Network Support and Control Ancillary Service (NSCAS) Quantity Procedure

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FINAL

This document has been created by the Planning Department and will be reviewed from time to time.

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Glossary

(a) In this document, a word or phrase *in this style* has the same meaning as given to that term in the NER.

(b) In this document, capitalised words or phrases or acronyms have the meaning set out opposite those words, phrases, or acronyms in the table below.

(c) Unless the context otherwise requires, this document will be interpreted in accordance with Schedule 2 of the *National Electricity Law*.

TERM	MEANING
10 % POE	A 10% probability of exceedence of *load* forecast used by AEMO for the purposes of determining the *short term capacity reserve* and *medium term capacity reserve* requirements under the *power system security and reliability standards* referred to in clause 4.9.1(e) of the NER.
APR	*Annual Planning Report*
Committed	In the context of a *transmission network* development or a *generation* project, it refers to those projects that are described as such in the relevant APR, or ESOO, as the case may be.
FACTS	Flexible alternating current *transmission system*
HVDC	High *voltage* direct current
HVAC	High *voltage* alternating current
MW	MegaWatt
MVAr	Mega Volt Amp reactive
NEM	*National Electricity Market*
NER	National Electricity Rules
NLAS	Network loading ancillary service
NSCAS Description	The document available in December 2011
NTNDP	National Transmission Network Development Plan, as that term is defined in the *National Electricity Law*
N-1	A *network* with one element out of service
OPDMS	AEMO's Operations and Planning Data Management System
P	Real power
Q	*Reactive power*
QV	*Reactive power* – *voltage* curve
Reactive power safety margin	The amount of *reactive power* (in MVAr) to be added on top of the *reactive power reserve* requirement to obtain the total amount of *VCAS*
RIT-T	*Regulatory investment test for transmission*
ESOO	*Electricity statement of opportunities*

TERM	MEANING
STATCOM	Static compensator - A device specifically provided on a network to generate and absorb *reactive power* similar to a *synchronous compensator*
SVC	*Static VAR compensator*
TNSP	*Transmission Network Service Provider*
TOSAS	Transient and oscillatory stability *ancillary service*
VCAS	*Voltage* control *ancillary service*

1 Introduction

(a) This NSCAS Quantity Procedure is made in accordance with clause 3.11.4(a) of the National Electricity Rules (**NER**).

(b) This NSCAS Quantity Procedure commences on 5 April 2012.

(c) This NSCAS Quantity Procedure may only be amended in accordance with clause 3.11.4(c).

(d) If there is any inconsistency between this NSCAS Quantity Procedure and the NER, the NER will prevail to the extent of that inconsistency.

2 Purpose

This document details a procedure for determining the location and quantity of each type of *NSCAS* required.

3 Type of NSCAS required to be procured

There are three types of *NSCAS*:

- *network* loading *ancillary service (NLAS);*
- *voltage control ancillary service (VCAS); and*
- *transient and oscillatory stability ancillary service (TOSAS).*

These are described in detail in the NSCAS Description.

4 Determining the Quantity of NLAS

The purpose of NLAS is to allow an increase in the *power* transfer of a *transmission network* whilst ensuring that the *network* will still be in a *secure operating state*. NLAS could be in a form of reduction of *load*, increase/decrease in *generation*, increase in inertia, or increase in fault levels.

For determining the NLAS needs to increase power transfer over the AC *transmission networks, load* flow analysis will be used.

For determining the NLAS needs to increase the *power* transfer through HVDC links, design or commissioning information on variation of *power transfer capability* of the links with system inertia or *power system* fault levels will be used.

AEMO will undertake the following steps in determining the quantity of NLAS required:

(1) Identify transmission issues

AEMO will identify issues related to *power system security* for which control of loading of the *transmission network* is likely to be an effective solution. The issues will be identified from review of previous APRs, NTNDPs, previous assessments of NLAS, and operational experience. Additional issues may also be identified through the *power system* simulation studies carried out in step 4.

AEMO will also review at least the top 10 binding system normal *constraint* equations to identify the *network* loading issues, resolution of which may provide sufficient economic benefits to all those who produce, consume or transport electricity in the *NEM.*

(2) Collect required data for further assessment of NLAS needs

AEMO will obtain the following information (if it is not already available to AEMO):

- *Interconnector active power* transfer limits, continuous and *ratings* of *transmission* assets from the relevant TNSP;
- A list of future Committed *transmission network* and *generation* developments from the most recent relevant APRs and ESOO;
- TNSP's *connection point* MW and MVAr forecasts from the most recent relevant APRs; and
- For determining NLAS needs to improve the capability of a HVDC link, assessment of the variation of capability of the link with system inertia or fault levels, and modelling data and operating information for confirming this assessment.

(3) Develop study cases

Study cases will be developed to model the relevant *power system* operating conditions.

NSCAS needs are to be assessed over a five-year planning horizon and, hence, five years' of future Committed *transmission network augmentations* and new *generation* projects will be included in the study cases.

(4) Conduct power system simulation studies to determine the NLAS needs

Pre- and post-contingency, *power system* simulation studies will be carried out to determine the indicative NLAS need for resolving a specific issue, which depends on the location of the NLAS and how quickly the NLAS can be dispatched.

A margin can be applied to the indicative NLAS needs identified to take into account the uncertainties in the *power system* simulation studies.

The NLAS must be provided in the appropriate *region* to have the desired effect. For example, for a NLAS by way of controlling *generation* to be effective for reducing line loading following a contingency of a parallel line, the *generating units* associated with this NLAS will need to be located in the importing *region*.

Further, the impact of subsequent changes in *power system* operating conditions, such as a *generating unit* responding to post-contingency *power system frequency* changes also has to be considered. NLAS may need to be location-specific to have the desired effect. For example, to be effective for improving the *active power* transfer of an HVDC link, an increase in fault level will need to be close to the inverting HVDC terminal.

AEMO will use the NLAS quantities acquired during the previous year as a guide for ensuring the quality of its NLAS need assessments.

(5) Conduct economic benefit assessment of NLAS for enhancing network transfer capability

For the identified binding system normal *constraint* equations, AEMO will carry out economic benefit assessments, and will determine the value of procurement of

NLAS for relieving the relevant *constraints*. This economic benefits assessment is outlined in Section 7.

5 Determining the Quantity of VCAS

The requirements for VCAS are strongly localised. Therefore, for this assessment, AEMO will specify VCAS needs on a bus or an area basis. AEMO will assess the VCAS needs based on *credible contingency events* in the *transmission network* that could result in a *voltage* issue or a *voltage* stability issue in the identified area.

VCAS may be in the form of services that *generate reactive power*, thus improving *voltage* stability and mitigating the *network's* low *voltage* issues or in the form of services that absorb *reactive power*, thus mitigating the *network's* high *voltage* issues.

Following are the steps AEMO will undertake to determine the quantity of *VCAS* required:

(1) Identify issues

AEMO will identify *power system security* and *network* transfer capability issues which can be mitigated by regulating the *network voltages* within required limits or maintaining the *voltage* stability. The issues will be identified from a review of previous APRs, NTNDP, previous assessments of VCAS, and operational experience. Additional issues may also be identified though the *power system* simulation studies carried in step 4.

AEMO will also review at least the top 10 binding system normal *constraint* equations to identify the *network voltage* quality or *voltage* stability issues, resolution of which may provide sufficient economic benefits to all those who produce, consume or transport electricity in the *NEM.*

(2) Collect required data for further assessment of VCAS needs

AEMO will obtain the following information:

- Historical *power system* snapshots representative of high and low demand conditions;
- A list of Committed *transmission network* developments and new *generation* proposals from the most recent relevant APRs and ESOO;
- TNSP's *connection point* MW and MVAr forecasts from the most recent relevant APRs;
- *Generating unit reactive power* capabilities (both physical and according to agreed *performance standards)*;
- Technical details of the existing *network support agreements*;
- Maximum fault levels for ensuring that sufficient reactive support margin are maintained in accordance with clause S5.1.8 of the NER.

(3) Develop study cases

Study cases will be developed to model the relevant *power system* operating conditions, including maximum demand, minimum demand or conditions corresponding to extreme *inter-regional* imports/exports.

VCAS requirements are to be assessed over a five-year planning horizon and, hence, five years' of future Committed *transmission network augmentations* and new *generation* projects will be included in the study cases.

These study cases will then be used in studies to determine VCAS needs.

(4) Conduct power system simulation studies to determine the VCAS needs

VCAS may need to be location-specific to have the desired effect, for example, control of *voltage* at a specific busbar. AEMO will simulate critical *credible contingency events* at various locations and determine whether there is any *voltage* limit violation or shortage in *reactive power* margin and, therefore, a VCAS need. The assumptions used to determine the VCAS quantities are detailed in Schedule 1.

AEMO will use the VCAS quantities acquired during the previous year as a guide for ensuring the quality of its VCAS need assessments.

A Reactive Power Safety Margin is also applied in determining the VCAS requirement. The Reactive Power Safety Margin to be applied is at least 1% of the maximum fault level at each *connection point* (expressed as capacitive *reactive power* in MVAr) as required by clause S5.1.8 of the NER[1].

The VCAS needs for maintaining the required Reactive Power Safety Margin can be determined by QV analysis using the peak load loadflow study cases.

In situations where the *reactive power* supply may not be adequate to meet the *reactive power* demand, while the power system is in a transient state following a contingency, *power system* dynamic simulations will be performed to determine the VCAS needs.

(5) Conduct economic benefit assessments of VCAS for enhancing network transfer capability

For the identified binding system normal *constraint* equations, AEMO will carry out economic benefit assessments, and will determine the value of VCAS for relieving the relevant *constraints*. This economic benefits assessment is outlined in section 7.

6 Determining the Quantity of *TOSAS*

TOSAS may be provided in the form of many different types of services, including those that can control and fast-regulate *network voltage*, increase the inertia of the rotating mass connected to the *power system*, or rapidly increase or reduce the *load connected* to the *power system*.

Following are the steps AEMO will undertake in determining the quantity of *TOSAS* required:

(1) Identify issues

AEMO will identify a *transmission network's* transient or oscillatory stability issues for which TOSAS is likely an effective solution. The issues will be identified from

[1] AEMO will also consider other criteria, if any, used by the relevant TNSP in determining the VCAS requirement.

APRs, NTNDP, previous assessments of NSCAS, and operational experience. Additional issues may also be identified through the *power system* simulation studies carried in step 4.

AEMO will also review at least the top 10 binding system normal *constraint* equations to identify the *network's* transient and oscillatory stability issues, resolution of which may provide sufficient economic benefits to all those who produce, consume or transport electricity in the *NEM.*

(2) Collect required data for further assessment of TOSAS requirements

AEMO will collate information and data necessary for modelling and simulating the transient or oscillatory stability performance of the *power system*, including the following:

- Data for modelling the performance of the existing *generating systems*, such as the performance of *generating units*, governors, voltage regulators, and *power system* stabilisers during transient periods following a disturbance;
- Data for modelling the performance of the existing dynamic *plant* in the *network*, including SVC, HVDC, STATCOM, breaking resistors and any other FACTS devices;
- Data for modelling the performance of relevant fast control schemes that affect *power system* performance during transient periods following a disturbance;
- Clearance times of key *transmission network* components;
- A list of Committed *transmission network* developments and new *generation* proposals and the necessary data for their dynamic modelling;
- TNSP's *connection point* MW and MVAr forecasts and regional maximum demand forecasts from the most recent APRs.

(3) Develop study cases

Study cases will be developed to model and simulate the performance of the relevant *power system* during the transient period following a disturbance under a number of operating conditions, including maximum demand, minimum demand conditions, trough demand or conditions corresponding to particular *inter-regional* import/exports patterns, for assessing TOSAS requirements. Study cases may include some or all of the *regions* because transient or oscillatory stability might not be localised. The cases will then be used in transient or oscillatory stability simulation studies to determine the quantity of the requirements.

TOSAS requirements are to be assessed over a five-year planning horizon and, hence, five years' of future Committed *transmission network augmentations* and new *generation* projects will be included in the study cases.

(4) Conduct transient stability and/or oscillatory stability simulation studies to determine the TOSAS requirements for security and reliability

AEMO will first simulate transient instability conditions resulting from critical *credible contingency events* at relevant locations or identify oscillatory modes with insufficient damping. Then further simulation studies will be carried out to identify the quantity of TOSAS required to make the *power system* transient or oscillatory stable, according to the stability criteria and standards in the NER, particularly clause S5.1.8.

A margin will be added to the assessed TOSAS quantity to take into account the uncertainties in the *power system* simulation studies.

The assumptions used in the simulation studies are documented in Schedule 1.

(5) Conduct economic benefit assessments (market simulation studies) for TOSAS for enhancing network transfer capability

For the identified binding system normal *constraint* equations, AEMO will carry out economic benefit assessments, and will determine the value of TOSAS for relieving the relevant *constraints*. This economic benefits assessment is outlined in section 7.

7 Assessment of economic benefits

This section details the process used by AEMO to assess the economic benefits of NSCAS. The purpose of this is to indicate the economic value of relieving a binding constraint if NSCAS can be procured at a cost lower than the assessed economic benefit. Where such opportunities are identified, the local TNSP should consider this information and, if warranted, proceed either to procure NSCAS or to make a network investment, subject to a RIT-T or other justification as required.

The RIT-T, or other justification, takes into account the economic value of relieving the *constraint*, the costs of implementing various options available for relieving the *constraint*, and any other economic costs and benefits.

The economic benefit test used for a screening analysis in the NTNDP process is aligned with the requirements of the RIT-T. However AEMO is undertaking a screening analysis, and the test it performs cannot supplant the economic test a TNSP would need to perform to compare the options available to fulfil the need identified in the NTNDP. At the time of identification and publication in the NTNDP of a need AEMO will not be carrying out an in-depth economic analysis, with the accuracy and comprehensiveness required for justifying procurement of a *network support agreement* or investment in new assets.

These are the steps AEMO will follow to determine the economic benefit of using NSCAS for relieving a *constraint*:

1. Identify where the NSCAS may be able to provide *market* benefits;
2. Assess the benefits of that NSCAS using a *market* modeling approach as follows:
    a) Calculate the NSCAS requirements to increase power transfer capability in discrete quantities;
    b) For each level of *power transfer capability* increase, calculate the *market* benefits relative to a reference case (no NSCAS):

- Test and validate a set of *dispatch constraints* that are affected by the NSCAS option;
- Determine annual benefits over a planning horizon of 5 years or longer, if warranted;
- Consider committed and advanced *generation* projects[2] only for assessing benefits in the next 5 years. For a longer term assessment, use new entry generation schedules as per the NTNDP scenarios;
- Use demand assumptions from latest ESOO;
- Capture *generation outages*.

c) Plot market benefits on a *market* benefits curve.

The *market* benefits curve would show how *market* benefits increase as the limiting transfer capability of a *transmission network* is relaxed. The *market* simulation will provide an indication of *market* benefits of the relevant NSCAS options.

This approach identifies the *market* benefits of avoiding *unserved energy* and enabling efficient *generation dispatch*. It does not consider any other benefit including::

- Capital deferral;
- Reductions in *ancillary service* costs;
- Competition benefits;
- Reduction in impact of high-impact-low-probability events; and
- Additional optional value gained or forgone from implementing the investment.

These additional benefits should be captured in any RIT-T or other economic test undertaken, if considered material from an NSCAS perspective. AEMO will consider these additional market benefits if they are deemed to be important to the market benefit test decision, and if it is practical to do so.

[2] As per AEMO's Generation Information Page: http://aemo.com.au/data/gendata.shtml

Schedule 1: Assumptions for NSCAS need assessments

These are the assumptions made when determining the required *NSCAS.* Some of the assumptions are applicable to the assessment of all NSCAS types and the others are only applicable to certain types.

1) Assumptions associated with *generation* and *interconnector* transfers:

- All *scheduled generating units* required to meet 10% POE demand are assumed to be in service.
- Committed new *generating units*, as reported in the most recent ESOO, are assumed to be in service and are included in the *power system* model.
- If the total *generation* comprised of the existing *scheduled generating units* and future Committed *generating units* is insufficient to meet 10% POE demand, some proposed *generation* projects, as reported in the most recent ESOO, will be assumed in service to meet the 10% POE demand..
- When simulating *credible contingency events*, a *generating unit* in the region may be assumed out of service as a prior *outage* to assess the impact of variations in total *generation* availability on NSCAS needs provided that the remaining *generation* still meets 10% POE demand.
- *Generating unit* capacities are obtained from the most recent ESOO, with their *reactive power* outputs capped to the values specified in their *performance standards.*
- *Interconnector* transfer capability is initially assumed to be the transfer capability modeled in the base cases developed for NTNDP studies. If it is necessary to alter the original transfer capability modeled, the revised transfer capability will not exceed the maximum *interconnector* transfer limit.
- *Generation* future *dispatch* patterns will be derived considering the assumed short run marginal costs used in NDNTP *market* simulation and also operational experience for existing *generating units*.
- *Intermittent generation* is assumed to be *generating* at either its maximum or minimum levels, so that VCAS can be estimated conservatively as required under these conditions.

2) Assumptions associated with Loads and demands

- The 10% POE *regional* demand forecasts developed by AEMO for the ESOO will be used to determine *reactive power* injection requirements. The medium economic growth scenario will be used as a base case, with the impact of other scenarios assessed in high level relative to the base case.
- The minimum *regional* demands observed in *power system* snapshots from AEMO's Operations and Planning Data Management System (**OPDMS**) representing the actual minimum *regional* demand conditions in the past 12 months will be used to determine *reactive power* absorption requirements. It is assumed that the minimum *regional* demand will stay constant over the planning horizon for determining VCAS.
- *Loads* are modelled in a manner consistent with the type of the study to be performed for determining the NSCAS need. .
- The load power factors at 10% POE *regional* demands are consistent with either *connection point* (or bulk supply point) MW and MVar forecasts provided by TNSPs,

or the load power factors observed at maximum *regional* demand over the past three years, if suitable MW and MVar forecasts from TNSPs are not available.

3) Other Assumptions

- Only Committed *transmission network augmentations* are modelled in determining NSCAS.
- Existing *network support agreements* are assumed to be in place until TNSP advises that they have expired.
- Relevant control schemes are enabled as appropriate in assessment of NSCAS needs.
- All installed *reactive plant* is available and in service.
- AEMO will only simulate an N-1 level of *credible contingency events*. The worst *credible contingency event* modelled is based on contingency analysis outcomes. Other contingencies may be simulated and assessed if required.
- Prior *transmission network outages* are not considered because they would not be permitted to proceed if *power system security* could not be maintained.