



ABC AND AGC INTERFACE REQUIREMENTS

TECHNICAL SPECIFICATION

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IMPORTANT NOTICE

Purpose

AEMO has prepared this document to provide information about the requirements for interfacing with the AGC and ABC systems used by AEMO in the Wholesale Electricity Market (WEM), as at the date of publication.

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1. INTRODUCTION

1.1 Purpose and scope

Facilities wishing to participate in the Load Following Ancillary Service (LFAS) market in the Wholesale Electricity Market (WEM) must be commissioned for Automatic Generation Control (AGC¹) to provide the Ancillary Service. Many of the same SCADA signals can also be used to receive and acknowledge Dispatch Instructions/Operating instructions in a timely manner.

Non-Scheduled Generators intending to receive the Dispatch/Operating Instructions via SCADA are not configured through AGC but through a different scheme that does the automatic sending of the Dispatch/Operating Instruction setpoint and ramp rate (described in Section 5).

This document describes the SCADA point requirements for Scheduled and Non-scheduled Generators wishing to use SCADA-based signals for Dispatch/Operating Instructions, and participate in the LFAS market. This document also describes the testing AEMO requires to accredit Facilities in each case.

The SCADA signals specified in this document are in addition to any other SCADA signals required by either AEMO or the respective Network Operator as part of connecting the Facility to the South West Integrated System (SWIS).

1.2 Glossary

Table 1 Abbreviations and terms

Abbreviation	Meaning
ABC	Automatic Balancing Control – a mechanism to represent Dispatch Instructions electronically
AGC	Automatic Generation Control – a feature of an Energy Management System
BMO	Balancing Merit Order
DCS	Distributed Control System (control system used to control facility)
EMS	Energy Management System – System Management's main SCADA system
Generated megawatts (MW)	The gross (generator terminal) MW value for a facility, before losses
GIA	Generator Interim Access
LFAS	Load Following Ancillary Services – implemented via AGC
LFMO	Load Following Merit Order
NCS	Network Control Service – contract with a Network Operator
NSG	Non-Scheduled Generator
RTU	Remote Terminal Unit
SCADA	Supervisory Control and Data Acquisition – control and indication logic used to remotely monitor and control plant
Sent out MW	The nett (over the fence) MW value for a facility

¹ AGC is a module of the SCADA/EMS system currently used by AEMO. AGC provides closed loop control for selected generating units connected to the SWIS (for controlling frequency as part of Load Following Ancillary Services). AGC is essential for Load Following facilities as SCADA/EMS system uses AGC to balance load with available generation and maintain a constant system-wide frequency of 50 Hz.

2. AGC INTERFACE SIGNALLING²

Table 2 describes the SCADA signals AEMO will send to Scheduled Generators for the purpose of issuing Dispatch Instructions or sending frequency directions via AGC. The name of the signal is indicated in brackets under the Signal Description column. The scan rate of all signals used for AGC is a minimum of 4 seconds³.

Table 2 Scheduled Generators SCADA control point list requirement

Inputs (RTU to DCS) master station to Facility				
Item no	Units	Signal	Signal description	Comment
1	MW	Analogue Output	Facility Desired MW Set point (XXX DESIRED MEGAWATTS)	Target MW set point, sent every 4 seconds if the unit is under AGC control. Note this is the Facility SENT OUT MW dispatch; the facility must be able to work out the corresponding generator's GENERATED MW.
2	MW/min	Analogue Output	Facility Desired Ramp Rate Set point (XXX DESIRED RAMP RATE)	This is the Dispatch Required Ramp rate, sent every minute regardless whether the unit is in AGC control or Local control. If the unit is in AGC control and doing Balancing (see the AGC Control Mode indication in section 3), the facility should use this ramp rate to move the unit. If the unit is in AGC control and doing load following (see the AGC Control Mode indication in section 3) the facility should ignore this and use the maximum rate to move the facility.
3	MW	Analogue Output	Look Ahead Dispatch Instruction (DI) MW Set point (XXX LOOK AHEAD DI MEGAWATTS)	This is sent every minute regardless whether the unit is in AGC control or Local control. This is a 300 second (5 minute) look ahead which tells the facility what Desired MW the facility is expected to receive 5 minutes ahead of the current time, this is a representation of the actual Dispatch Instruction Target MW.
4	MW/Min	Analogue Output	Look Ahead DI Ramp Rate Set point (XXX LOOK AHEAD DI RAMP RATE)	This is sent every minute regardless whether the unit is in AGC control or Local control. This is a 300 second (5 minute) look ahead which tells the facility what Ramp Rate the facility is expected to receive 5 minutes ahead of the current time, this is a representation of the actual Dispatch Instruction ramp rate.
5	MW	Analogue Output	Look Ahead 2 MW Set point (XXX LOOKAHEAD 2 MEGAWATTS)	This is sent every minute regardless whether the unit is in AGC control or Local control. This look ahead which tells the facility what Target MW the facility is expected to receive in a configurable interval which can be specified by the Facility (minimum of 5 minutes, maximum of 60 minutes).
6	MW	Analogue Output	Look Ahead 3 MW Set point (XXX LOOKAHEAD 3 MEGAWATTS)	This is sent every minute regardless whether the unit is in AGC control or Local control. This look ahead which tells the facility what Target MW the facility is expected to receive in a third configurable interval which can be specified by the Facility (minimum of 5 minutes, maximum of 60 minutes)

² Any variations from these requirements need to be agreed in writing by AEMO

³ The slowest scan rate should be 4 seconds.

Inputs (RTU to DCS) master station to Facility				
7	MW	Analogue Output	Facility LFAS Low Operating Limit Set point (XXX LOAD FOLLOWING LOW OPERATING LIMIT MW)	This is sent every 1 minute and is calculated as the current Dispatch Instruction plus the cleared Load following margin down. Can be used by the facility for information or can be just ignored. No need to define if facility is not using it.
8	MW	Analogue Output	Facility LFAS High Operating Limit Set point (XXX LOAD FOLLOWING HIGH OPERATING LIMIT MW)	This is sent every 1 minute and is calculated as the current Dispatch Instruction plus the cleared Load Following Margin Up. Can be used by the facility for information or can be just ignored. No need to define if facility is not using it.
9	MW	Analogue Output	Facility Actual MW Set point (XXX ACTUAL MEGAWATTS)	This is the current Facility Loading as seen from the Master Station. Can be used by the facility for information or can be just ignored. No need to define if facility is not using it.
10	MW	Analogue Output	AGC Basepoint MW Set point (XXX BASEPOINT MEGAWATTS)	Can be used by the facility for information or can be just ignored. No need to define if facility is not using it.
11	MW	Analogue Output	AGC Control Mode Indication (XXX CONTROL MODE)	This is sent every 30 seconds and is an indication of what AGC mode the Facility is currently set to.
12		Digital Output	EPCC Master Station Communications Fail	Indication that the communications between the WP SCADA RTU and the WP SCADA Master Station has failed.
13		Digital Output	RTU to DCS Comms Watchdog	This bit is sent to the DCS and is read back via an output from the DCS below. If this bit fails to change state within a designated interval it generates an alarm.

Table 3 describes the SCADA signals AEMO requires from Scheduled Generators for the purpose of acknowledging Dispatch Instructions or responding to frequency control directions via AGC. The scan rate should be a minimum of 4 seconds⁴.

Table 3 Scheduled Generators SCADA input requirement

Outputs (DCS to RTU), Facility to master station				
Item no	Units	Signal	Signal description	Comment
1	MW	Analogue Input	Facility Gross MW Telemetry (XXX GROSS MEGAWATTS)	An instantaneous measure of the current MW loading level of the facility. This is the sum of the gross MW output of each generating unit.
2	MW	Analogue Input	Facility Net MW (XXX NETT MEGAWATTS)	An instantaneous measure of the SENT OUT MW loading level of the facility.
3	MW	Analogue Input	Facility Received Desired MW (XXX DESIRED MEGAWATTS)	Feed Back of the "Facility Desired MW Set point".

⁴ The slowest scan rate should be 4 seconds.

Outputs (DCS to RTU), Facility to master station				
4	MW/min	Analogue Input	Facility Received Ramp Rate (XXX DESIRED RAMP RATE)	Feed Back of the "Facility Desired Ramp Rate Set point".
5	MW	Analogue Input	Facility Received DI MW (XXX LOOK AHEAD DI MEGAWATTS)	Feed Back of the "Look Ahead DI MW Set point".
6	MW/min	Analogue Input	Facility Received DI Look Ahead Ramp Rate (XXX LOOK AHEAD DI RAMP RATE)	Feed Back of the "Look Ahead DI Ramp Rate Set point".
7	MW	Analogue Input	Maximum Operating Limit Megawatts (XXX MAX OPERATING LIMIT MEGAWATTS)	Maximum available capacity for dispatch for the facility at the moment (Used for auto-acknowledgement).
8	MW/min	Analogue Input	Minimum Operating Limit Megawatts (XXX MIN OPERATING LIMIT MEGAWATTS)	Minimum available capacity for dispatch for the facility at the moment (Used for auto-acknowledgement).
9	MW	Analogue Input	Look Ahead 2 MW Received (XXX LOOKAHEAD 2 MEGAWATTS)	Feed Back of the "Look Ahead 2 MW Set point"
10	MW	Analogue Input	Look Ahead 3 MW Received (XXX LOOKAHEAD 3 MEGAWATTS)	Feed Back of the "Look Ahead 3 MW Set point".
11	MW	Analogue Input	Facility LFAS High Operating Limit (XXX LOAD FOLLOWING HIGH OPERATING LIMIT MW)	Feed Back of Facility LFAS High Operating Limit Set point.
12	MW	Analogue Input	Facility LFAS Low Operating Limit (XXX LOAD FOLLOWING LOW OPERATING LIMIT MW)	Feed Back of Facility LFAS Low Operating Limit Set point.
13	MW/min	Analogue Input	Maximum Un Ramp Rate Up (XXX MAX RAMP RATE UP)	Facility Maximum Ramp up capability.
14	MW/min	Analogue Input	Maximum Unit Ramp Rate Down (XXX MIN RAMP RATE DOWN)	Facility Maximum Ramp down capability.
15	MW/min	Analogue Input	Ramp Rate in use (xxx CURRENT RAMP RATE)	Facility ramp rate currently being used.
16	MW	Analogue Input	AGC Basepoint MW Received (XXX BASEPOINT MEGAWATTS)	Feed Back of the "AGC Basepoint MW Set point".
17	On/Off	Digital Input	Facility online status	An indication that the facility is connected to the Western Power transmission grid. This can be as simple as a single telemetered circuit breaker on/off indication, or a more complex calculation of breakers and switches for situations where the generating unit may be connected to more than one bus. For the latter, the calculation is normally performed in the XA/21 master station based on available breaker/switch telemetry.

Outputs (DCS to RTU), Facility to master station				
18	On/Off	Digital Input	AGC Control Status (XXX AGC CONTROL SELECTION)	An indication from the facility that it is available for AGC control. In this mode the facility will received the 4 seconds "Facility Desired MW Set point" and must respond to this signal correspondingly.
19		Digital Input	RTU to DCS Comms Watchdog (XXX DCS COMMS LINK FAIL)	This bit is sent from the DCS for the alarming on the status of the communications link.
20		Digital Input	DCS Internal Communications Fail	An indication of any internal communication failure. Facility should set the AGC Control Status to "Off" and take control of the facility.

Important notes:

- The above requirements describe the additional signals required for Facilities in addition to those required by AEMO and the Network Operator for connection to the SWIS. For new Facilities connecting to the grid, these signals need to be added to the standard connection signalling requirement if the unit is to be commissioned for AGC/ABC.
- Dispatch Instructions are re-estimated internally every minute, therefore it is possible for the Lookahead 2 and Lookahead 3 values to change each minute before being locked in as an actual Dispatch Instruction value. These values should be used for information only.
- The Load Following High and Low limits are calculated based on cleared market information in the BMO and LFMO and the expectation is that the Facility is fully capable of running within these limits. However, it is required that the Facility implement any additional logic internally that may be required to prevent any potential equipment damage or other implications from arising when running in AGC mode.
- Some signals listed above may already be available due to previous commissioning activities, where possible existing signals will be re-used.

All signals required for control under AGC (Load Following) need to be scanned at a fast rate, at a minimum of 4 seconds.



3. AUTOMATIC BALANCING AND LOAD FOLLOWING THROUGH AGC

This section describes the modes that AGC can operate in, and how these modes are used when a facility is operating in the balancing market or providing Load Following Ancillary Services. This section applies for Scheduled Generators only.

3.1 Participation modes

The primary signals used by AGC are:

- Desired megawatts (MW) Set point.
- AGC Control Status.
- AGC Mode Indication.

AGC is the common mechanism for providing the signalling for both Automatic Balancing and Load Following Services. Under AGC control, the facility can either be in Automatic Balancing or Load Following Mode.

The important distinction between ABC and LFAS is that while AGC is actively controlling the facility when providing LFAS, ABC is only providing a representation of a Dispatch Instruction and an acknowledgement mechanism.

The AGC Control Status indicator is set by the Facility locally and determines whether the facility is participating in either Automatic Balancing or Load Following. If this is “Off”, the facility is under local (facility) control and AGC will be disabled.

In addition to the AGC Control Status indicator, which is driven from the facility end, AEMO sends an AGC Mode Indication point which indicates to the facility whether AGC is actively sending balancing or load following signals. This is an analogue signal representing a matrix of possible AGC modes.

Table 4 shows the possible values for this signal. When actively providing Load Following, AGC will be in “Base Full” mode (value 120), and when in Automatic Balancing mode, AGC will be in “Base None” mode (value 90). If AGC is in Manual mode (value 80), it will no longer be actively sending Desired MW signals and control will need to be transferred back to the facility.

The other AGC modes are not actively used for Automatic Balancing or Load Following, and are provided here for completeness only.

Table 4 AGC control and participation mode

Control mode / Participation mode	Full	Regulation	Assist	None
Econ	200	180	190	170
Ramp	160	140	150	130
Base	120	100	110	90
Manual	80	N.A	N.A	N.A
Available	40	N.A	N.A	N.A
Unavailable	20	N.A	N.A	N.A



3.2 Automatic balancing

The following set points are sent to the Facility every minute, regardless of whether the Facility is actively providing LFAS or not:

- Look Ahead Dispatch Instruction (DI) MW Set point.
- Look Ahead DI Ramp Rate Set point.
- Look Ahead 2 MW Set point.
- Look Ahead 3 MW Set point.
- LFAS High Operating Limit Set point.
- LFAS Low Operating Limit Set point.
- Facility Desired Rate Set point.

The following setpoints are sent to the Facility every 30 seconds:

- AGC Control Mode Indication (see Table 4).
- Actual MW Set point.
- AGC Basepoint Set point.

The desired MW Set point is sent every 4 seconds if in AGC (LFAS or ABC), and every 30 seconds if unit in MANUAL.

The Look Ahead DI MW and the Look Ahead DI Ramp Rate are the Target MW and Ramp Rate that the facility is expected to receive **300 seconds (5 minutes)** ahead of the current time, and represent the actual issued Dispatch Instruction. The expectation is that the Facility will **commence ramping 5 minutes after** the look ahead is received at the specified ramp rate, until it achieves the specified MW value. In terms of equivalent information to the formal Dispatch Instruction:

- Target MW = Look Ahead DI MW.
- Ramp Rate = Look Ahead DI Ramp Rate.
- Start Time = Time the step change is received + 5 minutes.

When under automatic balancing, the High Operating Limit and Low Operating Limit are set to be the same as the Desired MW Set point. This ensures AGC can only send signals that match the current Dispatch Instruction.

The Facility is required to send the following information back to AEMO for the purposes of Dispatch Instruction acknowledgement:

- Facility Received DI MW = Positive confirmation that the Facility has received the required Dispatch Instruction target MW.
- Facility Received DI Ramp Rate = Positive confirmation that the Facility has received the required Dispatch Instruction ramp rate.
- Maximum Operating Limit MW = indication of the current maximum possible output for the Facility.
- Unit Ramp Rate Up = indication of the current maximum possible ramp up rate for the Facility.
- Unit Ramp Rate Down = indication of the current maximum possible ramp down rate for the Facility.



A step change in the Look Ahead DI MW Set point (5-minute) indicates a new Dispatch Instruction (according to a normal Dispatch Instruction). The Market System will auto-acknowledge the DI 4 minutes and 30 seconds before the DI start time if it is equal or less than the unit telemetered “Maximum Operating Limit Megawatts” and “Unit Ramp Rate Up”.

If the “AGC control Status” is set to “On”, the EMS will set the Facility under AGC control (“Base None” mode in AGC). The facility will continue to receive the real-time Desired MW Set point signal which is indicating the current Dispatch Instruction. The Facility may opt to either manually or automatically control the unit to this Desired MW Set Point (this is an electronic representation of a Dispatch Instruction).

The frequency of the Look Ahead DI 2 and 3 can be configured separately for individual Facilities and can be used by the Facility for whatever purpose they need (for example, just for information, or for automatically starting and stopping a unit). The Facility need not acknowledge these Look Aheads.

3.3 Facility providing LFAS through AGC

If the facility is cleared for LFAS, the “Facility Desired MW” set point (sent every 4 seconds when actively providing LFAS) will be frequently changing within the Facility LFAS High and Low Operating Limits to compensate for the changes in the frequency. Frequent changes on the “Facility Desired MW” set point indicate that the unit is performing frequency control.

Also, the “Facility LFAS High Operating Limit” and “Facility LFAS Low Operating Limit” set point (normally set to match the Facility Desired MW when not providing LFAS) would be modified to match the cleared LFAS quantities for the Facility. A quick response is required in this mode, hence the facility should ignore the “Facility Desired Ramp Rate” set point and instead use the facility maximum ramp rate to respond to the “Facility Desired MW” set point. (The logic in the DCS should be able to use either the Operating Limits to check if the unit is in load following, or the AGC Mode Indication to select the correct ramp rate to use. See section 4.3).

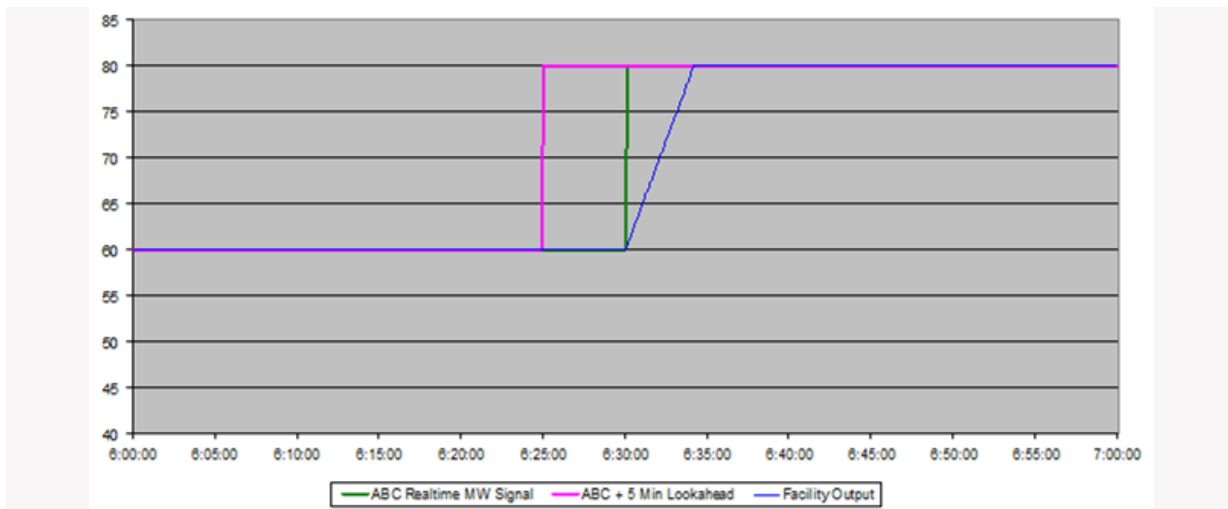
3.4 Facility response to a DI through ABC

If the Facility is doing Automatic Balancing Control, the “Facility Desired MW” set point would vary in step changes to reflect new Dispatch Instructions rather than individual small changes. The Facility should be able to move to this new Sent Out MW output at the rate sent through the “Facility Desired Ramp Rate” set point, either Manually or Automatically (this is an electronic representation of a Dispatch Instruction).

Aside from seeing a step change on the “Facility Desired MW” set point, the “High Operating Limit” and the “Low Operating Limit” sent to the Facility will also be equal to the “Facility Desired MW” set point to indicate the facility is not providing frequency control.

This is illustrated in Figure 1 below. In this example, the current Dispatch Instruction is 60 MW and a new Dispatch Instruction for 80 MW is due to commence at 06:30. The 5-minute Dispatch Instruction Look Ahead would come in 5 minutes before the required ramping time (in this case 06:25) as a separate signal with a step change, then, at the required ramp time, the facility would be expected to commence ramping up to the new required value at the specified ramp rate (see the blue line). The green line indicates the “current” Dispatch Instruction target MW.

Figure 1 Illustration of 5-minute DI look ahead



3.5 Load following scenarios

The scenarios below illustrate how the SCADA signals vary when a Facility is actively providing LFAS.

3.5.1 Scenario one

Figure 2 below shows underlying dispatch instructions (60 MW for the first interval and 70 MW for the next interval). The ramp rate for this example is 6 MW/min.

Figure 2 Underlying increasing DI

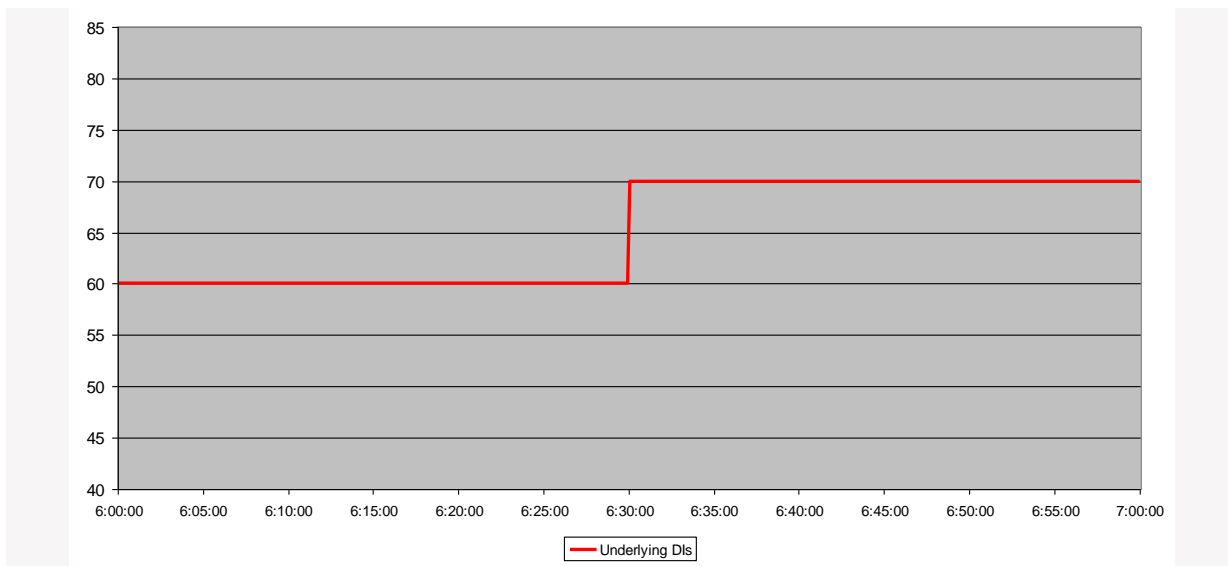
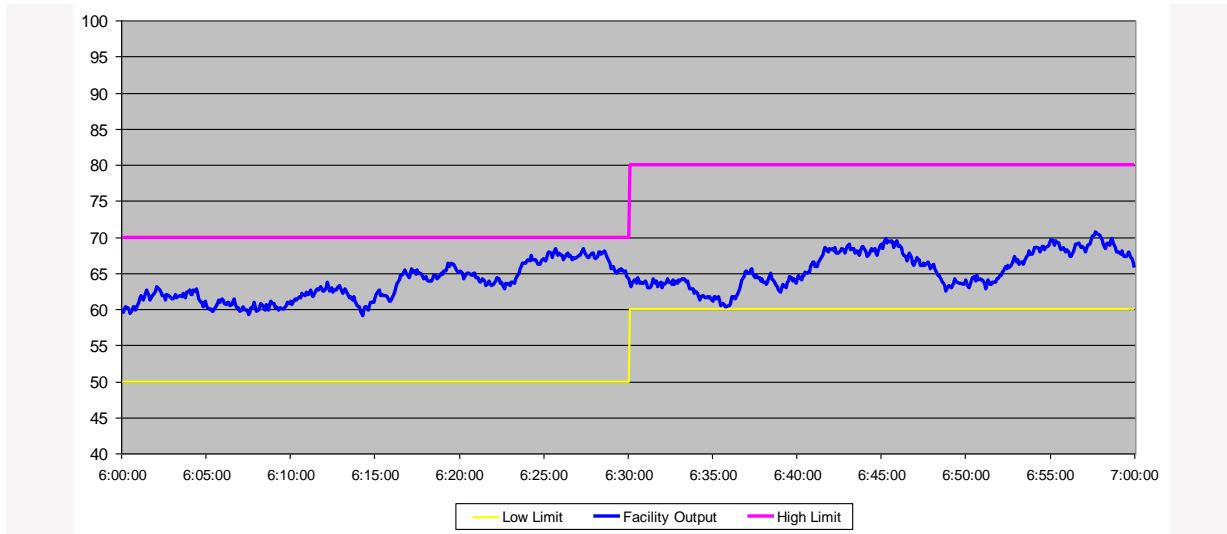


Figure 3 shows that, if the unit were on AGC providing load following support with (for example) a +/-10 MW range, AGC would automatically move the facility every 4 seconds within these limits based on what the frequency is doing. At the time the new DI is issued, The Low and High operating limits are recalculated and there would be a step change of the AGC high and low Operating limits relative to the new DI.

Figure 3 Movement of limits to align with increasing DI



3.5.2 Scenario 4

Figure 4 below shows underlying reducing DI (70 MW for the first interval and 60 MW for the next interval). The ramp rate for this example is 6 MW/min.

Figure 4 Underlying decreasing DI

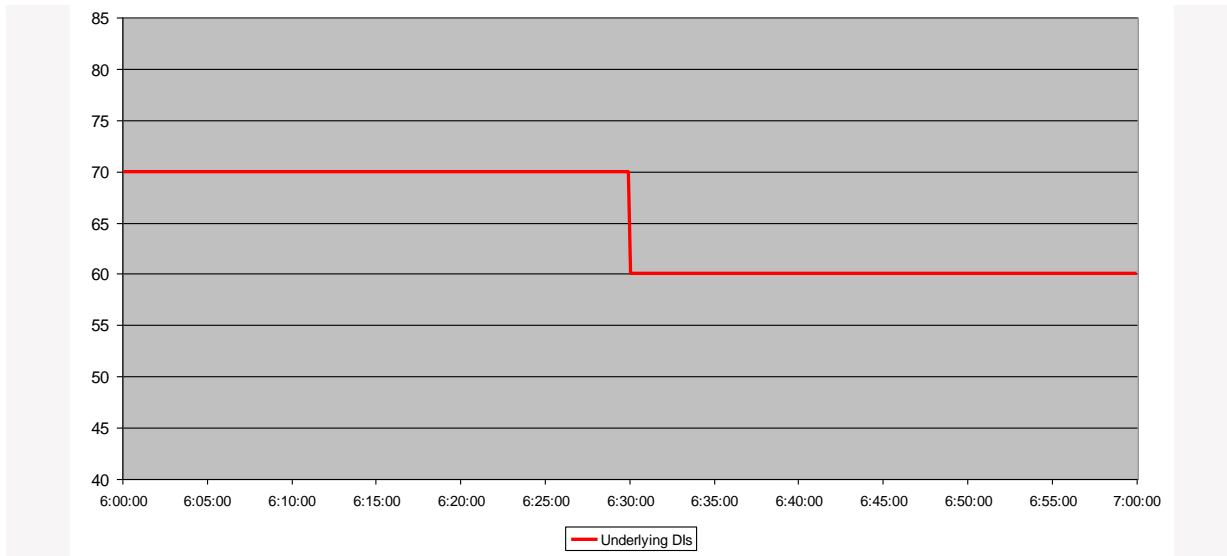
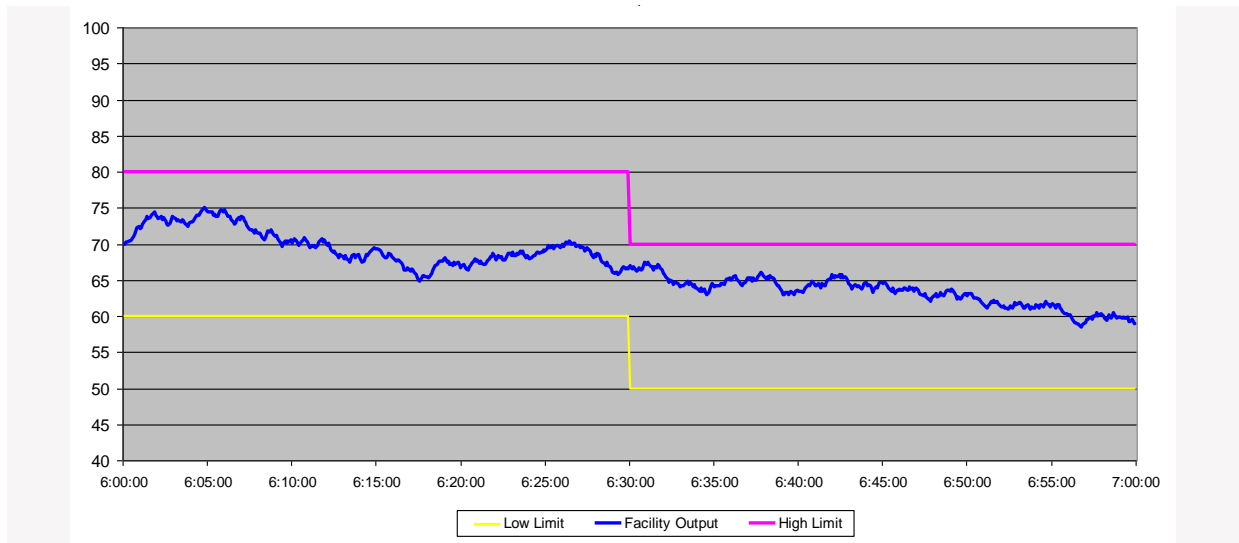


Figure 5 shows that, if the unit were on AGC providing load following support with (for example) a +/-10 MW range, AGC would automatically move the facility every 4 seconds within these limits based on what the frequency is doing. At the time the new DI is issued, the Low and High operating limits are recalculated and there would be a step change of the AGC High and Low Operating limits relative to the new DI.



Figure 5 Movement of limits to align with decreasing DI





4. FACILITY DCS DESIGN CONSIDERATIONS

This section describes logic that Scheduled Generators may be required to implement.

4.1 Desired MW set point with multiple generating units

This is particularly critical for units participating in load following. The on-site logic must be designed to manage the Desired MW requirement across the available online units. The algorithm for this is Facility-dependent, however this re-allocation of Desired MW should be done without introducing any sizeable inherent delay to the process, so as not to impact on the performance of AGC.

The Facility must be able to follow a linear ramp rate at a constant ramp rate in order to be capable of providing LFAS.

The facility must demonstrate that it can respond to a change in Desired MW by commencing ramping within 5 seconds of receipt of the signal (as per the Power System Operating Procedure – Ancillary Services). See section 5 below for testing requirements.

4.2 Dispatch instruction acknowledgement

Dispatch instructions for units in ABC are automatically acknowledged by the Market System if the Dispatch instruction Target MW and Ramp Rate are less than or equal to the telemetered Maximum Operating Megawatts and Ramp Rate.

4.3 Ramp rates

The Facility DCS should respond to the AGC “Facility Desired MW” set point using the “DI Ramp Rate” set point if the Facility is only participating in balancing:

- AGC Mode Indication = 90.
- Facility Desired MW set point = Facility LFAS High and Low Operating Limit set point.

The Facility DCS logic must be able to respond to the “Facility Desired MW Set point” using the facility ramp rate if the Facility is participating in load following:

- AGC Mode Indication = 120.
- Facility Desired MW set point equal high operating limit and not equal to the Low operating limit (load following in the DOWN direction only).
- Facility Desired MW set point equal low operating limit and not equal to high operating limit (load following in UP direction only).
- Facility Desired MW set point not equal to high and low operating limit (load following in both directions).

4.4 AGC or SCADA (communications) failure

For the loss of SCADA or communications between AEMO’s EMS and the Facility, the Facility DCS should trip the AGC Control Status back to local until the communications have been re-established with AEMO. During this period, the Facility will be under local control.

For an internal failure of AGC, or if there are repeated control or response failures between AGC and the Facility, AGC will automatically switch back to “Manual” mode (AGC Mode Indication = 80).

If the AGC goes into “Manual” mode, there should be a 40-second delay before the Facility take local control. This prevents the unit going back into “Local” control due to short communication glitches.



4.5 Feedback

Required feedback points are described in the SCADA IO List requirement in Table 3.

4.6 AGC control selection

The “AGC Control Status” Point is set at the Facility end by the Participant.

If the “AGC Control Status” is set to “On”, the Facility control system should prepare to receive the 4 seconds “Facility Desired MW” set point and associated Dispatch Instruction values from AEMO.

If the “AGC Control Status” is set to “Off”, the Facility is considered to be under local control and should ignore the “Facility Desired MW” set point. Also, a calculation function in the EMS will update the Facility Desired MW set point periodically to equal the Generator’s current MW output every 30 seconds, even though this set point will be ignored by the Facility DCS.

4.7 Starting and stopping individual generating units

It is assumed that the Facility will have enough generating units online and synchronised to meet the requirements of any balancing Dispatch Instructions or load following commands received (Desired MW and ramp rate).

Given the delay in starting (and possibly stopping) individual generating units, it follows that the Facility would need to be made aware of its requirements to run ahead of time. Where this information is not available in advance, or if the Facility is to be unmanned and/or automatically controlled, the use of Look Ahead set points is available.

The EMS interface is configured to transmit additional Look Ahead set points – “Look Ahead basepoint 2” or “Look Ahead basepoint 3” – which represent the Dispatch Instruction Target MW values at some point(s) in the future, as interpreted from the current dispatch forecast. The Look Ahead values may be used by the Facility DCS to determine when to start and stop generating plant to match required future dispatch instructions.

Take, as an example, a Facility with a number of gas turbines each having an 8-minute start cycle. The EMS master station interface could be configured to send:

- A Desired MW set point (current dispatch instruction target) and Required Ramp Rate.
- A 5-minute Dispatch Instruction set point (and ramp rate).
- A 10-minute look ahead set point (used to start GTs so that they are online when required).
- A 30-minute look ahead (as information to plant operators, etc).

So, at an arbitrary time $t=7:50\text{am}$:

- The Desired MW set point would contain the dispatch instruction target MW for 07:50.
- The required Ramp Rate to achieve the desired MW target.
- The 5-minute Look Ahead set point would not yet contain the dispatch instruction target MW for 08:00 (as it has not yet been issued), but would still show the active dispatch instruction for 07:55.
- The 10-minute Look Ahead set point would contain the currently ‘scheduled’ dispatch instruction target MW for 08:00 (based on the best information available at 07:50). This would show a step change for 08.00 if a new DI is required. The DI itself will be locked in at 07:55:00 via the 5-minute Look Ahead, and acknowledged at 07:55:30.
- The 30-minute Look Ahead set point would contain the currently ‘scheduled’ dispatch instruction target MW for 08:20 (based on the best information available at 07:50).



5. NON-SCHEDULED GENERATOR ABC IMPLEMENTATION

This section describes the SCADA signals and logic required for Non-scheduled Generators that wish to receive Dispatch Instructions via SCADA and have Dispatch Instructions automatically acknowledged. This section also includes additional signals that are required if the Facility is operating under a Generator Interim Access (GIA) Network Control Service (NCS) contract.

5.1 Non-scheduled Generator interface signalling⁵

Table 5 describes the SCADA signals that AEMO will send to Non-scheduled Generators for the purpose of issuing Dispatch Instructions or Operating Instructions.

Table 5 NSG SCADA ABC IO List requirement

(RTU to DCS) Master Station to Facility					
Item no	Units	Signal	Minimum scan rate ⁶	Signal description	Comment
1	MW	Analogue Output	4 seconds	Facility Desired MW Setpoint (XXX DESIRED MEGAWATTS)	Target MW Setpoint. This is the facility SENT OUT MW dispatch, facility must be able to work out the corresponding facility gross MW. This signal indicates either the current Dispatch Instruction target MW, or the current Operating Instruction target MW (if the NCS Flag is On)
2	MW/Min	Analogue Output	4 seconds	Facility Desired Ramp Rate Setpoint (XXX DESIRED RAMP RATE)	This is the Facility Instruction Required Ramp rate sent to the facility. If the NCS flag is on, this is the Operating Instruction ramp rate. If the NCS flag is Off, this is the Dispatch Instruction ramp rate.
3	On/Off	Digital Output	4 seconds	NCS Flag (XXX NCS FLAG)	NCS Control Flag 0 - Off NCS Flag Not Set 1 - On NCS Flag Set This is required if the unit is a GIA generator

Table 6 describes the SCADA signals that AEMO requires from Non-scheduled Generators for the purpose of acknowledging Dispatch Instructions.

Table 6 NSG SCADA Output List requirement

(DCS to RTU) Facility to Master Station					
Item no	Units	Signal	Minimum scan rate	Signal description	Comment
1	MW	Analogue Input	4 seconds	Facility Net MW (XXX NETT MEGAWATTS)	An instantaneous measure of the SENT OUT MW loading level of the facility.
2	MW	Analogue Input	4 seconds	Facility Received Desired MW (XXX DESIRED MEGAWATTS)	Feed Back of the "Facility Desired MW Setpoint".

⁵ Any variations from these requirements need to be agreed in writing by AEMO.

⁶ This reflects the slowest scan rate.



(DCS to RTU) Facility to Master Station					
3	MW/Min	Analogue Input	4 seconds	Facility Received Ramp Rate (XXX DESIRED RAMP RATE)	Feed Back of the "Facility Desired Ramp Rate Setpoint"
4	MW	Analogue Input	4 seconds	Maximum Operating Limit Megawatts (XXX MAX OPERATING LIMIT MEGAWATTS)	Maximum available capacity for dispatch for the facility at the moment (Used for auto-acknowledgement).
5	MW	Analogue Input	4 seconds	Minimum Operating Limit Megawatts (XXX MIN OPERATING LIMIT MEGAWATTS)	Minimum available capacity for dispatch for the facility at the moment (Used for auto-acknowledgement).
6	MW/Min	Analogue Input	4 seconds	Maximum Ramp Rate Capability (XXX MAX RAMP RATE)	Facility Maximum Ramp Rate capability. (Used for auto-acknowledgement)
7	MW/Min	Analogue Input	4 seconds	Ramp Rate in Use (XXX RAMP RATE IN USE)	Current ramp rate used by the facility.
8	On/Off	Digital Input		Local/Remote Status (XXX CONTROL SELECTION)	An indication from the facility that it is available for ABC control.
9	On/Off	Digital Input		NCS Flag (XXX NCS FLAG)	Return Indication of the NCS flag digital control 0 - Off NCS Flag Not Set 1 - On NCS Flag Set This is required if the unit is a GIA generator

Important notes:

- The above requirement describes the additional signals required for Facilities in addition to those required by AEMO and the Network Operator for connection to the SWIS. For new facilities connecting to the SWIS these signals needs to be added to the standard connection signalling requirement if the unit is to be commissioned for ABC.
- For Non-Scheduled Generators, the Facility Desired MW set point specifies a “maximum” quantity that the Facility is required to operate under (in Sent-out MW). I.e. this value represents a cap on the operation of the facility.
- If the Facility is participating under a GIA NCS contract, the Facility Desired MW will indicate **either** the current Dispatch Instruction maximum allowable MW, or the relevant Operating Instruction maximum allowable MW, depending on whether the NCS flag is True or False (True = OI, False = DI).

5.2 NSG ABC operation

- The Facility should have a local/remote switch that allows the facility to be selected for remote or local control. This is set at the Facility end by the participant.
- When selected to Remote control, the Facility should prepare to receive the Facility Desired MW and Facility Desired Ramp Rate set point that the SCADA/EMS is sending. The Facility Desired MW set point and Facility Desired Ramp Rate set point matches the current Dispatch Instruction, however can also be used to represent the current Operating Instruction where the facility is participating under a GIA NCS contract.



- Facility Desired MW set points will vary in step changes in a similar way to that for Scheduled Generators as shown previously. When an NSG Facility receives a step change in the Facility Desired MW set point, it is expected to commence ramping at the specified ramp rate within 5 seconds to ensure it moves below the specified MW value.
- The automatic sending of setpoint scheme will send the Facility Desired MW and the Facility Desired Ramp Rate setpoint on a step change of a Dispatch/Operating Instruction, and will continuously send it every 4 seconds until the difference between the Facility Desired MW and the Facility Received Desired MW is within a tolerance (set at .5 MW).
- When the local/remote switch is selected to Local Control, the Facility is considered to be under local control and should ignore the “Facility Desired MW” set point.
- For GIA Generators, an NCS flag Digital signal is sent to the Facility to indicate the type of dispatch sent (DI/OI)⁷.

5.3 SCADA Communication failure.

In case of a communication failure, the facility should retain the last valid set points. The current implementation does not require automatic switching of the Facility from Remote to Local in case of a communication failure, and will automatically re-commence Dispatch Instruction/Operating Instruction sending upon re-establishment of the communications link.

5.4 Dispatch instruction acknowledgement

Dispatch Instructions for Non-Scheduled Generator units in ABC are automatically acknowledged within 30 seconds if the Facility Received Desired MW and Facility Received Ramp Rate match the desired values, and the Dispatch instruction Target MW and Ramp Rate is less than or equal to the telemetered Maximum Operating Megawatts and Ramp Rate.

Operating Instructions for Non-scheduled Generator units in ABC are automatically acknowledged within 30 seconds if the Facility Received Desired MW Operating instruction Target MW is less than or equal to the telemetered Maximum Operating Megawatts.

5.5 Implementation of desired ramp rate

Facilities may be required to implement logic to manage the output of multiple devices in order to meet the aggregate facility ramp rate requirement for the Dispatch Instruction.

⁷ When operating under a GIA NCS contract, the facility may be required to implement additional logic as specified under the NCS contract when this flag is True.



6. TESTING AND COMMISSIONING

To prove that the signalling is working correctly and the Facility is responding correctly to the AGC signals, the following suite of tests need to be conducted:

6.1 Automatic balancing testing

Automatic Balancing requires the following testing:

- The signals in the tables in Section 2 are all functioning and scanning correctly.
- A step change in the Look Ahead DI MW Set point is picked up at the facility end as a new Dispatch Instruction, and two Acknowledgement signals are received for the Target MW and Ramp Rate.
- When the Desired MW Set point makes a step change, the Facility commences ramping at the Desired Ramp Rate and stops ramping when the Desired MW is achieved (in SENT OUT MW terms).
- When the AGC Control Mode is switched to local, the Facility ignores Desired MW signals from AGC and can be controlled locally.
- When there is a communication failure, the Facility should automatically trip to local.
- When the AGC Mode goes to Manual, the facility should automatically trip to local.
- Other Facility-specific testing that may be required to prove automation at the Facility end (such as automatic starting/stopping of units).

6.2 Load following testing

Proving Load Following capability is more onerous than proving Automatic Balancing, primarily due to the signal timing requirements and response time requirements. The following tests are required:

- The signals in the table in Section 2 must all be fully commissioned, functioning, and scanning correctly.
- Prove that the Facility is capable of responding to a step change in Desired MW by commencing ramping within 5 seconds.
- For each available LFAS range being tested, prove the Facility is able to achieve continuously the minimum ramp rate required. This will be demonstrated by AEMO implementing a MW step change equal to the full MW range and observing that the facility ramps continuously at no less than the minimum ramp rate required for that MW range (until the Facility achieves the full MW change required). Several tests of this nature may be done to confirm consistent results (including in both the positive and negative directions).
 - LFAS ranges are determined by the available ramp rate.
 - For example, the Ancillary Services Power System Operating Procedure (PSOP) specifies a minimum ramp rate of 0.2 MW/min for each MW of the available LFAS range, so a facility with a ramp rate of 5 MW/min would have a maximum LFAS range of 25 MW.
- Prove for a communications failure (such as RTU failure) the Facility automatically trips back to local control and no longer responds to AGC MW set points.
- Prove for an internal AGC failure, where the AGC control mode is returned to Manual, the Facility automatically trips back to local control and no longer responds to AGC MW set points.
- Leave the Facility actively running under AGC and actively responding to frequency variations for a period of 6 hours without material failures (such as unit trips or inadequate response times).



6.3 NSG ABC testing

Automatic Balancing requires the following testing:

- The signals in the table in Section 5 are all functioning and scanning correctly.
- When Facility Desired MW and Desired Ramp Rate set points are issued, the appropriate return values are received.
- When the Desired MW Set point makes a step change, the Facility commences ramping at the Desired Ramp Rate within 5 seconds and stops ramping when the Desired MW is achieved (in SENT OUT MW terms).
- The facility is capable of responding to different desired ramp rate values.
- When the Local/Remote is switched to local, the Facility ignores Desired MW signals from the AEMO EMS and can be controlled locally.
- Other Facility-specific testing that may be required to prove automation at the facility end.
- Other Facility-specific testing that may be required to prove operation under an NCS contract.