Independent Market Operator

SM Procedure Change and Development Group

Agenda

Meeting No.	1
Location:	IMO Boardroom Level 22, The Forest Centre, 221 St Georges Terrace, Perth
Date:	Monday 23rd July 2007
Time:	Commencing at 2.00pm to 4.00pm

Members		
Murray Caston	System Management (Chair)	
Rachael Smith	Alinta Ltd	
Shane Cremin	The Griffin Group	
Yin Heng	Perth Energy	
Bill Bowyer	Renewable Power Ventures	
Jason Walters	Verve Energy	
Jenni Conroy	Synergy Energy	
Alistair Butcher	System Management	
Dora Guzeleva	IMO	

Item	Subject	Responsible	Time
1.	**WELCOME AND APOLOGIES / ATTENDANCE**	**Chair**	5 min
2.	**OPERATIONAL DATA POINTS FOR GENERATORS** A draft Power System Operating Procedure has been circulated and workgroup members are invited to express their views on this procedure.	**SM**	45 min

Item	Subject	Responsible	Time
3.	**SYSTEM RESTART OVERVIEW** A draft System Restart Overview procedure has been circulated and workgroup members are invited to express their views on this procedure.	**SM**	45 min
4.	**OTHER MATTERS** Other matters will be considered on a case by case basis		20min
5.	**NEXT MEETING** Next System Management Procedure Change and Development workgroup meeting to be scheduled	**Chair**	5min

POWER SYSTEM OPERATING PROCEDURE: OPERATIONAL DATA POINTS FOR GENERATING PLANT

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Document release information

Document number	DMS# 3296759
Document title	Power System Operating Procedure: Operational Data Points for Generating Plant
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Table of contents

1. Introduction

Clause 2.35.4 of the Wholesale Electricity Market Rules (**WEM Rules**) requires that System Management (**SM**) document the communication and control system requirements needed to support the dispatch process. System Management has done so in the Power System Operating Procedure: Communications and Control Systems.

The purpose of this Power System Operating Procedure is to specify the SM requirements for the operational data points to be transmitted through the SCADA Operational Interface between generating plant connected to the South West interconnected system (**SWIS**) and the Western Power Networks (**WPN**) Control Centre at the East Perth (**EPCC**). It does not specify the requirements for the operational data points to be transmitted through the SCADA Operational Interface between WPN owned and operated Transmission and Distribution elements of the SWIS network and the EPCC. Nor does it specify the performance requirements for the SCADA Operational Interfaces.

This document discusses the factors that influence the requirements and how they are to be applied to the specific types of generators connected to the system. The requirements are summarised in the spreadsheet tables attached to this document.

This Power System Operating Procedure is additional, and complementary, to the Power System Operating Procedure: Communications and Control Systems. To the extent of any inconsistency, this Power System Operating Procedure applies.

1.1 Associated Procedures

Power System Operating Procedure: Communications and Control Systems.

2. Generators in the WEM

Registration requirements are covered in clauses 2.29 and 2.28 of the WEM Rules. Any person who owns, controls, or operates a generation system who wishes to participate in the WEM is required to register as a Rule Participant in the class of Market Generator. A Market Generator who owns, controls, or operates generation system is, depending on the size of the plant and whether or not it is intermittent generation, also required to register as a Scheduled or Non- Scheduled Generator.

Intermittent Generators with a rated capacity equal to or exceeding 0.005 MW must register as Non-Scheduled Generators.

Non – Intermittent Generators with a rated capacity equal to or exceeding 0.005 MW and less than 0.2 MW must register as Non-Scheduled Generators.

Non – Intermittent Generators with a rated capacity equal to or exceeding 0.2 MW and less than 10MW may register as Non –Scheduled Generators OR as Scheduled Generators.

Non – Intermittent Generators with a rated capacity equal to or exceeding 10 MW must register as Scheduled Generators.

The Market Rules allow some discretion to be taken by the Independent Market Operator (**IMO**) in determining the need to register a Market Generator where the generation system was not expected to export or import more than 10 MW average in a Trading Interval, and where System Management has determined that it does not require information about the generation system to maintain Power System Security and Reliability. This provision would be most applicable to embedded generation.

Market Generators can be connected at Transmission or Distribution level however it is expected that larger generators will be connected at Transmission level.

Although provision is made for generators to be given conditional exemption from registration any plant connected to the SWIS will have an impact on system security and these operational data point requirements have been developed for all generators connected to the SWIS. In the case of generators who have gained exemption from Registration as a Market Generator they are to be assumed to be Non-Scheduled Generators.

3. Network Access for Generators

All generating plant that requires access to the SWIS must have an Access Agreement with WPN. The Monitoring and Control Requirements for the connection of generators to the SWIS Network are set out in section 3.3.5 of the Technical Rules.

The Technical Rules require the owners/operators of generating plant connected to the SWIS to provide Remote Monitoring Equipment (**RME**) to enable SM to remotely monitor operation of a generating unit where this is necessary in real time for control, planning, or security of the SWIS.

Whilst the purpose of this document is to specify the operational data point requirements that SM considers reasonable to enable it to comply with its obligations under the WEM Rules. However, due to the differences between different generating systems, the list of requirements shown in the attached spreadsheet tables is not exhaustive. Depending upon the type of generating plant involved, a specific list of requirements shall be developed and agreed upon in discussion with the owner/operator of the generating plant and shall be specified in the relevant Access Agreement.

4. Types of Generation Facilities

The requirements detailed in this document shall apply to all types of generating plant that are likely to be connected to the SWIS including :

- Intermittent Generating Systems with a large number of small units
- Conventional Steam Turbine Generators
- Open Cycle Gas Turbine Generators
- Combined Cycle Gas Turbine Generators with associated Steam turbine Generators
- Generators that are part of a co-generation facility

- Biomass Generators
- Landfill Gas Generators

Both generating plant connected at transmission network level and generating plant connected at distribution network level are included. These requirements shall apply to all generating plant that is connected at transmission network level and to all generating plant, with a rated capacity equal to or exceeding 1 MW, that is connected at distribution network level. Note that where the generator is connected within a plant and supplies local load at distribution level voltages, but is connected to the SWIS at transmission level, these generators are considered as being connected at transmission level.

5. Aggregation of Facilities

Clause 2.30 of the WEM Rules covers the requirements for the aggregation of generating facilities.

In the case of Non-intermittent Generators where the facilities have been aggregated in accordance with clause 2.30 of the WEM Rules the requirements detailed in the document shall apply to individual generators within the facility.

Note that clause 2.30 of the WEM Rules specifically excludes Intermittent Generators including wind farms from registering individual units as individual facilities. In the case of Intermittent Generators the requirements detailed in this document shall apply to the aggregated facility.

6. Boundaries of Responsibility

The level of operational data to be interfaced with the SCADA will depend upon how the generating plant involved is to be operated. In most cases it is expected that the generating plant will be operated from a 24 per hour 7 day per week attended generator control facility. However in some cases the owner/operator of the generating plant may include in the Access Agreement provision for the generating plant to be remotely operated, outside normal business hours, by SM from the EPCC.

To enable SM to monitor the operating state of generators connected to the SWIS, the Generator shall provide real time operational data points from the generators to interface through the SCADA Operational Interface with WPN SCADA Remote Terminal Units (**RTU**) in the adjacent WPN Substation. The operational data points shall be transmitted between the WPN Substation SCADA RTU and the WPN SCADA Master Station at the EPCC. At the EPCC the operational data points shall be interfaced with the SM SCADA operational displays that will provide operational information similar to that provided on the generating plant operational displays.

For generating units where the owner/operator has agreed that SM will remotely operate the plant, the operational data points shall provide the same level of control and monitoring that is provided to a local operator. Where appropriate remotely operated unit alarms requiring SM to take the same action shall be grouped.

Where SM has the provision to transmit desired set point levels to the generating plant the operational data points shall include separate feedback data points to enable the actual operating set point level to be monitored independently of the desired level.

7. Generation Dispatch

Generation Dispatch requirements in the WEM are governed by chapter 7 of the WEM and the Dispatch Rules and Procedures issued by SM.

A Market Generator subject to the dispatch process shall provide a mechanism for the sending, receiving, and acknowledgement of Dispatch Instructions, Dispatch Advisories, changes to the Rated Capacity, and Outage Plans relating to the generating system concerned.

The generating plant shall also be interfaced with the System Management Market Information Technology System (**SMMITS**).

In the case of intermittent generating systems, where SM issues a dispatch instruction (either verbally or through an automatic control system) that requires the generating system to operate below its actual capability at that time, SM may be required to provide the IMO with an estimate of the actual capacity that would have been available if the output of generating system had not been limited. This data is used by the IMO to calculate the compensation to be paid to the Intermittent Generator. In these cases the Intermittent Generator shall provide sufficient operational data points to enable SM to calculate and provide the IMO with an estimate of the actual capacity available from the generating system for the prevailing conditions. The Intermittent Generator shall include operational data points for the number of generator units available and for the critical quantities required to enable the required capacity calculations to be made (eg wind speed at the nacelle height).

Also in the case of intermittent generating systems, where the loss of integral reactive support devices causes a reduction in the permitted operating capacity of the generating system the Intermittent Generator shall include operational data points to indicate the number of reactive support devices available.

For intermittent generators with a large number of small generating units the SCADA interface does not need to monitor individual units but shall provide data points for all the units aggregated at the low voltage busbar of the step-up transformer connecting the units to the SWIS.

8. System Security

System Security requirements in the WEM are governed by chapter 3 of the WEM, section 5 of the Technical Rules, and the System Security Rules and Procedures issued by SM.

8.1 Network Analysis Facilities

In order to facilitate the monitoring and control of the security of the SWIS it is necessary for SM to analyse the operating state of the SWIS using a number

of Network Analysis facilities that are integrated with the SCADA Systems at the EPCC.

To account for the loss of incoming operational data points SM must be able to estimate the operating state of the SWIS using the State Estimation facility.

To anticipate possible operating scenarios, where the power system security limits may be breached, SM must be able to perform calculations, using Contingency Selection and Analysis facility, to determine voltage and ampere levels in the power system for a range of contingency situations. SM will, when necessary, use the results of these calculations to take appropriate pre-emptive action in order to prevent the occurrence of a breach of power system security limits.

To ensure that the elements of the power system are not subject to fault operating conditions that may exceed the switchgear fault rating SM must be able to perform Fault Level calculations as the power system configuration changes. SM, when necessary, will use the results of these calculations to reconfigure the network to ensure that the network elements are operating within their rated capacity.

The Network Analysis facilities in the SCADA require SM to be able to model operation of the power system using modelling data provided through the SMMITS interface and using real time power system operational data provided through the SCADA Operational Interface including real time operational data from generating systems. The Generator shall provide all the operational data points that are required to enable SM to model the generating plant and its connections to the SWIS.

Where the generating system is embedded into a local network the Generator shall provide operational data points for all elements in the local network that can interconnect the generation plant with the SWIS and account shall be taken of any locally connected loads.

In the case of intermittent generating systems, where the individual generating units contribute to the fault current, operational data points for the number of units available shall be provided to enable the power system model to be correctly configured.

8.2 Emergency Disconnection of Unattended Generating Systems

Section 4.3 of the Technical Rules provides for Western Power to direct that a generation system must be taken out of service and/or disconnected if it is likely to adversely affect the secure operation of the SWIS. Where a generating system does not comply with such directions within a reasonable period of time Western Power may disconnect it from the SWIS without further recourse.

It should be noted that a generator will only be disconnected as a last resort when SM have taken all reasonable measures to contact the owner/operator of the generating plant or when the owner/operator has not complied with a

reasonable request to disconnect and the secure operation of the SWIS is still being adversely affected.

Where the generating unit is to be operated unattended or may be unattended at any time the Generator shall provide operational data points to allow SM to remotely open the Generator main circuit breaker connecting the generating unit to the SWIS.

Where the generating unit is operated from a 24 hr 7 days per week attended control facility and where the connection arrangement does not include a Generator main circuit breaker, SM will implement emergency disconnection by opening the circuit breaker(s) at the point of connection in the WPN substation on the circuits through which the generator(s) are connected to the SWIS

9. Ancillary Services

Ancillary Service requirements in the WEM are governed by chapter 3 of the WEM together with the Ancillary Rules and Procedures issued by SM.

Where the generating unit is contributing to the Spinning Reserve, Load Following/Frequency Keeping, Load Rejection, and Dispatch Support Ancillary services the Generator shall provide the operational data points required to enable SM to send and receive real time operational data to and from the Automatic Generation Control (**AGC**) facility incorporated in the SCADA system at the EPCC. This shall include governor system raise/lower commands, AGC enable and disable commands, loading and unloading ramp rate commands, and target MW output, as well as “handshake” signals to ensure that the communications channels are intact.

10. Network Control Services

Network Control Service requirements in the WEM are governed by chapter 3 of the WEM.

Where the generating unit is contributing to the provision of Network Control Services the Generator shall include operational data points to enable SM to monitor and, where agreed, control the operational status of any device that is critical to the provision of these services. This shall include start and stop commands, starting/rundown in progress, Synchronous Compensator/Generator mode selection commands, Reactive Plant switching commands, Tap Changer position commands, excitation system raise/lower commands, voltage levels, and MVAr output, SVC control mode (power factor or voltage) selection and related set point commands.

In the case of intermittent generating systems where static reactive compensator devices have been provided for network voltage support operational data points for the number of devices available and the MVAr input/output to the devices shall be provided.

11. Network Protection Scheme

In some cases the connection of a generating system may, under specific generating plant and network operating conditions, cause a breach of the

security limits. In these cases the Access Agreement shall include for the provision of special network protection schemes that send and receive operational control and data signals to and from the generating systems. These signals will generally require the generating systems to either reduce output or to disconnect from the SWIS, until the network operating conditions return to normal. Such schemes will be designed and implemented in consultation with the owner/operator of the generating system.

Where the agreed access conditions includes the provision of these special network protection schemes, the SCADA operational interface shall include operational data points for the control and monitoring of the generating system. This shall include signals to control the output of the generating systems and to provide both the generating system operators and the System Management Power System Controllers with indications that these schemes have operated.

12. Compliance Monitoring

SM is required to monitor compliance of generating systems with the Scheduled Resource Plans, Dispatch Instructions and Advisories, Ancillary Service provisions, and Network Control provisions. In order to monitor compliance SM must be able to monitor the operating state of critical operational data points on all generating systems connected to the SWIS. This will normally be implemented by interfacing data points from the generating systems to a high-speed recording device.

Where it has been determined that SM will monitor the performance of the generating systems the Generators shall provide the operational data points that SM considers critical to ensuring that the generating systems are meeting their obligations under the WEM Rules. These data points shall be separate to those transmitted to the EPCC and shall normally be interfaced directly with the high-speed recording device.

13. SCADA Interface Performance

The provision of reliable, accurate and timely operating data to and from the generating systems is critical for SM to perform its role required by the WEM Rules. The Generator shall ensure that the SCADA Operational interface operates in accordance with the specified performance requirements.

The performance requirements for the SCADA Operational Interfaces are dealt with in a separate document.

14. Specified Points

The attached tables indicate the types of SCADA Operational Data points that are required. Alarm points may be provided as a single point where the points from individual devices are paralleled within the generation facility or may be provided as individual points from the individual devices and paralleled within the WPC RTU. Status points must be provided directly from the auxiliary contacts provided on the device concerned. To ensure adequate redundancy for the Security Dispatch Functions in the SCADA System all analogue points must be provided from a direct measurement of the quantities. Summated analogue values are not acceptable.

Table 1 - System Management Operational Data Points Requirements for Scheduled Generators without AGC

Point Description	Transmission Connected and 10 MW or more	Transmission Connected and less than 10 MW	Distribution Connected
Status			
All IPP facility switching devices opened/closed (isolators, earth switches, circuit breakers, etc - 2 complementary contacts ie. NO/NC pair)	√	√	√
Remote generation load control on/off	R		
Generating unit operating mode (e.g.gen/synch comp if applicable)	R		
AVR or SVC control mode (eg constant q, constant V, manual or off)	R		
Turbine control limiting operation (e.g. temp etc)	R		
Governor mode (e.g. droop/isochronous)	√		
Generating facility synchronising	√	√	√
Generator run up and run down	R		
Fuel type (e.g. liquid/gas/coal)	√		
Base/Peak mode	G		
Associated reactive plant switching devices opened/closed (isolators, circuit breakers, etc 2 complementary contacts ie NC/NO pair)	√		
Alarms			
Main circuit breaker(s) tripped by protection			√
Protection defective alarms	R		
Over/Under Excitation Limiter Operated	R		
Protective Load Shed Operated	√		
Communications Link(s) Fail	√	√	√
High/Low Severity Alarms	R		
Generator protection operated	√	√	
Step up transformer protection operated	√	√	
Associated Reactive plant protection operated	√		
Measured Values			
Gross active and reactive power output of each generating unit	√		
Nett active and reactive power output of each generating unit	√		
Net facility active and reactive power import or export at each connection point	L	L	L
Local Load and/or Unit Auxiliary active power and reactive power	L	L	L
Generating unit stator voltage	√	√	√ see note 1
Generator step-up transformer tap position	√		
Net facility output of active energy (impulse)	M	M	M
Speed of rotor as percentage of synchronous speed	R		
Reactive power flow for each associated reactive power device	√		

Point Description	Transmission Connected and 10 MW or more	Transmission Connected and less than 10 MW	Distribution Connected
Control			
Pulse or set point control of exciter	R		
Generator step-up transformer tap position	R		
Generator Start /Stop (note: separate start commands are required if unit can be started to different output levels (i.e. min, 50%, max)	R		
Generator main circuit breaker	U		
Base/Peak mode selection	R		
Associated reactive plant operating mode (power factor/voltage)	R		
Power factor and voltage set points	R		
Each reactive power device circuit breakers	R		

Note 1 : voltage on Western Power side of Main Switch
Blank cell = not required
Points with grey background are sent from WPN SCADA to the Generator
√ = required
F = If providing AGC for frequency load following ancillary service support
G = required for Gas Turbines generators only
L = required if local load or a unit auxiliary transformer is connected anywhere between the generator terminals and the point of connection
M = not required if metered
R -=required if WP contracted to provide remote control
U = required if facility unattended or if WP contracted to provide remote control

Table 1A – System Management Additional Operational Data Points Requirements for Scheduled Generators with AGC

Point Description	Transmission Connected and 10 MW or more	Transmission Connected and less than 10 MW	Distribution Connected
Automatic Generation Control (AGC)			
AGC pulse or Desired Load MW Set Point (control of the governor)	F		
Base Load MW	F		
AGC Control and Participation Mode (Assist/Full/Regulation/None)	F		
AGC Communications Link Fail Alarm	F		
AGC Control Status (Local/SOCC)	F		
High Loading limit MW value	F		
Low Loading limit MW value	F		
Ramp up rate limit MW/min value	F		
Ramp down rate limit MW/min value	F		
Governor On/Off	F		
AGC Regulation Mode (Normal/Assist)	F		
AGC Control Mode (Base/Econ/Ramp)	F		

Blank cell = not required
Points with grey background are sent from WPN SCADA to the Generator
F = required if providing AGC for frequency load following ancillary service support

Table 2 – System Management Operational Data Points Requirements for Transmission Connected Non- Scheduled Generators

Point Description	Non-Intermittent and 10 MW or more	Non-Intermittent and less 10 MW	Intermittent and 10 MW or more	Intermittent and less than 10 MW
Status				
All IPP facility switching devices opened/closed (isolators, earth switches, circuit breakers, etc – 2 complementary contacts ie. NO/NC pair)	√	√	√ See note 1	√ See note 1
Associated reactive plant Control Mode (eg power factor, voltage)	√		√	
Generating facility synchronising	√	√	√	√
Associated reactive plant switching devices opened/closed (isolators, circuit breakers, etc 2 complementary contacts ie NC/NO pair)	√		√	
Alarms				
Main switch tripped by protection		√		√ see note 1
Generator protection operated	√		√	
Step up transformer protection operated	√		√	
Associated Reactive plant protection operated	√		√	
Communications Link(s) Fail	√	√	√	√
Measured Values				
Gross active and reactive power output of each generating unit	√		See note 1	
Nett active and reactive power output of each generating unit	√		See note 1	
Net facility active and reactive power import or export at each connection point	√	√		√ see note 1
Local Load and/or Unit Auxiliary active and reactive power	L		L	
Generating unit stator voltage	√		√ see note 1	
Generator step-up transformer tap position	√		√	
Net facility output of active energy (impulse)	M	M	M	M
Wind speed data including relationship of wind to generator output			W	
Number of individual generator units available for service	√		√	
Number and rating of reactive power devices available for services	√		√	
Reactive Power flow in each reactive power device				

Point Description	Non-Intermittent and 10 MW or more	Non-Intermittent and less 10 MW	Intermittent and 10 MW or more	Intermittent and less than 10 MW
Control				
Generator Set point from special network protection schemes	S		S	
Set point control of reactive power devices (power factor and voltage)	R		R	
Generator step-up transformer tap position	R		R	
Generator Emergency Stop	√	√	√	√
Generator Main Circuit Breaker	U	U	U	U

Note 1: For intermittent generators with a large number of small generating units the SCADA interface does not need to monitor individual units but must provide data points for the aggregate of all the units
Points with grey background are sent from WPN SCADA to the Generator
Blank cell = not required
√ = required
M = not required if metered
S = required where special network protection schemes are installed
U = required if facility unattended
W = required for wind farms

Table 3 - System Management Operational Data Points Requirements for Distribution Connected Non- Scheduled Generators

Point Description	Intermittent and 1MW or more and less than 10MW (see note 1)	Non-Intermittent and 1 MW or more and less than 10MW (see note 1)
Status		
All IPP facility switching devices opened/closed (isolators, earth switches, circuit breakers, etc - 2 complementary contacts ie. NO/NC pair)	√	√
Generating facility synchronising	√ see note 2	√
Alarms		
Generating unit circuit breaker(s) tripped by protection;	√	√
Main switch tripped by protection;	√	√
Generator electrical or mechanical protection operated	√	√
Communications Link(s) Fail	√	√
Measured Values		
Gross active power output of each generating unit;	√ see note 2	√
Gross reactive power output of each generating unit;	√ see note 2	√
Net facility active power import or export at each connection point;	√ see note 2	√
Net facility reactive power import or export at each connection point;	√ see note 2	√
Voltage on Western Power Side of Main Switch voltage;	√	√
Net facility output of active energy (impulse); (not required if metered)	√ see note 2	√
Wind speed data including relationship of wind to generator output	W	
Number of individual generator units available for service	√	√
Number and rating of reactive power devices available for services	√	√
Control		
Generator circuit breaker (s) or Main Switch Intertrip	√	√
Generator circuit breakers(s) or Main Switch Close Enable Interlock	√	√

Note 1: The requirements listed may be applied to generators with a rating less than 1 MW where concerns for safety and reliability arise.
Note 2: For intermittent generators with a large number of small generating units the SCADA interface does not need to monitor individual units but must provide data points for the aggregate of all the units
Points with grey background are sent from WPN SCADA to the Generator
Blank cell = not required
√ = required
W = required for wind farms

ELECTRICITY INDUSTRY ACT

ELECTRICITY INDUSTRY (WHOLESALE ELECTRICITY
MARKET) REGULATIONS 2004

WHOLESALE ELECTRICITY MARKET RULES

Power System Operation Procedure:

System Restart Overview

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1. Purpose

Clause 3.7 of the Wholesale Electricity Market (**WEM**) Rules requires System Management (**SM**) to prepare a System Restart Plan. This document forms part of the SM System Restart Pan.

The purpose of this document is to provide Rule Participants with an overview of the System Restart Procedures, describe the actions to be taken by SM, and define the responsibilities of participants, in response to a black system condition or a major supply disruption.

2. Relevant procedures

The SM System Restart Plan consists of a number of procedures as shown in figure 1.

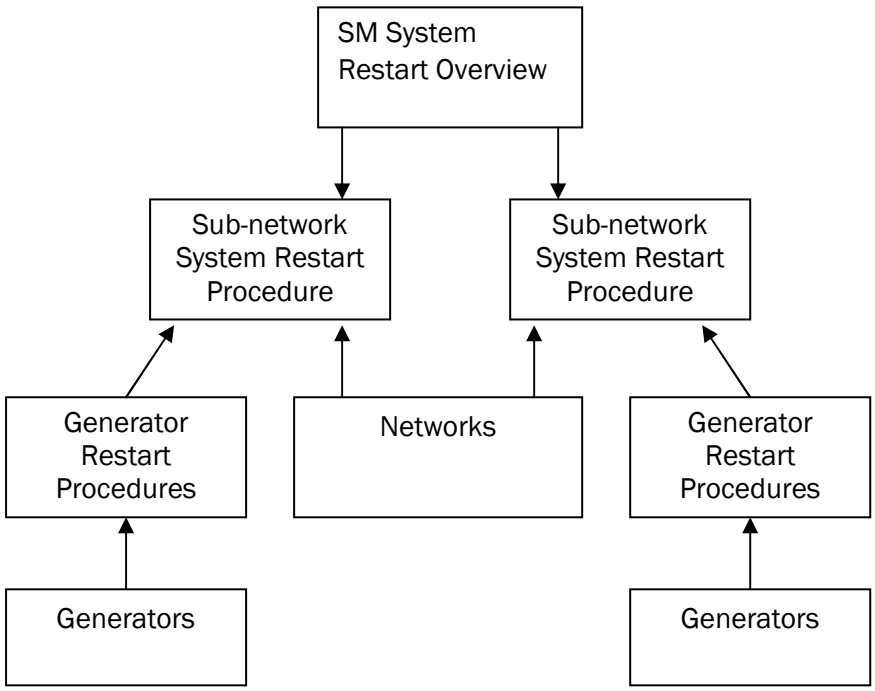

Figure 1: System Restart Procedures

2.1 SM System Restart Overview

This procedure provides a definition of a black system and describes at a high level SM's response to a black system or major system disturbance.

A major part of SM's responsibility is the operation of the WEM and this procedure provides information on how the WEM will be operated during a black system or major system disturbance.

Although the WEM Rules give SM overall authority for restoration of the power system, all participants have a responsibility to supply relevant information and assist in the restoration process. This procedure defines the areas of responsibility of the major participants including SM in its role as Market Operator (SM), SM in its role as the Transmission Network Operator (**SOCC**) and Distribution Network Operator (**NOCC**), and Generators

A major requirement necessary for a successful system restart is the provision of System Restart Ancillary Services (**SRAS**). An overview of these services is provided.

This procedure also provides an overview of system restart principles but does not provide detailed technical information relating to the restoration of generation and transmission systems in specific regions or areas. This type of information will be provided in the more detailed Local Black Start Procedures and the Sub-network System Restart Procedures.

2.2 Sub-network Restart Procedures

SM has determined that in the initial stages it will be necessary to restart separate sub-networks using the SRAS within those sub-networks. Due to the configuration of the SWIS network and the location of the generators in relation to the load centres the synchronising of these sub-networks will be a major priority. This is necessary to enable sufficient generation to be connected to match the load demand.

SM has developed a standard for SRAS that includes the criteria to be used to determine where the boundaries of the sub-networks will be. Details of this standard and how it has been applied to the South West interconnected system (**SWIS**) will be published on the SM website.

Detailed information to assist SM in understanding the likely condition and capabilities of network plant following a system shutdown or major system disturbance will be used as input into developing the Sub-network Restart Procedures. Whilst the information required by SM will be included in the SM guidelines which will be published on its website it will be sourced internally from within Western Power.

The Sub-network Restart Procedures will provide an overview of the general strategy that SM will use to restart a particular sub-network as well as the detailed steps to be followed and will be developed in conjunction with the relevant market participants. SM cannot reliably predict how a system shutdown or major system disturbance may occur or in what condition the power system will be after such an event. As a consequence the detailed plans will need to be develop to include a number of possible restart scenarios and will identify a number of possible restart methods based on the contracted SRAS generating units and other options SM considers viable.

The Sub-network Restart Procedures will be reviewed on an ongoing basis to ensure that network, generator, and SRAS contract changes are taken into account

2.3 Generator Restart Procedures

Any generator that is contracted to provide SRAS will be expected to prepare internal procedures detailing switching sequences used by the power station staff to restart the generating units at the power stations from the black start unit(s). Other generators will be expected to have internal procedures detailing the switching sequences used by power station staff to restart the generating units from a network source.

All Generators (including those providing SRAS) will be required to provide detailed information to assist SM in understanding the likely condition and capabilities of plant following a system shutdown or major system disturbance. Provision of full and accurate information is important as this allows SM to be fully informed of the technical requirements and limitations of the power stations. SM will use this information as a major input into developing the Sub-network Restart Procedures. The information required by SM should conform to the SM guidelines which will be published on its website.

It is recognised that some of the information provided may be confidential and although relevant information may be used to compile the Sub-network Restart Procedures. SM will discuss confidentiality issues with relevant parties prior to publishing any Sub-network Restart Procedures.

It is expected that Generator Restart Procedures will be reviewed on an ongoing basis to ensure that network, generator, and SRAS contract changes are taken into account

3. Definition of a Black System Condition

In order for SM to declare a Black System condition the following condition must be satisfied:

> *The absence of voltage on all or a significant part of the transmission system or within a sub-network following a major supply disruption, affecting a significant number of customers.*

A major supply disruption is defined as 'The unplanned absence of voltage on a part of the transmission system affecting one or more power stations.'

SM will use the following interpretation to determine whether a black system condition exists.

3.1 Criteria for a significant part of the transmission system

If there were an absence of voltage in all of the transmission system a black system condition would clearly exist. The black system definition can also include the absence of voltage in a significant part of the transmission network. SM will

determine when a black system condition exists and will inform participants accordingly

It is noted that the definition of black system also requires at least one power station to be affected by the supply disruption.

3.2 Exiting a Black System Condition

Once there has been significant improvement in the power system emergency situation that resulted in the declaration of a black system condition, SM will declare that the power system is no longer in a black system condition and inform participants accordingly.

However the non-existence of all the conditions for declaring a black system condition alone is not itself sufficient to exit from the black system condition. Prior to exiting the black system condition, SM must have confidence that:

- a “Normal Operating State” as defined in the WEM Rules can be achieved and maintained;
- the threat of further or continuing power system collapse is removed; and
- all involuntary load shedding has ceased and clearance to restore the last load block has been given by SM.

This is to minimise potential for successive movement in and out of a black system condition due to contingencies that can occur during the restoration of the power system.

4. Notification of a Black System Condition

SM will advise registered participants via a Dispatch Advisory or other communication systems that SM may develop or utilise, should significant SCADA or communication degradation occur.

In the event of a black system condition arising SM may declare a “High Risk Operating State” or an “Emergency Operating State” as defined in the WEM Rules. When this occurs SM may exercise some or all of the powers conferred under the relevant operating state.

5. Responsibilities

5.1 System Management

SM will be responsible for overall co-ordination of all restoration processes. During a black system condition SM will:

- advise participants of the declaration of a black system;
- determine the cause of the contingency and assess the status of the power system;
- develop a restoration strategy;
- activate System Restart Ancillary Service contracts as required;

- manage the restoration process for all sub-networks. This will involve SM giving the broad instructions that will be converted into the necessary detailed switching instructions;
- perform switching on the transmission system in accordance with the overall restoration strategy including converting broad instructions into detailed switching sequences;
- liaise with the NOCC on load restoration;
- manage voltage levels; and
- use some or all the powers applicable to the relevant operating state.

5.2 NOCC

During a black system condition the NOCC will:

- perform switching on the distribution system in preparation for load restoration;
- follow directions from SOCC for load restoration; and
- maintain details of the priorities for feeder restoration.

5.3 Generators

During a black system condition generators will:

- stabilise any generating plant on line and supplying load to the system;
- stabilise any generating plant that has tripped to house load;
- advise SM of :
  - any urgent requirement for load to stabilise on line plant;
  - the status of generating plant and ability to supply load;
  - any requirement for a start up supply;
  - any issues that may jeopardise generating plant;
- restart generating units and supply load as required by SM; and
- otherwise respond to directions from SM applicable to the relevant operating state

6. System Restart Ancillary Services

Chapter 3 of the WEM Rules state that sufficient black start facilities should be available to allow the restoration of power system security and to allow restarting of generating units following a black system condition and also details the procedure SM will use for determining and procuring the quantities of system restart ancillary services (SRAS).

SRAS is the capability of a generating unit to start up or form an island with house load, and send out sufficient amounts of electrical energy, without using energy supplied externally from the power system, in order to assist other generating units to start during a black system condition.

To ensure sufficient facilities will be available SM may enter into contracts with various generators for the provision of SRAS. Generators providing the SRAS will be required meet specific standard performance criteria to ensure that the SWIS can be restored to normal operation as soon as possible. Generators providing the

SRAS may be required to undertake testing, both at the procurement stage and during the period of the contract, to prove that the black start generators can comply with the requirements of the published performance standard.

While SM has contracted with various generators for the provision of SRAS the restoration strategy will not necessarily be limited to these generating units alone. SM may use any generation source that is available to assist in the restoration process.

7. System Restart Principles

7.1 System Characteristics - General

The characteristics of an interconnected power system are such that there will be a great deal of complexity when starting up following system shutdown. It is possible the cause of the shutdown may not be known prior to commencing restoration. Most power stations would be expected to be without auxiliary supply for restart purposes even though the transmission network might be left in a comparatively solid condition. Furthermore, essential services required for control of the restart procedure will be relying on stored energy (mainly DC batteries) that has a limited capability of possibly not more than a few hours.

7.2 Thermal Power Stations

The majority of coal fired generating units will require an external supply for their auxiliaries before they can restart. However it is expected that a number of generating units may trip to house load and be available for immediate use. Restoration of auxiliary supply to generating units will be a high priority in any system restart strategy.

If thermal power stations are left off line for more than a defined period it may not be possible to restart them for a substantial period of time. This is due to the need for them to be heated up slowly to avoid overstressing of thermal components. It is therefore important to be able to restart such units as quickly as possible to avoid long delays in restoring customer supply.

7.3 Gas Turbine Generating Plant

Gas turbine generating plant can usually be started and run up to synchronous speed ready to take load within five to fifteen minutes.

7.4 Wind Farms

Due to the highly variable and unpredictable nature of wind farm generation they have a major impact on the output levels of other generators connected to the sub-networks and cannot be relied upon for black start purposes. Wind farms will not be reconnected to the system until a significant portion of load has been restored and sufficient other generation is on line to allow for any significant change in wind farm output.

7.4 Transmission and Distribution Networks

To enable a successful restart, all essential facilities that provide operating functions to monitor and control the transmission/distribution system and substations, whether of automatic or manual initiation, must remain available when there is no external source of energy. Such facilities include system protective devices, operational control devices, communication systems and telemetering of essential information to advise the operating staff of system conditions.

Limiting conditions will exist on the rate at which load can be reconnected to the system. For example, increments of load that are added to the restarted system must be within the capability of frequency control of the limited generation sources at the time. Strategic placement of load throughout the system during network re-energising is necessary to stabilise the operation of the connected generators and to maintain stable voltage levels and an acceptable voltage profile on the system network. This requirement can be achieved with control devices, such as additional generating units, synchronous condensers and static VAr compensators, which are located to provide system voltage support at critical locations.

Other limiting conditions on the transmission system are caused by the need for adequate fault contribution to ensure operation of protection devices, and the need to limit out of balance between phase voltages, which might be caused if there is inadequate transposition of lines on the restarted system.

During a system restart SM will attempt to apply and maintain the normal rules for system security. SM will attempt to operate the system in a secure manner at all times in order to prevent further system collapse or shutdown. This however may be impracticable in the early stages of a system restart.

7.5 Frequency Control

To ensure frequency deviations are not excessive, load block sizes being restored should be limited to the capability of connected generation. SM will ensure that sufficient frequency control ancillary services both regulation and contingency services are available at all times.

Where appropriate SM will ensure that a generator in each sub-network is assigned to perform the role of controlling frequency and will advise the appropriate participant accordingly

7.6 Voltage Control

To limit voltage depression and to prevent voltage collapse when reloading the system, load is to be added in small increments. It is desirable to maintain voltage within +/- 5% of nominal on the main grid.

Voltage is more sensitive to load increments the more remote the load is from the generating source and as the system loading increases.

7.7 Line Energisation

Energising the high voltage network may inject significant amounts of reactive power into what may be a very lightly loaded system.

Excessive reactive power must be absorbed by either generation on line, application of static reactors, energisation of synchronous compensators and static VAr compensators or application of load.

The number of lines energised should also take into account the number of generators in service to ensure the fault level is high enough to activate protection should a fault occur.

8. Communication Protocols and Facilities

Figure 2 shows the communication protocol that applies for black system conditions.

During a system restart or major supply disruption:

- SM will liaise directly with all major generators and NOCC; and
- NOCC will liaise directly with parties connected to their distribution network and with embedded generators.

Each Rule Participant is expected to establish and maintain communications facilities consistent with the requirements of the Power System Operations Procedure: Communications and Control Systems.

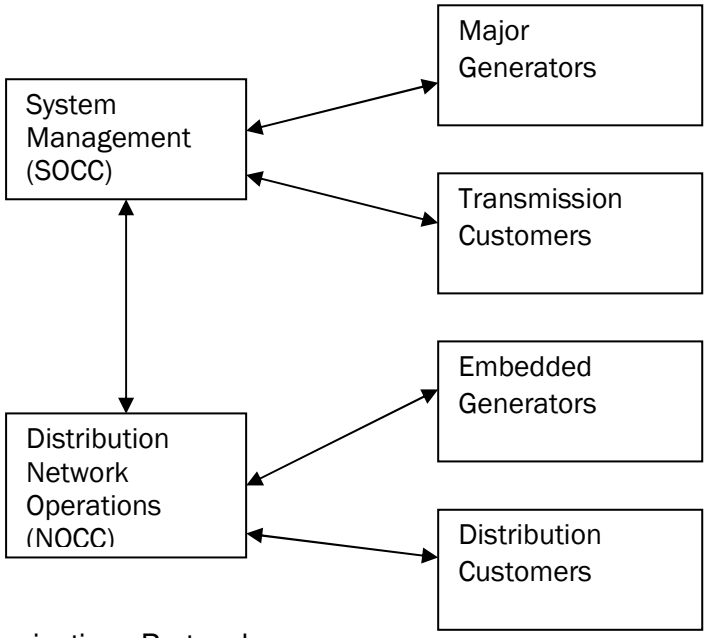

Figure 2: Communications Protocol