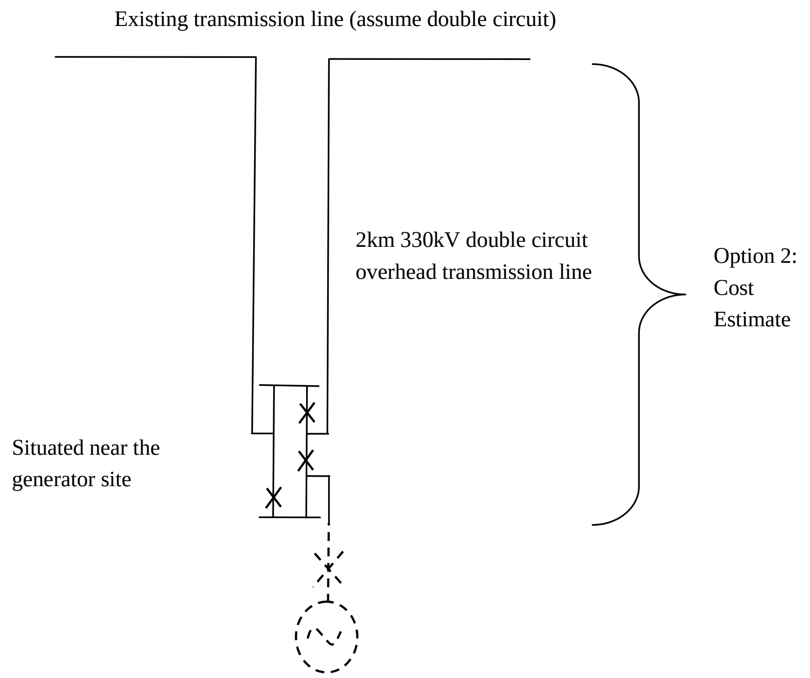
The combined capital costs of the switchyard and transmission line along with the new tension tower of $100k have been estimated at $7.5m ±15 %. This cost includes EPCM costs, plus an adjustment factor for higher contractor cost in South Western region of Western Australia.

4.3 Option 2

4.3.1 General Issues and Assumptions

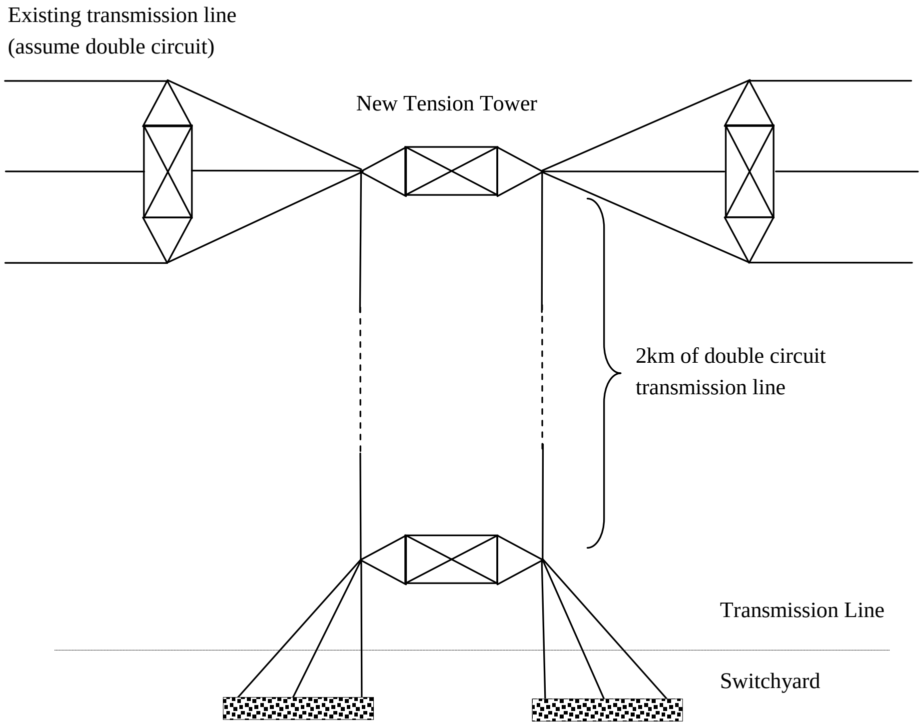
Option 2 considers connecting the generator to the existing transmission line via a 3 breaker mesh arrangement in a breaker and a half configuration. It has been assumed that this switchyard arrangement would be located adjacent to the generator site. A general arrangement and single line diagram for this switchyard can be seen in Appendix E. It has been assumed that the existing overhead transmission line is double circuit. A 2 km long 330 kV double circuit transmission line will connect the switchyard to the existing transmission line. This connection arrangement is shown in Figure 4-3.

It has been assumed that the transmission line rating is 940 MVA. All transmission connection costs have been calculated from the isolator on the high voltage side of the generator transformer and therefore have not been included in any of the cost estimates.



▪ **Figure 4-3 Overall arrangement for Option 2**

The 2 km of transmission line connecting the switchyard to the existing line considers 50 % flat – 50 % undulating land, 50 % rural – 50 % urban conditions, allowance for one road crossing per km, and with no unforeseen environmental or civil costs associated with the development. It is assumed that the existing transmission line will not require modification for this connection with the exception of a single new tension towers located in between two existing transmission towers to allow for tee connection as shown in Figure 4-4. Costs associated with any staging works have not been considered.



▪ **Figure 4-4 Plan of connection point into existing transmission line for Option 2**

The 3 breaker mesh arrangement configured as a breaker and a half consists of 3 complete switch bays and a single isolator bay. The main advantage of this arrangement is the flexibility for future development of the power station. This is achieved by additional generation capacity being connected via additional feeder bays. The subsequent drawback with this configuration is the added cost of the land occupied by the yard, the associated establishment costs, the switch bay support structure costs and the 2 km of double circuit transmission line. It should be noted that the establishment costs generally consist of the civil and infrastructure components of the switchyard.

4.3.2 Option 2: Switchyards Capital Costs

The capital costs for the 3 breaker mesh arrangement configured as a breaker and a half has been estimated at $5.6m ±15 % (excluding EPCM).

4.3.3 Option 2: Transmission Line Capital Costs

To accommodate the requirements of this option, SKM has developed costs for a 330 kV double circuit line of steel tower construction with 2 × Mango ACSR conductor. As the line is only 2km in length a 100 % allowance for short length factor has been applied to the line cost based on SKM's recent experience on similar projects (note SKM's standard unit rates for transmission lines are based on a reference asset where the transmission line is constructed on a 100km length). The total cost for the 2 km of transmission line is $1.7m ±15 % (excluding EPCM).

4.3.4 Option 2: Combined Switchyard and Transmission Line Capital Costs

The combined switchyard and transmission line capital costs along with the new tension tower of $100k have been estimated at $8.8m ±15 %. This cost includes engineering, procurement and contract management, plus an adjustment factor for higher contractor cost in South Western region of Western Australia.

4.4 Compliance to Technical Rules for 330kV Switchyard and Transmission Line

The existing Western Power Technical Rules sets out the Transmission and Distribution System Planning Criteria for the SWISS network. Clause 2.5.2.3 states

"The N-1-1 criterion applies to those sub-networks of transmission system where the occurrence of a credible contingency during planned maintenance of another transmission element would otherwise result in the loss of supply to a large number of consumers. Sub-network of the transmission system that are designed to the N-1-1 criterion include all 330kV lines, substation and power stations"

The complete section containing the clause above is shown in Appendix B.

Clause 2.5.2.3 states that sub-networks are required to meet N-1-1 criterion. This means that the network will be required to withstand a forced outage of a transmission or generating element while another element are out of service due to maintenance without causing loss of supply to customers.

The proposed connections only meet N-1 security criteria when considered in isolation from the network. This is less than the requirements set out in Clause 2.5.2.3. However this may not be the case when the complete network is considered as alternative solutions to meet this planning requirement may be available. It should be noted that new network connections would not be treated in isolation and any new connections would need to go through Western Power's planning process to ensure that the requirements under the technical rules can be met.

4.5 Connection Cost Escalation Calculation

To determine the 2007 escalation values for the connection costs, SKM has developed a series of formulae that consider the individual elements that make up the connection component of this study.

The escalation of the individual elements has been based on the information in Table 4-1. The EPCM component of the costs has been developed using SKM's most recent experience on similar projects. EPCM has been applied at 15 % of all other costs and is therefore represented in 2007 terms.

- **Table 4-1 Capital Costs Escalation Data Sources**

Source	Factors	Used for
ABARE, IMF, LME, World Bank, Wachovia, Brent, CRUspi	Aluminium, Copper, Iron Ore, Oil, Steel, Nickel	Equipments, P&C, Misc Materials, Structure
ABS, SKM, Treasury	CPI, General labour, Utility Labour	Installation, Erection, Commissioning, Foundation, Civil, Structure
ETA Union	Site Labour	Installation, Erection, Commissioning
SKM	Switchgear, Transformers	Equipments

4.5.1 Capital Cost Escalation

The composite 2006-2007 capital cost escalators for both the switchyard and transmission line options are shown in Table 4-2.

- **Table 4-2 Capital cost escalators**

	Switch yard	Transmission Line
Option 1	5.00 %	9.6 %
Option 2	5.11 %	9.7 %

4.5.2 Switchyard and Transmission Line O&M Cost Escalation

The O&M costs of switchyard and transmission line have been developed using a percentage multiplier[6] of the switchyard and transmission line capital costs. Therefore the escalation applied to the connection O&M costs is identical to the capital costs. The switchyard and transmission line O&M costs are medium values with a potential range of ±10 %.

[6] This multiplier has been determined from O&M data gathered over a number of years by SKM and is periodically validated against known O&M costs. The multiplier varies in an increasing and approximate exponential manner with equipment age.

5. Switchyard and Overhead Transmission Line Operation and Maintenance Costs

5.1 Options considered

SKM has developed the operation and maintenance costs for the transmission connection on an asset class basis. This has been achieved by using the unit costs developed in Section 4 of this report and applying a variable percentage value for O&M over the life of the assets. The percentage value used allows for the following:

- salaries / wages of personnel;
- public utilities (water, electricity, telephone);
- maintenance of equipment; and
- depreciation of equipment.

SKM has assumed that the average life of the 330 kV transmission line and switch yard assets is 60-years and 50-years respectively. Annual insurance costs and tax have been omitted from the O&M costs as these cost components will be dependent on the ownership arrangement.

5.2 Option 1: Switchyard and Transmission line Operational & Maintenance Costs

Table 5-1 shows the operation and maintenance costs over the life of the assets for Option 1. The average annual O&M costs over the asset lifetime for the transmission line are $5k, with the average annual O&M costs for the switchyard component being $100k ±10 %.

- **Table 5-1 O&M costs for option 1**

Cost over 5 year period	Transmission Line $'000	Switchyard $'000	Combined Cost $'000
1 to 5 years	$9	$252.7	$261.8
6 to 10 years	$10.6	$290.0	$300.7
11 to 15 years	$12.5	$323.9	$345.4
16 to 20 years	$14.7	$382.0	$396.8
21 to 25 years	$17.2	$438.5	$455.7
26 to 30 years	$20.2	$503.3	$523.5
31 to 35 years	$23.7	$577.6	$601.3
36 to 40 years	$27.9	$66.9	$690.8
41 to 45 years	$32.7	$760.8	$793.5
46 to 50 years	$38.4	$873.2	$911.6
51 to 55 years	$45.1	n/a	n/a
56 to 60 years	$53.0	n/a	n/a

5.3 Option 2: Switchyard and Transmission line Operational & Maintenance Costs

Table 5-2 shows the operation and maintenance costs over the life of the assets for Option 2. The average annual O&M costs over the asset lifetime for the transmission line are $7k with the average annual O & M costs for the switchyard component being $112k ±10 %.

- **Table 5-2 O&M costs for option 2**

Cost over 5 year period	Transmission Line $'000s	Switchyard $'000s	Combined Cost $'000s
1 to 5 years	$12.8	$281.7	$294.6
6 to 10 years	$15.1	$323.3	$338.4
11 to 15 years	$17.7	$371.1	$388.8
16 to 20 years	$20.8	$425.9	$446.7
21 to 25 years	$24.4	$488.8	$513.2
26 to 30 years	$28.7	$561.0	$589.7
31 to 35 years	$33.7	$643.9	$677.5
36 to 40 years	$39.5	$739.0	$778.5
41 to 45 years	$46.4	$848.2	$894.6
46 to 50 years	$54.5	$973.4	$1,027.9
51 to 55 years	$64.0	n/a	n/a
56 to 60 years	$75.1	n/a	n/a

A table comparing options 1 and 2 can be seen in Appendix F.

6. Legal, Approval, Financing Costs (term 'M' – Wholesale Electricity Market Rule)

6.1 General Issues and Assumptions

SKM has estimated the Legal, Approval and Financing costs for a generic open cycle gas turbine plant of this nature. The costs have been estimated from in-house data and knowledge of similar recent developments. SKM has statistically compared and correlated the costing data of several projects to develop a generic OCGT legal, approval and financing cost estimate for a generic 160 MW liquid fuelled open cycle gas turbine plant. Costs are accurate to ±15 %.

The varying costs were each normalised and any abnormal cost variations relating to unique or unusual project factors removed. Much of the original data has been sourced from confidential projects and so cannot be directly presented in this report.

Table 6-1 shows SKM estimate for the term 'M' used in appendix 4 of the Wholesale Electricity Market Rule, with due consideration given to standard industry practices. These costs include,

- legal cost associated with the design, construction and of the power station,
- approval cost including environmental consultancies and approvals, and local, state and federal licensing, planning and approval costs, and
- estimate reasonable design costs associated with the power station.
- **Table 6-1 Estimate of term 'M'**

	Cost estimate $'000s
Legal Costs	$1,200
Approvals	$1,050
Financing costs not directly covered in term "D"	$820
Design Costs	$770
Total	**$3,840**

Appendix A Scope of Work

Extract from proposal letter HAP8084

The project shall consist of three discrete elements as follows:

1.1. Power Station Estimate

1.1.1. Taking into account the review completed for the IMO as part of its Maximum Reserve Capacity Price Advisory Group, estimate the capital cost (procurement, installation and commissioning, excluding land cost) of a generic, industry standard liquid fuelled 160MW Open Cycle Gas Turbine power station. The estimate will include all the components and costs associated with a complete gas turbine project; and

1.1.2. Estimate the fixed operation and maintenance costs of the liquid fuelled OCGT power station of 160MW with capacity factor of 2% to mid 2007 value. The cost shall be in 5 year periods covering 1 to 5 years; 6 to 10 years; 11 to 15 years; 16 to 20 years; 21 to 25 years; and 26 to 30 years respectively.

1.2. Connection Works Estimate

1.2.1. Estimate the capital cost (procurement, installation and commissioning, excluding land cost) of a generic, industry standard 330kV substation that facilitates the connection of the above mentioned power station. The estimated cost will be based on a generic three breaker mesh substation configuration. The substation will be located under an existing transmission line and include an allowance for 2km of 330kV overhead single circuit line to the power station that will have one road crossing. It shall be assumed that the switchyard will be located on 50% flat - 50% undulating land, 50% rural - 50% urban location and there will be no unforeseen environmental or civil costs associated with the development. The connection of the switching station into the existing transmission line will be turn-in, turn-out and will be based on the most economical (i.e. least cost) solution. It is assumed that the existing transmission line will not require modification to allow the connection with the exception of one new tower located at the substation to allow a point of connection. Costs associated with any staging works will not be considered. The estimate will include all the components and costs associated with a standard substation;

1.2.2. Estimate the fixed operation and maintenance costs of this transmission line and meshed switchyard to mid 2007 value. The cost shall be in 5 year periods covering 1 to 5 years; 6 to 10 years; 11 to 15 years; 16 to 20 years; 21 to 25 years; 26 to 30 years; 31 to 35 years; 36 to 40 years; 41 to 50 years; 51 to 55 years; and 56 to 60 years respectively; and

1.2.3. Ensure the above mentioned transmission line and substation design and arrangement comply with the requirements of Western Power's technical standards for new developments.

1.3. Legal, Approval and Financing Estimate

1.3.1. Estimate a reasonable margin for the term 'M' used in Appendix 4 of the Wholesale Electricity Market Rule (see attachment) giving due consideration to standard industry practices. It is expected that this will cover the following:

a. Legal cost associated with the design, construction and of the power station;

b. Approval cost including environmental consultancies and approvals, and local, state and federal licensing, planning and approval costs;

c. Direct financing costs not directly covered in the application of the cost of finance term 'D' mentioned in Appendix 4 of the Wholesale Electricity Market Rule; and

d. Estimate reasonable design costs associated with the power station.

Appendix B Western Power's Technical Rule, Clause 2.5.2.3

2.5.2.3 N-1-1 Criterion

(a) The N-1-1 Criterion applies to those sub-networks of the *transmission system* where the occurrence of a *credible contingency* during planned maintenance of another *transmission element* would otherwise result in the loss of *supply* to a large number of *Consumers*. Sub-networks of the *transmission system* that are designed to the N-1-1 criterion include:

(1) all 330 kV lines, *substations* and *power stations*;

(2) all 132 kV *terminal stations* in the Perth metropolitan area, and Muja *power station* 132 kV *substation*;

(3) all 132 kV *transmission lines* that *supply* a sub-system of the *transmission system* comprising more than 5 *zone substations* with total *peak load* exceeding 400 MVA; and

(4) all power stations whose total rated export to the *transmission system* exceeds 600 MW.

(b) The range of operating conditions that are allowed for when planning a part of the *transmission system* to meet the N-1-1 criterion is set out in Table 2.9.

Table 2.9 Transmission system operating conditions allowed for by the N-1-1 criterion

Maintenance *Outages* and Contingencies
transmission line maintenance and unplanned *transmission line outage*
transformer maintenance and unplanned *transformer outage*
transformer maintenance and unplanned *transmission line outage*
busbar maintenance and unplanned *transmission line outage*
busbar maintenance and unplanned *transformer outage*
circuit breaker maintenance and unplanned *transmission line outage*
circuit breaker maintenance and unplanned *transformer outage*
circuit breaker maintenance and unplanned *busbar outage*
transmission line maintenance and unplanned *transformer outage*

(c) Under the N-1-1 criterion, each sub-network must be capable of withstanding the coincident planned and unplanned *outages* of *transmission elements* listed in Table 2.9 at up to 80% of the expected *transmission system peak load*. In determining whether the N-1-1 criteria have been met, the *Network Service Provider* may assume that, during the planned *outage*, *generation* has been rescheduled to mitigate the effect of the subsequent unplanned *outage*.

(d) Following the unplanned *outage* of the *transmission element*, the *power system* must continue to operate in accordance with the performance standards specified in clause 2.2, provided the *transmission system load* remains below 80% of the expected *peak load*.

Appendix C Connection Option 1 Capital Costs

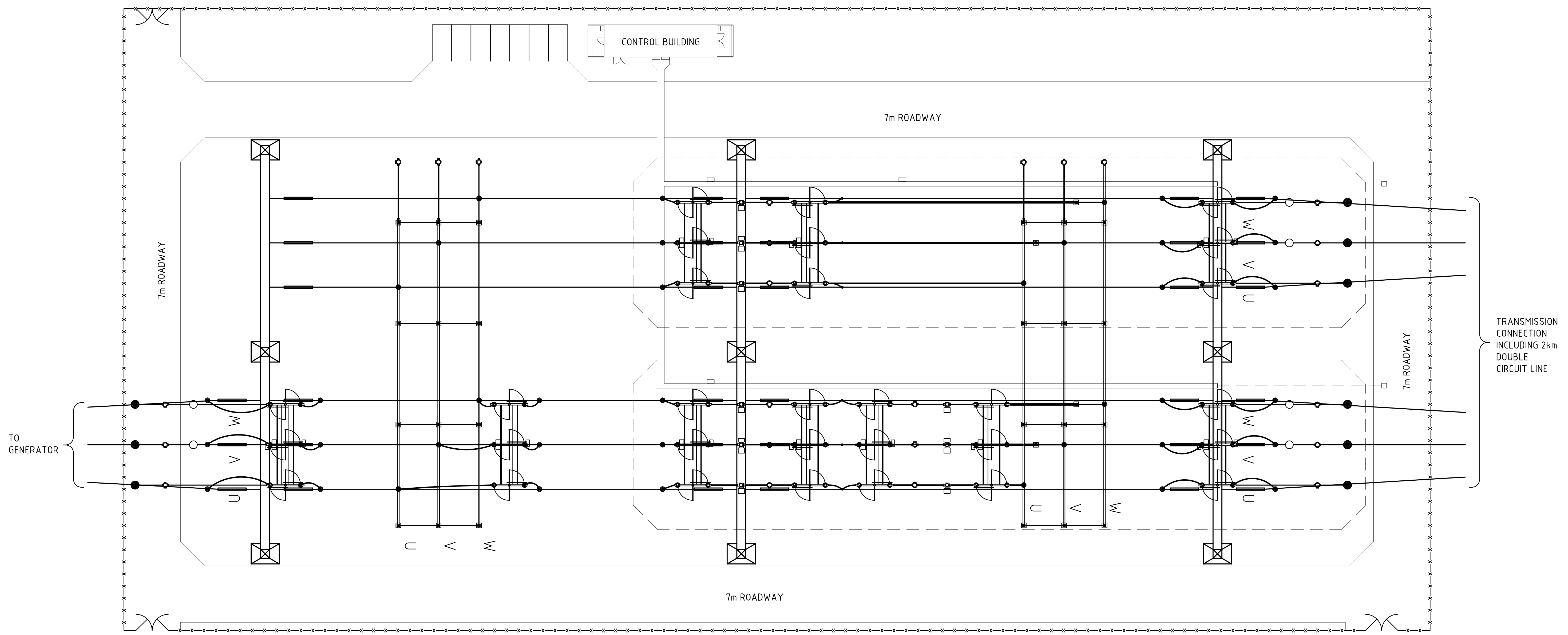
SWITCHYARD ASSET		
Primary Plant Procurement	1 Lot	$ 2,463,124
Secondary and Support structure	1 Lot	$ 1,023,402
Establishment Cost (Buildings, Civil, Infrastructure)	1 Lot	$ 1,497,503
Total Switchyard Cost		**$ 4,984,029**
TRANSMISSION ASSET		
330kV, Double Circuit, ACSR, 2 × Mango, 746 sqmm, Steel tower, combined cost (50% flat - 50% undulating land, 50% rural - 50% urban, one road crossing per km)	2 km	$ 603,870
Short line adjustment factor (100%)		$ 603,870
Total Transmission Line Cost		**$ 1,207,739**
CONNECTION POINT		
275kV Steel tension tower with average foundation, Double Circuit, each	1	$ 100,000
Total New tension Tower Cost		**$ 100,000**
Sub-Total		**$ 6,291,768**
EPCM @ 15%		$ 943,765
Western Australia Factor		$ 283,130
Total Cost		**$ 7,518,663**

Appendix D Connection Option 2 Capital Costs

SWITCHYARD ASSET		
Primary Plant Procurement	1 Lot	$ 2,531,891
Secondary System and Support Structure	1 Lot	$ 1,180,884
Establishment Cost (Buildings, Civils, Infrastructure)	1 Lot	$ 1,843,379
Total Switchyard Cost		**$ 5,556,154**
TRANSMISSION ASSET		
330kV, Double Circuit, ACSR, 2 × Mango, 746 sqmm, Steel tower, combined cost (50% flat - 50% undulating land, 50% rural - 50% urban, one road crossing per km)	2km	$ 856,215
Short line adjustment factor (100%)		$ 856,215
Total Transmission Line Cost		**$ 1,712,431**
CONNECTION POINT		
275kV Steel tension tower with average foundation, Double Circuit, each	1	$ 100,000
Total New tension Tower Cost		**$ 100,000**
Sub-Total		**$ 7,368,584**
EPCM @ 15%		$ 1,105,288
Western Australia Factor		$ 331,586
Total Cost		**$ 8,805,458**

Appendix E Drawings

HA010137-E-001	3 breaker mesh in breaker & half configuration general arrangement
HA010137-E-002	3 breaker mesh in breaker & half configuration single line diagram
HA010137-E-003	3 breaker mesh configuration general arrangement
HA010137-E-004	3 breaker mesh configuration single line diagram



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TC	PC	PRA	
DESIGNED RD	DESIGN REVIEW PRA		

TITLE
3 BREAKER MESH IN BREAKER & HALF CONFIGURATION GENERAL ARRANGEMENT

SCALE	PROJECT No	DRAWING No	AMDT
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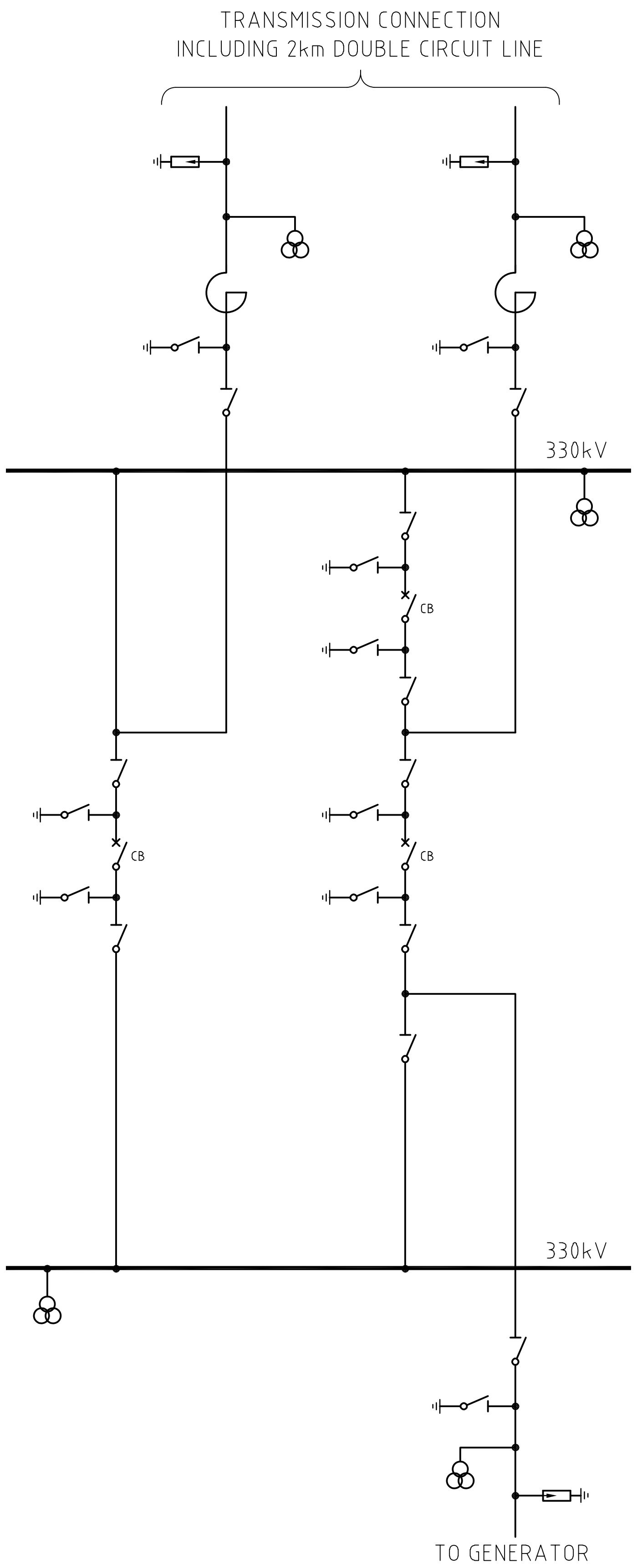

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DESIGNED RD	DESIGN REVIEW RPA		

TITLE 3 BREAKER MESH IN BREAKER AND HALF CONFIGURATION SINGLE LINE DIAGRAM

SCALE	PROJECT No	DRAWING No	AMDT
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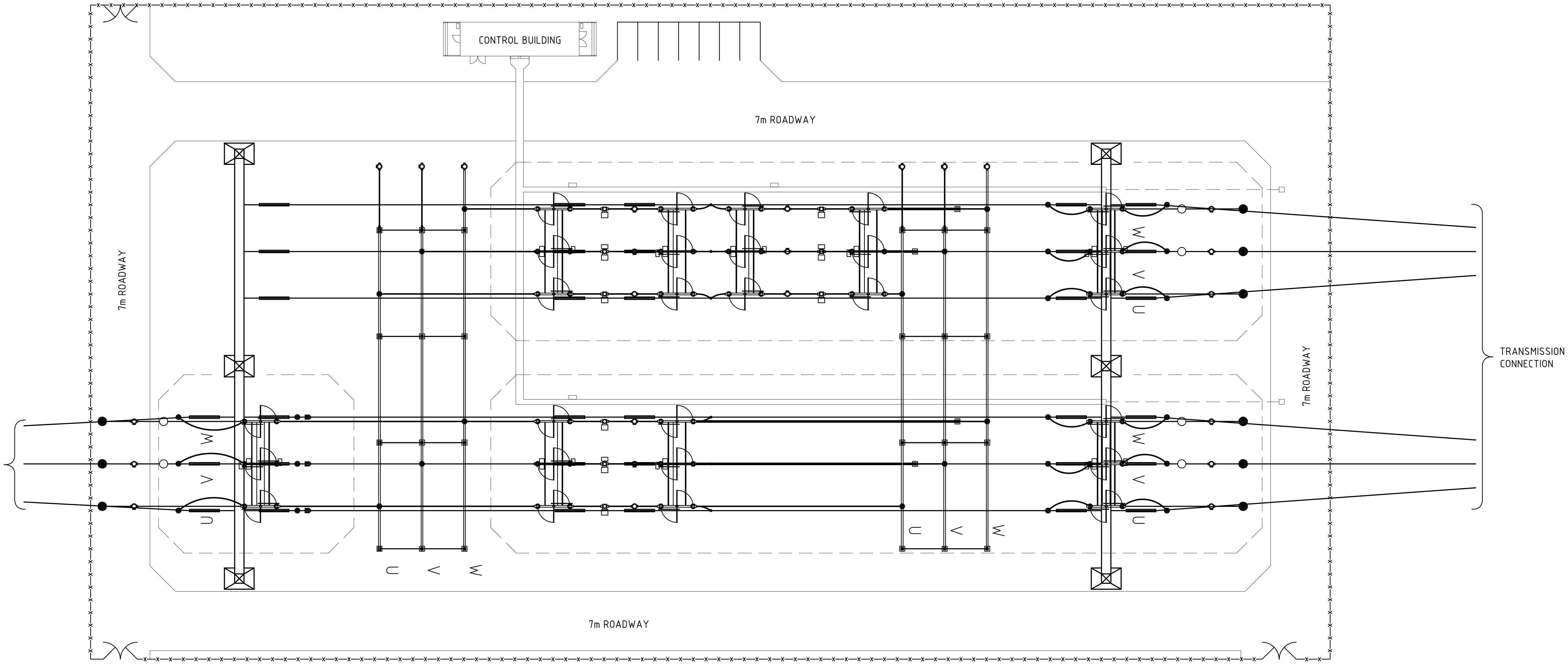

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TITLE
3 BREAKER MESH CONFIGURATION GENERAL ARRANGEMENT

SCALE	PROJECT No	DRAWING No	AMDT
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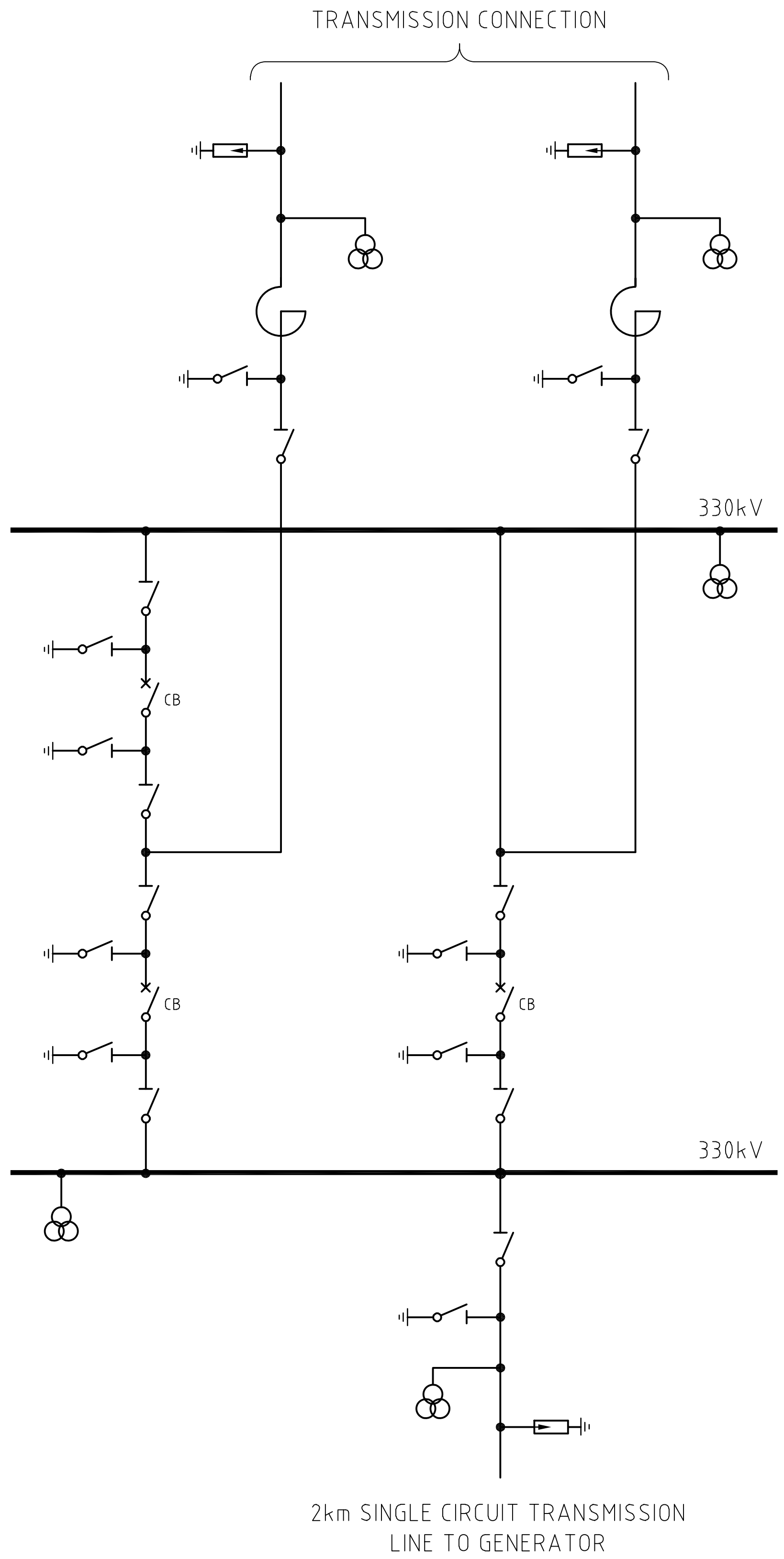

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TITLE 3 BREAKER MESH CONFIGURATION SINGLE LINE DIAGRAM

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Appendix F Comparison of Options

Options	Factors							
	Switchyard	**Switchyard Location**	**Support Structure**	**Land/Space requirements**	**Transmission Line**	**Capital Cost**	**O&M Costs**	**Advantages and disadvantages**
Option 1:	3 breaker mesh arrangement configuration. with a 50 year life.	Located under the existing transmission line	6 switch bay towers and 4 beams are required	Approx. 50m × 80m	2km long 330kV single circuit overhead with steel tower construction and 2 × Mango ACSR conductor with a 60 year life	Switchyard: $4,984,029 Transmission Line: $1,207,739 New Tension Towers: $100,000 ___________ $7,518,663 with EPCM	Switchyard: $100,402 annual average for life of the asset Transmission Line: $5,029 annual average for life of the asset	Advantages: Cheaper initial capital outlay with lower O&M costs Disadvantages: Restriction on future development
Option 2:	3 breaker mesh in breaker and half configuration. with a. 50 year life	Located near the generator site	9 switch bay towers and 6 beams are required	Approx. 50m × 120m	2km long 330kV double circuit overhead with steel tower construction and 2 × Mango ACSR conductor with a 60 year life	Switchyard: $5,556,154 Transmission Line: $1,712,431 New Tension Towers: $100,000 ___________ $8,805,458 with EPCM	Switchyard: $111,927 annual average for life of the asset Transmission Line: $7,131 annual average for life of the asset	Advantages: Flexible for future development Disadvantages: Marginally higher capital outlay and subsequently higher O&M costs

- **Table 6-2 Comparison between option 1 and option 2**