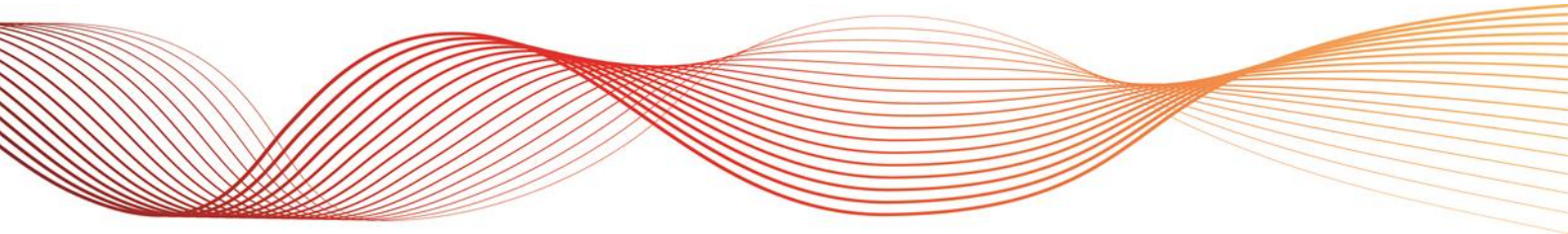




FIVE MINUTE SETTLEMENT

WORKING PAPER

Last updated: **November 2016**





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1. INTRODUCTION

This staff working paper reviews alternatives for the 5 Minute Settlements Rule Change proposal with respect to implementation impacts. The purpose of this paper is to provide guidance on key implementation considerations in order to inform appropriate design of and facilitate discussion on the 5 Minute Settlements Rule Change. We have primarily focused on implementation impacts from a market operator’s perspective but have also, where relevant, referred to impacts on market participants and the broader market.

2. SETTLEMENT SYSTEMS

In order to assess the impact of implementation it is useful to set out AEMO’s key information systems and the current market information flows in respect of the NEM settlement process. Simplified schematics of key information systems and market information flows in the NEM are set out in Figure 1 and Figure 2 respectively.

Figure 1 AEMO Settlement Systems in the NEM

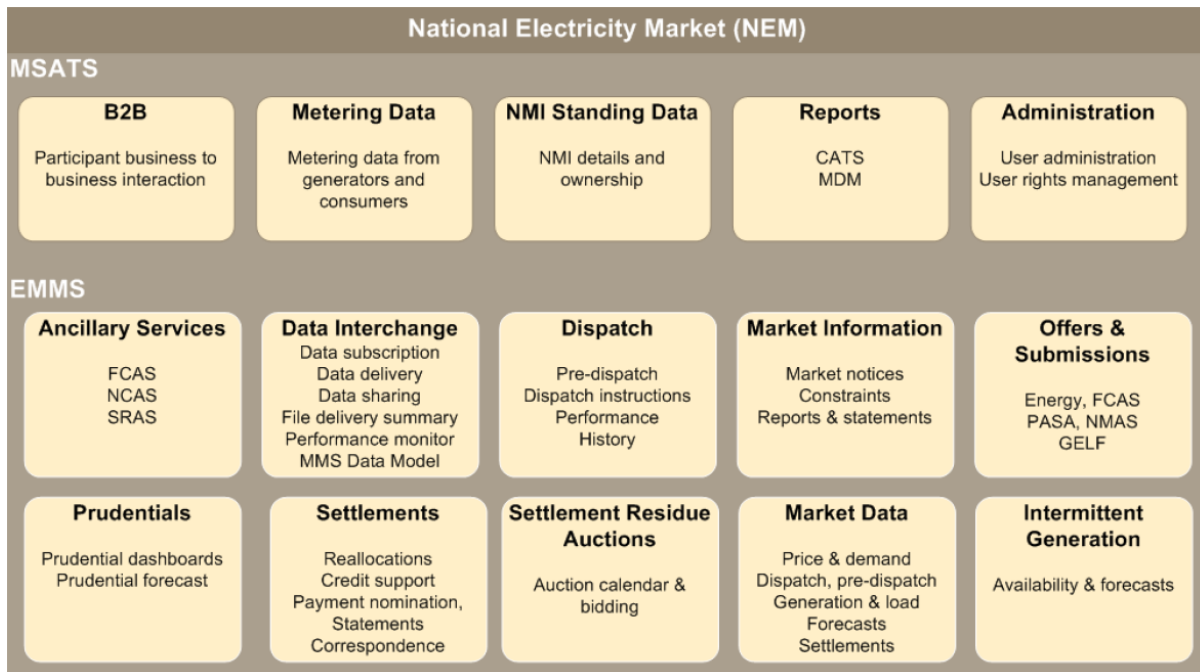
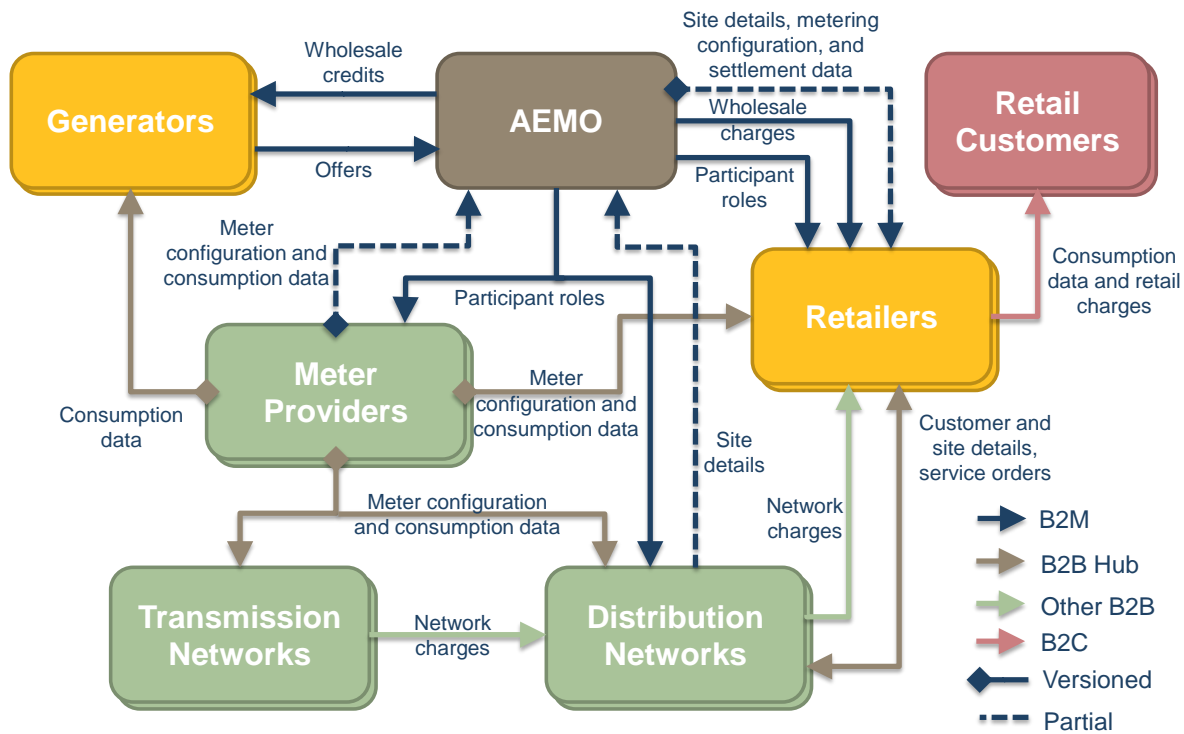


Figure 2 Market Information Flows for NEM Settlement



3. IMPLEMENTATION CONSIDERATIONS

3.1 Data Sources

3.1.1 SCADA

The Rule Change proposal recommends the establishment of a ‘five-minute settlement’ adjustment to market participant credits and charges based on SCADA data. It involves retaining the existing 30 minute settlement process but incorporates an ex-post adjustment that aims to simulate five-minute settlement using information extracted from supervisory control and data acquisition (“SCADA”) systems. From a settlements perspective, SCADA profiling is currently used for the purposes of frequency control ancillary service (“FCAS”) causer-pays factor calculations on a quarterly basis. Payments to FCAS providers are determined under an enablement model and thus SCADA is not currently used for calculations of trading amounts¹. This proposal would effectively seek to use SCADA as part of a profile to adjust *trading amounts* and settle energy payments.

SCADA is an industry term that is not explicitly referred to in the National Electricity Rules (“NER or the Rules”). AEMO generally considers this to mean remote control and monitoring devices, as described in clause 4.11.1 and in Schedules S5.2, S5.3 and S5.3a of the Rules. In the context of this proposed rule change, we understand this to refer to remote monitoring devices.

Currently, AEMO receives SCADA data from all scheduled generators, scheduled loads and market network service providers (“MNSPs”).

¹ a trading amount is the positive or negative dollar amount resulting from a transaction, determined pursuant to clause 3.15.6 for spot market transactions and clause 3.15.6A for ancillary service transactions.



The provision of remote monitoring data (SCADA) is negotiated as part of connection agreement for a new generator. New generators greater than 30 MW are required to provide SCADA data as part of the connection process under Chapter 5 of the Rules. The system specifications for each generator vary based on size and classification of the generator (i.e. scheduled, non-scheduled or semi-scheduled). SCADA is not generally available for retail consumers, except for certain large energy users.

It is our understanding that generators (rather than the network service provider) would typically own SCADA marshalling equipment at their site. The data stream is then provided to the transmission network service provider (“TNSP”) or distribution network service provider (“DNSP”) who then passes the information onto AEMO.

Data from SCADA systems is provided roughly every four seconds for a number of system variables including power, system frequency and area control error.² For the purposes of five minute settlement, it is the power from generators and market loads that is of interest. Each variable is provided to AEMO with a quality flag with three options: “good quality”, “not applicable”, “bad quality”, which is an inherent quality of the system and is based on validation processes at the system level (e.g. reasonability calculations, old data, legal/illegal states). AEMO conducts reasonableness and consistency checks where unit power is checked against unit status and capacity. These checks identify incorrect inputs where for example, data has been incorrectly flagged as good quality. It is important to recognise SCADA can only provide data which is indicative of energy throughput over any given period of time. As SCADA does not record or retain energy data, there is no single point of truth that can be referenced in the case of data validation or disputes between participants.

Generally the provision of SCADA data from most generators appears to be regular, though certain generators in the NEM have experienced outages for sustained periods. Consequently for the purposes of FCAS causer pays calculations some dispatch intervals are discarded and excluded from calculations.³ Five minute settlement would be calculated for each individual market generator/load and would only exclude invalid data from that participant (i.e. invalid data for one participant would not require discarding the entire interval for all participant). Measures may need to be in place to protect against data manipulation or gaming of SCADA systems/outages. Further work is being undertaken to understand SCADA reliability and corrupted/discarded data.

From a systems perspective the implementation of a SCADA-based design is likely to affect the following systems:

- **Within EMMS**
 - Settlements systems and processes - The SCADA data flows would need to be incorporated within settlement adjustment calculations.
 - Ancillary services are currently already dispatched and settled on five-minute intervals thus impact on ancillary services markets are likely to be limited.
 - Prudential - Indicative analysis suggests that while prudential volatility factors may need to be reviewed, impacts on prudential systems are likely to be limited.
 - Market Information, Market Data, Data Interchange may also be impacted.
- **MSATS** - Under this design, AEMO considers that MSATS systems would be unaffected.

² FCAS causer pays procedures convert this data into a five minute value. For further detail please see

<https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Data/Ancillary-Services/Ancillary-Services-Market-Causer-Pays-Data>

³ However it is important to note that these the causer pays loss-factor calculations requires for every dispatch interval that all data generator and load data to be valid, otherwise the entire dispatch interval is discarded.



AEMO's standard for power system data communications describes requirements for SCADA metering in the NEM (see Appendix 1). This standard is currently undergoing a consultation process. Key elements of the data communications standard include requirements on:

- data resolution, age of information and control command delay.
- reliability - maximum outage times ranging from 6 to 48 hours over any 12 month period. In the event that requirements are not met, corrective action must be taken.
- Data errors and substitution - AEMO data standards establishes requirements on detection of errors in transmission and data communication, and allows for mutually agreed substitute data to be used, to relieve impact on central dispatch.
- data security / error detection (99.99%) and physical/network security
- maintenance, outage coordination and failure response - AEMO data standards establish initial testing and compliance and maintenance & repair (failure response) requirements, but do not establish processes for ongoing auditing.
- testing and compliance of equipment
- systems redundancy

The data standards were developed with respect to power system operations and security, rather than measuring energy over a period of time to a high degree of accuracy, and thus is necessarily different to the rules and procedures in place for metering. Metering rules and procedures set out comprehensive and specific arrangements (including metering installation accuracy, data collection, validation and delivery, storage, auditing calibration and accuracy testing, performance standards and security).

Implementation of a SCADA based solution for five minute settlement requires an inherent acceptance of the operational nature of SCADA and its shortfalls (e.g. relation to accuracy, calibration, performance standards, security, etc.) relative to metering on the basis that it provides net benefits to the market. Thus it would be costly within an implementation to seek to fully equate SCADA rules and procedures to those in place for revenue metering installations. The impact of SCADA accuracy limitations may be mitigated by profiling. However there are relevant SCADA standards that may need review and modification when applied to energy settlements including:

- Ongoing auditing/testing of equipment.
- Data verification, validation and substitution processes, and processes for data exclusion.
- Information security and interface requirements
- Data storage requirements – we note that historical SCADA data (since December 2012) is stored in AEMO's market management databases.

Other considerations for implementation for a SCADA based adjustment include the following:

- Treatment of settlement residues/deficits
- Procedures for treatment during market events (e.g. market suspension etc).
- Other factors including impact on forecasts, and other market reforms.

3.1.2 State Estimator

The use of the state estimator has also been discussed as a potential alternative to actual SCADA data or as a substitute when SCADA is unavailable or unreliable. AEMO's RTNET (state estimator) application undertakes a snapshot of the power system and solves the power flow case resulting in an



estimate of system variables including power. The snapshots are taken in samples of 1 minute or less. Considerations relevant to the use of the state estimator include:

- The state estimator represents a theoretical calculation of the power flow rather than an actual measurement.
- The sampling interval is generally larger relative to SCADA data.
- Under certain system conditions, the state estimator may not solve for all values.

3.1.3 Metering Data

An alternative approach would be to allow the provision of five minute metering data. This is an approach relevant for both generator and customer settlement. This would involve the 1) the measurement of energy on a five minute basis at the meter, 2) the reconfiguration of AEMO's metering and settlement systems to accept and process five minute energy data, 3) and to calculate all energy settlements on a five minute basis.

On a preliminary basis, the need to cater for the provision of 5 minute metering data will likely be classified as a major project for AEMO⁴. The magnitude of costs are as yet unquantified though the scale will likely be much larger than for a SCADA based system as it impacts multiple systems and information flows. In addition to the EMMS systems identified in Section 3.1.1, changes to MSATS will be required:

- Metering Data and Metering Data Management Systems ("MDM") will require reconfigurations to process five minute data.
- Systems governing administration, standing data, B2B and CATS reports are less likely to be impacted.

Key considerations for implementation of a metering option are set out below:

- Participation - the type of participants that provide metering data and any restrictions (for example, by virtue of size, metering type etc).
- The timeframe for implementation and market-readiness. In general we expect a longer term (multiple year) transition period would be required for this implementation in order to allow participants time to mitigate impacts on meter rollout, modification and replacement schedules.
- Data storage, processing and communication infrastructure and requirements, and particularly whether modifications are needed to current regulations and procedures. Section 7.3.1 of the Rules sets out minimum meter storage of 35 days for Type 1-4 meters and 200 days for Type 5 meters. Storage requirements would be increased by a factor of around 6 times to cater for five minute metering. Given additional data volumes impact on AEMO storage, processing and communication infrastructure will need to be assessed.
- Equipment replacement / modification – for market participants, mandatory participation will likely require meter replacement or modification with associated cost impacts. While some meters may be able to be modified remotely, others may require on-site modification or replacement.
- Impacts on data storage, processing and communications infrastructure and systems, as it relates to market participants

⁴ A major project would typically have one or more of the following features - direct impacts on markets and stakeholders; complexity across technologies, resourcing and stakeholders; material risk; and would typically cost more than \$2 million.



- Settlement-by-differencing systems would need to be reconfigured to incorporate a 5 minute interval.
- Data format – current data formats (NEM12 & 13) allow for provision of smaller interval data (including 5 minutes) but such data is not used in settlement.
- The extent of systems integration required. The scale of integration will depend upon the option design (i.e. participation, terms of exercise, timeframe). To the extent that there are multiple data sources are used (i.e. SCADA and metering) processes will be required to integrate the two data streams.
- Suitability of timeframes for implementation and market readiness - Given the scale of the implementation and potential impacts on market participants it may be desirable to have a longer timeframe for commencement in order to allow effective planning, design and implementation.
- Other factors including impact on financial markets and ongoing/future market reforms.

3.2 Optionality

The extent of participation and optionality afforded to other market participants is a critical element of the design approach and has an impact on implementation. In general, any optionality provided to participants means that AEMO's systems must cater for all or a significant portion of participants potentially exercising such an option. Key considerations in respect of the design includes:

- Whether optionality applies to participation in 5 minute settlement as a whole, or whether it relates to sources of data able to be provided.
- The ability and conditions around exercise of the option. For example, whether the election is one-off and permanent, or whether changes can be made to the election and on the terms of any changes.
- Whether data can be provided over portions of generation or load. For example, whether a Retailer is able to elect to provide 5 minute metering data for a subset of its National Metering Identities ("NMIs"), or whether it must provide it for all of its NMIs.
- Whether there is any optionality provided at the individual NMI level. For example, whether individual retail customers could elect to be metered at 5 minutes. The proposal does not mandate that retailers offer 5 minute settlement to end customers.
- For AEMO, the requirements for additional storage, communication and processing infrastructure may vary with respect to mandatory participation relative to optional participation.

3.3 Bidding Intervals

Based on clauses 3.4.2 and 3.8.6 of the Rules, energy offers (price and quantity) are currently submitted for each trading interval of 30 minutes. While price bands may not be modified, rebidding allows generators to modify their available capacity, ramp rates and other quantities for the price bands submitted for each trading interval at any point prior to the dispatch interval (subject to gate closure).

The implementation of five minute settlement may warrant a consideration of whether bidding intervals need to be amended to allow shorter term bidding, consistent with a five minute settlement interval. On an indicative basis, the rebidding rules appear to provide a mechanism for adjustment (in-part) of bids on a shorter term basis. However, this needs to be assessed in further detail giving consideration to:

- Bidding strategies and systems



- Current trading practices
- Extent of price band modification



4. ABBREVIATIONS

B2B	Business to Business
CATS	Consumer Administration and Transfer Solution
EMMS	Electricity Market Management System
FCAS	Frequency Control Ancillary Services
MDM	Metering Data Management
MSATS	Market Settlement and Transfer Solutions
MW	Megawatt
NCAS	Network Control Ancillary Services
SCADA	Supervisory Control and Data Acquisition



APPENDIX 1: AEMO STANDARD FOR POWER SYSTEM DATA COMMUNICATIONS

FINAL DETERMINATION - STANDARD FOR POWER SYSTEM DATA COMMUNICATIONS

PREPARED BY: Electricity System Operations Planning and Performance

VERSION: 1.2

DATE: 7 April 2005

FINAL

This separate copy of the standard was revised on 24 June 2004 to correct a typographical error in the definition of “data concentrator” to make it consistent with the final determination. This correction is not an amendment of the standard.

This separate copy of the standard was revised on 7 April 2005 to be consistent with the National Electricity Rules, for the convenience of readers.

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1 INTRODUCTION

1.1 Purpose

- a. The purpose of this document is to set out the standards with which:
 - i. Network Service Provider must comply when providing and maintaining communications facilities for control, operational metering and indication from the relevant local sites to the appropriate interfacing termination as nominated by AEMO, in accordance with clause 4.11.2(a) of the National Electricity Rules; and
 - ii. any other Registered Participant must comply when installing and maintaining remote control, operational metering and monitoring devices and local circuits for use in AEMO's control centres, in accordance with clause 4.11.1 of the National Electricity Rules.
- b. This Standard has been prepared by AEMO pursuant to clause 4.11.2(c) of the National Electricity Rules.

1.2 Application

- a. This Standard applies to:
 - i. operational metering and indication to AEMO from a substation of a Network Service Provider (refer clauses 4.11.1 of the NER);
 - ii. operational metering and indication to AEMO from a power station of a Generator for which the relevant Network Service Provider has provided data communications facilities (refer clause S5.2.6.3 of the NER);
 - iii. generation controls from AEMO to a power station of a Generator for which the relevant Network Service Provider has provided data communications facilities (refer clauses 4.11.1 and S5.2.6.3 of the NER);
 - iv. operational metering and indication to AEMO from a power station of a Generator (refer clauses 4.11.1 and S5.2.6.1 of the NER);
 - v. generation controls from AEMO to a power station of a Generator (refer clauses 4.11.1 of the NER);
 - vi. operational metering and indication to AEMO from a substation of a Customer for which the relevant Network Service Provider has provided data communications facilities (refer clauses 4.11.1, 5.3.5(h) and S5.3.9 of the NER);
 - vii. operational metering and indication to AEMO from a substation of a Market Network Service Provider (refer clauses 4.11.1 and S5.3a.4.1 of the NER); and
 - viii. controls from AEMO to a substation of a Market Network Service Provider (refer clauses 4.11.1 of the NER).
- b. This Standard applies to the person who is required by the NER to arrange or provide the data communications facilities, whether or not they use facilities or services of another person. This Standard is not intended to prevent subcontracting to any person for any part of the facilities or services required to comply with the NER.

1.3 Structure

This Standard is structured in six sections:

1. INTRODUCTION
2. CAPACITY AND PERFORMANCE REQUIREMENTS
3. RELIABILITY REQUIREMENTS
4. SECURITY REQUIREMENTS
5. INTERFACING REQUIREMENTS
6. MAINTENANCE REQUIREMENTS

1.4 Interpretation

- a. The rules of interpretation set out in clause 1.7.1 of the NER apply to this Standard, but with each reference to “the Rules” or “these Rules” replaced by a reference to this Standard.
- b. Explanatory notes enclosed in a rectangular border do not affect interpretation of this Standard.
- c. In this Standard, italicised words and phrases have the meaning given to them in the following table:

Word or phrase	Meaning
analogue value	means a digital representation of a continuous value (for example a power flow) that is required by AEMO under clause 2.1 of this Standard.
application level protocol	means a data communications protocol described in clause 5.2 of this Standard.
business day	has the meaning given to it in the NER.
central dispatch	has the meaning given to it in the NER.
control command	means a representation of an instruction to perform a defined action (for example a generation increase) that is required by AEMO under clause 2.1 of this Standard.
critical outage	<p>means:</p> <ol style="list-style-type: none"> a. in respect of data communications facilities of remote monitoring equipment or remote control equipment, a loss for more than 60 seconds of the ability to transmit operational data to AEMO or receive control commands from AEMO, but not including such a loss: <ol style="list-style-type: none"> i. arising from a force majeure; or ii. arising from a failure or outage of equipment that does not form part of the data communications facility; or iii. arising from a failure or outage of equipment that affects less than 5% of all operational data items (rounded up to next whole number) of that remote monitoring equipment or remote control equipment; or

	<ul style="list-style-type: none"> iv. relating to a scheduled generating unit, scheduled network service or scheduled load that is not available for central dispatch; or v. relating to power system plant that is not in service and AEMO’s control centre has been so notified; or vi. relating to an outage for work being carried out to upgrade facilities to comply with this Standard provided that the outage is reasonably required and AEMO’s control centre has been notified in advance; or vii. arising from a loss of data communications facilities of an intervening facility, and <p>b. in respect of data communications facilities of an intervening facility, a loss for more than 4 minutes of the ability to transmit operational data to AEMO or receive control commands from AEMO, but not including such a loss:</p> <ul style="list-style-type: none"> i. arising from a force majeure; or ii. arising from a failure of equipment that does not form part of the data communications facility; or iii. for less than 10 minutes that does not affect dispatch data; or iv. affecting no more than one 5 minute central dispatch (or as otherwise agreed with AEMO) arising from a test of data communications facilities at a disaster recovery site, for which AEMO’s control centre has been given at least 24 hours prior notice; or v. affecting no more than one 5 minute central dispatch (or as otherwise agreed with AEMO) arising from a test of a major upgrade of an intervening facility, for which AEMO’s control centre has been given at least 24 hours prior notice; or vi. arising from a loss of data communications facilities of a data concentrator, remote monitoring equipment or remote control equipment.
Customer	has the meaning given to it in the NER.
data communications facility	<p>means any part of the equipment used to transmit operational data from one site to another, and includes:</p> <ul style="list-style-type: none"> a. that part of remote monitoring equipment and remote control equipment that provides the analogue to digital conversion function; b. that part of remote monitoring equipment and remote control equipment that provides a data communication function; c. telecommunications equipment and media; d. any data concentrator or intervening facility; and e. power supply equipment for items (a) to (d) above.

	For the purposes of this definition, high voltage measurement transformers, transducers, together with the associated wiring, do not provide a data communication function.
data concentrator	<p>means a data communications facility that:</p> <ol style="list-style-type: none"> a. communicates with an intervening facility and not with a AEMO control centre; and b. collects information from two or more remote monitoring equipment at <u>two or more</u> substations or power stations and relays that information to AEMO via an intervening facility, or relays control commands from AEMO to remote control equipment at substations or power stations via an intervening facility. <p>For the purposes of this definition, a data concentrator includes telecommunications equipment and media to communicate with an intervening facility.</p>
discrete value	means a digital representation of one of a limited set of values (for example a transformer tap position) that is required by AEMO under clause 2.1 of this Standard.
dispatch data	<p>means operational data that represents:</p> <ol style="list-style-type: none"> a. the loading level of a scheduled generating unit (both physical and aggregated if dispatched as aggregated), scheduled network service or scheduled load; b. an interconnector flow; c. the status, or the amount, of a market ancillary service; or d. a dispatch instruction.
dispatch instruction	has the meaning given to it in the NER.
force majeure	means an event or effect which is neither anticipated nor controllable by the affected parties including acts of nature, governmental interventions and acts of war.
generating unit	has the meaning given to it in the NER.
Generator	has the meaning given to it in the NER.
interconnector	has the meaning given to it in the NER.
interconnector flow	has the meaning given to it in the NER.
interconnection substation	<p>means a substation from which an analogue value representing:</p> <ol style="list-style-type: none"> a. an interconnector flow; or b. a power flow of a scheduled network service, <p>is required by AEMO under clause 2.1 of this Standard.</p>
interim standard	means a level of performance that is acceptable for an interim period only, under clause 1.5 of this Standard.
intervening facility	means a data communications facility that:

	<p>a. receives polls from a AEMO control centre; and</p> <p>b. collects information from remote monitoring equipment at substations or power stations and relays that information to AEMO in response to polls, or relays control commands from AEMO to remote control equipment at substations or power stations.</p> <p>For the purposes of this definition, an intervening facility includes telecommunications equipment and media to communicate with an AEMO control centre, but not any facility provided by AEMO.</p>
ISD	means the proprietary protocol of ALSTOM ESCA Corporation called "Inter Site Data".
lack of reserve notice	means a notice issued by AEMO under clause 4.8.4 of the NER.
loading level	has the meaning given to it in the NER.
main dispatch data	means dispatch data from a power station, market customer station or interconnection station capable of generating, consuming or transmitting more than 100 MW of power.
main system data	<p>means, unless otherwise agreed with AEMO in respect of a particular station or a part of a station, operational data concerning all plant within:</p> <ul style="list-style-type: none"> a. a power station having a generating unit of at least 30 MW capacity; b. an interconnection substation; c. a market customer substation; d. a substation containing plant that operates at a nominal voltage of at least 220 kV; or e. a substation having at least four sources of supply, including power station sources.
market	has the meaning given to it in the NER.
market ancillary service	has the meaning given to it in the NER.
market commencement	has the meaning given to it in the NER.
Market Customer	has the meaning given to it in the NER.
market customer substation	means a substation of a Market Customer.
market load	has the meaning given to it in the NER.
Market Network Service Provider	has the meaning given to it in the NER.
AEMO	has the meaning given to it in the NER.
NER	means the National Electricity Rules

Network Service Provider	has the meaning given to it in the NER.
operational data	means status indications, discrete values, analogue values and control commands.
outage	has the meaning given to it in the NER.
poll	means an electronic request sent from a AEMO control centre or from an intervening facility, usually periodic, to request transmission of status indications, discrete values or analogue values.
power station	has the meaning given to it in the NER.
power system	has the meaning given to it in the NER.
power system security	has the meaning given to it in the NER.
remote control equipment	has the meaning given to it in the NER.
Registered Participant	has the meaning given to it in the NER.
remote monitoring equipment	has the meaning given to it in the NER.
satisfactory operating state	has the meaning given to it in the NER.
scale range	means the range of measurements of an analogue value that can be represented by its digital value transmitted to AEMO.
scheduled generating unit	has the meaning given to it in the NER.
scheduled load	has the meaning given to it in the NER.
scheduled network service	has the meaning given to it in the NER.
Standard	means this document.
status indication	means a representation of the state of a device exhibiting a finite number of discrete states that is required by AEMO under clause 2.1 of this Standard, and includes indication of switching devices, control devices and alarm conditions.
substation	has the meaning given to it in the NER, but in this Standard includes a similar facility with only one line.
substitute value	means, in respect of an item of main dispatch data, another analogue value from a substantially independent remote monitoring equipment that AEMO agrees it can substitute for that item while it is unavailable, to substantially relieve the impact on central dispatch.

TASE.2	means the standard protocol of that name administered by the International Standards Organisation.
Telecommunications Carrier	means a "carrier" as defined in the Telecommunications Act 1997 (Cth).
Transmission Network Service Provider	has the meaning given to it in the NER.

1.5 Transitional Arrangements

- a. If a Registered Participant, in respect of a data communications facility for which it is responsible (either under the NER or otherwise) reasonably considers that the data communications facility would not comply with a particular provision of this Standard, the Registered Participant may within six months of the date this Standard comes into effect submit to AEMO a plan to upgrade that data communications facility to make it comply. A person who was not a Registered Participant at the date this Standard came into effect but had a data communications facility at that time, may submit such an upgrade plan for that facility within 30 business days of becoming a Registered Participant (or such later date agreed with AEMO).
- b. A plan submitted under paragraph (a) must include:
 - i. a date (the "upgrade date") by which the Registered Participant agrees to achieve the upgrade; and
 - ii. a reporting regime to keep AEMO informed of progress of the upgrade.
- c. If the data communications facility complies with the corresponding interim standard in respect of each provision with which it does not comply and maintains substantially the same performance that it had at the time of market commencement (if the facility then existed), the upgrade date must be within 48 months of the date of submission under paragraph (a) or such later date agreed with AEMO.
- d. If the data communications facility does not comply with the corresponding interim standard in respect of each provision with which it does not comply or does not maintain substantially the same performance that it had at the time of market commencement (if the facility then existed), the upgrade date must be within 18 months of the date of submission under paragraph (a) or such later date agreed with AEMO.
- e. An upgrade plan that seeks to only comply with the relevant interim standard or to only achieve substantially the same performance that it had at the time of market commencement (if the facility then existed) under paragraph (d) must also seek to fully comply with the relevant provision within 48 months of the date of submission under paragraph (a) or such later date agreed with AEMO.
- f. In granting an extension of time under paragraph (c), (d) or (e), AEMO must consider the scope of the necessary work, the Registered Participant's funding arrangements and co-ordination with other planned upgrades.
- g. If a Registered Participant intends to submit or has submitted and committed to an upgrade plan under this clause 1.5 in respect of a particular data communications facility and a particular provision of this Standard, that facility is taken to comply with that provision until the expiry of the relevant upgrade date.

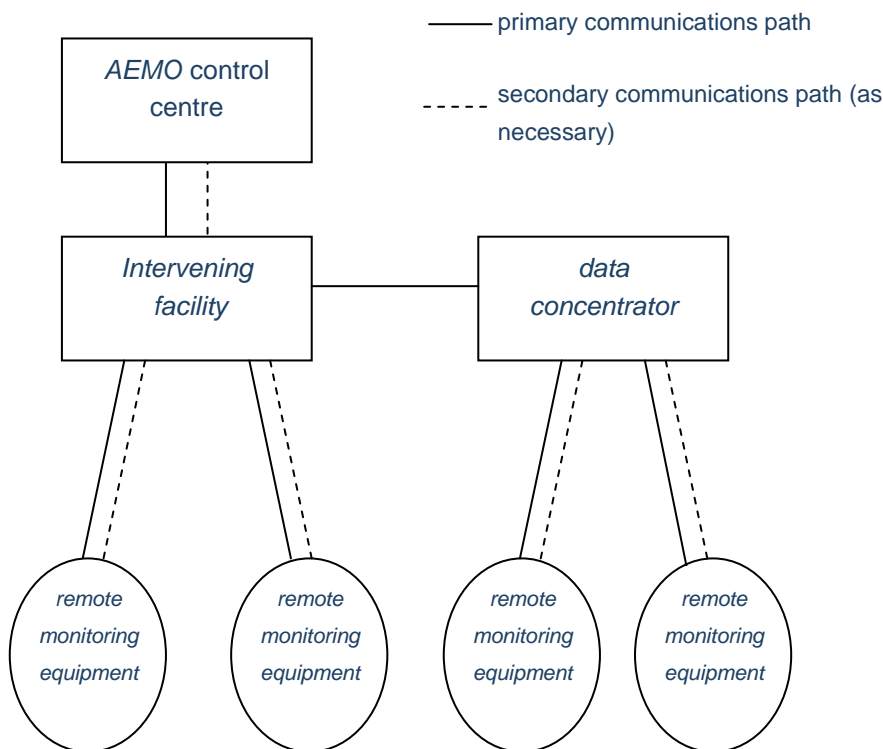
- h. If Each Registered Participant to which this Standard applies must, within 6 months of the date when this Standard comes into effect, notify AEMO of the remote monitoring equipment for which it is responsible (whether under the NER or otherwise) and the data that it passes to AEMO on behalf of another Registered Participant. A person applying to AEMO to become a Registered Participant must so notify AEMO at the time of application for registration.

1.6 Commencement Date of this Standard

This Standard comes into effect on 1 January 2004.

1.7 General Structure of Facilities

The following diagram illustrates the relationships between the AEMO control centres, intervening facilities, data concentrators and remote monitoring equipment (or remote control equipment). The diagram does not affect interpretation of this Standard.



2 CAPACITY AND PERFORMANCE REQUIREMENTS

The purpose of the following standards is to ensure that data communications facilities have sufficient capacity and performance to allow AEMO to discharge its market and power system security functions as set out in Chapters 3 and 4 of the NER.

2.1 Quantity of Information

- a. Data communications facilities must be capable of transmitting all of the information that AEMO requires pursuant to the NER. The information required by AEMO is the information that:
- i. is being transmitted to and from AEMO's control centre at or about the time this Standard comes into effect; or
 - ii. has been requested in writing by AEMO,
- and has not been subsequently rejected in writing by AEMO.

Explanatory note: Chapters 4 and 5 of the NER allow AEMO to request data that it requires to discharge its market and power system security functions. This Standard sets out requirements that apply to data that AEMO already receives and to data that AEMO might require at some time in the future. However, this Standard should not be taken to be a request by AEMO to provide all of the data described by this Standard.

- b. The transmission of additional information beyond that required by AEMO under the NER and pursuant to any agreement between AEMO and a Registered Participant does not diminish the obligations of the Registered Participant to comply with this Standard.

2.2 Representation of Information

- a. Data communications facilities must transmit information to and from AEMO as follows:
- i. Analogue values must be transmitted:
 1. with a sign conforming with the sign convention of the Registered Participant who directly communicates with the remote monitoring equipment at which the analogue value is first converted to digital form;
 2. with a resolution of:
 - A. if the analogue value is main dispatch data, 0.1% (or less) of its scale range (interim standard 0.2%);
 - B. if the analogue value is main system data or dispatch data but not main dispatch data, 0.2% (or less) of its scale range (interim standard 0.4%); and
 - C. otherwise 1% (or less) of its scale range (interim standard 2%); and
 3. with an indication of the quality of the value that complies with, and utilises the capability of, the relevant application level protocol.
 - ii. Discrete values must be transmitted with an indication of the quality of the value that complies with, and utilises the capability of, the relevant application level protocol.
 - iii. Status indications must be transmitted with an indication of the quality of its indication that complies with, and utilises the capability of, the relevant application level protocol.

- iv. Control commands must be transmitted such that they are issued by the remote control equipment either:
 1. as a discrete control action (such as to shed a particular block of load); or
 2. as an analogue or discrete set-point or target (to adjust a particular level to the transmitted value); or
 3. as an incremental control action (to raise or lower a particular value by a set amount),

as AEMO, in consultation with the relevant Registered Participant, considers appropriate to the particular control action.
- v. Indications of quality under paragraphs (i)(3), (ii) and (iii) above must indicate, to the extent contemplated by the relevant application level protocol, whether:
 1. communication between an intervening facility and the relevant remote monitoring equipment is incurring a sustained communications failure (including failure of a relevant data concentrator); and
 2. the value has been overridden at any remote monitoring equipment, data concentrator or intervening facility.
- b. For the purposes of paragraph (a)(i)(1), a Registered Participant must notify AEMO of its sign convention within 30 business days from the date that this Standard comes into effect, and thereafter by giving 60 business days prior written notice to AEMO of any change to the convention. A person applying to AEMO to become a Registered Participant must so notify AEMO at the time of application for registration.
- c. For the purposes of paragraph (a)(v), a sustained communications failure is a failure for at least the time agreed between AEMO and the relevant Registered Participant to be a reasonable period to distinguish between transient loss and sustained loss, being a period of approximately 30 seconds.

Explanatory note: This paragraph (c) is to allow different methods of timing to be accommodated.

2.3 Age of Information

- a. Except during a relevant outage or as a consequence of an event of force majeure, operational data of the type and category shown in Columns 1 and 2 of Table 1 must be available for transmission to AEMO in response to a poll within the corresponding time interval specified in:
 - i. Column 4 of Table 1 if the communication is via a data concentrator; or
 - ii. otherwise Column 3 of Table 1,from the time it was first converted to digital form.
- b. For the purpose of this clause 2.3:
 - i. a status indication is taken to be converted to digital form when the signal representing it is carried by circuits that are not solely used for that status indication; and
 - ii. Column 4 of Table 1 is also an interim standard.

Explanatory notes: In practice, this means that a status change or a step change in an analogue value will be apparent in the corresponding entry of the database of the intervening facility, ready for collection by the next AEMO poll, within the time given in the table. AEMO expects that for all except the first category, the requirement will usually be achieved by a scan time of 2 seconds less than the value in column 3, plus up to 2 seconds for transmission and intervening facility processing. A further 1 second is allowed if communication is via a data concentrator.

Table 1 Time intervals

Column 1	Column 2	Column 3	Column 4
		Time Interval	
Type	Category	Normal standard	Interim standard
analogue value	a high resolution measurement of system frequency or electrical time required by AEMO from a Transmission Network Service Provider for central dispatch	2 seconds	2 seconds
status indication	main dispatch data	6 seconds	7 seconds
analogue value or discrete value	main dispatch data	6 seconds	7 seconds
status indication	main system data or dispatch data that is not main dispatch data	8 seconds	9 seconds
analogue value or discrete value	main system data or dispatch data that is not main dispatch data	14 seconds	15 seconds
status indication	neither main system data nor dispatch data	12 seconds	13 seconds
analogue value or discrete value	neither main system data nor dispatch data	22 seconds	23 seconds

- c. A status indication need not be retransmitted if it has not changed since it was last transmitted, provided that its most recent measurement is transmitted at least once every 5 minutes (interim standard 10 minutes).
- d. A discrete value need not be retransmitted if it has not changed since it was last transmitted, provided that its most recent measurement is transmitted at least once every 5 minutes (interim standard 10 minutes).
- e. An analogue value need not be retransmitted if it has not changed by at least the relevant deadband amount since it was last transmitted, provided that its most recent measurement is transmitted at least once every 5 minutes (interim standard 10 minutes). The relevant deadband amount is:
- i. if the analogue value is main dispatch data, 0.2% of its scale range (interim standard 0.4%);
 - ii. if the analogue value is main system data or dispatch data but not main dispatch data, 0.5% of its scale range (interim standard 1%); and
 - iii. otherwise, 1% of its scale range (interim standard 2%).
- f. An intervening facility must be capable of consistently responding to polls at the rate of once per second by transmitting to AEMO all relevant information.

2.4 Control Command Delay

A Registered Participant must ensure that its data communications facilities issue control commands to the relevant remote control equipment within three seconds (interim standard 4 seconds) from receipt of the control command from AEMO, or within four seconds if the control command is transmitted via a data concentrator.

3 RELIABILITY REQUIREMENTS

The purpose of the following standards is to ensure that data communications facilities are sufficiently reliable to allow AEMO to discharge its market and power system security functions as set out in Chapters 3 and 4 of the NER.

3.1 Reliability Requirements

- a. A Registered Participant must design, procure and maintain its data communications facilities to reasonably ensure that in any 12 month assessment period:
 - i. for at least 95% of remote monitoring equipment or remote control equipment, the total period of critical outages of a remote monitoring equipment or remote control equipment in a category shown in Column 1 of Table 2 is not greater than the relevant period shown in Column 2 of the table (interim standard Column 3); and
 - ii. for the remaining remote monitoring equipment and remote control equipment, the total period of critical outages of a remote monitoring equipment or remote control equipment in a category shown in Column 1 of Table 2 is not greater than the relevant period shown in Column 3 of the table.
- b. For the purpose of this paragraph (a), the proportion of 95% of remote monitoring equipment or remote control equipment is to be determined as the proportion of remote monitoring equipment and remote control equipment that share either a common intervening facility or a common interface to AEMO's wide area network, disregarding any remote control equipment that is combined with a remote monitoring equipment at the same site.
- c. If in any 12 month assessment period the total period of critical outages in respect of a remote monitoring equipment or remote control equipment exceeds a relevant total period determined under paragraph (a), the Registered Participants responsible for the remote monitoring equipment, remote control equipment, any relevant data concentrator and the relevant intervening facility must jointly take reasonable corrective action to ensure that their data communications facilities could be reasonably expected to achieve the performance levels required under paragraph (a).

Table 2 Critical outages of remote monitoring equipment or remote control equipment

Column 1	Column 2	Column 3
Category of remote monitoring equipment and remote control equipment	Total period of critical outages	
	normal standard	interim standard
remote control equipment	24 hours	48 hours
remote monitoring equipment not transmitting or receiving main system data or dispatch data	24 hours	48 hours
remote monitoring equipment transmitting main system data or dispatch data but not main dispatch data	12 hours	24 hours
remote monitoring equipment transmitting or receiving main dispatch data for which AEMO has agreed that it has substitute values for that dispatch data	12 hours	24 hours
remote monitoring equipment transmitting main dispatch data for which AEMO has not agreed that it has substitute values for that dispatch data	6 hours	12 hours

- d. A Registered Participant must design, procure and maintain its data communications facilities to reasonably ensure that in any 12 month assessment period:
- i. after disregarding the longest critical outage of an intervening facility of a category shown in Column 1 of Table 3, the total period of its remaining critical outages is not greater than the relevant period shown in Column 2 of the table; and
 - ii. the total period of all critical outages of the intervening facility of a category shown in Column 1 of Table 3 is not greater than the relevant period shown in Column 3 of the table.
- e. If in any 12 month assessment period the total period of critical outages in respect of an intervening facility exceeds the relevant total period determined under paragraph (d), the Registered Participant must take reasonable corrective action to ensure that its data communications facilities could be reasonably expected to achieve the performance levels required under paragraph (d).

Table 3 Critical outages of intervening facilities

Column 1	Column 2	Column 3
Category of intervening facility	Total period of critical outages normal and interim standard	
	without longest critical outage	all critical outages
an intervening facility not transmitting any main dispatch data, where the interface termination is not located at an AEMO site	4 hours	6 hours
an intervening facility not transmitting any main dispatch data, where the interface termination is located at an AEMO site	5 hours	7 hours
an intervening facility transmitting main dispatch data, where the interface termination is not located at an AEMO site	1 hour	2 hours
an intervening facility transmitting main dispatch data, where the interface termination is located at an AEMO site	2 hours	3 hours

- f. For the purpose of determining the total period of critical outages, a critical outage in respect of an intervening facility does not also constitute a critical outage in respect of each of the affected remote monitoring equipment or remote control equipment.
- g. For the purpose of determining the total period of critical outages, a critical outage in respect of a data concentrator constitutes a critical outage in respect of each of the affected remote monitoring equipment or remote control equipment.
- h. The total period of critical outages is determined by adding all of the durations of critical outages that affect that particular remote monitoring equipment, remote control equipment or intervening facility and occur within the 12 month assessment period.

3.2 Redundant Elements

Data communications facilities must be arranged to have sufficient redundant elements to be reasonably expected to satisfy the reliability standards set out in clause 3.1 of this Standard, taking into account:

- a. the likely failure rate of their elements;
- b. the likely time to repair of their elements; and
- c. the likely need for planned outages of their elements.

4 SECURITY REQUIREMENTS

The purpose of the following standards is to ensure that data communications facilities do not cause incorrect operational data to be received from or issued to power system plant.

4.1 Data Communications Security

- a. Status indications, discrete values and analogue values must be communicated in a manner that can reasonably be expected to:
 - i. not be susceptible to the usual or reasonably expected levels of electromagnetic interference or other external influences; and
 - ii. detect at least 99.99% of errors in transmission.
- b. Control commands must be communicated in a manner that can reasonably be expected to:
 - i. not be susceptible to the usual or reasonably expected levels of electromagnetic interference or other external influences;
 - ii. detect at least 99.9% of errors in transmission; and
 - iii. take all reasonable precautions to prevent inadvertent operation or operation of the wrong plant, including sufficient checks to protect against database inconsistency.
- c. Data communication between an intervening facility and an AEMO control centre must be communicated in a manner that can reasonably be expected to detect at least 99.9999% of errors in transmission.

4.2 Physical Security and Computer Network Security

A Registered Participant providing a data communications facility that has a physical or logical connection to AEMO's wide area network must take all reasonable precautions to prevent unauthorised interference with data communications facilities and the information they carry to and from AEMO. Such precautions must include reasonable steps to:

- a. prevent unauthorised access to sites of data communications facilities;
- b. prevent unauthorised access to operational data and to data communications facilities through computer networks;
- c. prevent unauthorised access to or use of AEMO's wide area network through computer networks;
- d. prevent the ingress and distribution of computer viruses into data communications facilities or AEMO's wide area network;
- e. keep access information, including computer network address information, confidential;
- f. consult with AEMO on any matter that could reasonably be expected to adversely impact on the security of data communications facilities or AEMO's wide area network; and
- g. ensure that adequate procedures and training are provided to persons who are authorised to have such access.

Explanatory note: AEMO complies with its Information Systems Security Policy, which is consistent with these requirements but more detailed.

5 INTERFACING REQUIREMENTS

The purpose of the following standards is to ensure that data communications facilities are efficiently provided and maintained.

5.1 Physical and Logical Interfaces

- a. Where AEMO agrees to extend its wide-area network to a Registered Participant's data communications facilities, the Registered Participant must establish a physical connection to an AEMO-designated port on an AEMO router and it must use Ethernet and TCP/IP protocols.
- b. Where AEMO agrees that a Registered Participant may establish a logical connection to AEMO's wide area network, it must do so by engaging a Telecommunications Carrier to provide a digital communications service (such as the services known as DDS, Frame Relay or ISDN) between the Registered Participant's data communications facilities and a AEMO-designated network access facility.

5.2 Data Communications Protocols

- a. Subject to paragraph (b), any communication of operational data through a physical or logical interface with AEMO must use the TASE.2 application level protocol.
- b. An intervening facility that was using the ISD application level protocol when this Standard came into effect may continue to use that application level protocol until the intervening facility is replaced.

6 MAINTENANCE REQUIREMENTS

The purpose of the following standards is to ensure that outages of data communications facilities do not unduly impact on central dispatch or power system security.

6.1 Response to Failures

A person who is responsible for maintaining data communications facilities must:

- a. promptly repair any failure of data communications facilities, taking into account the reliability requirements quantified in Tables 2 and 3 above;
- b. keep AEMO's control centres informed of progress to repair any failure that is causing a critical outage; and
- c. consult with AEMO's control centres regarding the priority of work to correct failures causing or likely to cause a critical outage,

with the objective of minimising the impact of outages on central dispatch and power system security.

6.2 Outage Co-ordination

- a. Subject to paragraph (d), any planned outage of data communications facilities affecting:
 - i. dispatch data; or
 - ii. a substantial part of the operational data to or from a substation or power station,

must be notified to AEMO with 5 business days advance notice.

- b. Unless paragraph (d) applies, if a planned outage is proposed to AEMO such that 5 business days notice cannot be given, the outage must be deferred if reasonably required by AEMO.
- c. If AEMO determines that a planned outage would:
 - i. adversely affect power system security;
 - ii. occur when power system security is adversely affected by other events; or
 - iii. occur when AEMO has issued, or is likely to issue, a lack of reserve notice,then the relevant Registered Participant must, to the extent reasonably necessary, defer or cancel the outage and restore the equipment to a serviceable condition.
- d. If all of the plant to which the affected data communications facility relates is out of service at the time notice is given and will not return to service while the data communications facility is out of service, the period of notice may be reduced to 24 hours.
- e. For the purpose of this clause 6.2 of this Standard, a planned outage excludes an outage that could reasonably be expected to not cause a critical outage.

6.3 Data Management and Co-ordination

- a. Each Registered Participant providing data communications facilities must keep AEMO personnel informed of planned and unplanned changes to status indications, discrete values and analogue values they transmit to AEMO and control commands they receive from AEMO.

- b. Subject to paragraph (c), each planned change to a data communications facility must be notified to AEMO with sufficient details to allow AEMO to implement the corresponding change to its control centre facilities:
- i. for a minor augmentation of an existing power station or substation, at least 15 business days before it is to be implemented at the station; and
 - ii. for a new station or major augmentation of an existing power station or substation, at least 30 business days before it is to be implemented at the station,
- provided that any notice of a change more than 90 days before it is to be implemented must be repeated within the periods set out in paragraphs (b)(i) and (b)(ii).
- c. The periods of 15 and 30 business days in paragraph (b) may be reduced in relation to particular information by agreement between the Registered Participant and AEMO if the Registered Participant:
- i. includes AEMO's corresponding implementation tasks in the relevant project schedules, with task durations agreed with AEMO; and
 - ii. provides the major part of the detailed information in an electronic format suitable for AEMO to automatically populate its relevant databases.
- d. Each unplanned change to a data communications facility that changes information that was or would be provided to AEMO under paragraph (b) must be promptly notified to AEMO and at least coordinated with AEMO by telephone before the change is implemented and confirmed by notice within 14 days with sufficient details to allow AEMO to verify the corresponding changes at its control centres.
- e. For the purpose of this clause 6.3 of this Standard:
- i. an augmentation is taken to be implemented at the substation or power station when the relevant primary plant is first electrically connected to the power system, or if no primary plant is changed when the relevant secondary plant is commissioned;
 - ii. unless AEMO agrees otherwise, a major augmentation is a project that includes the installation of:
 1. a bus, transmission line or transformer intended to operate at a voltage of more than 100 kV; or
 2. a scheduled generating unit, scheduled network service or scheduled load,and a minor augmentation is any other project; and
 - iii. a planned change is one that could reasonably have been foreseen in sufficient time to give prior written notice under paragraph (b)(i) or (b)(ii) above.

6.4 Testing to Confirm Compliance

- a. A Registered Participant installing, upgrading or replacing remote monitoring equipment or remote control equipment forming part of data communications facilities must test a representative sample of status indications, discrete values, analogue values and control commands of that remote monitoring equipment or remote control equipment, to assess compliance with the age of information requirements set out in clause 2.3 of this Standard.
- b. A test under paragraph (a) must be carried out either prior to or within 60 business days following the relevant remote monitoring equipment or remote control equipment being placed into service for the affected operational data.

- c. Prior to a test, the Registered Participant installing, upgrading or replacing the remote monitoring equipment or remote control equipment must:
 - i. make suitable arrangements with the provider of each data concentrator and intervening facility relaying the operational data to be tested;
 - ii. prepare and provide to AEMO the procedure to be followed for the test;
 - iii. amend that procedure if AEMO reasonably considers that it will not adequately assess compliance; and
 - iv. consult and agree with AEMO with regard to the number of status indications, discrete values, analogue values and control commands to be tested and their corresponding remote monitoring equipment or remote control equipment.
- d. A Registered Participant that provides an intervening facility for operational data of another Registered Participant must cooperate with that Registered Participant and AEMO in the planning and conduct of the tests.
- e. Within a reasonable time after a test, the Registered Participant who provides the relevant remote monitoring equipment or remote control equipment must prepare and provide to AEMO a report summarising the results of the test and any remedial action necessary to ensure compliance.
- f. A test under this clause 6.4 of this Standard must determine the age of information by at least five measurements (not synchronous with scanning of the data) within a single period of at least 5 minutes.