MNSP DISPATCH ISSUE - MNSP NPL MODEL BUSINESS SPECIFICATION

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Version Control

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Table of Contents

1. Reference

1.1 Abbreviations

ABBREVIATION	EXPLANATION
AEMO	Australian Energy Market Operator (formerly NEMMCO)
5MPD	Five-Minute Pre-Dispatch process
ASR	Ancillary Services Review
EMS	AEMO's Energy Management System
Exporting Region	Region out of which interconnector flow occurs
Importing Region	Region into which interconnector flow occurs
MMS	Market Management System; software, hardware, network and related processes to implement the National Electricity Market (NEM); a AEMO department responsible for maintaining the system
MNSP	Market Network Service Provider
NEMDE	National Electricity Market Dispatch Engine (aka Market Solver)
NER	National Electricity Rules; also called the Rules
NPL	Non-Physical Losses
RRN	Regional Reference Node
Rules	National Electricity Rules (NER)
SCADA	Real Time Power System Data
Solver	NEMDE market solver, NEM dispatch engine or central dispatch algorithm
VoLL	Value of Lost Load

TABLE 1: ABBREVIATIONS

1.2 References

1. External Market Report - Non Physical Losses and NSW VoLL Event -2nd January 2002 (NEMMCO website: http://www.nemmco.com.au/marketandsystemevents/marketandsystems_events.htm#ReportsMarketEvents)
2. Dispatch CVP Paper (NEMMCO website: http://www.nemmco.com.au/dispatchandpricing/dispatch_pricing.htm)

2. Introduction

2.1 Overview

This Business Specification sets out the functional implications of this change to the method of calculation of the MNSP loss share.

This change replaces an interim solution for remedying the issue with MNSP non-physical losses in dispatch timeframe was implemented in August 2003. The interim solution involved the switching of the MNSP interconnector loss share by the Dispatch Uploader.

2.2 Business Drivers

The unintended creation of MNSP non-physical losses is an issue due to the current design of the MNSP dispatch model used within the NEMDE market solver software (herein called NEMDE Solver).

The interconnector non-physical losses (NPL) re-run functionality implemented in the NEMDE Solver is intended to only cater for cleared loss anomalies that typically occur when energy clearing prices are negative.

However interconnector NPL may also be incorrectly created on an MNSP type interconnector when the MNSP's flow target is constrained-on by the application of a generic constraint at one connection point end (either through a AEMO direction, network constraint, or its own bid fixed loading). If the flow target was constrained to a level that is contrary (after accounting for expected physical MNSP losses) to the intended MNSP dispatch level at the other connection point end based upon the MNSP Link Flow Offer at that point, MNSP interconnector NPL will then be unintentionally created.

The detection of interconnector NPL from the results of the first NEMDE Solver run automatically triggers the NPL corrective scheme, which involves replacing the full multi-segment loss model for all interconnectors with a single-segment equivalent (selected based upon initial flow) before re-running the NEMDE Solver. This model reduction for all interconnectors may result in a less accurate estimation of inter-regional losses and therefore dispatch and pricing, particularly where the cleared interconnector flow target substantially differs from the initial flow.

Over the period 02/01/2002 to 22/02/2002 there were 78 dispatch runs where an NPL re-run occurred, with the NPL re-run for dispatch interval ended 15:00 on the 2nd of January 2002 having the greatest impact on the market and for which an external Market Incident report was published. For this dispatch run, the “hard” interconnector limits imposed by the NPL re-run model bound for the SNOWY1 interconnector, resulting in a VoLL energy price for the NSW1 region and an over-constrained dispatch re-run.

Note that, for this dispatch run, if all of the MNSP losses had been assigned to the NSW1 region (therefore effectively bringing together the point at which the MNSP Link Flow Offer was dispatched and the MNSP network constraint applied) then NPL would not have been created on the MNSP, and an NPL re-run would not have occurred.

Furthermore NER Clause 3.8.6A (f) requires that the central dispatch process interprets the MNSP price offered for power transfer between MNSP connection points as the minimum net revenue that the participant is willing to accept in order to deliver an increment of power <u>at the receiving end</u>. While this principle holds true where there is no binding generic constraint on MNSP flow, the principle breaks down where MNSP flow is constrained by a binding “generic” style constraint (such as a AEMO direction, network constraint, or its own bid fixed loading) which applies to the opposite connection point end to where one of the MNSP Link Flow Offers is dispatched.

Under the current MNSP loss/flow model, all MNSP losses are assigned to only one of the connecting regions, therefore fixing the point where generic constraints apply to the connection point end of the other region. This becomes an issue where a joint interconnector flow limit binds for a set of parallel interconnectors that includes an MNSP and this excessively constrains-off the dispatch of the MNSP Link Flow Offer effective at the other connection point end. In this case, the NEMDE Solver attempts to trade-off the relative flows on each interconnector to satisfy the joint flow limit, with the final flow combination based upon the lowest overall marginal cost of losses incurred on both interconnectors.

Note that while this issue has existed since the introduction of the bi-directional MNSP Link Flow Offer model in December 2000, the reporting of NPL re-runs has only been possible since the ASR-related NEMDE Solver changes were introduced in October 2001.

An interim fix was implemented to resolve the known issue of creation of un-intentional NPL and the inconsistent treatment of MNSP losses in Link Flow Offer dispatch. The requirements of the interim fix is documented in ‘MNSP Dispatch Issue – Switching of MNSP Interconnector Loss Share’ (Reference #1). However, this interim fix only resolves the MNSP NPL issue in the dispatch timeframe. In order to resolve the issue in the other Market modes (i.e. Pre-dispatch and 5MPD), a solver change with the same business logic is necessary.

2.2.1 Benefits

This project is expected:

To enhance compliance with the intent of NER Clause 3.8.6A(f), which defines how the central dispatch algorithm should interpret an MNSP Link Flow Offer;

To address issues of unintentional creation of MNSP non-physical losses by the NEMDE Solver when the solver is attempting to resolve apparent conflicts in flow dispatch.

2.2.2 National Electricity Rules (NER)

No change to the NER is required for the implementation of this change.

However, the implementation of this project enhances compliance with the intent of NER Clause 3.8.6A(f), which defines how the central dispatch algorithm should interpret an MNSP Link Flow Offer.

3. Previous Status Summary

MNSP interim fix was implemented in August 2003 to resolve the following two issues with MNSP in dispatch timeframe:

1. Unintended creation of MNSP non-physical losses
2. Inconsistent treatment of MNSP losses in Link Flow Offer dispatch

This interim fix resolved these issues in the dispatch timeframe only.

3.1 Previous Processes and Systems

The current MNSP losses/flow model used within the NEMDE Solver calculates cleared losses as a piece-wise linearised function of cleared flow at a single connection point end, with a fixed allocation of total losses between the connected regions independent of the direction of dispatched MNSP flow. This allocation ratio (called the "Interconnector FromRegion Loss Share") was dynamically determined by the direction of energy flow through the MNSP interconnector in the Dispatch Process. The Dispatch Uploader was responsible for this dynamic allocation of Loss Share ratio.

3.2 Previous Process Timing and Frequency

The interconnector loss model inputs for MNSP interconnectors only was passed into the Dispatch Process based on the direction of the cleared flow from the previous dispatch run.

4. Business Requirements

In order to resolve MNSP dispatch issue, the ratio "Interconnector FromRegion Loss Share" for MNSP type interconnector is required to be dynamically determined based on the initial flow direction of energy through the MNSP type interconnector.

4.1 Scope

In order to resolve the issue of unintended creation of MNSP non-physical losses and inconsistent treatment of MNSP losses in Link Flow Offer dispatch, the ratio "Interconnector FromRegion Loss Share" for MNSP type interconnector is required to be dynamically allocated based on the initial energy flow direction through MNSP type interconnector.

A solver change has been made to include the allocation logic for the ratio "Interconnector FromRegion Loss Share" that is based on the energy flow direction through MNSP type interconnector, for all Solver modes (Dispatch, Pre-dispatch, 5MPD)

4.2 Details of New Process

4.2.1 Process Differences Summary

For Dispatch, Pre-dispatch (both Base Case and Scenarios) and 5MPD, the allocation ratio "Interconnector FromRegion Loss Share" is dynamically determined by the direction of initial energy flow through the MNSP interconnector. Previously, this was implemented for Dispatch only as an interim arrangement to be replaced by this final arrangement.

4.2.2 Process Requirements

The ratio "Interconnector FromRegion Loss Share" is to be dynamically determined at each interval (i.e. each dispatch interval in Dispatch and 5MPD, trading interval in Pre-dispatch) based on the following business logic.

For every NEMDE Solver LP run (during an intervention period this involves both the physical or Outturn run & the What-if or Intervention Pricing run)…

For each interval 'i' (dispatch interval in Dispatch/5MPD or trading interval in Pre-dispatch),

IF *Interconnector 'I' is an MNSP*

THEN

(Initially set MNSP Losses Share based on flow direction as signalled in cleared flow target from pdi)

IF *Initial Interconnector Flow (i, I) > = 0*

THEN *Set Interconnector FromRegion Losses Share(i,I) = 1*

(ie 100% losses are assigned to FromRegion)

ELSEIF *Initial Interconnector Flow (i, I) < 0*

THEN *Set Interconnector FromRegion Losses Share(i,I) = 0*

(ie 100% losses are assigned to ToRegion)

ENDIF

(Now check whether there is a bid Fixed Loading to override the FromRegion Losses Share setting above. However if there are bid fixed loadings in both directions then ignore the override and default to above FromRegion Losses Share setting)

IF .NOT.

[FromRegion Flow Offer Fixed Loading(i,I) > 0

AND

ToRegion Flow Offer Fixed Loading(i,I) > 0]

(i.e. if there is a bid fixed loading defined for only one MNSP flow direction)

THEN

IF *FromRegion Flow Offer Fixed Loading(i,l) > 0*

THEN *Set Interconnector FromRegion Losses Share(i,l) = 1*

ELSEIF *ToRegion Flow Offer Fixed Loading(i,l) > 0*

THEN *Set Interconnector FromRegion Losses Share(i,l) = 0*

ENDIF

ENDIF

Where;

Initial Interconnector Flow (i, l) is defined as follows:

For First Interval…

IF this is the physical target solution (Intervention = 1) for an Intervention interval
OR
this is not an Intervention interval

THEN

Initial Interconnector Flow (i, l) = INTERCONNECTOR.METEREDMWFLOW(i,l)

ELSE IF this is the What-if solution (Intervention = 0) for an Intervention interval

THEN

Initial Interconnector Flow (i, l) = INTERCONNECTOR.WHATIFMWFLOW(i,l)

For Subsequent Intervals…

Initial Interconnector Flow(i,l) =

Cleared Interconnector Flow (i-1, l), for the relevant solve

FromRegion Flow Offer Fixed Loading(i,l) is defined as:

1. '=' operator
2. Constraint named with '$' as prefix
3. Only one MNSP interconnector term
4. interconnector term coefficient = 1

ToRegion Flow Offer Fixed Loading(i,l) is defined as:

1. '=' operator
2. Constraint named with '$' as prefix
3. Only one MNSP interconnector term
4. interconnector term coefficient = -1

This business-level pre-processing logic is implemented in the NEMDE Solver algorithm so that it is used in all Dispatch, Pre-dispatch & 5MPD modes. The following diagram illustrates the sequence of events:

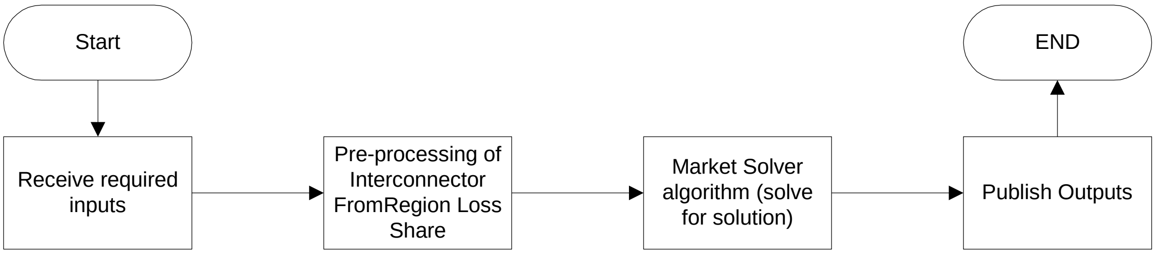

FIGURE 1: EVENT FLOW DIAGRAM

The abovementioned logic was implemented in August 2003 for Dispatch only as a temporary Database procedure change. This is now replaced by implementation of these changes.

4.3 Design Assumptions

- The business logic is unlikely to prevent NPL being incorrectly created where the initial flow direction (or cleared flow target in previous interval) is opposite to the intended direction of MNSP cleared flow target for the current interval. MNSP cleared flow reversals can arise from:
  - MNSP rebidding or band profile changes (except for bid fixed loadings). Rebidding to reverse the MNSP flow direction may occur to take advantage of sudden large inter-regional price differences resulting from a binding inter-regional limits, loss of the parallel interconnection or load shedding and VoLL price override in a region.
  - Changes to a binding security constraint applied by AEMO
  - Changes to a binding direction constraint applied by AEMO
  - Binding MNSP Ramp Rate limits in the opposite direction, owing to large actual MNSP flow reversals or flow non-conformance
- A bid MNSP fixed loading is deemed a better indicator of cleared flow target for the current dispatch interval than the cleared flow target from the previous dispatch interval run. Therefore, if there is an MNSP fixed loading, the flow direction of this fixed loading is used to set the MNSP's FromRegion Losses Share.
- The business logic handles the (unlikely) event that fixed loadings are bid **in both** MNSP Link directions. In this case the bid fixed loading 'override' is ignored and the MNSP FromRegion Losses Share is only set based upon the direction of the cleared flow target from the previous dispatch interval run.

4.4 Operational Implications

Previously the NEMDE Solver only reported the MNSP Link flow target at a fixed connection point end, usually corresponding to the connection point end at which MNSP flows are metered and controlled by the MNSP Participant, with this metered data sent to AEMO for use in the NEMDE Solver which then calculates flow targets at that control point.

With these changes the published MNSP Link flow target reported by the market solver for a particular MNSP Link direction is now be deemed to apply at its relevant importing region's connection point end (in accordance with NER Clause 3.8.6A(f)). The NEMDE Solver only needs to account for the static losses incurred for flow from that MNSP offer connection point to its corresponding RRN when dispatching that MNSP offer.

As the NEMDE Solver continues to only report a single cleared MNSP flow quantity, the abovementioned changes have the following implications detailed below.

4.4.1 MNSP Flow Dispatch Target interpretation

If the MNSP Participant is set up to only control MNSP flow at one fixed connection point end, and this is opposite to the end where the MNSP Link flow target applies, then they will need to adjust the published MNSP Link flow target by the published cleared MNSP losses before using this to control MNSP flow.

Under the current MNSP losses models, losses for the Directlink MNSP can range up to 11 MW.

The cleared MNSP flow quantities reported to the market now represents the MNSP flow offer cleared at its associated MNSP connection point, rather than under the previous design where the cleared MNSP flow is reported at one fixed end of the MNSP link (being the end where official metered quantities are taken). Under the existing NER, as these quantities are inter-regional flows they must be published to the market.

4.4.2 MNSP Link Losses calculation

Following these changes, the NEMDE Solver's MNSP Link losses calculation in the Dispatch, Pre-dispatch and 5MPD processes use the MNSP flow at the appropriate MNSP connection point end depending upon the initial MNSP flow direction, rather than one fixed end. The NEMDE Solver also performs an initial MNSP Link losses calculation prior to solving for each interval to adjust the forecast regional demand to the RRN.

Note that the initial MNSP flow for the first interval is the derived MNSP metered flow SCADA analog value captured from EMS; for subsequent intervals it is the MNSP flow target from the previous interval.

4.4.3 MNSP Interconnector Flow Limit interpretation

Following these changes, the MNSP Interconnector Flow Export and Import limits reported to the market from the Dispatch, Pre-dispatch and 5MPD processes consistently refer to flow limits at the initially importing region's MNSP connection point end, rather than the one fixed MNSP connection point end.

4.5 Business Scenarios

The following is a summary of how this change operates under various scenarios for each of Dispatch, Pre-dispatch and 5MPD (first and a subsequent interval):

SCENARIO #	DESCRIPTION	EXPECTED RESULT
1 – System Normal Operation	System operates at normal condition without intervention and no fix loading for MNSP interconnector	If initial IC flow >= 0, then Interconnector FromRegion Loss Share = 1 If initial IC flow < 0, then Interconnector FromRegion Loss Share = 0
2 – System Normal Operation with Fix Loading	System operates at normal condition without intervention with fix loading for MNSP interconnector	Bid Fix Loading overrides business logic for Interconnector FromRegion Loss Share.
3 – Intervention without Fix Loading	System is under intervention without fix loading	If initial IC flow >= 0, then Interconnector FromRegion Loss Share = 1 If initial IC flow < 0, then Interconnector FromRegion Loss Share = 0
4 – Intervention with Fix Loading	System is under intervention with fix loading for MNSP interconnector	Bid Fix Loading overrides business logic for Interconnector FromRegion Loss Share.
5 – The flow direction of initial condition and cleared condition is different regardless of whether intervention or Fix loading is present or not	Either (initialMW > 0 & clearedMW < 0), or (initialMW < 0 & clearedMW > 0).	NPL might be expected. Results need to be analysed. Note: This case is most probably when energy flow through MNSP type interconnector is ramped from one direction to the opposite direction