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(Lodged electronically via mass.consultation@aemo.com.au) **21 June 2022**

REVIEW OF (AEMOs) MARKET ANCILLARY SERVICES SPECIFICATION (VERY FAST FCAS)
RESPONSE TO ISSUES PAPER
Date of Notice: 03/02/2022

Delta Electricity operates the Vales Point Power Station located at the southern end of Lake Macquarie in NSW. The power station consists of two 660MW conventional coal-fired steam turbo-generators.
Delta Electricity appreciates the opportunity to comment on the proposals for the new very fast frequency control ancillary service (FCAS) addressing the questions raised in AEMO's Issues paper.

The following pages provide a table of comments to the AEMO's specific questions included in the issues paper.

If AEMO wishes to discuss this submission please contact Simon Bolt on (02) 4352 6315 or simon.bolt@de.com.au.

Yours sincerely

Simon Bolt
Marketing/Technical Compliance

ATTACHMENT – ISSUES PAPER QUESTIONS – AEMOs TEMPLATE

Market Ancillary Service Specification Consultation - May 2022

Submission to Issues paper template

This template has been developed to assist Consulted Persons in providing submissions on the questions posed in the Issues Paper. AEMO encourages Consulted Persons to use this template to assist AEMO when considering the views expressed on each issue.

Consulted Persons should feel free to address only those questions that are of particular interest/concern to them and delete those they are not responding to.

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1 Background	
1.4 Industry advice	
Question 1:	Are there any further issues for investigation by the Consultative Forum that are relevant to the specification of Very Fast FCAS?
Response: No other issues.	
3 Capability of different technologies to deliver Very Fast FCAS	
Question 2:	Do you agree with the capabilities expressed in Table 3? If not, please advise which of these you do not agree with and provide evidence to support alternative capabilities.
Response: Generally, the list is Ok. When considered in detail, the initial mechanical-hydraulic governor reaction from relevant conventional steam turbines takes place in less than 0.5s. This reaction is applicable to the very fast service. It is also relevant that, where DCS support is inactive and/or not well coordinated with the governor reaction, the initial mechanical-hydraulic reaction will be countered by correction to setpoint response. When DCS support is included in the response	

considerations, 2s for "Time to full response" is more accurate but, in many cases, is faster. The peak MW response will often be in the first second with the sustained response (from the DCS), although of similar droop proportion, usually lower due to the size of the frequency deviation at the specific (later) time during normal frequency recovery or limited by the design of the DCS supported response.	
Question 3:	Are there any technologies not mentioned in Table 3 that could potentially provide Very Fast FCAS? If so, what characteristics (including response time) could be expected of them? Please provide evidence to support their capabilities.
Response: Heavy weights and gravity storage systems using disused mine-shafts or railway corridors.	
Question 4:	How could wind farm and solar farm operators be incentivised to participate in the Very Fast FCAS markets? What are the technical barriers impeding participation? For example, this may be a conflict of voltage disturbance controls with frequency response controls.
Response: No response.	
Question 5:	Are there any other issues relevant to the capability to provide Very Fast FCAS by different technologies that AEMO should consider?
Response: The triggering mechanisms and recorded frequency values, and the specifications of them, is probably even more relevant to be accurately specified for effective very fast FCAS compared to fast, slow and delayed FCAS. Mechanical-hydraulic systems do not trigger on speed or frequency really. They trigger on change of speed as determined by centrifugal movement of spinning weights and the same detection action initiates the response instantaneously. Systems that wait to make decisions based on a reading of frequency need very good specifications to precisely indicate how fast the detection to activation needs to be. There will be poor overall system frequency coordination if a very fast service is being triggered by a very slow determination of what the frequency actually is followed by another very slow determination of whether frequency has left a particular deadband or not followed by another slow activation relay that then releases the very fast reaction. By the time a slow detection system detects and releases a fast responding system, the reaction may be uncoordinated with the overall system reaction required at the eventual time it reacts.	

4 Proposed design of Very Fast FCAS markets	
4.2 Guidance from other FFR Markets	
Question 6:	Are there any specific useful lessons to be learned from other FFR markets around the world?
Response: No response.	
4.3 Proposed design of Very Fast FCAS markets	
4.3.2 AEMO's proposed high level market design	
Question 7:	Are there any issues with the concept of shifting Fast FCAS to accommodate a similar, but faster, Very Fast FCAS? Is there a better alternative that is compatible with the Amending Rule?
Response: There is no technical rationale to reducing the 6s FCAS from 0 to 6s to 1 to 6s. It actually makes better sense in frequency control to focus on the faster responses instead of the slower responses and it is suggested that AEMO consider revising Fast FCAS into a 1 to 7s service and the slow service a 7 to 60s (or 61s if the slow would also benefit) instead of the proposed reduction in the fast service. 1s removed from the fast service reaction is a greater proportion of its assignment than 1s removed from the slow service. Registration issues may be affected by the expected change to cap the performance to peak active power change so there appears to be scope to revise all services in designing the very fast FCAS service.	
Question 8:	Are there any other issues relevant to market design that AEMO should consider?
Response: If all existing frequency reactions that provide existing FCAS services are, as determined from arithmetic that will calculate the very fast frequency response, already providing a very fast frequency reaction, it is questionable that the service will demonstrably prove its worth. i.e. why develop a market to pay participants for a service already being provided unless, for whatever reason, the quantity expected to be required in the very fast service is quite distinct from the quantity expected from fast services. How will the new system demonstrably deliver better overall frequency control for contingency events? If a distinct system is required, it may be preferable to have a distinct measurement in time that does not overlap Very fast into the fast response. A similar problem exists with the Fast and Slow (and maybe delayed services) with regards to the distinction between a proportional reaction and a switched reaction. A proportional reaction is really delivered in a single response and is quite simply directly proportional and opposite to the frequency deviation. Whether the delivery is fast or slow actually depends on the overall system response, and the subsequent period of time the overall system recovery takes which is outside the control of any one machine. e.g. as a result of mandatory PFR, fast/slow delivery on any one	

machine is very different to what it was prior to mandatory PFR and this is not surprising but the MASS and assessing responses for it remain a strange arithmetic where a unit's existing readiness and capability to provide a singular proportional reaction to any one frequency deviation can actually be an applicable service in two separate markets let alone now proposed to be additionally paid for by a new third market.

4.3.3 Impact of inertia

Question 9:	Are there any other issues relevant to the impact of inertia that AEMO should consider?

Response:

Inertia has a more obvious impact on a Unit's reaction in the timeframes relevant to the very fast service sometimes negating the total response observed to a changing frequency especially if the frequency change is complex which is the case in the NEM as a result of regular 50mHz peak-to-peak variations occurring in the normal operating band of system frequency.

4.3.4 Primary Frequency Response

Question 10:	Are there any other issues relevant to the interaction between Very Fast FCAS and PFR that AEMO should consider?

Response:

PFR and FCAS are delivered from an assortment of controllers. Sustained PFR as required by AEMOs PFRR is not a simple system to evaluate because of the reaction time and coordination between initial reaction detected and delivered from the turbine reacting to a change in turbine speed, followed by the Unit DCS MW setpoint error detection and then the correction reaction followed/interlaced with (dependent on detection of frequency by separate frequency readings) DCS controller FCAS reaction that will typically override the MW correction action that may or may not commence before it, dependent on the size of initial frequency deviation. The FCAS assessment calculations run data from recorders through arithmetic which mathematically removes inertia but it is hard to distinguish between PFR and 6/60s FCAS because they are co-delivered. It is easier to distinguish between PFR/FCAS delivered initially by mechanical-hydraulic governor action then corrected by DCS MW setpoint correction action and the PFR/FCAS then delivered by governor setpoint change made by the DCS supported by Boiler/Turbine FCAS reactions.

4.4 Existing capability to deliver Very Fast FCAS	
Question 11:	Does a 1-second response time specification automatically exclude certain technologies from being able to participate in the Very Fast FCAS markets? Which ones and why?
Response: If specified correctly, it should define whether the response time is measured from detection (by any detection system no matter how slow it is) or from a specified continuous and fast frequency record. It is suggested AEMO should reject any controller that is not rapidly tracking and detecting what frequency actually is and reacting to that signal regardless of how fast a system can deliver a response after any unspecified speed of detection of the need for a response.	
Question 12:	Is there anything else AEMO should consider in maximising the pool of potential Very Fast FCAS?
Response: No response.	

5 Specification of Very Fast FCAS and associated changes to the MASS	
5.2 Proposed key parameters for Very Fast FCAS	
5.2.1 Response time, timeframe and initiation delay	
Question 13:	Will some technology types be locked out of the Very Fast FCAS markets if the maximum response time is specified as 0.5 seconds rather than 1 second?
Response: The design should try to separate out response time from reaction time. If response time is delayed because of the time it takes to detect frequency to initiate a reaction, this should be considered separately to how fast the response from the system following initiation. They can be separate things as can be the method of detection. The mechanical-hydraulic reaction is detected by a change in speed on a mechanical system and is almost instantaneous following detection because the detection system movement is mechanical coupled to the delivery mechanisms. The Unit DCS reaction, in contrast, relies on multiple elements including detection, deadband assessment and delivery and therefore is slower, having process time to develop frequency in a frequency transducer, read the frequency measurement from the transducer, detect a level outside deadband requiring a FCAS reaction, and then setting the subsequent adjusted setpoint on the turbine governor.	

Question 14:	Are there benefits to setting the response time for Very Fast FCAS faster than 1 second that AEMO should consider?
Response: Coordination between various systems is an important consideration. AEMO should seek systems that can be tuned and undertake frequency tuning activities with participants NEM-wide to improve overall frequency control, including PFR and FCAS delivery. However, the mechanical-hydraulic systems of conventional machines, which provide the fastest delivery, are complicated and expensive to tune or adjust so it is better if the proportional response as found to exist in these systems is accepted as already configured.	
Question 15:	Are there any other issues relevant to the proposed response time and timeframe that AEMO should consider?
Response: No further issues from those raised in Question 14.	
5.2.2 Market ancillary service offer requirements	
Question 16:	Are there any other issues relevant to the proposed market ancillary service offer requirements that AEMO should consider?
Response: AEMO could consider changing the Fast FCAS to be a 1 to 7s service and therefore the equivalent declining period of the very fast service would change to be a 1 to 7s period also. Subsequent changes to slow and delayed could be also considered to arrange the timing necessary for the best overall application.	
5.2.3 Reference frequency levels	
Question 17:	Are there any other issues or concerns relevant to AEMO's proposal to apply the current definitions of 'Raise Reference Frequency' and 'Lower Reference Frequency' to Very Fast FCAS?
Response: Focusing on islanded conditions for the design of FCAS seems to focus on conditions rarely experienced and undermines the effectiveness of the controllers that for more than 99% of the time are applied to non-islanded conditions. The FCAS reassignment process in NEMDE after the development of islands might be useful to consider and may require more rapid assignment than is generally considered possible by manual operator intervention. However, the maximum delivery of many systems, and the sustainable response, is a function of other factors rather than simply how large the frequency deviation is and it seems that the assignment of caps based on maximum	

MWs will cause necessity for this reconsideration of capacities of all systems in general regardless of which reference frequency is used to define the capacity.	
5.2.4 Frequency Ramp Rate	
Question 18:	Are there any other issues relevant to RoCoF that AEMO should consider?
Response: No response.	
5.3 Control system requirements	
Question 19:	Is AEMO's proposal to permit the use of a 'combination' controller, namely, a hybrid of proportional and switched controls for Very Fast FCAS appropriate? Please provide reasons for your response.
Response: Coordination of faster controls is important and best achieved with proportional systems working off rapid detection regimes drawing on equivalent specifications. Switched control is unlikely to coordinate well with fast proportional reactions and could damage systems if out of phase and poorly timed or producing conflicting or undamped reactions and counterreactions. Switched control is considered better suited to slower FCAS. Slower FCAS services already contain hybrid mixtures of proportional and switched which demonstrates that hybrid systems can be considered appropriate already.	
Question 20:	Are there any other issues relevant to the proposed control system requirements for a combined FCAS controller that AEMO should consider?
Response: Very fast and fast FCAS should be delivered exclusively by proportional controls. Switched controls are better suited to Delayed Service corrections that in the timing of response are procured to follow on from presumably ineffective faster controls where, despite delivery of all fast proportional service, overall frequency remains incompletely corrected. Such conditions presumably occur if energy storage was exhausted in the very fast, fast and slow proportional reactions, overall system requirements were miscalculated and/or system events represented a multiple contingency.	
Question 21:	Are there other FCAS delivery methods that AEMO should consider allowing for Very Fast FCAS?
Response: No response.	

5.4 Verification and measurement requirements	
5.4.3 Frequency measurements	
Question 22:	What is the error margin and resolution for frequency measurements by high-speed metering installed by Fast FCAS Providers that could be retrofitted to existing Ancillary Service Facilities for participation in Very Fast FCAS markets?
Response: The accuracy of high-speed metering is typically +/- 0.01Hz. Resolution can depend on how wide a range of frequency is being catered for in cheaper instruments i.e. wider range of measurement can reduce the resolution of the resultant signal. In the recorders Delta Electricity currently uses, the accuracy and resolution depends on the AtoD conversion rate of the source signal (commonly a voltage input to the recorder) and whether any time-smoothing over consecutive zero-crossing is taking place. 12bit in older systems and 16bit in newer systems. A 16bit system seems to have a resolution less than 0.0001Hz. A 12bit system seems to have a resolution of 0.0012Hz.	
Question 23:	What is the error margin and resolution for frequency measurements by high-speed metering that is not currently in use in the NEM, but is available for use in the Very Fast FCAS markets?
Response: No response but resolutions better than the above, which is technology available several years ago, are probably available in the latest technology.	
Question 24:	What is the cost of high-speed metering that captures frequency measurements with a margin of error lower than <0.1 Hz?
Response: The cost of recorders is in the order of $250k installed but cheaper varieties are available.	
Question 25:	Can metering providers submit the specifications of their high-speed metering currently available, or in use by Fast FCAS providers?
Response: No response.	

Question 26:	Are measurement rates of <100ms feasible for your technology? What is the nature and extent of changes that would need to be made to support rates of <100ms?
Response: There are measurement rates relevant to the monitoring recorders and separate measurement rates for the controllers. Rates at the cycle of electricity are feasible for the recorders. Rates of detection systems depend on the system but range from instantaneous such as is the case with mechanical speed detection to slower systems (in the range of 1s) used to activate slower controllers. A faster measurement rate for the slower systems is not feasible presently and would require improved source instrument and upgraded control equipment.	
Question 27:	Are there any other issues relevant to the proposed verification and measurement requirements that AEMO should consider?
Response: Rapid detection of frequency and initiation of service is even more critical for very fast FCAS than for Fast FCAS. There is no point having a very fast service and monitor of that service if its frequency detection and control activation processes are slow except that, , at least the fast monitor should record and display and confirm that the overall detection/initiation was slow. A slow detection and response system coupled with an equally slow or slower recorder should be cause for rejection of any such proposed very fast service.	
5.5 Overload capacity	
Question 28:	How long can overload capacity be sustained?
Response: The answer to this question depends on the system. However, in considering very fast FCAS, why does it matter as long as overload can be sustained for period the service demands (0-6s)? In any case, the capacity available to Delta Electricity, which depends on many factors including atmospheric, time of year, fuel quality and plant conditions, is in the order of minutes. Delta Electricity will probably not provide overload capacity for use in FCAS as its overload capability is delivered with caveats that require care to ensure a Unit remains secure and this generally means Raise FCAS is not available during overload operations.	
Question 29:	What percentage of a generating unit's nameplate rating is equivalent to the overload capacity?
Response: The overload is Unit dependent but estimated to be in the range 2-5% of MCR for many plants.	

Question 30:	How often can overload capacity be triggered in a 5-minute trading interval?
Response: Delta Electricity would not be proposing to use overload capacity for any type of raise FCAS.	
Question 31:	Can overload capacity be delivered proportionally to the frequency deviation, or can it only be delivered by a step change in active power?
Response: It is considered conceivable that overload capacity could be delivered as proportional FCAS if a Unit was so designed but is such a design is not presently under consideration for use in any FCAS service.	
Question 32:	Is there an energy payback after overload capacity is delivered?
Response: No response.	
Question 33:	What technologies other than BESS have overload capacity that (could) be sustained for at least 6 seconds?
Response: Conventional Steam boiler and turbogenerator sets would have capacity, either switched or proportional, but it is not presently expected that many are designed for this use for FCAS.	
Question 34:	Are there any other issues relevant to the potential use of overload capacity for Very Fast FCAS that AEMO should consider?
Response: Designs may be possible for existing steam generators but the estimated expected utilisation of overload capacity for this service does not yet justify the expense in designing and testing such a system. The overload capacity and the need to use it for FCAS will depend on considerations as to what regularity of operation a unit is at maximum output and the Contingency FCAS prices as to whether the deployment would be feasible. Units can provide FCAS raising services up to the PMAX but unless, by virtue of energy market dynamics, units are generally operated at PMAX, there may be no incentive to provide FCAS that utilises overload capacity unless also required whilst raise Contingency FCAS markets are also regularly at very high prices due to lack of supply. Such conditions could occur and may prompt considerations for such systems.	

5.6 Changes to other FCAS	
5.6.1 Interaction between Very Fast FCAS and Fast FCAS	
Question 35:	Can Consulted Persons identify any case where a decrease in Fast FCAS capability could be observed?
Response: The overall system response appears to have a large bearing on the performance of individual machines. This is not surprising. Fast FCAS performance of individual machines alongside Mandatory PFR is improved upon what it was for events prior. However, the prevalence of regular 50mHz peak-to-peak variations, and subsequent reactionary PFR, mean that sometimes calculations will start from either a supporting or counteracting position and it is therefore hard to predict cases which might yet demonstrate a reduction in Fast FCAS capability. Theoretically, having fast FCAS calculated only over 5s instead of 6s, it is expected will occasionally result in less overall response in Fast FCAS. Therefore, it is recommended that AEMO consider making the Fast FCAS a 1 to 7s service recovering over 7 to 60s (or 61s) and subsequently adjusting slow FCAS to suit.	
Question 36:	Are there any other issues relevant to the interaction between Very Fast FCAS and Fast FCAS that AEMO should consider?
Response: The very fast FCAS response will occur through the transition from mechanical-hydraulic governing to DCS/Boiler supporting FCAS and this is not easy to coordinate to improve precision in the delivered response.	
5.6.2 Interaction between Very Fast FCAS and Slow FCAS and Delayed FCAS	
Question 37:	Are there any issues relevant to the interaction between Very Fast FCAS and Slow FCAS and Delayed FCAS that AEMO should consider?
Response: No issues.	
5.6.3 Interaction between Very Fast FCAS and Regulation FCAS	
Question 38:	Are there any issues relevant to the interaction between Regulation FCAS and Very Fast FCAS that AEMO should consider?
Response: No issues with regulation FCAS but the issues with the unchecked large regular 50mHz frequency variations on a 20-30s period and the mandatory PFR reactions to these variations are expected to	

affect the calculations of very fast FCAS responses as they already would be affecting Fast and slow service caclulations.

5.6.4 Revision to FCAS measurement

Question 39:	Are there alternatives to capping the registered Very Fast FCAS capacity to the actual peak active power change to minimise the discrepancy between the amount of FCAS enabled and the actual contingency size?

Response:

No response.

Question 40:	Are there any other issues relevant to the proposed market ancillary service offer requirements that AEMO should consider?

Response:

As mentioned previously, the detection time and the reaction time may be separate in some systems. AEMO are encouraged to determine a permitted time period between detection and initiation of a response to avoid future challenges in the overall coordination of frequency. A proportional reaction to a real frequency condition is useful. A delayed yet rapid proportional reaction to an earlier frequency deviation is, by virtue of the delay, uncoordinated and could contribute to dysfunctional frequency control.

5.7 Proposed handling of Contingency Event Time

Question 41:	Are there any other issues relevant to the proposed removal of Contingency Event Time that AEMO should consider?

Response:

There remains a likelihood that reserves prepared for Contingency FCAS are being eroded by an unsteady (lowering or rising or both) "normal" frequency conditions prior to any defined contingency event that requires the reserves. Such conditions were occurring prior to Mandatory PFR but, although triggers of FCAS recorders have lowered by the narrowing of overall frequency range, continued unsteadiness of frequency normal is large enough to be regularly utilising reserves for PFR. The use of energy dispatch trajectories (actual to target) to determine the PFR position at a frequency event time can display a real MW support (or retardation) already deployed that should be included with the very fast FCAS calculation but should also be considered as the initial MW position in MASS FCAS calculations. The dispatch trajectory target point can be sizeably (a few MWs) different from the basepoint MWs as determined in the present arithmetic examining Actual MWs just prior to certain frequency deviations as measured. The base starting MWs from which to measure a response should really be worked out from the dispatch trajectory base point (actual to target) and not from the actual MWs as recorded just prior to a frequency transition.

Question 42:	In there a better alternative to the baseline compensation approach than the one proposed by AEMO? Please provide reasons for your response.
Response: As for Question 41.	
6 Issues not under consideration	
6.4 Geographic diversity	
Question 43:	Are there any other issues relevant to geographic diversity that AEMO should consider?
Response: No response.	