Geoff Brown & Associates Ltd

NEW FACILITIES INVESTMENT TEST
MID WEST ENERGY PROJECT

Technical Review

Prepared for

ECONOMIC REGULATION AUTHORITY

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SECTIONS

EXECUTIVE SUMMARY

Estimated Costs

- The base project costs in Western Power's NFIT pre-approval application are planning phase cost estimates prepared by Western Power's cost estimation section. These costs are considered accurate to within +/-10%. To these base cost estimates, Western Power has added a risk component, determined using Monte Carlo analysis, so that the probability of the delivered cost being lower than the estimate is 80%. We consider the cost estimates are reasonable and that Western Power's "P80" cost estimate is a reasonable basis for determining the NFIT amount, noting that it should be the actual cost, rather than the NFIT amount, that is added to the regulatory asset base (RAB).

- The cost estimates have been prepared in July 2010 Australian dollars. The pre-approval application has not included any proposal as to how any NFIT amount based on these estimates should be adjusted for inflation and for foreign exchange and commodity price movements, although it notes that these adjustments will be made before a business case seeking formal approval to proceed with the project is submitted to the Western Power Board. Western Power considers that, in general, the estimates are still valid, because cost escalations have largely been offset by savings due to the rise in the Australian dollar.

- Western Power's proposed NFIT amount includes $21.3 million for project development costs incurred to date. We suspect that some of these costs do not meet the requirements of Part (a) of the NFIT, although we are unable to quantify this without further information from Western Power.

Temporary Mine Supply

- The project, which is known as the Mid West Energy Project (MWEP) (southern section), still has to be approved by Western Power's Board. However, the 330 kV line section between the Eneabba 132 kV substation (ENB) and the Three Springs terminal station (TST), as well as TST itself, are currently under construction in order to provide a temporary 95 MW supply to the Karara Mining Ltd's (KML's) magnetite mine in time for production to commence during the first half of 2012.

- The ENB-TST line is being constructed by KML, who will retain ownership of the line until it is transferred to Western Power. Upon initial commissioning, both circuits of the line will be operated at 132 kV until the remainder of the MWEP is completed. Over this time the line will be used by Western Power to provide a 132 kV supply to the existing 132 kV substation at Three Springs and by KML to provide the temporary mine supply.

- As we understand it, TST is being constructed by Western Power, although it has negotiated a sole source contract with KML to construct the electrical works. While the asset is needed to provide a temporary supply to the mine, it is not required by Western Power until the remainder of the MWEP is complete and a 330 kV supply is available. The status and ownership of this asset from the time of commissioning until the completion of the MWEP is therefore unclear but we suggest that it be treated as a KML connection asset as it is of no value to Western Power until the reminder of the MWEP is completed. Hence the asset will not meet NFIT requirements and should not be included in the RAB until the rest of the MWEP is commissioned.

Pinjar-Eneabba Line and Associated Substation Works

This component of the project will be constructed and commissioned by Western Power using its standard procedures for the management of capital works. Construction works have still to commence and will not proceed until Board and Ministerial approvals have been received. Commissioning is necessary before the ENB-TST circuit presently under construction can be energised at 330 kV. Western Power's proposed NFIT amount is $[redacted] million, including a risk provision of $[redacted] million. It thus represents [redacted]% of Western Power's proposed total NFIT amount.

Design

We consider the design to be reasonable and consistent with good industry practice. However we note that Western Power has designed the line for a maximum conductor temperature of 85^{0}C, rather than the 75^{0}C maximum conductor temperature used elsewhere on its 330 kV network, in order to increase the thermal power transfer capacity of each 330 kV circuit from 1,000 MVA to 1,200 MVA. This has required the use of taller towers to increase ground clearance at an additional cost of $500,000. While this additional cost is relatively modest, we do not consider the additional capacity provided is needed, even under a high load growth scenario.

We also note that Western Power appears to have taken a conservative approach to risk management and has included provision in the design to mitigate risks that we think many service providers seeking to minimise costs would consider tolerable. In particular, Western Power has provided for the undergrounding of a section of the double circuit 132 kV Pinjar-Cataby line where it passes under the new 330 kV circuit, at an estimated cost of $[redacted] million, in order to avoid a double circuit outage in the event of a conductor failure at that particular location. We think this risk is very small and could potentially be mitigated by implementing an enhanced maintenance regime for the span concerned. While it was also necessary to address a clearance issue at this location, this could have been addressed at a much lower cost by diverting the existing line on to shorter towers.

Delivery

Western Power's delivery plan for this part of the project is based largely on competitive tendering. However in-house resources will be used for work on secondary systems and for commissioning. This should lead to efficient cost outcomes.

NFIT Amount

We consider the cost estimate in the pre-approval application of $[redacted] million represents a reasonable NFIT amount. Adjustments would need to be made for any design changes the Authority considered appropriate. The value of the asset actually included in the RAB should be the actual cost of the asset, provided it did not exceed the NFIT amount.

Three Springs Terminal Station

Design

We consider the design of TST reasonable except that, in our view, a 250 MVA transformer is all that is required. Installation of a smaller transformer would reduce the estimated cost by $1.07 million.

Delivery

Western Power's delivery plan is based on competitive tendering for the civil works and a sole source contract to KML for the electrical works. The cost to Western Power will be the actual costs incurred by KML to deliver its contracted works and appropriate procedures are in place to ensure that this does not exceed a reasonable market cost. We are therefore satisfied that Western Power's delivery plan will lead to an efficient cost outcome.

NFIT Amount

- The cost of TST should only be included in Western Power's RAB on completion of the MWEP, scheduled for March 2014, as KML is the only customer to benefit from the use of the asset before that time;

- Western Power's estimated asset cost of $[redacted] million, including interest during construction (IDC), is a reasonable basis for determining the NFIT amount. This would need to be adjusted should the Authority decide that a 250 MVA transformer should be provided for. However the actual amount to be included in the RAB should be based on the actual cost of the asset provided that it did not exceed the NFIT amount.

- IDC should be included in the NFIT amount as there is no opportunity for either Western Power or KML to earn a return on the capital costs incurred prior to commissioning.

- The value of the asset that should be included in the RAB should be the actual cost of the asset, including IDC, less accumulated depreciation to the time of transfer. We estimate the accumulated depreciation to be approximately $[redacted] million, calculated on a straight line basis.

Eneabba Terminal Station – Three Springs Terminal Station Line

This is being constructed by KML and is to be purchased by Western Power for inclusion in the MWEP at the Authority's approved NFIT amount.

- Western Power's proposed NFIT amount of $[redacted] million is based on its P80 cost estimate for the construction cost of the line. This is a budget price, which we think is likely to be higher than KML's actual construction cost.

- Had construction been delayed to coincide with the construction of the PNJ-ENB line, the cost would have reduced by an estimated $5.00 million because the line would have been built to an optimised design.

- The Authority could consider reducing Western Power's proposed NFIT amount by $5.00 million to allow for the optimised design but permitting the value at which the asset is included in Western Power's RAB to be based on the P80 cost estimate rather than KML's actual construction cost. In our view this pragmatic approach would produce a reasonable outcome for both Western Power and KML.

- IDC should be included in the NFIT amount as there is no opportunity for either Western Power or KML to earn a return on the capital costs incurred prior to commissioning.

- We see no basis for the asset being included in Western Power's RAB prior to the commissioning of the remainder of the MWEP.

- Accumulated depreciation should be deduced from the as-new NFIT amount to determine the value at which the asset is included in Western Power's RAB. Assuming an expected economic life of 40 years (for transmission lines), this would amount to $[redacted] million, based on the full NFIT amount proposed by Western Power, straight line depreciation and a two year delay.

Eneabba Substation – Eneabba Terminal Station Line Section

- Western Power has proposed that the approved NFIT amount be based on its estimated P80 cost to construct the line, based on an optimised design. This cost estimate ($[redacted] million) seems a reasonable, albeit pragmatic, NFIT amount for this relatively short line section.

- IDC on the full cost of the asset should be included in the NFIT amount. There is no opportunity for either KML or Western Power to earn a return on the capital expenditure incurred prior to commissioning.

- We see no reason for the cost of this asset to be included in Western Power's RAB prior to the commissioning of the PNJ-ENB line. Accumulated depreciation should be deduced from the as-new NFIT amount to determine the value at which the asset is included in Western Power's RAB. Assuming an expected economic life of 40 years (for transmission lines), this would amount to $[redacted] million, based on the NFIT amount proposed by Western Power, straight line depreciation and a two year delay.

1. INTRODUCTION

Western Power is planning to construct a new double circuit 330 kV transmission line between Pinjar and Three Springs in the Mid West region of Western Australia.

The purpose of the new line is threefold:

- It will allow new mining loads in the Mid West region to connect to the South West Interconnected System (SWIS) and take an electricity supply from the transmission grid. The initial load is expected to be a magnetite mine being developed at Karara, approximately 100 km east of Three Springs by Karara Mining Ltd (KML). Development of this mine has already commenced and it is planned to be producing approximately 10 million tonnes per annum (mtpa) with the first shipment being targeted for June 2012. A second potential customer is Asia Iron's Extension Hill magnetite project, which has received most of the required approvals. Asia Iron is currently seeking debt financing in order for the project to proceed. It is planned that this project will also take a power supply from the SWIS through a dedicated 330 kV connection at Three Springs.

- It will allow new power stations in the Mid West region to connect to the SWIS and participate fully in the Wholesale Electricity Market (WEM). Western Power has current applications from in excess of 1,400 MW of new generation in the Mid West region that it is unable to connect because of a lack of transmission capacity. According to the information supplied with the pre-approval application, apart from the 170 MW Eneabba Gas plant, these applications are for wind generation, driven by the fact that the wind resource available in the Mid-West is higher than other regions of the SWIS and amongst the highest in Australia. However, more recently, ERM Power has announced plans for a 330 MW open cycle gas turbine power station at Three Springs.

- It will increase the available power delivery capacity into Geraldton and surrounding areas. The load in this area is already reaching the capacity of the existing 132 kV network, even without the new mining loads. Some relatively low cost strategic upgrades have been identified, which would delay the need for additional transmission capacity until around 2015/16 assuming continuation of current incremental growth rates. A requirement to connect new block loads would bring this date forward.

In accordance with Chapter 9 of the Electricity Networks Access Code (Code), Western Power was required to submit the project to the Authority for Regulatory Test approval before it could commit to the expenditure. This was done in November 2010 and the Authority issued a final determination approving the project in February 2011.

However, notwithstanding this Regulatory Test approval, Western Power will not be able to include the project in its Regulatory Asset Base (RAB) unless it meets the requirements of the New Facilities Investment Test (NFIT) as set out in Clause 6.52 of the Code. On 2 August 2011, Western Power submitted the project for NFIT pre-approval, in accordance with clause 6.71(b) of the Code and the Authority has engaged Geoff Brown and Associates Ltd to review the technical merits of this application and Western Power's estimated costs. This report documents the findings of this review.

2. BACKGROUND

2.1 NEW FACILITIES INVESTMENT TEST REQUIREMENTS

The NFIT requirements are set out in clause 6.52 of the Code, which states that a new facilities investment satisfies the new facilities investment test if:

(a) the new facilities investment does not exceed the amount that would be invested by a service provider efficiently minimising costs having regard, without limitation, to:

(i) whether the new facility exhibits economies of scale or scope and the increments in which capacity can be added; and

(ii) whether the lowest sustainable cost of providing the covered services forecast to be sold over a reasonable period may require the installation of a new facility with capacity sufficient to meet the forecast sales;

and:

(b) one or more of the following conditions is satisfied:

(i) the anticipated incremental revenue for the new facility is expected to at least recover the new facilities investment; or

(ii) the new facility provides a net benefit in the covered network over a reasonable period of time that justifies the approval of higher reference tariffs; or

(iii) the new facility is necessary to maintain the safety or reliability of the covered network or its ability to provide contracted covered services.

This review assesses the extent to which the project meets the requirements of part (a) of the test. More specifically, it considers whether:

- the capacity of the proposed grid augmentation is reasonable, given the forecast growth in demand;
- the design of the project is consistent with good industry practice and not gold plated;
- project delivery is planned in a way that is consistent with good industry practice and that will reasonably minimize the overall cost of the project; and
- Western Power’s estimated total project cost is reasonable.

2.2 HISTORY OF THE MID WEST ENERGY PROJECT

Geraldton, a city with a population of about 37,000 and located approximately 420 km north of Perth is the administrative and commercial centre of the Mid West region. The region between Perth and Geraldton is currently served by a 132 kV system, which has limited spare capacity after supplying the existing peak demand in the region and which cannot accommodate the connection of new generation.

The augmentation project was originally conceived as a 400 km, 330 kV transmission line between Pinjar and Geraldton, following a westerly alignment with a line route running just east of Eneabba. The line would terminate at a new 330/132 kV terminal station at Moonyoonooka, approximately 13 km east of Geraldton. While Western Power has purchased a site for a new 330/132 kV terminal station at Eneabba, there was no plan to construct this as part of the initial project. This project received Regulatory Test and NFIT approval in 2007.

The project as formulated for the original Regulatory Test and NFIT application did not proceed after it became apparent that the original cost estimate that was used by Western Power as the basis for its regulatory applications was grossly inadequate. The Government subsequently required that the project formulation be reviewed on the basis of updated information and using more realistic costs.

With the potential development of the Karara and Extension Hill mines, it is now clear that the centre of electricity demand in the Mid West region is likely to be Three Springs rather than Geraldton, as assumed for the original project. The project has now been reformulated to reflect revised assumptions on the location of the electrical load.

2.3 PROJECT DESCRIPTION

It is now proposed that the MWEP will be constructed in two stages. Western Power's NFIT pre-approval application covers only the first or southern stage, which includes a 330 kV double circuit line between Pinjar, north of Perth and Three Springs in the Mid West and the construction of a 330/132 kV substation at Three Springs. Initially only one circuit of the new line will be operated at 330 kV; the second circuit will be operated at 132 kV until the load increases to a level where a second 330 kV circuit is needed. The project also includes miscellaneous substation works to interface the new line to the existing grid as well as relatively minor upgrades to secondary systems north of Three Springs.

In this report the project is divided into four components, each of which is considered individually. These are:

- A new 330 kV double circuit line between Pinjar and the existing Eneabba 132 kV substation. This component also includes (i) the modifications to existing substations in order to interface this line to the existing grid, (ii) the installation of a new 330 kV reactor at the Three Springs terminal station[1] and (iii) the modifications to secondary systems in substations north of Three Springs. Construction of this component has not commenced.

- A new 330/132 kV terminal station at Three Springs (TST). As this is required to provide a temporary supply to the Karara mine, construction is already underway, with commissioning planned for early 2012.

- A double circuit 330 kV line between the site of the future Eneabba terminal Station (ENT) and TST. This is required for the temporary mine supply and is currently being constructed by KML. It will be commissioned in early 2012.

- A short section of 330 kV line between the existing Eneabba 132 kV substation (ENB) and the ENT site. It is treated separately in this report as it is the subject of a separate arrangement between ENT and TST. As a result there are some differences from the treatment of the ENT-TST line section, which may be relevant to determining the NFIT amount.

The temporary mine supply will be provided by supplying the new line between ENB and TST from ENB at 132 kV. This will then be stepped up 330 kV by feeding the power "backwards" through the TST 330/132 kV transformer and then fed to the mine through KML's private 330 kV transmission line to the mine site. KML requires this supply to be available in early 2012 in order to meet its target date of June 2012 for delivery of its first iron ore shipment.

[1] While this reactor is located at the new Three Springs terminal station, it is included in this component as it is required only for the operation of the new 330 kV circuit at its rated voltage. It will also be constructed as part of the transmission line rather than the substation.

3. PLANNING AND DESIGN

3.1 TRANSMISSION LINE DESIGN

3.1.1 Engineering Considerations

Reactive Power Compensation

The power transfer capability of a high voltage transmission line is limited by the need to manage its reactive power characteristics. An energised but unloaded transmission line generates reactive power (MVAr) while the real or useful power flowing through the line (which is measured in MW) absorbs this reactive power. An equilibrium arrangement exists when the reactive power generated by the line is fully absorbed by the useful power flowing through it. The load at which this equilibrium arrangement exists, known technically as the surge impedance load (SIL), varies with line voltage but, for a particular voltage, is largely independent of the size of conductor and the line length.

It is important to note that the SIL is not the maximum power that can be transferred through a line. If the load to be transferred is higher than the SIL, the reactive power absorbed by the load as it passes through the line would exceed the reactive power generated by the line. This situation would be manifested in a lower voltage at the receiving end of the line. This in itself need not be critical as high voltage transmission systems can generally tolerate voltage drops of up to 10%. However when the power transfer level is further increased, the level of voltage drop will become progressively less acceptable from a system control perspective and, in extreme situations, voltage collapse can occur and voltage stability will be lost.

It is possible to increase the power transfer capacity of a line by installing reactive power compensation equipment at the receiving end. This compensation would generate reactive power to compensate for the reactive power absorbed by the high real power transfers. The amount of compensation required will increase with load transfer and also with line length. Modern power compensators, such as STATCOMs, have electronic controls, which allow the amount of compensation to be continuously varied to match changes of load in the line. With sufficient compensation it is possible to achieve power transfer capacities up to the thermal rating of the line conductor.

Western Power has indicated that power transfers of up to 500 MVA should be possible on the MWEP line without additional reactive power injection.

Corona

Another factor influencing the design of high voltage lines is the need to control corona discharge. High voltage gradients surrounding transmission line conductors can lead to a breakdown of the air around the conductor surface, which will cause problems with the reception of radio communication equipment and also increase the losses in the line. Corona discharge can be controlled by using conductors with a larger diameter or using a bundled conductor arrangement. At voltages of 330 kV, a twin conductor bundle is needed to control corona and the use of very small conductors is precluded for the same reason.

Hence, the need to control corona means relatively large conductors must be used in a twin conductor bundle. This means that the minimum thermal rating of a 330 kV circuit is around 800 MW.

3.1.2 Conductor Selection

Western Power has decided to use aluminium core steel reinforced conductor with the steel reinforcing conductor being aluminium clad in preference to the more traditional galvanised steel (ACSR/AC in preference to ACSR/GZ). We agree with this and note that ACSR/AC conductor is increasingly used in transmission grids due to its superior corrosion resistance, particularly in coastal environments.

Western Power has undertaken extensive studies to determine the optimal conductor size for the new line. The studies have included a very detailed analysis of the cost of power losses and a study by the University of Western Australia of the likely corona losses under different conditions[2]. The studies compared the relative cost of losses for three different conductor sizes, Lacrosse, Hurdles and Gymnastics[3], using discounted cash flow analysis. The three conductors chosen for analysis were at the smaller end of the range of conductor sizes typically used for 330 kV lines. It should be noted that studies of this nature are indicative only because values must be assumed for variables that have a high level of uncertainty.

The study found that:

- Corona losses from the smallest of the three conductors, Gymnastics, were relatively high and for this reason this conductor was not favoured. The comparative analysis was therefore limited to the other two conductors. The expected corona losses of Hurdles conductor were relatively moderate while the corona losses of Lacrosse conductor were very low.

- The incremental capital cost of using Lacrosse conductor rather than Hurdles for the Pinjar-Eneabba line is $3.3 million or around 1.5% of the estimated total line cost.

- Western Power found that, given the likely environmental conditions over line route[4], the use of the larger Lacrosse conductor will reduce the lifetime cost of the line by between $11 million and $21 million depending on the load growth and load factor[5]. The $11 million figure corresponds to the central load growth scenario and a load factor of 0.6, while the $21 million corresponds to the high load growth scenario and a load factor of 0.8.

We agree with Western Power's decision to use Lacrosse conductor rather than Hurdles. Further, our review of the results of Western Power's analysis indicates that most of the cost savings result from the reduction in corona losses and that the net savings in the cost of resistive losses is relatively small. Given that the corona losses from Lacrosse conductor are already minimal, there would appear to be little or no benefit in moving to a conductor larger than Lacrosse.

3.1.3 Line Profile

Western Power has designed the line to operate at a maximum temperature of 85^0C giving a maximum thermal rating of 1,200 MVA. This is higher than Western Power's standard design temperature of 75^0C. The higher temperature increases the conductor sag, which necessitates the use of higher towers in order to maintain ground clearance, which is usually the governing constraint in the design of overhead transmission lines.

Western Power has advised that the circuit rating at 75^0C maximum conductor temperature would reduce to a little over 1,000 MVA. As this is still well over the 20-year peak demand forecast assuming a high load growth scenario, we are satisfied that the additional thermal capacity gained by the use of an 85^0C design is not required. Indeed we suggest that, even under a high growth scenario, it is likely that much of the Mid West load will be supplied by local generation that could not be connected if the project does not proceed[6]. Under these circumstances the line will largely serve as a robust

[2] Power losses include resistive losses, which result from the load flowing though the line and vary with the square of the load, and corona losses, which are independent of the load.

[3] In the industry, aluminium conductors are given unique names for each size and type of conductor.

[4] Actual corona discharge depends heavily on weather conditions.

[5] Load factor is the ratio of average demand to peak demand. The load factor of the Geraldton load is currently 0.6. However this may rise with the connection of new mining load, which we understand is primarily used by ore processing plant which is likely to operate 24/7.

[6] This is supported by submissions on the Authority's Issues Paper. ERM Power Ltd has advised that it is planning a 330 MW open cycle gas turbine power station at Three Springs, for which it already has Environmental Protection Agency approval. The Shire of Perenjori notes the potential for large scale solar powered generation in the area traversed by the proposed lines to Karara and Extension Hill mines. It suggests that this area offers the best conditions anywhere in Australia for solar powered generation close to a major grid.

connection allowing generators in the Mid West to remain synchronised to the rest of the grid under all operating conditions. The thermal rating of the line then becomes a secondary consideration.

However, Western Power has stated that the additional sag due to the higher conductor temperature is only 0.5 metres and it estimates the additional cost to design for this is approximately $0.5 million. This amounts to less than 0.2% of the overall project cost, which is hardly material in the context of the total project cost.

3.1.4 High Voltage Reactor

Section 3.1.1 discusses the need for reactive power injection at the receiving end of a long 330 kV line if it is to be operated at close to its thermal conductor capacity. However the opposite problem exists at very low loads where the reactive power that is produced by the line is greater than that needed by the load. In this situation reactors, rather than capacitors, are required to absorb the excess reactive power. If reactors are not used the voltage at the receiving end could rise above the limits allowed in the Technical Rules and could potentially damage connected equipment such as transformers. This situation can be a significant problem when a line is energised from one end prior to being put into service. In this condition no power can flow but the line will still produce reactive power, causing a voltage rise at the remote end. This voltage rise is known as the Ferranti effect.

In order to manage the Ferranti effect, Western Power's project design allows for the following reactors at the Three Springs terminal station.

- Two 25 MVAr 22 kV reactors connected to the tertiary winding of the 330/132 kV transformer. The cost of these reactors, which will be used for voltage control under normal operation, is estimated to be $1.0 million; and

- One 50 MVAr reactor connected to the 330 kV bus for a cost of $7.9 million including the cost of the additional 330 kV circuit breaker and other equipment that will also be required to support the asset.

The fact that reactors are needed but that no capacitors have been provided for indicates that the initial forecast loads are low relative to the ultimate capacity of a 330 kV system.

We questioned Western Power closely on the need for the 330 kV reactor given that its cost was significant and that a similar reactor was not included in the original 2007 project design. We noted that the Ferranti effect increases with line length and the length of the 330 kV line for this new project is relatively moderate[7]. The response indicated that:

- Western Power currently relies on medium voltage 22 kV reactors for voltage control and was planning to continue this practice when it designed the 2007 project. However, this practice potentially subjects a transformer to high Ferranti effect voltages when a long 330 kV line is put into service and recent international research has indicated that this can be potentially damaging to the transformer. It cited a recent CIGRE paper[8] that documented this damage.

- Western Power's network operating simulations have indicated that, at times of elevated 330 kV voltage levels at the Neerabup terminal station the Ferranti effect voltage at the Three Springs end of the line could rise to 380 kV. Western Power therefore considered it prudent to protect this transformer by using a 330 kV reactor at Three Springs to reduce this voltage rise before connecting the transformer to the line. It noted that the Three Springs line will be Western Power's longest 330 kV line and the high voltage reactors are used in other parts of Australia, particularly Queensland, to manage transmission network over voltages.

[7] The primary transmission voltage of Powerlink, Queensland is currently 275 kV. 330 kV transmission is used by Powerlink only for the interconnection with New South Wales.

[8] *Transformer Internal Over-Voltages Caused by Remote Energisation;* J A Lapworth, P N Jarmin and T Breckenridge, CIGRE (International Council on Large Electric Systems), 2006.

- Western Power had considered a number of alternative strategies to mitigate the risk of potential harmful transformer damage but discounted them all for various reasons.

The CIGRE paper reviews a number of unexplained instances in the United Kingdom where insulation damage was found in otherwise apparently healthy high voltage transformers and notes that a common factor in all the instances investigated was the exposure of the affected transformers to energisation from the remote end of a long high voltage transmission line. The damage found in most instances was not sufficiently serious to cause the transformer protection to trip and was only detected during routine transformer condition monitoring. We accept that the Three Springs transformer would be subjected to similar remote energisation if Western Power was to rely on the 22 kV reactors as its primary method of 330 kV voltage control.

Since transformers constructed to international standards are designed, rated and tested to withstand over-voltage impulses that can occur as a result of switching events or lighting strikes, the paper postulates that the damage is caused by the development of a voltage resonance between the transformer and the rest of the high voltage power system. Such a resonance can last longer than a normal switching or lightning impulse, so the impulse rating intended to protect against standard switching over-voltages would not apply. The paper notes that this failure mechanism is not well understood and that development of dangerous resonant voltages could be influenced by random factors such as the point on the voltage wave at which energisation occurred, the effect of manufacturing tolerances on the electrical response of a particular transformer unit and the operating condition of the system at the time of the energisation. It notes that such damage is “comparatively rare” and considers that further research is needed. It suggests a number of mitigation measures but indicates that, as the failure mode is not well understood, their impact could be limited. It does state that, as remote energisation appears to be a common cause of all the faults reviewed, the first consideration should be whether this can be avoided. In installing 330 kV reactors, Western Power has chosen to design the system so that remote energisation will not be needed.

We consider the risk that Western Power has designed the system to avoid is real but given the randomness on many of the factors thought to contribute to the situation, it is not clear that the risk of transformer damage occurring through remote energisation is high. The CIGRE paper relied on by Western Power notes that the phenomenon is “comparatively rare” and states that it is suspected that damaging over-voltages are not produced every time a remote energisation occurs. Western Power itself suggests that a problem is likely to arise only when the voltage at Neerabup is high but it does not discuss whether it would be practical to take steps to lower this voltage prior to line energisation.

On balance, we consider that the risk of transformer damage is relatively small and that it could be managed by Western Power without the installation of the 330 kV reactor. However we do not recommend that the reactor be deleted from the project because the TST 330 kV bus is the grid connection point for the KML mine. Under clause 2.2.2(a) of the Technical Rules, Western Power is required to keep this voltage within 10% of the nominal voltage of 330 kV, irrespective of the load being drawn by the mine. Without the reactor, it might not be able to do this in an n-1 contingency situation where the 330/132 kV Three Springs transformer was out of service.

3.1.5 Undergrounding of Affected Assets

The project scope provides for the undergrounding a section of the double circuit 132 kV lines and for the undergrounding of a total of 25 sections of distribution lines where these lines cross the proposed line route or easement.

It is not Western Power’s normal practice to underground 132 kV lines that pass under 330 kV lines and it has not proposed to underground other 132 kV line crossings along the route of the new line. However the double circuit 132 kV line has higher than normal towers at the point where undergrounding is proposed and standard clearances between the two circuits would not be achieved using the standard 330 kV tower design for this project. In order to address this situation, Western Power is proposing to underground both existing 132 kV circuits at this point at an estimated cost of $[redacted] million.

Western Power has submitted a risk management argument to justify the undergrounding solution. It has stated that a failure of a conductor on one of the new 330 kV circuits could remove both of the existing 132 kV circuits from service. After the second new circuit has been upgraded to 330 kV operation, this would disconnect all supply to both Cataby and Eneabba zone substations. However, failure of high voltage transmission line conductors is very rare and the probability of such a failure on a specific span is very low indeed. The risk could be further mitigated by targeting the span concerned for more frequent and thorough asset inspection. In our view the chance of such a situation arising is remote and the risk should be acceptable.

The reason that the double circuit 132 kV line is high at this point was that it crossed above the old "cricket wicket" line that is being removed under the project. With the old line removed, the additional height will no longer be needed and we are surprised that Western Power has not commented on the option of simply diverting the existing line onto shorter towers or poles at the crossing point.

The undergrounding of distribution lines along the route of a transmission line is consistent with Western Power's policy and is justified by Western Power for safety reasons. The estimated cost is $[redacted] million. Not all jurisdictions have this requirement and many clearly feel that any safety risk can be managed in a more cost effective manner. However, safety is an issue that is outside the Authority's jurisdiction and, given that this has been Western Power's standard practice for a number of years, we are not suggesting that this cost not be allowed.

3.2 SUBSTATIONS

3.2.1 Configuration of Three Springs Terminal Station

Western Power's standard design for 330 kV switchyards is a double bus "circuit breaker and a half" arrangement, which provides the high level of security required of major substations located in strategic grid locations. The term "circuit breaker and a half" refers to the design, which provides for a spare or redundant circuit breaker to be shared between two connected circuits – hence there is one and a half circuit breakers per connected circuit. The design provides "n-1" security without incurring the full cost of a redundant circuit breaker for each connected circuit.

Given that there will be only one incoming 330 kV circuit, this level of security is not required at Three Springs, at least for the first stage of the project. Western Power has designed the project as a mesh arrangement[9], requiring one circuit breaker per connected 330 kV circuit but has designed the circuit breakers and associated infrastructure to facilitate future development to a breaker and a half arrangement. While this approach has increased the cost by approximately $240,000 over that of a simple mesh, we consider it appropriate.

3.2.2 Three Springs Terminal Station Transformer Size

As issue we raised in the Regulatory Test review was the size of the transformer to be installed at the Three Springs terminal station. We were of the view that the installation of a 490 MVA transformer was not justified, given the forecast load around Geraldton. This is consistent with observations that we have made previously that, because Western Power only has one standard 330/132 kV transformer size, it is installing larger transformers than justified for many projects and over time this will result in the installation of significant excess transformer capacity across the network. This is

9 In a mesh arrangement the circuits are connected in a loop with a circuit breaker between each connected circuit. While it is effective when the number of connections is small, the cost of supporting infrastructure increases substantially as the number of connections increases. The initial Three Springs substation configuration includes four circuit breakers, one for each of the three connected circuits (lines to Neerabup and Karara and the 330/132 kV transformer) and one for the 330 kV reactor.

economically inefficient as it means that transformer capacity that is never likely to be used must be paid for by customers.

Attachment 2 of the NFIT Application[10] includes an analysis that purports to show that the installation of the larger transformer can be justified on the basis of cost-benefit considerations. The analysis notes that the ability of the existing network to supply Geraldton is limited to 122 MW by the thermal capacity of the 132 kV lines between the Mungarra power station and Geraldton under n-1 conditions. Three load growth scenarios are provided, all of which assume that load in the Geraldton area will grow significantly over the next few years to support accelerated mining development in the Mid West region[11].

The transformer sizing analysis assumes that the high load growth forecast outcome will materialise and concludes that in this event the installation of the larger transformer now is more cost effective because it will allow the proposed new double circuit to be operated for a longer period at 132 kV before an upgrade to 330 kV is required. We have significant concerns with the quality and robustness of this analysis. In particular:

- It is selective in that it justifies the decision on the basis of a single outcome of a range of possible scenarios. Logically, it would be equally valid to select the low growth outcome and then conclude that a smaller transformer would be adequate. Indeed, it could now be argued that a low growth scenario is more probable as the commodity prices that are driving the mining boom, which is assumed to continue in the high growth scenario, are the result of high consumer demand in developed Western economies[12]. It is now clear that this demand has largely been funded by high debt levels, which cannot be sustained. This hypothesis would suggest that commodity prices are likely to fall as Western economies experience a period of austerity as they move to more sustainable growth trajectories.

- Given that it is possible to add additional transformer capacity incrementally, it is not clear what the relationship is between the size of transformer and the timing of any upgrade to 330 kV operation. Based on Western Power's own load forecast, two 250 MVA transformers will provide sufficient capacity to meet the central forecast through until 2030 with a third transformer only being required before that time if load growth approaches the high forecast. Our view is that developing Three Springs on the basis of 250 MVA transformers is a rational approach as it minimises the risk of over investment but does not preclude the installation of a third transformer should a high load growth situation eventuate.

- The analysis assumes that it is possible to transmit 400 MVA of power at 132 kV over a distance of up to 150 km over a single circuit in an n-1 contingency situation. Given the large conductor size, this could be technically possible but it would be well outside standard industry design envelopes[13] and would, we suspect, require a significant investment in line compensation. We think that, in reality, serious consideration would be given to upgrading to 330 kV operation well before the load in the Geraldton area reached 400 MVA.

- We also note that Western Power appears to be assuming that a double circuit 330 kV line between Three Springs and Moonyoonooka will need to be constructed once the 122 MW thermal capacity of the lines between Mungarra and Moonyoonooka is reached. However, it may be possible to construct this line in stages, with the relatively short section between Mungarra and Moonyoonooka being constructed first. This should allow the Mungarra power station to continue to be used to support the Geraldton load. A load duration

[10] DM# 8473229, Attachment 2.

[11] The low growth forecast assumes the Geraldton load will increase from the 2010 level of 85 MW to 135 MW an increase of almost 60% in just seven years.

[12] While the demand for Australian commodities comes primarily from China, they are nevertheless used in the manufacture of goods for export to the West.

[13] Figure 18.3(a) of the book *Transmission and Distribution Electrical Engineering* by Colin Bayliss and John Hardy suggests that the maximum load on a 132 kV is normally about 200 MVA.

curve covering the Geraldton area is provided in the PB report on the initial regulatory test application which shows that the demand exceeds 80% of the peak only about 5% of the time[14].

- While not included in its numerical analysis, Western Power cites Crosslands Resources as a further potential 132 kV customer connecting at Three Springs, in support of its premise that economic analysis should be based on high load growth options. Crosslands is considering expanding its Jack Hills mine, located 560 km north east of Geraldton, and connecting to the SWIN at Three Springs via an HVDC link. Its initial load would be 200 MW with a potential additional 200 MW if the mine is expanded to the full capacity of the resource[15]. Western Power states that:

  > *Crosslands Resources has confirmed a preference for a 132 kV connection at TST into their proposed HVDC converter as a lower cost connection option from Three Springs Terminal.*

  We have discounted this as we do not believe that Western Power's existing customers should be expected to fund assets that may or may not be required by a single large new mining load. We are also surprised by the suggestion that it would be cheaper for Crosslands to connect at 132 kV than at 330 kV. This is different from other transmission pricing regimes we have encountered, which invariably offer progressively lower connection costs with increasing voltage. This is because the network owner does not need to install lower voltage assets when it provides a higher voltage connection. Our view is that this is a more economically rational pricing approach and that, if Crosslands wants to connect at 132 kV, it should pay for the transformer capacity required to service its load.

We note that the Three Springs substation is already under construction and that 490 MVA is the only size 330/132 kV transformer that Western Power currently uses. It is difficult to avoid the conclusion that the analysis provided by Western Power is an attempt to provide an economic basis for a decision that has already been made and that the analysis assumptions have been selected accordingly. As indicated in Section 3.1.4, the installation of a smaller transformer would reduce the project cost by $1.07 million (including risk).

3.2.3 Other Substation Work

The project includes the installation of a new bay at Neerabup to accommodate the new 330 kV circuit, extensions to the existing Three Springs 132 kV substation and the new double circuit 132 kV tie line to the new Three Springs terminal station. These augmentations of the existing primary assets are necessary to integrate the new 330 kV line into the existing transmission grid.

The scope also includes protection, SCADA and communications upgrades at a number of substations in the Mid West region. We note that some of this work involves the upgrade of secondary assets at substations that are not directly affected by the project. In particular, Western Power appears to have "piggy backed" onto the project a protection upgrade on the existing 132 kV lines north of Three Springs. Arguably, this upgrade is not directly associated with the southern section upgrade and should therefore have been considered on its own merits and treated as a separate project. However, given that the cost of these miscellaneous secondary asset upgrades represents only 2.6% of the total project cost, and that most of this work is undoubtedly required to integrate the primary assets installed under the project into the existing network, we are not recommending any change to the scope of this component.

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14 *Technical Appraisal of Western Power's Major Augmentation Proposal for a 330 kV Transmission Line and Associated Works in the Mid-West Region of Western Australia;* Parsons Brinckerhoff Australia, 29 October, 2007; Figure 5, p13.

15 Given that the Jack Hills mine is located north of Geraldton we considered (at a very high level) whether the mine load should be connected at Moonyoonooka assuming the north section of the MWEP proceeds. However the distances from the mine site to both terminal stations appear to be similar.

4. PROJECT COSTS

4.1 INTRODUCTION

The NFIT amounts proposed by Western Power for various components of the project in its pre-approval application are shown in Table 4.1 below. We have compiled the breakdown in this table using the information provided in the pre-approval application and supporting documents. The 330 kV line reactor and associated works has been included in the line costs in Item 1 rather than the TST costs in Item 2 since, while the reactor is located at TST, it will be installed by Western Power as part of the main line project. Planning, design and project management costs are as allocated by Western Power.

Table 4.1: NFIT Amounts ($ million)

Item	Description	Estimated Cost	Risk	Interest During Construction	Total
1.	330 kV line between PNJ and ENB and associated works (including the 330 kV TST reactor).	[redacted]	[redacted]	[redacted]	[redacted]
2.	TST	[redacted]	[redacted]	[redacted]	[redacted]
3.	330 kV line between ENB and ENT	[redacted]	[redacted]	[redacted]	[redacted]
4.	330 kV line between ENT and TST	[redacted]	[redacted]	[redacted]	[redacted]
Total NFIT amount		**355.00**	**18.18**	**10.20**	**383.38**
Connection assets		1.80			1.80
Total project cost		**375.0**	**18.18**	**10.20**	**385.18**

Source: GB Associates' analysis of information provided by Western Power.
Terminology: PNJ = Pinjar 132 kV substation (existing);
ENB = Eneabba 132 kV substation (existing);
TST = Three Springs 330 kV terminal station (to be constructed under project);
ENT = Eneabba 330 kV terminal station (to be built in future on a new site owned by Western Power);

The provision for connection assets relates to the assets required to connect KML's line to the Three Springs terminal station. While these assets will be built as part of the project, they do not form part of the shared network and will be fully funded by KML. Hence the cost of these assets is not included in the proposed NFIT amount.

All estimates based on costs as of July 2010. Costs for Items 1-3 above were estimated by Western Power. The cost for Item 4, which will be constructed by Karara Mining Ltd, is the transfer price agreed between Western Power and KML, as discussed in Section 4.4.

The cost estimates prepared by Western Power are based on planning phase cost estimates prepared by Western Power's specialist cost estimation section with an accuracy of +/-10%. They include a base cost plus a risk provision, derived using Monte Carlo simulation techniques, so that there is an 80% probability of the actual cost coming in below the estimate. The estimate includes a business indirect cost (overhead) recovery rate of 5%.

Our review of these costs has been limited to a review of the methodology used to prepare the estimates and, on this basis, we are satisfied that the estimates were reasonable as of 1 July, 2010.

A major uncertainty is the impact of cost changes since July 2010 and the issue arises as to how these cost changes should be treated by the Authority in determining the NFIT amount that it should specify in its decision. The changes are potentially significant. For example the estimate is based on an USD exchange rate of 0.8345, whereas the exchange rate as of 22 September 2011, as reported by the Reserve Bank of Australia, was 1.0027, a movement of more than 20%. On the other hand the estimate was also based on an aluminium price of USD1,928 per tonne whereas the current price, as reported by the London Metal Exchange is USD2,225 per tonne, an increase of over 15%. Inflation over the last year has been around 3%.

Western Power's cost estimate report states:

> *This estimate has been prepared on a 1 July 2010 basis. No escalation has been applied. Escalation based on foreign exchange variation, commodity rate variations and CPI will be used for business case purposes.*

Since the NFIT amounts in the pre-approval application will not be the same as the business case amount approved by the Western Power Board, and because Western Power's project management procedures require project costs estimates to be updated six monthly, we asked Western Power to provide an updated cost estimate.

Western Power responded:

> *Yes, Western Power have a policy of refreshing project cost estimates. Refreshing of project estimates is undertaken through the governance system to ensure that project estimates are appropriate, and are flagged for refreshment every 6 months.*
>
> *Western Power has not refreshed this estimate since July 2010, given this estimate includes materials based on market quotations, which have been reasonably stable since that time. On this project there would be a high cost to refresh this estimate. In addition, Western Power has carried out some high level checks and assessments, and benchmarked key components with manufacturers, suppliers and other utilities. We believe the current estimate is still valid, within the level of escalation to be applied.*

We are very surprised that Western Power is not applying a key element of its own expenditure governance procedures to one of the largest and most critical capital projects on its books. We also do not understand why refreshing the cost estimate should be such a high cost exercise when the estimate is broken out into materials and labour, the price of major substation equipment is based on the pricing in Western Power's period contracts and the impact of exchange rates and materials commodity prices is set out transparently in its cost estimation report. Finally we have no idea what Western Power means when it says:

> *We believe the current estimate is still valid, **within the level of escalation to be applied*** [our emphasis].

as there is no proposal in the NFIT pre-approval application for the inclusion of a provision for cost escalation in the Authority's approved NFIT amount.

Since July 2010, movements in exchange rates have tended to reduce the cost of imported materials although these reductions may have been largely offset by increases in commodity prices. Labour cost movements since the estimate dates would tend to increase the project cost.

As we understand it, Western Power will be able to include the actual project cost in the regulatory asset base up to the value of the NFIT amount in the Authority's decision, but will be required to seek further NFIT approval should the actual project cost that it wishes to include in the asset base exceed the approved NFIT amount. We think that, in general, Western Power's validated P80 estimate is the appropriate basis for determining the NFIT amount. As Western Power has not provided an escalated cost estimate, we suggest the NFIT amount be set on the basis of the July 2010 cost estimate provided in its pre-approval application. Should the actual project cost exceed this amount, Western Power should be required to make a further NFIT application if it wants to include the additional amount in the RAB.

While the proposed NFIT amount does not include any provision for exchange rate and commodity price movements since July 2010, Western Power has a policy of hedging for commodity price movements when a contract is executed and has included a provision of $2.2 million in the cost estimate to cover these hedging costs. Hedging for foreign exchange rate movements would seem reasonable for contracts denominated in foreign currencies but we have not examined the basis for determining the amount of this hedging provision in the cost estimate.

4.2 PJR-ENB LINE AND ASSOCIATED WORKS

This component of the project covers almost [redacted]% of the NFIT amount and will be designed and project managed by Western Power. It includes:

- Demolition of the existing 132 kV "cricket wicket" line;
- Construction of the 330 kV line between PNJ and ENB;
- Construction of the double circuit 132 kV tie line between TST and the existing Three Springs 132 kV substation;
- Construction of a new 330 kV switchyard bay at Neerabup terminal station (NBT). This is required to provide a 330 kV supply to the project, which will use an existing 330 kV line between NBT and PNJ, both circuits of which are currently operated at 132 kV;
- Connection of eastern circuit of the new 330 kV line, which will initially be operated at 132 kV, into Pinjar, Regans, Cataby and Eneabba substations; and
- Miscellaneous protection, SCADA and communications upgrades at various existing substations throughout the Mid West.

This work will be undertaken by Western Power, with all delivery of all works being by competitive tender or using Western Power's in-house resources[16]. We consider that the cost estimate is reasonable, based on the scope set out in the pre-approval application. We also consider the proposed delivery strategy is efficient and, if used, see no reason why the actual implementation cost should not be considered efficient.

Interest during construction has not been provided for as Western Power's policy is to add capital expenditure to the RAB as spent rather than as commissioned. Hence Western Power can earn a regulated return project expenditure incurred prior to commissioning.

On this basis we consider that, subject to a potential adjustment for the undergrounding of 132 kV circuits, $[redacted] million is a reasonable NFIT amount for this project component.

4.3 THREE SPRINGS TERMINAL STATION

As shown in Table 4.1 the estimated cost of the Three Springs terminal station is $[redacted] million. It was originally intended that all work would be undertaken through competitive tendering or using Western Power resources. However, delays in finalising commercial arrangements with KML, and in applying for regulatory approvals, now mean that, if this delivery approach was used, the station would not be completed in time to meet KML's target mine commissioning date of mid 2012[17]. Hence the electrical construction works at the Three Springs terminal station, except the 330 kV line reactor,

[16] Western Power's internal resources will generally be used for project management and design, commissioning and specialist work on secondary systems.

[17] Initially the mine will be provided with a limited capacity power supply. As discussed in Sections 4.4 and 4.5, KML is constructing the new 330 kV line between the existing Eneabba zone and Three Springs. Power will be injected into this line at 132 kV from Eneabba and will be fed "backwards" through the 330/132 kV Three Springs transformer to supply the mine. This implies that construction of the ENB-TST section of the project and the Three Springs terminal station is already well advanced.

has been accelerated and will be undertaken by KML using its mine site construction resources, through a sole source contract. The estimated cost of the Three Springs terminal station can therefore be broken down as follows.

Table 4.3: Breakdown of Three Springs Terminal Station NFIT Amount ($ million)

Item	**Cost**
Sole source contract – KML (base cost)[1]	[redacted]
Sole source contract – KML (risk)[1]	[redacted]
Other works (base cost)	[redacted]
Other works (risk)	[redacted]
Interest during construction	[redacted]
Total	[redacted]

Note 1: See Attachment 3B (DMS# 8334047) of the pre-approval application, p11.
Note 2: The $1.8 million cost for connection assets does not form part of the NFIT amount as this cost will be funded by KML rather than Western Power.

We consider that the cost estimates (including risk provisions) are reasonable for both the KML component and the other works, given that they have been have been estimated using Western Power's planning phase estimating procedures and that they are based on a delivery approach combining competitive tendering and the use of in-house resources.

4.3.1 As New NFIT Amount

In its pre-approval application, Western Power advised that the reimbursements to KML for its contract for the Three Springs terminal station will be the lower of KML's actual costs and Western Power's estimated cost for the works. Western Power subsequently clarified that, for the purposes of this assessment, the estimated cost will not include the risk provision. However, Western Power will reimburse for realised risks where it considers the KML claim reasonable.

While this arrangement does not provide a direct incentive for KML to reduce its costs below the amount of Western Power's base cost estimate, there are provisions in Western Power's contract with KML requiring disclosure of the subcontract, an independent third party review of evidence that demonstrates the cost competitiveness of subcontract pricing and all actual costs incurred by the subcontractor.

We are satisfied that, under these arrangements, the costs to be included in the RAB will be similar to the costs that would be incurred by Western Power under a delivery model using only fully competitive tenders and Western Power's own resources. Indeed they may well be lower as KML's sole source subcontractor is already mobilised both at the mine site and for the construction of the Eneabba-Three Springs terminal station transmission line.

Given that only the actual costs incurred by KML in the construction of the asset will be included in the RAB, we consider it reasonable for the risk component to be included in the estimated cost that is used as the basis for determining the "as new" NFIT amount.

For large capital projects undertaken by Western Power the following preconditions must be met before construction work commences.

1. Regulatory test approval must be obtained from the Authority;

2. Approval to proceed must be given by the Western Power Board;

3. Approval must be given by the Minister of Energy in accordance with Section 68 of the Electricity Corporations Act 2005.

The MWEP has regulatory test approval but the project still awaits Board and Ministerial approval. In spite of this, construction of the TST terminal station is preceding as it is required to provide the temporary supply to the mine described in Section 2.3. Western Power is therefore in the position where its constructing the terminal station without all the approvals required for MWEP. We think that, for the purposes of NFIT analysis, the TST terminal station should be treated as if construction was being undertaken by KML on the basis that Western Power would assume ownership once all regulatory approvals were in place. It is highly probable that KML has indemnified Western Power should the remaining approvals for the MWEP not be forthcoming, although we have not clarified this point.

Commissioning of the terminal station is expected in early 2012. From then until commissioning of the MWEP in March 2014 the only Western Power customer benefiting from the TST substation will be KML. In effect the Three Springs terminal station will operate as a KML connection asset over this period.

On this basis we consider that it is reasonable to include IDC in the NFIT amount as neither Western Power nor KML will earn a return on the capital cost of the terminal station before it is commissioned. Hence we conclude that, subject to a potential adjustment for a reduction in transformer size, $[redacted] million is a reasonable NFIT amount for the TST component.

4.3.2 RAB Amount

In this report we make a distinction between the NFIT amount, which is the maximum amount that we consider the Authority should approve for inclusion of a new asset in Western Power's RAB and the "RAB amount". We define the RAB amount as the value at which the asset should be included in Western Power's RAB, when the asset is not new at the time of its inclusion.

In our view, the TST terminal station should not be included in Western Power's RAB until the remainder of the MWEP is commissioned since, until that time, KML is the only Western Power customer that will benefit from the use of the asset. If this is accepted the asset will have been in service for approximately two years before it can be included in Western Power's RAB. In these circumstances we consider that the NFIT amount should be reduced to reflect the fact that some of the expected economic service life of the asset would have already been used by the time the asset is included in the RAB.

To reflect this we consider that the Authority's NFIT amount should be the estimated RAB amount, which should be the "as new" NFIT amount less accumulated depreciation up until the time the asset is entered into the RAB. Based on Western Power's proposed NFIT amount, without any adjustment for transformer size, we estimate the accumulated depreciation to be $[redacted] million, assuming an average economic life of 30 years for substation assets, a two year delay and depreciation calculated on a straight line basis.

4.4 ENT-TST 330 KV LINE

This line is being designed, project managed and constructed by KML. This is a legacy of the original 2007 project design, which provided for a 330 kV supply at Eneabba rather than at Three Springs. The ENT-TST line was originally planned as a private line, owned by KML, to provide a connection to the mine from the original project. However, the line has now been incorporated into the reformulated MWEP and is to be purchased by Western Power for inclusion in the project.

Construction is in progress as the line is required for the temporary supply to the mine. Once it is commissioned, it will also be used by Western Power in place of the 132 kV line between the existing Eneabba and Three Springs zone substations. However, the existing line has sufficient capacity to meet Western Power's current requirement and the only reason for advancing the construction of the ENT-TST line is to ensure that a temporary mine supply will be available in time to meet KML's production schedule.

The components of Western Power's proposed NFIT amount for this component of the project are shown in Table 4.4.

Table 4.4: Breakdown of ENT-TST Line NFIT Amount ($ million)

Item	Cost
Base cost	[redacted]
Risk	[redacted]
Interest during construction	[redacted]
Total	[redacted]

Western Power is proposing to purchase the line from KML at the full NFIT approved amount, including the risk provision, as approved by the Authority.

4.4.1 Design

The base cost shown in Table 4.4 has been determined using Western Power's planning phase cost estimation procedure. However, it assumes an average span length of 500 metres, consistent with Western Power's standard at the time KML designed the line.

When it became apparent that the estimated costs in its original regulatory test and NFIT applications were inadequate, Western Power reviewed its standard line design and found that a 600 metre span was more cost effective. The PJR-ENT 330 kV line component of the MEWP is designed and costed on this basis. Western Power has estimated that had the ENT-TST line been designed with 600 metre spans, the base cost would reduce by $5 million to $[redacted] million. There would be no change in the risk provision. This saving would have been achieved had the line been constructed with the rest of the MWEP.

We also note that the design is based on a conductor temperature of 85^0C rather than Western Power's standard 75^0C. As noted in Section 3.1.3, we don't consider the higher rated line is required for this project. However, we estimate the additional cost involved to be only about $175,000.

4.4.2 NFIT Amount

Western Power is proposing to purchase the line for the NFIT amount approved by the Authority, including the risk provision. This would amount to $[redacted] million, excluding IDC, assuming the Authority accepted Western Power's proposal in full, including the unoptimised design.

The proposed NFIT amount is Western Power's P80 estimate and, by definition, there is an 80% probability that the actual cost incurred would be lower than this. It is possible that KML, as a private company, would take a more aggressive approach to managing costs than Western Power, in which case the probability of the actual cost coming in lower than the proposed sale price would be even higher.

We consider that the cost estimates that Western Power has used as the basis for determining its proposed NFIT amount are reasonable.

4.4.3 RAB Amount

Unlike the PNJ-ENB line and TST, Western Power is proposing that the amount to be added to the RAB be the full NFIT amount rather than the actual cost of the work. This means that any difference between the actual cost and the NFIT amount would be paid by Western Power and retained by KML as profit.

Our views on the RAB amount are:

- We see no reason why the cost of this line should be included in Western Power's RAB before the balance of the MWEP is commissioned. While Western Power and KML will both be using this line before then, the existing line (which route planning consents require be demolished after the new line is commissioned) would meet Western Power short term requirements. Hence it is reasonable to take the view that construction has been accelerated ahead of the rest of the MWEP solely for the benefit of KML;

- Western Power's estimate of the NFIT amount is likely to exceed the actual construction cost of the line. Furthermore, had construction not been accelerated for the benefit of KML the NFIT amount would have been reduced by $5 million. It may be that reducing the NFIT amount by $5 million, but allowing the amount to be included in the RAB to be based on the P80 estimate would be a pragmatic approach that would provide a reasonable outcome for both Western Power and KML. This would also be consistent with Western Power's proposed treatment for the ENB-ENT line discussed in Section 4.5;

- We consider that, consistent with normal accounting practice, IDC on the full cost of the asset should be included in the NFIT amount. There is no opportunity for either KML or Western Power to earn a return on the capital expenditure incurred prior to commissioning;

- Accumulated depreciation should be deduced from the as-new NFIT amount to determine the value at which the asset is included in Western Power's RAB. Assuming an expected economic life of 40 years (for transmission lines), this would amount to $[redacted] million, based on the full NFIT amount proposed by Western Power, straight line depreciation and a two year delay.

4.5 ENB-ENT LINE SECTION

The relatively short 11.6 km section of 330 kV line between the existing Eneabba 132 kV substation and the site of the proposed Eneabba terminal station was initially included in the Western Power component of the project and was not part of the original private line planned by KML to supply the mine. However, Western Power and KML have agreed that this section should be constructed by KML and purchased by Western Power for the Authority's approved NFIT amount, as it is also needed for the temporary supply that is required for the mine to commence production in 2012.

The proposed NFIT amount for this component of the project is shown in Table 4.5.

Table 4.5: Breakdown of ENB-ENT Line Section NFIT Amount ($ million)

Item	Cost
Base cost	[redacted]
Risk	[redacted]
Interest during construction	[redacted]
Total	[redacted]

The cost estimate is based on an optimised design using 600 metre spans and 85^{0}C maximum conductor temperature.

4.5.1 NFIT Amount

Western Power has proposed that the approved NFIT amount be based on its estimated P80 cost to construct the line, based on an optimised design. This seems a reasonable, if rather pragmatic, solution noting that:

- We understand that KML is constructing the line with unoptimised 500 metre spans. Hence its actual cost may well be higher than Western Power's cost estimate, which is based on an optimised design;

- Western Power's cost estimate included route development costs, which were not incurred by KML; and

- This component of the project is relatively small.

IDC on the full cost of the asset should be included in the NFIT amount. There is no opportunity for either KML or Western Power to earn a return on the capital expenditure incurred prior to commissioning.

4.5.2 RAB Amount

- We see no reason for the cost of this asset to be included in Western Power's RAB prior to the commissioning of the PNJ-ENB line. The reasons for this are discussed in Section 4.4.3; and

- Accumulated depreciation should be deduced from the as-new NFIT amount to determine the value at which the asset is included in Western Power's RAB. Assuming an expected economic life of 40 years (for transmission lines), this would amount to $[redacted] million, based on the NFIT amount proposed by Western Power, straight line depreciation and a two year delay.

4.6 DEVELOPMENT COSTS

Development costs of $21.3 million incurred to date have been included in the project cost estimate. This includes project planning and approvals, project estimates, project development, design and the strategic purchase of equipment. It does not include $9.1 million allocated to the northern section of the MWEP for work completed in project planning, design, cost estimates and environmental works[18].

Western Power has stated that these costs will be capitalised against the project, consistent with Western Power's capitalisation policy and so are presumably included in the proposed NFIT amount. However, we are unable to reconcile these costs against the project breakdown provided in Table 4.1 of the Planning Phase Cost Estimate Report[19]. This report estimates a total cost of $22.6 million, excluding risk, for project and contract management, planning and design. This would imply that the cost still to be incurred on these activities through to the end of the project is only $1.3 million, which seems unrealistic. Alternatively the balance of the cost will need to come out of the risk component.

We suspect this issue has arisen largely because the costs of preparing the 2007 regulatory and NFIT test applications and the subsequent reformulation and redesign of the project are included in this amount. If this is the case, then we suggest the some of these costs would not meet the requirements of part (a) of the NFIT, since Western Power must accept some of the responsibility for the need to rework the project.

We are not suggesting that the full $21.3 million does not meet NFIT requirements. In particular, the line route between Pinjar and the Eneabba terminal station has not changed so funds spent on route development remain relevant. Further investigation and analysis would be required in order for us to form a view on the amount that meets NFIT requirements.

[18] If this $9.1 million relates to the direct route between Eneabba and Moonyoonooka, it may need to be written off, since it is unlikely to meet NFIT requirements if this route is abandoned in favour of a new route between Three Springs and Moonyoonooka.

[19] DM# 7482729v6D, p11.