# Review of the System Restart Standard

## Peer Review of NSW Restoration by Mal Park

## November 2016

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## 1. Background

The AEMC has tasked the Reliability Panel (the Panel) to undertake a review of the System Restart Standard (the Standard) applying to the National Electricity Market (NEM). The Standard establishes several key parameters regarding the restoration of the power system following a major supply disruption in the NEM. The Panel is aiming to review and determine the Standard by no later than December 2016.

Clauses 8.8.3(aa)(1)-(7) of the National Electricity Rules (NER) require the Standard to define the maximum amount of time in which the power system must be restored to a specified level of supply following a major supply disruption. The Standard will also define the aggregate level of reliability and provides guidance on the diversity of the System Restart Ancillary Services (SRAS) that are used to begin the process of system restoration.

The Panel published a draft determination on this review on **25 August 2016** along with an economic assessment of SRAS undertaken by Deloitte Access Economics. The Deloitte report was based on black system restoration modelling results provided by the Australian Energy Market Operator (AEMO). The Panel held a public forum to discuss this draft determination on 21 September 2016, where a number of stakeholders questioned the accuracy of the black system restoration models used as an input to the economic assessment.

## 2. Biography of Reviewer

While working as the Assistant Operations Planning Engineer with The Electricity Commission of NSW, Mal Park was the original author of the NSW “Black Start” operating manual OM666. Later reviewing and updating OM666 many times including the formation of operator training procedures and processes.

Mal was also on the “System Development Engineers Committee” that determined the initial interstate transfer limits with Victoria following completion and connection of all Snowy generation and T3 pumps. In later years Mal was the NSW representative on the NEMMCO “Interregional Planning Committee” (IRPC) as the Executive Manager/Strategic Network Development with TransGrid.

Other operational and maintenance roles Mal has held include four years as Manager of the Murray side of the Snowy Scheme, three years as Manager of a NSW Transmission Region and six years as Manager/Wallerawang Power Station. Mal also spent three years as GM/Development for Delta Electricity and more recently some years as a “Principle Advisor” to NSW Treasury on power industry matters.

## 3. Key Elements of the Draft Standard Relating to NSW

*"The Draft Standard defines a restoration set-point or set-points for each electrical sub-network in terms of:*

- *A level of generation and transmission capacity to be expected to be available at the end of "Stage 1" of the restoration process;*
- *A maximum time to achieve this level of generation and transmission capacity; and*
- *An aggregate reliability, or probability, for achieving this level within the required maximum time."*

*"For each electrical sub-network, AEMO shall procure sufficient SRAS to restore generation and transmission such that supply equivalent to the prescribed level of average operational demand in that sub-network, could be restored within the time defined in Table 6.1 after a major supply disruption occurring."*

*"In addition, for the NSW electrical sub-network AEMO shall procure SRAS sufficient to:*

- *Re-supply and energise the auxiliaries of at least 500MW of generation capacity north of Sydney within 1.5 hours of a major supply disruption with an aggregate reliability of at least 75%."*

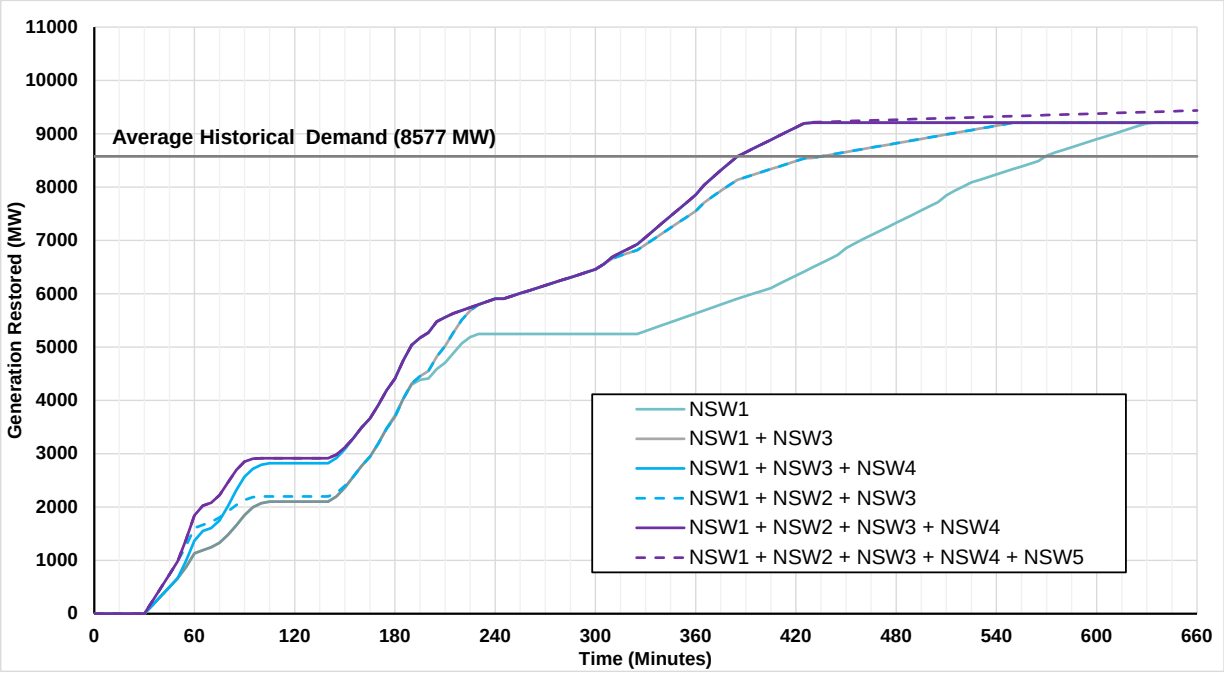
## 4. Scope of this Review

The AEMC has sought an independent review of AEMO's black system restoration modelling results for NSW to provide the Reliability Panel and its stakeholders with confidence around the input variables used in the economic assessment of System Restart Ancillary Service (SRAS).

AEMO provided the Reliability Panel with generator restoration curves for each electrical sub-network, based on modelling and the local "black system procedures". In so far as these curves relate to the NSW sub-network, stakeholders have raised concern that the curves are 'optimistic' or otherwise may be unreasonable when compared to historical outcomes. Given that the restoration curves are based on confidential data that cannot be made available to stakeholders, the Panel is interested to receive a peer review of the NSW generator restoration curves, to understand whether the curves are in fact reasonable.

These restoration curves have been developed by AEMO using scenarios of various combinations of five different restart services that could be available for NSW and are displayed below.

**NSW SRAS Restoration Scenarios – AEMO modelling results November 2016**




## 5. Characteristics of the NSW Sub-Network Relevant to the Restart Standard

- There are two main generation sources in NSW – large coal-fired plant north and west of Sydney and large hydro plant in southern NSW
- There are relatively severe network constraints – about 1700MW – for power flow from the south in the NSW network to the north of Yass/Canberra.
- The Panel recognises that the NSW sub-network has some additional constraints when compared to other sub-networks by making additional requirements for some contracted restart service in NSW to be north of Sydney.
- It has been argued by some NEM participants that NSW could be separated into two sub-networks because of the Yass/Canberra constraint. I do not agree. The importance of providing auxiliary supply to both the large hydro stations in southern NSW and to some coal-fired power stations to the north of Sydney at an early stage adequately manages this constraint as well as the timely restoration of supply in NSW.
- If a restart service is required to initiate a restart of the NSW sub-network, then clearly interconnections with Queensland and Victoria have been severed.
- The most likely separation locations with those sub-networks are between Bulli Creek in Queensland and Liddell and in Victoria either to the north or south of Dederang.

- Under these conditions the whole of the NEM is likely to be severely disrupted not only in NSW but also supply in Queensland and Victoria.
- The selection of contracted restart services in NSW has regard for the likely system conditions at the time of a severe supply disturbance.
- Operating steps that require actions by TNSP and DNSP operators to restore some load to segments of the network before the next step can be safely initiated in the recovery process is likely to add considerable time to the restoration process.
- Where possible, complex operational steps should be avoided especially between a contracted restart service and the major power station that will utilise that supply to energise station auxiliaries.

## 6. AEMO Restoration Modelling

**General Restoration Process**

The timeframe allowed by AEMO to energise the auxiliaries of nearby major generation from each possible NSW restart service is outlined below.

AEMO has the following general expectations:

| **Time (min)** | **Activity** | **Comments (in principle operating steps required)** | |
|---|---|---|---|
| 0 | Event Occurs | Recognise the event, instruct SRAS to start | |
| 15 | SRAS available | Run up SRAS unit(s), energise any transmission line connections and any transformer(s) required to provide connection of the restart service to supply power to the auxiliaries of the nearby major station(s). | |
| 30 | Auxiliaries energised | Commence restoration of major generating unit(s) | |
| 40 to 90 | Extend network energisation | Energising additional segments of the transmission system to extend supply to other substations and power stations. All steps will remain within the capability of the "SRAS island" to safely manage frequency control, reactive control and voltage control. | |
| 180 | Generation export | Some major generation becoming available across NSW – at least 20% of Average NSW Demand | |
| 240 | More Generation | Significant generation available across NSW – at least 40% of Average NSW Demand | |
| | | | |

NSW has two main generation sources – large coal-fired plant north and west of Sydney and large hydro plant in southern NSW. Also under these conditions a relatively severe constraint exists (about 1,700MW) for power flows from the south in the main transmission network to the north of Yass/Canberra.

It is recognised to effectively manage that network constraint, restart services need to be available for the simultaneous restoration of both hydro generation in southern NSW and separately to major thermal stations north of Sydney. At a later time in the restoration process synchronisation and connection of these "islands" will be undertaken.

**Restart Service from SRAS – Southern NSW**

Restart of the major hydro units in southern NSW will follow the steps outlined in the table above. The timetable for some southern NSW restart services appears optimistic in some scenarios but at this stage I consider they are reasonable and achievable.

The available supply from southern stations within say 3 hours of the system disturbance should be around 2,500MW or more.

**Restart Service – North of Sydney**

The importance of providing supply to the auxiliaries of major thermal power stations to the north of Sydney is recognised by the Panel. The timeframe expected to achieve supply to major generating units by AEMO is realistic on the understanding that the "return-to-service" of that first unit is optimal without any delays or major technical issues.

Output from the first major unit is critical in providing auxilliary supply to other stations north of Sydney.

AEMO has the following expectations:

| **Time (min)** | **Activity** | **Comments (operating steps required before progressing)** | |
|---|---|---|---|
| 0 | Event Occurs | Recognise the event, instruct SRAS to start | |
| 30 to 50 | Secure tripped units, | Start emergency diesel gen, carry out required internal &/or external switching, Initiate the contracted restart service and prepare to connect to auxiliaries of one major generating unit. | |
| 90 | Commence run-up 1st unit | When the unit is at 3000rpm energise unit transformer and adjacent 330kV busbar | |
| 180 | Energise 330kV busbar | Provide auxilliary supply to other major generating units. Stabilise 1st unit output, Commence 2nd unit restart | |
| 180 to 240 | Extend 330kV supply to other stations | Auxiliary supply provided to all major thermal stations – Calongra, Vales Point, Eraring, Bayswater, Liddell and Mt.Piper – by this period | |
| 240 | 2nd Unit ready to synchonise | 1st unit to above half output capacity | |

The available generation at four hours after the system disturbance should be up to about 1,300MW or more from northern stations.

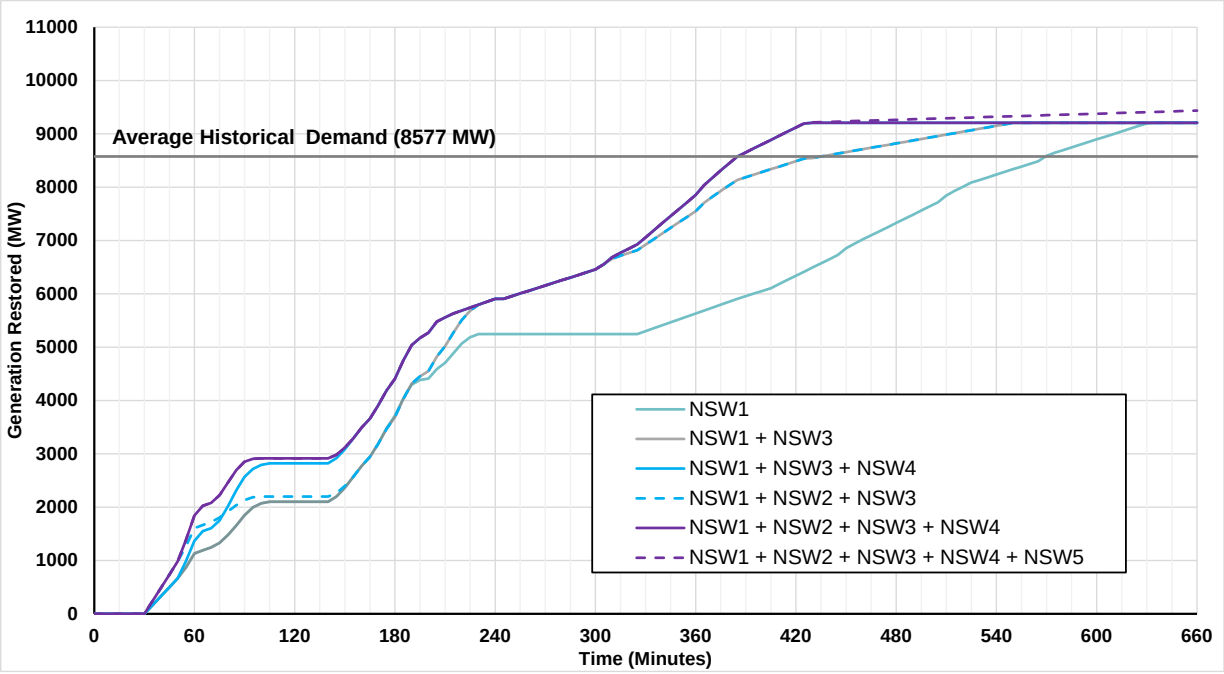
This program is dependant on the performance of the SRAS restart service and the sucessful "return-to-service" of the 1st Unit. Considerable delays of a number of hours could result if the initial unit fails to operate successfully.

## 6. Conclusions – Combined Southern and Northern NSW

These restoration curves have been developed by AEMO using scenarios of various combinations of five different SRAS services that could be available for NSW. They represent a relatively optimistic but achievable restart process for southern NSW and they assume the optimum technical performance from the initial plant connected with the restart process to the north of Sydney.

I consider that the assumptions used for the preparation of these curves to be realistic and achievable. I would expect variations to these curves would only be relatively minor if some delays occurred in some parts of the restoration process. Opportunities exist to cover any poor performance of some individual steps in the process without markedly extending the recovery of supply in NSW.

**NSW SRAS Restoration Scenarios – AEMO modelling results November 2016**



**NSW Electrical Sub-Network**