# Regulatory Submission

ACTEWAGL DISTRIBUTION

## Review of AER Draft Decision - Augex

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## Regulatory Submission

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# Executive summary

Attachment 6, Section A of the AER's draft decision outlines the analysis undertaken and reasons given for AER's decision to reduce ActewAGLDistribution's system augmentation (Augex) forecast by $37.81 million (approx. 38%) over the 2014/15 – 2018/19 regulatory period.

It is worth noting that all of this reduction is associated with just five major augmentation projects proposed by ActewAGL Distribution, but challenged by the AER, as listed below:

- Molonglo zone substation and associated works - $24.6 million
- Belconnen zone substation - $12.7 million
- Zone substation earth grid upgrade - $2.619 million
- Gold Creek 11 kV switchboard extension - $0.77 million
- Mitchell zone substation - $0.6 million

This report does not address the technical/economic justifications for each of the above projects, as this is being addressed in other project specific business cases.

Rather, this report addresses the AER assertion that ActewAGL Distribution's system security and planning criteria are overly conservative, and does not provide an assessment framework for evaluating and managing risks associated with expected unserved energy.

The key issues and findings that have emerged from this review are:

1) ActewAGL Distribution's system security and planning criteria applicable to the transmission system (132 kV feeders) applies emergency overhead ratings which are at the 'upper end' of contemporary electricity industry practice.
2) ActewAGL Distribution's system security and planning criteria applicable to the primary distribution system (11 kV and 22 kV) are similar to other DNSP's in the NEM, with distribution feeders being loaded up to 75% of their thermal rating depending on the number of inter-feeder ties available.
3) ActewAGL Distribution's system security and planning criteria applicable to zone substations utilise a two hour emergency rating for power transformers, which is the highest level of allowable loading recommended by manufacturers, and the relevant Australian Standard.
4) When compared with the Victorian DNSP's, who use a lower emergency cyclic rating plus an unserved energy calculation, the ActewAGL Distribution criteria may put it in the same 'risk zone' as the Victorian DNSP approach.
5) The recently issued report by AEMO adopting generally lower values of customer reliability (VCR) has caused the Victorian and Queensland DNSP's to question the appropriateness of unserved energy/VCR calculations to power system planning.
6) Jacobs is not aware of any requirement in any of the National Electricity Law, Rules, Objectives, Criteria, and other relevant documentation, nor in the amended ACT Distribution Code, for unserved energy assessments to be included in the cost evaluation of major augmentation projects.
7) The AER may have erred in introducing this requirement into the draft decision, without giving prior notice of this new 'capex factor' in writing.

## Important note about your report

The sole purpose of this report and the associated services performed by Jacobs® is to provide input into ActewAGL Distribution's 2014-19 Regulatory Proposal, in accordance with the scope of services set out in the contract between Jacobs and the Client. That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

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Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

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# 1. Introduction

Attachment 6, Section A of the AER's draft decision outlines the analysis undertaken and reasons given for the AER's decision to reduce ActewAGLDistribution's Augex by $37.81 million (approx. 38%) over the 2014/15 – 2018/19 regulatory period. It is worth noting that all of this reduction is associated with just five major augmentation projects proposed by ActewAGL Distribution, as listed below:

- Molonglo zone substation and associated works - $24.6 million
- Belconnen zone substation - $12.7 million
- Zone substation earth grid upgrade - $2.619 million
- Gold Creek 11 kV switchboard extension - $0.77 million
- Mitchell zone substation - $0.6 million

The proposed AER reductions on the above five projects total $41.3 million, which more than accounts for the proposed overall Augex reduction of $37.81 million. Presumably this indicates that the AER considers the planned Augex expenditure on other projects and programmes of work is justified.

Separate enhanced business cases are submitted addressing each of these projects, however an underlying theme of the AER draft decision is that ActewAGL Distribution has used *"…overly conservative criteria when making augmentation decisions on zone substations…"*[1], and that ActewAGL Distribution's distribution network augmentation standard does *"… not incorporate the change in the ACT Electricity Distribution Supply Standards Code (2013)…"*[2] and that the criteria *"… do not provide an assessment framework for evaluating and managing risks associated with expected unserved energy."*[2]

Further, the AER determination incorrectly postulates that ActewAGL Distribution's proposed VCR values for STPIS purposes may have been used somehow in the justification of the timing for some of the above five projects (particularly Molonglo and Belconnen). This is not the case, as the justification and timing of the projects have been based on the ActewAGL Distribution Network Augmentation Standard, and the Distribution Network Planning and Expansion Framework, not on the basis of project specific unserved energy (also known as energy at risk) and VCR studies.

In planning the augmentation of its distribution and transmission systems ActewAGL Distribution uses a mixture of deterministic (rule based) criteria and probabilistic criteria as outlined in section 6.5 of the SRP. Both elements of the planning criteria have risk parameters built into the process, whether they are deterministic or probabilistic in nature. The AER draft determination has selectively quoted[2] only a part of the ActewAGL Distribution criteria, which appears to indicate that the risk to security and reliability of customer supplies has been ignored. The AER needs to consider the full range of ActewAGL Distribution's deterministic and probabilistic criteria to appreciate that the risks of customer outages and unserved energy is inherently being taken into account, without actually being the subject of unserved energy calculations using VCR (whether it be the AEMO VCR, or ActewAGL Distribution proposed VCR).

[1] AER 2014, *Draft Decision ActewAGL Distribution Determination: ActewAGL Distribution Determination* . P6-30
[2] AER 2014, *Draft Decision ActewAGL Distribution Determination: ActewAGL Distribution Determination* . P6-34

# 2. Summary of ActewAGL Distribution's network augmentation standards

## 2.1 Transmission lines

### 2.1.1 System normal ratings

ActewAGL Distribution rates its transmission lines (132 kV) under system normal conditions based on the assumption that at the time of system maximum demand, ambient temperatures will be 35°C in summer and 15°C in winter. It is also assumed that the wind speed is 1.0 m/s, and at right angles to the transmission line. There are also a number of other assumptions about ambient conditions. If an outage of a transmission line occurs at the time of the maximum demand on that part of the system, there will not be a loss of supply as the system is designed with N-1 security (100% redundancy). There is no, or near zero, risk of loss of supply to customers if the assumed ambient conditions are approximately correct.

### 2.1.2 Emergency ratings

Once an N-1 situation has occurred however (for example, storm or wind damage has damaged one of the transmission lines, and a permanent fault has occurred), the remaining healthy transmission line(s) are given a much higher rating which assumes the same wind speed, but allows for the maximum conductor temperature to rise from 75°C to 120°C (which would be 40°C and 85°C respectively above the 35°C assumed ambient temperature in summer).

Under such N-1 conditions the remaining healthy feeder(s) would be loaded to much higher loads than normal, and there is an increased risk that a second outage may develop due to:

- Conductor annealing and failure
- Overheating and failure of bridges, clamps, connectors, conductor joints, and other similar hardware
- The second healthy circuit tripping out simply because the actual load has exceeded the protection settings
- The conductors on the remaining healthy circuit may sag below their statutory ground clearance, causing a safety hazard
- The actual load on the remaining healthy feeder may be higher than forecast because the ambient conditions are more onerous than expected (for example, the ambient temperature may be 40°C, not 35°C)

As indicated in section 6.5.1 of ActewAGL Distribution's SRP, on average across the whole of ActewAGL Distribution's transmission system, the application of the transmission line emergency ratings increases the summer ratings by 51.7%, and winter ratings by 30.5%.

### 2.1.3 General electricity industry practice

Jacobs is aware that contemporary electricity industry practice by Australian TNSPs and DNSPs is varied in regard to transmission line ratings (specifically 132 kV). Most, if not all TNSPs and DNSPs assign 'system normal' and 'emergency ratings' but use different ambient temperature and wind-speed criteria for those ratings. All use assumptions about ambient temperatures that are appropriate to their geographical locations, and assumptions about prevailing wind-speeds typically vary from 0.5 m/s to 1.0 m/s for 'system normal' ratings, and 1.0 m/s to 2.0 m/s for 'emergency' ratings. Such differing assumptions about wind speed do not result in emergency ratings as high as those adopted by ActewAGL.

ActewAGL Distribution's emergency rating criteria is considered to be at the 'upper end' of emergency ratings, indicating that it can hardly be considered as conservative, and is considered appropriate to be applied to the southern supply to the ACT – Stage 2 Transmission project.

## 2.2 Zone substations

### 2.2.1 Transformer ratings

The cyclic and emergency ratings of zone substations are normally determined by the ratings of the installed transformers. On some occasions the substation emergency ratings may be constrained by other items of equipment in the substation other than the transformers (eg, switchgear, cables, etc.). In such cases the emergency rating of the constraining piece of equipment is used.

Power transformers typically have up to four (4) assigned ratings:

- **Nameplate rating** – this is the continuous and constant load that a transformer can deliver, 24 hours per day, seven days per week, 365 days per year, with an acceptable loss of operating life. There may be different nameplate ratings given for different cooling modes (eg, ONAN, ONAF, OFAF, and other similar ratings). Nameplate rating is normally considered as the 100% base rating.
- **Normal cyclic rating** – this is the continuous cyclical load that a transformer can deliver, 24 hours per day, seven days per week, 365 days per year, while still maintaining an acceptable loss of operating life. The normal cyclic rating is higher than nameplate rating by a margin that is dependent on the load shape.
- **Six month emergency cyclic rating** – this is the cyclical load that a transformer can deliver nominally once or twice in its operating life under fault conditions, while still maintaining an acceptable loss of asset life. The six month period is selected on the basis that this is the expected replacement time for a power transformer, assuming no system spare transformer is available. The six month emergency cyclic rating is higher than both the nameplate and normal cyclic ratings by a margin that is dependent on the load shape.
- **Two hour emergency cyclic rating** – this is the maximum short time load that a transformer can carry nominally once or twice in its operating life under fault conditions, while still maintaining an acceptable loss of life. The two hour time is selected on the assumption that a DNSP will be able to despatch crews to enable manual switching to be done, to either transfer or shed load within this duration. Alternatively, modern SCADA systems and distribution automation systems could enable remotely controlled load shedding or transfers within much shorter periods of time.

ActewAGL Distribution adopted the use of two hour emergency cyclic ratings and normal cyclic ratings for its zone substations some years ago. Manufacturer's nameplate ratings for continuous and two hour emergency loading of power transformers are used for calculating the permissible loading on zone substations. For older transformers where manufacturer's recommendations on short term emergency loadings are unavailable, ActewAGL Distribution uses the methodology detailed in AS/NZS 60076.7:2013 - Power transformers, Part 7: Loading guide for oil-immersed power transformers (IEC 60076-7, Ed. 1.0 (2005) MOD).

For assets other than power transformers, ActewAGL Distribution regularly reassesses the cyclic loading capability based on the nameplate ratings.

ActewAGL Distribution does not use the six month emergency cyclic rating, but instead uses the more onerous two hour emergency cyclic rating for all its power transformers, even though it does not currently hold a system spare power transformer for the network.

ActewAGL Distribution maintains a high level of zone transformer utilisation by the adoption of the two hour emergency rating, and effective load balancing between zone substations wherever possible. During the 2009-14 regulatory period a conscious decision was made to install just a single transformer in the new East Lake zone substation, and operational plans were developed to enable East Lake, Fyshwick, and Telopea Park zone substations to be operated on a 'combined N-1 basis'.

This means that instead of each zone substation being operated individually on an N-1 basis, the substations at Eastlake, Fyshwick, and Telopea Park are operated as a combined group, such that the loss of any one of the total of seven transformers (a significantly increased risk) can be covered by load transfers on the 11 kV distribution system. Depending on which transformer in the group fails, some load may be lost initially, but able to be restored with manual switching.

### 2.2.2 General electricity industry practice

Jacobs is aware that contemporary electricity industry practice by Australian DNSPs is varied in regard to power transformer ratings. Some DNSPs use normal cyclic ratings, some use the six month emergency cyclic rating, and some use the two hour emergency cyclic rating. The appropriateness of each rating is dependent upon the substation configuration, the load shape and criticality, and the availability of adequate load transfer capability. Some DNSPs use unserved energy and VCR modelling to determine the optimum timing of substation augmentations, while others use essentially deterministic criteria.

In conclusion, and considering all of the differences in system security and planning criteria across DNSP's in the NEM, Jacobs does not consider that ActewAGL's zone substation loading methodology as described above is overly conservative.

# 3. Contemporary electricity industry policies and practices

## 3.1 Differing security of supply and planning criteria across Australia

Jacobs is aware of the range of deterministic, probabilistic and hybrid (a mixture of both), system security and planning criteria used by most DNSPs in Australia. This was the subject of an SKM (Jacobs) report to the AEMC in May 2009, and Jacobs has kept abreast of further changes/refinements by some DNSPs to their security and planning criteria since that time (including ActewAGL Distribution).

ActewAGL Distribution is not alone in the NEM, in not using unserved energy modelling to justify the scope and timing of augmentation projects. In fact the majority of DNSPs still use a mixture of mainly deterministic criteria, together with an acceptable level of risk of loss of load under certain contingency conditions, but with the magnitude and duration of lost load constrained to certain values.

## 3.2 Safety net approach in Queensland

System security and planning criteria in Queensland are contained within the distribution authorities of the Queensland DNSPs and they are slightly different for Ergon and Energex. Both DNSP's use a suite of mainly deterministic criteria overlaid with a set of safety net limits on the amount of load that may be lost under certain contingency situations. The load at risk limits for Energex and Ergon Energy are as shown in Table 1 and Table 2 below:

Table 1 Energex

| Feeder Type | Targets |
|---|---|
| CBD | • Any interruption in customer supply from an N-1 event at the sub-transmission level is restored within one minute |
| Urban – Following an N-1 event | • No greater than 40 MVA (16,000 customers) is without supply for more than 30 minutes<br>• No greater than 12 MVA (5,0000 customers) is without supply for more than three hours<br>• No greater than 4 MVA (1,600 customers) is without supply for more than eight hours |
| Short Rural – Following an N-1 event | • No greater than 40 MVA (16,000 customers) is without supply for more than 30 minutes<br>• No greater than 15 MVA (6,000 customers) is without supply for more than four hours<br>• No greater than 10 MVA (4,000 customers) is without supply for more than 12 hours |

In effect, some customers may be off supply, for a normal single contingency event, for durations of up to 11.5 hours (extreme events excluded).

Table 2 Ergon Energy

| Feeder Type | Targets |
|---|---|
| Regional Centre | Following an N-1 Event, load not supplied must be:<br>• Less than 20 MVA after one hour<br>• Less than 15 MVA after six hours<br>• Less than 5 MVA after 12 hours<br>• Fully restored within 24 hours |

| Feeder Type | Targets |
|---|---|
| Rural area | Following an N-1 Event, load not supplied must be:<br>• Less than 20 MVA after one hour<br>• Less than 15 MVA after eight hours<br>• Less than 5 MVA after 18 hours; and<br>• Fully restored within 48 hours |

In effect, some customers may be off supply, for a normal single contingency event, for durations of up to 24 hours in regional centres, and 48 hours in rural areas (extreme events excluded).

We understand that these limitations on the magnitude of load lost were adopted because of concerns that the unserved energy approach when linked to relatively low values of VCR could result in an unacceptable level of system integrity and reliability (from both a customer and DNSP perspective).

## 3.3 Unserved energy approach in Victoria

The unserved energy approach to optimise the scope and timing of zone substation augmentation projects has been used by the Victorian DNSPs for many years. The use of this approach (also known as energy at risk modelling), was originally based on a 1997 Monash University study of VCR, which was subsequently updated by a 2008 VENcorp study.

There are differences however, between the way in which substation ratings are determined by the Victorian DNSPs to apply their unserved energy calculations, when compared with the substation ratings determined by ActewAGL Distribution. These differences can be summarised as follows:

**Victorian DNSPs:** Timing of zone substation augmentation is when load exceeds cyclic emergency rating and unserved energy equals annualised cost of augmentation.

**ActewAGLDistribution:** Timing of zone substation augmentation is when load exceeds two hour emergency rating of the substation.

The use of the higher (two hour) emergency rating by ActewAGL Distribution essentially means that it may be operating within the same 'risk zone' as the unserved energy approach used by the Victorian DNSPs.

## 3.4 Impact of a lower VCR

Historically, DNSPs who have applied an unserved energy approach to planning the augmentation of their power systems, have used either the Monash University study figures or the VENcorp figures, which typically resulted in an average value of VCR in the approximate range of $41.00 - $57.00/kWh (which varied according to the customer mix on a state-wide basis).

As noted in the AER draft decision, the AEMO values of VCR for NSW (including the ACT), are lower than the values proposed by ActewAGL Distribution, and are in fact materially lower than the values concluded by previous studies.

The reasons behind the AER overall reduction of state by state VCR is unclear, and it is noted that some customer category VCR's increased slightly (eg, industrial), while other customer categories' decreased markedly.

The overall impact of the materially lower average AER VCR is to defer augmentation projects, in some cases to a point where the maximum demand could exceed the cyclic rating of the substation with all equipment in service (ie, no N-1 contingency event). Such a situation would result in excessive loss of asset life of the installed transformers.

The Victorian DNSP's have written to AEMO expressing concern, and seeking to ensure that:

- The VCR used in network planning evaluations is fit for purpose
- The VCR is applied in an appropriate manner, having regard to the inherent uncertainty of its estimated value

The main concerns of the Victorian DNSP's fall under four broad headings.

1) Recognising error and uncertainty
2) Cost of high impact, low probability events
3) Costs of widespread outages
4) Potential re-weighting of outage probabilities

# 4. National electricity objective

The AER draft decision dated November 2014, rejects a number of ActewAGL Distribution's proposed network augmentation projects on the basis that *"…of the information before us, these amounts are overstated and exceed the amount required to achieve the capex objectives."*[3]

The National Electricity Objective[4] is to:

*"promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers with respect to:*

*a) Price, quality, safety, reliability and security of supply of electricity, and*

*b) The reliability, safety and security of the national electricity system."*

The AER further outlines in the draft decision, its assessment techniques (eg, capex benchmarking, trend analysis, capex criteria, engineering review), and a range of capex factors that it has taken into account in reaching its draft decision for capex. These are contained in Table 6-5 (p 6-28), and include factors such as:

- Recent benchmarking analysis and results
- The actual and expected capex during any preceding regulatory control period
- Expenditure to address concerns of electricity consumers
- The relative prices of operating and capital inputs
- Substitution possibilities between operating and capital expenditure
- Consistency between the capex forecast and any incentive scheme or schemes that apply to ActewAGL Distribution.
- Extent to which the capex forecast is referable to other arrangements with a person other than the DNSP that do not reflect arm's length terms
- Whether the capex forecast includes an amount for a project that should more appropriately be considered a contingent project
- The extent to which ActewAGL has considered and made provision for efficient and prudent non-network alternatives
- Any relevant final project assessment report (as defined in clause 5.10.2 of the NER)
- **Any other factor the AER considers relevant and which the AER has previously notified to ActewAGL Distribution in writing**

Lastly, the AER has undertaken an engineering review of ActewAGL Distribution's major augmentation projects, and it is in the conducting of some of these engineering reviews that Jacobs believes the AER's analysis has erred. None of the above capex factors refer to the use of unserved energy calculations for augmentation planning purposes, and unserved energy modelling is not referred to by any National or ACT jurisdictional documents.

[3] AER 2014, *Draft Decision ActewAGL Distribution Determination: ActewAGL Distribution Determination* , Table 6-2, p 6-10
[4] National Electricity Law (NEL)

# 5. Modelling of 'unserved energy'

Throughout attachment 6 of the AER's draft decision, there is consistent reference to projects not being justified on the basis that *"…no analysis of the probability of risk and cost of unserved energy has been carried out."*

Specifically on p6-34 of attachment 6, AER commented that:

> *"It appears that ActewAGL Distribution has used overly conservative criteria when making augmentation decisions on zone substations. In our view, this has affected the scope and unnecessarily advanced the timing of projects. For example, clause 6.2.2 of ActewAGL Distribution's distribution network augmentation standard states:*
>
> > *"Zone substation capacity must be augmented if the forecast zone substation maximum demand based on 10% PoE under N-1 conditions is to exceed the two hour emergency rating".*
> >
> > *"Major zone substation augmentation such as installation of additional transformer will not be considered unless other constraints that limit the transformer loading are removed.""That is, ActewAGL Distribution augments zone substations when it expects maximum demand 10 per cent PoE forecast to exceed the substation's two hour emergency rating."*
> >
> > *"These criteria do not incorporate the change in the ACT Electricity Distribution Supply Standards Code (2013), which removed the requirement on supply capacity. The criteria also do not provide an assessment framework for evaluating and managing risks associated with expected unserved energy. Instead, the criteria require network capacity to fully meet expected maximum demand with no cost benefit assessment."*

ActewAGL Distribution has previously responded to the AER on 3 Oct 2014 (AER040) regarding the inclusion of the requirements of the ACT Electricity Distribution Supply Standards Code (2013). The removal of the requirement to put words into a customer's connection agreement that ActewAGL Distribution will ensure capacity is available in the distribution network to meet the customer demand requirements, does not remove the obligation set out in National Electricity Rules to:

> *"…(iii) **maintain the quality, reliability and security** of supply of standard control services;…"*

It is a concern that the AER conclude the removal of an obligation in the ACT Electricity Distribution Supply Standards Code (2013) of ensuring capacity is available in ActewAGL Distribution's distribution network to supply customers, removes the obligation from ActewAGL Distribution to augment its network to meet the demand growth.

Jacobs is aware that ActewAGL Distribution is familiar with the application of unserved energy (or energy at risk) modelling, and did use such an approach for one major project during the 2009/14 regulatory period (Civic zone substation switchboard replacement).

It is Jacobs' experience that unserved energy modelling is not suitable for all augmentation projects, and in some cases involves a number of subjective assumptions that leads to potential inaccuracies in the output results of the modelling. These subjectivities include:

- The assessed value of customer reliability (VCR)
- The use of average asset fault rates (whether they are DSNP specific or an industry average).
- The lack of 'age/condition sensitivity' in the results of such modelling (the modelling produces the same level of 'unserved energy' for a 'new' substation, as it would for an ageing substation at the end of its service life, when average outage rates are applied).
- The lack of 'time sensitivity' in the results, such that all unserved energy is valued at the same amount even though it is widely accepted that customer acceptance of outages decline as the duration of the outage increases

# 6. Have the AER followed due process?

Jacobs has reviewed all relevant regulatory and statutory documents, including the amended *ACT Electricity Distribution Supply Standards Code (2013),* and can find no reference that specifically requires DNSPs to justify augmentation projects on the basis of unserved energy. This includes:

- National Electricity Law
- National Electricity Rules
- National Electricity Objective
- The capex criteria
- AER assessment techniques (in draft decision)
- Capex factors (in draft decision)

The last capex factor listed on p6-29 of the AER draft decision requires AER to notify ActewAGL Distribution in writing of any additional capex factors that it requires the DNSP to take into consideration, prior to the submission of its revised regulatory proposal. This has not happened with AER's requirement that major augmentation projects undergo an unserved energy analysis.

It appears that the AER is seeking to impose a specific economic evaluation technique which would effectively change the system security and planning criteria of ActewAGL Distribution.

Unserved energy modelling is not a specific requirement of any element of the national regulatory regime, nor the ACT Electricity Distribution Supply Standards Code (2013). In addition, Jacobs would have serious concerns about an economic evaluation technique which relies on the robustness of a particular customer survey technique and which can produce such variable outcomes as is evident in the latest AEMO VCR studies, when compared with previous studies.

While Jacobs believes that there is a role for unserved energy modelling in certain circumstances, and for certain projects, such as reliability improvement (STPIS), there is not universal acceptance amongst DNSPs that it is superior to their existing system security and planning criteria.

Jacobs believe that it is inappropriate for AER to seek to impose a new and additional augmentation capex factor during the determination process.