Independent Market Operator

Compliance of the IMO's market software systems and processes for software management

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Executive summary

This report sets out the results of the market audit by PA Consulting Group in carrying out its assessment of the compliance of the IMO's market software with the Western Australia Wholesale Electricity Market Rules.

This market audit has been carried out under Market Rule 2.14.3.(c) which requires that;

The IMO must ensure that the Market Auditor carries out the audits of such matters as the IMO considers appropriate, which must include:

   a. *the compliance of the IMO's internal procedures and business processes with the Market Rules*

   b. *the IMO's compliance with the Market Rules and Market Procedures*

   c. *the IMO's market software systems and processes for software management.*

This report concludes that:

* other than a small number of non-material exceptions, the IMO's market software systems comply with the Market Rules; and

* the IMO's processes for software management comply with the Market Rules.

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1   Introduction

This document sets out the results of the market audit by PA Consulting Group in carrying out its assessment of the IMO's market software systems and processes for software management.

1.1   Scope of the market audit

This market audit has been carried out under Market Rule 2.14.3 which requires that:

The IMO must ensure that the Market Auditor carries out the audits of such matters as the IMO considers appropriate, which must include:

    a.   *the compliance of the IMO's internal procedures and business processes with the Market Rules*

    b.   *the IMO's compliance with the Market Rules and Market Procedures*

    c.   *the IMO's market software systems and processes for software management.*

This document covers our audit under sub-paragraph (c).

1.2   Market audit process

We have approached the audit in two components, respectively examining:

1.   IMO's software management processes and controls.

2.   Changes to the software itself.

With respect to the software management processes and controls we have:

- Examined the documented processes for software management;
- Compared them to actual operational practices; and
- Reviewed the compliance of operational practices with the Market Rules

With respect to the software changes, we have:

- Reviewed all system changes implemented since the last audit;
- Assessed whether those changes have potential for material effect on prices and quantities;
- Reviewed whether or not those changes have been certified as required under the Rules;
- Reviewed all rule changes commencing since the last audit;
- Assessed whether a rule change requires a change to the systems; and
- Identified where those changes have not been implemented.

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1.3   Structure of this report

The report is in two parts:

- Chapter 2 *Compliance of the IMO's software management processes and controls* reports on the compliance of the market software management processes;

- Chapter 3 *Compliance of the IMO software* reports on the compliance of the market software with the Market Rules.

2 Compliance of the IMO's software management processes and controls

Appropriate management of the market software by the IMO is essential given the nature of the business risk to both the IMO and the Western Australia Electricity Market.

Although there are no relevant Market Procedures relating to this subject, there are two Internal Procedures:

- Internal Procedure: Change Management Procedure
- Internal Procedure: IT Support Pack

2.1 Market Rules

The Market Rules set out certain obligations with respect to the IMO's software management systems and controls. These rules have not changed in the period since the last audit.

The requirements set out in Market Rule 2.36.1 are:

Where the IMO uses software systems in the Reserve Capacity Auction, STEM Auction or settlement processes, it must:

a. *maintain a record of which version of software was used in producing each set of results, and maintain records of the details of the differences between each version and the reasons for the changes between versions;*

b. *maintain each version of the software in a state where results produced with that version can be reproduced for a period of at least 1 year from the release date of the last results produced with that version;*

c. *ensure that appropriate testing of new software versions is conducted;*

d. *ensure that any versions of the software used by the IMO have been certified as being in compliance with the Market Rules by an independent auditor;*

e. *require vendors of software audited in accordance with clause (d) to make available to Rule Participants explicit documentation.*

2.2 Changes to software management processes and controls

In the period since the last audit the IMO's IT processes and practices have changed substantially. This includes:

- Increased use of the Jira tool to:
  - manage incidents, problems and defects;
  - effect change control and release processes; and
  - report on system and business process activities.
- Introduction of service level agreements with external support partners;

- Enhancement of initial test planning for software releases; and

- Introduction of environment management for development, test and production environments.

A number of further changes are planned in the period before the next audit, including, with the Market Evolution Programme, the introduction of a regression test suite.

These developments reflect the IMO's desire to effect a step change in the maturity of its IT practices.

Implementation of these changes to operational activities have resulted in creation of some new documentation (such as the IT Support Pack), and some updates to existing documentation (such as the IT Change Process). While these do not cover all software management processes, we note that the IMO is currently working on an IT Policy framework, which will fill out the internal documentation set, some of which already exists in draft form.

As a result, the internal processes as currently written do support the compliance of the IMO's software management processes with the Market Rules, but do not provide full coverage of the obligations.

2.3   IMO compliance with the Market Rules

Notwithstanding any gaps in the coverage of documentation, we found that the IMO's software management processes remain sufficient to comply with the market rules with one exception:

- With respect to 2.36.1(a), the IMO continues to maintain a record of all versions of market software used together with their dates in service, details of the differences between each version and the reasons for the changes between versions;

- With respect to 2.36.1(b), the IMO maintains the ability to roll back versions of the market software by re-installing previous versions of the software and a restore of the database backup to the point before the implementation of the version;

- With respect to 2.36.1(c), the IMO tests all new releases of the market software prior to their being placed in service, and in the last year has strengthened test planning activities to ensure appropriate testing coverage;

- We comment further on 2.36.1(d) below; and

- With respect to 2.36.1(e), the IMO provides documentation on the functionality of the market software and the IMO is also provided with copies of the release notes provided by the vendors. Given the degree of confidentiality over the software imposed by the vendors, PA accepts that the degree to which the IMO provides documentation is sufficient for compliance with this Market Rule.

2.3.1   2.36.1(d): Market software systems audit

The IMO Internal Procedure: Market Audits sets out its policy with regard to certification of changes to its market software by an independent auditor. It states that[1]:

- Software changes that **do not** result from Market Rule changes **and are not** expected to have a material effect on the prices or quantities will be regression tested by IMO staff and the Market Auditor is not required to test/certify the changes.

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[1] IMO Internal Procedure: Market Audits, Version No: 2, Date Issued: 17/02/2009

- Software changes that **do** result from Market Rule changes **and/or are** expected to have a material effect on the prices or quantities:
    - Will be tested/certified as part of the next Six Monthly or Annual Audit, if the software **can** be rerun and market or other outcomes corrected if the software is found to be defective during the next Six Monthly or Annual Audit; and
    - Will be tested and certified before they are applied to production, if the software **cannot** be rerun and market or other outcomes cannot be corrected if the software is found to be defective during the next Audit.

In past years, the IMO's Change Manager has been largely responsible for identifying when a software change triggered the certification requirement. As a result of organisational change, this position is not currently filled, and the responsibility has not transitioned to another person.

We also note a number of changes in IT personnel involved in the testing and release of new software versions. In the absence of a documented and used change procedure, the new personnel have not been aware of this obligation.

As may be expected, we have observed a small number of departures from this policy in the last year, where the IMO has implemented software changes without independent certification of their correctness, in breach of Market Rule 2.36.1(d). We have also noted instances where a rule change requires an update to IMO software or a supporting tool, and this change has not been implemented at rule commencement. The specific cases are covered in Chapter 3.

We note that the IMO has already taken steps to address this gap in process, and has recently built in a certification decision check at time of release. The IMO also intend to include consideration of certification requirements earlier in the updated change process.

2.3.2   Tools external to the core market systems

The IMO has identified a number of tools which are external to the core market systems, but still used in calculations with potential for material impact on market outcomes.

For the purposes of compliance with the Market Rules, it is unclear whether these tools are covered under the 'software' referred to in clause 2.36.1. Nonetheless, the IMO have determined that as part of prudent operation of the market, these tools should also be subject to certification where they meet the criteria in the Internal Procedure: Market Audits.

These tools are not subject to the same rigour of change and release management as the core market software is. It is therefore difficult to determine when a version change occurs, and build in appropriate controls. Nevertheless, several of these tools have been certified since the last audit, as noted in chapter 3.

2.4   Opinion

With the addition of the recent process improvements identified above, the software management processes employed by the IMO comply with the requirements of the market rules.

3 Compliance of the IMO software

The market software testing and certification process assesses whether the mathematical formulations specified in the Market Rules, Market Procedures, and vendor documentation have been correctly implemented by the software.

The software systems covered by this section of the review are the core market systems:

- The Reserve Capacity system;
- The Energy Market systems (including STEM); and
- The Settlements systems.

Where a tool that is external to the core market systems has been tested and certified, that certification is also covered.

3.1 Approach taken to reviewing the market software

3.1.1 Initial software testing

Verification of the market software results is generally conducted using one or both of the following methods:

- Directly comparing the software results to our understanding of the formulation. This may involve answering questions such as:
  - Are the appropriate constraints binding?
  - Does the set of calculations change as we expect when input values are altered and the software is re-run?
  - Does the software make optimal trade-offs between alternative resources, given their costs and associated constraints?
- Constructing spreadsheet models of the specific case. The spreadsheet model may perform a set of calculations (such as pre-processing of data or quantity allocations, as defined by the formulation), or it may include an optimisation procedure designed to replicate a portion of the software's formulation.

In testing the IMO's market software, we use both approaches.

Because much of the software tested is embedded in the market software systems, the tests to be performed have been specified by PA and then conducted by IMO staff. PA has then reviewed the test results to determine whether the results are in accordance with the requirements of the market rules.

3.1.2 Repeat software testing

Once software has been tested and shown to be compliant, it is not necessary to retest the software unless:

- Changes have been known to be made to the software which render the previous testing no longer valid; or

- It is believed that unapproved changes have been made to the software.

The first circumstance is readily picked up where there is a rigorous software change control procedure. The second exists where such a change control procedure is lacking.

In carrying out the 2006-7 and 2007-8 annual audit of the IMO's market software systems we carried out full regression tests to verify that the market software systems comply with the requirements of the Market Rules. Since the 2008-09 year, we have determined the status of the market software by:

- Examining the market software change procedures to ensure that they are robust;
- Examining the changes made to the market systems software to determine whether the changes required independent testing and certification; and
- Carrying out such testing and certification on those software changes as required.

Under this regime, should there be no changes made to the software since the last time it was certified, we may deduce that the software continues to comply with the Market Rules.

This is in line with the approach we use when verifying software compliance in other jurisdictions.

3.2   Tests conducted

This section provides a summary for the full set of tests conducted on the IMO market systems previously along with our conclusion of those tests.

This detail is provided in tabular form below and covers:

- The features of Market Systems software which have been tested;
- The nature of the tests conducted; and
- A statement of conclusion, being either:
  - PASS, meaning the test returned the expected result (i.e. consistent with our interpretation of the Rules);
  - FAIL, meaning the test didn't return the expected result and that this unexpected result was likely to have a material effect on the market outcomes; or
  - CONDITIONAL, meaning that the test returned an unexpected result, but can be accepted on the provision that the proposed corrective action is accepted and implemented within the proposed timeframes.

Table 1: Summary of previous tests conducted

System	Subject	Test	Result	Year
Market Systems	STEM & Non-STEM	STEM ST1: Two Participants	PASS	2008
		STEM ST2: Multiple Optima Clearing Quantities	PASS	2008
		STEM ST3: Multiple Optima Clearing Prices	PASS	2008
		STEM ST4: Price set at Min-STEM price by default bid	PASS	2008
			PASS	2008
		STEM ST5: Price set at Alt-Max-		

		STEM price by default bid	PASS	2008
		STEM ST6: Bilateral position outside of Price Curve	PASS	2008
		STEM ST7: Three Participants	PASS	2008
		NST 1 Dispatch Merit Order	PASS	2008
		NST 2 Dispatch Instructions	PASS	2008
		NST 3 Administered Balancing Prices	PASS	2008
		NST 4 Reserve Capacity Obligation Quantities		
Settlement	Ancillary services Settlements	Test AS1: USHARE and Reserve Share	PASS	2008
		Test AS2: Reserve Cost Share	PASS	2008
		Test AS3 Availability Cost Spinning Reserve	PASS	2008
		Test AS4: Consumer Share	PASS	2008
		Test AS5: Load Following Share	PASS	2008
		Test AS6: Ancillary Services Settlement Amount	PASS	2008
Settlement	STEM Settlement	Test SS1: Calculating STEM Settlement Amounts	PASS	2008
Settlement	Reserve Capacity Settlement	Test RCS1: Calculating Reserve Capacity Settlement Amount for Supply	PASS	2008
		Test RCS2: Calculating Reserve Capacity Settlement Amount for Demand	PASS	2008
		Test RCS3: Calculating Reserve Capacity Refund Settlement Amount	PASS	2008
		Test RCS4: Calculating Reserve Capacity Rebates and Offsets	PASS	2008
Settlement	Balancing Settlement	Test BS1: Authorised Deviation Settlement Amounts	PASS	2008
		Test BS2: Authorised Deviation Settlement Amounts for Verve Energy	PASS	2008
		Test BS3: Unauthorised Deviation Settlement Amounts	PASS	2008
		Test BS4: Resource Plan Deviation Settlement Amount	PASS	2008
		Test BS5: Dispatch Instruction Settlement Amounts	PASS	2008
Settlement	Other Settlement	Test OS1: Reconciliation Settlement Amount	PASS	2008
		Test OS2: Market Fee Settlement Amount	PASS	2008
		Test OS3: NCS, CO and NCC Settlement Amounts	PASS	2007

Settlement	Other Settlement	Test OS1: Reconciliation Settlement Amount	PASS	2008
			PASS	2008
		Test OS2: Market Fee Settlement Amount		
			PASS	2008
		Test OS3: NCS, CO and NCC Settlement Amounts		
Settlement	Other Settlement	Test OS1: Reconciliation Settlement Amount	PASS	2008
			PASS	2008
		Test OS2: Market Fee Settlement Amount		
			PASS	2008
		Test OS3: NCS, CO and NCC Settlement Amounts		
Settlement	Meter Data Warehouse	Peak determination methodology relating to Temperature Dependent Loads	PASS	2008
Protected Excel Workbook	Reserve Capacity	Maximum Reserve Capacity Price calculation	PASS	2008
Market Systems	Non-STEM	Maximum Alternative Maximum Stem Price calculation	PASS	2008
Market Systems	Non-STEM	Incremental Reserve Capacity Ratio calculation	PASS	2008
Market Systems	Non-STEM	Prudential Requirements calculation	PASS	2008
Market Systems	STEM & Non-STEM	Change to the resource plan calculation	PASS	2009
Settlement	Other Settlement	Settlement of intermittent load generators	PASS	2009
Market Systems	Reserve Capacity	Supplementary Reserve Capacity calculation	PASS	2009
Settlement	Reserve Capacity	Change of Reserve Capacity date range from August - 30 November inclusive to 1 June - 30 September	PASS	2010
Protected Excel workbook	Reserve Capacity	Maximum Reserve Capacity Price calculation	PASS	2010
Settlement	Reserve Capacity	Early Certified Reserve Capacity calculation	PASS	2010
Settlement	Ancillary Service Settlement	Treatment of negative MCAP on the settlement of Ancillary Services	PASS	2010
Settlement	Reserve Capacity	Calculation of net STEM shortfall	PASS	2010

We have reviewed the relevant IMO IT system change control logs and have confirmed that, other than set out in section 3.3, the above software has not been materially changed since the referenced tests were performed.

3.3   2010-11 market software tests

There have been 10 software version changes in settlements systems since July 2010, and 5 in market systems.

Most of these changes maintained certification without additional testing, as they did not involve changes that would be expected to have material impact on prices or quantities.

3.3.1   Changes maintaining certification

In the Settlements system, there were 6 changes affecting only reporting outputs, and 1 change to file import processes.

In the Market systems, there were 4 changes affecting reporting outputs, user interface, information retention and other changes not affecting core calculations.

The above changes maintain the certification status of the software.

3.3.2   Changes tested for compliance

PA has certified changes to systems and supporting tools as shown in Table 2. Note that the first entry was also covered in the previous audit report, but is included here for completeness, as it is within the change window covered by this audit.

Table 2: 2010-2011 software and supporting tool certification

System	Subject	Test	Result	Date certified
Settlement	Reserve Capacity	Determination of capacity shortfall for curtailable loads	PASS	30 September 2010
Protected Excel workbook	Capacity Refunds	Capacity Refunds associated with curtailable loads calculation	PASS	31 March 2011
Settlement	Ancillary Service Settlement	Ancillary Service Availability Cost calculation	PASS	14 April 2011
Protected Excel workbook	Reserve Capacity	Relevant Level for Intermittent Generation Capacity calculation (RC_2010_24)	PASS	17 August 2011
Market systems	STEM	Inclusion of more than 50 participants in STEM auction and dispatch merit order calculations	PASS	16 September 2011
Settlements	Capacity Refunds	Capacity Refunds calculation: Relief from capacity refund and unauthorised deviation penalties for consequential outages (RC_2010_23)	PASS	16 September 2011

The latter two changes were not certified until after the system changes were implemented. In any case, the changes were correct as implemented, therefore there is no material rule breach.

All of the above software has either been tested by PA, or the IMO testing has been reviewed and accepted by PA. PA has then certified that the above software complies with the requirements of the Market Rules.

3.3.3 Changes not yet made

We also note changes that have not yet been made, to implement rule changes which have already commenced. This means that the IMO's software and supporting tools cannot be certified to comply with the Market Rules as follows:

Table 3: 2010-2011 software or supporting tool changes not yet made

System	Subject	Rule change reference	Commenced	Change	Comment
Protected Excel Workbook	Other Settlement	RC_2010_04	1 October 2010	Settlement in default situations calculation: ordering of settlement payment and division of remaining monies when a participant has defaulted	No default situation has occurred since the rule change, therefore this is not material.
Settlements	Reserve Capacity	RC_2009_08	1 June 2010	Updates to commissioning provisions	The new calculations will not be required until 1 October 2012, so this is not material. New software has been developed, but not yet implemented.
Settlements	Ancillary Services	RC_2010_11	1 July 2011	Price paid to NCS providers is now MCAP. Removal of NCS from calculation of Monthly Settlement Amounts	There are currently no NCS contracts in place, therefore this is not material. New software has been developed, but not yet implemented.

3.3.4   Additional findings

We also identified two issues with the calculation of the dispatch merit orders.

1.   Facilities with zero capacity are included in the merit orders.

2.   Curtailable loads which cannot be activated, due either to reaching their maximum annual
curtailment, or to restrictions on activation on consecutive days, are included in the merit orders.

The IMO's software calculates the merit orders in accordance with section 6.12 of the Market Rules,
which do not include consideration of these operational issues. This means that the merit orders
specified in the Rules are not an operationally valid representation of the facilities available for
dispatch. We recommend a Rule change and system changes to correct this.

3.4   Opinion

Other than the non-compliances identified above, IMO software is certified to comply with the
requirements of the Market Rules.