Australian Energy Market Commission

AEMC Reliability Panel

Transmission Reliability Standards Review

Issues Paper

December 2007

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About the AEMC

The Council of Australian Governments, through its Ministerial Council on Energy, established the Australian Energy Market Commission (AEMC) in July 2005 to be the Rule maker for national energy markets. The AEMC is currently responsible for Rules and policy advice covering the National Electricity Market. It is a statutory authority. Our key responsibilities are to consider Rule change proposals, conduct energy market reviews and provide policy advice to the Ministerial Council as requested, or on AEMC initiative.

About the AEMC Reliability Panel

The Panel is a specialist body within the AEMC and comprises industry and consumer representatives. It is responsible for monitoring, reviewing and reporting on the safety, security and reliability of the national electricity system and advising the AEMC in respect of such matters. The Panel's responsibilities are specified in section 38 of the NEL.

Disclaimer

The views and recommendations set out in this document are those of the Reliability Panel and are not necessarily those of the Australian Energy Market Commission.

Foreword

This Issues Paper represents the first stage in the Reliability Panel's (the Panel's) review of transmission reliability standards across the National Electricity Market (NEM).

On instruction from the Council of Australian Governments (COAG), the Australian Energy Market Commission ("the Commission") has been directed by the Ministerial Council for Energy (MCE) to "review transmission network reliability standards with a view to developing a consistent national framework for network security and reliability, for MCE decision". The direction reflects COAG's response to the Final Report of the Energy Reform Implementation Group (ERIG).

The Commission in turn has asked the Reliability Panel to undertake the review of the jurisdictional transmission reliability standards and provide advice to the Commission. The Commission's Terms of Reference to the Panel are provided as an attachment to this Issues Paper. The Terms of Reference require that the Reliability Panel provide its final report to the Commission by 23 September 2008, so that the Commission can provide a report to the MCE by 30 September 2008.

The Panel welcomes submissions from stakeholders by 8 February 2008 on the specific issues highlighted throughout the document. In particular, the Panel is seeking views on:

- Approaches that could be taken towards developing a consistent framework of transmission standards across the NEM.
- What does a 'nationally consistent' framework mean?
- To what degree should the framework include specific levels of reliability?
- Who will define the framework?
- Who would define any standards within that framework?
- What are the interactions between the framework standard and other parts of the regulatory regime?
- What steps are required to implement the new framework?

The Panel looks forward to receiving your contributions to this important Review.

Ian C Woodward

Chairman, Reliability Panel
Commissioner, Australian Energy Market Commission

Other AEMC Reliability Panel Members

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Contents

Abbreviations

ACCC	Australian Competition and Consumer Commission
AEMC	Australian Energy Market Commission
AER	Australian Energy Regulator
BETTA	British Electricity Trading and Transmission Arrangements
capex	Capital Expenditure
CBD	Central Business District
COAG	Council of Australian Governments
Commission	see AEMC
CPI	Consumer Price Index
CRR	Comprehensive Reliability Review
DNSP	Distribution Network Service Providers
DSC	Distribution System Code
ERIG	Energy Reform Implementation Group
ESC	Essential Services Commission (Victoria)
ESCOSA	Essential Services Commission of South Australia
ESIPC	Electricity Supply Industry Planning Council
ETC	Electricity Transmission Code
ETSA	ETSA Utilities
FCAS	Frequency Control Ancillary Services
FERC	Federal Energy Regulatory Commission (USA)
IEC	International Electrotechnical Commission
ISO	Independent Systems Operator
JPB	Jurisdictional Planning Body
kV	Kilovolt
MCE	Ministerial Council on Energy
MNSP	Market Network Service Provider
MW	Megawatt
NCAS	Network Control Ancillary Services
NECA	National Electricity Code Administrator
NEL	National Electricity Law

NEM	National Electricity Market
NEMMCO	National Electricity Market Management Company
NER	National Electricity Rules
NERC	North American Electricity Reliability Corporation
NTNDP	National Transmission Network Development Plan
opex	Operating Expenditure
PASA	Projected Assessment of System Adequacy
PJM	Pennsylvania-Jersey-Maryland
QCA	Queensland Competition Authority
RNPP	Tasmanian Reliability and Network Planning Panel
Rules	National Electricity Rules
SCO	Standing Committee of Officials
SVC	Static VAR Compensators
SOO ANTS	Statement of Opportunities Annual National Transmission Statement
TNSP	Transmission Network Service Provider
TUoS	Transmission User of Service
USE	Unserved energy
VCR	Value of Customer Reliability
VESC	Victorian Electricity System Code
VoLL	Value of Lost Load
WACC	Weighted Average Cost of Capital

1 Background

1.1 What has led to this Review

On 3 July 2007, the Ministerial Council on Energy (MCE) directed the Australian Energy Market Commission (Commission), under section 41 of the National Electricity Law (NEL), to conduct a review into electricity transmission network reliability standards, with a view to developing a consistent national framework for network security and reliability. The MCE's direction also requires the Commission to conduct a review into the development of a detailed implementation plan for the national electricity transmission planning function and develop a new form of Regulatory Test, which amalgamates the reliability and market benefits criteria of the current Test and expands the definition of market benefits to include national benefits. The Commission views the project to establish a National Transmission Planner (NTP) as related to the discrete task of developing a consistent national framework for network security and reliability. The framework of consistent national transmission reliability standards will affect the requirement for transmission development projects considered by the NTP and individual Transmission Network Service Providers (TNSPs). The standards will also affect the technical design, scale, and criteria used to evaluate transmission projects.

On 17 August 2007, the Commission requested that the Reliability Panel, in accordance with section 38 of the NEL, undertake the review of the jurisdictional transmission reliability standards and provide advice to the Commission. The Commission's Terms of Reference to the Panel are provided as an attachment to this Issues Paper. The Terms of Reference require that the Reliability Panel provide its final report to the Commission by 23 September 2008, so that the Commission can provide a report to the MCE by 30 September 2008.

This Transmission Standards Review, together with the NTP Review, are part of a range of reforms agreed to by the Council of Australian Governments (COAG) on 13 April 2007 in response to the Final Report of the Energy Reform Implementation Group (ERIG).[1] The other energy reforms agreed to by COAG in its response to ERIG have implications for the Transmission Standards Review, and their relevance and interaction are discussed in this Issues Paper.

1.1.1 ERIG Report

ERIG was established by COAG in February 2006 to develop proposals for:

- achieving a fully national electricity transmission grid;
- measures to address structural issues affecting the ongoing efficiency and competitiveness of the electricity sector; and

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[1] See COAG Communiqué, 13 April 2007 and supplementary COAG document, "COAG Reform Agenda – Competition Reform April 2007"; both available at www.coag.gov.au

- measures to ensure transparent and effective financial markets to support energy markets.

ERIG's Final Report was published in January 2007.[2]

In relation to developing an efficient national transmission grid, ERIG concluded that there is a need for a consistent national framework for transmission reliability standards. ERIG concluded that jurisdictionally based transmission reliability standards are the "principle drivers for investment in transmission"[3] and that a "clear shortcoming…is the different standards to which networks are built in each NEM jurisdiction"[4].

ERIG noted the following range of concerns with existing transmission standards:

- There is a lack of specificity in the reliability standards set out in Schedule 5.1 of the National Electricity Rules and the majority of jurisdictional reliability obligations, which are open to interpretation. The consequence of this is that TNSPs have considerable discretion in the application of reliability obligations at various locations across the network.

- There may be questions about conflicts of interest in circumstances where responsibility for either setting jurisdictional reliability criteria or for interpreting broad criteria contained in transmission licence conditions is delegated to the TNSP. "This conflict is exacerbated where the TNSP's revenue and profitability is also driven by constructing assets to meet their own reliability requirements."[5]

- "There are significant efficiency and investor certainty implications associated with the current transmission planning criteria. The lack of specificity in the current criteria and the diversity of approaches across jurisdictions may create uncertainty for investors in generation."[6]

ERIG concluded that there would be benefits from using a consistent national approach to specifying transmission standards across the NEM. It suggested three possible approaches to establishing a consistent national standard for transmission reliability:

1. A probabilistic economic reliability standard;

2. A probabilistic outcomes based standard; or

3. A deterministic redundancy planning criteria.

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[2] ERIG 2007, *Energy Reform – The Way Forward for Australia*, A report to the Council of Australian Governments by the Energy Reform Implementation Group, Canberra, January 2007. (URL http://www.erig.gov.au)

[3] ERIG 2007, p. 167

[4] ERIG 2007, p. 181

[5] ERIG 2007, p. 181

[6] ERIG 2007, p.165

These three approaches are defined and discussed in Chapter 2.

ERIG recommended that:

- "…reliability standards should at least be clear and specific as to how they are applied, be set by a body independent of the entity responsible for meeting these obligations, and be cast in technology neutral manner."[7]
- "Any technical standard should be defined narrowly and as clearly as possible." [8]
- "A consistent and clear national framework should be implemented through the redrafting schedule 5.1 of the Rules." [9]
- "The Reliability Panel would be the appropriate body to undertake the necessary review and devise such a framework before the actual standards applying to individual connection points are specified by jurisdictions." [10]
- "There may be long term benefits from making this framework consistent with the IEC [International Electrotechnical Commission] standard on reliability centred design of transmission system." [11]

ERIG's recommendations on the development of consistent national framework for reliability standards are linked to its other recommendations concerning the function and form of the Regulatory Test.[12]

Of significance for this review of transmission reliability standards, ERIG warned that the "economic benefits from integrating the two limbs of the Regulatory Test in any future investment decision making process may be eroded by poorly specified and inconsistent reliability standards and planning criteria".[13]

The AEMC is currently examining the form and function of the Regulatory Test as part of the NTP Review.

1.1.2 COAG Response to ERIG

COAG agreed with the recommendations by ERIG concerning the establishment of an enhanced planning process for the nation's electricity transmission network.

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7 ERIG 2007, p.182

8 ERIG 2007, p.182

9 ERIG 2007, p.182

10 ERIG 2007, p.182

11 ERIG 2007, p.182

12 The Regulatory Test made by the AER in accordance with clauses 5.6.5A of the NER is the principal vehicle for transmission project assessment and consultation for the NEM. The Regulatory Test consists of a 'reliability limb' and a 'market benefits limb'. For further information on the Regulatory Test, see AEMC 2007, *National Transmission Planning Arrangements, Issues Paper*, 9 November 2007, Sydney.

13 ERIG 2007, p.168

COAG consider that an enhanced planning process will "ensure a more strategic and nationally coordinated process to transmission network development, providing guidance to public and private investors to help optimise investment between transmission and generation across the power system."[14]

In relation to the review of jurisdictional electricity network reliability standards, COAG agreed that this review should be progressed, but with appropriate caution noting: the different physical characteristics of the network; existing regulatory treatments in balancing reliability and costs to consumers; and that these standards underpin security of supply.[15]

The Panel notes the cautionary qualifications outlined by COAG, which will be considered by the Panel in this review.

1.2 Panel's approach to the review

There are four key mechanisms in the NEM which affect the secure and reliable delivery of electricity to end users:

1. the reliability standard of 0.002% unserved energy (USE), set by the Reliability Panel;

2. technical standards specified in the Rules relating to security and reliability in an operational timeframe;

3. jurisdictional transmission reliability standards relating to the design and planning of transmission and distribution networks; and

4. reliability safety net provisions, comprising the Reserve Trader and NEMMCO's powers of direction for security or reliability. These safety provisions allow NEMMCO to contract for reserves when it projects reserve shortfalls and issue directions to Market Participants in order to maintain power system security or reliability.

This review is focused solely on developing a consistent national framework for reliability standards relating to the design and planning of transmission networks. These transmission reliability standards are primarily set out in jurisdictional instruments, and relate to a planning timeframe, but must conform with the technical standards specified in the Rules relating to security and reliability in an operational timeframe.

The review will not be examining issues concerning the reliability standard of 0.002% USE because the Reliability Panel has recently reviewed this standard as part of its Comprehensive Reliability Review (CRR). For the same reason, the reliability safety net provisions of the Rules will not be re-examined. As a consequence of the CRR,

[14] COAG Reform Agenda – Competition Reform April 2007 p. 4, Attachment to COAG Communiqué, 13 April 2007.

[15] *Ibid*, p.5.

the Panel will be soon lodge Rule changes with the AEMC that aim to refine the NEM's reliability safety net mechanism.

Technical standards concerning security and reliability of the bulk power system in an operational timeframe (in Chapter 5, Schedules 5.1a and 5.1 of the NER) and connection standards (Schedules 5.2 to 5.4 of NER) will be the subject of a separate review by the Panel in 2008.

1.3 Structure of this paper

The remainder of this issues paper is structured as follows:

- Chapter 2 provides an overview of the NEM and introduces basic concepts relating to power system reliability and security standards.

- Chapter 3 outlines the existing transmission reliability standards in the NEM, and briefly compares them to standards in a selection of other electricity markets. Chapter 3 also discusses the policy issues that a framework for nationally consistent transmission standards is trying to solve, the size and scope of the issues, and the motivations for changing current jurisdictional standards.

- Chapter 4 discusses three potential frameworks that could be used to improve the consistency of transmission reliability standards across the NEM. It also examines the implications arising from any attempt to change the form and/or level of existing jurisdictional transmission standards.

- Chapter 5 explores a range of issues associated with the implementation of a nationally consistent transmission reliability standard, including:

  - Who would define the framework?

  - To what level would the framework contain specific standards?

  - What implementation steps are required?

  - What process should be followed?

  - Inter-dependencies, such as standards for sub-transmission networks, the regulatory incentive regime and regulatory approval cycles.

Throughout the Issues Paper are questions which the Panel is seeking views on.

1.4 Consultation process

The following key dates outline the intended consultation process leading up to the delivery of the Panel's final report to the AEMC on a framework for nationally consistent standards for transmission network security and reliability.

Date	Milestone
21 December 2007	Publish Issues Paper
8 February 2008	Close of submissions on Issues Paper
18 April 2008	Publish Draft Report
30 April 2008	Public forum on Draft Report
3 June 2008	Close of submissions on Draft Report
30 July 2008	Submit Final Report to AEMC
30 July 2008	Publish Final Report

1.5 Submissions on the Issues Paper

The Panel invites written submissions from interested parties in response to the Issues Paper by 5pm (Australian Eastern Standard Time) on 8 February 2008. Submissions may be sent electronically or by mail in accordance with the following requirements.

1.5.1 Lodging a submission electronically

The submission must be sent by email to submissions@aemc.gov.au. The email must contain the phrase "Transmission Reliability Standards – Issues Paper" in the subject line or heading. The submission must be on letterhead (if submitted on behalf of an organisation), signed and dated. The submission must be in PDF format, and must also be forwarded to the Panel via ordinary mail.

Upon receipt of the electronic version of the submission, the Panel will issue a confirmation email. If this confirmation email is not received within 3 business days, it is the submitter's responsibility to ensure successful delivery of the submission has occurred.

1.5.2 Lodging a submission by mail

The submission must be on letterhead (if an organisation), signed and dated by the respondent. The submission should be sent by mail to:

The Reliability Panel
Australian Energy Market Commission
PO Box A2449
Sydney South
NSW 1235

The envelope must be clearly marked "Transmission Reliability Standards – Issues Paper".

Except in circumstances where the submission has been submitted electronically, upon receipt of the hardcopy submission the Panel will issue a confirmation letter. If this confirmation letter is not received within 3 business days, it is the submitter's responsibility to ensure successful delivery of the submission has occurred.

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2 NEM transmission reliability standards

This chapter provides a general introduction to the National Electricity Market (NEM), what reliability is, how transmission reliability standards are defined in the NEM, and how these fit in with other reliability mechanisms in the NEM. The chapter also discusses key concepts about reliability standards — such as the form and level of standard — which are used throughout the rest of the paper.

2.1 What is the NEM?

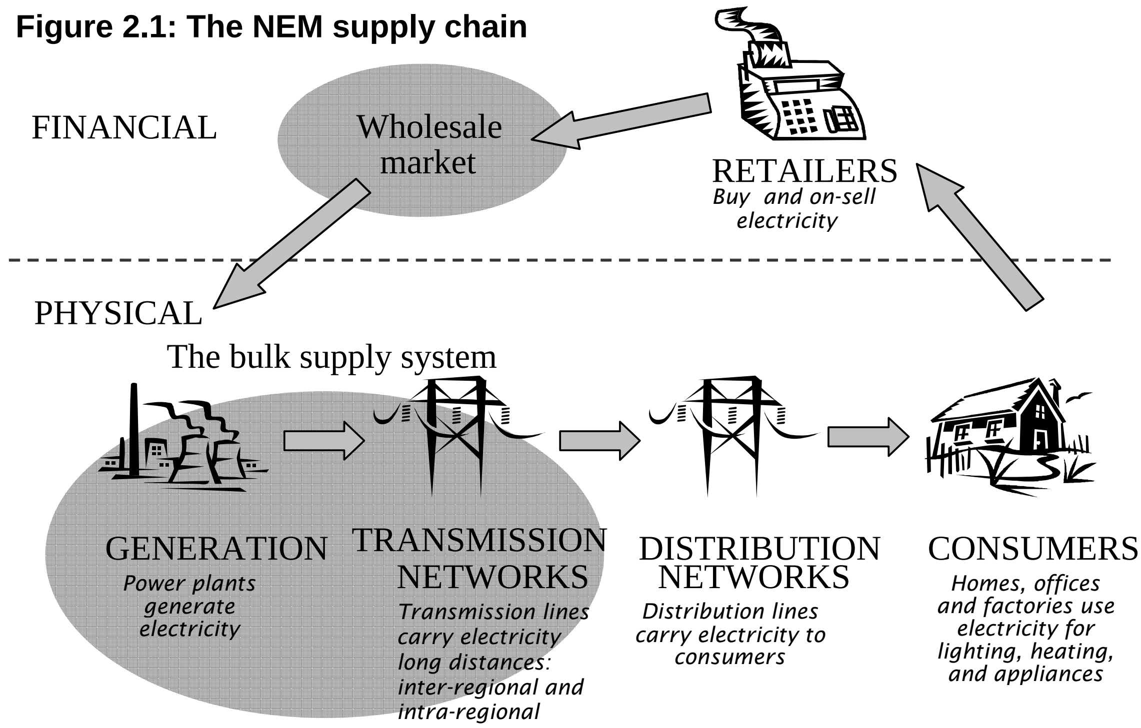
The NEM is the single interconnected power system stretching from Queensland through New South Wales, the Australian Capital Territory, Victoria, and South Australia to Tasmania. It does not currently include the Northern Territory or Western Australia. The NEM is divided into pricing regions which closely align with State borders (the ACT forms part of the NSW region), and there is an additional region encompassing the Snowy Mountains Hydro Electric Scheme.[16]

The NEM comprises a number of elements including:

- A wholesale market for the sale of electricity by generators to wholesale consumers (typically retailers and large consumers), and which allows trading in contracts between generators, wholesale consumers and merchant traders;
- The physical power system used to deliver the electricity from generators via transmission networks (together referred to as the 'bulk supply system') and local distribution networks; and
- Retail arrangements whereby retailers on-sell the energy they purchase to end-user consumers such as households and businesses.

[16] On 27 September 2007 the AEMC made a Rule to abolish the Snowy Region, with effect from 1 July 2008, and alter the boundaries of the NSW and Victoria regions. All other regional boundaries in the NEM remain unchanged.

Figure 2.1: The NEM supply chain



The NEM is a partially-regulated market. That is, generators and retailers operate according to competitive market conditions, whereas owners of 'natural monopoly' assets – transmission networks and distribution networks – are largely regulated. An option for market network service providers also exists for specific network assets to operate under competitive market arrangements. This means that if public or private enterprises are to provide adequate generation capacity to meet demand at all times, there needs to be sufficient financial incentives for them to do so. These incentives are delivered through the operation of a wholesale spot market.

Spot electricity prices are calculated for each region every five minutes (known as a dispatch interval). Six dispatch prices are averaged every half-hour (trading interval) to determine the regional spot market price used as the basis for settling the market.

The wholesale spot price can vary considerably, potentially dramatically, in short periods of time. The degree to which the price moves is important to many stakeholders. A large proportion of suppliers and consumers negotiate financial contracts to manage the financial risk associated with market volatility. Those contracts are private arrangements in that the prices are not visible other than to the participants who are party to the contracts.

All electricity generated is traded via the spot market (this is known as a 'gross pool' arrangement) and dispatched centrally by the National Electricity Market Management Company (NEMMCO) – the market and system operator. NEMMCO also manages the security of the power system and provides ongoing information to market participants about forecast and actual supply and demand. NEMMCO and transmission network companies also acquire specific technical or ancillary services from generators and consumers to support the operation of the physical power system.

2.2 What is 'reliability'?

Broadly, the reasons why consumers may not receive a continuous, uninterrupted supply of electricity may fall into two categories. The first is technical: action has been taken to ensure that power system equipment is protected from damage or exceeding operating limits that, if left unchecked, may lead to wider interruptions to supply. This is *security*. Ensuring that the power system is operated securely is the responsibility of NEMMCO and the network operators. The second is non-technical: quite simply there is not enough capacity to generate or transport electricity across the networks to meet all consumer demand. This is *reliability*. This second reason is economic to the extent that it must be cost-effective for generators and networks to have enough capacity to meet demand at all times.

Operational standards for power system security are set in the Rules and by the Panel.[17] Operational standards are concerned with maintaining the integrity of the power system in the short term, following a sudden fault or failure of a component of the system, such as a line, transformer or generator. Such sudden faults or failures of key components of the bulk power system are called contingencies. In technical terms, the formal definition of reliability includes single credible contingencies[18] but excludes non-credible contingencies, including multiple contingencies, which are classified as security events.[19]

These operational standards affect the design and planning of transmission networks, but there are other, longer term, considerations that affect network planning, including: jurisdictional transmission standards; economies of scale and scope in building transmission networks; long term load growth at different points of the network; and the regulatory regime and its incentives.

For security or reliability reasons, or a combination of both, some consumers may be without electricity for some of the time. Most commonly, interruption to supply is caused by unforeseeable events such as storm damage to local distribution networks. Such events are, as explained above, security. From the consumer's perspective, however, there usually appears to be little if any difference between an interruption caused by a reliability issue and one caused by a security issue. But from a market design perspective, the two causes have very different ramifications: security events – managed through standards applied by NEMMCO and network operators –

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17 Chapter 4 of the Rules sets out system security standards, while system performance standards are set out in Schedules 5.1 and 5.1a of the Rules and jurisdictional transmission codes, licenses, legislation or network management plans.

18 A credible contingency event is defined in clause 4.2.3(b) of the Rules as "a contingency event the occurrence of which NEMMCO considers to be reasonably possible in the surrounding circumstances including the technical envelope." A contingency event is defined as "an event affecting the power system which NEMMCO expects would be likely to involve the failure or removal from operational service of a generating unit or transmission element."

19 For example, the unserved energy arising from events in NSW on 13 August 2004 was a security event rather than a reliability one.

usually pass quickly, whereas a reliability issue is far more likely to be long term as it may be the symptom of a fundamental problem – a lack of sufficient supply capacity – which will take time to rectify.

There are any number of responses to the question of what degree of reliability is tolerable and how much value is ascribed to increased reliability. One group of consumers may tolerate a different level of reliability, and therefore would be willing to pay a higher price for reliable supply, from another. For example, businesses are likely to be less tolerant of interruption to supply during working hours, whereas families are likely to be less tolerant of power interruptions outside of working hours. Potentially, each individual consumer may have a unique tolerance threshold and there are millions of consumers in the NEM. Thus, the question as to what degree of reliability is tolerable also raises an issue concerning how differing expectations regarding reliability and the cost of that reliability can be communicated most effectively to suppliers.

There is also an important relationship between reliability and security. Security is fundamental to the operation of the power system. However, larger amounts of generation and network capacity generally will make it less likely that interventions will be required to keep the power system secure (although this is subject to how that capacity is distributed throughout the system and how reliable each component is itself).[20] Therefore, the level of reliability tolerated by consumers in respect of a system may impact on the technical risk that the system will be unable to supply electricity.

Transmission reliability standards are therefore concerned with both security and reliability, in both the short (i.e. operational) timeframe and in the long (i.e. planning) timeframe.

2.3 Security and reliability standards

Standards concerning the design and operation of the transmission system play a central role in ensuring the reliable and secure delivery of power to customer loads.

> "Stated simply, the ultimate objective of the transmission system is to deliver power reliably and economically from generators to loads. Power systems are large, highly complex, ever-changing structures that must respond continuously in real time. Electricity must be produced and delivered instantaneously when it is demanded by load [because it is not cost effective to store large volumes of electricity]. Power outages are not acceptable, so the system must also tolerate sudden disruptions caused by equipment failure or

20 In a large power system with a strongly meshed network, the physical mass and inertia of the system contribute to its resilience following a contingency of a given size. If the same sized contingency occurred on a smaller, less meshed, power system, it is likely that a greater level of manual intervention would be required to maintain power system security and reliability.

weather. And the system must perform as economically as possible, with transactions and sales monitored as accurately as possible." [21]

In order to ensure the secure and reliable operation of the power system, there are standards that relate to the design, construction, and operation of the system. These performance standards are critically important because the interconnected nature of the network and the physics of power flows mean that the loss of a single element (e.g. transmission line, generator, transformer) can instantaneously result in changes in power flows through all other elements of the network. The rapid change in flows through the other elements can overload them, resulting in an automatic shutdown of the affected elements. This pattern can continue in such a way that there are cascading blackouts across part of or the whole of the network.

Security standards are concerned with maintaining the integrity of the bulk power supply system (i.e. generation and transmission — see Figure 2.1). This means that uncontrolled cascading outages must be prevented by designing and operating the power system in such a way that it will continue to operate normally without major disruption when an component, such as a transmission line or generator, fails. "Normal operation means that (1) the frequency of the system stays within acceptable bounds, (2) all voltages at all locations are within required ranges, (3) no component is overloaded beyond its appropriate rating, and (4) no load is involuntarily disconnected."[22]

Transmission security standards for the NEM are contained in Schedule 5.1 of the Rules and jurisdiction specific laws, transmission licences, and regulatory instruments. These are discussed further in Chapter 3. Improving the national consistency of these jurisdictional transmission standards is the subject of this review.

Transmission standards can relate to two (overlapping) timeframes:

- Design/planning horizon — which can be from a few months ahead to several decades ahead; and

- Operational horizon — which ranges from the instantaneous through to several months into the future.

Security standards at the design/planning stage are concerned with ensuring that the power system can tolerate the outage of any component or several components. This entails building a degree of redundancy into the network that allows for equipment outages. A power system comprising N elements that is resistant to a single component being out of service is said to be N-1 secure. This means that all customer loads would continue to be supplied even with one bulk power system element out of service. A higher level of security is provided when the transmission system is planned to be N-2 secure or N-3 secure. With a N-2 secure standard, no

[21] Alvaro, F. and Oren, S. 2002, "Transmission System Operation and Interconnection", in US Department of Energy, *National Transmission Grid Study: Issues Papers*, US DOE, Washington D.C., May 2002, p. A-1.

[22] Alvaro, F. and Oren, S. 2002, p. A-3

customers loads will be affected even if two elements are out of service. This is a very high standard of transmission security requiring substantial capital expenditure, and in Australia it is generally only applied to central business districts of state capitals where there are large concentrations of customers with critical loads.

In designing a N-1 secure network, transmission planners also need to take into account limitations that occur in real time operations timeframe. "One way this is sometimes done is by considering the simultaneous failure of any one line and any one generator when doing planning timeframe studies. In an operations timeframe, however, N-1 security means that the current system must be able be able to tolerate the 'next worst' contingency. Because an actual operating system may have already sustained the outage of one or two components, this is tantamount to operating the system in an N-2 or N-3 condition from the planning point of view. Previous contingencies are 'sunk events' from the perspective of system operations. This means that, once a contingency occurs, meeting the N-1 criterion means considering the altered system, not the original system, as the new base case to which the criterion must be applied."[23]

The performance capability of a transmission network can be greatly affected by the significant elements connected to the distribution network (sometimes known as sub-transmission). In these cases, there needs to be compatibility between the reliability standards of the transmission network and distribution networks. This in turn requires considerable interaction between distribution and transmission network planners and operators, to ensure that the most economically efficient network augmentations take place and that transmission network reliability/security is maintained in an operational timeframe through appropriate co-ordination of actions on the transmission and sub-transmission networks.

Maintaining N-1 security in an operational timeframe requires that the system operator maintain sufficient quantities of two types of reserve:

- Spinning reserves — provided by generators that can instantaneously adjust their output up or down in response to fluctuations in load or generation so that system frequency can be continuously maintained in a narrow operating band around 50 Hz; and

- Contingency reserves — which allow the integrity of the power system to be maintained following a contingency. In the NEM, contingency reserves are defined over 6 seconds, 60 seconds and 5 minute timeframes.

Both types of reserve have to be available on a geographically dispersed basis, to ensure secure operation when an outage causes the power system to separate into islands (e.g. when a bush fire or lightening strike causes the electrical separation of two NEM regions). That is, prior to and after a contingency occurs, system operators need to be able to change the level of generation output (and reserves) at different locations around the network, so as to maintain the security of the power system and

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[23] Alvaro, F. and Oren, S. 2002, p. A-6

continue supplying loads, even when parts of the system have become electrically separated from one another.

Maintenance of security in an operational timeframe utilises a combination of:

- real time monitoring of all elements of the power system;
- communicating information on the current state of the system;
- estimating the future state of the system;
- assessing credible contingencies and taking appropriate precautionary or corrective action;
- controlling the system so it adjusts to changing circumstances and remains secure and reliable.

There are several ways the power system can be controlled:

- transmission line switching;
- automatic fault clearance;
- voltage control — transformer tap changes, Static VAR Compensators (SVCs), capacitor banks, Syncronous Condensors, etc. ;
- dispatch process;
- frequency Control Ancillary Services (FCAS);
- network Control Ancillary Services (NCAS); and
- directions from the system operator.

In the NEM, during the operational timeframe, the maintenance of power system security is shared between NEMMCO and TNSPs and involves tight co-ordination of their activities.

However, during the planning timeframe, power system security is assured through:

- the design and construction of the transmission network; and
- ensuring that there is sufficient installed generation capacity to meet load, without involuntary load shedding.

The design and construction of transmission networks in the NEM is the responsibility of the Jurisdictional Planning Body (JPB), which in most cases is the jurisdictional TNSP.

The NEM uses a number of market and regulatory mechanisms to ensure that there is sufficient installed generation and network capacity to meet load over the long term, including:

- the supply-demand balance and long term contracts for energy supply;
- reliability standard of 0.002% USE over the long term;
- the setting of the Value of Lost Load (VoLL), a cap on spot prices;
- reliability Safety Net — "Reserve Trader" and NEMMCO's powers of direction;
- system performance and security standards contained in the NEM;
- jurisdictional transmission reliability standards; and
- regulatory incentives for network owners and operators arising from the combination of (CPI–X) regulation, WACC, asset depreciation rates, the Regulatory Test, allowed capital and operating expenditure, and network performance incentives.

As mentioned in Chapter 1, this review is only focussing on the development of a framework for nationally consistent transmission network reliability standards. Under the existing arrangements in the NEM, there is some degree of national consistency in transmission standards because jurisdictional transmission standards all have to be aligned with the technical standards specified in the Rules relating to security and reliability in an operational timeframe (Schedule 5.1a and 5.1 of the Rules). Increasing the degree of national consistency in transmission reliability standards primarily requires that any new framework allow the alignment of transmission standards used in the planning timeframe.

The Panel has already investigated the 0.002% USE reliability standard, the Reliability Safety Net, and the level of VoLL as part of the Comprehensive Reliability Review.[24]

The AEMC has already completed major reviews of various aspects of the regulatory regime affecting transmission networks, and has implemented changes to Chapter 6 of the Rules,[25] pricing of regulated network services,[26] and the principles underlying the Regulatory Test. [27]

In 2008, the Panel will carry out a separate review of the technical standards in the Rules that relate to power system security and network connections. Nonetheless, one possible framework for nationally consistent transmission reliability standards would be to extend the existing Schedule 5.1 and 5.1a technical standards so that

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24 AEMC Reliability Panel 2007, *Comprehensive Reliability Review, Final Report*, AEMC, Sydney December.

25 AEMC 2006a, *National Electricity Amendment (Economic Regulation of Transmission Services) Rule 2006 No. 18*, Rule Determination, 16 November 2006, Sydney.

26 AEMC 2006c, *National Electricity Amendment (Pricing of Prescribed Transmission Services) Rule 2006 No. 22,* Rule Determination, 21 December 2006, Sydney.

27 AEMC 2006b, *Reform of the Regulatory Test Principles, Final Determination*, 30 November 2006, Sydney.

they cover issues relating to longer term planning timeframes, as recommended by ERIG.[28]

2.4 Form of transmission standard

There are two main forms in which a transmission reliability standard can be expressed. For a long time, transmission standards in many countries have been expressed in a deterministic form, along the lines of a 'N – x' standard. More recently, transmission standards in some jurisdictions have been expressed in a probabilistic form. Transmission network planners use different analytical techniques to assess whether the network meets these different forms of standard.

2.4.1 Deterministic form

A deterministic form of transmission reliability standard requires that the bulk power system can continue to provide adequate and secure supplies of energy to customers after any of a range of contingencies occurs. The contingencies involve outages (i.e. faults, failures) of some important elements of the power system, such as lines, transformers or generators. A deterministic standard does not take into account the probability of an outage. Taking into account these contingencies, planners and operators of the power system aim to incorporate sufficient redundancy so that any system failures can be prevented, either through automatic system protection mechanisms or manual intervention by operators. In the event of a contingency, the power system is required to remain within its performance parameters (e.g. flow limits, voltage levels, stability criteria), system security maintained, and all loads supplied without interruption from the contingency.

The contingency list plays a critical role in determining the level of reliability. The more comprehensive the contingency list, the lower the chance of a system failure from contingencies not listed.

When deterministic standards are used, they are often expressed as 'N–x', where x can be 0, 1 or 2, as discussed above. An N – 0 security standard is often used when there is a radial line serving a load — if the line fails, there is no way the load can continue to be served by the network. Continued supply in this case can be provided by a back-up generator or, if the load is small enough, by stored energy (batteries). Greater reliability is provided by having each load supplied by more than one source, typically via a meshed network, but this is not always cost effective. The need for redundancy is the main reason that transmission networks are meshed. This meshing generally provides N-1 secure or higher levels of reliability.

Deterministic standards have traditionally been used to plan power systems, and have played a key role in the delivery of high levels of power system reliability that people are used to in modern, industrialised economies.

28 ERIG 2007, p.182

Transmission planners use power flow modelling and other analytical techniques to assess the effects of each contingency on the power system. The effects of the contingency are assessed against the system performance and reliability criteria to determine whether any criteria are breached. Based on this analysis, measures of system reliability, such as loss-of-load probabilities, frequencies and durations can be calculated. This information then feeds into the design, planning and operational processes for the transmission network.

2.4.2 Probabilistic form

A probabilistic form of transmission reliability standard requires that the bulk power system be expected to provide adequate and secure supplies of energy to customers under a wide range of contingencies. A probabilistic form of transmission reliability standard explicitly takes into account the probabilities of contingencies (e.g. transformer failure rates) under a range of possible operating conditions (e.g. electric load levels, system states) that also have probabilities assigned to them. Each contingency is treated as a random event, with some events more likely to occur than others. Probabilistic modelling methods are applied to models of physical power system to calculate expected values of system reliability measures, based on probability distributions regarding power system performance. The results of this modelling informs the design and planning of the transmission network.

A probabilistic transmission standard could, for example, be expressed as the likelihood of a customer at a given supply point being without supply or the likely time without supply. The existing NEM reliability standard of 0.002% USE is a probabilistic form of standard.

Victoria is the only jurisdiction in the NEM which uses a probabilistic transmission planning standard to supplement the operational standards in the Rules.[29] The Victorian transmission planning process treats operator responses to contingencies as deterministic events, but assigns probabilities to system states and contingent events. Probabilistic assessments are then made concerning the level of power system performance, with an economic value assigned to any customer load that is not served. If power system performance does not meet the probabilistic standards or if the estimated value of the lost customer load is greater than the cost of network operational actions (e.g. NCAS contracting) or augmentation, the transmission network plan is reviewed.

2.4.3 Hybrid form

Sometimes a probabilistic standard is expressed in an equivalent, but deterministic manner. For example, the NEM's 0.002% USE reliability standard is operationalised

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29 VENCorp 2007, *Victorian Electricity Transmission Network Planning Criteria*, Issue No. 2, VENCorp, Melbourne, 3 May 2007. (URL http://www.vencorp.com.au/index.php?pageID=8070&action=filemanager&folder_id=497&sectionID=8246)

by NEMMCO into a deterministic standard for the minimum level of reserve in each NEM region.

In South Australia, the transmission reliability measures are derived using probabilistic methods but expressed deterministically to facilitate understanding and comparison with the deterministic transmission standards in the SA Electricity Transmission Code.[30]

2.5 Level of transmission standard

The level of transmission standard plays a critical role in determining the reliability, security and costs of the network.

When the form of standard is deterministic, if the level of the standard has a greater level of network redundancy, this implies that the security of the network and its capital and/or operational costs will be higher. For example, an N-2 secure network will be more expensive to build and operate than a N-1 secure network.

A level of a probabilistic transmission standard can be set using a range of methods, but again if a high standard of security is set (e.g. a very low probability of power system failure), this implies higher capital and operational expenditure on the network.

Choices about the level of standard can be influenced by a range of factors, including:

- judgements about the criticality of particular loads;
- judgements about the economic value of lost load for particular customer classes;
- public safety;
- difficulty and cost of restoring the power system to normal operations following shutdown;
- economic benefits of secure and reliable power supplies;
- differing costs of network construction, operational actions, and non-network solutions (e.g. demand side response);
- compatibility with standards used in other modern “digital economies”, in which production, commerce and many everyday processes rely on computer technology.

There may be little choice on the level of standard, if it is set by state governments, who may wish to take into account a range of other factors.

30 Electricity Network Owners Forum (ETNOF), Letter to Commissioner Ian Woodward, AEMC, received 5 November 2007.

Existing jurisdictional transmission standards have been set having regard to historical levels of reliability, the factors listed above, and 'good industry practice' concerning the operation of bulk power systems, which has developed internationally over the last 100 years.

Across the NEM, the level of transmission standard is generally 'N-1 secure' for meshed parts of the transmission network, 'N-0 secure' for radial lines serving a single load in rural areas, and the equivalent of 'N-2 secure' in CBD areas.

3 Today's transmission standards

This chapter discusses existing transmission reliability standards in the NEM and briefly compares them to standards in a selection of other electricity markets. It also seeks to identify the potential issues that might arise from inconsistencies in jurisdictional transmission standards, the size and scope of any issues, and the motivations for changing to a nationally consistent framework.

3.1 Transmission standards and network planning processes

Jurisdictional transmission planners seek to design their networks to ensure that: a) power system performance is within the technical limits of the system; b) the power system can be controlled by the system operator in such a way that security requirements are met; and c) that demand at all points of the network can be met in accordance with the Reliability Standard of 0.002% USE each year.

The regulatory regime for transmission also requires transmission planners to seek to design the network so these three objectives can be met at least economic cost, taking into account the value placed by customers on reliable supplies of electricity.

System performance standards define the technical limitations of the bulk power system, such as voltage ranges, reactive power limits, stability limits, maximum fault currents and fault clearance times. These performance standards can be thought of as defining a “performance envelope” within which the power system must operate.

System security standards oblige the system operator to take actions to ensure that the power bulk power system operates within its system performance standards, prior to and following a network contingency. The security standards also define the timeframe in which operational actions must be taken to restore the system to a secure state following a contingency. Operational actions include network switching, changes to dispatch of energy and/or ancillary services, and at a last resort, involuntary load shedding.

The focus of this review is on jurisdictional reliability standards, which primarily focus on the transmission planning timeframe. However, the network design and construction also needs to take into account the network performance and security in the operational timeframe set out in Chapter 5 of the NER. The Chapter 5 NER standards provide a nationally consistent benchmark for reliability and security in the operational timeframe. Jurisdictional transmission reliability standards are complementary to those in the NER. They can provide a greater degree of prescription about how reliability and security will be met in the operational timeframe than the standards set out in the NER. In addition, jurisdictional standards specify how the network will be planned and operated to meet specific local requirements.

Therefore, at present, while there is NEM wide consistency of transmission standards in an operational timeframe — albeit with some room for TNSP flexibility in delivering to those operational standards — there is a divergence in the reliability standards applied to planning transmission networks in NEM jurisdictions. It is this difference in transmission reliability standards that the MCE wishes to have addressed through the development of a framework for nationally consistent transmission standards.

3.2 NEM-wide transmission standards[21]

3.2.1 System performance standards

The bulk power system *performance standards* for all transmission networks in the NEM are set out in:

- Schedules 5.1a and 5.1 of the National Electricity Rules; and
- Jurisdiction specific transmission codes, licenses, legislation or network management plans.

In addition, in some cases, there may be location specific transmission system performance requirements, which are related to customer connection agreements. Schedule 5.1 of the Rules recognises that transmission reliability standards can be set in these connection agreements. It is understood that some of these customer connection agreements, where the Distribution Network Service Provider (DNSP) is the customer, can have widespread geographical coverage (e.g. all DNSP connections points to be supplied at N-1) , and are long term.

The system performance standards cover:

- frequency operating standards, which are determined by the Reliability Panel;
- stability criteria;
- steady state and transient voltage ranges;
- reactive power limits;
- fault levels;
- protection systems and fault clearance times.

Many of these performance standards also apply to (DNSPs) because of the strong interactions, in many cases, between the transmission or sub-transmission networks owned by DNSPs and the transmission networks owned by TNSPs.

These clauses of the Rules place explicit obligations on network service providers to design and operate their networks such that the system performance standards are met both before and after credible contingency events. The nature of the credible contingency events and their severity are also specified.

21 Phrases that are italicized in this section have the meaning defined in the National Electricity Rules.

3.2.2 System security standards

System security standards in Chapter 4 of the Rules require NEMMCO and NSPs to take actions to maintain power system security, while keeping the system within the system performance standards specified in Schedules 5.1a and 5.1 of the Rules.

The system security standards specify two levels of system security — *satisfactory operating state*[22] and *secure operating state*[23] — that are defined in terms of *credible* and *non-credible contingency events*. The *technical envelope,* defined in clause 5.2.5 of the Rules, is used as the basis for categorising credible contingency events. Under Clause 4.2.3 NEMMCO has guided discretion in determining the list of credible contingencies and non-credible contingencies.

The most common types of credible contingencies are loss of the largest generator in a region, loss of a line, and loss of a transformer. Non-credible contingencies, such as lightening strikes or bushfires, are treated as system security events but can be re-classified as credible contingencies, if NEMMCO deems them so.

General principles for maintaining power system security are contained in Clause 4.2.6 of the Rules. Arising from these principles are obligations on NEMMCO and TNSPs to maintain power system security, and to do so within set operational timeframes. First, NEMMCO must operate the power system so that it is normally in a *secure state*. Second, following a contingent event, NEMMCO must take reasonable actions to return the system to a *secure state* within 30 minutes.

The Rules recognise the strong inter-play between power system security and reliability. A *reliable operating state* (defined in Clause 4.2.7) occurs when all loads are being supplied and are expected to continue being supplied and that there are sufficient levels of *short term* and *medium term capacity reserves* to meet the *power system security and reliability standards*.

3.3 Jurisdictional transmission network standards

Jurisdictional standards for transmission networks exist because transmission networks were developed on a state by state basis, with interconnection between jurisdictions only occurring relatively recently.[24]

When the NEM was established, governments made a policy decision to retain jurisdictionally based transmission network companies and planning arrangements, rather than forming a single national transmission company, which would acquire all the assets of the existing jurisdictional TNSPs and thereafter develop and operate the

[22] Clause 4.2.2 of the Rules defines a *satisfactory operating state*.

[23] A *secure operating state* is defined in Clause 4.2.4 of the Rules.

[24] The first interconnection was that between the NSW and Victorian state transmission grids in November 1959. Other interconnections and their commissioning dates are: Victoria—South Australia (1990), Directlink (July 2000), Queensland–NSW Interconnector (February 2001), Murraylink (October 2003), and Tasmania—Victoria (April 2006).

transmission network to some agreed standards.[25] This decision on the corporate governance framework for transmission allowed jurisdictions to retain tighter control over jurisdictional network reliability standards, pursue corporatisation and privatisation at different paces, and pursue any other state government policy objectives via the pricing of electricity (e.g. "state development" agendas, uniform pricing for urban and rural consumers).

In addition, jurisdictional reliability standards reflect the political reality that if the lights go out in a jurisdiction, it is the government of the jurisdiction that faces the economic and political consequences and manages many of the public safety issues arising from a blackout.

Importantly, jurisdictional transmission reliability standards specify the *minimum standards* for the shared transmission network. A key aspect of the existing framework for transmission network development is the ability for network users to negotiate a standard of network reliability that is higher or lower than the minimum standard. Details of any negotiated standard are generally contained in the connection agreement between the network user and the TNSP, which sets out the terms and conditions of access to the network.[26]

As mentioned in Chapter 2, the form of existing jurisdictional reliability standards is either:

- deterministic;
- probabilistic; or
- hybrid, in which a probabilistic standard is translated into an equivalent deterministic standard.

Table 3.1 below sets out for each jurisdiction:

1. the form of the jurisdictional transmission standard;
2. the jurisdictional transmission standard;
3. the jurisdictional source of the standard;
4. interactions between transmission and distribution network standards;
5. interactions between transmission standards between interconnected transmission networks; and

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25 For a summary of the policy decisions concerning the corporate structure of transmission in the NEM, see Firecone 2007, *The Evolution of Transmission Planning Arrangements in Australia*, Report to the Australian Energy Market Commission, Firecone Ventures Pty Ltd, Melbourne, October, pp. 2-6. Available at http://www.aemc.gov.au

26 Schedules 5.2 to 5.7 of the Rules specify various technical requirements under three types of transmission access standard: an *automatic access standard*, *a minimum access standard*, and a *negotiated access standard*. These technical requirements are consistent with the power system performance and security obligations contained in Schedules 5.1a and 5.1 and Chapter 4 of the Rules.

6. Interactions between jurisdictional transmission standards and NEMMCO's security and reliability standards.

The following key observations can be made:

- The form of standard differs across NEM jurisdictions. The form of standard is deterministic (N-1) in three out of five jurisdictions. Victoria uses a combination of deterministic and probabilistic standards. SA uses a probabilistic standard, but expresses it in a deterministic fashion (N-1).

- The level of standard varies across NEM jurisdictions. In most jurisdictions, the planning standard is for N-1 secure operations in areas outside CBD, with an equivalent of N-2 secure operations in CBD. These deterministic security levels may be an explicit requirement with penalties (up to and including loss of license) associated with non-compliance. For example, in South Australia, the level of deterministic standards is set out in the *Electricity Transmission Code*[27], while in Queensland the level of standard is specified in an act of parliament and the transmission license.[28] Alternatively, when a probabilistic form of standard is used, such as in Victoria, a higher level of network security may be implied if a higher Value of Customer Reliability (VCR) is used for network planning for CBD areas compared to that used for residential areas.[29]

- The source of transmission standards is not uniform across jurisdictions, and is a combination of the NER and jurisdictional instruments. The range of jurisdictional instruments used to specify the standard is diverse, ranging from legislation, transmission licences and system codes, or Network Management Plans.

- There is, in many cases, a strong interaction with local DNSP planning standards. Both the NER and jurisdictional standards require joint planning of transmission (owned by the TNSP) and sub-transmission networks (owned by the DNSP), given that the latter connect to the former and can affect the performance of the transmission network.

- There are few interactions with transmission planning standards in interconnected jurisdictions. Apart from TNSPs jointly planning interconnectors, there is little interaction on the issue of jurisdictional transmission standards.[30] However, there are examples of effective joint reliability planning across jurisdictional boundaries. These include the joint planning by Queensland and

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[27] ESCOSA 2006, *Electricity Transmission Code ET/05*, 1 July 2008, ESCOSA, Adelaide. (URL http://www.escosa.sa.gov.au/webdata/resources/files/060906-R-ElecTransCodeET05.pdf)

[28] For details, see Powerlink 2006, *Planning Criteria Policy*, Version 1.0, Powerlink Queensland, Brisbane 23 March 2006 (Available at http://www.aer.gov.au)

[29] See *Transmission Connection Planning Report 2006*, Produced jointly by the Victorian Electricity Distribution Businesses 2006 (URL http://www.sp-ausnet.com.au/CA256FE40021EF93/Lookup/PlanningRep/$file/TCPR2006.pdf)

[30] Recent reviews of transmission standards in South Australia and Tasmania did have regard to standards applied in other NEM jurisdictions. See Section 3.3.1 below.

NSW TNSPs and DNSPs to deliver the requisite reliability (at lowest cost) to the border areas of Gold Coast/Tweed and Goondiwindi.

- There are strong interactions between jurisdictional transmission standards and NEMMCO's security and reliability standards. All jurisdictional planning and operational standards have to be consistent with NER standards applying to NEMMCO in an operational timeframe. Jurisdictional planning standards are generally more prescriptive than NER operational standards relating to reliability and security performance levels for connection points.

Table 3.1: Jurisdictional transmission standards

	NSW – TransGrid	QLD – Powerlink	SA – Electranet	TAS — Transend	VIC — VENCorp
Form of standard	Deterministic	Deterministic	Expressed as deterministic, but based on probabilistic analysis	Deterministic – Performance based – limits either the size of customer load that may be interrupted, or the length of interruption, or both.	• Deterministic assessment of operational actions for specific network conditions. • Probabilistic assessment used to account for uncertainty in system conditions.
Transmission reliability standard	N – 1 across jurisdiction, with the exception of modified N – 2 in CBD	N-1 in accordance with good electricity industry practice. No variation across jurisdiction. In addition, as far as technically and economically practicable, the transmission grid is to be augmented or extended to provide enough capacity to provide network services to persons authorised to connect to the grid or take electricity from the grid.	There are 6 categories of reliability standard in SA with a defined category applying to each connection point. The standard categories range from "N" to 'equivalent' "N-2" line and transformer capacity, depending on the load and importance of load at risk at each connection point.	Load interruption standard has two elements: 1. for an intact system • N-1 for connections >25 MW • no asset failure will interrupt > 850MW or cause system black; • unserved energy limits credible contingency 300MWh • any asset failure 3,000MWh 2. for network element out of service • unserved energy limit credible contingency 18,000MWh	Largely based on system performance and system security requirements defined in the NER, with some additional jurisdictional fault level and voltage limit standards contained in clauses 110.1 and 110.2 of the Victorian Electricity System Code (VESC). The transmission reliability standard applied to each connection point is a function of the sector specific Value of Customer Reliability (VCR) used for that point. This approach implies that the Melbourne CBD,

	NSW – TransGrid	QLD – Powerlink	SA – Electranet	TAS — Transend	VIC — VENCorp
					which uses the highest VCR ($62,215/MWh), has a higher level of network redundancy than most other parts of the Victorian transmission network.
Jurisdictional source of standard	Contained in a Network Management Plan which TransGrid is obliged to produce by legislation for acceptance by the Department of Water and Energy.	Transmission Authority (licence) issued to Powerlink by Qld Govt and S.34 of the Queensland *Electricity Act 1994*.	The Essential Services Commission of SA (ESCOSA) determines the reliability standards for SA through the SA Electricity Transmission Code which is published on the ESCOSA website.	Regulations issued by Tas Government. Supplied by Tasmanian Reliability and Network Planning Panel (RNPP). Yet to be brought in formally.	Victorian Electricity System Code (VESC).
Interaction with local DNSP standards	Via joint planning with each NSW/ACT DNSP. DNSPs expect their standards to be reflected into the transmission system.	Via joint planning with ENERGEX and Ergon, who are required to meet N-1 for their sub-transmission system and for bulk and major zone substations (i.e the distribution "backbone").	Via joint planning with ETSA Utilities. If required by the SA Electricity Transmission Code, contingency supply is provided where available via the distribution network.	Via Joint Planning with Aurora Energy under the NER requirements based on jurisdictional network security & planning criteria	• VIC Distribution System Code (DSC) sets out quality and reliability standards for DNSPs. • DNSPs align the planning process for connection assets to the transmission network with VENCorp's planning approach. • No interaction between NER transmission standards and those in DSC, apart from obligations on VENCorp to address fault levels and

	NSW – TransGrid	QLD – Powerlink	SA – Electranet	TAS — Transend	VIC — VENCorp
					voltage limits at sub-transmission level.
Interaction of standards between connecting TNSPs	Powerlink and TransGrid plan supply to Terranora/NSW Far North Coast and to Goondiwindi in conjunction with the relevant DNSP(s). Joint planning with VENCorp on interconnected assets and interconnector upgrade assessment.	Powerlink and TransGrid plan supply to Terranora/NSW Far North Coast and to Goondiwindi in conjunction with the relevant DNSP(s).	There are no connection points or transmission supplied customers in SA that are affected by directly adjacent TNSP reliability standards. However, as the Murraylink HVDC interconnection is utilised to provide N-1 supply to the Riverland, its continued ability to do so is affected by the available capacity of the adjacent transmission networks.	There are no connection points or transmission supplied customers in Tasmania that are affected by directly adjacent TNSP reliability standards. Tasmania is connected to the NEM by the only MNSP - Basslink.	VENCorp has conducted joint planning studies with TransGrid and ElectraNet when assessing interconnector upgrades. These studies relevant to the technical standards have typically been conducted using the same approach adopted by VENCorp when assessing intra-regional constraints.
Interaction of TNSPs with NEMMCO's system security and reliability standards	NEMMCO operates the power system assuming a credible contingency can occur at any time. • When the system is intact, this is equivalent to N-1. • If there are prior outages (planned or forced) or loss of multiple network elements is assessed as credible, NEMMCO's operation will be more onerous than N-1.				VENCorp's simulation of system operational actions (or security standards) are directly based on NEMMCO's system operation obligations, as defined in Ch. 4 of the NER, particularly clauses 4.2.2, 4.2.3, 4.2.4 and 4.2.6.

	NSW – TransGrid	QLD – Powerlink	SA – Electranet	TAS — Transend	VIC — VENCorp
Comparison with standards under the Rules	The jurisdictional standards specify the level of **redundancy for planning** (not explicit in the NER). The jurisdictional standards are consistent with, and rely on, the technical planning standards prescribed in the NER.		The jurisdictional standards specify the level of **redundancy for connection points** (not explicit in the NER). The jurisdictional standards are consistent with, and rely on, the technical planning standards prescribed in the NER.	The jurisdictional standards specify the level of **performance for connection points** (not explicit in the NER). The jurisdictional standards are consistent with technical planning standards prescribed in the NER.	Additional jurisdictional standards are complementary and additional to the NER standards. They add constraints on the planning process in areas that are more discretionary under the NER. VESC standards on fault levels are about co-ordinated planning with asset owners and DNSPs, while the voltage targets are not a limit but rather a desired operating level that would not constrain planning.

Sources: Correspondence from ETNOF, ESCOSA, VenCorp

3.3.1 Reviews of jurisdictional transmission standards

In recent years, there have been reviews of the jurisdictional transmission standards in both South Australia and Tasmania, and indirectly via the review of sub-transmission standards in Queensland as part of the Electricity Distribution and Service Delivery (Somerville) report. Sub-transmission standards have also been revised in New South Wales.

3.3.1.1 Tasmania

The Tasmanian review, completed in June 2006 by the Tasmanian Energy Regulator, aimed to align the transmission planning standards in Tasmania with the operational security standards specified in the National Electricity Rules and set minimum network performance standards against which proposals can be assessed under the reliability limb of the Regulatory Test.[39] The new transmission standards seek to maintain the same level of performance that Tasmanians are accustomed to.

The Tasmanian Energy Regulator accepted the advice of the Tasmanian Reliability and Network Planning Panel (RNPP), including:

- Retaining a form of deterministic (N-1) transmission standard, rather than moving to a probabilistic form of standard like that used in Victoria;
- The transmission security and planning criteria are "performance based", meaning that they specify limits on either the size of customer load that may be interrupted, or the length of interruption, or both. The criteria do not prescribe the particular technical solutions the TNSP should use to meet the performance criteria. Instead, the TNSP is allowed discretion to determine the least cost means of meeting the transmission standard, in line with the reliability limb of the Regulatory Test.
- The transmission security and planning standards do not apply to energy intensive customers connected directly to the transmission grid (e.g. smelters, pulp mills). The standards for these large customers are set in power supply agreements or connection agreements.
- Additional capital expenditure, over and above that allowed for in the AER's current regulatory allowance, is required for the transmission network to meet the new minimum transmission standards. This capital expenditure is estimated to total $31–38 million over 5 years if transmission solutions, such as new transformers or lines, are used to bring the existing network up to the new standards.

[39] OTTER (Office of the Tasmanian Energy Regulator) 2006, *Transmission Network Security and Planning Criteria*, Final Report, Reliability and Network Planning Panel, OTTER, Hobart July.

3.3.1.2 South Australia

A 2006 review of South Australian transmission standards by the Essential Services Commission of South Australia (ESCOSA) decided to retain the deterministic standard used in the SA Electricity Transmission Code (ETC).[40] ESCOSA's determination was informed by a 2004-05 review of transmission connection point reliability standards, carried out by the Electricity Supply Industry Planning Council (ESIPC) at the request of ESCOSA.[41]

ESCOSA's final decision sets out new transmission standards for the ETC, which will take effect on 1 July 2008.

Under the new standards, Clause 2.2.2 of the ETC specifies six categories of transmission reliability standard, with a defined category applying to each connection point.[42] The standard categories range from "N secure" to 'equivalent' "N-2 secure" for transmission line and transformer capacity, depending on the load and importance of load at risk at each connection point. The highest transmission standard (equivalent to N-2 secure) applies to the Adelaide CBD, reflecting an implicit high value of customer load in that area.

The new transmission standards also specify:

- Time limits for the 'best endeavours' restoration of secure supplies in the event of a contingency affecting a transformer or line;
- Grace periods allowing the TNSP up to 3 years to address breaches of the transmission standards;
- Standards for and limits on the use of non-network solutions, such as transmission network support provided by DNSPs, generation or voluntary load reduction;
- Timeframes for replacing or repairing transformers that have failed; and
- Obligations on the South Australian TNSP to hold an inventory of spare transformers.

3.3.1.3 Queensland

There has been an indirect review of Queensland's transmission standards, via the review of sub-transmission standards carried out as part of the Electricity

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40 ESCOSA 2006, *Review of the Reliability Standards specified in Clause 2.2.2 of the Electricity Transmission Code*, Final Decision, Essential Services Commission of South Australia (ESCOSA), Adelaide, September.

41 ESIPC 2005, *Transmission Code Review*, Electricity Supply Industry Planning Council (ESIPC), Adelaide, October.

42 ESCOSA 2006, *Electricity Transmission Code ET/05*, 1 July 2008, ESCOSA, Adelaide. (URL http://www.escosa.sa.gov.au/webdata/resources/files/060906-R-ElecTransCodeET05.pdf)

Distribution and Service Delivery (EDSD) Review, chaired by Mr Darryl Somerville.[43]

In Queensland, the DNSPs own sub-transmission networks which interact with the TNSP's transmission network to deliver the total transmission capability.

The EDSD (Somerville) report on distribution networks in July 2004 followed a series of distribution network problems in the previous summer.

The Queensland government adopted the EDSD recommendations, which included a requirement for the DNSPs to plan their sub-transmission networks and distribution "backbone" to an N-1 standard.[44,45] This aligned with, and effectively affirmed, the N-1 standard which existed in the TNSP's licence.

3.3.1.4 New South Wales

It is understood that in 2005 the NSW government subsequently adopted the same sub-transmission and distribution network standards as Queensland and made them part of the license conditions of NSW DNSPs from 1 August 2005.[46],[47]

TransGrid's *Network Management Plan 2007-2011* provides details on the transmission planning approach and standards used in NSW.[48]

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43 State of Queensland (Office of Energy) 2004, *Electricity Distribution and Service Delivery for the 21st Century, Queensland, Summary Report of the Independent Panel* (Chairman: D. Somerville), Department of Natural Resources, Mines and Energy, Brisbane, July. (Available at http://www.dme.qld.gov.au/Energy/independent_report.cfm)

44 Premier of Queensland (Hon Peter Beattie), "Electricity Fact Sheet Available for all Queenslanders", Media Release, 18 August 2004 (URL http://statements.cabinet.qld.gov.au/MMS/StatementDisplaySingle.aspx?id=36920)

45 Minister of Energy, Queensland (Hon. John Mickel), "Energy Minister Establishes Review Implementation Team", Media Release, 15 September 2004, (URL http://statements.cabinet.qld.gov.au/MMS/StatementDisplaySingle.aspx?id=37277)

46 Minister of Energy (NSW) 2007, *Design, Reliability and Performance Licence Conditions imposed on Distribution Network Service Providers by the Minister for Energy*, Published August 2005 and amended on 1 December 2007 (URL http://www.ipart.nsw.gov.au/electricity/documents/DesignReliabilityandPerformanceLicenceConditionsforDNSPs-23November2007.PDF)

47 TransGrid 2007a, "APR 2007 Outline" (Garrie Chubb, Manager Network Planning), NSW Annual Planning Report 2007 Public Forum (URL http://www.transgrid.com/trim/trim261655.pdf)

48 TransGrid 2007b, *Network Management Plan 2007-2011*, TransGrid, Sydney (URL http://www.transgrid.com.au/trim/trim211409.pdf)

3.4 International transmission standards

A brief comparison of transmission reliability standards in five wholesale electricity markets is presented in Table 3.2. The markets covered are:

- Ontario;
- Pennsylvania-Jersey-Maryland (PJM);
- Great Britain (England, Wales and Scotland);
- New Zealand; and
- Nordpool (Norway, Sweden, Denmark and Finland).

In all of these markets, a deterministic form of transmission standard is used. All networks are planned to an N-x secure standard, with two (Ontario and PJM) also utilising probabilistic criteria relating to loss of load.

The US Government's Federal Energy Regulatory Commission (FERC) recently published a new set of standards for power system operations that apply to continental North America (USA and Canada).[49] These standards were developed for FERC by the North American Electricity Reliability Corporation (NERC).[50] This action arose from the 14 August 2003 blackout in the northeast part of continental North America that affected over 50 million people and 61,800 megawatts of load. A key objective of FERC has been to improve planning process between separately owned, interconnected, transmission networks by giving Regional Transmission Organisations (RTOs) greater responsibility for network planning and harmonising operational standards. FERC has also changed the role of the North American NERC and the regional reliability councils. In the past, regional reliability councils would set standards and report those standards and compliance with them to NERC. Under the new arrangements, which took effect on 13 July 2007, NERC has set mandatory, enforceable reliability standards.

NERC's new standards specify how the system should perform, not how it should be designed. Network planning criteria to meet the NERC standards is left to individual RTOs, transmission owners, and users of the bulk power system. The NERC standards specify minimum criteria for network security and reliability, with regional Electric Reliability Organisations (EROs) empowered to develop more stringent regional reliability standards.[51] The eight EROs across North America

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[49] FERC (Federal Energy Regulatory Commission) 2007, *Order No. 693 – Mandatory Reliability Standards for the Bulk-Power System* (Docket No. RM06-16-000; Order No. 693), Issued 16 March 2007, FERC, Washington DC (http://www.ferc.gov/industries/electric/indus-act/reliability/standards.asp)

[50] NERC (North American Electric Reliability Corporation) 2007a, *Reliability Standards for the Bulk Electric Systems of North America*, NERC, 23 October. (URL http://www.nerc.com/~filez/standards/Reliability_Standards.html) .

[51] http://www.nerc.com/~filez/regional_standards/

replace the electricity regional reliability councils, established after 1968. These EROs are currently reviewing existing regional reliability standards.[52]

Consequently, a number of the NERC standards appear to correspond to the technical standards specified in Schedules 5.1 to 5.4 of the NER, and the system performance and security standards specified in Chapter 4 of the Rules. Other NERC standards establish a national framework for establishing transmission reliability over the planning horizon.[53]

Further information on international approaches to transmission planning is contained in a report to the AEMC by consultancy firm, the Brattle Group.[54] This study provides a factual description of transmission planning arrangements in international markets with similar characteristics to Australia.

The Panel intends commissioning further analysis of:

- the transmission reliability standards used in different international electricity markets; and
- the frameworks used in other markets to ensure consistency of transmission reliability standards across multiple political jurisdictions and/or multiple transmission network owners.

52 NERC 2007b, *Reliability Standards Development Plan: 2008–2010, Volume I, Work Plan and Schedule*, October 5, 2007 (URL https://standards.nerc.net/)

53 See in particular, NERC 2007a, "Transmission Planning" standards TPL-001-0 through TPL-006-0

54 Brattle Group 2007, *International Review of Transmission Planning Arrangements*, A report to the Australian Energy Market Commission, The Brattle Group, Bruxelles (URL http://www.aemc.gov.au/pdfs/reviews/National%20Transmission%20Planner/brattle.pdf)

Table 3.2: Transmission reliability standards in selected foreign electricity markets

Market	Form of transmission standard	Level of standard	Application to network planning and operations	Planning and operational responsibilities
Ontario	Deterministic N-1 standard set by NERC Probabilistic standard regarding loss of load, set by Northeast Power Coordinating Council (NPCC)	N-1	Transmission planned to NERC/NPCC and local area criteria, which include N-2 and multiple contingencies.	Independent Electricity System Operator (IESO) and TSO, Hydro One.
PJM	Deterministic N-1 standard set by NERC Probabilistic standard regarding loss of load, set by Mid Atlantic Area Council (MAAC).	N-1	Transmission planned to NERC/MAAC reliability criteria which include N-2 and multiple contingencies.	Office of the Interconnection (Independent System Operator) and TSOs in area covered by PJM market.
Great Britain	Deterministic N-1 standard	N-1	Transmission planned and operated to deterministic N-1 criterion.	National Grid Company (NGC) and TSOs for England & Wales, Southern Scotland, Northern Scotland.
New Zealand	Deterministic, N-x, with x varying with the size and criticality of load	N-0 for loads < 10MW on single radial line N-1 for loads between 10 and 300MW N-2 for loads between 10 and 300MW in the CBD N-2 for loads between 300 and 600MW N-2 for loads greater than 600MW		Transpower New Zealand
Nordpool	Deterministic	N-1	Transmission planned and operated to deterministic N-1 criterion	Nordel and TSOs: Stattnet (Norway), Fingrid (Finland), Eltra (Western Denmark), Elkraft System (Eastern Denmark), Svenska Kraftnat (Sweden).

3.5 Potential issues arising from divergent transmission standards

It has been suggested that there are issues that may arise from divergent jurisdictional transmission standards, including:

- Sub-optimal development and use of the national transmission grid arising from the application of the Regulatory Test to networks with differing standards;
- Poor balance between transmission and generation investments within and across NEM jurisdictions, and relatively low level of interconnection; and
- Technological bias in meeting jurisdictional transmission reliability criteria through network solutions rather than non-network solutions.

The Panel intends to investigate issues that have been observed in overseas electricity markets in which transmission planning standards vary across jurisdictions.

Q.	**What are the potential issues arising from divergent transmission standards across NEM jurisdictions?**

3.6 Size and scope of issues

As discussed above, there appears to be considerable variation in the form and level of transmission planning standards across the NEM.

However, this lack of uniformity of jurisdictional transmission standards does not appear to have manifested itself in the form of noticeably different levels of delivered power system reliability across the NEM.[27] Arguably, jurisdiction specific transmission standards, together with NEM-wide system performance and security standards, appear to have continued to deliver power system reliability in line with that experienced in the years before the start of the NEM in 1998. The differences in transmission standards do not appear to have led to materially different reliability outputs. Thus, on what basis should changes to the transmission reliability standards be pursued?

What is the relative importance of having the same transmission reliability standards for say, the Adelaide CBD and the Brisbane CBD? How does that compare with the relative importance of having the same network standards for the TNSP/DNSP jointly responsible for delivering reliability to those respective CBDs?

[27] See AER (Australian Energy Regulator) 2007, *State of the Energy Market 2007*, AER, Melbourne, pp.45–47 and pp.132–134 (URL http://www.aer.gov.au/content/index.phtml/itemId/713232)

Q. What are the size and scope of the policy and commercial issues arising from divergent transmission standards across NEM jurisdictions? Which are the most significant? How significant are they?

3.7 Motivations of changing existing jurisdictional transmission standards

Since the creation of the NEM, there are at least three motivating reasons for changing the existing jurisdictional transmission standards.

First, the transmission network is an increasingly interconnected system. The number of interconnections across jurisdictions has increased significantly since the start of the market, and this has resulted in greater financial trading and physical power flows across jurisdictions. These increased physical flows, together with market related changes in power flows, have required system planners and operators to pay greater attention to physical interactions that affect system security and reliability. The construction or augmentation of an interconnector can dramatically alter the economics of alternative projects, such as transmission or generation, that deliver the same level of reliability. Given the significant sunk capital costs associated with power generation and transmission projects, and their long asset lives, there are potentially significant dynamic efficiency benefits in optimising the timing, scale and use of transmission and generation assets. Conversely, there are likely to be significant, on-going, economic costs from having a poorly balanced mixture of transmission and generation assets.

Second, there is a need to derive an optimal balance between transmission and generation investments over space and time using a combination of market incentives and regulatory incentives. Power system reliability and security is no longer solely determined by a system planner, that designs, builds, owns and operates all the generation and transmission assets within a jurisdiction, with little or no regard to what occurs in other jurisdictions. Instead, generation investments are driven by a range of market-related factors concerning financial risks and payoffs, and the co-ordination of generation expansion with transmission planning augmentation occurring primarily through information disclosure in Transmission Annual Planning Reports, the SOO ANTS, connection applications, and public consultations on major transmission upgrades.

Third, it is claimed by ERIG that prospective benefits arising from any new National Transmission Planning arrangements and Reliability Test will be significantly diminished if divergent jurisdictional transmission standards continue to be used instead of nationally consistent standards.

Q. What motivations, if any, are there for greater national consistency of transmission standards across the NEM?

4 Frameworks for nationally consistent standards

This chapter discusses several approaches that could be taken towards developing a the consistent framework of transmission standards across the NEM.

Two broad approaches will be outlined:

1. Consistency through the alignment of regional standards. This approach allows for regional differences within a common framework; and

2. Uniform standards, universally applied; which represents one end of the spectrum for a nationally consistent framework

Also discussed are two key issues associated with any change in form and/or level of existing jurisdictional transmission standards. First, what are the pros and cons of each approach? Second, what are the costs and benefits of moving away from today's divergent jurisdictional standards to a more consistent national framework?

4.1 Before the NEM there were divergent standards, set regionally

Prior to the start of the NEM, transmission reliability standards were set on a regional (i.e. jurisdictional) basis. There was no formal framework to ensure 'nationally consistent' standards, other than via joint TNSP planning and operation of the interconnectors joining the transmission grids of:

a) NSW and Victoria; and

b) Victoria and South Australia.

Informally, there may have been a degree of consistency provided via requirements on TNSPs to plan and operate their networks in line with 'good industry practice'.

This approach was entirely consistent with the institutional arrangements in place prior to the establishment of the NEM, including the generally low level of interconnection between jurisdictions.

Under this approach, a degree of national consistency could arise by accident, rather than design, if all jurisdictions independently adopted the same form and level of transmission reliability standards, and applied them consistently to customers of similar types.

A somewhat more certain means of reaching a degree of national consistency using this approach would be for jurisdictions to agree to a common set of factors that each would have regard to when unilaterally determining their own standards. Agreeing on a common set of factors in this way could provide a "least change" option for moving towards nationally consistent standards.

In reality, there was no accidental alignment of jurisdictional transmission reliability standards, and this remains the case today (see Chapter 3).

Since the mid 1990s, in the lead up to the start of the NEM, there has been a deliberate shift away from purely jurisdiction specific transmission reliability standards. This shift has been prompted by the need to operate the NEM in secure and reliable manner as a single control area and the increased level of interconnection between jurisdictions, which has meant that electrical disturbances in one jurisdiction can affect the reliability of energy supplies in other jurisdictions.

4.1.1 Advantages

The benefits of a purely jurisdiction specific approach to setting standards include:

1. Accountability – since the jurisdiction "feels the heat" when there is a reliability failure, the jurisdiction should arguably be able to set the standards.

2. Flexibility - standards can be tailored to local conditions in each jurisdiction, taking into account:

   (a) historical expectations of reliability and nature of existing network;

   (b) load dispersion, density and growth within region;

   (c) nature of critical loads and economically important loads;

   (d) generation fleet mix and locations;

   (e) degree of interconnection with other NEM regions;

   (f) likelihood of localised critical contingencies — e.g. equipment failure; and

   (g) effects of local climate on network performance envelope – for example, dust on circuits, lightening strikes, wind, heat, cyclones, icing, bush fires, etc.

3. It enables consistency of standards between TNSP and DNSPs within the jurisdiction to be developed and maintained, thereby facilitating least cost development of the network.

4. It is evolutionary, requiring few changes to existing networks, and to long term connection agreements.

4.1.2 Disavantages

However, there are some potential disadvantages to this approach, including that:

1. It may be perceived as entrenching jurisdiction specific network planning, which appears at odds with the MCE's desire for a more co-ordinated development of the National Transmission Grid.

2. It may be perceived as focussing the attention of TNSPs on the development of their own networks in order to deliver reliable supply, potentially overlooking more economic means of meeting reliability standards, such as greater

interconnection or network augmentations in other transmission networks that provide increased reliability benefits to loads on their network.

3. The existence of differing jurisdictional transmission standards may result in significantly different transmission network outcomes when the new Regulatory Test is applied similar projects in different jurisdictions. This has the potential to alter the economics of transmission relative to generation investments across the NEM.

Q. Are there other advantages and disadvantages of having transmission standards that are divergent and are set on a jurisdiction specific basis? Do the advantages outweigh the disadvantages? Or vice versa?

4.2 Today's framework for transmission reliability standards

The NEM's existing framework for setting transmission reliability standards provides a degree of national consistency through a range of mechanisms:

1. NEM-wide power system performance standards relating to the operational timescale, which are contained in Schedules 5.1a and 5.1 of the Rules;

2. NEM-wide power system security standards, specified in Chapter 4 of the Rules; and

3. Minimum connection point standards for loads, distribution networks, MNSPs, and generators connected to the transmission grid (Schedules 5.2 to 5.7 of the Rules).

The existing framework also allows transmission reliability standards to diverge across (and within) jurisdictions, through:

4. Allowing jurisdictions to specify network connection point reliability standards or performance standards with greater precision than in the Rules. These jurisdictional transmission standards complement the standards in the Rules and apply to both the operational time horizon and longer term planning horizons; and

5. Allowing negotiated standards of reliability to be higher or lower than the minimums, with agreed standards specified in connection agreements between network users and TNSPs.

Accountability for the performance of the bulk power system against the reliability standards is ensured via a range of interacting mechanisms:

- Monitoring by the Reliability Panel of the level of USE in each jurisdiction;

- Enforcement of the Rules by the AER; and

- Enforcement of transmission licence conditions, including with transmission codes, by the Minister or regulator in a jurisdiction;

- Compliance with regulatory rulings made by AER;
- AER imposed performance incentives and monitoring across the regulatory cycle;
- Financial penalties relating to network performance that are specified in network connection agreements.

To summarise, the overall framework is one in which there are minimum national standards for network performance and security in an operational timeframe, with a measure of discretion given to jurisdictions in setting specific standards that are consistent with the national minimum standards. The way in which jurisdictional standards are given effect, together with the form and level of those standards, is left to the discretion of the jurisdiction. There is scope for individual energy users to negotiate higher or lower reliability standards. At a broad level, there is degree of national consistency in the accountabilities of TNSPs. All TNSPs have to answer to national institutions, such as the AER, jurisdictional regulators or governments, and network users.

4.3 Issues with existing framework

As discussed in Chapter 1, while the Rules specify a common set of standards for transmission, there are additional standards set at a jurisdictional level which affect the design, construction and operation of transmission networks.

ERIG noted that differences in jurisdiction specific standards and their interpretation could be leading to a pattern of investment in transmission networks across the NEM that is not as efficient as it otherwise could be and that this could be distorting the efficient balance of investment between transmission, demand side response, and generation. A specific issue raised by ERIG is that without a framework for greater national consistency in transmission standards, the projected benefits arising from the establishment of a National Transmission Network Development Plan and the development of a new Regulatory Test, would be significantly diminished. Greater consistency in transmission standards is viewed as key step in facilitating the efficient development of the national transmission network.

In agreeing to this review of jurisdictional transmission reliability standards, COAG stated the development of consistent national framework should proceed "with appropriate caution noting the different physical characteristics of the network, existing regulatory treatments in balancing reliability and costs to consumers, and that these standards underpin security of supply."[28]

Chapter 3 outlined how both the form and level of existing jurisdiction specific transmission standards differs across the NEM. Furthermore, jurisdictional transmission standards are imposed by a wide variety of legal and regulatory instruments, including: Acts of Parliament, Transmission License conditions,

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[28] COAG 2007, "COAG Reform Agenda – Competition Reform April 2007", p.5 (available at www.coag.gov.au)

Transmission and Distribution Network Codes, Network Management Plans, Connection Agreements, and Planning processes.

In order to have a nationally consistent framework for transmission reliability standards, there will need to be broad agreement on the specification of the form of standards, and the mechanism by which the detailed standards are determined.

Developing a framework for a 'nationally consistent' transmission reliability standard requires that questions about the following six issues need to be addressed:

- What does a 'nationally consistent' framework mean?
- To what degree should the framework include specific levels of reliability ?
- Who will define the framework?
- Who would define any standards within that framework?
- What are the interactions between the framework and other parts of the regulatory regime?
- What steps are required to implement the new framework ?

This chapter addresses the first of the above six issues, and its impact on the design of an appropriate framework, with the remaining issues discussed in the next chapter.

4.4 "Nationally consistent" framework

The notion of a "nationally consistent" framework is open to a range of interpretations, which potentially have very different implications for the design, construction and operation of the network and the costs of reliably and securely delivering power to customers.

A key factor in efficiently designing and operating transmission networks is that the level of reliability accords with the economic and/or social value placed on reliability. Power supply interruptions in a densely populated area will affect a greater number of businesses, transport networks, households and industries than the same interruption in a sparsely populated area. Also, the consequences of the loss of load in a densely populated area are likely to pose greater public safety issues than the loss of load in a sparsely populated area. Because of this, some loads are treated as critical, with a high level of network redundancy built in to maintain secure and reliable supplies, or in some cases with stand-alone back-up generation that operates when grid supplied power fails. For example, in a metropolitan area, an interruption to power supplies could cause failures of computer systems, telecommunications, railways, traffic lights, and the loss of mains power to critical loads such as hospitals. In contrast, the loss of supply to an isolated farm or a remote load will disrupt a smaller number of people and businesses and will most likely pose fewer public safety issues.

Transmission network standards in Australia recognise the differing economic and social impacts of supply reliability in metropolitan and rural areas. In most NEM jurisdictions, the transmission network reliability standards for capital city central business districts are at a higher level than in other metropolitan and rural areas. In addition, there is scope for parties connecting to the transmission grid to negotiate a higher or lower standard of reliability than the minimum standards set out under the Rules and in jurisdictional transmission standards.

The key implication of this is that a "nationally consistent" framework does **not** mean that a single level of reliability ("one size fits all") applies to all locations on the network. For example, developing a "nationally consistent" transmission framework would not mean that the reliability standard for electricity supplies to state capital CBD areas should be the same as the standard for part of the network supplying a modest, relatively remote load.

However, a "nationally consistent" transmission framework may mean that loads of similar size or critical importance should have the same reliability standard regardless of in which jurisdiction (or NEM region) they are located. For example, should the level of reliability for say, the Adelaide CBD and the Brisbane CBD be identical or not?

Finally, under any "nationally consistent" transmission framework, there should continue to be scope for parties to negotiate a different standard of service as part of their connection agreement, as long as this does not affect the ability of the network to meet the minimum standards applying to other users.

Q. What does "nationally consistent" framework mean, and what does it not mean?

Q. How is the notion of a "nationally consistent" framework best expressed?

4.5 Consistency through the alignment of regional standards

As discussed above, the current NEM framework provides a degree of consistency in transmission reliability standards in the operational timeframe, but allows for jurisdictional differences within that common framework. However, there is less harmonisation of standards over the planning horizon, and hence allowance for greater divergence across jurisdictions in the standards that underpin transmission network planning and investment decisions.

A move to a nationally consistent framework of transmission standards is therefore primarily concerned with standards that apply over the planning horizon, rather than the operational horizon.

There are at least four possible ways in which a nationally consistent framework of transmission reliability standards could be achieved through closer alignment of regional standards:

1. Making the operational standards in the Rules more specific, thereby limiting the degree of discretion available to TNSPs in meeting the operational standards contained in the Rules;

2. Expanding the transmission standards in the Rules to cover the planning horizon, as well as the operational horizon; and

3. Aligning *the form* of jurisdictional transmission standards across the NEM via coordinated changes to the jurisdiction specific instruments that specify the standards.

4. Aligning *both the form and the level* of jurisdictional transmission standards across the NEM via coordinated changes to the jurisdiction specific instruments that specify the standards.

Closer alignment of jurisdictional transmission reliability standards is also likely to require adjustments to TNSPs' accountabilities, incentives, penalties and regulatory processes and determinations. This is discussed more in Chapter 5.

Q. What are the pros and cons of having jurisdictional transmission standards aligned through:

- **Making the operational standards in the Rules more specific, thereby limiting the degree of discretion available to TNSPs in meeting the operational standards contained in the Rules;**

- **Expanding the transmission standards in the Rules to cover the planning horizon, as well as the operational horizon;**

- **Aligning *the form* of jurisdictional transmission standards across the NEM via coordinated changes to the jurisdiction specific instruments that specify the standards.**

- **Aligning *both the form and the level* of jurisdictional transmission standards across the NEM via coordinated changes to the jurisdiction specific instruments that specify the standards.**

4.6 Uniform standards, universally applied

COAG asked the MCE to "task the AEMC with reviewing transmission network reliability standards with a view to developing a consistent national framework for network security and reliability, for MCE decision"[29]. At one end of the spectrum of "nationally consistent frameworks", lies an approach of uniform standards, universally applied. Uniform standards, applied across the NEM, would ensure national consistency of transmission reliability. Under a uniform transmission

[29] "Council of Australian Governments' Response to final report of the Energy Reform Implementation Group", Attachment A of Ministerial Council of Energy letter to AEMC, 3 July 2007 directing it to conduct the National Transmission Planner Review (Available at http://www.aemc.gov.au/electricity.php?r=20070710.172341)

reliability standard, the form and level of the standards would the same across the NEM for loads which have the same implicit or explicit value of customer reliability.

For example, a uniform, deterministic, reliability standard could be applied when planning all transmission networks in the NEM, which required that the networks be built to deliver:

- N-0 secure transmission for rural loads on a single circuit line;
- N-1 secure transmission for all remaining areas other than state/territory capital CBD;
- N-2 secure transmission for the state/territory capital CBD; and
- 0.002% reliability for each NEM region over the long term/10-year time horizon.

Alternatively, a uniform standard could have a form that is probabilistic, applied to all connection points with a similar value of customer reliability, and designed to deliver 0.002% reliability to each NEM region over the long term/10-year time horizon.

Any uniform standard could be above or below the existing jurisdictional standards. This could present considerable challenges in implementing the new standard, and have a number of costs and benefits. For example, it may result in a "disconnect" between the reliability standards of the TNSP transmission network and the DNSP sub-transmission network within the same jurisdiction. (Note that DNSP reliability standards lie outside the scope this Reliability Panel review).

Q. What are the pros and cons of having a uniform transmission standard applied across the NEM?

4.7 Costs and benefits of moving to a uniform transmission standard

Any move towards a common form and level of "uniform" transmission standard across the NEM is likely to result in changes in the levels of transmission reliability and investment in jurisdictions over time.

A shift to a different form of standard could involve significant changes in the resources required for transmission planning. For example, probabilistic standards require considerably greater modelling and analysis than deterministic standards, but may not deliver any different a level of reliability.

A uniform standard could be above or below the existing standards in various jurisdictions, resulting in a potentially significant change in the capital and operational expenditures required to meet the new standard.

If significantly higher capital expenditure were required, this would contribute to an increase over time in the level of transmission charges faced by those connecting to and using the network. These higher charges may deliver higher level of reliability, but may only make sense if customers value such reliability.

Conversely, the shift to a lower level of transmission standard could see a gradual reduction in capital expenditure and transmission changes, which may be seen as a benefit. However, this might come at the cost of a reduction in transmission reliability, which might not be fully known. The reduction in reliability may be imperceptible most of the time, and only become apparent when there is a contingency or security event on the network. If such an event occurs, hard questions will be asked of governments, those who set the standards, and system operators as to why the standards were lowered and the costs/benefits of doing so.

The transition to any new standard is likely to require special allowances to be made in TNSP Regulatory Determinations by the AER, which would flow on into transmission pricing structures.

Q. What are the costs and benefits of moving to a common form and level of transmission planning standard?

Q. What allowances would have to be made in moving to a uniform standard?

Q. What are the costs and benefits of *not* moving to a common form and level of transmission planning standard?

Q. What are the costs and issues if a common transmission standard leads to an inconsistency with the DNSP sub-transmission standard in the same jurisdiction?

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5 Implementing a nationally consistent transmission framework

This chapter outlines a range of issues associated with implementing a nationally consistent transmission framework across the NEM.

5.1 Implementation issues

The divergence in the form and level of transmission standards across NEM jurisdictions, the different instruments used to give effect to those standards, and the degree to which standards are set independently of transmission owners all present challenges in implementing a nationally consistent transmission standard across the NEM.

Five key issues are:

- Who would define the framework ?
- To what level of detail should the framework be specified ?
- What are the interactions between the framework and other parts of the regulatory regime?
- What implementation steps are required?
- What process should be followed?

5.1.1 Who would define the framework?

Transmission standards are currently set in a mixture of Transmission Codes, Transmission Licenses, the NER technical standards, and via Network Management Plans.

As a matter of principle and good governance, JPBs should not set their own standards. This principle appears to be generally accepted, with transmission reliability standards in each jurisdiction ultimately decided on by governments (who, as noted, "wear the heat" for reliability failures). While, to varying degrees, governments in different jurisdictions seek the expert views of JPBs when determining the standards, the final decision is that of the government.

JBPs and transmission owners have a role in evaluating the most appropriate means of ensuring that standards are met, and the speed with which reliability issues have to be addressed.

A nationally consistent transmission framework could be determined by one of the following bodies:

1. the National Transmission Planner; or

2. the AEMC on the advice of the Reliability Panel; or

3. the Reliability Panel; or

4. the MCE, on advice from JPBs, the NTP or the Reliability Panel.

Whoever sets the new transmission framework will require access to resources with a solid technical understanding of power system operations and performance characteristics, understand existing jurisdictional network standards and network reliability, and be able to balance the economic and social costs and benefits of power system reliability. The setting of any new framework will also have to be guided by the requirements and concerns of jurisdictional governments.

Given the importance of reliability, the accountability arrangements for the body that sets the framework are also a relevant consideration.

Q. Which body is best placed to set any nationally consistent transmission standard and why? To whom, and how, should this body be accountable?

5.1.2 Interactions

The existing transmission reliability standards are a critical part of regulatory arrangements and incentives facing transmission network operators. TNSPs are required to plan, build, and operate their networks so that reliability standards are met and to do so in an efficient manner.

TNSP accountabilities for network reliability provide a good indication of the interactions that standards have with other aspects of the regulatory regime applying to TNSPs.

TNSPs are held accountable by the following bodies:

- the Reliability Panel, which issues an annual report on the performance of the market and the level of USE in each jurisdiction;

- the AER, which enforces the Rules, including those relating to power system performance and security;

- jurisdictional Ministers and regulators, who issue transmission licences and enforce transmission licence conditions specified in legislation or network codes;

- the AER, which also makes regulatory determinations, approving capital and operating expenditures, sets regulated transmission charges, establishes target performance levels and incentives, and checks compliance with those determinations and performance targets;

- network users with connection agreements that specify standards of network performance that differ from the minimum standard; and

- interested parties, more generally, through publications and consultation processes, such as Annual Planning Reviews and applications of the Regulatory Test for new transmission assets.

Any implementation of a consistent national framework for transmission standards would need to recognise the above inter-dependencies, any future MCE decision on the role and responsibilities of a National Transmission Planner, and recent changes to transmission standards in SA, Tasmania and the EDSD-driven changes in Queensland.

Specific interactions include:

1. Allowance within the regulatory framework for adjustments to the new standards.

2. The MCE has sought advice from the AEMC on the establishment of a National Transmission Planner. Decisions on the role and responsibilities of a National Transmission Planner and its interaction with the TNSPs will affect the planning process across the NEM.

3. The AER is currently developing a Service Target Incentive Scheme for transmission companies, which is likely to evolve as it makes regulatory determinations for each of the TNSPs. A framework for nationally consistent standards may affect the rewards and penalties of any Service Target Incentive Scheme, depending on the design of the scheme.

4. Recent reviews of jurisdictional transmission reliability standards in SA and Tasmania, and the EDSD-driven changes in Queensland, have all resulted in higher standards being set for a number of connection points. This has resulted in higher levels of capex and/or opex being required and having to be approved by the AER and allowances made for a transition to the new standards. Any shift to a nationally consistent framework will have to allow for a regulatory 'glide path' in capex and opex expenditures over time, and might have to have a transitional arrangement that allows for adjustments in a TNSP's regulated asset base, so that it is not penalised for sunk investments in its network that were required under a higher standard.

Q. What interactions are there between jurisdictional transmission standards and other aspects of the regulatory regime?

Q. What linkages are there between jurisdictional transmission standards and other reviews or Rule changes currently under consideration by the AEMC?

Q. How should these interactions be taken into consideration in developing a framework for nationally consistent transmission reliability standards?

5.1.3 What implementation steps are required?

Once a nationally consistent framework is defined, it would need to be implemented. The exact steps needed for implementation will depend on the approach taken. If a 'loose' approach were taken, consistency can be sought through the gradual alignment of jurisdictional standards. A 'tight' consistency could be achieved via all jurisdictions agreeing to immediately move to the standards currently set by one jurisdiction. Tight consistency could also be achieved by having transmission planning standards set in the Rules, in a common set of transmission licence conditions, or in common legislation that is passed concurrently by all jurisdictional parliaments.

The key implementation steps are:

- Specifying the form of the standards.
- If necessitated by the approach adopted, specifying the level of the standards.
- Giving effect to new standard through either:
  - Conformable changes to existing jurisdictional instruments; or
  - Referral in existing jurisdictional instruments to the new standard; or
  - Abolition of jurisdictional instruments and their replacement with a common instrument in which the new transmission standards are specified.
- Changing or clarifying the roles and responsibilities of Jurisdictional Planning Bodies and their relationship with the NTP.
- Changing the information publication requirements and public consultation processes associated with transmission planning.
- Transitioning to the new transmission planning standard over time, taking into account the interactions with the regulatory regime, existing contractual arrangements, NER technical standards and security settings, and any other relevant factors.
- Dealing with the existing long term connection agreements. This may be a significant issue in some jurisdictions.
- Dealing with the impacts, if any, of contractual arrangements which arose during privatisation.

5.1.4 What process should be followed?

Whichever framework is adopted to improve the national consistency of transmission standards, the implementation process will need to take into account the fact that the national electricity market is given effect within a constitutional federation of independent jurisdictions.

Any process will need to consider the following range of issues:

1. Where will any nationally consistent standards be specified:

(a) In existing jurisdictional instruments, such as Code and licenses, some of which would have to changed by an Act of Parliament?

(b) In the National Electricity Rules?

2. How would the new standards be incorporated into existing jurisdictional planning processes?

3. What time should be allowed for changes in existing transmission planning processes?

4. How long will it take to establish the legal and regulatory instruments which give effect to the standards?

5. How specific should the standards be and how much discretion should be left to transmission planners to devise ways of meeting those standards?

6. How should the new reliability standards be incorporated into current regulatory processes and future regulatory determinations?

7. How will the long term connection agreements (and other contractual arrangements) be dealt with?

Q. The Panel invites views on the above mentioned questions and opinions on what other implementation issues it should consider in developing a nationally consistent transmission reliability framework.

Q. What are the process steps you think will be necessary to establish a transmission reliability framework for the NEM?

Q. What difficulties do you see in implementing a nationally consistent transmission reliability framework and how could these best be managed or overcome?

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A Terms of Reference

AEMC

Reliability Panel

National Transmission Planner: Transmission Reliability Standards

AEMC Terms of Reference (17 August 2007)

Introduction

In its 13 April 2007 Communiqué, the Council of Australian Governments (COAG) asked the Ministerial Council on Energy (MCE) to request the AEMC to develop a detailed implementation plan for the national transmission planning function. COAG also indicated in its response to the final report of the Energy Reform Implementation Group (ERIG), contained in its 13 April 2007 Communiqué, that it agreed with the ERIG report that the Reliability Panel (Panel) should review the jurisdictional transmission reliability standards and develop a consistent national framework.

On 3 July 2007 the MCE requested the AEMC, pursuant to Section 41 of the National Electricity Law (NEL), to:

- Conduct a review into the development of a detailed implementation plan for the national electricity transmission planning function.

- Conduct a review into electricity transmission network reliability standards, with a view to developing a consistent national framework for network security and reliability.

The AEMC is therefore requesting the Panel, in accordance with section 38 of the NEL, to undertake the review of the jurisdictional transmission reliability standards for the MCE and to provide advice to the AEMC.

Scope

The AEMC requests the Panel, in accordance with section 38 of the NEL, to provide advice to the AEMC, and to this end, to undertake a review of the jurisdictional transmission reliability standards with a view to developing a consistent national framework for network security and reliability.

The Panel is requested to undertake the following:

- prepare a work program and timetable for undertaking this review;
- release an Issues Paper covering the National Framework for Electricity Transmission Reliability Standards
- by 31 March 2008 – hold at least one public forum
- by 31 July 2008 – release a Draft Report on the National Framework for Electricity Transmission Reliability Standards for public consultation
- by 23 September 2008 – provide a Final Report on the National Framework for Electricity Transmission Reliability Standards to the AEMC who will provide this report to the MCE by 30 September 2008.

Process

Consultation

The review of the jurisdictional transmission reliability standards is likely to have important implications for NEM stakeholders. Consistent with its philosophy of engaging with those parties, the AEMC requests the Panel to plan to involve stakeholders by seeking submissions and holding forums on the main review issues paper and on each of its draft decisions.

Resourcing, planning and communication

The Panel is requested to:

- provide the AEMC with a detailed project plan and budget by 21 September 2007; and
- brief the AEMC on progress in relation to the review from time to time as appropriate.

The Panel may choose to utilise consultant support engaged and provided by the AEMC to assist the Panel in the preparation of scoping and issues papers, draft and final review documents, and undertaking research and analysis.