NEMMCO

ANCILLARY SERVICES REFERENCE GROUP

FRAMEWORK FOR THE DEVELOPMENT OF AN ANCILLARY SERVICES MARKET TO SUPPORT THE NATIONAL ELECTRICITY MARKET

December 18, 1998

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APPENDICES

1 Background

In its final determination in relation to the National Electricity Code, the Australian Competition and Consumer Commission (ACCC) required that NEMMCO conduct a review of Ancillary Services. This review should address the possibility of developing market-based arrangements for the provision of Ancillary Services, including a short-term market. The new Ancillary Services regime is to be in place from 1 July 1999.

To conduct this review, NEMMCO has established the Ancillary Services Reference Group (ASRG). The terms of reference for this review are contained in Appendix A. This review is conducted against the National Electricity Code's market objectives, the relevant clauses of which are included in Appendix B. The standards which are currently applicable to Ancillary Services as prescribed by the Reliability Panel are contained in Appendix C. An overview of Ancillary Services is contained in Appendix D.

The ASRG has appointed Intelligent Energy Systems to assist in the review process. This document represents a framework for the review of Ancillary Services, and has been jointly prepared by the ASRG and IES. IES will now undertake an evaluation of the provision of Ancillary Services within the context of the established framework, and will submit their findings to the ASRG early in 1999.

2 Review Framework

The ASRG has developed a framework against which this review will be conducted. This framework consists of:

- Regulatory Background and Economic Concepts
- Principles for Ancillary Services Review
- Ancillary Services Description
- Ancillary Services Classification Matrix

These elements are contained in the remaining sections of this report.

It should be noted that the transmission and distribution networks operate as a single physical unit. The need for and options for the provision of Ancillary Services is not necessarily confined to the transmission network, even though the transmission network defines the effective boundary of NEMMCO's immediate responsibility for such services. This relationship will need to be recognised during the review.

Section 3 of this document examines the regulatory background for the review (which is also summarised in Appendix A) and reviews the fundamental economic principles against which the options for meeting Ancillary Service requirements in the NEM will be examined.

Section 4 sets out principles to guide the conduct of the review. These principles are drawn from the Code, competition policy as interpreted by the ACCC in the Code Determinations affecting Ancillary Services as outlined in Appendix A and discussed in Section 3, and the economic concepts outlined in Section 3.

Section 5 summarises the particular Ancillary Services that will be examined in the review. Appendix D contains an overview of Ancillary Services which is intended as background information.

Section 6 contains an Ancillary Services Classification Matrix. This matrix describes each service in terms of the cause of the requirement, the determinants of the quantity of requirement, options for meeting the requirement including the measurement of the provision of service, and issues relating to the likely level of competition that might be achieved. This matrix provides a basic resource for the conduct of a detailed review of each service, based on the concepts and principles previously set out.

3 Regulatory Background and Economic Concepts

3.1 Competition Policy and Ancillary Services

The development of the national electricity markets and the associated initiative on Ancillary Services are parts of the competition policy program adopted by Federal and State governments and formalised in the COAG Agreement on Competition Principles and the Trade Practices Act. The objective of these measures is to obtain economic benefits in the infrastructure industries from greater competition, improved efficiency in resource allocation, the deferral of plant investment and complementarities among State systems. Measures to these ends form the content of the Code.

The parts of that policy relating to the establishment of markets is based upon the social and economic logic and justification of standard, or neo-classical, micro-economic theory of the behaviour of consumers and firms. This logic analyses the conditions for optimising economic efficiency in the buying and selling of goods or services in markets, which may be defined in various ways. The stability of market arrangements is provided for either by social norms (eg, ‘cricket bats’ as distinct from ‘baseball bats’), or by various forms of administrative law covering fair behaviour, product standards and technical and economic prescriptions such as operating and performance codes. The National Electricity Code governs the operation of the National Electricity Market.

The Draft Code provided that Ancillary Services would be acquired and provided to the market by NEMMCO. In its 10 December Determination on the Code (p95) regarding proposals on Ancillary Services, the ACCC noted that “the acquisition of Ancillary Services by NEMMCO is based on the possible failure of the market to provide sufficient Ancillary Services’. It pointed to the desirability of developing a market in such services, and discussed several limitations on the potential structuring of such a market. The present arrangements, applying until 1 July 1999, provide for acquisition by NEMMCO, as a centralised, sole buyer, by competitive tender, regulated acquisition or direction. In its subsequent authorisation dated 19 October 1998, the ACCC discussed in more detail economic issues relating to the role of NEMMCO and the acquisition and provision of Ancillary Services within market arrangements (pp31-34).

In its Determination of 10 December 1997 (8.10, p94) the ACCC noted that the central purchasing of Ancillary Services and the setting by NEMMCO of minimum standards raised issues of:

- exclusionary provisions - requirements that participants obtaining network services must comply with provisions for acquiring Ancillary Services;

- exclusive dealing provisions - participants trade on condition that NEMMCO will only acquire Ancillary Services from market participants;
- third line forcing provisions – stipulations by NEMMCO to Network Service Providers (NSPs) to whom they are providing services that they obtain ancillary services from Code participants;
- the substantial lessening of competition.

All the above represent restraints on trade.

In its 10 December 1997 Determination the ACCC (p95) noted that “without the Ancillary Service requirements of the Code there would be an under provision of Ancillary Services as some users would not bear the full costs of providing them, preferring instead to ‘free ride’”. It also considered that “ only some Ancillary Services possess the characteristics which warrant their provision on a centralised basis”, and that the “development of a market in the provision and consumption of Ancillary Services is possible for those services that can be attributed to specific users.” In its subsequent Determination of 19 October 1998, the ACCC further comments in some detail on the considerations involved in, and the interdependencies among, services acquisition by invitation to tender, regulated acquisition, the possibility of competitive markets, and the payment of fees for services (pp31-34).

It notes that there are features of Ancillary Services that benefit all participants. Any fee recovery model should allocate costs to those who caused the need for the services, or that they should be charged on the basis of benefits received, perhaps by reference to energy transactions in the market.

3.2 Economic Framework and the Presumptions of Competition

As noted by the ACCC, proposals to construct market arrangements for Ancillary Services raise complex issues of economic theory and practice. For the later exposition it is useful to restate some of the well-known propositions of standard economics that are relevant. The technical descriptions of Ancillary Services that follow can then be related to these basic concepts.

The central model of standard economics deals with the analysis of marginal changes in demand and supply under conditions of perfect competition. These are that:

- Firms sell a standardised product i.e. the product sold by one firm is assumed to be a perfect substitute for the product sold by any other.
- Firms are price takers, i.e. the individual firm treats the market price of the product as given, and believes that the market price will not be affected by how much output it produces.

- Factors of production are perfectly mobile, i.e. firms are able to buy the use of the factors of production necessary to take advantage of a profitable business opportunity at a given time and location.

- Firms and consumers have perfect information.

These conditions may be expressed in several, logically equivalent ways. Such arrangements are also said to constitute efficient markets. They are rarely if ever satisfied in practice, but in many cases they provide useful explanations and predictions about important aspects of real economic behaviour. As a well-known text comments:

"In some markets, most notably for agricultural products, the four conditions come close to being satisfied. The predictions of the competitive model in these cases are in many ways as precise as those of the physicist's model applied to the striking of a puck on dry ice. In other markets, such as those for garbage trucks or earthmoving equipment, at least some of the conditions are not even approximately satisfied. But even in these cases, the competitive model can tell us something useful if we interpret it with sufficient care."[1]

The *equilibrium* or *clearing price* in a perfectly (or effectively) competitive market (or one which is '*contestable*', i.e., for which entry involves zero *sunk costs*) is the pair of price and quantity at which both willing buyers and willing sellers are satisfied or, put another way, the price at which *the demand and supply schedules intersect*. At this point *all of the gains from trade, or exchange, are achieved*, i.e., *economic efficiency is maximised*, price equals the marginal cost of the marginal firm on its upward-sloping marginal cost curve. The market supply curve is the summation of the individual firm supply curves. This is the situation of *allocative, or short run, efficiency*. The *short run* is the period in which one or more of the inputs of firms cannot be varied. An advantage of competitive markets is that they also produce *dynamic efficiency*, that is, demand and supply equilibrium, efficient resource allocation and market clearing in *the long run*, defined as the period in which all inputs can be varied.

The model of perfect competition provides the basic insights upon which much of the analysis and judgement of economic behaviour is made. But, as noted above, it rarely ever exists in reality and in any case applies only to industries with the appropriate characteristics of goods and industry structure.

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[1] Robert H. Frank, *Microeconomics and Behavior*, McGraw-Hill International Economic Series, Third Edition, 1998, p343. *The Penguin Dictionary of Economics* (Fifth edition, 1992), p326, comments: "Although the features of perfect competition make it look a poor description of modern industry, it is a realistic description of world commodity markets where many traders deal in a homogeneous product. Moreover, its very powerful results indicate that the achievement of even a partially competitive market can be advantageous. Thus, the simple perfect competition model provides a good starting-point for illuminating the forces underlying the real behaviour of firms". Among many others, these two texts provide detailed discussion of the definitions and propositions outlined in this section.

Product differentiation affecting quality, production economies with small numbers of producers, contestability (i.e. the potential for new entrants), the nature of goods traded and other factors all introduce issues that have to be taken into account when assessing competitive effectiveness.

3.3 Other Forms of Competition: Some Definitions

There are other forms of competition analysed in standard economics. At the extremes are the situations of *monopoly*, a single seller, and *monopsony,* a single buyer.

- A monopolist makes profits in excess of those necessary to stay in business, and, in theory, prices will be higher and output lower than they would be in perfect competition. This is because demand is not elastic, and a rise in price will produce much less than a proportionate fall in output. The monopolist is not a price taker. Thus all of the gains from exchange are not realised.

- A monopsonist is also not a price taker. Its purchases will raise or lower the market price to some perceptible degree, and hence affect the rewards obtained by sellers. It will buy less and pay less than would apply under competition. Again, the gains from exchange are not maximised. A variation is that of a monopsonist who is guided by regulatory or code requirements rather than profit maximisation. This could be the position of NEMMCO in relation to some Ancillary Services.

- Oligopolistic competition refers to an industry in which there are only a few major sellers: their behaviour as to price and output is interdependent and depends upon strategic interaction. Such behaviour is analysed within the theory of games.

- *Monopolistic competition* is characterised by numerous firms producing products which are *close substitutes*, and where there is freedom of entry and exit. Here each firm has a small amount of *market power* and is not a price taker for its own product. Competition is based upon *product differentiation.* The extent of market power is set by the elasticity of demand for the individual firm's product. Compared with effectively perfect competition, output will be lower, price will be higher, and production will not take place at lowest cost. Many modern consumer markets exhibit monopolistic competition. A nodal or zonal electricity market exhibits some of these characteristics also – each node or zone is in principle a different market – although there is high correlation between the prices at nodes or zones unless constraints apply.

Competition is also affected where *joint costs* or *joint products* occur, where a *fixed resource* has to be shared between two outputs, or where products are *complements* or *substitutes*:

- For *joint products*, ie those for which a change in output of one requires a change in the output of the other, the allocation of costs between them will be arbitrary (there is no one unique best allocation). The equilibrium prices are those which clear the market for each product.
- For a *fixed resource used for two products*, the most efficient allocation is one where the marginal product for each is the same; and, similarly, where two processes have to produce a given quota, the efficient allocation is that where the marginal costs of each are equal.
- For goods that are *complements*, a rise in the price of one will lead to a fall in demand of both that product and its complement. For all substitutes the reverse applies.

An industry marked by conditions of *increasing returns to scale*, a long run concept, where marginal increases in inputs lead to proportionately larger increases in output, is said to be a *natural monopoly*. If there are two or more firms in such an industry there will be oligopolistic competition and their behaviour will be interdependent.

Important considerations arise when products are *public goods*, so called, because, as has been said, 'their consumption has to be decided by society as a whole rather than by each individual'[2]. In practice, though, private producers provide many public goods under various arrangements, which, typically, limit access. Public goods are characterised by:

- *non-diminishability* (ie one person's consumption does not effect the amount available for others),
- *non-excludability* (ie it is either impossible or excessively costly to exclude non-payers from consuming the good-the 'free rider problem'), and also they are often
- *non-rejectable* (a person cannot abstain from consumption even if he or she wants to).

3.4 Market Failure and Regulation

Market failure occurs where economic efficiency has not been achieved because of 'imperfections' in the market mechanism of perfect competition. Some such imperfections are always present so the term is usually applied to situations where there is gross mal-distribution of resources and hence of benefits. Public regulation in some form is required to adjust for market failure. The characteristics of market failure are that:

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[2] *Penguin Dictionary of Economics*, p350.

- externalities are present (i.e. all the effects of a transaction are not captured in the price of that transaction- externalities are an important issue in the electricity market and also for Ancillary Services);
- increasing returns to scale apply (i.e. a natural monopoly develops- important for both the electricity market as a whole and for Ancillary Services); and
- *there is marked asymmetry of information (*an issue both for the electricity market and for some aspects of Ancillary Services. The effect of this form of failure is that transaction costs may become too high for efficient market operation).

In these cases, competitive solutions can lead to substantial inefficiency and, depending upon the prevailing social values, inequity in the allocation of resources. The infrastructure industries and electricity in particular, all display these characteristics in various degrees. Historically, it was largely because of this that they were centrally provided by public agencies, and regulatory regimes are adopted to offset them. Thus, as a notable example, while it is believed that the spot market in electrical energy supply (generation) and demand can be constructed in a way providing effective competition, the 'wires' industry is believed to constitute various forms of natural monopoly to a large degree. Hence, in the Australian and other cases, a central regulatory regime has been established for the networks to simulate salient aspects of operation under competitive conditions. Such considerations are also present in some Ancillary Services.

Where a monopoly or tendency to monopoly exists, the first regulatory step is to foster competition by removing barriers to the entry of competitive firms. If there is natural monopoly, the conditions of sale and production can be regulated in such as a way as to limit the scope for monopoly profits, eg, by revenue caps, while attempting to ensure that output is set as close as possible to the efficient level. This is the intent of some of the current mandatory service requirements in the Code. Where neither of these measures is available the public interest can sometimes be served by skimming off monopoly rents by some form of taxation, e.g., by a variant of the sealed bid auction, in which the enterprise is left to function as a monopoly while paying royalty.

3.5 Procurement Issues and Options

For the purposes of establishing a framework for analysis, it is useful to identify the type of actions required to provide the service. The decision on the appropriate approach must rest on a detailed analysis of the competitive, regulatory and implementation issues as outlined earlier.

The first set of issues relates to the actions required to ensure the delivery of the service. Three steps can be identified in general:

- acquisition (by NEMMCO) of the *capability* to provide the service, which tends to be a long run issue (e.g. one year ahead);
- the *enablement* of the service, so that it can provided if required, noting that many services are intended to meet contingencies and are not normally used (e.g. be available if required at short notice); and
- the *use* of the service (if required).

The latter two are essentially short-run issues, potentially affecting the energy dispatch process in the case of joint products, even if the service is not used in a direct physical sense. These three steps imply three different commercial processes, the weight to be put on each as well as the approach and timing to be determined by study based on the principles set out in this framework.

Consideration of competition, regulatory and implementation issues will also lead to selection of one or more of the following approaches to the procurement of the capability, its enablement and ultimate use:

- Mandatory Code requirement;
- Mandatory connection agreement;
- Connection agreement or Code requirement – with the value of the Ancillary Service recognised;
- Negotiated contracts
- Periodic competitive contract tenders
- Regulated bids/offers;
- Competitive bids/offers.
- Some form of regulated pricing arrangement involving sellers, buyers or both
- Some form of two-sided market.

4 Principles for Ancillary Services Review

The following principles have been developed for the NEMMCO Ancillary Services review by the ASRG.

In developing these principles the ASRG have focussed on achieving efficient outcomes for the market place in both the provision and procurement of Ancillary Services (beyond what is a mandatory requirement on participants) while preserving price signals for efficient future investment so that Ancillary Services match needs over time.

The ASRG has purposely avoided being limited by current Ancillary Service arrangements and issues in drafting these principles. In this sense these principles represent the “light on the hill” for which the market should aim over time. Issues and arrangements that may place limitations on achieving these principles in full will be dealt with by an appropriate transition program.

In order to achieve an effective market, Ancillary Services should be classified as broadly as possible to maximise competition yet sufficiently defined so that NEMMCO is indifferent in its choice of supplier of Ancillary Services within a category in order to meet its Ancillary Service requirement. As a general rule services should be aggregated where on an individual basis the public benefits of defining the service narrowly does not outweigh the transaction costs of doing so.

It is intended that NEMMCO should undertake reasonable endeavours through commercial processes to ensure that there are sufficient Ancillary Services available to meet its Code obligations.

In order for NEMMCO to satisfy its power system security obligations, it is accepted that after exhausting all commercial processes NEMMCO may direct Participants to provide Ancillary Services to maintain power system security.

(i) Access

The following principles provide for consistency with the Code in relation to the provision and payment of Ancillary Services.

All areas of the market including networks participate in the provision of and payment for Ancillary Services.

a) Mechanisms will allow for non-Code Participants to participate in procurement processes, but they must become Code Participants if they are to become providers.

b) Equal treatment of available technologies.

(ii) Competitive services

The following principles have a basis the Code and in competition policy as specifically applied in a series of ACCC Determinations on the treatment of Ancillary Services in the Code.

a) Achieve competitive pricing outcomes where appropriate via the most suitable mechanism for each particular service that reflects the value of the service.

b) No energy Market Participant should be adversely affected by providing Ancillary Services at any time (i.e. the Participant receives payments which fully remunerate for the provision of Ancillary Services and foregone opportunities in the energy spot market for the current dispatch interval). Whether the above arrangements should apply to connection agreements and mandatory services will need further consideration.

c) Consistency and transparency in the criteria for determining the Ancillary Service requirements of the market, and in the procurement and the use of directions in procuring Ancillary Services.

(iii) Non-Competitive services

The following principles apply to the procedures for supply of the Ancillary Services in the event that competitive supply as provided for in (i) is not possible, after consideration of the scope for competition as outlined in Section 3 of this framework document.

If, after considering: industry structure; demand and supply-side options; feasibility and timing of new entrants and any substitute Ancillary Services capable of meeting the requirement; the market is deemed to be non competitive for the provision of an Ancillary Service then:

a) Wherever possible, commercial arrangements acceptable to both NEMMCO and the supplier will be used to purchase the Ancillary Service. The parties shall act reasonably in negotiating these arrangements.

b) For Code Participants, where mutually acceptable arrangements cannot be agreed, an independent expert may be requested by either party in order to determine binding terms for the provision of an Ancillary Service at a fair value.

c) For Non Code Participants, where mutually acceptable arrangements cannot be agreed, an independent expert may be requested by either party with the consent of the other party in order to determine binding terms for the provision of an Ancillary Service at a fair value.

d) Where NEMMCO directs a Code Participant to provide an Ancillary Service, the Code Participant shall be compensated at fair value for the service as determined by an independent expert that is appointed with the consent of both parties.

(iv) Treatment of Joint Production

The following principles relate to how joint production between energy and some classes of Ancillary Services are to be handled, especially in short term operations i.e. the dispatch process. Their basis is the market objectives and market design principles as set out in Attachment B, interpreted through the general principles for achieving economic efficiency in the case where there is joint production as outlined in Section 3.

Services priced and quantities determined on an economic basis in the dispatch and pricing process:

a) Consistency between dispatch and pricing.

b) Co-optimisation of Ancillary Services and energy market where possible with the objective of maximising value of spot market trade considering network and other constraints.

c) Ancillary Services should not systematically substitute for energy in the spot market. NEMMCO will ensure that the dispatch arrangements for energy and Ancillary Services achieve this aim wherever possible and that there is both sufficient transparency in NEMMCO's operations and sufficient information available to the market to independently gauge its performance in this respect.

(v) Information

The following principles relate to the information requirements for the effective operation of the Ancillary Service arrangements in the long and short term.

a) As part of the statement of opportunities Ancillary Service requirements will be identified in sufficient detail to facilitate a competitive market and to allow informed decisions in relation to both supply and demand.

b) Sufficient information regarding Ancillary Service requirements, quantities, prices, bids, offers and contract prices etc. will be published in a timely manner for the short term operation of the Ancillary Service arrangements to be efficient. As a minimum the market must be informed as to the cost of consuming, and the value of providing Ancillary Services.

(vi) Settlement

The following principle deals with an administrative matter in relation to the operation of the Ancillary Service arrangements.

a) Whenever NEMMCO dispatches and/or procures an Ancillary Service NEMMCO will be responsible for settlement of these services.

5 Ancillary Services Description

Broadly, Ancillary Services can be defined as those services that provide for the power system security, quality of supply and enhanced spot market trading benefits that would not be voluntarily provided by participants on the basis of energy prices alone. They are required to ensure that discrepancies between the commercial model in the NEM and the underlying physical behaviour of the electricity industry are dealt with. Some ancillary services have location-dependent characteristics; others do not.

To carry out a rigorous analysis of Ancillary Services it is necessary to notionally “unbundle” each Ancillary Service, then apply the principles and evaluation criteria to each service to determine the optimal treatment.

From this may follow the full unbundling and competitively pricing (via the most appropriate route for that service) of all Ancillary Services. This will need to be cognisant of any statutory obligations that may be in place, as well as the extent to which competition exists for each service. Some Ancillary Services are mandatory and some services subject to competition but it is intended that this will be reviewed as part of this process.

An overview of the role of Ancillary Services in the electricity market and their economic context is contained in Appendix D. Following is a description of the services that are to be the subject of further examination to determine the scope for competition in their supply. This description forms the basis for the classification matrix contained in the following section.

1 Frequency Management

1.1 Response to small scale frequency deviations

The continued and automatic balancing of demand and generation such that the system frequency remains within the limits specified by the National Electricity Code and where delegated by the Reliability Panel.

This service involves two generic forms of control systems:

- Automatic adjustment of consumption/generation on a near real time basis in direct response to system frequency deviations.
- Automatic adjustment of consumption/generation on a near real time basis in response to NEMMCO generated frequency control signals.

1.2 Response to large scale frequency deviations

Provision of the ability to increase or decrease generation, or increase or decrease demand, to mitigate the effects of generation failure, customer disconnection or transmission failure or interruption. By definition this service is utilised to cover only the initial time period prior to the energy market response to the changed system conditions.

2 Voltage Control

2.1 Continuous

The balancing of supply and consumption of reactive power such that voltages throughout the system remain within the limits specified by the National Electricity Code and where delegated by the Reliability Panel.

2.2 Contingency

The ability to increase or decrease reactive output and/or consumption to mitigate the effects of generation failure, customer disconnection or transmission failure or interruption.

3 System restart

The ability to provide restart real and reactive power services following partial or total power system failure.

These services include the ability to independently meet real and reactive power requirements in order to facilitate rebuilding the power system following either a partial or complete system shutdown.

4 Stability control

Provision of the ability to maintain dynamic and transient stability of the national electricity system following a credible contingency, by equipment located at generating units, within transmission systems and at customer premises.

5 Network Loading Contingency Control

The capability to adjust generation and/or consumption in order to manage the post contingent flow on network elements to within prescribed limits.

6 Spot market trading benefits

Provision or consumption of real or reactive power or provision of additional network capability, so as to increase spot market-trading benefits. This service refers to capability that would not be voluntarily provided by participants on the basis of energy prices alone. The need arises because the network is not accurately modelled in the NEM spot market. Such spot market trading benefits would be realised via:

- enhanced power flows on transmission networks,
- the general reduction of the impact of other constraints, and the reduction of losses.

7 Other services

In addition to these there are services that have been classed as Ancillary Services in other markets (such as in the UK and the US), which have been dealt with as follows in the NEM:

- Load following (this is considered to be provided by the energy market),
- Long term power reserve (this is a reliability service and is considered to be provided via the energy market)
- Generation scheduling and dispatch (this is a service provided by NEMMCO and covered under the participant fee regime)
- Transmission losses (the cost of losses is accounted for using loss factors and is therefore paid for through the energy market)
- Generation ‘constrained off’ due to transmission constraints (this is a firm access issue and is being considered as part of the NECA review on Network Pricing).
- Generation ‘constrained on’ to increase transmission capability (is covered by “Spot Market Trading Benefits” above).
- Power system protection (this is an essential part of access to the network and is covered through connection agreements and mandatory Code requirements).
- Transmission network availability (this is covered by either firm access or “Spot Market Trading Benefits” above).

6 Ancillary Services Classification Matrix

The following table classifies the Ancillary Services identified above under the following headings. The description below also includes an equivalent definition in economic terms. Each service can be regarded as a *good or product* in those terms.

- *Cause of requirement* - i.e. what leads to the need for this service. In economic terms this is the *need producing the demand for the good*.
- *Driver for quantity of requirement* - i.e. items that are important in determining the amount of service required. In economic terms these are the *determinants of the level of demand*.
- *Technical options for meeting requirement* - i.e. options for how this service can be delivered or requirement reduced. In economic terms these are the *supply and demand options*.
- *Measurement of provision* - i.e. options for measurement of the delivery of this service. In economic terms this is the *measurement of the units supplied*.
- *Measurement of cause* - i.e. options for measurement of the cause of the requirement for this service. In economic terms this is the *measurement of the units demanded*.
- *Geographic considerations* - i.e. service specifically required in particular locations, or sourced globally. In economic terms this relates to any tendency to *spatial monopoly.*
- *Potential for competition* - i.e. extent to which there is a potential for competing service providers for this service. In economic terms this relates to the *type of good, the type of production and associated issues that affect the potential for market failure*. This assessment requires a detailed consideration of each service so the remarks here are preliminary, based on the discussion in the previous section.

Another item for consideration not represented in the table is that of splitting capability to deliver a service, from response to a given event, i.e. the requirement for a certain contingency service may be based on one particular participant (e.g. the largest generator on line), even though that participant rarely causes a contingency event. On the other hand, there may be a participant who does not impact on the cause of a requirement (e.g. a relatively small generator), but who frequently causes a contingency event, and thus is a significant cause of the usage of the service.

<table>
<tr><th colspan="4">1.1: FREQUENCY MANAGEMENT - SMALL DEVIATIONS</th></tr>
<tr><td>Cause of requirement</td><td colspan="3">Net effect of:
a) Demand variations
b) Demand forecast error (5 min)
c) Non conforming scheduled participants</td></tr>
<tr><td>Driver for quantity of requirement</td><td colspan="3">Function of:
• Maximum / minimum acceptable frequency following credible contingency
• Frequency deviation due to credible contingent event
• Maximum acceptable time error
i.e.. The need to maintain freq pre-contingency is driven by the maximum / minimum acceptable post contingent frequency level. Thus there is an interaction between the ‘small deviation’ requirement described here, and the ‘large deviation’ requirement described in 3.5.2.</td></tr>
<tr><td>Technical options for meeting requirement</td><td>Short term (now):
• Central frequency control (e.g.: AGC)
• Local frequency control (e.g.: Governor)</td><td>Medium term (1 Yr):
• Central freq control (e.g.: AGC)
• Local frequency control (e.g.: Governor)
• Demand management control</td><td>Long term (2 Yrs):
• Central frequency control (e.g.: AGC)
• Local frequency control (e.g.: Governor)
• Demand. management
• Battery systems
• DC interconnectors
• Other</td></tr>
<tr><td>Measurement of provision</td><td colspan="3">• SCADA
• Frequency meter</td></tr>
</table>

1.1: FREQUENCY MANAGEMENT - SMALL DEVIATIONS	
Measurement of cause	a) Post analysis of demand variation - statistical b) Post analysis of demand forecast error c) Non conformance records
Geographic considerations	The frequency management service can be supplied over a wide geographic area.
Potential for competition	High, due to the many current options and few spatial limitations

<table>
<tr><th colspan="4">1.2: FREQUENCY MANAGEMENT - LARGE DEVIATIONS</th></tr>
<tr><td>Cause of requirement</td><td colspan="3">Significance determined by relative MW change, and includes:
a) Generation / Demand change (planned & unplanned)
b) Network contingencies</td></tr>
<tr><td>Driver for quantity of requirement</td><td colspan="3">Function of:
• Maximum / minimum acceptable frequency following credible contingency
• Frequency deviation due to credible contingent event
• System inertia
i.e.. As the maximum / minimum post-contingency frequency value is dependent upon the pre-contingent frequency value, there is an interaction between the ‘large deviation’ requirement described here, and the ‘small deviation’ requirement described in 3.5.1.</td></tr>
<tr><td>Technical options for meeting requirement</td><td>Short term (now):
• Central freq control (e.g.: AGC)
• Local frequency control (e.g.: Governor)
• Demand shed/increase
• Gen rapid start/stop
• Reduce largest credible contingency
• Network outage management</td><td>Medium term (1 Yr):
• Central freq control (e.g.: AGC)
• Local frequency control (e.g.: Governor)
• Demand shed/increase
• Gen rapid start/stop
• Reduce largest credible contingency
• Network outage management</td><td>Long term (2 Yrs):
• Central freq control (e.g.: AGC)
• Local frequency control (e.g.: Governor)
• Demand shed/increase
• Gen rapid start/stop
• Reduce largest credible contingency
• Network outage management
• Other</td></tr>
</table>

1.2: FREQUENCY MANAGEMENT - LARGE DEVIATIONS	
Measurement of provision	• SCADA : ⇒ Pre Contingency: Capability ⇒ Post Contingency: Delivery • Capacity - test to confirm capability • Local metering (trend recorders - for small, 'local' demand blocks) • Frequency meter
Measurement of cause	a) SCADA b) SCADA
Geographic considerations	• No significant limitations to supply except during some planned network outages which cause a region to be at risk of islanding. i.e.: In general, frequency response can be sourced from any location on the power system, recognising that there may be subsequent action required to reduce post contingent overloads. However, locally sourced frequency response is required where the network configuration places a region at credible risk of islanding.
Potential for competition	High, for the same reason as frequency management for small deviations.

2.1: VOLTAGE CONTROL - CONTINUOUS			
Cause of requirement	a) Changes in MW / MVAR demand b) Changes in MW / MVAR generation c) Network configuration / switching / characteristics d) Transmission distance between generation / demand		
Driver for quantity of requirement	• System security margins • Equipment tolerances • Voltage sensitive customers • Maximise network capability / minimise losses		
Technical options for meeting requirement	**Short term (now):** • Generators • Caps / reactors • OLTC transformers • SVCs • Synch Compensators • Customer PF management • Operations analysis (e.g. OPF)	**Medium term (1 Yr):** • Generators • Caps / reactors • OLTC transformers • SVCs • Synch Compensators • Customer PF management • Operations analysis (e.g. OPF)	**Long term (2 Yrs):** • Generators • Caps / reactors • OLTC transformers • SVCs • Synch Compensators • Customer PF management • Operations analysis (e.g. OPF) • Battery systems • Flexible AC transmission systems (FACTS) • Other
Measurement of provision	SCADA		

2.1: VOLTAGE CONTROL - CONTINUOUS	
Measurement of cause / consumption	a) SCADA b) SCADA c) SCADA d) Design characteristic
Geographic considerations	Both voltage and the demand and supply of its close complementary product *reactive power* are strongly influenced by electrical location
Potential for competition	Reactive power (used to control voltage) is potentially tradeable but there are potential problems with spatial monopoly.

<table>
<tr><th colspan="4">2.2: VOLTAGE CONTROL - CONTINGENCY</th></tr>
<tr><td>Cause of requirement</td><td colspan="3">Significance determined by relative MW / MVAr change, and includes:
a) Generation / Demand change (planned & unplanned)
b) Network contingencies
c) Pre Contingent network loading</td></tr>
<tr><td>Driver for quantity of requirement</td><td colspan="3">• Amount of power transfer across critical network elements
• Magnitude of critical contingency</td></tr>
<tr><td>Technical options for meeting requirement</td><td>Short term (now):
• Generators
• SVCs
• Synch Compensators
• Demand shed
• Operations analysis (e.g. OPF)</td><td>Medium term (1 Yr):
• Generators
• SVCs
• Synch Compensators
• Demand shed
• Network outage management
• Operations analysis (e.g. OPF)</td><td>Long term (2 Yrs):
• Generators
• SVCs
• Synch Compensators
• Demand shed
• Network outage management
• Operations analysis (e.g. OPF)
• Battery systems
• Other</td></tr>
<tr><td>Measurement of provision</td><td colspan="3">• SCADA
⇒ Pre Contingency: Capability
⇒ Post Contingency: Delivery
• Capacity - test to confirm capability</td></tr>
<tr><td>Measurement of cause</td><td colspan="3">d) SCADA</td></tr>
</table>

2.2: VOLTAGE CONTROL - CONTINGENCY	
	e) SCADA f) SCADA SCADA (power transfer, line configuration)
Geographic considerations	Yes: zonal
Potential for competition	Possibly as for continuous voltage control, but competitive issues require examination.

<table>
<tr><th colspan="4">3: SYSTEM RESTART[3]</th></tr>
<tr><td>Cause of requirement</td><td colspan="3">• Partial or total system black</td></tr>
<tr><td>Driver for quantity of requirement</td><td colspan="3">• Prompt system restart (economic / political drivers)
• Public safety</td></tr>
<tr><td>Technical options for meeting requirement[4]</td><td>Short term (now):
• Generators - including provision for
⇒ load blocks
⇒ network capability</td><td>Medium term (1 Yr):
• Generators - including provision for
⇒ load blocks
⇒ network capability</td><td>Long term (2 Yrs):
• Generators - including provision for
⇒ load blocks
⇒ network capability</td></tr>
<tr><td>Measurement of provision</td><td colspan="3">• SCADA - delivery
• Capacity - test</td></tr>
<tr><td>Measurement of cause</td><td colspan="3">NA</td></tr>
<tr><td>Geographic considerations</td><td colspan="3">Yes - Regional / Zones</td></tr>
<tr><td>Potential for competition</td><td colspan="3">Likely to be centrally procured. Potential for competition should increase over time.</td></tr>
</table>

[3] Need to consider how we delineate between black system & system normal. For example:

⇒ when does market suspension cease?

⇒ what is the price during black system period?

[4] It may be possible to introduce competition in which load blocks and network capability can be competitively procured for use during system restart

<table>
<tr><th colspan="4">4: STABILITY</th></tr>
<tr><td>Cause of requirement</td><td colspan="3">Significance determined by relative MW change, and includes:
a) Generation / Demand change (planned & unplanned)
b) Network contingencies</td></tr>
<tr><td>Driver for quantity of requirement</td><td colspan="3">• Amount of power transfer across critical network elements
• System security limit</td></tr>
<tr><td>Technical options for meeting requirement</td><td>Short term (now):
• Generators:
⇒ AVR
⇒ high speed control scheme
• Demand control (high speed)
• SVC
• Protection schemes
• Braking resistor</td><td>Medium term (1 Yr):
• Generators:
⇒ AVR
⇒ high speed control scheme
• Demand control (high speed)
• SVC
• Protection schemes
• Braking resistor
• Series Caps</td><td>Long term (2 Yrs):
• Generators:
⇒ AVR
⇒ high speed control scheme
• Demand control (high speed)
• SVC
• Protection schemes
• Braking resistor
• Series Caps
• Other</td></tr>
<tr><td>Measurement of provision</td><td colspan="3">• SCADA - measure enabling status
• Capacity - test to confirm capability
• Usage - high speed meters</td></tr>
<tr><td>Measurement of cause</td><td colspan="3">SCADA - power transfer, network state)</td></tr>
<tr><td>Geographic considerations</td><td colspan="3">Yes - regions / zones</td></tr>
<tr><td>Potential for competition</td><td colspan="3">Likely to be centrally procured. Potential for competition should increase over time.</td></tr>
</table>

5: NETWORK LOADING CONTROL			
Cause of requirement	Whenever a contingency event would leave remaining network elements overloaded		
Driver for quantity of requirement	• Network capability • Size of relevant contingency • Configuration and flow of pre-contingency network		
Technical options for meeting requirement	**Short term (now):** • Generator • Demand • Network outage management	**Medium term (1 Yr):** • Generator • Demand • Network outage management	**Long term (2 Yrs):** • Generator • Demand • Network outage management • FACTS • Other
Measurement of provision	• Capability - test • SCADA		
Measurement of cause	• SCADA - network configuration • SCADA - demand / generation state		
Geographic considerations	Yes: Zonal		
Potential for competition	Capability likely to be centrally procured. Competitive issues require examination.		

<table>
<tr><th colspan="4">6: SPOT MARKET TRADE</th></tr>
<tr><td>Cause of requirement</td><td colspan="3">Combination of the following simplifications in the current market design:
• does not schedule and price reactive power
• approximates nodal pricing on a regional basis</td></tr>
<tr><td>Driver for quantity of requirement</td><td colspan="3">Minimise total dispatch cost (maximises spot market trading benefit)</td></tr>
<tr><td>Technical options for meeting requirement</td><td>Short term (now):
• Generation / Demand
• Network (SVC, Caps)
• Network outage management</td><td>Medium term (1 Yr):
• Generation / Demand
• Network (SVC, Caps)
• Network outage management</td><td>Long term (2 Yrs):
• Generation / Demand
• Network (SVC, Caps)
• Network outage management
• FACTS
• Other</td></tr>
<tr><td>Measurement of provision</td><td colspan="3">Output of dispatch process against actual (SCADA)</td></tr>
<tr><td>Measurement of cause</td><td colspan="3">Design of dispatch process</td></tr>
<tr><td>Geographic considerations</td><td colspan="3">Yes: Regional / zonal</td></tr>
<tr><td>Potential for competition</td><td colspan="3">Capability likely to be centrally procured. Competitive issues require examination.</td></tr>
</table>

Appendix A

Ancillary Services Review Group -

Terms of Reference

Clause 3.13.1(c) of Version 2 of the National Electricity Code requires:

"*NEMMCO* must investigate, consult with *Code Participants* in accordance with the *Code consultation procedures* and report to *NECA* within 2 years of *market commencement* on the possible development of market-based arrangements for the provision of *Ancillary Services*, including a short term market in which *Market Participants* which are not parties to *Ancillary Services* agreements may submit offers for the provision of *regulating capability* or *contingency capacity reserve*."

In its final determination in relation to the National Electricity Code, the Australian Competition and Consumer Commission required that the above clause be amended to require NEMMCO to conduct the review and report within one year of market commencement.

This paper sets out the terms of reference for the review and the scope and project structure of the review and a timetable for the review.

This Ancillary Services Review Project has been established to achieve the implementation of a new Ancillary Services regime from 1 July 1999.

ACCC Considerations - Guiding Principles

In the ACCC's final determination, a number of points were made in relation to Ancillary Services. It is clear that the ACCC will take these into account when examining any proposed Code changes that may come from the review.

These points can be summarised as follows:

- The whole market benefits from the provision of services that maintain the quality of supply and, to avoid "free riding", centralised buying may be necessary for some of these services.
- The development of a market in the provision and consumption of Ancillary Services is possible for those services that can be attributed to specific users and this is foreshadowed in the Code in requiring the review.
- The development of a market in the provision of Ancillary Services is desirable to generate the right market signals to achieve productive and dynamic efficiency with respect to investment decisions.

- A competitive Ancillary Services market will depend on there being a sufficient number of eligible providers. The extent to which it is possible to identify cost causality economically should be investigated.
- Market signals will be enhanced if Ancillary Services are recovered from the parties responsible for creating the need to the greatest extent possible.

A number of submissions received when the ACCC was considering the Code suggested that Code changes are required in relation to Ancillary Services, system security contracts, connection agreements, demand side issues and technical derogations. The ACCC also noted that it will be critical that these issues are adequately addressed by the review and subsequent decisions, to ensure the successful implementation of market arrangements for Ancillary Services that are open to all Code participants.

Review Structure

NEMMCO will conduct the review in accordance with the requirements of the Code (in particular, the applicable Code consultation procedures).

NEMMCO proposes to appoint an Ancillary Services Reference Group whose purpose will be to provide ongoing consultation with Code participants and to advise NEMMCO on critical technical and policy issues that need to be addressed in the review. The Group will be chaired by NEMMCO's General Manager/Operations and comprise members of the following Code participant groups:

- Market Generators (2 proposed)
- Market Customers (2 proposed)
- Transmission Network Service Provider
- Distribution Network Service Provider
- NEMMCO
- Other Code participants as considered appropriate by NEMMCO, after consulting with Code participants.

NECA would also be invited to participate in the Reference Group.

NEMMCO also expects to appoint working groups to examine specific issues or aspects of the review from time to time. These working groups would not be expected to exist for the duration of the project. The terms of reference and membership of any Working Group will be determined by NEMMCO following consultation with Reference Group members.

NEMMCO will also engage consultants (appropriately qualified) to assist it, the Reference Group or a Working Group as necessary.

Objectives of Review

The objectives of the review are to:

a) identify the Ancillary Services required to maintain system security;

b) identify those services for which the development of a spot market in the provision and consumption of Ancillary Services is practicable, bearing in mind anticipated costs and benefits;

c) identify the most appropriate method of structuring a spot market for those Ancillary Services, bearing in mind anticipated costs and benefits;

d) identify the most appropriate method of procuring those Ancillary Services which it is not appropriate to procure by means of a spot market; and

e) identify who should pay for each kind of Ancillary Service and the basis on which they should do so.

Deliverables

The Ancillary Services review will have two levels of deliverables from this project, a high level report to be submitted by NEMMCO to NECA for its consideration and an implementation proposal for the major recommendations from the report. The review should also separately identify Code changes required to allow implementation of any proposed arrangements.

The high-level report will address each of the objectives. In preparing the high level report, NEMMCO will also:

- Review the Ancillary Services arrangements implemented for the start of the market.
- Conduct a survey of the approach in relation to the procurement of Ancillary Services and reimbursement in comparable overseas electricity spot markets.
- Consider what services are more appropriately procured by network service providers (to maintain power flow capability) and consequently reimbursed under “transmission use of system charges”.
- Review the services provided under connection agreements, which will include the implications of altering or removing the mandatory components on power system planning and operation under emergency conditions.
- The inclusion of services that could be provided by network service providers in either spot or contract based service provision.
- In conjunction with the review of services provided through connection agreements, review the technical standards for generators and technical derogations currently in place.
- Consider the bidding and dispatch process for Ancillary Services under any spot market arrangements.
- Consider the required IT system developments including the costs and benefits of any modifications.

Appendix B

National Electricity Code Market Objectives

The existing Code and market objectives are contained in the National Electricity Code clauses 1.3 (b), and 3.1.4 (a) which are set out below:

1.3 (b) The objectives of the national electricity market (called "market objectives") are as follows:

(1) the market should be competitive;

(2) customers should be able to choose which supplier (including generators and retailers) they will trade with;

(3) any person wishing to do so should be able to gain access to the interconnected transmission and distribution network;

(4) a person wishing to enter the market should not be treated more favourably or less favourably than if that person were already participating in the market;

(5) a particular energy source or technology should not be treated more favourably or less favourably than another energy source or technology; and

(6) the provisions regulating trading of electricity in the market should not treat intrastate trading more favourably or less favourably than interstate trading of electricity.

3.1.4 (a) These market rules are intended to give effect to the following market design principles:

(1) minimisation of NEMMCO decision-making to allow Market Participants the greatest amount of commercial freedom to decide how they will operate in the market;

(2) maximum level of market transparency in the interests of achieving a very high degree of market efficiency;

(3) avoidance of any special treatment in respect of different technologies used by Market Participants;

(4) consistency between central dispatch and pricing;

(5) equal access to the market for existing and prospective Market Participants;

Appendix C

System Reliability Panel Frequency Standards

Note: These are the current interim Reliability Panel standards, and are about to undergo a review.

Interim Frequency Operating Standards: Interconnected power systems of New South Wales, ACT, Victoria and South Australia

- The power system frequency must be maintained within the normal frequency band listed in table 1, except as provided below.
- In the event of a large change in system load, the power system frequency must be maintained within the normal frequency excursion band listed in table 1 and restored to within the normal frequency band within 5 minutes of the excursion.
- In the event of a loss of a single generating unit, the power system frequency must be maintained within the frequency tolerance band listed in table 1 and restored to within the normal frequency band within 5 minutes of the excursion.
- In the event of a credible contingency event other than loss of a single generating unit, the power system frequency must be maintained within the frequency contingency band listed in table 1 and must be returned to within the frequency tolerance band within 60 seconds of the excursion and to within the normal frequency within 5 minutes of the excursion.
- In the event of a multiple contingency event, the power system frequency must be maintained within the emergency frequency band listed in table 1 and must be returned to within the frequency tolerance band within 60 seconds of the excursion and to within the normal frequency band within 10 minutes of the excursion.
- System time (expressed in Universal Time, previously known as GMT) must be maintained within 3 seconds of Universal Time.

Table 1

Condition	NSW/ACT/VIC/SA Interconnected Power Systems Frequency (Hz)
Normal frequency band	49.9 to 50.1
Normal frequency excursion band	49.75 to 50.25
Frequency tolerance band	49.5 to 50.5
Frequency contingency band	49.0 to 51.0
Emergency frequency band	47.0 to 52.0

Interim Frequency Operating Standards: Queensland whilst operating electrically isolated from other states

- The power system frequency must be maintained within the normal frequency band listed in table 2, except as provided below.
- In the event of a large change in system load, the power system frequency must be maintained within the normal frequency excursion band listed in table 2 and restored to within the normal frequency band within 5 minutes of the excursion.
- In the event of a loss of a single generating unit, the power system frequency must be maintained within the frequency tolerance band listed in table 2 and restored to within the normal frequency excursion band within 5 minutes of the excursion and to within the normal frequency band within 10 minutes of the excursion.
- In the event of a multiple contingency event, the power system frequency must be maintained within the emergency frequency band listed in table 2 and must be returned to within the frequency tolerance band within 60 seconds of the excursion and to within the normal frequency excursion band within 5 minutes of the excursion and to within the normal frequency band within 10 minutes of the excursion.
- System time (expressed in Universal Time, previously known as GMT) must be maintained within 10 seconds of Universal Time.

Table 2

Condition	Queensland Power System (Isolated) Frequency (Hz)
Normal frequency band	49.85 to 50.15
Normal frequency excursion band	49.5 to 50.5
Frequency tolerance band	48.5 to 51.0
Frequency contingency band	not used
Emergency frequency band	47.0 to 52.0

Appendix D

Overview of Ancillary Services

Overview

Electrical power systems are designed and constructed to produce and deliver alternating current (AC) electricity at nominal voltage levels, waveform purity, phase balance and frequency. These are important attributes to the quality of supply (QoS) of electricity delivered to market participants at their respective points of connection, and to the integrity of the power system as a whole. Deviations from defined standards[5] may result in economic penalties to market participants, and/or may jeopardize the security of the power system[6].

The National Electricity Market (NEM)[7]energy spot market accounts only for energy transactions. For efficient electricity trading in the NEM, it is important that the energy spot market remains a valid model of the underlying physical power system during each market interval. This includes quality of supply and system security issues.

This provides a valuable perspective on the role of Ancillary Services in the NEM. Ancillary Services can be defined as those services that provide for services not included in the energy spot market, and that would not be provided on the basis of energy prices alone. These services are:

- Power system security;
- Quality of Supply; and
- Enhanced spot trading.

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[5] Quality of supply and security standards are established by the Reliability Panel. For the purposes of this report these standards are assumed as given.

[6] The economic and social consequences of wide spread and prolonged power interruptions have placed a high priority on maintaining the integrity of the power system. From a risk perspective, this has translated into operating the power system in such a manner that the unforeseen breakdown or outage of any one item of plant would not result in electricity supplies being interrupted.

[7] Initially, it is expected that there will be one region each for Victoria, South Australia and Queensland, and two regions for New South Wales. There are rules that govern the definition of regions, so that additional regions may be formed or regions consolidated if network conditions change.

Power system security can be regarded as a mandatory public good – a "must" for the market to operate satisfactorily. Quality of Supply may have some public good characteristics but tends to discretionary, at least to a degree. Enhanced spot trading is neither necessary for power system security of Quality of Supply. It refers to services that improve the supplier and consumer surplus above that incorporated in the energy spot market as currently implemented. It is, in essence, intended to correct a relatively mild form of market failure arising from the current form of market operation.

Frequency

The Australian power system is designed to operate at a frequency of 50 Hz (ie. the frequency of alternating current electricity). "System frequency" is determined by the balance of electrical power injected into the transmission network by generators compared to the electrical power being used by customers. An oversupply of electrical power will result in frequency rising above 50 Hz while an under supply of electrical power will result in frequency falling below 50 Hz. Varying sensitivities between generators and customers mean that frequency deviations from 50 Hz can impact system security and quality of supply.

QoS arises from the sensitivity of customer electricity use to frequency deviations. In the main these sensitivities are low, with the performance of most electrical equipment/appliances not impacted by frequency deviations (especially for domestic customers). Some particular industrial applications can have some frequency sensitivity, although frequency control devices are available in such cases. On the other hand, much customer equipment does reduce its draw on the system as frequency drops, and so can contribute to its stabilisation.

System security is associated with contingency events, and the probability of post contingency frequency[8] deviating outside of an acceptable range. In particular, ensuring that post contingency frequency does not decrease below some considered "minimum" level (in the event of supply loss), or rise above some considered "maximum" level (in the event of demand loss). For system security, frequency standards are established to ensure that there are sufficient margins between the normal frequency range (ie. tolerance band) and the minimum/maximum levels. Although not definitive, the frequency standards associated with system security and more stringent than those associated with QoS. Consequently, frequency standards are predominantly related to power system security.

Ancillary Services are required to regulate frequency within a tolerance band (under normal conditions of changing customer demands), and to restore

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[8] The frequency immediately following a contingency event such as the unexpected breakdown and outage of a large generator.

frequency to within the tolerance band following a major disturbance on the power system. The ability to restore frequency within defined time standards requires the capability to address any major power imbalance. This is accomplished by maintaining “spinning reserve”, a term used to refer to the ability to rapidly increase/decrease generation or rapidly switch off certain customer loads.

During the time following a contingency to the time when normal frequency levels are restored, the power system may not have sufficient “spinning reserves” to prevent the frequency deviating outside permissible limits in the event of a further contingency event. Power system operating guidelines usually provide 30 minutes for the power system to be returned to a secure state following a contingency event. A requirement to restore frequency to within the tolerance band within 5 minutes is considerably more stringent than the “normal” 30 minute operating principle.

For all practical purposes frequency is a universal property of the system (unless parts of the system separate for some reason) and, because its close control is necessary for system security, it can be regarded as a *mandatory public good*, and likely to require a central standard to be set and achieved. On the other hand, frequency is maintained by balancing energy supply and demand in real time (delays of the order of seconds) and this short-term energy is *complementary* product to frequency i.e. the demand for frequency control directly affects the demand for short term energy, in either direction.

Short-term energy used to meet small-scale frequency deviations has the characteristics of a normal tradeable product although it has not so far proved practical to trade on this time-scale. Thus while the usual method for acquiring this service has been by central acquisition and dispatch, there is a possibility of complementing this with a regime for the buying and selling of short term energy to achieve a regulated standard of frequency control. Given also that options for the provision of this service are widespread, the scope for introducing both short and long-term competition for the provision of this service seems good.

The service required to correct large frequency deviations is essentially driven by contingencies in load and generation which, while not unusual, are not regular or even every-day events. Thus while there is a great deal of similarity between the small and large deviation services in terms of the options for meeting the requirement, the uncertain use of the service introduces information issues that will need to be taken into account when considering options for competitive provision.

Voltage

Generators, transmission plant and customer appliances are all designed to operate within defined voltage levels. Excessive voltage levels can risk damage to equipment and compromise safety, while low voltage levels may severely deteriorate the performance of electrical equipment/appliances and the power system.

In technical terms, voltage levels in the power system are controlled by the generation, absorption and flow of reactive power[9] associated with the delivery of electrical power.

Unlike frequency that is common to all participants, voltage levels can vary considerably in different geographical locations. However, as voltage levels are corrected before “delivery” to customers by the distribution system[10], most customers are not unduly sensitive to voltage levels on the high voltage transmission system.

Main system voltage standards are predominantly associated with maintaining an acceptable profile of voltages across the power system for power system security reasons. Voltage control can also be used as a means to reduce transmission losses.

As in the case of frequency, Ancillary Services are required to regulate voltage under “normal” conditions of changing customer demands and also to restore voltage levels following a major disturbance on the power system. Measures invoked to control voltages at different locations on the transmission system include changing the reactive power output of certain generators, installing capacitor banks or reactors on a location basis and switching of transmission lines.

The ability to restore voltage levels following a major disturbance requires a reserve capability of reactive power that can be invoked at very short notice. Such reactive power reserves can be held via generators, static var compensators (SVR’s), capacitor banks and synchronous condensers. Power system operating guidelines provide 30 minutes for the power system to be returned to a secure state following a contingency event.

Voltage s in the transmission system exhibit some of the characteristics of public goods but there are strong spatial elements involved as discussed above. Reactive power is the close complement to voltage, and is used to control voltage as noted above. As with real time energy, it has the characteristics of a normal tradeable good, albeit with greater spatial issues arising than for frequency control. Nevertheless, it is conceivable that reactive power could be traded as a complementary product with real power

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[9] In technical terms, reactive power is a measure of the phase angle between the voltage and current of AC supply. Reactive power flows are the principal determinant of voltage changes in the power system.

[10] The distribution system uses on line tap changing transformers to regulate voltages to within prescribed limits.

by extending the scope of the current real-power market logic [11]. Given the spatial market power issues and the significant change to market logic that this would introduce, a more likely possibility for introducing some competitive “two-sided” arrangements for the provision of continuous voltage control (through the trading of reactive power) in the immediate future could be to establish pricing and dispatch logic for reactive power in selected sub-regions (e.g. the capital cities).

Provision of voltage control (reactive power capability) on a contingency basis introduces information issues that are likely to support an ongoing need for central acquisition, although this of course could be done competitively.

Stability

In addition to voltage and frequency (which are electricity attributes observed by customers), there are important power system management considerations to ensure that damage is not done to plant and that the integrity of the power system is not jeopardised. These issues are thermal overload and stability.

Stability refers to the ability of the power system to remain intact following a major disturbance[12]. This is solely a system security issue. The balance of risk management and operating economics has led to a regime in which the power system is operated in a manner such that the power system will remain stable following the unexpected loss of any single element. This is accomplished by operating the power system within predetermined limits. In the NEM, these limits are defined via power transfer capability limits between regions[13].

In the context of stability, Ancillary Services refer to those services that are required to operate the system within prescribed limits or, put another way, that provide for greater power transfer /security limits than would otherwise be the case. An example of a stability service is the application of an automatic voltage regulator (AVRs) on a generator to assist in dampening system oscillations. Without this service, power transfer limits may need to be reduced.

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[11] Nodal pricing based on AC load flow analysis would provide the necessary pricing and dispatch logic.

[12] Power system stability refers to transient and oscillatory stability. Transient stability refers to the ability of the power system to recover from a transmission line fault that interrupts the transport of electrical power during the fault. Oscillatory stability refers to the advent of under-damped power transfer oscillations (normally between regions) following the outage of a major transmission line. Either of these has the potential to result in the power system “breaking up” in an uncontrolled manner.

[13] Although there are intra-regional stability limits within the Queensland region.

The essence of most aspects of this service is protection against contingencies that would threaten system security, thus suggesting central provision as a likely course. On the other hand, limits can be affected by a range of other factors. Of note is that power transfer stability limits can in some circumstances be a function of the distribution of loads and generation, so that modifying this distribution can lead to change in the benefits of interregional trade. This possibility is also noted below.

Network Loading Contingency Control

The unforeseen breakdown and removal of a power system plant can result in the overloading of plant items that remain in service. To protect such plant and ensure personal safety, the power system is also managed in a manner such that equipment will not exceed specified limits under defined and potentially hazardous situations. This is accomplished by schemes that act to remove thermal overloads in the event that a defined contingency event occurs.

An Ancillary Service associated with network loading control could be a scheme to automatically trip load following a defined set of measurable power system conditions (such as the loading on certain transmission and system frequency).

The arrangements for the supply of this service will need to be examined but some form of central provision seems likely.

System Restart

Should the power system break up into many smaller components or total electricity supply be lost, infrastructure is required to enable the power system to be re-instigated. Among other things this requires the ability of (at least some) generators to be able to restart without the use of main system electrical supplies.

As the events that could result in the break up of the power system are not predictable, the capability to restart the power system is required at all times. Consequently this service is unlike the other Ancillary Services, in that it spans over a time range greater than the 5-minute market-trading interval.

The arrangements for the supply of this service will need to be examined but some form of central provision seems likely.

Enhanced Spot Trading

As previously mentioned, enhanced spot trading refers to those services that improve the supplier and consumer surplus above that incorporated in the energy spot market[14]. An example of such a service would be the removal of certain interregional transmission constraints through the use of “out of merit” generators, that would not be scheduled by the normal dispatch process.

Enhanced spot trading has not been regarded traditionally as an Ancillary Service. It does not arise out of the security needs of the system, nor from a desire to maintain quality of supply. It might be addressed by somehow encouraging side transactions to fix the problem as the Code apparently intends for constraints that might be imposed on local access. Another approach would be to improve the pricing and dispatch logic.

[14] The opportunity for enhanced spot trade arises because the simplified dispatch approach of the NEM does not capture some of the detail that, for example, determines the limits and interregional trade.