Transmission Asset Cost Benchmarking

REPORT SUMMARISING SKM BENCHMARKING OF SELECTED ASSET COST ESTIMATES TO ASSIST IN VERIFYING COST MODELS

- V0.4

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1 Introduction

Western Power is required to obtain independent verification that the estimated values used for transmission capital works is in line with national averages as part of the exercise of developing estimated costs for its Regulatory Access Arrangement for the 09/10 – 13/14 period.

Western Power has requested a written report that compares its estimated costs with industry averages within Australia.

This was not an exercise to determine whether the process used was rigorous but rather was a benchmarking exercise on the final costs produced for a few of the most common types of capital construction activities. These activities included the design, construction and commissioning of a selection of zone and terminal substations and transmission lines of different voltages.

SKM's understanding of requirements for this project is based on the Western Power correspondence referenced ***"Benchmarking Exercise for Western Power Transmission Facilities"***, dated 12 May 2008 and is subject to SKM's proposal document dated 14 May 2008.

Following issue of the first report in May 2008 (V0.3a), Western Power identified a number of issues and a revised set of estimates was submitted. SKM reviewed the estimates and revised the report.

2 Background

Benchmarking of cost estimates between states is problematic in the current period of growth in construction activity. Rawlinsons ‘Australian Construction Handbook – 2008” comments in relation to Perth that “*The continued high level of activity in commercial and residential sectors continues to place demands over sub-contract resources; these prices continue to rise, although at a slower rate. There appears to be no shortage of public and government building projects which is fuelling the uncompetitive and erratic tender market*..”

In Perth and in other major cities, the building price index has grown faster than the consumer price index (CPI). In addition, due to the size of the state, Western Australia has a larger regional cost variation than many eastern states[1]. Within the Western Power transmission network the regional variations for building costs are: Geraldton 1.1, Kalgoorlie 1.35 and Albany 1.15 compared to Perth 1.0 (Refer Rawlinsons 2008).

The challenge for all utilities including Western Power is to develop rigorous estimating processes that allow forward financial planning to balance shareholder business objectives with the need to provide network infrastructure to meet load demands.

SKM was engaged to provide an independent assessment and comparison of a number of selected cost estimates derived from Western Power estimating systems to provide benchmarking with similar utilities in other Australian states.

It should be noted that the benchmark cost review included only the output of the estimating process and the underlying assumptions and the processes and methodologies employed were outside of the scope of the review.

Following completion of the benchmark study, Western Power reviewed estimates and identified a number of reasons for differences between the estimates and the SKM benchmarks. The Western Power estimates for Items 4, 5, 7 and 8 were revised.

Benchmarking of the estimates from a selection of representative asset types has enabled Western Power to improve the accuracy and effectiveness of the capital estimating system, effectively “calibrating” the processes used to generate cost estimates. This will assist Western Power to manage its regulatory, commercial and customer obligations to Western Australian stakeholders, customers and shareholders.

[1] Rawlinsons 2008 – P30

3 Scope of Works

3.1 Substations

Comparisons have been made with the following substation items:

1. Zone substation 132/22 kV stage 1: 1 transformer, two line and 1 indoor switch board
2. Additional transformer into a zone substation
3. Additional line into a zone substation
4. 132 kV terminal yard: 1 full “1 ½ bay” consisting of 3 circuit breakers
5. 330 kV terminal yard: 1 full “1 ½” bay consisting of 3 circuit breakers

Specifications for each item are listed in the attached appendices.

3.2 Transmission Lines

Comparisons have been made for the following line designs:

6. 132 kV wood pole line, 20 km length
7. 132 kV single circuit steel pole line, 100 km length
8. 132 kV double circuit steel pole line, 100 km length
9. 330 kV double circuit tower line, 100 km length

Note that Item 6 is a wood pole line with 200 metre spans in an urban application using a single “Venus” conductor. This is considered to be impractical and may be not be a feasible design. Span lengths of 100 metres may be possible under some circumstances. Comparisons have been made with nearest possible equivalent.

3.3 Industry Comparisons and Benchmarking

Cost benchmarking was carried out to compare estimates for projects carried out in Queensland, South Australia, New South Wales, Victoria and Tasmania and adjusted where necessary to allow for regional and other variations to provide an accurate comparison for Western Australia estimates.

Where comparable prices were not available, bottom up estimating techniques were used to determine a comparable project price.

In some cases benchmark estimates are an amalgam of separate projects adjusted to provide a valid comparison of Western Power costs.

4 Analysis

The following table provides a summary of estimate comparisons undertaken by SKM for Substations and Lines:

Category	*Item*	*WP Estimate 1*	*WP Estimate (Revised[2])*	*SKM Estimate*	*Revised Variation (%)[3]*	
Substation	1. Zone substation 132/22 kV stage 1: 1 transformer, 2 lines and 1 indoor switch board	$6,500,000	-[4]	$7,100,000	-8 %	✓
	2. Additional transformer into a zone substation	$3,300,000	-	$3,660,000	-10 %	✓
	3. Additional line into a zone substation	$950,000	-	$920,000	+3 %	✓
	4. 132 kV terminal yard: 1 full 1 ½ bay consisting of 3 CBs	$5,106,000	$4,579,000[5]	$5,270,000	-13 %	✓
	5. 330 kV terminal yard: 1 full 1 ½ bay consisting of 3 CBs	$10,127,000	$8,922,000	$7,910,000	+13 %	✓

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[2] WP Estimates were revised following submission of the first SKM report indicating variations with benchmark amounts

[3] Estimates ≤20% are considered to be a reasonable comparison indicated by a tick (✓). Estimates >20% are marked with cross (✗)and require further analysis to determine reason for disparity

[4] - indicates that estimates were not revised for this item.

[5] In items 4 and 5 an error in the original estimate was identified. This was corrected for the revised estimate.

Category	*Item*	*WP Estimate 1*	*WP Estimate (Revised)*	*SKM Estimate*	*Variation Revised (%)*[6]	
Lines	6. 132 kV wood pole line, 20 km length[7]	$340,000	-	$281,000	-7 %	✓
	7. 132 kV single circuit steel pole line, 100 km length	$640,000	$569,000	$410,000	+39%	✗
	8. 132 kV double circuit steel pole line, 100 km length	$890,000	$716,000	$643,000	+11%	✓
	9. 330 kV double circuit tower line, 100 km length	$900,000	-	$914,000	-2 %	✓

[6] Estimates ≤20% are considered to be a reasonable comparison indicated by a tick (✓). Estimates >20% are marked with cross (✗)and require further analysis to determine reason for disparity

[7] This line span is considered to be not feasible for this pole type in an urban location. Line costs are per km.

SKM

5 Conclusions

The cost estimates for a number of Western Power infrastructure projects were compared to the costs of similar projects in other Australian utilities. After analysis and a subsequent review of Western Power cost estimates, the following conclusions can be drawn:

- After review of items 4 and 5, the cost estimates for Western Power substations are closely aligned with those in other states.
- Line construction costs show a higher degree of variability to the SKM benchmark than substation costs.
- There is a general industry trend away from wooden poles lines due to availability and cost of suitable timber species particularly for long lengths.
- The design specification for the wooden pole line (Item 6) may be unfeasible due to the required span length of 200 metres.
- Western Power adopted a “worst case” assumption for soil conditions for the purpose of budget estimating. This is a valid approach given the characteristics of soils in the region. A review of benchmark cost estimates shows that pole based line designs as opposed to lattice tower designs are more impacted by soil types and cost estimates demonstrate a higher degree of variability to soil types for pole designs.
- Different assumptions in relation to soil type will markedly affect benchmark estimates. Item 7 is estimated at $410,000. Different assumptions with regard to these factors could result in a benchmark estimate up to $600,000 per km or close to the Western Power estimate. The benchmark study was based on a range of project estimates and a range of soil types along a line route.
- The benchmark study indicated that the costs of double circuit vs single circuit lines was consistently close to 1.5. In Western Power estimates the ratio is 1.25. It is assumed this is due to the assumption of worst case soils and the proportion of footing costs to total line cost estimates.

6 Clarifications, Assumptions & Exclusions

6.1 Clarifications & Assumptions

6.1.1 General

ALL budget estimates are exclusive of the following items:

- Goods & Service Tax (GST);
- Foreign Exchange (FOREX) variations;
- Insurances;
- Customs duties;
- Consumables;
- Unidentified or latent site conditions;
- Labour or industrial relations disputes;
- Land acquisition , purchase costs and Right of Way (where applicable);
- Any approvals / permits / licences whatsoever (environmental or otherwise)
- Force Majeure;
- Costs associated with Environmental Impact(s);
- Legal and Financing costs;
- Interest and other owner's cost (owner's staff and other internal costs)

The benchmark estimate is calculated based on SKM's generalised knowledge and experience gained in similar projects that SKM has been involved with.

SKM cannot place an informed level of accuracy on the benchmark estimates. In SKM's recent experience, accurate estimates are difficult to achieve as many unknown factors can influence the project outcome. Some of the unknown factors include but are not limited to the following:

- availability of contractors and market conditions at the time of tendering
- performance of contractors
- volatility in manufacturer cost
- volatility in international metal prices
- special foundation requirements
- adverse soil conditions
- environmental considerations
- heritage issues

(Note: These factors have not been allowed for in the cost benchmarks as it is impossible to predict at this stage).

SKM has prepared these benchmark estimates on behalf of and for the exclusive use of Western Power.

SKM has used reasonable endeavours and its general industry knowledge to provide the benchmark estimates for this project.

However, SKM accepts no liability to Western Power or any third party arising from or in connection with the use of or reliance on these desktop budget estimates and does not guarantee the accuracy of these estimates.

A formal tendering process will be necessary in order to obtain more accurate estimates.

The estimates provided by SKM are based on past projects subject to confidentiality agreements with other clients. Specific client confidential information cannot be either published or released to Western Power.

All prices in this desktop budget estimate are based on Australian dollars ($ AUD) as at May 2008 and do not include any escalation.

Release of this benchmark estimate is conditional upon Western Power's acceptance of the limitations and qualifications set out in these Assumptions.

Where applicable, Rawlinsons "Australian Construction Handbook - 2008" has been used to determine state adjustment factors.

6.1.2 Substations

- Civil costs are based on flat site with no unusual rock or reactive soils to establish surface bench
- Fencing is standard security rating, chain metal wire, 3.6M high
- VESDA fire detection and 2 hour fire ratings assumed for buildings

6.1.3 Transmission Lines

- Actual conductor size has been matched where available. Near equivalent when no direct comparison.
- Minimal cost for earthing assumed based on good soil resistivity
- Line costs assume suitable soil types with minimal allowance for additional works for sandy or reactive soils.
- Item 6 specifies 200M span lengths which may not be practical as a design option for the pole type specified using "Venus" conductor.

- A number of assumptions have been made in relation to item 7 and 8 in relation to tension poles and guys, foundation types (direct buried in sand or concrete fill). Different assumptions on soil types markedly affect the total line cost estimate.

6.2 Exclusions

The scope of this project excludes commentary or analysis of the processes used to develop cost estimates. Prices are for 2008 and do not include escalation or any account for regional cost variations within Western Australia.

Appendix A Item Specification

Substation Item Specification

1. A new zone substation consists of :
   - 1 x 132/22 kV, 20/27/33 MVA transformer,
   - H configuration HV busbar, with two HV line circuits in and one HV transformer circuit
   - Bus bar is 100 OD aluminium tube
   - 1 x indoor 22 kV, 25 kA switchboard consisting of 6 by 22 kV feeders, 1 transformer circuit, 1 feeder for station transformer and 1 bus section breaker.
   - Switchboard is enclosed by transportable building on stilts
   - Control room is in transportable building on stilts
   - Overhead line entry onto gantries
   - 2 x 5 MVAr 22 kV cap banks
   - AC supply (station tx,160 kVA)
   - DC supply (2 x 110VDC 45 AH, 1 x 50VDC 45 AH)
   - SCADA connected through OPGW back to Central Control
   - Primary plant is 40 kA fault rated

2. An existing zone substation where an additional transformer and LV switchboard is added consisting of :
   - One HV transformer circuit
   - 1 x 132/22 kV, 20/27/33 MVA transformer,
   - 1 x indoor switchboard consisting of 6 by 22 kV feeders, 1 transformer circuit, 1 cfs unit (for station transformer) and 1 bus section.
   - Switchboard is housed in transportable building on stilts
   - 2 x 5 MVAr 22 kV cap banks
   - SCADA connected through OPGW back to Central Control
   - Primary plant is 40 kA fault rated

3. An existing zone substation where an additional HV line circuit is added consisting of:
   - One 132 kV Line circuit (1 x CB, 1 x DES, 1 x DIS, 3 x CT, 3 x VT, 3 x SA, 18 x SPI)
   - Overhead line entry onto gantries
   - SCADA connected through OPGW back to Central Control
   - Primary plant is 40 kA fault rated

4. A new 132 kV terminal switching yard consisting of one full 1 ½ bay with 3 circuit breakers:
   - 1.5CB yard full bay (2 line circuits 3 x CB, 9 x CT, 2 x DES, 6 x DIS, 6 x VT, 6 x SA, 72 x SPI not including busbar.

- busbars - SPIs required for bus support, 160 OD alum tube
- AC supply (station transformer, 315 kVA)
- DC supply (2 x 110VDC 215 AH, 1 x 50VDC 215 AH)
- SCADA connected through OPGW back to Central Control
- Primary plant is 50 kA fault rated
- Control room is brick building to cater for 6 full bays (see drawing attached)
- Overhead line entry onto gantries

5. A new 330 kV terminal switching yard consisting of one full 1 ½ bay with 3 circuit breakers:
   - 1.5CB yard full bay (2 line circuits 3 x CB, 9 x CT, 8 x DES, 12 x VT, 6 x SA, 72 x SPI not including busbar.
   - busbars - SPIs required for bus support, 160 OD alum tube
   - AC supply (station transformer, 315 kVA)
   - DC supply (2 x 110VDC 215 AH, 1 x 50VDC 215 AH)
   - SCADA connected through OPGW back to Central Control
   - Primary plant is 50 kA fault rated
   - Control room is brick building to cater for 4 full bays (see drawing attached)
   - Overhead line entry onto gantries

Transmission Lines

6. A new 132 kV wood pole line consisting of :
   - Total length of 20 km
   - Span length of 200 m, urban
   - Single "Venus" conductor per phase
   - OHEW on top of pole as earth wire, 7/2.75SC/GZ
   - "Fir tree" electrical configuration
   - Earth electrode at each pole
   - All suspension poles

7. A new 132 kV steel pole single circuit line consisting of the following
   - Total length of 100 km
   - Span length of 350 m, country
   - Single "Phosphorus" conductor per phase
   - OPEW on top of pole is "Krypton"
   - Proportion of strain to suspension = 20/80%

8. A new 132 kV steel pole double circuit line consisting of the following
   - Total length of 100 km
   - Span length of 350 m, country

- Single “Golf” conductor per phase
- Twin OHEW , 7/4.25 SC/AC on top of pole as earth wire
- Proportion of strain to suspension = 20/80%

9. A new 330 kV steel tower double circuit line consisting of the following
   - Total length of 100 km
   - Span length of 400 m, country
   - Double Lacrosse conductor per phase
   - Twin OPGW on top of pole as earth wire