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Dear Sir

Certification of vSPD version 1.4

The Electricity Authority (the Authority) has requested the PA Consulting Group (PA) to test changes made to the vectorised Scheduling, Pricing and Dispatch (vSPD) model (version 1.4) developed by the Authority. Specifically the Authority has requested that PA:

- Test the compliance of vSPD's Scheduling, pricing and dispatch functionality with *Schedule 3 (Scheduling, Pricing and Dispatch Software Model Formulation v9.0) of the System Operator Service Provider Agreement* (SPD Model Formulation v9.0)
- Test the compliance of vSPD's Financial Transmission Rights (FTR) Rental calculations with *Schedule 14.6 of the Electricity Industry Participation Code (the Code) (Calculation of amount of loss and constraint excess to be paid into FTR account)* (FTR Rentals Formulation)
- Provide an opinion on vSPD's compliance with the formulations above.

Overview of changes made to vSPD

PA has previously tested version 1.3 of vSPD in March 2013 and has provided an opinion (dated 15 March 2013) certifying vSPD's compliance against SPD Software Model Formulation v7.0.

Since then the Authority has implemented the following changes to vSPD:

- Introduced scarcity pricing functionality to implement:
  - Changes arising as a results of the Scarcity Pricing Code Amendment dated 26 October 2011 (implemented in the market on 1 June 2013)
  - Corresponding changes to SPD Software Model Formulation v9.0
- Introduced dispatchable demand functionality to implement:
  - Changes arising as a result of the Modified Dispatchable Demand Code Amendment dated 9th of December 2013 (implemented in the market on 15 May 2014)
  - Corresponding changes to SPD Software Model Formulation v9.0.

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- Introduced functionality to calculate Financial Transmission Right (FTR) rentals in accordance with Schedule 14.6 of the Code.

Approach to testing

Our approach to testing has focussed on assessing whether:

- Existing (previously tested) functionality is compliant with SPD Software Model Formulation v9.0. In other words, our testing has checked that the introduction of new functionality has not adversely impacted on existing functionality. We have approached this as follows:
  - *Testing existing functionality by rerunning old tests (regression tests)*: We have rerun previously conducted tests to ensure the new version of vSPD produced consistent results.
  - *Testing existing functionality by running new tests*: We have run a more comprehensive suite of tests to ensure the new version of vSPD is compliant with SPD Software Model Formulation v9.0. These tests have included more comprehensive testing of reserve and risk (including secondary HVDC risks) and security constraints.
- New functionality (i.e. scarcity pricing and dispatchable demand) has been implemented correctly and in compliance with SPD Software Model Formulation v9.0. We have approached this by running new cases to test vSPD's:
  - *Scarcity pricing functionality*: We have run tests to determine whether vSPD behaves correctly under different scenarios that could arise under Section 6.3 of the SPD Software Model Formulation (including the threshold test). We have also tested the Virtual Reserve Provider (VRP) functionality to determine whether vSPD correctly clears reserve offered by the VRP.
  - *Dispatchable demand functionality*: We have run tests to determine whether vSPD clears the market and calculates nodal prices correctly under different scenarios involving a dispatch capable load station.
  - *FTR rental calculation functionality*: We have run tests to determine whether FTR rentals are calculated accurately for AC losses, DC losses, congestion, branch constraints and islanding.

Limitations of testing

Scheduling, pricing and dispatch functionality

We have tested the scheduling, pricing and dispatch functionality of vSPD in final pricing mode only.

Our testing excludes:

- Sensitivity of results to extreme values in transmission system parameters.
- Application of mixed constraints. As indicated in our opinion dated 15 March 2013, although mixed constraints are included in the formulation, Transpower (as System Operator) no longer applies this in their SPD software (and cannot resume doing so without the Authority's approval).

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FTR rental calculation functionality

Our test cases are limited to the two node model and do not test rental calculations under a multi-node model.

Findings

- All regression tests passed which indicates that the new functionality in version 1.4 has not adversely impacted on vSPD's existing functionality.
- New cases run to test vSPD's reserve and risk functionality (including secondary HVDC risks) have passed, indicating that vSPD is compliant with Section 3.4 of the SPD Software Model Formulation.
- New cases run to test vSPD's application of security constraints have passed, indicating that vSPD is compliant with Section 3.5 of the SPD Software Model Formulation.
- The new functionality introduced in vSPD version 1.4 has been correctly implemented. Particularly, vSPD:
  - Correctly applies scarcity pricing in accordance with Section 6.3 of the SPD Software Model Formulation and correctly clears reserves offered by the VRP.
  - Correctly implements the dispatchable demand functionality and clears and prices the market correctly when a dispatch capable load station is added to the test data.
  - Correctly calculates FTR rentals for AC losses, DC losses, congestion, branch constraints and islanding.

Opinion

Subject to the limitations and caveats expressed above, we believe that the vectorised Scheduling Pricing and Dispatch software, contained within vSPD version 1.4, will perform in compliance with its software specifications as set out in:

- *Schedule 3 (Scheduling, Pricing and Dispatch (SPD) Software Model Formulation v9.0) of the System Operator Service Provider Agreement*
- *Schedule 14.6 of the Electricity Industry Participation Code (Calculation of amount of loss and constraint excess to be paid into FTR account).*

Limitation of Liability

This opinion has been prepared by PA Consulting Group for the Electricity Authority on the basis of information supplied by the Electricity Authority. To the maximum extent permitted in law, PA Consulting Group excludes all liability to any other persons for any loss or damage, whether direct or indirect and however caused (including through negligence) that may be suffered as a result of reliance on this opinion by that third party.

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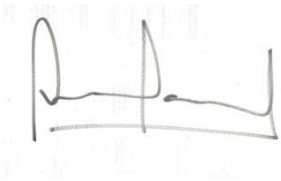
Should you wish to discuss the matters raised in this certificate further, please do not hesitate to contact me.

Yours sincerely



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