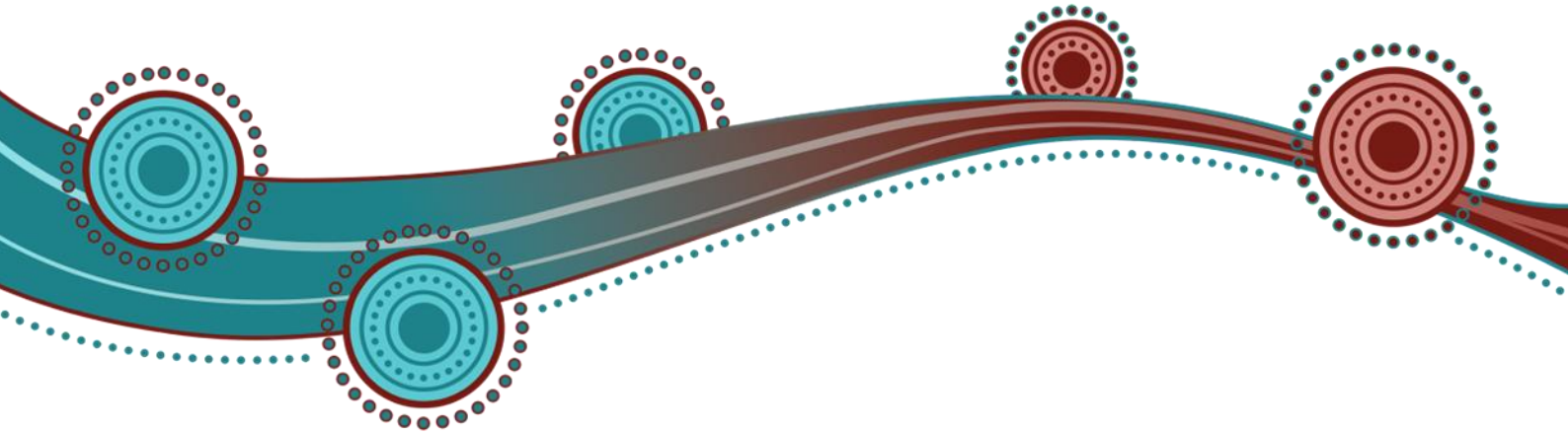
2026-27 ESSENTIAL SYSTEM SERVICES STUDIES

METHODOLOGY – CONSULTATION PAPER



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1. Executive Summary

1.1.5 This consultation paper sets out the proposed methodology Pilbara ISOCo (ISO) will use to determine the Spinning Reserve Essential System Services (SRESS) requirements for the 2026-27 ESS procurement cycle.

1.1.6 Under the Pilbara Networks Rules, ISO procures Essential System Services (ESS) to support secure operation of the North West Interconnected System (NWIS). ESS includes Frequency Control ESS (FCESS), which regulates system frequency, and SRESS, which provides headroom to respond to generation shortfall contingency events.

1.1.7 The Required Headroom Level (RHL) is the quantity of contingency reserve required to meet the Contingency Reserve Standard. ISO determines the RHL through ESS studies, which use dynamic power system simulations to test whether the system remains within the applicable frequency operating standard after the relevant credible contingency.

1.1.8 This consultation focuses on the methodology for SRESS studies only. It invites stakeholder feedback before ISO finalises the studies, so that key assumptions can be tested before they inform procurement outcomes.

1.1.9 The proposed methodology addresses the main inputs and assumptions that affect SRESS outcomes, including:

- Input data;
- Network configurations;
- Load levels;
- Load inertia;
- Load relief;
- Generator modelling;
- Credible dispatch scenarios;
- Credible contingency size; and
- Simulation approach.

1.1.10 Several assumptions may materially affect the RHL, including load levels, load inertia, load relief, generator and BESS modelling, credible dispatch scenarios, credible contingency size and the simulation approach. The most significant assumption is the credible contingency size used to underpin ESS procurement.

1.1.11 For the 2026-27 cycle, ISO proposes to limit the credible contingency size used for procurement by formalising agreements with relevant registered NSPs to manage their networks to a 58 MW contingency limit and, where required, implement risk reduction measures at their own cost. ISO considers this approach better balances system security, efficient ESS procurement and the Pilbara Electricity Objective than procuring to the largest observed contingency without regard to operational mitigations. Alternative options to reduce the credible contingency size used in ESS studies are also presented.

1.1.12 ISO seeks stakeholder feedback on the consultation questions summarised in Table 1 and discussed throughout this paper. Submissions are due by 5 pm on Tuesday 21 July 2026. ISO will consider submissions before finalising the ESS studies methodology and commencing the procurement processes required under the Pilbara Networks Rules.

Table 1 - Stakeholder consultation questions

Item	Assumption	Feedback requested	Discussed
1	Load levels	*Do stakeholders agree with the proposed criteria to determine minimum, medium and maximum load levels in the ESS studies, including using coincident NSP load calculated at 2nd, 50th and 98th percentiles?*	Section 5.3
2	Load inertia	*Do stakeholders agree with the approach to estimate load inertia in each credible island based on the ratio of its credible island load to System Whole load, or is another approach preferred to estimate load inertia in each credible island?*	Section 5.4
3	Load relief	*Do stakeholders agree with the assumption that load relief will be ignored, due to the lack of information available to accurately estimate it in the NWIS?*	Section 5.5
4	Generator modelling	*Do stakeholders agree with the generator modelling and headroom assumptions?*	Section 5.6
5	Generator modelling	*Do stakeholders agree with the capacity augmentation systems (e.g. SPRINT) modelling assumptions?*	Section 5.6
6	Credible dispatch scenarios	*Do stakeholders agree that the proposed dispatch merit order approach, including sequentially dispatching units to maximum output until portfolio load is met, is the most effective approach for ESS studies?*	Section 5.7
7	Credible dispatch scenarios	*Do stakeholders consider that the credible dispatch scenarios presented are sufficient, or should any additional cases be included?*	Section 5.7
8	Credible dispatch scenarios	*Do stakeholders support the approach to consider System Whole separation events in determining any locational ESS requirements within credible islands during the procurement process?*	Section 5.7
9	Credible contingency size	*ISO proposes to limit the credible contingency size used to procure ESS by formalising agreements with relevant registered NSPs to manage their networks to a contingency limit of 58 MW, this being the 4th largest credible contingency in 2025, and otherwise implement risk reduction measures at their own cost. Agreements would be listed and published on ISO's website and underpinned by ESS studies to confirm mitigations are appropriate to the agreed contingency limit.* *Do stakeholders support this approach to selecting the credible contingencies used to underpin ESS procurement?*	Section 5.8

Item	Assumption	Feedback requested	Discussed
10	Credible contingency size	*Do stakeholders consider that an alternative approach to the credible contingency size in ESS studies is more effective in satisfying the ESS objectives and the Pilbara Electricity Objective?*	Section 5.8
11	Simulation approach	*Do stakeholders support the single bus model approach?*	Section 5.9

2. Introduction

2.1 Background

2.1.1 Subchapter 8.1 of the Pilbara Networks Rules (PNR) provides for two Essential System Services (ESS) to be procured by ISO. Frequency Control ESS (FCESS) regulates system frequency at 50 Hz. Spinning Reserve ESS (SRESS) provides headroom that responds to generation shortfall contingency events, such as a generator trip.

2.1.2 ISO must periodically determine and publish the Required Headroom Level (RHL), which represents the contingency reserve required to meet the Contingency Reserve Standard under PNR 212. The Contingency Reserve Standard requires the power system, or a credible island, to remain within the frequency operating standards in clause 2.1.1 of the Harmonised Technical Rules (HTR) following the largest credible contingency that could cause a shortfall between generation and load on a covered network.

2.1.3 For ESS studies and procurement, the relevant frequency operating standard is the "Single contingency event" standard in Table 2.1 of clause 2.2.1 of the HTR, which requires system frequency to remain between 49.00 Hz and 51.00 Hz.

2.1.4 ISO typically conducts ESS studies annually to determine ESS requirements. The studies addressed in this consultation paper are limited to SRESS.

2.1.5 For the 2026-27 ESS procurement cycle, ISO intends to procure the RHL through contracted SRESS under PNR 214. Contracted FCESS may also be counted towards contracted SRESS under PNR 214.

2.1.6 During the 2025-26 ESS procurement cycle, ISO released an Issues Paper for consultation after receiving initial study results and before commencing procurement. The paper discussed challenges associated with procuring ESS for that cycle and included the initial study results and high-level methodology. Following consultation, ISO finalised the ESS study results and completed the ESS procurement process required under the PNR, including formal consultation.

2.1.7 For the 2026-27 ESS procurement cycle, ISO has decided to consult on the proposed ESS studies methodology before finalising the studies. This will transparently test ISO's assumptions and allow stakeholder feedback to be incorporated into the study design. The methodology covers:

- Input data;
- Network configurations;
- Load levels;
- Load inertia;
- Load relief;
- Generator modelling;
- Credible dispatch scenarios;
- Credible contingency size; and
- Simulation approach

2.1.8 ISO will perform the ESS studies using the methodology determined following this consultation. Once the study results are finalised, ISO will conduct the ESS procurement processes required under the PNR, including the formal consultation required under the Rules before entering into ESS contracts.

2.1.9 This consultation paper includes the following sections:

- Section 3 – Relevant Rules;
- Section 4 – Consultation process and timeline; and
- Section 5 – ESS studies methodology.

2.2 Definitions and interpretation

2.2.1 Unless the context requires otherwise, terms defined in the Electricity Industry Act 2004 (WA), the Electricity Industry (Pilbara Networks) Regulations 2021, the Pilbara Networks Access Code and the Rules have the same meaning in this report. ISO does not capitalise or italicise terms defined in those instruments in this report.

3. Relevant Rules

3.1.1 Subchapter 8.1 of the Rules deals with the specification, procurement and enablement of ESS.

3.1.2 Rule 199 of the Rules sets out the ESS objectives. The primary objective is to establish the arrangements and provide the ISO Control Desk with access to the Essential System Services required to:

a) pending any contingencies — maintain the Power System in a Secure State; and

b) following a Credible Contingency — maintain the Power System Inside the Technical Envelope and return it to a Secure State as soon as practicable; and

c) following any other Contingency —

i. maintain the Power System Inside the Technical Envelope where practicable, and otherwise return it to Inside the Technical Envelope Promptly; and

ii. maintain the Power System in a Secure State where practicable, and otherwise return it to a Secure State as soon as practicable; and

d) take or Direct Pre-Contingent Actions as necessary.

The secondary objective is to achieve the primary objective in a way that seeks to —

a) equitably and efficiently share the burden and benefit of doing so; and

b) achieve the lowest practicably sustainable cost of doing so in accordance with the Rules and GEIP, having regard to the Pilbara Electricity Objective.

3.1.3 The Pilbara Electricity Objective as defined in the Act seeks to promote efficient investment in, and efficient operation and use of, services of the Pilbara networks for the long-term interests of consumers of electricity in the Pilbara region to –

a) price, quality, safety, Reliability and Security of supply of electricity; and

b) the Reliability, safety and Security of any Interconnected Pilbara System.

3.1.4 For ease of reference, Attachment 1 reproduces Subchapter 8.1 of the Rules.

3.1.5 In performing ESS studies for the 2026-27 procurement cycle, ISO assumes the current Rules, procedures and visibility arrangements remain unchanged.

4. Consultation process and timeline

4.1.1 Public consultation is an important part of ISO's transparent decision-making process. ISO invites submissions from stakeholders and interested parties to inform its approach.

4.1.2 This consultation paper is published on ISO's website to facilitate informal stakeholder consultation. ISO recognises that ESS studies are important to procurement outcomes and that results are sensitive to the methodology and assumptions applied.

4.1.3 ISO seeks stakeholder feedback on the consultation questions listed throughout this report and summarised in the Executive Summary. Confidential and public submissions are welcome by 5 pm on Tuesday 21 July 2026.

4.1.4 ISO will review submissions, publish them where appropriate, and publish any required responses and the final ESS studies methodology on ISO's website. ISO may consider additional feedback on the ESS studies methodology, but any response will be at ISO's discretion.

4.1.5 If a submission contains confidential information, the stakeholder must notify ISO, clearly identify the confidential material, and provide a non-confidential version. Submissions must be received by the deadline and lodged electronically through the online form on ISO's website.

The ESS studies consultation timeframe is set out below.

Table 2 - Consultation timeline

Event	Date
Publish consultation paper and invitation for submissions	7 July 2026
Public submission period	7 July 2026 – 21 July 2026
Publish responses to stakeholder submissions and final ESS studies methodology	4 August 2026

5. ESS studies methodology

5.1 Input data

5.1.1 ISO requested information from NSPs and Registered Controllers for the ESS studies, including:

a) Half-hourly Supervisory Control and Data Acquisition (SCADA) data over the 2025 calendar year including network flows, load data, and generation data;

b) Disturbance event data, including data from high speed data recorders where available;

c) Typical dispatch merit orders for each NSP portfolio and any output dependent dispatch between facilities (e.g. steam turbines); and

d) The availability and characteristics of any capacity boosting systems such as SPRINT and EVAP.

5.1.2 In general, ISO assumes the input data provided is representative of conditions during the 2026-27 ESS procurement cycle. In making this assumption, ISO has considered changes in dispatch behaviour following the introduction of new solar farms and BESS facilities from mid-2025, and changes in procured ESS quantities from December 2025.

5.2 Network configurations

5.2.1 The ESS studies consider the System Whole scenario, representing the normal power system state when no islands have formed, and the Credible Islanding Scenarios defined in the Protocol Framework Procedure. The three Credible Islanding Scenarios are:

a) Covered Networks Island: The Horizon Power Coastal Network and APA Port Hedland Network as a combined island, as separated from Rio Tinto.

b) West Pilbara Island: The western portion of the Horizon Power Coastal Network (including the Cape Lambert Terminal) and the Rio Tinto network as a combined island, separated from the East Pilbara Island.

c) East Pilbara Island: The eastern portion of the Horizon Power Coastal Network (including the South Hedland Terminal) and the APA Port Hedland Network as a combined island, separated from the West Pilbara Island.

5.2.2 The three Credible Islanding Scenarios are illustrated in Figure 1.

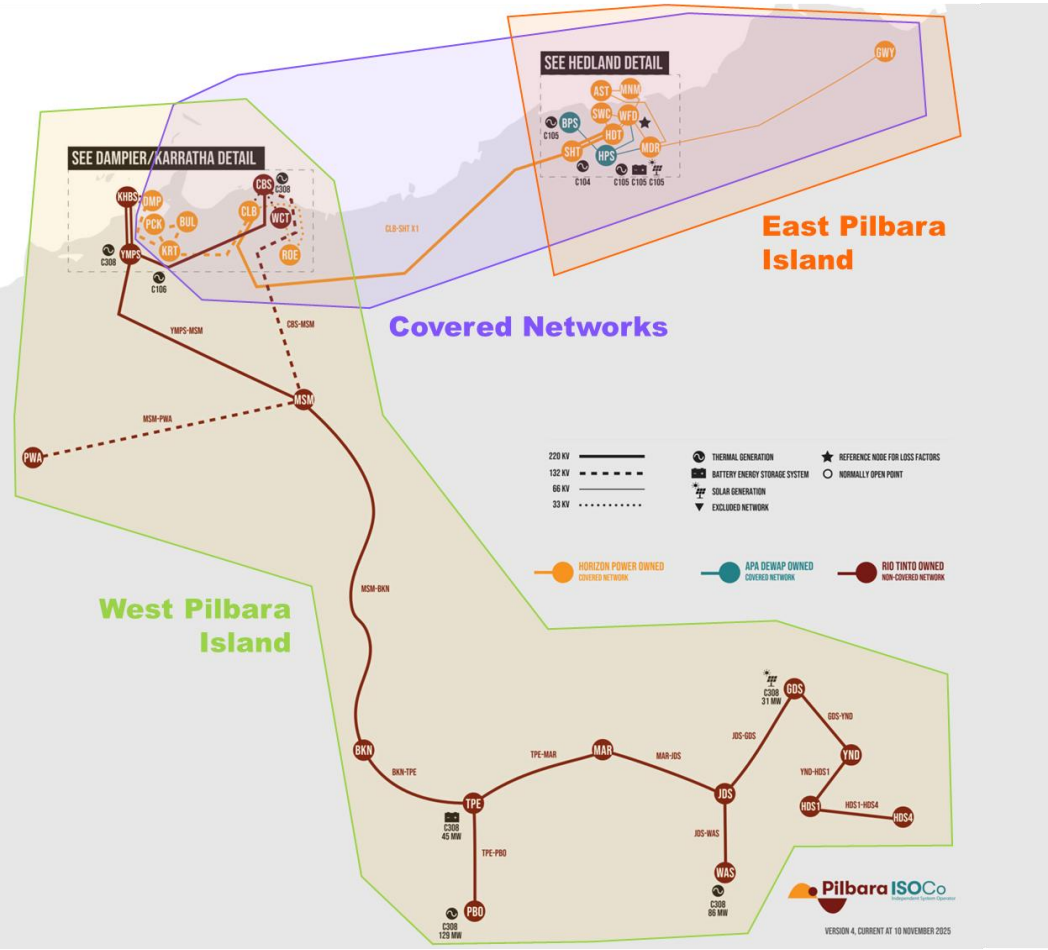

Figure 1 - Credible Islanding Scenarios illustrated on NWIS system map

5.2.3 In general, the ESS studies methodology is applied consistently across the System Whole and Credible Islanding Scenarios, except where stated otherwise.

5.3 Load levels

5.3.1 ISO requested half-hourly SCADA consumption data from each NSP for the 2025 calendar year, including substation and major load data. ISO used this data to determine the historical distribution of load within the System Whole and Credible Islanding Scenarios and to establish the minimum, medium and maximum load levels modelled in the ESS studies.

5.3.2 Appropriate load levels are important because load influences the generation dispatch profile, generation inertia and, in Credible Islanding Scenarios, the load inertia calculation. Load selection can affect study results, as lower loads generally create more onerous ESS scenarios because fewer inertia-providing generators are online.

5.3.3 ISO analysed percentile distributions of load levels in each network scenario using the 2025 half-hourly dataset. Distributions were prepared for both coincident load and non-coincident NSP load, where:

a) Coincident load refers to the total load observed at a specific point in time, calculated as the sum of each NSP's loads when measured at the same time.

b) Non-coincident load represents a hypothetical total load in which each NSP's loads are assumed to be at the same specified point in their respective load distributions at the same time. For example, each NSP may be assumed to be operating at maximum load concurrently. Non-coincident load is calculated by applying a common percentile threshold, such as the 98th percentile, to each NSP's load distribution and summing the results. This approach is useful for identifying theoretical load levels, but is conservative in practice because it does not account for load diversity.

5.3.4 Both coincident and non-coincident load levels were assessed at the 2nd, 50th and 98th percentiles of their respective distributions. These thresholds were considered to conservatively represent the upper and lower ends of the distribution. Selecting more conservative thresholds would produce minimum and maximum loads that reflect more extreme conditions, as illustrated by the distribution in Figure 2.

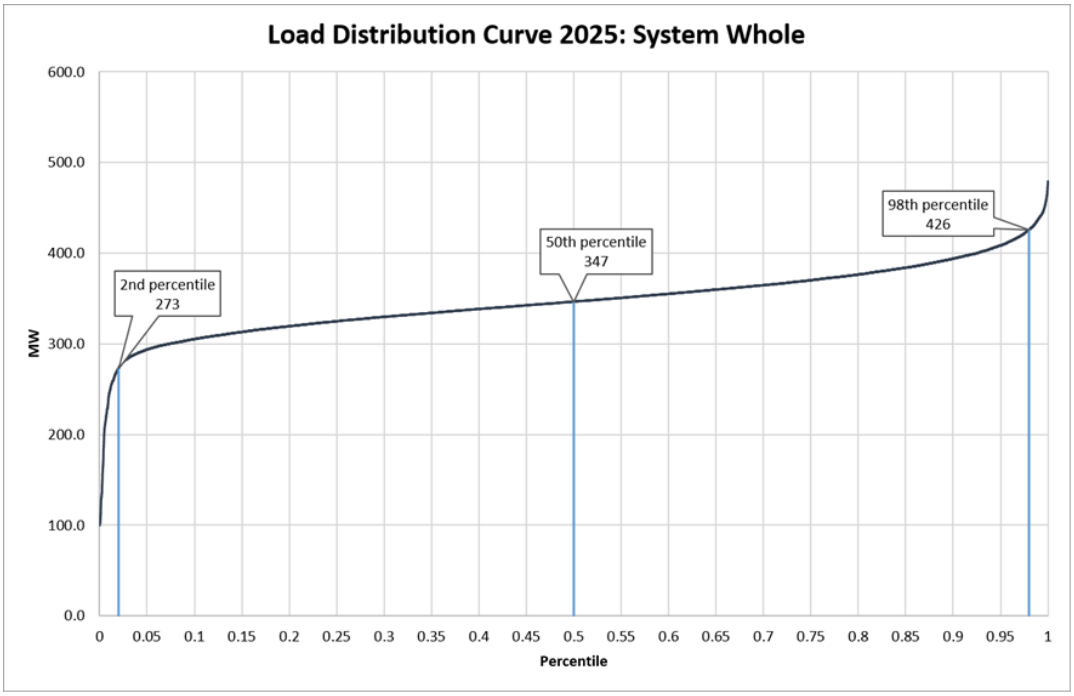

Figure 2 - Distribution of coincident System Whole load levels

5.3.5 For comparison, ISO compared the non-coincident load distribution with the coincident load distribution for the System Whole scenario, as shown in Table 3.

5.3.6 To preserve confidentiality of commercially sensitive information, load distributions for Credible Islanding Scenarios are not shown.

Table 3 - Coincident vs. non-coincident load distribution for System Whole

Load level	Coincident NSP load	Non-coincident NSP load
Minimum load (2nd percentile)	273 MW	234 MW
Medium load (50th percentile)	347 MW	347 MW
Maximum load (98th percentile)	426 MW	460 MW

5.3.7 The non-coincident load method produces more conservative minimum and maximum load outcomes because it does not account for load diversity. ISO therefore proposes to use coincident load and considers the 2nd, 50th and 98th percentile thresholds appropriate for determining minimum, medium and maximum load levels in the ESS studies for both the System Whole and Credible Islanding Scenarios.

Consultation question
1. *Do stakeholders agree with the proposed criteria to determine minimum, medium and maximum load levels in the ESS studies, including using coincident NSP load calculated at 2nd, 50th and 98th percentiles?*

5.4 Load inertia

System Whole

5.4.1 Load inertia is the stored mechanical energy in rotating loads synchronised to the power system. During a frequency disturbance, this inertia resists frequency change and reduces the Rate of Change of Frequency (RoCoF) as stored energy is released as electrical power. Like generation inertia, load inertia can materially affect ESS study results.

5.4.2 ISO derived load inertia by analysing high-speed data recorder measurements from a generation contingency event. RoCoF was determined from the measured frequency trace, contingency size from the contingent generator's measured active power output, and online generation inertia from the generator model parameters.

5.4.3 Load inertia was calculated by subtracting generation inertia from system inertia. System inertia was determined by rearranging the power system swing equation below using the known values described above:

$$\frac{df}{dt} = \frac{\Delta p \times f_0}{2H \times S}$$

where

$\frac{df}{dt}$ = RoCoF of the frequency event in Hz/s

Δp = contingency size in MW

$H \times S$ = system inertia in MWs

f_0 = system nominal frequency in Hz

5.4.4 ISO validated the derived load inertia by simulating the event and comparing the result with the measured frequency trace from the high-speed data recorder. As shown in Figure 3, the responses align closely and have similar initial RoCoF, indicating that the derived load inertia is suitable.

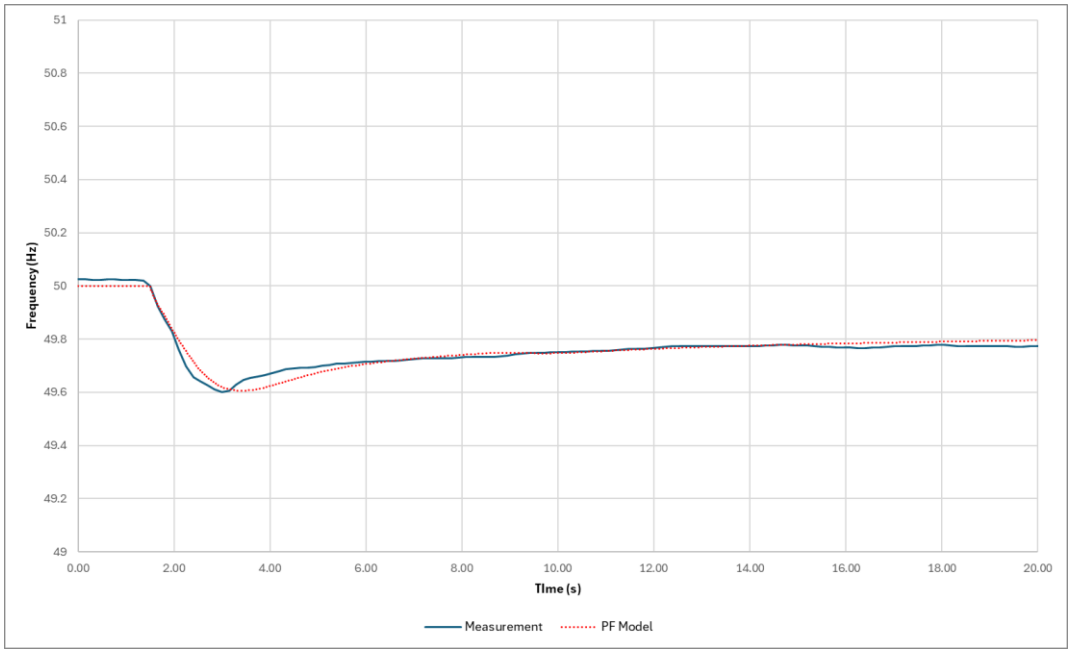

Figure 3 - Measured and modelled frequency response of the NWIS

5.4.5 For the System Whole scenario, ISO assumes load inertia remains constant across minimum, medium and maximum load scenarios. Load inertia is an inherent characteristic of online plant such as motors and pumps, and the NWIS load profile is relatively flat because of mining and port operations. Analysis of different network events also suggests that load inertia remains relatively constant within a given network under different load conditions.

Credible Islanding Scenarios

5.4.6 RoCoF in credible islands could not be derived because there have been no suitable frequency disturbances and insufficient high-speed measurement data in those islands. ISO therefore assumes load inertia is proportional to the island's share of total system load at maximum demand, calculated as follows:

$$\text{Credible Island Load Inertia} = \frac{\text{Credible Island Maximum Load}}{\text{System Whole Maximum Load}} \times \text{System Whole Load Inertia}$$

Consultation question
2. *Do stakeholders agree with the approach to estimate load inertia in each credible island based on the ratio of its credible island load to System Whole load, or is another approach preferred to estimate load inertia in each credible island?*

5.5 Load relief

5.5.1 Load relief, or load damping, is a frequency-dependent load characteristic where load reduces active power consumption during a frequency decline, supporting frequency recovery.

5.5.2 For ESS studies, ISO will ignore load relief because there is insufficient information to accurately estimate it in the NWIS. Frequency-dependent load modelling has not yet been completed for most loads in the NWIS power system model, and this approach reflects stakeholder feedback on the October 2025 ESS Issues Paper. The assumption may produce slightly more conservative ESS study results.

Consultation question
3. *Do stakeholders agree with the assumption that load relief will be ignored, due to the lack of information available to accurately estimate it in the NWIS?*

5.6 Generator modelling

5.6.1 Generator and BESS models were obtained from the latest full NWIS model. Where a more recent approved model was available, ISO used that model where possible. Only generators and BESS facilities that are fully operational at the commencement of ESS studies are included.

5.6.2 ISO performed droop response tests on each generator and BESS model using SMIB simulations to confirm consistency across models.

5.6.3 ISO applied the following modelling assumptions when calculating Required Headroom Levels:

a) Solar farms provide no contingency reserve capability, regardless of output level.

b) Battery Energy Storage System (BESS) facilities are available to provide contingency reserve, unless stated otherwise. It is assumed in the ESS studies that adequate state of charge is available[1] over the simulation timeframe.

c) Headroom from steam turbines is not considered due to its dependency on associated combined cycle generators, and its slower response time compared to gas generation, making it difficult to calculate meaningful Required Headroom Levels with its headroom included.

d) For all generating units providing headroom, the quantity of headroom considered to be available in Required Headroom Level calculations is the difference between a generating unit's initial active power output and its maximum steady-state capability (Pmax).

[1] ISO recognises this may not always be true in practise, depending on the purpose of the BESS including whether it is contracted for ESS. However, the assumption is appropriate for the purposes of determining required headroom levels to avoid load shedding in response to the initial contingency. Operational realities that exceed simulation timeframes will be considered during ESS procurement.

Consultation question
4. Do stakeholders agree with the generator modelling and headroom assumptions?

Capacity augmentation systems

5.6.4 Generators with capacity augmentation systems use various methods, typically cooling, to improve performance. These systems are particularly relevant in the Pilbara because ambient conditions can derate generator output if additional cooling is not available.

5.6.5 To accurately reflect generator capability in the ESS studies, ISO obtained information from Registered Controllers on capacity augmentation systems, including SPRINT and EVAP cooling systems, and any activation thresholds or conditions required for enablement.

5.6.6 ISO modelled SPRINT capability using the information provided. SPRINT is typically enabled only when initial generator output exceeds the relevant activation threshold and any other permissive conditions are met. When enabled, SPRINT typically increases turbine capacity by approximately 15-30%, depending on environmental conditions.

5.6.7 ISO assumes SPRINT is enabled when the initial generator output in the simulation is above the activation threshold, and disabled otherwise. Because SPRINT typically has a 1-3 minute delay before it becomes effective, it cannot become enabled during a dynamic simulation merely because output exceeds the activation threshold.

5.6.8 When SPRINT is enabled, Pmax is set to the facility's maximum active power capacity.

5.6.9 When SPRINT is disabled, Pmax is reduced to the SPRINT activation thresholds advised by Registered Controllers.

Consultation question
5. Do stakeholders agree with the capacity augmentation systems (e.g. SPRINT) modelling assumptions?

5.7 Credible dispatch scenarios

System Whole

5.7.1 ISO requested typical portfolio dispatch merit orders from each registered NSP and independent power producer to ensure the studied dispatch profiles represent expected generating unit dispatch sequences. ISO validated the merit orders against 2025 calendar year SCADA data.

5.7.2 This approach ensures the ESS studies reflect the generating units and BESS facilities expected to be online in each scenario. This is important because inertia and frequency response vary across synchronous units and BESS facilities, and asynchronous generation may displace synchronous inertia.

5.7.3 In the reference case, each portfolio's generating units are dispatched to maximum output in merit order until portfolio load is met. Solar and BESS facilities are assumed to operate at fixed initial dispatch levels, conservatively set at maximum output and 0 MW respectively.

5.7.4 Dispatching units to maximum output before dispatching the next unit in a portfolio is conservative because it reduces the number of online units and therefore minimises system inertia. It also

excludes natural headroom by limiting study headroom to the amount required to maintain frequency within the frequency operating standards following a contingency event.

5.7.5 Although conservative, this approach allows the Required Headroom Level (RHL) to be determined meaningfully by limiting headroom in ESS studies to the quantity required. It enables ISO to procure ESS to meet the RHL and is consistent with the principle that only contracted ESS services should normally be relied on.

Consultation question
6. *Do stakeholders agree that the proposed dispatch merit order approach, including sequentially dispatching units to maximum output until portfolio load is met, is the most effective approach for ESS studies?*

5.7.6 ISO includes additional credible dispatch scenarios to test variations from the reference dispatch case. These scenarios are intended to represent operationally credible conditions, including credible network flows, by simulating variations in portfolio dispatch. ISO considers cases with different generating units offline while otherwise following portfolio dispatch merit orders. These cases are repeated with one or both BESS facilities offline, partial BESS availability at 25%, 50% and 75%, and solar output at maximum output or offline.

Consultation question
7. *Do stakeholders consider that the credible dispatch scenarios presented are sufficient, or should any additional cases be included?*

Credible Islanding Scenarios

5.7.7 For Credible Islanding Scenarios, ISO applies the same approach, except that studied load levels are adjusted to match the island load and dispatch portfolios are limited to the generating units available in each island.

5.7.8 Although the Credible Islanding Scenarios are configured as post-separation cases, they will also be used to assess System Whole separation events that create a generation deficit within an island. ISO will apply the equivalent percentile threshold used to determine the largest credible contingency to separating network elements to determine credible maximum and minimum pre-contingent network flows. This ensures directional flow changes are captured. Studies will then be repeated with the determined credible generation deficit to inform any location-specific SRESS requirements.

Consultation question
8. *Do stakeholders support the approach to consider System Whole separation events in determining any locational ESS requirements within credible islands during the procurement process?*

5.8 Credible contingency size

5.8.1 Credible contingency size is a critical ESS study assumption. It represents the generation deficit the system must withstand and directly influences the RHL, or contingency reserves, required to maintain system security and therefore the volume of contracted ESS procured.

5.8.2 For ESS studies, ISO considers a credible contingency to be:

any single, credible, unplanned loss of a network element, generating unit or storage works, as defined in Rule 8 of the PNR and section 2.1 of the Protocol Framework Procedure, that results in an immediate net loss of active power supply as seen by a covered network.

5.8.3 ISO notes that related reform initiatives are being progressed by the Department of Energy and Economic Diversification (DEED). However, those changes will not take effect in time for the 2026-27 ESS studies, so the existing PNR framework and definitions will apply.

5.8.4 ISO created a defined contingency set covering all radial network elements injecting power into the NWIS, single generating unit contingencies, and any associated loss of generation, such as input to a steam turbine operating as part of a combined cycle plant.

5.8.5 In the 2025-26 ESS studies, all generation and network contingencies were considered credible, and the largest credible contingency was set at 59 MW based on forecast credible power system conditions informed by 2024 calendar year dispatch data. ISO obtained commitments from registered NSPs to limit credible contingencies to 59 MW or implement risk reduction measures at their own cost.

5.8.6 For the 2026-27 ESS studies, ISO requested 2025 calendar year SCADA network flow data. ISO combined generation and network data and determined the largest real-time credible contingency for each half-hourly interval in 2025 using the defined contingency set.

5.8.7 The dataset shows that credible network contingency sizes above 59 MW occurred frequently in the 2025 calendar year. ISO derived a percentile distribution of 2025 real-time contingency sizes using 30-minute interval data. Large increases in contingency size occur at the upper end of the distribution over short durations, meaning the determined contingency size is highly sensitive to the percentile threshold selected. Table 4 shows this variation.

5.8.8 ISO has not reviewed 2026 data for the current procurement cycle. However, ISO routinely seeks confirmation that relevant network service providers are managing their networks to the agreed credible contingency level and, where they are not, have implemented short-term risk reduction measures.

Table 4 - Credible Contingency size distribution for the NWIS in 2025

Contingency size (MW)	Percentile of contingency size distribution in CY 2025 (%)	Contingency type	Projected SRESS cost based on scaled 2025-26 costs ($/month ex GST)[1, 2]
58	64%	Generating unit	98%
59 (2025-26 ESS cycle)	66%	Radial network element	$265,800

Contingency size (MW)	Percentile of contingency size distribution in CY 2025 (%)	Contingency type	Projected SRESS cost based on scaled 2025-26 costs ($/month ex GST)[1, 2]
77	90%	Radial network element	131%
83	95%	Radial network element	141%
90	98%	Radial network element	153%
93	99%	Radial network element	158%
108	100%	Radial network element	183%

[1] Assumes the contracted ESS volume in 2026-27 ESS studies scales linearly from the 2025-26 ESS studies based on the contingency size. This is for indicative cost comparison only, as ESS studies and procurement are required to determine actual outcomes.

[2] FCESS (20 MW) contributes to the contracted SRESS volume, but associated FCESS costs are not included. Supplementary SRESS costs are also excluded.

Risk-based vs deterministic approach

5.8.9 ISO notes that many jurisdictions use a deterministic approach to system security in planning or operational timeframes. For contingency management, a deterministic approach would require the system to withstand the largest actual or potential credible contingency, usually by procuring headroom through contracted or market-based services.

5.8.10 For the NWIS, based on Table 4 and assuming registered NSPs make no commitments to reduce credible contingency sizes, a deterministic approach would require ISO to procure ESS to manage a credible contingency of at least 108 MW. The required level could be higher if theoretical maximum inflows on radial network elements are considered.

5.8.11 A deterministic approach does not inherently account for the risk associated with a credible event. By contrast, a risk-based, or probabilistic, approach can allow for a defined level of risk over short periods. A more advanced statistical model could also consider:

a) The likelihood of the contingency occurring; and

b) The likelihood that the system is in a state where it cannot withstand the contingency, taking into account probabilistic distributions of load, system inertia and natural, non-contracted headroom where available.

5.8.12 Because large incremental increases in contingency size occur only for short periods, and because ESS studies do not include operational margins such as natural non-contracted headroom and synchronous inertia, the true system risk is likely to be low during periods where credible contingency sizes exceed this threshold. However, ISO cannot determine that risk in real time

because of current SCADA visibility limitations, the absence of real-time ESS study tools, and the current PNR framework's limited support for a dynamic ESS regime. ESS studies must therefore consider credible risks across the full ESS procurement cycle.

5.8.13 Table 5 shows that the largest contingencies arise from a small number of contingency elements, predominantly radial lines. ISO may formalise agreements with registered NSPs to limit the credible contingency level used for ESS procurement.

Table 5 – Contingency type and percentile in 2025 ranked by contingency size

	100th Percentile		99th Percentile		90th Percentile	
Rank	**Element**	**Cont. size (MW)**	**Element**	**Cont. size (MW)**	**Element**	**Cont. size (MW)**
1	Radial line A	107.8	Radial line A	93.0	Radial line A	76.5
2	Radial line B	74.1	Radial line B	56.5	Generator A	53.5
3	Radial line C	67.0	Generator A	55.9	Generator G	40.7
4	Generator A	58.3	Generator F	45.5	Generator I	38.9
5	Generator B	47.6	Radial line C	45.3	Generator F	38.3
6	Generator C	47.0	Generator B	43.9	Generator X	36.2
7	Generator D	46.6	Generator L	43.0	Generator H	35.0
8	Radial line D	46.3	Generator G	43.0	Generator R	34.9
9	Generator E	45.9	Generator C	42.6	Generator D	34.7
10	Generator F	45.8	Generator I	42.6	Generator K	34.3

Consultation question
9. *ISO proposes to limit the credible contingency size used to procure ESS by formalising agreements with relevant registered NSPs to manage their networks to a contingency limit of 58 MW, this being the 4th largest credible contingency in 2025, and otherwise implement risk reduction measures at their own cost. Agreements would be listed and published on ISO's website and underpinned by ESS studies to confirm mitigations are appropriate to the agreed contingency limit.* *Do stakeholders support this approach to selecting the credible contingencies used to underpin ESS procurement?*

5.8.14 ISO considers the proposed approach consistent with the Contingency Reserve Standard over the ESS procurement cycle, having regard to known operational margins and proposed NSP commitments. ISO also considers the approach efficient and consistent with both the ESS objectives and the Pilbara Electricity Objective. A higher limit or deterministic approach is unlikely to better satisfy those objectives and may impose more stringent locational constraints, limiting efficient ESS procurement.

5.8.15 Alternative approaches could reduce the credible contingency size used in ESS studies, including:

a) Nominating a lower contingency size and introducing constraint rules to limit single supply losses from generation or network contingencies to that level. This would require agreement from covered NSPs and would not apply to non-covered networks, which are excluded from the constraint regime. It would also impose a fixed operational constraint over the ESS procurement cycle, which may not reflect the system's true capability or efficient operation.

b) Requiring ISO Control Desk to be informed of, or monitor, credible risks above a nominated contingency size and dispatch Supplementary SRESS based on expected exceedances. ISO considers this approach impracticable under current visibility limitations, and the existing framework does not readily support this dynamic approach. It would also add administrative burden, complexity and operational uncertainty, and may increase overall ESS costs if Supplementary SRESS is dispatched for this purpose. Additional ESS studies would also be required to determine both the Base SRESS RHL at the nominated contingency size and the extra headroom needed to manage exceedances.

c) A risk-based approach, where the largest credible contingency size for the purposes of ESS studies is set to a lower threshold e.g. 95th percentile (83.1 MW), and ESS is procured accordingly.

5.8.16 ISO considers the proposed approach provides a more balanced outcome and more effectively meets the ESS objectives and the Pilbara Electricity Objective.

Consultation question
10. *Do stakeholders consider that an alternative approach to the credible contingency size in ESS studies is more effective in satisfying the ESS objectives and the Pilbara Electricity Objective?*

5.9 Simulation approach

System Whole

5.9.1 Required Headroom Level studies will be performed in DIgSILENT PowerFactory 2024 using dynamic RMS simulations.

5.9.2 ISO created a simplified single bus model using the latest full NWIS model and the generator and BESS models. The single bus model reduces the NWIS transmission network to a single point by modelling each generating unit on one bus, including its connection path to the nearest 220 kV network point. This assumes that impedance and losses on the 220 kV transmission system are approximately zero, which is supported by the relatively low transmission losses observed in measured data. Where multiple generating units share a connection path to the 220 kV network, that shared path is also used in the single bus model.

5.9.3 The single bus model uses the following discrete elements to represent the aggregated parameters described in previous sections:

a) System load is represented as a single aggregated static load connected directly to the 220 kV bus and set equal to the determined load level.

b) Load inertia is represented as an unloaded synchronous generator without controllers, connected directly to the 220 kV bus. This machine acts as the swing generator in the simulation.

5.9.4 The single bus model reduces simulation run time compared with the full NWIS model by aggregating network elements on a common bus and avoiding the need to achieve study case convergence in the full model. This allows a large number of simulation cases to be run efficiently.

5.9.5 Network constraints will be assessed separately after ESS bids are received.

5.9.6 To validate the single bus model approach, ISO simulated the same generation deficit event in both the single bus model and the full NWIS model at minimum and maximum load levels. The comparison results are shown in Table 6. Based on those results, ISO considers the approach sufficiently accurate for ESS studies.

Table 6 - Frequency response on Full NWIS Model vs equivalent Single Bus Model

Load Levels	Full NWIS Model		Single Bus Model	
	ROCOF (Hz/s)	Frequency nadir (Hz)	ROCOF (Hz/s)	Frequency nadir (Hz)
Minimum Load	-0.486	49.47	-0.432	49.42
Maximum Load	-0.298	49.66	-0.265	49.60

Consultation question
11. Do stakeholders support the single bus model approach?

5.9.7 Simulation cases will include each relevant credible dispatch scenario at each load level: minimum, medium and maximum. The relevant credible contingency will be simulated dynamically by applying a generation deficit event representing the defined contingency, comprised of the net loss of generation, the associated loss of inertia, and the loss of load (if the contingency represents a radial line trip). If frequency does not remain above 49 Hz following the contingency, an additional generating unit is brought online at minimum output and the remaining units are re-dispatched to meet system load, increasing headroom and inertia. This process is repeated until frequency remains above 49 Hz and a secure state is achieved. The Required Headroom Level is then calculated and recorded.

5.9.8 Required Headroom Level is calculated by summing the headroom available on each generating unit in the simulation based on its pre-contingent dispatch. Headroom is the difference between the generator's initial output and Pmax, excluding generating units assumed not to provide headroom. Where a BESS is included, the RHL includes both gas and BESS headroom, which can be reported separately.

Credible Islanding Scenarios

5.9.9 The same approach applies to credible islands. However, based on previous studies, the largest credible contingency may need to be reduced or constrained to a nominal level that allows the NWIS to remain secure following the contingency under most scenarios. This reflects the lower headroom and inertia available in credible islands.

5.9.10 The initial dispatch will be iterated by reducing the largest contingency to the nearest 5 MW increment until it reaches 30 MW. These studies will inform the scenarios in which constraint rules may be required for each credible island.

Attachment 1: Rules Subchapter 8.1 Essential System Services

Subchapter 8.1 – Essential System Services

199 The ESS objectives

(1) This Subchapter 8.1's primary objective is to put in place the necessary arrangements, and equip the ISO Control Desk with access to the necessary Essential System Services, to Enable it to —

(a) pending any contingencies — Maintain the Power System in a Secure State; and

(b) following a Credible Contingency — Maintain the Power System Inside the Technical Envelope and return it to a Secure State as soon as practicable; and

(c) following any other Contingency —

(i) Maintain the Power System Inside the Technical Envelope where practicable, and otherwise return it to Inside the Technical Envelope Promptly; and

(ii) Maintain the Power System in a Secure State where practicable, and otherwise return it to a Secure State as soon as practicable;

and

(d) take or Direct Pre-Contingent Actions as necessary.

(2) This Subchapter 8.1's secondary objective is to achieve the primary objective in a way that seeks to —

(a) equitably and efficiently share the burden and benefit of doing so; and

(b) achieves the lowest practicably sustainable cost of doing so in accordance with these Rules and GEIP, having regard to the Pilbara Electricity Objective.

{It is expected that rule 199(2)(a) will promote outcomes in which a beneficiary of Essential System Services shares a fair proportion of the burden.}

200 ESS Contracting process

(1) Before entering into a proposed ESS Contract, the ISO must —

(a) Publish —

(i) the projected cost of the contract to likely Payers, together with the projected cost under other contracts for the Essential System Service, in a form which reasonably Enables each likely Payer to assess its likely future cost burden; and

(ii) reasonable details of the proposed ESS Provider's experience in providing the Essential System Service and the systems it will use to do so;

and

(b) conduct at least an Expedited Consultation Process.

(2) Unless the ISO determines that an alternative approach will better promote the secondary objective in rule 199(2), the ISO must undertake ESS procurement through a competitive tender or other transparent process.

{Example — It may be a waste of money to run a competitive tender if there is only one potential supplier in a particular Island.}

(3) The ISO's Decision to enter into an ESS Contract may be the subject of a Rules Dispute, but the only issue to be determined is whether the proposed ESS Contract represents a reasonable attempt to achieve the objectives in rule 199. The dispute resolver has Limited Discretion on this issue.

(4) Without limiting rule 200(3) —

(a) the ISO is not required by rule 200(1)(a)(i) or otherwise to investigate or disclose the proposed ESS Provider's anticipated costs of providing the Essential System Service or any margin which may be reflected in the ESS Provider's proposed charges; and

(b) the matters referred to in rule 200(4)(a) cannot be the subject of a Rules Dispute.

(5) An ESS Contract, and the procurement process that precedes it, may deal with more than one Essential System Service.

210 Spinning reserve – Definition of Headroom

In these Rules —

(a) "Headroom" at any time —

(i) for a Generating Unit — means the difference between its actual output at the time, and its maximum output capability at the time taking into account environmental conditions and Equipment Limits;

{For each Generating Unit, Headroom measures its droop response capacity to help arrest a fall in frequency after a Contingency.}

and

(ii) for the Power System — means the aggregate, across all Enabled Generating Units in the Power System at any time of each Generating Unit's Headroom as defined in 210(a)(i) at the time; and

(b) **"Required Headroom"** means the amount of Headroom needed in the Power System (or, if applicable, a Credible Island) to satisfy the Contingency Reserve Standard, determined by the ISO or ISO Control Desk under rule 212(1); and

(c) **"Required Headroom Level"** for the Power System or an Island is determined by the ISO under rule 212(1)(a) or by the ISO Control Desk under rule 212(2)(a).

211 Requirements – Spinning reserve – The Contingency Reserve Standard

The **"Contingency Reserve Standard"** is that the quantity of Headroom within the Power System (or, if applicable, a Credible Island) at any time must be sufficient to Enable the Power System (or Credible Island) to remain within the Frequency Operating Standards following the largest single Credible Contingency which could cause a shortfall between generation and Load on a Covered Network.

212 Requirements – Spinning reserve – ISO to determine

(1) The ISO must either —

(a) from time to time determine and Publish the Required Headroom Level for the Power System (or, if the ISO determines it to be appropriate, a Credible Island); or

(b) if it determines that a more flexible approach will better serve the objective in rule 199(2) — from time to time determine and Publish the process and Decision criteria which the ISO Control Desk is to apply to determine the Power System's (or, if the ISO determines it to be appropriate, a Credible Island's) Required Headroom Level from time to time, depending on the Power System's configuration and other circumstances.

(2) If the ISO has published Decision criteria under rule 212(1)(b), the ISO Control Desk must —

(a) as frequently as required by the criteria, apply the criteria to determine the Required Headroom Level; and

(b) notify each SRESS Provider of the Required Headroom Level whenever it changes.

213 Definition – The spinning reserve (Contingency reserve) service

The spinning reserve service (**"SRESS"**) is a service in which a person (the **"SRESS Provider"**) commits to Maintain an amount of Headroom in its Generating Units which equals or exceeds a specified amount, at a specified level of availability.

214 Procurement – Spinning reserve contracts

(1) The ISO must from time to time enter into an ESS Contract with one or more SRESS Providers to obtain SRESS.

(2) The ISO must ensure that the aggregate amount of SRESS for which it contracts is sufficient to ensure that —

(a) in Normal Operating Conditions, the SRESS Provider or providers between them Maintain an amount of Headroom which meets or exceeds the Required Headroom Level with a level of availability which is acceptable to a GEIP standard; and

(b) outside Normal Operating Conditions, or otherwise where necessary for example due to Network constraints, the ISO Control Desk can Enable a Generating Unit to provide SRESS in order to ensure that there is an amount of Headroom available to each part of the Power System, which meets or exceeds the Required Headroom Level.

(3) The Regulation Raise Reserve specified, or to be specified, in the Primary FCESS Provider's ESS Contract may be counted as contracted SRESS for the purposes of rule 214(2).

(4) If the ISO contracts with more than one SRESS Provider, the contracts may specify how the obligation to Maintain Headroom in rule 214(2)(a) is to be apportioned and managed between the SRESS Providers.

(5) The price and other terms of an SRESS Contract are to be negotiated in the ISO's discretion, having regard to the objectives in rule 199.

(6) The SRESS Contract will set out the SRESS Provider's entitlement to be paid under rule 228(2)(b).

215 Enablement – Spinning reserve

The ISO Control Desk must on a 24/7 Basis —

(a) monitor the Power System; and

(b) outside Normal Operating Conditions, or otherwise where necessary for example due to Network constraints — Enable Generating Units to provide SRESS as necessary,

to ensure that the Headroom available in each part of the Power System, having regard to Network configuration and constraints, meets or exceeds the Required Headroom Level.

216 Spinning reserve – Trial of alternative SRESS approach

If the ISO considers that the objectives in rule 199 might be better served by an alternative SRESS approach, then it may, in consultation with Rules Participants —

(a) propose and develop trials of an alternative SRESS approach; and

(b) determine whether there is support for an alternative approach, and whether the approach can adequately achieve the primary objective in rule 199(1) in a way which maximises the secondary objective in rule 199(2); and

(c) thereafter develop and submit suitable Rule Change Proposals or Procedure Change Proposals to implement the alternative approach.

{Example — In a "dynamic Enablement" approach, the ISO Control Desk, on a 24/7 Basis or otherwise, monitors and takes into account the aggregate Headroom available across all (or selected) Generating Units in the Power System (also known as "incidental Headroom"), and Enables and Disables Generating Units as necessary to minimise machine starts while ensuring that the aggregate available Headroom does not fall below a specified margin.}

217 Annual reporting

By 1 June each year, the ISO must Publish a report setting out reasonable details of the cost and effectiveness of arrangements under this Subchapter 8.1 in meeting the primary and secondary objectives in rule 199, and suggestions for any improvements.