

Efficient procurement of extended reserves - draft Code amendment

Consultation Paper

Submissions close: 20 May 2014

3 April 2014

Executive summary

Overview

Electrical systems around the world are subject to the risk of rare and extreme events that, if not appropriately planned for, could lead to catastrophic power failure.

The current principal means of addressing such risks is through dropping large blocks of load as Automatic Under-Frequency Load Shedding (AUFLS).

Several events have recently occurred in New Zealand that put these 'last resort' systems to the test. While the system stayed on for these events, Transpower has identified that the AUFLS scheme could be improved to reduce the risk of non-performance for a wider range of events than considered when the AUFLS scheme was first designed. It has proposed a revised technical design to address this risk.

In parallel, the Electricity Authority (Authority) has identified significant inefficiencies in the current mechanisms for determining which loads should provide AUFLS to meet the overall system requirement. As well as economic costs arising from inappropriate load being assigned to provide AUFLS, the current poor procurement approach is also exacerbating system reliability risks.

After multiple sets of industry dialogue and consultation, and having engaged extensively and in an ongoing way with the system operator, the Authority has developed a mechanism that greatly improves the efficiency of selection and delivers improved system security.

Although the new arrangements will initially apply only in the North Island, they are flexible enough to be applied in modified form to the South Island at a later date. If the proposal proceeds, the Authority will amend the Electricity Industry Participation Code 2010 (Code) to bring the new design into effect.

The preferred mechanism is one that combines provisions in the Code and a set of key documents developed pursuant to, and governed by, the Code. This facilitates greater innovation and flexibility in the provision of AUFLS, and enables the development of additional resources other than AUFLS as new technology and systems allow. As part of these changes, a new term 'extended reserves' is being introduced. Extended reserves will consist of AUFLS and any other related resources that might be introduced in the future (however, AUFLS is the only type of extended reserves currently).

This consultation is on the proposed Code amendments to implement this approach. However, further consultation will be undertaken later this year on two of the key documents – namely the extended reserves technical requirements schedule, and extended reserves selection methodology.

Summary of problem and proposed solution

AUFLS are procured to prevent system collapse

AUFLS is the 'last resort' mechanism by which large blocks of load are shed to prevent electricity system collapse in the event of a significant loss of net injection within the supply system. AUFLS is intended to only be used where the loss is of a size greater than that which can be covered solely by instantaneous reserves (IR).

Current AUFLS arrangements require transmission-connected loads to arm two blocks to each provide a minimum of 16% of their load at all times, with the blocks configured to standard frequency trigger settings.

Both the technical design and means of procuring AUFLS could be improved

The Authority and system operator have been reviewing these arrangements and identified areas for improvement, particularly:

- the design of 2 x 16% load blocks is too 'coarse' to adequately cover a wide range of possible interruption events. This results in a residual risk of having too little AUFLS for some events, and too much for other events
- the coarseness of the two-block design is exacerbated by the percentage quantity requirement not varying with the changing system conditions (i.e. size of risk, demand, system inertia, etc.)
- this is further exacerbated by significant and systematic over-provision of AUFLS due to the asymmetric compliance risk on parties, whereby they are penalised for providing too little but not for providing too much
- the procurement approach and lack of information reporting requirements on participants gives the system operator very little visibility of how much load is armed for AUFLS. This impairs the system operator's ability to manage the system to prevent system collapse
- the 'one-size-fits-all' common obligation procurement approach creates additional economic costs because it:
 - prevents some load from being used for higher value purposes such as interruptible load (IL), and potentially other forms of demand response
 - results in some relatively high interruption cost load being armed for AUFLS, while other lower interruption cost load is not armed, plus generally has resulted in over-provision resulting in some load being unnecessarily dropped
- because of these concerns about the economic costs associated with some parties providing AUFLS, all direct connect consumers in the North Island (and

one lines company with a very large industrial load), have been granted temporary exemptions from the need to provide AUFLS until a more enduring solution is implemented.

The Authority and system operator have engaged with interested parties on revised arrangements

The Authority and system operator have engaged with interested parties, with the Authority engaging most recently in January 2014 via the second consultation on extended reserves.¹

The Authority has considered issues raised by submissions on that (second) consultation, and published its responses in a paper which has been released at the same time as this (third) consultation paper.²

New arrangements are proposed

Having taken into account the submissions to the second consultation, this paper sets out the Authority's proposed Code amendments to implement new arrangements. The key aspects of the proposed design are:

- to have an approach which allows for other possible measures to be procured in addition to AUFLS. (As outlined above, these measures, along with AUFLS, will collectively be referred to as 'extended reserves')
- to continue to procure AUFLS via an obligation, but through a process the objective of which is to:
 - vary the amount of AUFLS parties are obliged to provide, according to their relative suitability
 - provide some 'flexible' AUFLS which the system operator can call upon to arm or disarm to meet changing circumstances as required³
 - establish a new extended reserves manager (ERM) role as a market operation service provider, which will manage the process of procuring extended reserves, including developing the methodology that will be used to select participants to provide AUFLS
 - require, for the procurement process, parties to provide information to the ERM as to the load offered for AUFLS

¹ <http://www.ea.govt.nz/dmsdocument/16595>

² <https://www.ea.govt.nz/development/work-programme/wholesale/efficient-procurement-extended-reserves/consultations/#c7618>

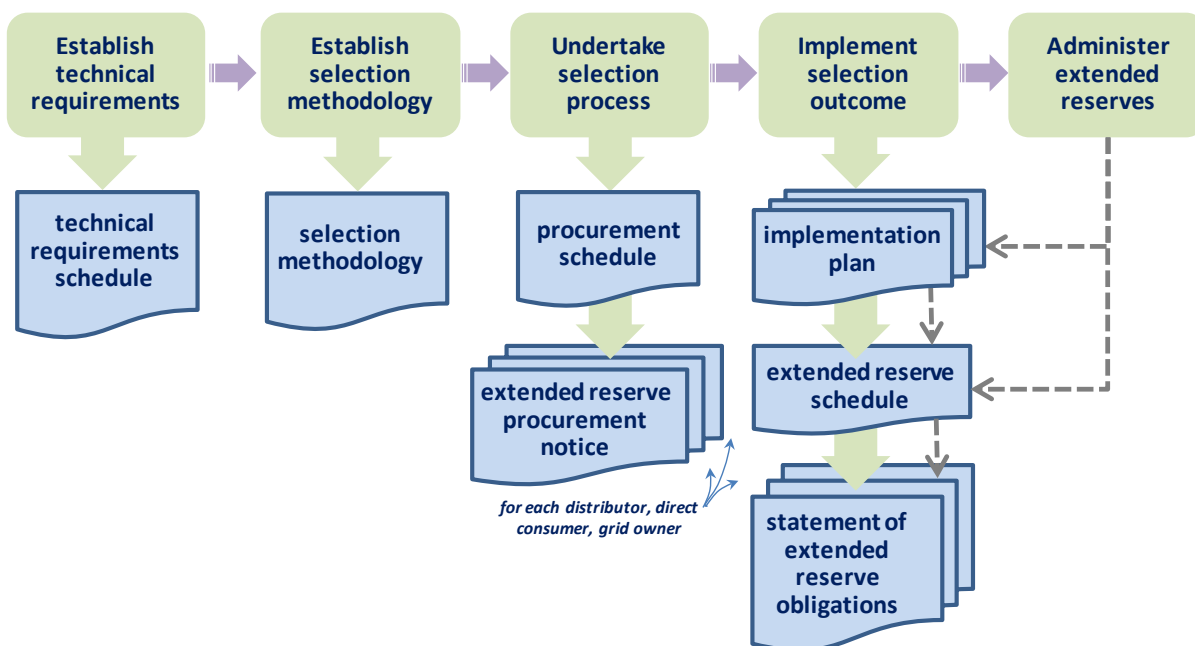
³ This means short-term changes (not real-time) in armed quantities of AUFLS that the system operator can account for by calling on the flexible provider.

- require, during operation, parties to provide information to the system operator as to the load armed for AUFLS
- to enable parties to be compensated for the provision of AUFLS (and other extended reserves), and for such payments to be recovered from distributors and direct consumers in proportion to their demand
- to remove the *detailed technical & procurement specifics* of AUFLS provision from the Code, and replace it with a framework where:
 - the Code *enables and governs* the provision of extended reserves (including AUFLS), particularly through creating the obligation for parties to comply with two associated documents – a technical requirements schedule, and selection methodology
 - these associated documents, collectively, set out the *specifics* of: the technical design of AUFLS (and any other extended reserves); the methodology by which it will be procured; and, the on-going terms and conditions for parties to comply with having been selected.

The arrangements involve five elements and some new documents

The proposed new arrangements comprise five elements, shown in green in Figure 1 below, with the Authority, the system operator, and a new service provider (the ERM), having roles in the new arrangements. The arrangements are delivered through a package that includes Code provisions, as well as documents governed by the Code (shown in blue in Figure 1).

Figure 1: Overview of extended reserves arrangements



Cost-benefit analysis indicates material net benefits, consistent with the Authority's statutory objective

The Authority has carried out a cost-benefit analysis, including using a prototype of the optimisation tool which is proposed to be used for the Authority's preferred 'central optimisation' procurement option. This cost-benefit analysis has been updated following information provided in submissions to the January 2014 consultation.

The results of the analysis indicate that, although the preferred option has greater implementation and operation costs, it delivers significantly greater benefits that are of a scale to materially outweigh the increased costs. The scale of net benefits is considered to deliver an NPV of approximately \$147m relative to the status quo.

However, approximately half of this benefit ($\approx$ \$75M) is purely from the reliability benefits of implementing the revised four-block technical scheme design in comparison with the status quo procurement approach.

In terms of determining the most appropriate procurement option, the evaluation considered the extent to which each option would deliver extra reliability benefits plus additional economic efficiency benefits. The Authority considered several alternative procurement approaches that had different implementation costs, and which varied in the extent to which they delivered extra operational benefits. The preferred option is estimated to deliver NPV net benefits which are \$72M greater (over a 15 year period) than the status quo procurement approach, and \$20m greater than the next best procurement option.

With reference to the Authority's statutory objective, the proposal is considered to achieve:

- **competition** benefits, through minimising the extent to which load is prevented from competing in the IR, energy, and network services markets⁴
- **reliability** benefits from reduced risk of system collapse through:
 - better targeting of the right quantity of load to provide AUFLS
 - incentivising the provision of enhanced AUFLS services
 - improving the system operator's visibility of how much load is armed for AUFLS
- **operational efficiency** benefits through minimising:

⁴ Load control is often used as an alternative to consuming network services (the provision of electricity over the transmission and distribution networks). Such load control is typically undertaken at times of peak demand, when such networks are operating close to their maximum capacity.

- the extent to which load is prevented from being allocated to potentially higher value uses such as IL or demand response
- the extent to which high interruption cost load is dropped during events that trigger AUFLS.

Some supporting documents have not been finalised, but indicative examples have been provided

As mentioned above, the process for determining the detailed specifics of AUFLS provision⁵ will include a number of new documents. Two of these are:

- the extended reserves technical requirements schedule which specifies the required technical design of the overall AUFLS scheme
- the extended reserves selection methodology which specifies the approach to identifying which loads should be armed to deliver this overall technical requirement.

These two documents will be finalised in 2014/15, and the details of what they will contain will be subject to further consultation with interested parties. For the purpose of this consultation, the Authority and system operator have developed indicative examples of the documents (included as appendices) for information purposes only. This is to enable submitters to make informed submissions on the proposed Code amendments.

The approach set out in the indicative example selection methodology is based on the preferred procurement approach the Authority put forward in the January 2014 consultation, but with some changes to reflect information provided by submissions. The key aspects of this approach are:

- an optimisation tool will be used to select which loads should provide AUFLS, including selecting a proportion of 'flexible' AUFLS providers that can be armed and dis-armed on notice
- parties will provide information to the optimisation process, including (it is expected): historical load profiles, historical extent of the load being used for other demand-side purposes (IL, dispatchable demand (DD), demand response

⁵ Such specifics include: the technical design of AUFLS (how much load should be provided as AUFLS at different times, the block configuration and trigger settings), the methodology to select which loads should provide AUFLS, the amount to pay parties for provision of AUFLS, the means by which parties can change which loads are armed to provide AUFLS to meet their changing circumstances, and the details of the information reporting and compliance requirements.

(DR)), estimates of load interruption costs (sometimes referred to as VoLL),⁶ and whether the load has existing AUFLS capabilities

- compensation payments will comprise two key elements: payments to cover the expected interruption costs of loads armed for AUFLS, and payments to cover the costs of providing AUFLS capability (e.g. relays, associated control systems), with payments distinguishing between 'standard' and 'enhanced' AUFLS provision
- parties selected to provide AUFLS will have an on-going obligation to:
 - provide annual updates on historical profiles of loads armed to provide AUFLS, and the extent to which load under AUFLS feeders is used for other purposes such as IL
 - notify the system operator of any changes to the configuration of their networks which will affect the delivery of AUFLS (subject to a de-minimis requirement in the case of temporary, maintenance-related changes), and replace on a like-for-like basis any feeders which can no longer provide AUFLS if such replacement is practicable.

⁶ For the majority of lines company load, this VoLL estimation will be achieved via a simplified centrally-determined framework that will be consistent with the current framework used by lines companies for prioritising feeders for rolling outages, and consistent between lines companies in terms of the VoLL values for classes of customers (e.g. residential, commercial, critical civil defence etc.)

Glossary of abbreviations and terms

Act	Electricity Industry Act 2010
AOPO	Asset Owner Performance Obligation means a performance obligation specified in subpart 2 of Part 8 that an asset owner must comply with so that the system operator can plan to comply and comply with its PPOs
AUFLS	Automatic Under-Frequency Load Shedding, an extended reserve service that is a 'last resort' mechanism by which large blocks of load are shed to prevent system collapse in the event of a (rare) failure of major parts of the supply system
Authority	Electricity Authority
CBA	Cost-benefit analysis
CBD	Central business district
Code	Electricity Industry Participation Code 2010
CE	Contingent event, defined as an event for which the impact, probability of occurrence and estimated cost and benefits of mitigation are considered to justify implementing policies that are intended to be incorporated into the scheduling and dispatch processes pre-event
CRE	Competition, reliability, and efficiency. The three components of the Authority's statutory objective under the Act (to promote competition in, reliable supply by, and the efficient operation of, the New Zealand electricity industry for the long-term benefit of consumers)
DD	Dispatchable demand, a regime which enables demand-side participants to participate more fully in the wholesale electricity market
df/dt trigger df/dt relay	a trigger or relay that operates on the basis of rate of change of frequency
Direct consumer	an electricity consumer with a point of connection to the national grid
Distributor	a party who conveys electricity on lines other than lines that are part of the national grid (the term Distributor includes Direct Consumers for the purposes of Part 8 of the Code)

DR	Demand response, a generic term that encompasses a variety of responses from the demand-side including interruptible load, control of hot-water heating load by distributors and peak period load control
ECE	Extended contingent event, defined as an event for which the impact, probability, cost and benefits are not considered to justify the controls required to totally avoid demand shedding and maintain the prescribed quality limits
Extended reserves	Services provided by selected asset owners to restore frequency to the normal band after disturbances of a magnitude that makes it impracticable or uneconomic to restore frequency using ancillary services (currently AUFLS is the only extended reserves service)
ERM	Extended reserves manager, a proposed new service provider that will establish the selection methodology and undertake the selection process
Extended reserves procurement notice	The notice given to an asset owner by the ERM following completion of the selection process and approval by the Authority of the extended reserves procurement schedule
Extended reserves procurement schedule	The schedule, approved by the Authority following consultation, that sets out the outcomes of the selection process
Extended reserves provider	An asset owner required to provide extended reserves under Schedule 8.3, Technical Code B, clause 7 of the Code
Extended reserves selection methodology	The methodology by which extended reserves will be procured, developed by the ERM and approved, following consultation, by the Authority
Extended reserves schedule	The schedule that sets out all current extended reserves obligations, maintained and published by the system operator
Extended reserves technical requirements report	A report prepared and published by the system operator at least every five years reflecting its most recent review and analysis of the technical requirements for extended reserves

Extended reserves technical requirements schedule	The technical requirements schedule prepared and published by the system operator (and reviewed at least every five years), setting out the technical requirements for extended reserves (including AUFLS) as indicated in the extended reserves technical requirements report
Frequency collapse	Significant reduction in frequency, generally caused when the failure of one part of the system triggers the failure of successive parts (a significant increase in frequency can also result in frequency collapse)
GXP	Grid exit point, typically a point of connection on the grid at which electricity predominantly flows out of the grid
Hz	Hertz, the unit of measure for frequency
IL	Interruptible Load, a form of IR
IR	Instantaneous Reserve, an ancillary service the system operator contracts for to assist in managing frequency disturbances outside the normal band
Load	a consumer's demand for electricity, or the collective demand across a group of consumers
Lines company	an alternative term for Distributor
Normal band	the frequency band between 49.8 Hertz and 50.2 Hertz
NPV	Net present value
Policy Statement	A document, incorporated by reference in the Code, setting out the policies and means that are considered appropriate for the system operator to observe in complying with the PPOs
PPOs	Principal Performance Obligations, the system operator obligations in Clause 7.2 of the Code
PROPs	Participant rolling outage plans, required under Part 9 of the Code as part of the arrangements for management and co-ordination of planned outages as an emergency measure during energy shortages
Regulations	Electricity Industry (Enforcement) Regulations 2010
RPO	Reasonable and Prudent Operator obligation on the system operator as defined in Part 1 of the Code
SERO	Statement of extended reserves obligations prepared by the system operator setting out, for each relevant asset owner, that party's specific obligations, terms and conditions for extended reserves

system operator	Transpower NZ Ltd, in its role as the service provider under the Act and Code responsible for ensuring the real-time co-ordination of the electricity system
system collapse	Failure in the interconnected electricity system, generally caused when the failure of one part of the system triggers the failure of successive parts
TRS	Extended reserves technical requirements schedule
UFM	Under-frequency management
UoSA	Use of system agreement
VoLL	Value of lost load

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1. What you need to know to make a submission

1.1 What this consultation paper is about

Focus of this consultation is the proposal for procurement of extended reserves and supporting Code amendments

- 1.1.1 The purpose of this paper is to consult with participants and persons that the Authority thinks are representative of the interests of persons likely to be affected by the Authority's proposed arrangements for extended reserves procurement and the associated Code amendment proposal.
- 1.1.2 Section 39(1)(c) of the Electricity Industry Act 2010 (Act) requires the Authority to consult on any proposed amendment to the Code and the regulatory statement. Section 39(2) provides that the regulatory statement must include a statement of the objectives of the proposed amendment, an evaluation of the costs and benefits of the proposed amendment, and an evaluation of alternative means of achieving the objectives of the proposed amendment. The regulatory statement is set out in Section 6 of this paper.
- 1.1.3 The proposed Code amendment is attached as Appendix B. The Authority invites submissions on the proposed arrangements for extended reserves and the associated regulatory statement and proposed Code amendment, including drafting comments.

Supporting material is provided to assist stakeholders

- 1.1.4 The proposed arrangements for extended reserves will be delivered by a package that includes:
 - (a) the Code provisions for extended reserves arrangements set out in Appendix B
 - (b) several key documents developed pursuant to, and governed by, these Code provisions, in particular:
 - (i) the extended reserves technical requirements schedule which sets out the proposed new AUFLS technical requirements (number, size, and trigger settings of blocks and so on)
 - (ii) the extended reserves selection methodology which specifies the information each party is required to submit into the selection process and sets out how feeders will be selected to provide AUFLS

- (iii) a statement of extended reserves obligation, specific to each party, setting out that party's obligations resulting from completion of the selection process.

1.1.5 In simple terms, the distinction between these is that:

- (a) the Code provisions will enable and govern the proposed approach to procuring extended reserves (of which AUFLS is currently the only extended reserves product to be procured). The new provisions will include an obligation to comply with certain aspects of two key associated documents –the selection methodology and statement of extended reserves obligation;
- (b) the associated documents, collectively, set out the detailed specifics of:
 - (i) the required technical design of the overall AUFLS scheme – to be specified in the technical requirements schedule
 - (ii) the approach to identifying which loads should be armed to deliver this overall technical requirement – to be specified in the selection methodology
 - (iii) the outcomes of the selection process – to be specified in the (centralised) extended reserves schedule and individualised statements of extended reserves obligations.

1.1.6 Due to the strong inter-relationships between the Code and two of these associated documents, the system operator and the Authority have started to prepare examples of the technical requirements schedule and the selection methodology based on the preferred procurement option recently consulted on, in parallel with developing and consulting on the Code amendment proposal.

1.1.7 To assist stakeholders in their understanding of the Code amendment proposal, the Authority has included with this consultation material an indicative example for each of these two documents for information purposes only. The example documents are included in Appendix D and Appendix E respectively.

1.1.8 The two documents will continue to be refined beyond this consultation. The proposed Code amendment provides for formal stakeholder consultation before the documents are finalised, and this will be carried out later in the project.

1.2 How to make a submission

1.2.1 The Authority's preference is to receive submissions in electronic format (Microsoft Word). It is not necessary to send hard copies of submissions to the Authority, unless it is not possible to do so electronically. Submissions in electronic form should be emailed to submissions@ea.govt.nz with Consultation Paper—Efficient procurement of extended reserves - draft Code amendment in the subject line.

1.2.2 If submitters do not wish to send their submission electronically, they should post one hard copy of their submission to either of the addresses provided below.

Submissions
Electricity Authority
PO Box 10041
Wellington 6143

Submissions
Electricity Authority
Level 7, ASB Bank Tower
2 Hunter Street
Wellington

Tel: 0-4-460 8860

Fax: 0-4-460 8879

1.2.3 The Authority will acknowledge receipt of all submissions electronically. Please contact the Submissions' Administrator if you do not receive electronic acknowledgement of your submission within two business days.

1.2.4 If possible, submissions should be provided in the format shown in Appendix A. Your submission is likely to be made available to the general public on the Authority's website. Submitters should indicate any documents attached, in support of the submission, in a covering letter and clearly indicate any information that is provided to the Authority on a confidential basis. However, all information provided to the Authority is subject to the Official Information Act 1982.

1.3 Deadline for receiving a submission

1.3.1 Submissions should be received by 5pm Tuesday 20 May 2014. Please note that late submissions are unlikely to be considered.

1.4 The Authority and system operator have consulted previously on extended reserves arrangements

1.4.1 As is set out in more detail later in this document, this is the latest in a series of consultations on extended reserves arrangements. Recent

consultations and reports that are of particular relevance to this Code amendment proposal are:

- (a) Under-frequency management (UFM) project – AUFLS II - Economic and Provision Report (Aug 2011)⁷
- (b) First Authority consultation on extended reserves – October 2012⁸
- (c) System operator technical report – August 2013⁹
- (d) Joint Authority and System operator stakeholder workshops on technical proposal and procurement options – October 2013¹⁰
- (e) Second Authority consultation on extended reserves procurement options – January 2014¹¹

1.4.2 At the same time as releasing this consultation, the Authority has published a Response Paper which analyses all the submissions made by submitters to the January 2014 consultation, and sets out its conclusions with regards to each of the issues raised.¹²

⁷ <http://www.systemoperator.co.nz/market/development/current-projects/automatic-under-frequency-load-shedding-aufls-review>

⁸ <http://www.ea.govt.nz/dmsdocument/13764>

⁹ <http://www.systemoperator.co.nz/sites/default/files/bulk-upload/documents/20130807%20AUFLS%20Scheme%20Design%20Report.pdf>

¹⁰ <http://www.systemoperator.co.nz/market/development/current-projects/automatic-under-frequency-load-shedding-aufls-review#prvfid-977> and <http://www.ea.govt.nz/dmsdocument/15989>

¹¹ <http://www.ea.govt.nz/dmsdocument/16595>

¹² <https://www.ea.govt.nz/development/work-programme/wholesale/efficient-procurement-extended-reserves/consultations/#c7618>

2. Technical and economic problems with the existing arrangements

2.1 The existing arrangements

- 2.1.1 The system operator is required under Part 7 of the Code to act as a reasonable and prudent system operator (RPO) with the objective of meeting its principal performance obligations (PPOs). The PPOs relate to managing frequency and avoiding cascade failure of the power system.
- 2.1.2 The policy statement, incorporated by reference in the Code, sets out the policies and means considered appropriate for the system operator to observe in complying with the PPOs. Of particular relevance here is the security policy section of the policy statement. The security policy recognises that there are some types of event, extended contingent events (ECEs), where the impact, probability, cost and benefits are not considered to justify the controls required to totally avoid demand shedding. Extended reserves are important in the management of such events. AUFLS is the only practicable option at present for extended reserves. However, as technology progresses it is possible that additional types of extended reserves could be used to manage such severe events.
- 2.1.3 AUFLS is the 'last resort' mechanism by which large blocks of load are shed to prevent system collapse in the event of a (rare) failure of major parts of the supply system.
- 2.1.4 AUFLS requirements are currently set out alongside other obligations under the Asset Owner Performance Obligations (AOPOs) and Technical Codes in Part 8 of the Code. Distributors and directly connected consumers in the North Island, and the grid owner in the South Island, are required to meet the specified AUFLS obligations at all times.
- 2.1.5 Currently each obligated party faces a common obligation – i.e. each party is required to provide exactly the same proportion of its load for AUFLS, in the same technical configuration. However, concerns about the appropriateness of some parties providing AUFLS has resulted in several North Island participants (directly connected consumers and one distributor with a large industrial load on its network) being granted exemptions from these obligations.
- 2.1.6 The current AUFLS requirements are based around an intended design of two x 16% blocks of load with simple frequency threshold triggers. More specifically, the obligation requires that the AUFLS system must enable, at all times, automatic disconnection of two blocks of demand (each block

being a minimum of 16% of the total pre-event demand) at every North Island grid exit point (GXP) with:

- (a) block one disconnecting demand in the North Island, within 0.4 seconds after the frequency reduces to, and remains at or below, 47.8 Hz
- (b) block two disconnecting demand in the North Island 15 seconds after the frequency reduces to, and remains at or below, 47.8 Hertz, or within 0.4 seconds after the frequency reduces to, and remains at or below, 47.5 Hz.

2.1.7 There are similar provisions for AUFLS in the South Island. However in the South Island the frequency threshold triggers differ, and the obligation rests with the grid owner rather than with distributors and direct consumers. It is the North Island AUFLS arrangements that have been the focus of the technical review.¹³

2.1.8 AUFLS load must not include any interruptible load procured by the system operator. There are also other provisions in the Code relevant to AUFLS, including requirements relating to testing AUFLS equipment, provision of AUFLS block demand profile information, and allowing redistribution of AUFLS load between GXPs.

2.1.9 The Authority, with the assistance of the system operator, has been reviewing the AUFLS arrangements as part of a wider review of the suite of UFM arrangements:

- (a) the system operator has focussed on problems with the technical design of AUFLS – how much load should be placed under AUFLS, how should such load be organised into blocks, and what types of triggers should be used to disconnect the load
- (b) the Authority has focussed on problems with the procurement of AUFLS – what type of load should be placed under AUFLS, and what mechanisms should be used to select such load and ensure it is available for use.

¹³ The system operator has determined that the current wide frequency envelope in the South Island (45 to 55 Hz, versus 47 to 52 Hz in the North Island) makes the risk of under- or over-frequency collapse in an AUFLS event significantly less in the South Island. This makes the changing of AUFLS arrangements a much less pressing issue in the South Island.

2.2 Problems with existing arrangements

The current technical design of AUFLS could be improved

- 2.2.1 The system operator has identified that the current technical AUFLS design of two x 16% blocks with simple frequency threshold triggers has inherent secondary risks associated with it for some events that would trigger AUFLS.
- 2.2.2 The nature of this system collapse risk arising from the current AUFLS technical design is twofold:
- (a) firstly, in some situations the amount of AUFLS armed on the system will be insufficient to cover the size of loss, and under-frequency collapse will occur
 - (b) secondly, in other situations *too much* AUFLS load will be dropped, which may result in the system frequency significantly over-shooting and resulting in over-frequency collapse.¹⁴
- 2.2.3 Analysis presented by the system operator indicated that the current scheme design may not perform in approximately 6.8% of AUFLS events. Given that an event large enough to trigger AUFLS is only likely to occur approximately once in every 5.4 years, this would mean that system collapse due to non-performance of the AUFLS scheme would occur 'only' once in every 80 years (i.e. $5.4 \text{ years} \div 6.8\%$). However, given that the cost of a black-out is so large (approximately \$1.5bn for loss of the North Island), the 'expected annual' system collapse cost arising from non-performance of the current AUFLS scheme design is approximately \$19m per year (calculated on the basis of $\$1.5\text{bn} \div 80 \text{ years}$).
- 2.2.4 It should be noted that the above analysis was based on assumptions that the amount of AUFLS provided met the *intended* design – i.e. 2 x 16% blocks of load. However, the system operator has also identified that there appears to be systematic over-provision of AUFLS such that at times of high demand the quantity of load armed for AUFLS can be greater than 50%.¹⁵ There is currently very poor visibility of how much AUFLS is actually provided at different times, so it is possible that the actual collapse risk is greater than that estimated above.

¹⁴ If too much load is dropped in an AUFLS event, the system frequency can shoot back up beyond the normal range, potentially above 52 Hz. Such over-frequency levels may cause some generators to trip, thereby causing system frequency to fall again, but this time without the benefit of under-frequency resources such as IR or AUFLS to arrest such fall given that they would have been used in the first under-frequency fall.

¹⁵ This systematic over-provision is because of the incentives created by the obligation being expressed as a requirement to provide a *minimum* of 2 x 16% at all times. This is explained in more detail on page 29.

- 2.2.5 In August 2013, the system operator put forward its revised technical solution.¹⁶ The key elements of the system operator's solution are to move to a design where the AUFLS load is configured in a larger number of smaller blocks, some of which will be faster to act in very severe events through the use of df/dt triggers.¹⁷
- 2.2.6 Splitting the load into a smaller number of blocks improves the ability to only drop 'just enough' load to match the size of event. This significantly reduces the risk of over-frequency collapse in particular. Further, the use of df/dt triggers reduces the risk of under-frequency collapse in very large events.
- 2.2.7 The key design elements of this new AUFLS scheme design are to have four blocks, configured in a 10%:10%:6%:6% fashion, with the last block additionally triggered by a df/dt mechanism.
- 2.2.8 The system operator's technical analysis identified that moving to this new scheme design, *if coupled with a requirement to provide approximately 32% of load on average as AUFLS*, would reduce the non-performance rate of the AUFLS scheme from 6.8% per AUFLS event to 2.8%. This would reduce the expected system collapse cost due to non-performance of the AUFLS scheme to approximately \$7.8m per year.
- 2.2.9 The phrase "*if coupled with a requirement to provide approximately 32% of load on average as AUFLS*" is italicised in the above paragraph because analysis undertaken by the Authority¹⁸ and presented in paragraphs C.62+ of this consultation highlights that the optimal quantity of load provided as extended reserves varies with system conditions. Ensuring that the right amount of load is armed at different times is considered by the Authority to be one of the key challenges of the procurement aspect of AUFLS arrangements. This aspect is addressed in the following section.

¹⁶ See: <http://www.systemoperator.co.nz/sites/default/files/bulk-upload/documents/20130807%20AUFLS%20Scheme%20Design%20Report.pdf> which can be found on the system operator's AUFLS review web page: <http://www.systemoperator.co.nz/market/development/current-projects/automatic-under-frequency-load-shedding-aufls-review>

¹⁷ The current 'standard' approach to triggering an AUFLS block is if system frequency drops below a fixed frequency threshold (e.g. the first block in the current design is triggered if frequency drops below 47.8Hz). A df / dt trigger is activated if the *rate of change* of frequency is greater than some specified level. This allows an AUFLS block to be triggered much sooner in very severe events than waiting for frequency to drop below a fixed trigger level.

¹⁸ This analysis was based on data provided by the system operator from its technical analysis in relation to how the system collapse risk varies with the % of load armed for AUFLS for high, medium, and low demand conditions.

- 2.2.10 The system operator is continuing to develop its proposed new technical requirements for AUFLS, drawing on technical studies and stakeholder feedback. The example technical requirements schedule included in this consultation package is representative of the likely outcome of the technical review for the Authority's proposed preferred procurement option consulted on in January 2014. Following the completion of this consultation process, stakeholders will have an opportunity to make formal submissions on any associated new technical standards later in the implementation process. As is set out in section 4, this is likely to be in the 4th quarter of 2014.

The means by which AUFLS load is procured is inadequate

- 2.2.11 Analysis undertaken by the Authority has revealed that the current procurement approach of placing a common percentage obligation on all transmission-connected loads is resulting in higher costs across three main dimensions:
- (a) system reliability costs from a higher risk of collapse during an AUFLS event
 - (b) higher energy and IR market costs from preventing some loads from being more valuably used to provide IR or DR
 - (c) higher load-shedding costs during an AUFLS event from placing some relatively high interruption-cost load under AUFLS.¹⁹
- 2.2.12 These costs are due to four challenges inherent in procuring AUFLS:
- (a) not all loads are equally suitable for AUFLS
 - (b) transaction costs prevent AUFLS being procured from individual customers
 - (c) the standard Code mechanisms (dispensations or equivalence) for varying obligations on individual stakeholders are inadequate in the case of AUFLS
 - (d) creating an obligation framework which strikes the right balance between delivery of what is required for system security versus the compliance burden on parties.

Not all loads are equally suitable for AUFLS

- 2.2.13 The fundamental issue with AUFLS provision is that some loads are more suitable to provide AUFLS than others. There are three aspects to this:

¹⁹ The cost of interruption is often referred to as the "value of lost load" (VoLL).

- (a) ***variations in the ‘shapes’ of the different loads result in differences in system reliability outcomes*** – The system operator’s technical analysis identified that the ideal percentage of load to be placed under AUFLS varies significantly with system conditions. At times of low demand a high percentage of load under AUFLS would be desirable, and vice versa. Loads with different within-day and within-year shapes (baseload versus a peaky or seasonal shape) would have varying levels of suitability to meet the optimal AUFLS level
- (b) ***competing uses for load*** – Some load has characteristics that make it suitable to be used in other aspects of the market, e.g. being offered as IL in the IR market, or other demand-side ‘products’ such as DD, or DR. Requiring such load to provide AUFLS may prevent it from being used for these other purposes, which may increase overall system costs
- (c) ***variations in VoLL*** – Some loads are more expensive to disconnect in an AUFLS event than others. Central business districts in the main cities, some industrial processes, hospitals and critical civil emergency infrastructure are examples of that. The scale of interruption cost is typically expressed as the VoLL.

2.2.14 Some loads which have relatively low VoLL (domestic feeders), may not have an ideal load shape from the system reliability perspective. Identifying the most suitable load will therefore require evaluating the trade-offs between different cost aspects.

2.2.15 There are two other aspects that can affect the suitability of load:

- (a) ***variations in the divisibility of loads*** – A small lines company with a small number of feeders or a direct connect with a small number of large load blocks within its site will find it much harder to arm its load to provide specific-sized AUFLS blocks than a large lines company with many hundreds of feeders. Loads facing such divisibility problems may end up being forced to place a greater amount of load under AUFLS than the obligated (ideal) amount, thereby potentially resulting in a poorer system security outcome and higher VoLL and/or IR costs
- (b) ***variations in the predictability of loads*** – Some loads have a much less predictable and less ‘stable’ shape than others. For example, some industrial sites have major processes turning on and off at varying times throughout the day and year, making it extremely challenging to configure their sites to provide certain percentage quantities of AUFLS at different times of the day and year.

Transaction costs prevent AUFLS being procured from (most) individual customers

- 2.2.16 Given the variation in customers' load characteristics, it would be ideal to secure AUFLS only from those individual customers who were most willing (and suitable) to provide AUFLS.
- 2.2.17 However, given current technological constraints, it is not practicable to adopt such an approach for any but a small number of the very largest consumers. This is because the cost of installing AUFLS relays on multiple small consumers (coupled with the associated contractual transaction costs) would rapidly become prohibitive.
- 2.2.18 Instead, it is much more cost effective to arm AUFLS relays at a substation level and to use a single relay to arm the load of thousands of customers.
- 2.2.19 This technological constraint means that it is really only practicable to procure AUFLS from lines companies and a small number of the very largest industrial customers.
- 2.2.20 It is possible that future developments in advanced metering may facilitate arrangements where individual consumers could provide extended reserves. However, it is not the case at present, and it could be many years away before this option becomes practicable.

The standard Code provisions to vary obligations on individual stakeholders are inadequate in the case of AUFLS

- 2.2.21 The standard Code mechanisms to address special situations are equivalence arrangements or dispensations. However, as was set out in the January 2014 consultation, these have some inherent barriers in the AUFLS context that make the use of such arrangements ineffective – in particular the poor information, incentives and contractual ability of lines companies to voluntarily place their customers under AUFLS.
- 2.2.22 Because of concerns about the appropriateness of the current arrangements for all participants, all North Island direct connect industrial customers have been granted temporary exemptions by the Authority.²⁰

Structuring an obligation which delivers the amount required, without an excessive compliance burden

- 2.2.23 The current obligation is specified as being to provide two blocks each of a *minimum* of 16% of demand at all times. This creates an asymmetric

²⁰ The first exemptions were granted in 2004, but because arrangements were not put in place to address the inadequacies with AUFLS, these exemptions have been extended several times.

compliance risk on parties in that they will be penalised for providing too little, but not for providing too much. This compliance requirement is resulting in significant systematic over-provision of AUFLS. Parties will generally arm a greater number of feeders than is necessary to meet a 32% total requirement, in order to be able to meet the minimum requirement at all times.

- 2.2.24 This over-provision is exacerbated by the fact that lines companies have tended to place AUFLS on feeders with a high proportion of residential customers because of their lower interruption costs. However, because such feeders have a very strong day / night profile, they need to arm sufficient feeders to meet the minimum 32% requirement overnight. This results in substantially greater provision (of the order of 50% of load) during the day. As set out elsewhere (paragraphs C.69+ in Appendix C give the most detailed description), this pattern of provision (high at times of high demand, low at times of low demand) is the exact opposite of what is desired.
- 2.2.25 To address this pattern of over-provision, it would be possible to specify a structured obligation that varied with time of day and year, and have tight tolerances for maximum as well as minimum delivery. However, such an obligation could create significant compliance costs for parties to meet. These extra costs are reflected in the cost-benefit analysis set out in Appendix C.

2.3 The Authority has reviewed alternative AUFLS procurement options

- 2.3.1 The Authority issued the first consultation paper "*Efficient procurement of extended reserves*" in October 2012.²¹ The paper outlined a range of potential options, from a simple centrally-coordinated approach through to highly complex market arrangements.
- 2.3.2 Subsequent analysis during the course of 2013 resulted in further issues being identified, and further procurement options were developed in addition to those set out in the first consultation.
- 2.3.3 The procurement options that were identified are set out in Table 1 below:

²¹ <http://www.ea.govt.nz/dmsdocument/13764>

Table 1: AUFLS procurement options

High-level family	Sub-variant
1) Common AUFLS percentage obligation	1.a) <i>Standard Code mechanisms</i> (equivalence, dispensations and exemptions) used to vary individual stakeholders provision away from the common percentage requirement.
	1.b) As above, <i>plus prioritised block coordination</i> (enabling high value load to be put in AUFLS block 4 rather than block 1, ²² and allowing small stakeholders to provide a single block of 32%, rather than four blocks of 10%:10%:6%:6%.)
	1.c) As above, <i>plus special exclusions</i> to exempt certain stakeholders, including: exempting direct connects from any obligation and allowing IL to be counted towards meeting an AUFLS obligation
	1.d) As above, <i>plus profiled minimum and maximum obligations</i> (i.e. varying the percentage obligation by time of day and year, and penalising for over-provision as well as under-provision.)
2) Varying AUFLS provision via optimisation (the amount each stakeholder provides will be based on the relative suitability of the load)	2.a) <i>No compensation, plus central VoLL estimation</i> of lines companies' load
	2.b) <i>With compensation, plus central VoLL estimation</i> of lines companies' load
	2.c) <i>With compensation, plus lines companies' VoLL estimation</i> of lines companies' load
3) Voluntary AUFLS tender	3.a) <i>Simple pay-as-bid tender</i>
	3.b) <i>'Sophisticated' AUFLS market</i>

²² Initial analysis suggests that the return period of the first block being called upon would likely be approximately one in five years, whereas the return period of the fourth block being called upon could be of the order of one in 50 years.

- 2.3.4 Following the completion of the system operator's technical analysis,²³ the Authority and the system operator held a series of stakeholder workshops in October 2013.²⁴ The proposed technical solution was presented in detail and the range of different procurement options was discussed.
- 2.3.5 Having considered all the stakeholder input on the relative pros and cons of the different procurement options, the Authority identified a preferred option for the procurement of AUFLS as an 'extended reserves' product – namely: *2.b) Varying AUFLS provision via optimisation, with compensation plus central VoLL estimation of lines companies' load*. This was set out in the January 2014 consultation paper.²⁵

2.4 The Authority reviewed the submissions on the January 2014 consultation paper

- 2.4.1 Eleven stakeholders made submissions to the January 2014 consultation paper, as listed in the following table

Lines companies	Direct connects	Retailers
Northpower	MEUG	Contact
Orion	NZ Steel	Meridian
Powerco	Norske Skog	
Vector	Pacific	
Transpower	Aluminium	

- 2.4.2 All submitters agreed with the key issue behind the development of revised arrangements, namely that a one-size-fits-all common obligation approach would deliver poor outcomes. Submitters also agreed that a voluntary market-based approach to procuring AUFLS would be impracticable – in large part because of the inability of lines companies to engage in such a market due to not having the contractual rights to do so under their use of system agreements with their customers.

²³ [http://www.systemoperator.co.nz/sites/default/files/bulk-upload/documents/20130807%20AUFLS%](http://www.systemoperator.co.nz/sites/default/files/bulk-upload/documents/20130807%20AUFLS%20)

²⁴ <http://www.systemoperator.co.nz/market/development/current-projects/automatic-under-frequency-load-shedding-aufls-review#prvfid-977> and <http://www.ea.govt.nz/dmsdocument/15989>

²⁵ <http://www.ea.govt.nz/dmsdocument/16595>

- 2.4.3 Only two parties (Orion and Northpower) suggested that a different option to that proposed by the Authority would deliver superior outcomes. Both parties effectively suggested that options 1c or 1d in Table 1 above would be better.
- 2.4.4 Norske Skog was concerned about whether the optimisation model would work.
- 2.4.5 Transpower didn't endorse the proposed approach but neither did it say it couldn't work or promote an alternative.
- 2.4.6 All remaining submitters were supportive of the proposed approach, although in many cases expressed reservations about specific aspects of the detail of its implementation. Vector in particular was concerned as to whether the approach would work in practice due particularly to concerns about whether the proposed compensation mechanism would provide adequate incentives on lines companies to provide enhanced AUFLS within the context of the Commerce Commission's price control regime.
- 2.4.7 The Authority has analysed all the issues raised by submitters, and presented the results of such analysis in a Response Paper released at the same time as this consultation.²⁶
- 2.4.8 At a high level, the Authority believes that the preferred option that was put forward in the consultation remains the most appropriate.
- 2.4.9 However, the submissions made many useful suggestions that have enabled the Authority to refine some of the detailed implementation aspects of the proposed approach, and to update the assumptions in the cost-benefit analysis in Appendix C.

²⁶ <https://www.ea.govt.nz/development/work-programme/wholesale/efficient-procurement-extended-reserves/consultations/#c7618>

3. Description of the proposed Code amendment proposals

- 3.1.1 Having considered all submissions made by stakeholders, and having engaged extensively and in an on-going way with the system operator, the Authority has designed a set of arrangements to implement its preferred approach for procuring AUFLS.
- 3.1.2 Changes will be required to the Code to implement the proposed new arrangements. The following subsections describe the key features of the new arrangements, and the proposed Code amendment in Appendix B gives full details of how the new arrangements will be structured.
- 3.1.3 Section 4 of this paper sets out the proposed implementation tasks and target timeline, and Section 5 provides more detail on the key features and the Authority's rationale for the design it is proposing. The Authority's Regulatory Statement, including the cost-benefit analysis and assessment against the Code amendment principles, is set out in Section 6.

3.2 The key drivers for the design of the proposed arrangements

- 3.2.1 The Authority has designed a set of arrangements that deliver the preferred approach to address the problems set out in section 2.2.
- 3.2.2 The key drivers for the Authority's design are:
 - (a) the design must meet the Authority's statutory objective and functions under the Act, in particular to efficiently improve the reliability of electrical supply where there is a net benefit in doing so and to improve the efficient operation of the market for the long-term benefit of consumers
 - (b) the design needs to be consistent with the system operator's role under the Code, particularly in relation to security of supply and real-time co-ordination
 - (c) the governance framework embedded in the design needs to reflect the Authority's statutory objectives and the interests of affected parties (including end consumers, existing and potential providers of extended reserves and the system operator)

- (d) the design must be sufficiently flexible to accommodate:
 - (i) as well as delivering the Authority's preferred approach, a reasonable range of variations on this preferred approach without the need for substantive Code amendments
 - (ii) the possibility of there being other types of extended reserves²⁷ in the future, not just AUFLS
 - (iii) AUFLS arrangements in the South Island which differ from those in the North Island
 - (iv) small or localised changes in extended reserves requirements without the need to undertake and implement a full selection process
 - (v) extended reserves providers being able to manage their normal day to day business operations and, if necessary, to make reasonable changes to the manner in which they meet their extended reserves obligations
- (e) the design must deliver meaningful progress towards the Authority's objective of a more market-based approach to extended reserves
- (f) the design needs to integrate extended reserves arrangements into the Code using existing Code mechanisms wherever practicable (e.g. monitoring and compliance, ancillary services clearing and settlement, monthly system operator reporting, and asset owner testing arrangements)
- (g) the design needs to ensure extended reserves arrangements can operate effectively alongside existing arrangements for ancillary services (particularly IR) and emergency management (in particular rolling outage planning requirements under Part 9 of the Code).

The proposed design combines aspects of asset owner obligations and ancillary service arrangements

- 3.2.3 The design recognises that the new approach to procuring AUFLS retains many of the existing aspects of AUFLS as an asset owner performance obligation (AOPO) under Part 8 of the Code, but incorporates certain aspects of ancillary service arrangements (e.g. a procurement process set

²⁷ As set out earlier, 'extended reserves' are defined as those resources used to prevent system collapse in events which are too large to be managed solely with instantaneous reserves.

out in an associated document, cost recovery provisions in the Code and undertaken by the clearing manager).²⁸

3.2.4 The design is also generalised to accommodate the possibility of there being other types of extended reserves in the future, not just AUFLS. However, at the present time the only practicable form of extended reserves is the provision of large blocks of load via AUFLS relays. Accordingly, where the arrangements are only relevant to the provision of AUFLS, this paper refers specifically to AUFLS rather than extended reserves.

3.2.5 In essence, the existing obligation on distributors and direct consumers to meet AUFLS requirements specified in the Code is replaced by:

- (a) a set of technical requirements for extended reserves (AUFLS) specified by the system operator (after consulting with the Authority and with affected parties) in an associated technical requirements schedule
- (b) an obligation on lines companies and direct consumers to provide information on extended reserves (AUFLS) capability into a centralised selection process, the methodology of which will have been approved by the Authority (after a consultation process with the system operator and affected parties), and which will be governed by principles specified in the Code
- (c) an obligation on those participants to arm/disarm/re-set their respective AUFLS loads (and possibly to invest in new AUFLS equipment) according to the outcome of the selection process. This may include requiring parties to provide 'flexible' AUFLS load. That is, to be able to either:
 - (i) arm a feeder which is on 'standby' within a specified notice period; or
 - (ii) dis-arm a feeder which is currently armed to become on standby
- (d) an on-going obligation on those participants selected to provide AUFLS to notify the system operator of any material changes to loads selected to provide AUFLS, and to provide like-for-like replacements where possible

²⁸ A further similarity is that extended reserves obligations are specified in a statement of extended reserves obligations, prepared by the system operator from the outcome of the selection process and sent to each extended reserves provider. This is comparable to ancillary services which are provided under ancillary service contracts between each provider and the system operator.

- (e) an on-going obligation on those participants selected to provide AUFLS to provide updated information on an annual basis on the feeders selected to provide AUFLS regarding historical load profiles and the extent of use of load for alternative uses such as IL
 - (f) compensation payments to those participants selected to provide AUFLS that recognises the potential interruption costs, the opportunity cost of making the load available for AUFLS, capital cost of new equipment (if relevant), and so on
 - (g) a pro rata cost allocation to lines companies and direct consumers to recover the amounts paid to extended reserves providers.
- 3.2.6 Some of the detailed thinking about the specifics of some of the arrangements and the rationale for the Authority's preferred approach is set out in the Response Paper released at the same time as this consultation.²⁹ Stakeholders are encouraged to review the items addressed in that Response Paper.
- 3.2.7 The above arrangements will apply initially only to the North Island. The Authority does not propose to change the procurement arrangements for AUFLS in the South Island at this time given the very different situation,³⁰ but intends to implement the revised technical standard in terms of revising the trigger setting for the second block in the South Island in accordance with the system operator's technical review of AUFLS.³¹ The transitional arrangements described in section 5 explain how this will be achieved.

Flexible arrangements based around five key elements

- 3.2.8 The proposed arrangements for extended reserves consist of five key elements, as shown in the green boxes in Figure 2.

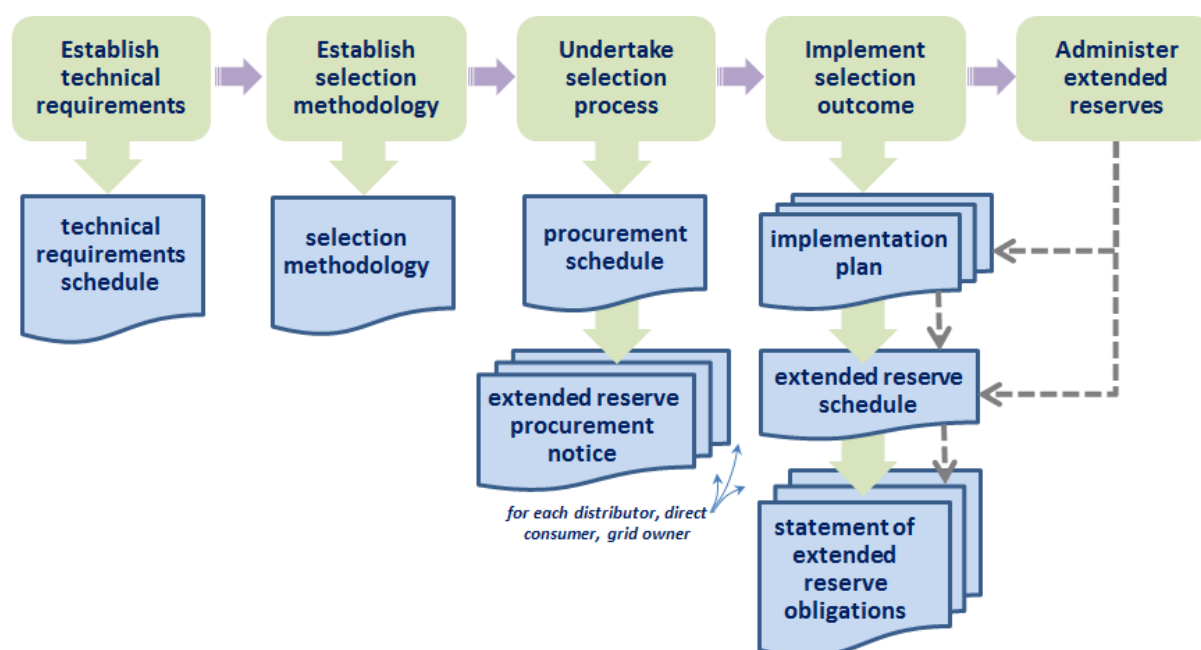
²⁹ <https://www.ea.govt.nz/development/work-programme/wholesale/efficient-procurement-extended-reserves/consultations/#c7618>

³⁰ While the situation in the North Island is giving rise to a strong system security driver to change the AUFLS arrangements, the system operator has determined that the current wide frequency envelope in the South Island (45 to 55 Hz, versus 47 to 52 Hz in the North Island) makes the risk of under- or over-frequency collapse in an AUFLS event significantly less in the South Island. This makes the changing of AUFLS arrangements a much less pressing issue in the South Island. The development of the South Island AUFLS arrangements is likely to commence once the Authority has amended the Code to implement the North Island AUFLS regime. The South Island development is also subject to the system operator determining whether the South Island frequency envelope needs to change to facilitate initiatives such as the National Reserves Market and National Frequency Keeping markets.

³¹ <http://www.systemoperator.co.nz/sites/default/files/bulk-upload/documents/AUFLS-III-RoCoF-testing-summary.pdf>

- 3.2.9 The arrangements are delivered through Code provisions, and documents developed pursuant to, and governed by, those Code provisions (shown in blue in Figure 2). The Authority, the system operator and a new service provider, the extended reserves manager (ERM), have key roles in the new arrangements.
- 3.2.10 To the extent practicable, the new extended reserves arrangements use existing mechanisms in the Code, such as monitoring and compliance, settlement procedures, monthly system operator reporting, and asset owner testing arrangements.

Figure 2: Overview of extended reserves arrangements



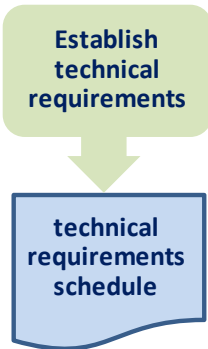
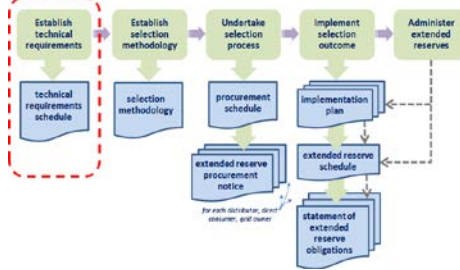
- 3.2.11 The arrows in the diagram above illustrate the various stages and the process to produce the various documents.
- 3.2.12 The diagram shows an initial AUFLS selection process (green arrows) as well as updates to the key documents (grey arrows) between selection processes, for example to accommodate parties changing feeders armed for AUFLS due to network reconfigurations.
- 3.2.13 This approach has been designed to deliver an appropriate balance between:
- certainty for affected parties (particularly the system operator and potential providers)
 - enforceability of provisions

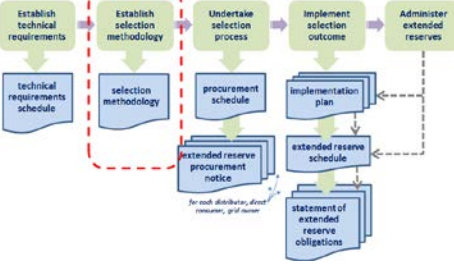
- flexibility to accommodate dynamically changing information, and changes in circumstance and technology over time.
- 3.2.14 The five elements are designed to deliver greater flexibility. Although they are depicted in sequence, it is not necessarily the case that a change in circumstances requires all five elements to be undertaken every time a selection process is undertaken. In particular, the Authority expects that the technical requirements and selection methodology may remain unchanged for several years, and that:
- small changes in circumstances can be accommodated by flexible procurement arrangements provided by some selected providers
 - larger changes can be accommodated by undertaking the selection process again with a scope limited to a certain area or type of service.
- 3.2.15 The Code requires that key aspects of the process be undertaken at least once every five years, namely a review of the technical requirements schedule and a full selection process. However, the Code allows for some elements to be carried out more frequently if necessary. It is possible, for example, to re-run part of a selection process, limiting the scope to a particular geographic region, or to review the selection methodology and then re-run a selection process.
- 3.2.16 Each of the five elements is a straightforward process. The Authority expects that the inputs and outputs of the selection process will be relatively simple, leaving any complexity to the selection tool that implements the selection methodology and determines the selection outcomes.
- 3.2.17 The Authority expects that the central optimisation tool will undertake all the ‘heavy lifting’ of identifying the appropriate loads to place under AUFLS. As a result, the information and compliance burden on participants should not be significantly greater than (and may possibly be even less than) a process which places the responsibility on participants for selecting feeders to meet a common obligation which is highly structured with tight maximum and minimum tolerances.³² This is reflected in the cost estimates in the cost-benefit analysis in Appendix C – which also shows that a simpler obligation would result in lower costs for participants, but with reduced system security benefits that are estimated to be of a greater magnitude than these lower costs.

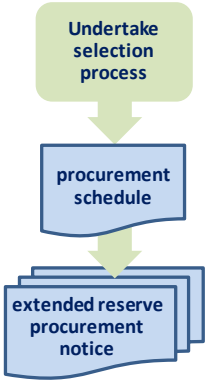
³² An example of such a structured obligation would be to require participants to arm different % quantities of load at different times of day and year, within maximum and minimum limits.

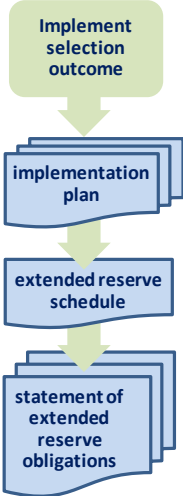
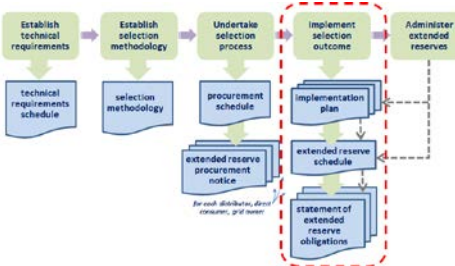
3.3 Detailed description of the five key elements and associated documents

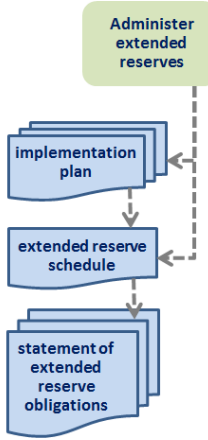
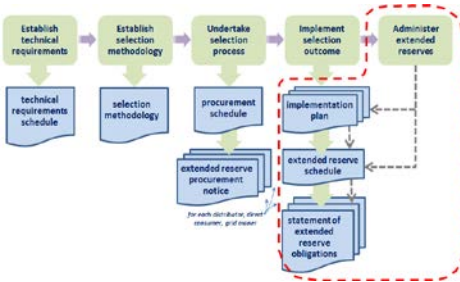
Table 2: Overview of the five key elements

Element	What and when	Key roles
 Establish technical requirements technical requirements schedule	 - process set out in the Code by which the system operator reviews the technical requirements for extended reserves (including AUFLS) and establishes the technical requirements schedule (TRS) - key output is the TRS which sits outside the Code (refer Table 3) - undertaken as part of implementing the new extended reserves arrangements, but might not be undertaken again for 3-5 years - technical requirements must be reviewed at least every 5 years	<i>system operator:</i> - reviews technical requirements and produces technical requirements report - produces TRS, which sets out technical requirements for extended reserves to be procured (reflects the analysis in the report) - in subsequent processes, reviews TRS and decides whether to propose an amendment - if an amendment is required, produces a new report and a new draft TRS, then runs consultation process, and approves final TRS after considering submissions and liaising with the Authority <i>Authority:</i> - may set principles for system operator's review of the technical requirements - prescribed role in the system operator's consultation process - may request system operator to review technical requirements at any time <i>affected stakeholders:</i> - participate in consultation process

Element	What and when	Key roles
 The diagram shows a green box labeled 'Establish selection methodology' with a downward arrow pointing to a blue box labeled 'selection methodology'.	 The flowchart illustrates the process of establishing and implementing a selection methodology. It starts with 'Establish technical requirements' leading to 'technical requirements schedule'. This leads to 'Establish selection methodology' (highlighted with a red dashed box), which leads to 'Undertake selection process' and 'Implement selection outcome'. 'Undertake selection process' leads to 'procurement schedule' and 'extended reserve procurement notice'. 'Implement selection outcome' leads to 'implementation plan' and 'extended reserve schedule'. 'Administer extended reserves' leads to 'statement of extended reserve obligations'. There are feedback loops from 'extended reserve schedule' back to 'procurement schedule' and 'implementation plan'. A note at the bottom states 'for each distributor, direct consumer, grid owner'. • a process set out in the Code by which the ERM establishes the selection methodology that prescribes – how extended reserves providers are selected in order to meet the TRS – how extend reserves providers will be paid – arrangements for how changes to extended reserves providers' circumstances will be accommodated between selection processes • key output is the selection methodology (SM) (refer Table 3) • also specifies the standard terms and conditions which participants are required to comply with • undertaken as part of implementing the new extended reserves arrangements, but no requirement to review unless directed by the Authority	ERM: • produces draft selection methodology (SM) within a specified timeframe after TRS is published by the system operator • produces revised draft SM if requested by the Authority • runs consultation process and gives proposed SM to the Authority for approval system operator: • provides data sets for ERM to test draft SM before it is published for consultation • comments on early draft SM and selection outcomes using data provided • comments on final draft SM Authority: • involved in ERM's consultation process • may undertake its own consultation on SM if it does not approve SM the ERM submits • approves SM after considering submissions • may request ERM to review SM at any time affected stakeholders: • participate in consultation process

Element	What and when	Key roles
	 • a process set out in the Code by which the ERM undertakes the selection process set out in SM • key output is – the procurement schedule listing the parties and specific loads selected (or deselected) to provide extended reserves; it sits outside the Code (refer Table 3) – an extended reserves procurement notice is then generated for each affected party, setting out the selection outcomes for that party following completion of the selection process and approval of the procurement schedule • undertaken as part of implementing the new extended reserves arrangements, but might not be undertaken again in full for 3-5 years • a partial selection process might be required earlier if circumstances change sufficiently to warrant this • a full selection process must be undertaken at least every 5 years	ERM: • runs selection process according to SM • produces draft procurement schedule, runs consultation process and gives proposed procurement schedule to the Authority for approval • prepares and sends an extended reserves procurement notice to each affected party system operator: • comments on early draft of procurement schedule • comments on final draft of procurement schedule Authority: • may direct ERM on scope of selection process (full or partial) • prescribed role in ERM's consultation process • may undertake its own consultation on procurement schedule if it does not approve the version submitted by ERM • approves procurement schedule after considering submissions • may request ERM to undertake selection process at any time affected stakeholders: • provide information to ERM as required under SM as input to selection process • participate in consultation process

Element	What and when	Key roles
 Implement selection outcome implementation plan extended reserve schedule statement of extended reserve obligations	 - processes by which the outcome of a selection process is implemented by the system operator and affected parties - key outputs are (refer Table 3) : - an implementation plan for each affected party - the central extended reserves schedule - a statement of extended reserves obligations (SERO) for each affected party - undertaken whenever a new procurement schedule has been approved by the Authority - some aspects of the extended reserves schedule may be updated from time to time, e.g. - if the system operator calls on flexible extended reserves offered by a party during the selection process - if an affected party agrees amendments to the manner in which it is meeting its SERO	<i>each party:</i> - develops its own implementation plan for approval by the system operator to establish or disestablish provision of extended reserves as set out in its extended reserves procurement notice - proposes possible variations to the standard terms and conditions that it wishes to negotiate - takes steps necessary to be able to meet its SERO, in accordance with its approved implementation plan <i>system operator:</i> - agrees an implementation plan with each party - considers variations to standard terms and conditions a party may propose - establishes the date(s) on which extended reserves will be provided or cease to be provided by each affected party - prepares and maintains the extended reserves schedule recording all current extended reserves obligations - creates a set of SEROs consistent with the extended reserves schedule, and sends each party its specific SERO - advises clearing manager of information it requires for extended reserves compensation and cost recovery <i>Authority:</i> - approves variations to standard terms and conditions proposed by a party

Element	What and when	Key roles
	 - processes by which: - parties are obliged to meet their SERO at all times - parties are compensated each month in accordance with their SERO - the total cost of extended reserves each month (if any) is recovered from those parties identified in the Code - the system operator reports to the Authority as part of regular reporting processes - as the obligation to comply with a SERO is an AOPO, existing Code provisions apply (such as dispatch, emergencies, compliance, reporting, asset testing, information provision)	<i>each party:</i> - takes actions to ensure it continues to meet its SERO - notifies the system operator if it is unable to meet its SERO in relation to any AUFLS loads (for example following a network reconfiguration) - notifies of any breach - undertakes actions, subject to system operator approval, to address situations where it may no longer be able to meet its SERO in relation to any specific AUFLS loads, including through potentially providing replacement AUFLS load if possible - undertakes actions to meet the terms and conditions, which may include, for example, providing information on an annual basis to the system operator, potentially including the historical load profiles for each AUFLS load, and the extent to which load is being used for alternative purposes such as IL <i>system operator:</i> - monitors extended reserves arrangements and determines if action is required (e.g. calling on flexible providers to adjust their service, proposing a new selection be undertaken) <i>clearing manager:</i> - administers compensation and cost recovery arrangements <i>Authority:</i> - receives regular reports from system operator

3.3.1 There are five key documents produced as outputs from the processes depicted in Figure 2 and described in Table 2. Each of these documents is discussed (in order) in more detail in Table 3 below, together with a brief commentary on the key design features.

Table 3: Overview of the key documents produced

Document	Key contents	Commentary
 <i>an indicative example TRS is included in Appendix D</i>	• schedule specifying the technical requirements, which for AUFLS might include: – number of blocks – block sizes, potentially with different sizes for different times of day and year – relay settings – extent and type of flexible AUFLS required • the schedule may also include technical requirements for other types of extended reserves in the future • specifies testing requirements • sets out key conditions for provision of extended reserves	• the TRS will be developed by the system operator after conducting a review of the technical requirements for extended reserves (AUFLS) • the TRS will set out the technical requirements for extended reserves to be procured, and will reflect the analysis set out in the technical requirements report (produced at the end of the review) • system operator accountability for developing and approving the TRS recognises the key role extended reserves play in the system operator meeting its PPOs • it is likely that the TRS will include a requirement for some flexible AUFLS services, to enable a low cost means to adapt to minor changes without the need to rerun the selection process • Code requirement to review the TRS at least every five years balances the desire for stability with the need to reflect changes in system configuration, policies and technology over time • a review need not result in a change if the system operator and Authority are satisfied that no change is required

Document	Key contents	Commentary
 <i>an indicative example SM is included in Appendix E</i>	• a description of how the ERM will procure extended reserves to meet the requirements of the TRS • specifies participants that will be required to provide information during selection process • specifies the information those participants must provide and the timeframe within which it must be provided • basis on which ERM selects participants to be extended reserves providers • includes default terms and conditions for provision of extended reserves.³³ • specifies how payments to extended reserves providers are to be set	• establishing the ERM as a service provider enables contestability for the provision of services relating to the selection methodology and selection process • system operator has an important role in reviewing a draft selection methodology to ascertain if it is likely to meet the requirements of the TRS; also provides test data sets for the ERM to undertake a “dummy selection run” and comments on the final draft SM • there is no requirement to review this on a regular basis, giving full flexibility to the Authority • the selection methodology will set out how the selection process will make trade-offs between selecting different types of load to minimise overall costs relating to: system collapse, load being used for other purposes such as IL, the interruption costs of load during an AUFLS event, and the costs of providing AUFLS capabilities. • the selection methodology will also set out the basis for calculating: – the interruption costs for different types of load, possibly including a value of lost load (VOLL) set centrally by the Authority – compensation for providing, installing, arming, and testing AUFLS equipment

³³ These cover technical and testing requirements and post AUFLS event obligations, as well as on-going information requirements. They also set out the requirements on flexible providers to be able to arm or disarm as instructed by the system operator within a specified notice period.

Document	Key contents	Commentary
 procurement schedule	• sets out the results of the selection process • specifies the parties required to be extended reserves providers • specifies the extended reserves each is to provide • includes information on how the amounts payable to each provider will be calculated • specifies the parties that have not been selected to provide extended reserves	• it is likely that the procurement schedule will be the output of a selection tool (the optimisation model) that undertakes the selection process in accordance with the SM • inputs and outputs of the selection tool are likely to be relatively simple, but the tool itself may be complex • it is envisaged that the procurement schedule will include both “standard” and “enhanced” extended reserves to meet the requirements of the TRS. Enhanced AUFLS may include faster-responding capabilities (e.g. 250ms response instead of 400ms), and remote ‘real-time’ arming and/or monitoring capabilities • Authority may direct ERM on the scope of any selection process, giving flexibility for a partial selection to be undertaken tailored to the circumstances • Code requirement to undertake a full selection at least every five years balances the desire for stability with the need to reflect changes in system configuration, policies and technology over time
 extended reserve procurement notice	For each party: • the information in the extended reserves procurement schedule relating to that party • if the party has been selected to be an extended reserves provider, then – default terms and conditions (from the SM) that apply to the provision of extended reserves by that party – information on how the amounts payable will be calculated	• this is largely an administrative function, translating the procurement schedule (once approved by the Authority) into a set of notices, one for each party, and sending these out • this activity marks the completion of the ERM role • it then triggers the implementation process for each party and the system operator

Document	Key contents	Commentary
	For each party: • information on how the party will implement the obligations allocated to it in its extended reserves procurement notice • the date the implementation plan comes into force • one or more dates on which the extended reserves will begin, or cease, to be provided	• the system operator needs to be able to co-ordinate the implementation of all extended reserves selection outcomes, particularly the initial round when it is envisaged the new AUFLS technical requirements will come into force • an implementation plan is required from every party, whether they are selected to be a provider or not – a party that had previously been providing extended reserves, but who is 'deselected' through the selection process will need to agree with the system operator how and when to cease providing extended reserves – a party that is selected to provide extended reserves on a modified basis relative to their previous obligations will need to agree with the system operator how and when to make the required changes • each implementation plan must be approved by the system operator, and can be varied subsequently by agreement with the system operator • the system operator can require changes in an implementation plan • the first set of implementation plans under the new arrangements play an important role in the transition to the new regime (refer section 5.10 of this paper)

Document	Key contents	Commentary
extended reserve schedule	• master schedule detailing the current requirements of each party identified in the extended reserves procurement schedule based on information from: – the latest procurement schedule – each approved implementation plan – any amendment to terms and conditions agreed between a provider and the system operator – any notifications from obligated parties of any changes to their AUFLS loads – annual information provided by selected parties on their AUFLS loads – any other information held by the system operator that describes the obligations of an extended reserves provider to provide extended reserves	• the extended reserves schedule is, in effect, the master list of all current extended reserves obligations across all parties • the system operator prepares and maintains this, and it is published for transparency • the extended reserves schedule will undergo significant change whenever a new selection process is undertaken • it will undergo minor updates from time to time to accommodate changes such as the system operator calling on flexible extended reserves established in the most recent selection process, or following notification by parties of changes to their AUFLS loads

Document	Key contents	Commentary
	For each party: • requirements in the extended reserves schedule relating to that party • if the party has been selected to provide extended reserves than: – the default terms and conditions from the selection methodology that apply to the party – any amendments to the default terms and conditions agreed with the system operator and approved by the Authority – information on how amounts payable will be calculated for that party	• a party's SERO is enforceable through a Code provision requiring each party to comply with its SERO at all times • a SERO is produced for every party, whether they are selected to be a provider or not – a party that had previously been providing extended reserves, but who is "deselected" through the selection process will have that outcome recorded in new SERO – a party who is selected to provide extended reserves on a modified basis relative to their previous obligations will have that recorded in a new SERO • it is envisaged that some parties will be selected to provide some flexible extended reserves (e.g. on a variable or stand-by basis) – the SERO will record the flexible reserves obligation and the process by which the system operator might call on the flexible reserves • an updated SERO will automatically be produced each time there is a change to the extended reserves schedule for loads relating to a party, for example following notification by a party of a network reconfiguration change which affects its loads

3.4 Concluding comments

The proposed arrangements are expected to deliver a range of benefits

3.4.1 The Authority believes that the key advantages of the proposed arrangements with regards to the specifics of AUFLS provision are that they will:

- (a) allow a more optimal selection of loads to be identified for AUFLS

- (b) provide improved visibility to the system operator as to the amount of load armed for AUFLS at any time, and that this will better enable the system operator to operate the system securely
 - (c) have the flexibility to accommodate on-going changes to AUFLS load as required, particularly to allow:
 - (i) parties to make changes to their AUFLS feeders if required for their core business purposes
 - (ii) load beneath an AUFLS feeder to be re-assigned to other, higher value uses such as IL or demand-response
 - (iii) the system operator to vary the amount of AUFLS provided through calling upon flexible AUFLS providers
 - (d) incentivise the progressive development of enhanced AUFLS services by parties that will facilitate further system security improvements
 - (e) facilitate the faster progression to more sophisticated real-time co-optimisation of load to be assigned to the highest value use, whether that be AUFLS, IL, DD or something else.
- 3.4.2 Offsetting these benefits are higher implementation and operating costs associated with the preferred approach compared with other AUFLS procurement options. However, as set out in the Authority's cost-benefit analysis (Appendix C), the scale of these higher costs is estimated to be more than outweighed by the higher benefits.
- 3.4.3 More broadly, removing the *specifics* of AUFLS requirements for each provider out of the Code, coupled with enabling the arrangements to procure other forms of extended reserves in addition to AUFLS, is considered to better enable the arrangements to adapt over time to changing circumstances as required.

The process for determining the detailed specifics of AUFLS provision will include two key new documents: ³⁴

- (a) the technical requirements schedule which specifies the required technical design of the overall AUFLS scheme

³⁴ Such specifics include: the technical design of AUFLS (i.e. how much load should be provided as AUFLS at different times, the block configuration and trigger settings); the methodology to select which loads should provide AUFLS; the amount to pay parties for provision of AUFLS; the means by which parties can change which loads are armed to provide AUFLS to meet their changing circumstances; the details of the information reporting and compliance requirements.

- (b) the selection methodology which specifies the approach to identifying which loads should be armed to deliver this overall technical requirement, and the on-going obligations on parties that have been selected

3.4.4 These two documents are not being finalised at this time, and decisions on the details they will contain will be subject to further consultation with interested parties. However, the Authority and the system operator have developed indicative examples of these documents based on the Authority's current preferred approach, which have been included as appendices in this consultation (Appendix D and Appendix E), to enable submitters to make informed submissions on the proposed Code amendments.

3.4.5 The proposed approach in the indicative example selection methodology is fundamentally the same as the preferred approach put forward in the January 2014 consultation. The key aspects of the approach are:

- (a) an optimisation tool will be used to select which loads should provide AUFLS, including selecting a proportion of 'flexible' AUFLS providers that can be armed and dis-armed at notice to meet changing system circumstances
- (b) parties will provide information into the optimisation process, including (it is expected), historical extent of the load being used for other demand-side purposes (IL, DD, DR), estimates of load interruption costs,³⁵ and whether the load has existing AUFLS capabilities
- (c) compensation payments made up of: payments to cover the expected interruption costs of loads armed for AUFLS, and payments to cover the costs of providing AUFLS capability (e.g. relays, associated control systems), with payments distinguishing between 'standard' and 'enhanced' AUFLS provision
- (d) parties selected to provide AUFLS will have an on-going obligation to:
 - (i) provide annual updates on historical profiles of loads armed to provide AUFLS, and the extent to which load under AUFLS feeders is used for other purposes such as IL

³⁵ For the majority of lines company load, this VoLL estimation will be achieved via a simplified centrally-determined framework that will be consistent with the current framework used by lines companies for prioritising feeders for rolling outages, and consistent between lines companies in terms of the VoLL values for classes of customers (e.g. residential, commercial, critical civil defence etc.)

- (ii) notify the system operator of any changes to the configuration of their networks which will affect the delivery of AUFLS (subject to a de-minimis in the case of temporary, maintenance-related changes), and replace on a like-for-like basis any feeders which can no-longer provide AUFLS if such replacement is practicable.

Q1. Do you have any comment on the Authority's overall design of the proposed extended reserves arrangements?

4. Indicative timeline for implementing proposed arrangements

- 4.1.1 If the new arrangements are adopted, the Authority and the system operator plan to start *physically* implementing the new AUFLS regime (i.e. re-arming existing AUFLS relays for the new settings, and installing new AUFLS relays as required) for the North Island by October 2015. The key deliverables that must be achieved in order to meet that date are listed in section 4.2 below.
- 4.1.2 A half-day workshop is planned for early May 2014, which will provide an opportunity for the interested parties to clarify aspects of the proposed design and Code amendments, and to express their views on the preferred procurement option, the selection methodology and the technical requirements schedule. The Authority will publish dates and details of the proposed workshop on its website.

4.2 Key implementation deliverables and due dates

- 4.2.1 If new AUFLS requirements for parties are to be finalised with implementation plans by October 2015, the following key deliverables need to be completed by the dates set out here:
- gazette Code amendments: July-14³⁶
 - publish technical requirements schedule: Oct-14
 - publish selection methodology: Nov-14
 - release production version of the selection tool: Nov-14
 - arrange for new ERM service provider: mid-15³⁷
 - undertake first selection under new regime: Apr-15
 - implementation plans of the new regime approved and the implementation phase started: Oct-15
- 4.2.2 The timetable was developed by the Authority and the system operator following the close of the second consultation on the efficient procurement of extended reserves, after having considered the submissions. That

³⁶ The majority of the proposed Code amendments would come into force on the date specified in the Gazette notice. The exceptions are the proposed Code amendments relating to additions to Part 8 (allocation of costs for extended reserves) and to Part 14 (the process for payments). The likely timeline for implementing the new extended reserves arrangements extends well into 2015, which is after the new Part 14 and 14A of the Code comes into force on 24 March 2015. Accordingly, the Authority proposes that the Part 8 and Part 14 Code amendment would come into force on 24 March 2015.

³⁷ Section 5 below describes why the Authority may undertake the role of ERM initially – at least through the initial phase of developing the selection methodology. If the Authority undertakes the ERM role initially it would appoint an external agent to carry out the ERM functions.

consultation suggested the new regime should be physically implemented by the end of 2016. However some submitters suggested that scarce technician resource to make the changes to the hundreds of relays required may mean that the physical implementation could take longer.

Q2. What comments do you have on the indicative timeline the Authority has developed for transitioning to the proposed arrangements for extended reserves?

5. Explaining key design decisions in more detail

5.1 What this section of the consultation paper is about

- 5.1.1 This section of the consultation paper provides more detail on the proposed design, including the rationale for key design decisions. It also asks and answers some important questions about the proposed arrangements, and sets out some specific consultation questions for stakeholders to consider.

5.2 Role of the system operator, ERM and Authority

- 5.2.1 The Authority has considered the nature of the various roles in the proposed arrangements for extended reserves, and who would be best placed to undertake each role. In doing so the Authority has considered factors such as the Authority's statutory objective, relevant existing accountabilities under the Code, and the functions and accountabilities of the system operator.

Develop and approve the technical requirements schedule

- 5.2.2 This role includes:
- (a) to review the technical requirements and produce the extended reserves technical requirements report, at least every five years
 - (b) to decide on the basis of that review, or at another time, whether the technical requirements schedule needs to be amended
 - (c) if amendments are required, then to develop a draft technical requirements schedule, consult on the draft and obtain approval of the final version.
- 5.2.3 The Authority considers that the only service provider that would have the necessary technical skills and experience for this role, and the information and tools with which to undertake it, is the system operator.
- 5.2.4 Further, the Authority considers that developing, consulting on and approving the technical requirements schedule would be an important aspect of the system operator meeting its PPOs. The Authority considers that the alternative, whereby the Authority would approve the technical requirements schedule, would be inconsistent with the system operator's obligation to comply with its PPOs.

- 5.2.5 The Authority's role in the consultation process on the technical requirements schedule is consistent with its general role in terms of appointing the system operator as a service provider on behalf of the whole interested parties.

Develop the selection methodology

- 5.2.6 While the technical requirements of AUFLS (and other extended reserves services) are clearly driven by system operation requirements, the choice of which loads should be selected to provide AUFLS requires consideration of other aspects, particularly the economic cost of different loads and interactions with other aspects of the electricity market (for example, IR or DD).
- 5.2.7 Because of the distinct skill-sets required, and because developing a selection methodology is a function which can be tightly defined,³⁸ the Authority considers that this is a role that should be undertaken by a service provider.
- 5.2.8 The draft Code amendments in Appendix B anticipate the creation of a new market operation service provider called the extended reserves manager (ERM). This would require that a new role be specified in regulations, so as to extend the definition of 'market operation service provider' in the Act, and that the Electricity Industry (Enforcement) Regulations 2010 (Regulations) be amended to limit the liability of the ERM, as is the case for other market operations service providers.
- 5.2.9 If such a role were created, the Authority would appoint a party which it believed was most suitable to undertake the role, either by direct negotiation with one of the current service providers (such as NZX or Transpower) or after carrying out a competitive tender process.
- 5.2.10 In deciding on the ERM appointment, the Authority would likely consider factors such as:
- (a) the type of skills required to undertake the ERM role
 - (b) whether it is important for the ERM role to be undertaken by a current or a new service provider
 - (c) the size and duration of the ERM role³⁹

³⁸ The role of developing the selection methodology would include consulting on the (draft) selection methodology and considering submissions.

³⁹ For example, whether the ERM is required to develop a new selection methodology, or whether the ERM will be required to carry out a full or partial extended reserves selection process

(d) the cost of appointing and remunerating a new service provider.

- 5.2.11 The Authority anticipates that it could take from 12 to 18 months from the date that Code amendments are made to arrange for regulations to be amended, to appoint a new service provider, and for that new service provider to be ready to carry out its functions. Therefore, the draft Code amendment also allows for the Authority to carry out the functions of the ERM if the new service provider role has not yet been created. In addition, the Act allows the Authority to perform the functions of a market operations service provider on a temporary basis if, for example, no service provider has been appointed or if the appointee is unable or unwilling to perform the service.
- 5.2.12 It is the Authority's proposal that the Authority undertake the initial development of the selection methodology, and the first procurement process. By doing so, it is more likely that the timetable in the section 4.2 can be met. In that case the Authority would engage an external agent to carry out the day-to-day functions of the ERM until such time a service provider was appointed. Once the ERM role is established by regulation, the Authority will be able to appoint a service provider to the role. Depending on how long this process takes, the service provider may be in place before the first procurement schedule is required. However it is unlikely that the process would be completed before the selection methodology was developed.
- 5.2.13 As noted earlier, the Authority's proposed set of arrangements is a mix of Code provisions and documents outside the Code. Two documents in particular, the technical requirements schedule and the selection methodology, are critical to the design of the overall regime. The Authority and the system operator have developed an indicative draft of each of these two documents, for the purposes of:
- (a) enabling the Authority to be confident that the Code amendments can meet the design drivers described in section 3.2.2
 - (b) enabling stakeholders to be fully informed on the proposed set of arrangements when submitting on this consultation.
- 5.2.14 The Authority has also progressed development of a prototype selection tool to assist with testing the arrangements and with the cost-benefit analysis presented in this consultation.
- 5.2.15 If the Code amendment progresses, the ERM (either an external agent appointed by the Authority to act on its behalf, or a service provider as soon as one is appointed) would take over the role of finalising the selection methodology and development of the selection tool.

Approve the selection methodology

- 5.2.16 The Authority has proposed that the ERM role be structured as a market operation service provider under the Act. Unlike other service providers, the ERM will carry out its activities for the duration of time required to develop a selection methodology and run a selection process. After that point, nothing more is required of it until the next procurement process is run. This is envisaged to be once every five years.
- 5.2.17 The Authority considers that, following consultation on the draft selection methodology, the final selection methodology should be independently approved by an entity that has a strong vested interest in the results of the procurement process. The options are therefore the Authority itself or the system operator.
- 5.2.18 The selection methodology is a mix of technical and economic optimisation, and has the potential to significantly impact those parties selected (or deselected) to provide extended reserves through the extended reserves obligations resulting from a selection process.
- 5.2.19 Given the nature of the selection methodology and the potential significance of its impact, the Authority considers that accountability for final approval of the selection methodology should be the responsibility of the Authority. However, in recognition of the system operator's interest in ensuring that the selection methodology meets the requirements of the technical requirements schedule, and its expertise in making this assessment, the Authority's proposal includes the following important roles for the system operator in relation to the selection methodology:
- (a) before the ERM releases the draft selection methodology for consultation, the process requires the ERM to:
 - (i) provide the system operator and the Authority with a draft selection methodology, along with one or more worked examples of an extended reserves procurement schedule created using that draft selection methodology and data specified by the system operator
 - (ii) consider comments provided by the system operator and the Authority
 - (b) before approving the final selection methodology, the process requires the Authority to:
 - (i) provide the system operator with a copy of the selection methodology it intends approving

- (ii) allow the system operator 15 days to advise the Authority of any comments
- (iii) consider any comments made by the system operator

Develop, consult on and approve the procurement schedule

- 5.2.20 The Authority considers that the rationale set out above for the selection methodology also applies to the procurement schedule, that is:
- (a) that the ERM should have the role of developing and consulting on the draft Procurement Schedule
 - (b) that the Authority should be responsible for final approval of the procurement schedule
 - (c) that the system operator be given an opportunity to comment on the final procurement schedule that the Authority intends approving

Prepare extended reserves procurement notices

- 5.2.21 The Authority considers that this is largely an administrative function, translating the procurement schedule (once approved by the Authority) into a set of notices, one for each party, and sending these out.
- 5.2.22 The Authority considers that the ERM is best placed to undertake this role, which is a natural follow-on from its role in establishing the procurement schedule.
- 5.2.23 This marks the completion of the ERM role in the process, and is consistent with a sensible delineation between:
- (a) undertaking the selection process, primarily the role of the ERM (as discussed above) and
 - (b) implementing the selection outcome, primarily the role of the system operator (as discussed below).

Prepare and agree implementation plans

- 5.2.24 When a party receives a procurement notice, this would prompt the need for an implementation plan. Each draft implementation plan should be prepared, in the first instance, by the party that is most affected by it and has the best information. Accordingly, the Authority proposes that each party develop its own draft implementation plan to meet its specific extended reserves procurement notice. The alternative is to have the system operator prepare each party's implementation plan, but this appears to be neither appropriate nor practicable.

- 5.2.25 Although an implementation plan is specific to the party concerned, there is a need to co-ordinate the set of implementation plans that collectively deliver the outcome of a new selection process in order to ensure that the TRS, and system security requirements more generally, continue to be met.
- 5.2.26 The Authority considers that:
- (a) only the system operator has the information and expertise to undertake this co-ordination role across the set of implementation plans
 - (b) undertaking the co-ordination role is consistent with the system operator's accountabilities under the proposed extended reserves arrangements, and more generally (e.g. meeting its PPOs)
 - (c) to undertake the co-ordination role, the system operator would need the ability to approve each implementation plan and to require (reasonable) changes to be made to accommodate specific circumstances.
- 5.2.27 Accordingly, the Authority considers the system operator is best placed to approve each implementation plan.

Maintain the extended reserves schedule

- 5.2.28 The Authority considers that the system operator is best placed to undertake this role:
- (a) the system operator has the information required to populate the extended reserves schedule as part of its role in implementing selection outcomes
 - (b) the system operator is also the recipient of any updates to the information that is contained in the extended reserves schedule.
- 5.2.29 The only practicable alternative would be for the Authority to undertake this role, however, to do so the Authority would need to source the information from the system operator, thereby introducing unnecessary costs and risks, for example the risk of introducing information errors.

Prepare statements of extended reserves obligations

- 5.2.30 The Authority considers that this is a natural extension of the extended reserves schedule, and that the rationale set out above for the extended reserves schedule also applies to the statements of extended reserves obligations, that is:

- (a) the system operator has the information required to prepare statements of extended reserves obligations as part of its role in implementing selection outcomes
- (b) the system operator is also the recipient of any updates to the information that is contained in the statements of extended reserves obligations.

5.2.31 The only practicable alternative would be for the Authority to undertake this role, however, to do so the Authority would need to source the information from the system operator, thereby introducing unnecessary costs and risks, for example the risk of introducing information errors.

- Q3. Do you agree with the Authority's proposed allocation of roles in relation to the technical requirements schedule, selection methodology, procurement schedule, extended reserves procurement notices, implementation plans, the extended reserves schedule and statements of extended reserves obligations? If not, what alternative would you propose, and why?
- Q4. Do you agree with the Authority's proposal that the Authority undertake the ERM role initially? If not, what alternative would you propose, and why?

5.3 The proposed mix of Code provisions and other documents

5.3.1 The Authority has considered how best to structure the proposed arrangements for extended reserves. In particular it has considered:

- (a) which aspects of the arrangements should be prescribed in the Code
- (b) whether any documents should be incorporated by reference in the Code
- (c) which aspects of the arrangements should be set out in other documents
- (d) which aspects of the arrangements should be left to the relevant parties to undertake in the manner they consider appropriate.

5.3.2 The Authority has considered factors such as the relevant provisions in the Act, the Authority's statutory objective, relevant existing arrangements under the Code, and the functions and accountabilities of the system operator and service providers more generally.

- 5.3.3 The Authority's rationale for its proposed mix of Code provisions and documents that sit outside the Code is as follows.
- 5.3.4 To the extent practicable, the new extended reserves arrangements use existing mechanisms in the Code, such as monitoring and compliance, clearing and settlement, monthly system operator reporting, and asset owner testing arrangements.
- 5.3.5 In relation to procurement, the Authority considered whether the new arrangements should use the same model as for the procurement of ancillary services. That is, by creating a new procurement plan for extended reserves and by using contracts entered into between providers and the system operator. Two problems were identified in relation to these arrangements.
- 5.3.6 First, the Act anticipates that provisions which impose rights and obligations on participants will be specified in the Code. When the Authority wishes to change the rights or obligations of participants, it does so by amending the Code, following the process prescribed in the Act, which in most cases required consultation with participants.
- 5.3.7 The Act also provides for certain documents to be incorporated into the Code by reference. This is desirable where the Authority wishes to make those documents part of the Code, but the documents have been prepared by someone else. However, the Act limits the kind of material that can be incorporated into the Code in this way.
- 5.3.8 Section 32(3) of the Act provides:
- "(3) The Code may incorporate by reference any of the following:*
- (a) New Zealand Standards, or standards, requirements, or recommended practices of any overseas or international body:*
 - (b) codes of practice issued under Part 4 of the Electricity Act 1992:*
 - (c) any other written material dealing with technical matters that, in the opinion of the Authority,—*
 - (i) is too long to publish as part of the Code; or*
 - (ii) is impracticable to publish as part of the Code."*
- 5.3.9 In this case, the new provisions would be created by the Authority as amendments to the Code, and therefore it was not necessary to incorporate them by reference. Further, the new material might not have met the test in section 32(3)(c)(ii) of being too long or impracticable to

publish as part of the Code. If that had turned out to be so, the Authority could not have brought it into the Code.

- 5.3.10 The second argument against using the same model as for the procurement of ancillary services is that under the new arrangements, the selection process is mandatory, as compared with the ancillary services arrangements where contracts are voluntarily entered into between the providers and the system operator. The additional element of compulsion required that the procurement process be specified in the Code.
- 5.3.11 Although the new selection and compensation arrangements for extended reserves are akin to ancillary services procurement, the fact that participation in the selection process is mandatory means that extended reserves arrangements retain key characteristics of AOPOs. Accordingly, extended reserves arrangements cannot be fully implemented alongside other ancillary services which are entered into voluntarily and take the form of contracts between providers and the system operator.
- 5.3.12 Documents that do not create obligations, but which provide information to which participants are required to refer, such as the technical requirements schedule, selection methodology and the procurement schedule, will be created by the system operator or ERM and published on a website as is the case for other comparable documents. The Code requires participants to comply with these documents (as in the case of the statement of extended reserves obligations).
- 5.3.13 This will allow for flexibility to accommodate changes in circumstance, the fact that documents are dynamic and may change over time, and the development of technology in the future.

Q5. Do you agree with the Authority's proposed mix of Code provisions and documents that sit outside the Code? If not, what alternative would you propose, and why?

5.4 Publishing key documents will enhance transparency

- 5.4.1 Under the new arrangements, four key documents will be published:
 - (a) the system operator publishes the technical requirements schedule which sets out the technical requirements for extended reserves
 - (b) the ERM publishes the selection methodology, setting out how extended reserves will be procured

- (c) the ERM publishes the extended reserves procurement schedule which sets out the results of the procurement process
- (d) the system operator publishes the extended reserves schedule which details the obligations of extended reserves providers

5.4.2 The Authority considers that publication of these four documents will bring a greater degree of transparency to the process for specifying and procuring AUFLS, and mean that more detail about the obligations of each provider are publically available, than under current arrangements.

Q6. Do you agree with the Authority's proposal that publishing more details about extended reserves specification and procurement will bring a greater degree of transparency to extended reserves arrangements? If not, what changes would you propose, and why?

5.5 Coordination of AUFLS with IL and other forms of demand response

5.5.1 The Authority acknowledges concerns expressed by some that a party may be constrained in its ability to develop new IL or other demand-response products on feeders if it has been selected to provide AUFLS via the central process.

5.5.2 In addressing this issue, the Authority notes that concerns about the potential economic cost associated with load being prevented from being more valuably used for another purpose was a key driver behind choosing a central optimisation option. In this respect, the Authority considers that the key mechanism to achieve desirable outcomes is along the following lines:

- (a) participants offering load into the selection process would be required to provide historic data as to how much IL and other demand response uses load has been used for, plus indications if such historic values are likely to vary by more than 50% in the future
- (b) the selection methodology would take account of such load in determining whether to select a feeder to provide AUFLS – that is, it will assume such load is not available during an AUFLS event
- (c) selection of a feeder to provide AUFLS would not prevent load beneath it being used to provide IL or for other demand response purposes, including increasing or decreasing the amounts used for such purposes beyond historical levels

- (d) changes to the amount of load beneath an AUFLS feeder being used for other purposes would be captured in the annual compliance reporting requirements on parties
- (e) any such changes would be accommodated through the system operator adjusting the amount of AUFLS armed through use of the flexible AUFLS providers it has procured.

- 5.5.3 The Authority has yet to determine whether changes to the amount of IL or other forms of demand response on a feeder should flow through to changes in the amount of payments made to AUFLS providers.
- 5.5.4 Given that the issue of AUFLS' coherence with IL and other forms of demand response is to be addressed within the selection methodology, rather than the Code, the Authority will ensure that there is continued consultation with interested parties on this issue as the selection methodology is developed further.
- 5.5.5 The Authority also notes that this issue of coherence between AUFLS and IL and other forms of demand response is an inherent issue which affects all options for AUFLS procurement. One example of this is the current lack of visibility which lines companies currently have with regards to load aggregators offering load within their network for IL or other purposes. The Authority understands that this has resulted in some feeders not dropping the amount of load during the recent AUFLS events that lines companies were expecting.
- 5.5.6 To address this issue of poor visibility, the proposed Code amendment (Appendix B) includes a requirement that parties offering IL within a lines company's network must provide information about such load to that lines company.
- 5.5.7 More generally, the Authority notes that this issue of ensuring consistency between AUFLS and other forms of demand response will be a key aspect of its forthcoming joint initiative with the system operator addressing the issue of the different forms of demand response in a holistic manner.

Q7. What comments do you have on the Authority's proposed approach to co-ordinating AUFLS with IL and other forms of demand response?

5.6 How can the Authority be sure that AUFLS will be delivered?

- 5.6.1 Under the proposed arrangements the AUFLS requirements would be specified in the TRS which is published by the system operator. The obligation to make the specified AUFLS amounts available is a Code requirement, and is enforceable like all other Code provisions.
- 5.6.2 The Code amendment proposal that is set out in Appendix B includes a set of obligations that collectively satisfy the Authority that extended reserves, and more specifically AUFLS, will be delivered. The obligations include:
- (a) that the selection methodology must be designed to meet the TRS
 - (b) that parties identified in the selection methodology must participate in the selection process
 - (c) that parties selected to provide extended reserves will receive a statement of extended reserves obligations tailored to their specific obligations
 - (d) that all parties must comply with their statement of extended reserves obligations at all times
 - (e) that failure to fulfil these obligations would be a breach of the Code, and the normal compliance arrangements would apply.

5.7 Consistency between AUFLS and rolling outage requirements

- 5.7.1 The January 2014 consultation did not substantially address how the AUFLS and rolling outage arrangements could be implemented to ensure consistency of outcome. The Authority has considered this issue further following submissions to the January 2014 consultation.
- 5.7.2 Having reviewed a number of participants' rolling outage plans it is apparent that there is currently inconsistent practice with regards to how participants interpret the dual requirements of AUFLS and rolling outages:
- (a) some participants actively exclude all AUFLS feeders from being included as rolling outage feeders

- (b) other participants aim to include a proportion of AUFLS feeders in their rolling outage feeders in order to maintain the same proportion of load armed for AUFLS during rolling outages.⁴⁰

- 5.7.3 It is clear that this issue will need to be addressed, and that parties will need to re-visit their rolling outage plans irrespective of which AUFLS procurement option is implemented.
- 5.7.4 It is the Authority's provisional view that the practice set out in paragraph 5.7.2(b) above is likely to achieve the desired outcomes for both the AUFLS and rolling outage requirements.
- 5.7.5 The Authority's initial view on how to address this matter is that:
- (a) the AUFLS selection methodology is the appropriate place to specify what parties need to do with respect to making load available for possible selection for AUFLS
 - (b) the selection methodology should specify that, in deciding which loads a party should submit to meet the requirement to make a minimum of [60%] of their load available for possible AUFLS selection, a party should *not* factor whether a load is currently included within a rolling outage plan as part of that decision
 - (c) guidance should be issued to parties on how to develop appropriate rolling outage plans that are consistent with any AUFLS requirements that they may have following a selection process
 - (d) such guidance should be produced within the regulatory framework pertaining to rolling outages.
- 5.7.6 If the Authority decides to pursue this approach, it does not consider that an amendment to Part 9 of the Code would be required. However, it welcomes submitters' views on this.

Q8. What comments to you have on the Authority's initial view on how to achieve consistency of outcomes between AUFLS and rolling outages?

⁴⁰ For example, if 32% of a lines company's feeders were armed to provide AUFLS, and it was required to drop 10% of its load to meet a rolling outage requirement, the lines company would drop 10% of its AUFLS feeders and 10% of its non-AUFLS feeders. This would simultaneously satisfy the requirement to provide the overall 10% of load reduction, while maintaining the requirement to have 32% of its load armed for AUFLS.

5.8 Consistency with the Commerce Commission's price control regime

- 5.8.1 Some submitters raised the issue that the positive incentive aspects of compensation payments in terms of investing in AUFLS technologies that can deliver enhanced services⁴¹ may be removed for some lines companies if the Part 4 price control regime administered by the Commerce Commission requires them to pass through any compensation payments direct to customers.
- 5.8.2 Some lines companies have also highlighted the fact that much of the equipment used to provide AUFLS is also used to provide other network services for the lines company – and that such network services are the core reason for the equipment. For example, lines companies are investing in network protection relays and associated control systems for network management purposes, but these modern relays also have the capability to undertake AUFLS services. Powerco said in discussions with the Authority that the proportion of assets providing AUFLS that are dedicated AUFLS assets (assets whose sole purpose is to provide AUFLS) is significantly less than 50% and progressively falling as the company invests in upgrade network protection assets. It also noted that the dedicated AUFLS assets tended to be the old electro-mechanical relays which have inferior functionality in that they typically needed to be manually programmed and armed.
- 5.8.3 Where assets provide core network services in addition to AUFLS services, it will become very difficult to construct compensation payments for such assets which are part 'regulated' (and thus subject to the potential diluting incentive effects of pass-through as indicated in paragraph 5.8 above) and part 'unregulated'.
- 5.8.4 The Commerce Commission has indicated in informal discussions with the Authority an in-principle willingness to implement price control arrangements which support the policy intent of mechanisms developed by the Authority, providing such arrangements are practicable and consistent with achievement of the Commission's own statutory objectives. (Noting also, that the Commerce Commission would need to consult on proposed price control arrangements).

⁴¹ Examples of such enhanced AUFLS services include

- faster-acting response; or
- remote programming, arming, and monitoring capabilities

5.8.5 Given the issues outlined above, the Authority believes that the following approach could achieve the desired outcomes for all parties in a pragmatic manner:

- (a) costs incurred in the provision of network assets used to provide AUFLS would not have any special treatment under the Part 4 regime.
- (b) compensation payments will distinguish between:
 - (i) compensation for expected customer interruption costs
 - (ii) compensation for provision of assets to provide standard AUFLS services. These will be based on the costs of providing such assets; and
 - (iii) payments for provision of assets to provide enhanced AUFLS services. These payments will be based in part on the extra system security value that such services provide.
- (c) payments could then be treated differently under the Part 4 regime, with some being 'regulated' and some being 'unregulated':
 - (i) compensation payments for expected interruption costs and standard AUFLS services could be treated as regulated revenue under the price control regime. This would appear appropriate for interruption cost compensation as it is the customers incurring such costs, not the lines company's shareholders. Similarly, it would be appropriate for provision of assets to provide standard AUFLS services as it will be in relation to costs which will have already been recovered through the 'standard' approach to cost recovery under the Part 4 regime consistent with paragraph 5.8.5(a) above
 - (ii) payments for enhanced AUFLS services would be excluded from determination of price caps – i.e. it would be effectively 'unregulated'.

5.8.6 This treatment of payments for enhanced AUFLS services should preserve any incentive on regulated parties to provide such enhanced services.

5.8.7 However, the Authority notes that:

- (a) such proposed compensation arrangements would need to be consulted on further with interested parties as part of development of the selection methodology
- (b) the treatment of payments for enhanced AUFLS under the Part 4 price control regime is entirely for the Commerce Commission to

determine. In this respect, irrespective of any informal discussions between the Authority and Commission, the Commerce Commission can only formally consider the treatment of AUFLS compensation payments once they are finalised, and any proposed treatment by the Commerce Commission of such payments would need to go through the Commission's own consultation processes before being finalised.

- 5.8.8 That said, the Authority is hopeful that an approach similar to that outlined above can be developed. As such, it believes that introducing Code which can *enable* such compensation and cost-allocation approaches is likely to be of benefit.
- 5.8.9 Any decision on the form of the compensation regime will take into account whether compensation payments for expected interruption costs and AUFLS services are a pass-through under Part 4 of the Commerce Act.

Q9. Do you have any comments in relation to the consistency of the proposed AUFLS regime and the Commerce Commission's price control regime?

5.9 Exacerbators pay versus beneficiaries pay

- 5.9.1 The Authority acknowledges the variety of views on whether any compensation should be recovered under an exacerbators-pay or beneficiaries-pay basis. This was a key aspect of the Authority's second consultation.
- 5.9.2 Most of the direct consumers who made submissions suggested that an exacerbators-pay approach would deliver more appropriate outcomes. They suggested that an exacerbators-pay approach would deliver economic and reliability benefits through providing incentives on the 'causers' of the need for AUFLS (that is, Transpower and the owners of large generating assets) to alter their investment and operating decisions such that the incidence of AUFLS events would be reduced.
- 5.9.3 In contrast, Transpower and those generators and lines companies who submitted agreed that a beneficiaries-pay approach was the most appropriate mechanism for AUFLS cost recovery.
- 5.9.4 The Authority has reviewed this issue and concluded that:
- (a) an exacerbators-pay approach would be unlikely to affect future HVDC investment upgrade decisions, and thus have no impact on the future quantity of AUFLS needed to be procured

- (b) it is not apparent that an exacerbators-pay approach would result in reduced incidence of AUFLS events given that, almost by definition, AUFLS events are unpredictable, and the generators and Transpower already face strong incentives to avoid their assets failing in such a way
- (c) implementing an exacerbators-pay approach would be contentious and give rise to costs in terms of:
 - (i) determining an appropriate cost allocation approach viz the proportion of costs to be borne by the owners of the various 'causer' assets (the HVDC, and generators)
 - (ii) implementing an audit regime to verify the interruption costs submitted by direct connects as part of the selection methodology
 - (iii) addressing legal challenges to determinations of an event 'causer' – noting that an event-based causer pays regime is the only mechanism to incentivise potential causers in a way which would result in them reducing the incidence of events
- (d) an exacerbators-pay approach could have unintended economic costs in terms of creating perverse incentives on owners of supply assets to inefficiently withdraw capacity – as was the case in recent years in relation to Transpower withdrawing HVDC capacity in order to reduce its exposure to the IR event charge.

5.9.5 On balance, therefore, the Authority continues to believe that a beneficiaries-pay approach will deliver the greatest net benefits.

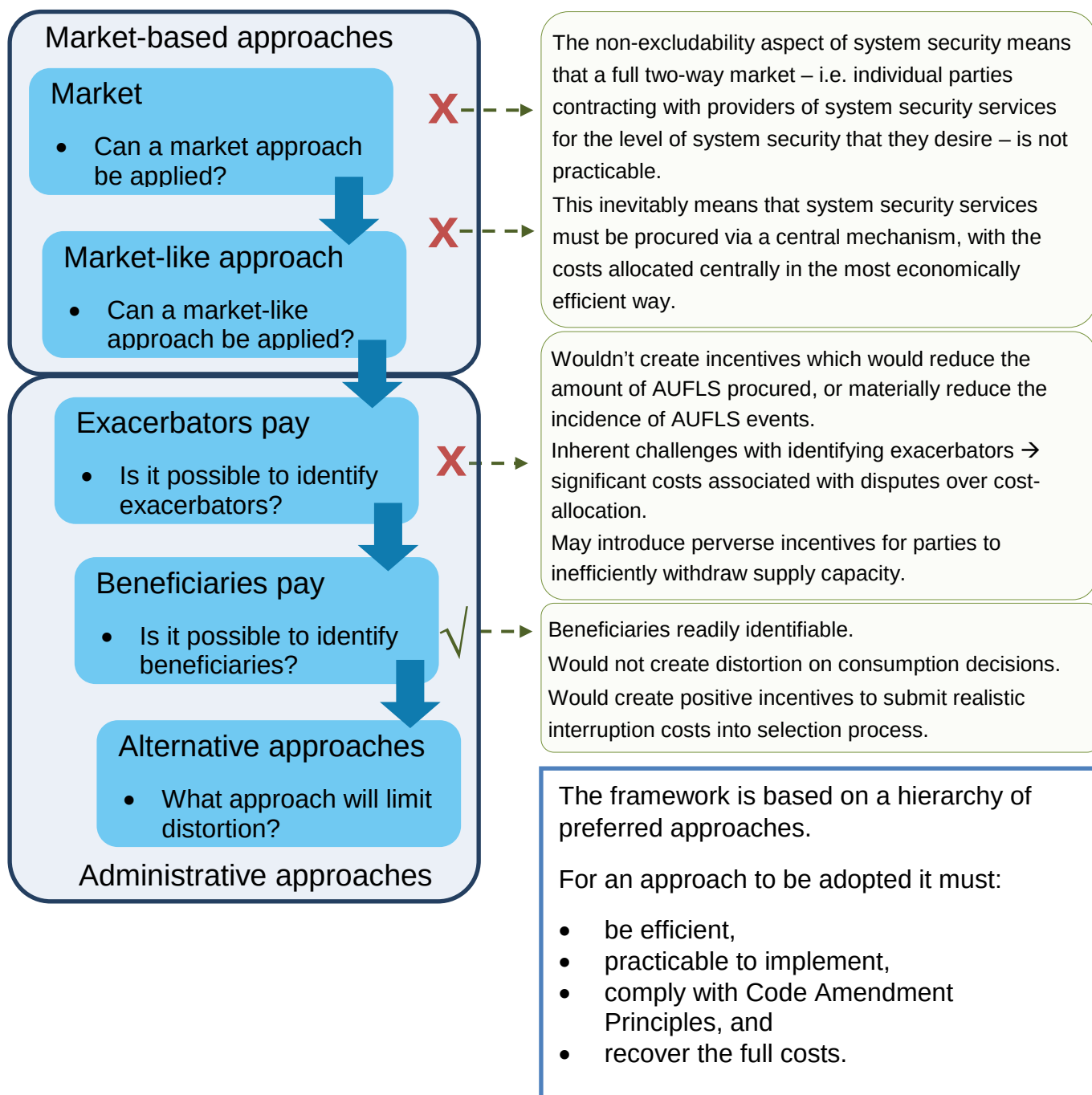
5.9.6 The flowchart in Figure 3 below sets out the decision making and economic framework that the Authority originally developed to assist with decisions about the Transmission Pricing Methodology, which the Authority considers is also appropriate for other cost recovery decisions including AUFLS. Figure 3 outlines and summarises the application of the framework with respect to determining the most appropriate charging approach for AUFLS.

5.9.7 As is indicated in Figure 3, a beneficiaries-pay approach is the first approach in the hierarchy of preferred charging approaches that gets a "tick", rather than a "cross", because it is the approach the Authority considers most likely to deliver net benefits for recovering the costs of AUFLS.

Figure 3: Decision-making and economic framework for cost-allocation

Hierarchy of preferred approaches

Appropriateness in context of AUFLS



5.10 Transitional provisions

- 5.10.1 The Authority has considered the appropriate approach and timing for transitioning from the existing to the new arrangements. The key implementation tasks and indicative timeline are set out earlier in this consultation paper (Section 4).
- 5.10.2 The proposed Code amendment includes new transitional provisions (in Part 17 of the Code) for moving to the new arrangements. The transitional provisions include that each party would be required to comply with current North Island AUFLS obligations as if they still existed under Part 8 of the Code until the earlier of a specified date, or the date that the party's implementation plan comes into force.⁴²
- 5.10.3 A similar set of transitional provisions is included for South Island AUFLS obligations, with two key differences:
- (a) the Authority does not propose to change the procurement arrangements for AUFLS in the South Island at this time given the very different situation, even though the transitional provision enable this to happen at any time.⁴³
 - (b) the Authority does intend implementing the revised trigger setting for the second block in the South Island in accordance with the system operator's technical review of AUFLS.^{44 45 46}
- 5.10.4 Accordingly, the transitional provisions include a clause that amends the trigger setting for the second block in the South Island from 45.5 Hz to 46.5 Hz. The Authority has not prepared a Regulatory Statement for this

⁴² The specified date will allow sufficient time for all implementation plans to have been put into effect after the last planned implementation date, and is specified so that the implementations will actually be completed.

⁴³ While the situation in the North Island is giving rise to a strong system security driver to change the AUFLS arrangements, the system operator has determined that the current wide frequency envelope in the South Island (45 to 55 Hz, versus 47 to 52 Hz in the North Island) makes the risk of under- or over-frequency collapse in an AUFLS event significantly less in the South Island. This makes the changing of AUFLS arrangements a much less pressing issue in the South Island. The development of the South Island AUFLS arrangements is likely to commence once the Authority has amended the Code to implement the North Island AUFLS regime. The South Island development is also subject to the system operator determining whether the South Island frequency envelope needs to change to facilitate initiatives such as the National Reserves Market and National Frequency Keeping markets.

⁴⁴ <http://www.systemoperator.co.nz/market/development/current-projects/automatic-under-frequency-load-shedding-aufls-review>

⁴⁵ <http://www.systemoperator.co.nz/sites/default/files/bulk-upload/documents/AUFLS-III-RoCoF-testing-summary.pdf>

⁴⁶ <http://www.systemoperator.co.nz/sites/default/files/bulk-upload/documents/AUFLS-III-Appendix-D-high-level-SI-CBA.pdf>

aspect of the Code amendment as it considers that the amendment meets the requirements of section 39 (3) (b) and (c) of the Act, that is:

- (a) there is widespread support for the amendment among the people likely to be affected by it
- (b) there has been adequate prior consultation and all relevant views have been considered.

- 5.10.5 There may be arrangements or agreements between parties pursuant to the AUFLS provisions currently in the Code that the Authority is unaware of and which may be adversely affected by the proposed transition to the new arrangements. Stakeholders are invited to advise the Authority of such arrangements, particularly where Authority assistance may be required in order to ensure a smooth transition.

Q10. What comments do you have on the Authority's proposal to amend the Code to change the trigger setting for the second AUFLS block in the South Island from 45.5 Hz to 46.5 Hz?

Q11. Are there any arrangements or agreements between parties pursuant to the AUFLS provisions currently in the Code that the Authority ought to be made aware of? If so, please give details.

5.11 Do the dispensation and equivalence provisions apply?

- 5.11.1 A key feature of the common quality design set out in Part 8 of the Code is the ability for asset owners to:
- (a) seek a dispensation from the system operator for an AOPO or Technical Code obligation where the system operator can still meet its PPOs despite the asset owner's non-compliance with the obligation
 - (b) apply to the system operator for approval of an equivalence arrangement as an alternative means of complying with an AOPO or Technical Code obligation.
- 5.11.2 Under the proposed new arrangements, extended reserves obligations are still deemed AOPOs, but have some aspects that are more akin to ancillary services (for example central procurement).
- 5.11.3 The Authority considers that equivalence arrangements are one means of providing asset owners with flexibility in meeting their obligations (subject to system operator approval) and can result in innovation and lower compliance costs for the asset owners concerned. The Authority

anticipates that the proposed central optimisation approach should inherently address most of the issues for which equivalence arrangements might otherwise be sought, but sees no reason why extended reserves obligations should be excluded from the existing equivalence regime. It would welcome stakeholders' views on this position.

5.11.4 The Authority considers that the case for allowing dispensations from extended reserves obligations is more complex. On balance, however, it considers that dispensations are not an appropriate mechanism for addressing compliance issues asset owners may have with extended reserves obligations:

- (a) it is difficult to think of circumstances under which a party should receive a dispensation from the obligation to supply information into the selection process
- (b) it would be a failing of the selection and procurement arrangements if they resulted in a party being selected that could not, from the outset, meet the obligations it had been selected to provide
- (c) although it is possible that a party, having been selected, might subsequently find itself unable to meet its obligations, this is more appropriately addressed through other mechanisms specific to the extended reserves arrangements such as:
 - (i) the terms and conditions of the party's statement of extended reserves obligation (eg the ability to change the configuration of AUFLS load if required for other purposes (e.g. network reconfiguration to meet a lines company's core business needs), coupled with the flexibility to substitute alternative feeders in certain circumstances and provision for compensation to cease if the party is no longer providing AUFLS at specific locations)
 - (ii) the ability for the system operator to call on flexible extended reserves (e.g. stand by or remotely armed AUFLS relays) to address changed levels of AUFLS provision by parties
 - (iii) the Authority's ability to call for a partial or full selection process to be undertaken which would, presumably, result in the relevant party no longer having obligations it cannot comply with.

Q12. Do you agree with the Authority's proposal that the equivalence regime remain applicable to extended reserves, but that extended reserves be excluded from the dispensation regime? If not, what alternative do you propose and why?

5.12 Can there still be exemptions from Code obligations?

- 5.12.1 All directly connected consumers in the North Island and one distributor with a large consumer connected to its network currently have exemptions from the existing AUFLS obligations. These exemptions were first granted shortly after the Electricity Governance Rules came into force on 1 April 2004, and have been extended a number of times since then. One of the aims of the AUFLS review has been to address the underlying issues giving rise to the need for these continued exemptions.
- 5.12.2 The Act provides for participants to apply to the Authority for an exemption from obligations under the Code. It would not be lawful for the Code to prescribe that exemptions cannot apply to extended reserves obligations.
- 5.12.3 The Authority considers, however, that the characteristics of the selection methodology and procurement processes in the proposed extended reserves arrangements make it less likely that a participant would have cause to seek an exemption.

6. Regulatory Statement

6.1 Authority's proposal

6.1.1 The Authority proposes to amend the AUFLS procurement approach to a "centrally coordinated optimisation with compensation". This is option 2b in Table 4 on page 79 below.

6.1.2 The Authority's proposed Code amendment is set out in Appendix B.

6.2 Statement of the objectives of the proposed amendment

6.2.1 The objectives of the proposed amendment are to reduce the significant system security risk and costs associated with the current AUFLS procurement approach, including:

- (a) **competition** benefits, through minimising the extent to which load is prevented from competing in the IR, energy, and network services markets.
- (b) **reliability** benefits from reduced risk of system collapse through:
 - (i) better targeting of the right quantity of load to provide AUFLS
 - (ii) incentivising the provision of enhanced AUFLS services
 - (iii) improving the system operator's visibility of how much load is armed for AUFLS
- (c) **operational efficiency** benefits through minimising:
 - (i) the extent to which load is prevented from being allocated to higher value uses such as IL or demand response
 - (ii) the extent to which high interruption cost load is dropped during events that trigger AUFLS

6.3 Evaluation of alternative means of achieving the objectives of the proposed amendment

6.3.1 As set out in Table 4 below, a range of alternative procurement approaches were considered

Table 4: AUFLS procurement options

High-level family	Sub-variant
1) Common AUFLS percentage obligation	1.a) <i>Standard Code mechanisms</i> (equivalence, dispensations and exemptions) used to vary individual stakeholders provision away from the common percentage requirement.
	1.b) As above, <i>plus prioritised block coordination</i> (enabling high value load to be put in AUFLS block 4 rather than block 1, ⁴⁷ and allowing small stakeholders to provide a single block of 32%, rather than four blocks of 10%:10%:6%:6%.)
	1.c) As above, <i>plus special exclusions</i> to exempt certain stakeholders, including: exempting direct connects from any obligation and allowing IL to be counted towards meeting an AUFLS obligation
	1.d) As above, <i>plus profiled minimum and maximum obligations</i> (i.e. varying the percentage obligation by time of day and year, and penalising for over-provision as well as under-provision.)
2) Varying AUFLS provision via optimisation (the amount each stakeholder provides will be based on the relative suitability of the load)	2.a) <i>No compensation, plus central VoLL estimation</i> of lines companies' load
	2.b) <i>With compensation, plus central VoLL estimation</i> of lines companies' load
	2.c) <i>With compensation, plus lines companies' VoLL estimation</i> of lines companies' load
3) Voluntary AUFLS tender	3.a) <i>Simple pay-as-bid tender</i>
	3.b) <i>'Sophisticated' AUFLS market</i>

⁴⁷ Initial analysis suggests that the return period of the first block being called upon would likely be approximately one in five years, whereas the return period of the fourth block being called upon could be of the order of one in 50 years.

- 6.3.2 The qualitative and quantitative analysis detailed in Appendix C identified that these alternative approaches were unlikely to deliver as great a net benefit as the preferred option when measured against the Authority's statutory objectives.

6.4 Evaluation of the costs and benefits of the proposed amendment

- 6.4.1 Appendix C provides details showing that the scale of net benefits is estimated to deliver an NPV of approximately \$147m relative to the status quo.
- 6.4.2 However, approximately half of these benefits (approximately \$75m) is purely from the reliability benefits of implementing the revised four-block technical design of the AUFLS scheme with the status quo procurement approach.
- 6.4.3 In terms of determining the most appropriate procurement option, the evaluation considered the extent to which each option would deliver extra reliability benefits plus additional economic efficiency benefits. The Authority considered several alternative procurement approaches that had different implementation costs, and which varied in the extent to which they delivered extra operational benefits. The preferred option is estimated to deliver NPV net benefits which are \$72M greater than the status quo procurement approach, and \$20m greater than the next best procurement option.

6.5 Assessment under section 32(1)

- 6.5.1 Section 32(1) of the Act provides that Code provisions must be consistent with the Authority's objective and be necessary or desirable to promote any or all of the following:
- (a) competition in the electricity industry
 - (b) the reliable supply of electricity to consumers
 - (c) the efficient operation of the electricity industry
 - (d) the performance by the Authority of its functions
 - (e) any other matters specifically referred to in the Act as a matter for inclusion in the Code.
- 6.5.2 The following table sets out an assessment of the proposed amendment against the requirements of section 32(1) of the Act

Section 32(1) requirements:	Response
The proposed amendment is consistent with the Authority's objective under section 15 of the Act, which is as follows:	
(a) to promote competition in, reliable supply by, and the efficient operation of, the electricity industry for the long-term benefit of consumers	The proposal has been evaluated to materially improve the operational efficiency of electricity supply. It should also facilitate competition in the IR and broader energy markets.
The proposed amendment is necessary or desirable to promote any or all of the following:	
(a) competition in the electricity industry;	The proposal is likely to facilitate competition in the IR markets, and the broader energy market, through removing potential impediments to IL or dispatchable demand or demand response being offered to such markets.
(b) the reliable supply of electricity to consumers;	The proposal is considered to improve the reliability of supply by better achievement of the optimal level of AUFLS required.
(c) the efficient operation of the electricity industry;	The proposal will prevent inefficient withdrawal of load from the IR or dispatchable demand markets, plus should minimise the incidence of high interruption cost load being lost during an AUFLS event.
(d) the performance by the Authority of its functions;	The proposal will further the achievement of the Authority's statutory objectives.
(e) any other matter specifically referred to in this Act as a matter for inclusion in the Code.	

6.6 Assessment against the Code amendment principles

- 6.6.1 When considering amendments to the Code, the Authority is required by its Consultation Charter to have regard to the following Code amendment principles, to the extent that the Authority considers that they are applicable.
- 6.6.2 *Principle 1 – Lawfulness:* The Authority and its advisory groups will only consider amendments to the Code that are lawful and that are consistent

with the Act (and therefore consistent with the Authority's statutory objective and its obligations under the Act).

- 6.6.3 The Authority considers that the proposed approach is lawful and consistent with the Act.
- 6.6.4 Indeed, some of the options that were rejected were on the basis that although lines companies could acquire contractual rights to act in a way which the option required, it would be costly to do so.
- 6.6.5 *Principle 2 – Clearly Identified Efficiency Gain or Market or Regulatory Failure:* Within the legal framework specified in Principle 1, the Authority and its advisory groups will only consider using the Code to regulate market activity when:
- (a) it can be demonstrated that amendments to the Code will improve the efficiency⁴⁸ of the electricity industry for the long-term benefit of consumers;
 - (b) market failure is clearly identified, such as may arise from market power, externalities, asymmetric information and prohibitive transaction costs; or
 - (c) a problem is created by the existing Code, which either requires an amendment to the Code, or an amendment to the way in which the Code is applied.
- 6.6.6 The analysis set out in Appendix C indicates that the proposed approach will result in significantly more efficient outcomes for the long-term benefit of consumers, both when measured against the status quo and when measured against the other alternative approaches considered.
- 6.6.7 Further, it is considered that it is likely that under the proposed approach AUFLS exemptions for the direct connects will no longer be required, as the revised framework will appropriately address the direct connects' circumstances.
- 6.6.8 *Principle 3 – Quantitative Assessment:* When considering possible amendments to the Code, the Authority and its advisory groups will ensure disclosure of key assumptions and sensitivities, and use quantitative cost-benefit analysis to assess long-term benefits for consumers, although the Authority recognises that quantitative analysis will not always be possible. This approach means that competition and reliability are assessed solely

⁴⁸ Where efficiency refers to allocative, productive and dynamic efficiency, and improvements to efficiency include, for example, a reduction in transaction costs or a reduction in the scope for disputes between industry participants.

in regard to their economic efficiency effects. Particular care will be taken to include dynamic efficiency effects in the assessment, and the assessment will include sensitivity analysis when there is uncertainty about key parameters.

- 6.6.9 An indicative quantitative cost-benefit assessment has been set out in Appendix C, including highlighting key assumptions and methodological approaches.
- 6.6.10 It is considered that the proposed approach has been demonstrated to be preferable to the alternative options, and thus the tie-breaker principles 4-8 need not be applied.

- Q13. Do you have any comments relating to the proposed extended reserves Code amendments? Please provide comments and suggested drafting improvements with reference to specific parts, schedules and clauses of the draft Code amendments set out in Appendix B.
- Q14. What comment do you have on the Authority's cost-benefit assessment summarised here and detailed in Appendix C?
- Q15. What comment do you have on the Authority's assessment of the proposed amendment against the requirements of section 32(1) of the Act?
- Q16. What comment do you have on the Authority's assessment of the proposed amendment against the Code amendment principles?

Appendix A Format for submissions

	Question	Submitter's response
1.	Do you have any comment on the Authority's overall design of the proposed extended reserves arrangements?	
2.	What comments do you have on the indicative timeline the Authority has developed for transitioning to the proposed arrangements for extended reserves?	
3.	Do you agree with the Authority's proposed allocation of roles in relation to the technical requirements schedule, selection methodology, procurement schedule, extended reserves procurement notices, implementation plans, the extended reserves schedule and statements of extended reserves obligations? If not, what alternative would you propose, and why?	
4.	Do you agree with the Authority's proposal that the Authority undertake the ERM role itself initially? If not, what alternative would you propose, and why?	
5.	Do you agree with the Authority's proposed mix of Code provisions and documents that sit outside the Code? If not, what alternative would you propose, and why?	
6.	Do you agree with the Authority's proposal that publishing more details about extended reserves specification and procurement will bring a greater degree of transparency to extended reserves arrangements? If not, what changes would you propose, and why?	
7.	What comments do you have on the Authority's proposed approach to co-ordinating AUFLS with IL and other forms of demand response?	

	Question	Submitter's response
8.	What comments to you have on the Authority's initial view on how to achieve consistency of outcomes between AUFLS and rolling outages?	
9.	Do you have any comments in relation to the consistency of the proposed AUFLS regime and the Commerce Commission's price control regime?	
10.	What comments do you have on the Authority's proposal to amend the Code to change the trigger setting for the second AUFLS block in the South Island from 45.5 Hz to 46.5 Hz?	
11.	Are there any arrangements or agreements between parties pursuant to the AUFLS provisions currently in the Code that the Authority ought to be made aware of? If so, please give details.	
12.	Do you agree with the Authority's proposal that the equivalence regime remain applicable to extended reserves, but that extended reserves be excluded from the dispensation regime? If not, what alternative do you propose and why?	
13.	Do you have any comments relating to the proposed extended reserves Code amendments? Please provide comments and suggested drafting improvements with reference to specific parts, schedules and clauses of the draft Code amendments set out in Appendix B. (refer suggested format for drafting comments in the table below)	
14.	What comment do you have on the Authority's cost-benefit assessment summarised here and detailed in Appendix C?	

	Question	Submitter's response
15.	What comment do you have on the Authority's assessment of the proposed amendment against the requirements of section 32(1) of the Act?	
16.	What comment do you have on the Authority's assessment of the proposed amendment against the Code amendment principles?	
17.	Do you have comments on the indicative implementation costs used in the CBA (Appendix C)?	
18.	Do you have comments on the indicative on-going costs assumed in the CBA (Appendix C)?	
19.	Do you have comments on the indicative base level and future benefits assumed in the CBA (Appendix C)?	
20.	Do you have any other comments on the CBA (Appendix C)?	

Suggested format for providing drafting comments on the proposed Code amendment in Appendix B.

Clause reference	Submitter's comment	Submitter's alternative drafting

Appendix B Proposed amendment

Changes to Part 1

automatic under-frequency load shedding means a form of **extended reserves** in which electrical load is automatically shed ~~automatic shedding of electrical load~~ when frequency falls below a the relevant ~~the relevant~~ preset frequency specified by the **system operator** in the relevant **extended reserves provider's statement of extended reserves obligation** ~~in clause 7(6) of **Technical Code B** of Schedule 8.3~~

extended reserves means services provided to restore frequency to the **normal band** after disturbances of a magnitude that make it impracticable or uneconomic to restore frequency using **ancillary services**

extended reserves manager means the **market operation service provider** that is for the time being appointed as the extended reserves manager for the purposes of this Code, or if no regulations have been made establishing the **extended reserves manager** as a **market operations service provider**, the **Authority**

extended reserves procurement notice means the notice given to an **asset owner** by the **extended reserves manager** under clause 8.54L

extended reserves procurement schedule means the schedule **published** by the **extended reserves manager** under clause 8.54J

extended reserves provider means an **asset owner** required to provide **extended reserves** under Schedule 8.3, **Technical Code B**, clause 7

extended reserves selection methodology means the methodology **published** by the **extended reserves manager** under clause 8.54G

extended reserves schedule means the schedule **published** by the **system operator** under clause 8.54O

extended reserves technical requirements report means the report **published** by the **system operator** under clause 8.54D

extended reserves technical requirements schedule means the schedule of requirements **published** by the **system operator** under clause 8.54D

statement of extended reserves obligation, in relation to an **asset owner**, means the latest statement of obligation given to the **asset owner** by the **system operator** under clause 8.54P

Changes to Part 8

8.1 Contents of this Part

This Part relates to **common quality**. In particular, this Part concerns the performance obligations of the **system operator**, the performance obligations of **asset owners**, arrangements concerning **ancillary services**, **extended reserves**, and **technical codes**.

...

8.5 Restoration

- (1) If an event disrupts the **system operator's** ability to comply with the **principal performance obligations**, the **system operator** must act as a **reasonable and prudent system operator** to re-establish normal operation of the power system as soon as possible, given—
 - (a) the capability of **generation**, ~~and ancillary services~~, and **extended reserves**; and
 - (b) the configuration and capacity of the **grid**; and
 - (c) the information made available by **asset owners**.
- (2) When re-establishing normal operation of the power system under subclause (1), the **system operator** must have regard to the following priorities:
 - (a) first, the safety of natural persons;
 - (b) second, the avoidance of damage to **assets**;
 - (c) third, the restoration of **offtake**;
 - (d) fourth, conformance with the **principal performance obligations**;
 - (e) fifth, full conformance with the **dispatch objective**.

...

8.19 Contributions to frequency support in under-frequency events

- (1) Subject to subclause (3), each **generator** must at all times **ensure** that, while connected, its **assets**, other than any **excluded generating stations**, contribute to supporting frequency by remaining **synchronised**, ensuring that each of its **generating units** can and does, at a minimum, sustain pre-event output—
 - (a) at all times when the frequency is above 47.5 Hertz; and
 - (b) for at least 120 seconds when the frequency is 47.5 Hertz; and
 - (c) for at least 20 seconds when the frequency is 47.3 Hertz; and
 - (d) for at least 5 seconds when the frequency is 47.1 Hertz; and
 - (e) for at least 0.1 seconds when the frequency is 47.0 Hertz; and
 - (f) at any frequencies between those specified in paragraphs (b) to (e) for times derived by linear interpolation.
- (2) If the **inherent characteristics** and design of a **generator's generating unit** are such that it is reasonably able to operate beyond the above requirements, the **generator** must

declare such capabilities in accordance with clause 2(5) of **Technical Code A** of Schedule 8.3.

- (3) Each South Island **generator** must ensure that each of its **assets**, other than excluded **generating units**, remains **synchronised**, and can and do, at a minimum, sustain pre-event output—
 - (a) at all times when the frequency is above 47 Hertz; and
 - (b) for 30 seconds if the frequency falls below 47 Hertz but not below 45 Hertz.
- (4) The **HVDC owner** must at all times ensure that, while connected, its **assets** contribute to supporting frequency during an **under-frequency event** in either **island** by—
 - (a) remaining connected to those **assets** making up the **grid** in the North Island and South Island while the frequency in both **islands** remains above 48 Hertz; and
 - (b) remaining connected to those **assets** making up the **grid** in the North Island and South Island while the frequency in both **islands** remains below 48 Hertz and above 47 Hertz for 90 seconds; and
 - (c) remaining connected to those **assets** making up the **grid** in the North Island and South Island while the frequency in both **islands** remains above 45 Hertz for 35 seconds, unless the frequency in either **island** is less than 46.5 Hertz and the frequency is falling at a rate of 7 Hertz per second or greater; and
 - (d) subject to the level of transfer and the **HVDC link** configuration at the beginning of the **under-frequency event**, if the **HVDC link** itself is not the cause of the **under-frequency event**, modifying the instantaneous transfer on the **HVDC link** by up to 250 **MW** with the objective of limiting the difference between the North Island and South Island frequencies to no greater than 0.2 Hertz.
- (5) Each **extended reserves provider** ~~North Island distributor and each South Island grid owner~~ must provide **extended reserves** in accordance with Schedule 8.3, **Technical Code B**, clause 7. ~~ensure that it has established and maintained automatic under-frequency load shedding in block sizes and with relay settings in accordance with the technical codes.~~

...

Equivalence arrangements and dispensations

8.29 Right to apply for approval of equivalence arrangement or grant of dispensation

- (1) Subject to subclause (2), if an **asset owner** cannot comply with an **AOPO** or a **technical code** obligation in respect of a particular **asset** or configuration of **assets**, being an existing, new or proposed **asset**, the **asset owner** may apply for an **equivalence arrangement** to be approved or **dispensation** to be granted in accordance with Schedule 8.1.
- (2) A **dispensation** may not be granted in relation to an obligation to provide **extended reserves** under clause 8.19(5) or Schedule 8.3, **Technical Code B**, clause 7.

...

Subpart 4—Interruptible load

8.54A Contents of this subpart

This subpart provides for the provision of information relating to **interruptible load**.

8.54B Ancillary service agents to provide information about interruptible load

- (1) Each **ancillary service agent** that contracts for **interruptible load** in a **network** must notify the following **participants** of the existence of the contract:
 - (a) if the **interruptible load** is contracted on a **local network**, the **distributor** that operates the **local network**;
 - (b) if the **interruptible load** is contracted on an **embedded network**, the **distributor** that operates the **local network** to which the **embedded network** is connected;
 - (c) if the **interruptible load** is contracted on the **grid**, the **grid owner** that owns or operates the part of the **grid** on which the **interruptible load** is contracted.
- (2) A **distributor** or **grid owner** may require that an **ancillary service agent** that has notified the **distributor** or **grid owner** of the existence of a contract under subclause (1), give the **distributor** or **grid owner** information about the **interruptible load** to which the contract relates.
- (3) An **ancillary service agent** must comply with a requirement under subclause (2).

Subpart 5—Extended reserves

8.54C Contents of this subpart

This subpart provides for the procurement of **extended reserves**.

8.54D System operator to review extended reserves

- (1) The **system operator** must review the technical requirements for **extended reserves** in accordance with this clause.
- (2) The **Authority** may, no later than 10 **business days** after this clause comes into force, give the **system operator** a set of principles outlining the **Authority's** expectations for the objectives of the review.
- (3) As part of the review, the **system operator** must consider any principles given to the **system operator** by the **Authority** under subclause (2).
- (4) On the basis of the review, the **system operator** must prepare and **publish**—
 - (a) an **extended reserves technical requirements report**; and
 - (b) an **extended reserves technical requirements schedule**.
- (5) The **extended reserves technical requirements report** must reflect the **system operator's** analysis of the technical requirements for **extended reserves** on which the **extended reserves technical requirements schedule** is based.
- (6) The **extended reserves technical requirements schedule** must—
 - (a) set out the technical specifications for **extended reserves** that the **system operator** requires in order to be able to comply with the **principal performance obligations**; and
 - (b) specify requirements for periodic testing that each **extended reserves provider** will be required to carry out in relation to the relevant **assets**.
- (7) The consultation requirements set out in Part 1 of Schedule 8.5 apply to the preparation and **publication** of the **extended reserves technical requirements schedule**.
- (8) If the **system operator** takes any action before this clause comes into force that, if this clause had been in force at the time of the action, would have contributed to complying

with this clause, the action is deemed, for the purposes of this clause, to have been taken when this clause was in force.

- (9) The **system operator** must comply with this clause so that it gives a draft of the **extended reserves technical requirements schedule** to the **Authority** under clause 2(2) of Schedule 8.5 no later than 40 **business days** after this clause comes into force.

8.54E Timeframe for review of extended reserves technical requirements schedule

- (1) The **system operator** must—
- (a) review the **extended reserves technical requirements schedule** under this clause; and
 - (b) as soon as practicable after completing the review, decide whether to propose a change to the schedule; and
 - (c) advise the **Authority** of its decision.
- (2) The review must be conducted so that the **system operator** advises the **Authority** of its decision no later than 5 years after—
- (a) in the case of the first review, the **publication** of the first **extended reserves technical requirements schedule** under clause 8.54D; and
 - (b) in the case of each subsequent review, the date on which the **system operator** advised the **Authority** of its decision on the previous review.
- (3) The **Authority** may direct the **system operator** to review the **extended reserves technical requirements schedule** at a time that is sooner than required under subclause (2).
- (4) If the **system operator** decides to propose a change to the **extended reserves technical requirements schedule** as a result of a review, the **system operator** must—
- (a) prepare and **publish**—
 - (i) an **extended reserves technical requirements report**; and
 - (ii) an **extended reserves technical requirements schedule**; and
 - (b) provide the following additional information when giving a draft of the revised schedule to the **Authority** under clause 2(2) of Schedule 8.5:
 - (i) an explanation of the proposed change and a statement of the objectives of the proposed change;
 - (ii) an evaluation of the costs and benefits of the proposed change;
 - (iii) an evaluation of alternative means of achieving the objectives of the proposed change.
- (5) Clause 8.54D(2), (3) and (5) to (9) applies to each review of the **extended reserves technical requirements schedule**.
- (6) If the **system operator** advises the **Authority** that it does not intend to propose a change to the **extended reserves technical requirements schedule**, the **system operator** must provide the **Authority** with the findings of its review of the schedule.

8.54F Authority may require system operator to reconsider

- (1) The **Authority** may require the **system operator** to reconsider a decision made under clause 8.54E(1)(c) not to propose a change to the **extended reserves technical requirements schedule**.
- (2) If the **Authority** requires the **system operator** to reconsider, the **Authority** must advise the **system operator** of—

- (a) the **Authority**'s reasons for requiring the **system operator** to reconsider; and
- (b) the date, determined after consulting with the **system operator**, by which the **system operator** must—
 - (i) confirm its decision under clause 8.54E(1)(c); or
 - (ii) give a draft of the revised schedule to the **Authority** under clause 2(2) of Schedule 8.5.
- (3) The **Authority** must as soon as practicable **publicise** the advice received from the **system operator** under clause 8.54E(1)(c) and any advice given by the **Authority** to the **system operator** under subclause (2).

8.54G Preparation and publication of extended reserves selection methodology

- (1) The **extended reserves manager** must prepare and **publish** an **extended reserves selection methodology**.
- (2) The methodology must specify how the **extended reserves manager** will procure **extended reserves** according to the **extended reserves technical requirements schedule**.
- (3) No later than 40 **business days** after the initial **extended reserves technical requirements schedule** is **published**, the **extended reserves manager** must, in accordance with clause 5(2) of Schedule 8.5, provide to the **Authority** and the **system operator**—
 - (a) a draft of the **extended reserves selection methodology**; and
 - (b) one or more worked examples of an **extended reserves procurement schedule**, created using—
 - (i) the draft **extended reserves selection methodology**; and
 - (ii) data specified by the **system operator**.
- (4) The methodology must—
 - (a) be based on the principles set out in clause 8.54H; and
 - (b) identify the **asset owners** that are required to provide information during an **extended reserves** selection process; and
 - (c) specify the information that the **asset owners** are required to provide; and
 - (d) specify the timeframe within which **asset owners** are required to provide the information; and
 - (e) set out the basis on which the **extended reserves manager** selects **asset owners** to be **extended reserves providers**; and
 - (f) include default terms and conditions specifying the basis on which **extended reserves** must be provided, including requirements for periodic testing of **assets**; and
 - (g) specify how payments to **asset owners** for providing **extended reserves** are set.

- (5) The consultation and approval requirements set out in Part 2 of Schedule 8.5 apply to the preparation and **publication** of the **extended reserves selection methodology**.

8.54H Principles for extended reserves selection methodology

- (1) The **extended reserves selection methodology** must give effect to the principles set out in subclause (2).
- (2) The **extended reserves selection methodology** must—
- (a) reflect a balance of interests between potential **extended reserves providers**, and between such providers and the **system operator**; and
 - (b) enable **extended reserves** to be procured cost-effectively, by setting out how to evaluate—
 - (i) the expected cost of providing the **extended reserves** (including capital and operating costs); and
 - (ii) in the case of **extended reserves** that involves the interruption of load, the expected cost of an interruption during an event that calls on **extended reserves**, taking into account opportunity cost and the performance characteristics of the relevant load; and
 - (iii) the likely transaction costs associated with administering **extended reserves** and in providing **extended reserves**; and
 - (c) seek an appropriate balance between certainty in the provision of **extended reserves** products and flexibility to accommodate changes in circumstances and technologies.

8.54I Review of extended reserves selection methodology

- (1) The **Authority** may direct the **extended reserves manager** to review the **extended reserves selection methodology**.
- (2) Clause 8.54G applies to each review of the **extended reserves selection methodology**, except that the **extended reserves manager** must provide a draft of the revised methodology to the **Authority** and the **system operator** under clause 5(2) of Schedule 8.5 no later than 40 **business days** after the date of the direction under subclause (1) or the approval under subclause (2).

8.54J Extended reserves manager must undertake extended reserves selection process

- (1) The **extended reserves manager** must undertake an **extended reserves** selection process in accordance with the **extended reserves selection methodology** when directed to do so by the **Authority**.
- (2) The **Authority** must make a direction under subclause (1)—
- (a) in the case of the first selection process after this clause comes into force, no later than 5 **business days** after the **extended reserves selection methodology** is **published**; and
 - (b) in the case of each subsequent selection process, no later than 5 years after the **publication** of the current **extended reserves procurement schedule**.
- (3) The **Authority** may direct the **extended reserves manager** as to the scope of a selection process.

- (4) If the **Authority** directs the **extended reserves manager** to undertake a limited selection process under subclause (3), the **Authority** must give reasons for the direction.
- (5) After completing a selection process, the **extended reserves manager** must prepare and **publish** an **extended reserves procurement schedule**.
- (6) The **extended reserves procurement schedule** must—
 - (a) set out the results of the selection process; and
 - (b) identify the **asset owners** that are required to be **extended reserves providers**;
and
 - (c) specify the **extended reserves** to be provided; and
 - (d) include information as to how the amounts payable to each **extended reserves provider** will be calculated; and
 - (e) identify **asset owners** that have not been selected to be **extended reserves providers**.
- (7) The consultation and approval requirements set out in Part 3 of Schedule 8.5 apply to the preparation and **publication** of the **extended reserves procurement schedule**.
- (8) The **extended reserves manager** may undertake consultation additional to that required by Part 3 of Schedule 8.5 if the **extended reserves manager** considers it necessary to do so.
- (9) The **extended reserves manager** must comply with this clause so that a draft **extended reserves procurement schedule** is given to the **Authority** and the **system operator** under clause 11(2) of Schedule 8.5 no later than 40 **business days** after receiving a direction from the **Authority** under subclause (2).
- (10) The **publication** of an **extended reserves procurement schedule** relating to the provision of **extended reserves** for only part of an **island** must be disregarded for the purposes of determining the date by which the **Authority** must give a direction under subclause (2).

8.54K Information required for extended reserves selection process

- (1) During an **extended reserves** selection process, an **asset owner** identified in the **extended reserves selection methodology** must comply with a request from the **extended reserves manager** to provide any information described in the methodology.
- (2) An **asset owner** required to provide information to the **extended reserves manager** must provide the information within the timeframe specified in the **extended reserves selection methodology**.
- (3) If the **extended reserves manager** considers that any information provided by an **asset owner** is incomplete or insufficient, the **extended reserves manager** may require that the **asset owner** provide further information.
- (4) An **asset owner** must comply with a requirement under subclause (3) within the timeframe specified by the **extended reserves manager**.

8.54L Extended reserves manager to issue extended reserves procurement notices

- (1) The **extended reserves manager** must issue an **extended reserves procurement notice** to each **asset owner** specified in the **extended reserves procurement schedule**.

- (2) Each **extended reserves procurement notice** must—
 - (a) specify the information in the **extended reserves procurement schedule** relating to the **asset owner**; and
 - (b) if an **asset owner** has been selected to be an **extended reserves provider**,—
 - (i) specify the default terms and conditions (as specified in the **extended reserves selection methodology**) that apply to the provision of **extended reserves** by the **asset owner**; and
 - (ii) include information as to how the amounts payable to each **extended reserves provider** will be calculated.
- (3) The **extended reserves manager** must give each **asset owner** its **extended reserves procurement notice** no later than 5 **business days** after **publishing the extended reserves procurement schedule**.

8.54M Asset owners to prepare implementation plans

- (1) Each **asset owner** identified in an **extended reserves procurement schedule** must prepare an implementation plan specifying how the **asset owner** will implement the obligations allocated to it.
- (2) Each **asset owner** must give its implementation plan to the **system operator** for approval no later than 40 **business days** after receiving its **extended reserves procurement notice**, or by such later date as may be agreed between the **asset owner** and the **system operator**.
- (3) The first implementation plan that an **asset owner** gives the **system operator** under subclause (2) must specify how the **asset owner** will implement the transition from complying with its obligations (if any) under Schedule 8.3, Technical Code B, clause 7 as before this clause came into force to complying with its obligations (if any) under its **statement of extended reserves obligation**.
- (4) Each subsequent implementation plan must specify how the **asset owner** will implement the transition to complying with its obligations (if any) under its most recent **extended reserves procurement notice** from complying with its obligations (if any) under its previous **extended reserves procurement notice**.
- (5) Each implementation plan must specify 1 or more dates on which payments to the **asset owner** will commence or cease for all or part of the provision of **extended reserves** under the **asset owner's extended reserves procurement notice**.
- (6) Each date specified in an implementation plan under subclause (5) must be the date on which provision of the **extended reserves** to which the payment relates will commence or cease, as the case may be.
- (7) The first implementation plan that an **asset owner** gives the **system operator** must specify the date on which the plan comes into force.
- (8) An **asset owner** may amend an implementation plan after giving it to the **system operator** under subclause (2) with the agreement of the **system operator**.
- (9) If the **system operator** requires that an **asset owner** make changes to an implementation plan given to the **system operator** under subclause (2), the **asset owner** must comply with the requirement.
- (10) The **system operator** must approve an implementation plan given to it by an **asset owner** under subclause (2) if the plan meets the requirements of this clause.

8.54N Terms and conditions applying to the provision of extended reserves

In the case of an **asset owner** that has been selected to be an **extended reserves provider**, the terms and conditions in the **asset owner's extended reserves procurement notice** apply to the provision of **extended reserves** by the **asset owner** but may be amended by agreement in writing between the **asset owner** and the **system operator**.

8.54O System operator must publish and maintain extended reserves schedule

- (1) The **system operator** must **publish** an **extended reserves schedule**.
- (2) The **extended reserves schedule** must specify the obligations of each **asset owner** identified in the **extended reserves procurement schedule**, based on information from—
 - (a) the latest **extended reserves procurement schedule**; and
 - (b) each approved implementation plan; and
 - (c) any amendment to terms and conditions applying to an **extended reserves provider** agreed under clause 8.54N; and
 - (d) any other information held by the **system operator** that describes the obligations of an **extended reserves provider** to provide **extended reserves**.
- (3) The **system operator** must amend the **extended reserves schedule** to reflect any change to any information described in subclause (2), so that the schedule is kept up to date.

8.54P System operator to issue statements of extended reserves obligations

- (1) The **system operator** must issue to each **asset owner** identified in the **extended reserves schedule** a **statement of extended reserves obligations** in accordance with this clause.
- (2) Each **statement of extended reserves obligation** must specify the obligations of the **asset owner** to which it relates, as specified in the **extended reserves schedule** as at the date on which it is issued.
- (3) The **system operator** must issue a **statement of extended reserves obligation** to an **asset owner** at each of the following times:
 - (a) as soon as practicable after the **asset owner's** implementation plan is approved under clause 8.54M;
 - (b) as soon as practicable after it makes an amendment to the schedule under clause 8.54O(3) that relates to the **asset owner's** obligations under this subpart;
 - (c) as soon as practicable after the **system operator** becomes aware of any other information to which clause 8.54O(2)(d) applies that relates to the obligations of the **asset owner**.

8.54Q System operator must notify clearing manager of dates

- (1) The **system operator** must notify the **Authority** and the **clearing manager** of all dates for the commencement or cessation of the provision of **extended reserves**, as set out in the **extended reserves schedule**.
- (2) If an amendment to an implementation plan made under clause 8.54M(8) or (9) results in provision or cessation of provision of any **extended reserves** on a date that is

different from the relevant date specified in the implementation plan, in each case the **system operator** must—

- (a) update the **extended reserves schedule** with the new date; and
- (b) notify the **Authority** and the **clearing manager** of the new date.

8.54R System operator must report to the Authority

In its monthly report provided to the **Authority** under clause 3.14, the **system operator** must include information about any use of **extended reserves**.

8.54S New distributors and new grid owners to provide information

- (1) The purpose of this clause is to require new **distributors** and new **grid owners** to provide information so that their obligations under this subpart can be determined.
- (2) No later than 20 **business days** after a **distributor** commences taking **electricity** from the **grid**, it must give the **Authority** either—
 - (a) historical records of the quantity of **electricity** consumed in the **distributor's network** or by the **distributor**; or
 - (b) if the **Authority** is not satisfied with the records provided under paragraph (a), or if there are no such records, a bona fide **business** plan that permits a realistic estimate to be made of the amount of **electricity** to be consumed in the **distributor's network** or by the **distributor**.
- (3) No later than 20 **business days** after a **grid owner** commences the conveyance of **electricity** on the **grid**, it must give the **Authority** either—
 - (a) historical records of the quantity of **electricity** conveyed by the **grid owner** on the **grid**; or
 - (b) if the **Authority** is not satisfied with the records provided under paragraph (a), or if there are no such records, a bona fide **business** plan that permits a realistic estimate to be made of the amount of **electricity** to be conveyed by the **grid owner** on the **grid**.

8.54T Assignment of extended reserves obligations

- (1) An **extended reserves provider** that proposes to assign **assets** that it uses to provide **extended reserves** may apply to the **Authority** by notice in writing for approval to assign its obligations to provide **extended reserves** that relate to those **assets**.
- (2) The **Authority** may, on receiving an application under subclause (1)—
 - (a) approve the assignment; or
 - (b) approve the assignment with conditions; or
 - (c) decline to approve the assignment.
- (3) If the **Authority** gives an **extended reserves provider** approval to assign its obligations under subclause (2), the **Authority** must notify the **system operator**.
- (4) An assignment of an **extended reserves provider's** obligations is not effective except in accordance with an approval by the **Authority** under subclause (2).

Subpart 6—Allocating costs

8.54U Contents of this subpart

This subpart provides for the allocation of costs relating to **ancillary services** and **extended reserves**.

Allocating ~~ancillary services~~ costs for ancillary services and extended reserves

8.55 Identifying costs associated with each ancillary services and extended reserves

- (1) The **allocable costs** for each **ancillary service** are—
- (a) the actual amounts that the **ancillary service agents** are entitled to receive for that **ancillary service** under contracts entered into by the **system operator** in implementing the **procurement plan**; plus
 - (b) the actual **administrative costs** of the **system operator** (as approved by the **Authority**) incurred in administering the **procurement plan** in respect of that **ancillary service**; less
 - (c) any readily identifiable and quantifiable costs to be paid by **asset owners** in respect of that **ancillary service** as a condition of any **dispensations** stipulated in accordance with clause 8.31(1)(a); less
 - (d) any identifiable costs to be paid by any person in respect of that **ancillary service**, as a condition of any agreement reached by the **system operator**, in accordance with clause 8.6.
- (2) The **allocable costs** for **extended reserves** are the actual amounts (if any) that **extended reserves providers** are entitled to receive for providing **extended reserves** under the current **extended reserves procurement schedule**.

...

8.67A Extended reserves costs allocated to distributors

If there are **allocable costs** for **extended reserves** in a **billing period**, each **distributor** must pay a charge for **extended reserves** for the **billing period** in accordance with the following formula:

$$\text{Extended reserves charge}_D = \left(\text{TERAC}_{\text{NI}} \times \frac{L_{\text{NI}, D}}{L_{\text{NI}, \text{TOT}}} \right) + \left(\text{TERAC}_{\text{SI}} \times \frac{L_{\text{SI}, D}}{L_{\text{SI}, \text{TOT}}} \right)$$

where

Extended reserves charge_D is the **extended reserves** charge owing by the **distributor** for the **billing period**

$TERAC_{NI}$	is the sum of all payments for extended reserves provided in the North Island for the billing period
$L_{NI, D}$	is the distributor's total offtake at grid exit points in the North Island in the billing period
$L_{NI, TOT}$	is the total offtake by all distributors at grid exit points in the North Island in the billing period
$TERAC_{SI}$	is the sum of all payments for extended reserves provided in the South Island for the billing period
$L_{SI, D}$	is the distributor's total offtake at grid exit points in the South Island in the billing period
$L_{SI, TOT}$	is the total offtake by all distributors at grid exit points in the South Island in the billing period .

8.68 Clearing manager to determine amounts payable and receivable

- (1) The **clearing manager** must determine the amount payable to the **system operator** by each **grid owner, purchaser, generator** and **distributor** for **ancillary services** under clauses 8.55 to 8.67. On behalf of the **system operator**, the **clearing manager** must collect those amounts, and any amounts advised by the **system operator** as payable to it under clauses 8.6 and 8.31(1)(a), by including the relevant amounts in the invoices issued by the **clearing manager** under Part 14. ~~All amounts payable under this clause are subject to the priority order of payments set out in clause 14.47.~~
- (2) To enable the **clearing manager** to determine those amounts, the **system operator** must provide to the **clearing manager** the total **allocable cost** for each **ancillary service** and any additional information required to carry out the calculations under clauses 8.55 to 8.67 that is not otherwise provided by the **reconciliation manager** or the **pricing manager** under Part 13.
- (3) The **clearing manager** must determine the amount owing by each **distributor** for **extended reserves** under clause 8.67A.
- (4) The **clearing manager** must determine the amount owing to each **extended reserves provider** for the provision of **extended reserves** under—
 - (a) the **extended reserves schedule**; and
 - (b) any relevant notice received from the **system operator** under clause 8.54Q(2).
- (5) The **clearing manager** must collect the amounts determined under subclause (3) and pay the amounts determined under subclause (4) by including the relevant amounts in the invoices issued by the **clearing manager** under Part 14.
- (6) All amounts owing under this clause are subject to the priority order of payments set out in clause 14.56.

8.69 Clearing manager to determine wash up amounts payable and receivable

- (1) The **clearing manager** must determine the following amounts owing payable to the system operator by each grid owner, purchaser, generator and distributor, and the amount payable to each grid owner, purchaser, generator and distributor by the system operator for ancillary services under clauses 8.55 to 8.67 as a result of any washups that might occur under clause 14.65 under subpart 6 of Part 14:-
 - (a) the amount owing to the system operator by each grid owner, purchaser, generator and distributor for ancillary services under clauses 8.55 to 8.67;
 - (b) the amount owing to each grid owner, purchaser, generator and distributor by the system operator for ancillary services under clauses 8.55 to 8.67;
 - (c) the amount owing by each distributor for extended reserves under clause 8.67A;
 - (d) the amount owing to each extended reserves provider for extended reserves under clause 8.68.
- (2) On behalf of the **system operator** the **clearing manager** must collect or pay ~~those amounts~~ the amounts owing for ancillary services, and any amounts advised by the **system operator** as payable to it under clauses 8.6 and 8.31(1)(a) by including the relevant amounts advised by the clearing manager as owing in the invoices issued by the clearing manager under Part 14. All amounts payable under this clause are subject to the priority order of payments set out in clause 14.47.
- (23) To enable the **clearing manager** to determine the amounts payable for ancillary services, ~~those amounts~~, the **system operator** must provide to the **clearing manager** the **allocable cost** for each **ancillary service** and any additional information required to carry out the recalculations under clauses 8.55 to 8.67 that is not otherwise provided by the **reconciliation manager** or the **pricing manager** under Part 13.
- (4) All amounts owing under this clause are subject to the priority order of payments set out in clause 14.47.

Schedule 8.3 Technical codes

cl 1.1

Technical Code A – Assets

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8 Records, tests and inspections

- (1) Each **asset owner** must arrange for, and retain, records for each of its **assets** to demonstrate that the **assets** comply with the **asset owner performance obligations** and this **technical code**.
- (2) In addition to the requirements for commissioning or testing in clause 2(6) to (8), each **asset owner** must carry out periodic testing—
 - (a) of its **assets** and ~~automatic under frequency load shedding~~ systems in accordance with Appendix B; and
 - (b) in the case of an **asset owner** that is an **extended reserves provider**, of **assets** specified in its **statement of extended reserves obligation** in accordance with that statement.
- (3) If the **system operator** advises an **asset owner** that it reasonably believes that an **asset** may not comply with an **asset owner performance obligation** or this **technical code**, the **asset owner** must—
 - (a) as soon as practicable, but no later than 30 days after receiving a written request, advise the **system operator** of its remedial or test plan for the **assets**; and
 - (b) as soon as reasonably practicable undertake any remedial action or testing of its **assets** in accordance with its plan advised to the **system operator** in paragraph (a). The **system operator** may require such testing or remedial action to be undertaken in the presence of a **system operator** representative.
- (4) Each **asset owner** must, at the request of the **system operator**, provide access to records of the performance or testing of an **asset** and access to inspect an **asset**.

...

Appendix B: Routine testing of assets ~~and automatic under-frequency load shedding systems~~

1 Periodic tests to be carried out

- (1) This Appendix sets out periodic tests required for the purposes of clause 8(2) of **Technical Code A**. Each **asset owner** ~~and each owner of automatic under-frequency load shedding systems~~ may be legally required, other than under this Code, to carry out additional tests to ensure that their **assets** ~~and automatic under-frequency load shedding systems~~ are safe and reliable.
- (2) For the purposes of this Appendix, **generating unit** does not include a **generating unit** for which wind is the primary power source.

...

6 ~~North Island distributor automatic under-frequency load shedding systems profiles and trip settings~~

Each North Island ~~distributor~~ must—

- (a) ~~provide the profile information described in clause 7(9) of Technical Code B of Schedule 8.3 to the system operator in an updated asset capability statement at least once every year; and~~
- (b) ~~test the operation of its automatic under-frequency load shedding systems at least once every 4 years; and~~
- (c) ~~based on the test carried out in accordance with paragraph (b), provide a verified set of trip settings and time delays to the system operator in an updated asset capability statement within 3 months of the completion date of each such test.~~

7 ~~South Island grid owner automatic under-frequency load shedding systems profiles and trip settings~~

Each South Island ~~grid owner~~ must—

- (a) ~~provide the profile information described in clause 7(9) of Technical Code B of Schedule 8.3 to the system operator in an updated asset capability statement at least once every year; and~~
- (b) ~~test the operation of its automatic under-frequency load shedding systems at least once every 4 years; and~~
- (c) ~~based on the test carried out in accordance with paragraph (b), provide a verified set of trip settings and time delays to the system operator in an updated asset capability statement within 3 months of the completion date of each such test.~~

...

Technical Code B – Emergencies

...

7 Extended reserves providers must provide extended reserves

- (1) An **extended reserves provider** must provide **extended reserves** at all times in accordance with its current **statement of extended reserves obligations** issued by the **system operator** under clause 8.54P.
- (2) An **extended reserves provider** must notify the **system operator** as soon as practicable if the **extended reserves provider** is unable to comply with subclause (1).

7A Emergency load shedding

- (1) Each **distributor** must maintain a process for disconnection of **demand** for **points of connection**.
- (2) The process must specify the **participant** that will effect the disconnection of **demand**.
- (3) The **distributor** must obtain agreement for the process from the **system operator** and each **grid owner**.
- (4) Each **distributor** must advise the **system operator** of the agreed process in addition to any changes to a process previously advised.
- (5) If the **system operator** requires the disconnection of **demand** in accordance with this **technical code**, the **system operator** must instruct **distributors** and **grid owners** in accordance with the agreed process under subclause (3) to disconnect **demand** for the relevant **point of connection**.
- (6) If the **system operator** and a **distributor** or **grid owner** have not agreed on a process for disconnection of **demand** at a **point of connection**, the **system operator** must instruct **grid owners** to disconnect **demand** directly at the relevant **point of connection**.
- (7) To the extent practicable, the **system operator** must use reasonable endeavours when instructing the disconnection of **demand** to ensure equity between **distributors**.
- (8) Each **distributor** or **grid owner** must act as instructed by the **system operator** operating in accordance with clause 6.

7B Obligations of extended reserves providers in relation to automatic under-frequency load shedding

- (1) On the operation of **extended reserves** that is an **automatic under-frequency load shedding** system, an **extended reserves provider**—
 - (a) must, as soon as practicable, advise the **system operator** of the operation of the **automatic under-frequency load shedding** system and, if reasonably required by the **system operator** to plan to comply, or to comply, with its **principal performance obligations**, a reasonable estimate of the amount of **demand** that has been disconnected; and
 - (b) may restore **demand** only when permitted to do so by the **system operator**; and
 - (c) must ensure **demand** restored in accordance with paragraph (b) complies with the obligations in its **statement of extended reserves obligation**; and
 - (d) must report to the **system operator** if **demand** is moved between **points of**

connection; and

- (e) may request permission to restore **demand** from the **system operator** if no instruction to restore **demand** is received from the **system operator** within 15 minutes of the frequency returning to the **normal band**; and
- (f) may cautiously and gradually restore the **demand** disconnected through the **automatic under-frequency load shedding** system if there is a **loss of communication** with the **system operator**, 15 minutes after the **loss of communication** occurred.
- (2) An **extended reserves provider** may restore **demand** only while frequency is within the **normal band** and voltage is within the required range.
- (3) Each **extended reserves provider** must immediately cease the restoration of **demand** and, to the extent necessary, disconnect **demand**, if the frequency drops below the **normal band** or the voltage moves outside the required range.
- (4) As soon as practicable after communications are restored, each **extended reserves provider** must report to the **system operator** on the status of load restoration and the status of re-arming the **automatic under-frequency load shedding** system.

7—**Load shedding systems**

- (1) ~~Each North Island **distributor** must ensure, at all times, that an **automatic under-frequency load shedding** system is installed in accordance with subclause (6) for each **grid exit point** to which its **local network** is connected.~~
- (2) ~~Every South Island **grid owner** must ensure, at all times, that an **automatic under-frequency load shedding** system is installed in accordance with subclause (6) for each **grid exit point** in the South Island.~~
- (3) ~~Subject to subclause (8), each **distributor** and **grid owner** must use reasonable endeavours to ensure that at all times its **automatic under-frequency load shedding** systems are maintained in accordance with subclause (6).~~
- (4) ~~If, at any time, a **distributor** or **grid owner** believes that an **automatic under-frequency load shedding** system may not be capable of meeting the requirements of subclause (6), it must notify the **system operator** as soon as practicable and provide any information that the **system operator** reasonably requests.~~
- (5) ~~Each South Island **distributor** must co-operate fully with any **grid owner** in relation to an **automatic under-frequency load shedding** system installed at any **GXP**s at which the **distributor's local network** is connected to the **grid**. Each South Island **distributor** must also provide the **grid owner** with any information relating to **automatic under-frequency load shedding** that the **grid owner** reasonably requests.~~
- (6) ~~An **automatic under-frequency load shedding** system required to be provided in accordance with subclause (1), must enable, at all times, automatic disconnection of 2 blocks of **demand** (each block being a minimum of 16% of the total pre-event **demand**) at that **grid exit point** subject to subclause (8), with block one disconnecting **demand**—~~
 - (a) ~~in the North Island, within 0.4 seconds after the frequency reduces to, and remains at or below, 47.8 Hertz; and~~
 - (b) ~~in the South Island, within 0.4 seconds after the frequency reduces to, and remains~~

- at or below 47.5 Hertz;
and block two disconnecting **demand**—
- (c) ~~in the North Island,—~~
- (i) ~~15 seconds after the frequency reduces to, and remains at or below, 47.8 Hertz; or~~
- (ii) ~~within 0.4 seconds after the frequency reduces to, and remains at or below, 47.5 Hertz; and~~
- (d) ~~in the South Island,—~~
- (i) ~~15 seconds after the frequency reduces to, and remains at or below, 47.5 Hertz; or~~
- (ii) ~~within 0.4 seconds after the frequency reduces to, and remains at or below, 45.5 Hertz.~~
- (7) ~~To avoid doubt, **automatic under-frequency load shedding** blocks must not include any **interruptible load** procured by the **system operator**.~~
- (8) ~~Subject to the **system operator**'s agreement, which must not be unreasonably withheld, a **distributor** or a **grid owner** may redistribute **automatic under-frequency load shedding** quantities between **grid exit points**, if the overall **automatic under-frequency load shedding** quantity obligations in subclause (6) are met.~~
- (9) ~~Each **distributor** and each **grid owner** must provide **automatic under-frequency load shedding** block **demand** profile information to the **system operator** if reasonably requested by the **system operator**. That information must be in a form that enables the **system operator** to make a reasonable assessment of the total amount of **demand** available to be disconnected if **automatic under-frequency load shedding** blocks operate in accordance with subclauses (6) to (8).~~
- (9A) ~~If the **system operator** considers that its ability to comply, or plan to comply, with the **principal performance obligations** may be at risk if 1 or more **participants** comply with subclauses (1) to (4) and (6), the **system operator** may **publish** a declaration to that effect.~~
- (9B) ~~A declaration made under subclause (9A)—~~
- (a) ~~must specify the period to which it applies; and~~
- (b) ~~may be revoked by the **system operator**.~~
- (10) ~~[Revoked]~~
- (11) ~~The **system operator** may give notice to 1 or more of the **participants** specified in subclause (14), specifying modifications to the extent to which subclauses (1) to (4) and (6) apply to the **participant** during any 1 or more periods, or in any 1 or more circumstances, specified in the notice if—~~
- (a) ~~a direction given under clause 9.15 is in force; or~~
- (b) ~~a direction made under subclause 9A is in force.~~
- (12) ~~The **system operator** must keep a record of each notice given under subclause (11).~~
- (12A) ~~The **system operator** may give a notice to a **participant** under subclause (11)(b) only if—~~
- (a) ~~the **system operator** has consulted the **participant** about the notice; and~~

- (b) — the **participant** and the **system operator** agree that it is reasonably practicable for the **participant** to comply with the requirements of the notice.
- (12B) A **participant** that is given a notice under subclause (11)(b) must, during the period specified in the notice or in the circumstances specified in the notice, use reasonable endeavours to comply with the requirements of the notice.
- (13) Subject to subclause (12B), when a notice under subclause (11) is in force in relation to a **participant**, the requirements of subclauses (1) to (4) and (6) are modified for that **participant** to the extent, and during the periods or in the circumstances (as the case may be), specified in the notice.
- (14) The **participants** to whom the **system operator** may issue a notice in accordance with subclause (11) are —
- (a) — **distributors** in the North Island; and
 - (b) — **grid owners** in the South Island.
- (15) The **system operator** may amend or revoke a notice given under subclause (11).
- (16) A notice given under subclause (11) expires on the earlier of —
- (a) — the date (if any) specified in the notice for its expiry; and
 - (b) — the revocation or expiry of —
 - (i) — in the case of a notice given in relation to a direction given under clause 9.15, that direction; or
 - (ii) — in the case of a notice given in relation to a declaration made under subclause (9A), that declaration.
- (16A) If the **system operator** revokes a declaration made under subclause (9A), the **system operator** must, at the same time, give notice of the revocation to each **participant** to which a notice was given under subclause (11)(b).
- (16B) If a notice given under subclause (11) expires or is revoked, the **participant** to which the notice was given is not required to comply with subclauses (1) to (4) or (6) until —
- (a) — a date agreed by the **system operator** and the **participant**; or
 - (b) — if a date cannot be agreed, a date specified by the **system operator**, which must give the **participant** a reasonable amount of time to comply with subclauses (1) to (4) and (6).
- (17) The **system operator**, each **distributor**, each **grid owner** and relevant **retailers** must co-operate, if reasonably practicable, to ensure that any **interruptible load** contracted by the **system operator** that could affect the size of an **automatic under frequency load shedding** block is identified to assist the **distributor** or the **grid owner** to meet its obligations in subclauses (5) to (9).
- (18) On the operation of an **automatic under frequency load shedding** system, the **distributor** or **grid owner** —
- (a) — must, as soon as practicable, advise the **system operator** of the operation of the **automatic under frequency load shedding** system and, if reasonably required by the **system operator** to plan to comply, or to comply, with its **principal performance obligations**, a reasonable estimate of the amount of **demand** that has been disconnected; and
 - (b) — may restore **demand** only when permitted to do so by the **system operator**; and

- (c) ~~must ensure **demand** restored in accordance with paragraph (b) complies with subclause (6); and~~
 - (d) ~~must report to the **system operator** if **demand** is moved between **points of connection**; and~~
 - (e) ~~may request permission to restore **demand** from the **system operator** if no instruction to restore **demand** is received from the **system operator** within 15 minutes of the frequency returning to the **normal band**; and~~
 - (f) ~~may cautiously and gradually restore the **demand** disconnected through the **automatic under frequency load shedding** system if there is a **loss of communication**, after 15 minutes of the **loss of communication** occurring. This restoration must be done only while the frequency is within the **normal band** and the voltage is within the required range. Each **distributor** must immediately cease the restoration of **demand** and, to the extent necessary, disconnect **demand**, if the frequency drops below the **normal band** or the voltage moves outside the required range. As soon as practicable after communications are restored, each **distributor** or each **grid owner** must report to the **system operator** on the status of load restoration and the status of re-arming the automatic under frequency relays.~~
- (19) ~~Each **distributor** must maintain an up to date process for the disconnection of **demand** for **points of connection**, including the specification of the **participant** who will effect the disconnection of **demand**. The **distributor** must obtain agreement for the process from the **system operator** and each **grid owner** (such agreement not to be unreasonably withheld). Each **distributor** must advise the **system operator** of the agreed process in addition to any changes to a process previously advised.~~
- (20) ~~If the **system operator** requires the disconnection of **demand** in accordance with this **technical code**, the **system operator** must instruct **distributors** and **grid owners** (as the case may be) in accordance with the agreed process in subclause (19) to disconnect **demand** for the relevant **point of connection**. If the **system operator** and a **distributor** or **grid owner** (as the case may be) have not agreed on a process for disconnection of **demand** at a **point of connection**, the **system operator** must instruct **grid owners** to disconnect **demand** directly at the relevant **point of connection**. To the extent practicable, the **system operator** must use reasonable endeavours when instructing the disconnection of **demand**, to ensure equity between **distributors**.~~
- (21) ~~Each **distributor** or **grid owner** must act as instructed by the **system operator** operating in accordance with clauses 6 and 7.~~

...

Schedule 8.5

Consultation and approval requirements for extended reserves procurement documents

Part 1

Consultation on extended reserves technical requirements schedule

1 Application of this Part

This Part sets out the consultation requirements that apply to the **extended reserves technical requirements schedule**.

2 Publication of extended reserves technical requirements schedule

- (1) The system operator must prepare a draft of the extended reserves technical requirements schedule.**
- (2) The system operator must give the draft schedule to the Authority for comment, along with the extended reserves technical requirements report.**
- (3) The Authority must provide comments on the draft schedule to the system operator as soon as practicable after receiving it.**
- (4) The system operator must consider the Authority's comments.**
- (5) After the system operator has considered the Authority's comments, the system operator must—**
 - (a) consult with persons that the system operator thinks are representative of the interests of persons likely to be substantially affected by the draft schedule; and**
 - (b) consider submissions made on the draft schedule.**
- (6) The system operator must provide a copy of each submission received and a copy of the draft schedule that the system operator proposes to publish to the Authority.**
- (7) The Authority must provide comments on the draft schedule as soon as practicable after receiving it.**
- (8) The system operator must consider the Authority's comments.**

- (9) Following the consultation required by this clause, the **system operator** must finalise and **publish** the draft schedule.

3 Technical and non-controversial changes

- (1) The **system operator** may at any time make a change to the **extended reserves technical requirements schedule** that it considers is technical and non-controversial.
- (2) If the **system operator** makes a change to the **extended reserves technical requirements schedule** under subclause (1), the **system operator** is not required to comply with clause 2 of this Schedule.
- (3) The **system operator** must notify the **Authority** of any changes to the **extended reserves technical requirements schedule** made under this clause.

Part 2

Consultation on extended reserves selection methodology

4 Application of this Part

This Part sets out the consultation and approval requirements that apply to the **extended reserves selection methodology**.

5 Preparation of and consultation on extended reserves selection methodology

- (1) The **extended reserves manager** must prepare a draft of the **extended reserves selection methodology**.
- (2) The **extended reserves manager** must give the draft methodology to the **Authority** and the **system operator** for comment, along one or more worked examples of an **extended reserves procurement schedule**, created using—
- (a) the draft **extended reserves selection methodology**; and
 - (b) data specified by the **system operator**.
- (3) The **Authority** and the **system operator** must provide comments on the draft methodology to the **extended reserves manager** as soon as practicable after receiving it.
- (4) The **extended reserves manager** must consider the comments provided by the **Authority** and the **system operator**.

- (5) After the **extended reserves manager** has considered the comments provided by the **Authority** and the **system operator**, the **extended reserves manager** must—
- (a) consult with persons that the **extended reserves manager** thinks are representative of the interests of persons likely to be substantially affected by the draft methodology; and
 - (b) consider submissions it receives on the draft methodology.

6 Approval of extended reserves selection methodology

- (1) The **extended reserves manager** must give the **Authority** and the **system operator**—
- (a) a copy of each submission received on the draft **extended reserves selection methodology**; and
 - (b) a response to each issue raised in each submission; and
 - (c) a copy of the draft methodology that the **extended reserves manager** proposes to **publish**.
- (2) As soon as practicable, but no later than 15 **business days** after receiving a copy of the draft methodology, the **system operator** must—
- (a) give the **Authority** any comments it wishes to make on the draft methodology; or
 - (b) advise the **Authority** that it does not wish to make any comments.
- (3) The **Authority** must, as soon as practicable after receiving the **system operator's** comments, or advice that the **system operator** does not wish to make any comments, by notice in writing to the **extended reserves manager**,—
- (a) approve the draft methodology; or
 - (b) decline to approve the draft methodology.
- (4) If the **Authority** declines to approve the draft methodology, the **Authority** must **publicise** the changes that the **Authority** wishes the **extended reserves manager** to make to the draft methodology.

7 Consultation on proposed changes

- (1) When the **Authority** **publicises** changes that the **Authority** wishes the **extended reserves manager** to make to the draft **extended reserves selection methodology** under clause 6(4), the **Authority** must notify the **extended reserves manager** and interested parties of the date by which submissions on the changes must be received by the **Authority**.

- (2) Each submission on the changes to the draft methodology must be made in writing to the **Authority** and be received by the date specified by the **Authority** under subclause (1).
- (3) The **Authority** must—
 - (a) provide a copy of each submission received to the **extended reserves manager**; and
 - (b) **publicise** the submissions.
- (4) The **extended reserves manager** may make its own submission on the changes to the draft methodology and the submissions received in relation to the changes.
- (5) The **Authority** must **publicise** the **extended reserves manager's** submission when it is received.
- (6) The **Authority** must consider the submissions made to it on the changes to the draft methodology and prepare a revised draft methodology incorporating any amendments that the **Authority** proposes be made to the methodology.
- (7) The **Authority** must give the revised draft methodology prepared under subclause (6) to the **system operator** and clause 6(2) applies as if the revised draft methodology was the draft methodology prepared under clause 5.
- (8) As soon as practicable after receiving the **system operator's** comments, or advice that the system operator does not wish to make any comments, the **Authority** must, by notice in writing to the **extended reserve manager**,—
 - (a) approve the revised draft methodology; or
 - (b) amend the revised draft methodology to address any comments received from the **system operator**, and approve it; or
 - (c) **publicise** a further revised draft methodology, and notify the **extended reserve manager** and interested parties of the date by which submissions on the changes must be received by the **Authority**.
- (9) If the **Authority** **publicises** a further revised draft methodology under subclause (8)(c), subclauses (2) to (8) apply as if the further revised draft methodology was the revised draft methodology.

8 Technical and non-controversial changes

- (1) The **extended reserves manager** may at any time propose a change to the **extended reserves selection methodology** that it considers is technical and non-controversial by giving a draft methodology to the **Authority** together with an explanation of the proposed change.

- (2) If the **extended reserves manager** gives a draft methodology to the **Authority** under subclause (1) the **extended reserves manager** is not required to comply with clauses 5 and 6 of this Schedule.
- (3) The **Authority** must, as soon as practicable after receiving a draft methodology and the information required by subclause (1), by notice in writing to the **extended reserves manager**—
 - (a) approve the draft methodology; or
 - (b) decline to approve the draft methodology, giving reasons.

9 Publication of extended reserves selection methodology

As soon as practicable after the **Authority** approves the **extended reserves selection methodology** under clause 6(3)(a) or 8(3)(b), the **extended reserves manager** must **publish** the methodology.

Part 3

Consultation on extended reserves procurement schedule

10 Application of this Part

This sets out the consultation and approval requirements that apply to the **extended reserves procurement schedule**.

11 Preparation of and consultation on extended reserves procurement schedule

- (1) The **extended reserves manager** must prepare a draft of the **extended reserves procurement schedule**.
- (2) The **extended reserves manager** must—
 - (a) give the draft to the **Authority** and the **system operator** for comment; and
 - (b) if requested, give the **Authority** or the **system operator** the information used by the **extended reserves manager** to prepare the draft.
- (3) The **Authority** and the **system operator** must provide comments on the draft procurement schedule to the **extended reserves manager** as soon as practicable after receiving it.

- (4) The **extended reserves manager** must consider the comments provided by the **Authority** and the **system operator**.
- (5) After the **extended reserves manager** has considered the comments provided by the **Authority** and the **system operator**, the **extended reserves manager** must—
 - (a) consult with persons that the **extended reserves manager** thinks are representative of the interests of persons likely to be substantially affected by the draft procurement schedule; and
 - (b) consider submissions received on the draft procurement schedule.

12 Approval of extended reserves procurement schedule

- (1) The **extended reserves manager** must give the **Authority** and the **system operator**—
 - (a) a copy of each submission received on the draft **extended reserves procurement schedule**; and
 - (b) a response to each issue raised by each submission; and
 - (c) a copy of the draft procurement schedule that the **extended reserves manager** proposes to **publish**.
- (2) As soon as practicable, but no later than 15 **business days** after receiving a copy of the draft procurement schedule, the **system operator** must—
 - (a) give the **Authority** any comments it wishes to make on the draft procurement schedule; or
 - (b) advise the **Authority** that it does not wish to make any comments.
- (3) The **Authority** must, as soon as practicable after receiving the **system operator's** comments, or advice that the **system operator** does not wish to make any comments, by notice in writing to the **extended reserves manager**,—
 - (a) approve the draft procurement schedule; or
 - (b) decline to approve the draft procurement schedule.
- (4) If the **Authority** declines to approve the draft procurement schedule, the **Authority** must **publicise** the changes that the **Authority** wishes the **extended reserves manager** to make to the draft procurement schedule.

13 Consultation on proposed changes

- (1) When the **Authority** publicises changes that the **Authority** wishes the **extended reserves manager** to make to the draft **extended reserves procurement schedule** under clause 12(4), the **Authority** must notify the **extended reserves manager** and interested parties of the date by which submissions on the changes must be received by the **Authority**.
- (2) Each submission on the changes to the draft procurement schedule must be made in writing to the **Authority** and be received by the date specified by the **Authority** under subclause (1).
- (3) The **Authority** must—
 - (a) provide a copy of each submission received to the **extended reserves manager**; and
 - (b) **publicise** the submissions.
- (4) The **extended reserves manager** may make its own submission on the changes to the draft procurement schedule and the submissions received in relation to the changes.
- (5) The **Authority** must **publicise** the **extended reserves manager's** submission when it is received.
- (6) The **Authority** must consider the submissions made to it on the changes to the draft procurement schedule and prepare a revised draft procurement schedule incorporating any amendments that the **Authority** proposes be made to the schedule.
- (7) The **Authority** must give the revised draft procurement schedule prepared under subclause (6) to the **system operator**, and clause 12(2) applies as if the revised draft procurement schedule was the draft procurement schedule prepared under clause 11.
- (8) As soon as practicable after receiving the **system operator's** comments, or advice that the **system operator** does not wish to make any comments, the **Authority** must, by notice in writing to the **extended reserve manager**,—
 - (a) approve the revised draft procurement schedule; or
 - (b) amend the revised draft procurement schedule to address any comments received from the **system operator**, and approve it; or
 - (c) publish a further revised draft procurement schedule, and notify the **extended reserve manager** and interested parties of the date by which submissions on the changes must be received by the **Authority**.
- (9) If the **Authority** publicises a further revised draft procurement schedule under subclause (8)(c), subclauses (2) to (8) apply as if the further revised draft procurement schedule was the revised procurement schedule.

14 Publication of extended reserves procurement schedule

As soon as practicable after the **Authority** approves the **extended reserves procurement schedule** under clause 12(3)(a) the **extended reserves manager** must publish the schedule.

Changes to (new) Part 14

14.1 Contents of this Part

This Part provides for—

- (a) the sale and purchase of **electricity** to and from the **clearing manager**; and
- (b) the calculation and invoicing of amounts owing to and by the **clearing manager** for **electricity**, **ancillary services**, **extended reserves**, **FTRs**, and other payments that may be received or paid by the **clearing manager**; and
- (c) the settlement of amounts payable under this Part; and
- (d) processes and remedies for an **event of default**; and
- (e) obligations of the **clearing manager** in relation to clearing and settlement, including reporting obligations and requirements for the **operating account** that must be established and held by the **clearing manager**.

...

14.14 Amounts owing for ancillary services

The **clearing manager** must determine amounts owing in respect of **ancillary services** in accordance with clauses 8.6, 8.31, 8.55(1), and 8.68(1).

14.14A Amounts owing for extended reserves

The **clearing manager** must determine amounts owing in respect of **extended reserves** in accordance with clauses 8.55(2), 8.67A, and 8.68(3) and (4).

...

14.18 Clearing manager to advise participant of amounts owing and payable

- (1) The **clearing manager** must advise each **participant**, for which the **clearing manager** has determined that the **participant** owes or is owed an amount under subpart 3, the following:
 - (a) amounts owing by the **participant** to the **clearing manager** in accordance with clause 14.19:

- (b) amounts owing by the **clearing manager** to the **participant** in accordance with clause 14.20:
 - (c) the amount of the settlement retention amount calculated in accordance with the methodology **published** by the **clearing manager** under clause 14.21:
 - (d) any amount payable by the **participant** to the **clearing manager** and any amount payable by the **clearing manager** to the **participant** under subpart 5 in accordance with clause 14.22.
- (2) The **clearing manager** must advise each **participant** of each amount owing and each amount payable no later than—
- (a) the 9th **business day** of the month following the **billing period**; or
 - (b) if the **clearing manager** has not received **reconciliation information** in accordance with clause 28(c) of Schedule 15.4 or **dispatchable load information** under clause 15.20C(a) in respect of the prior **billing period** from the **reconciliation manager**, 2 **business days** after the **clearing manager** has received both the **reconciliation information** and the **dispatchable load information**.
- (3) A **participant** must not issue a **GST** invoice for supplies of **electricity**, ~~or~~ **ancillary services**, **extended reserves**, or **ancillary service administrative costs** to the **clearing manager**.

14.19 Amounts owing by participant to clearing manager

- (1) When advising a **participant** of amounts owing under clause 14.18(1)(a), the **clearing manager** must specify any amount owing by the **participant** to the **clearing manager** for—
 - (a) the relevant **billing period**, to the extent that the **clearing manager** has received the necessary information; and
 - (b) any prior **billing period** if the **clearing manager** receives the necessary information for that **billing period** after the date that amounts owing for that **billing period** were required to be advised by the **clearing manager**.
- (2) The **clearing manager** must specify any amount owing by the **participant** to the **clearing manager** in respect of the periods referred to in subclause (1) for the following:
 - (a) **electricity** purchased under clauses 14.2 to 14.7:
 - (b) **constrained off compensation** under clause 13.201A:
 - (c) **constrained on compensation** under clause 13.212:

- (d) a **washup** amount and any interest on that amount under subpart 6:
 - (e) **auction revenue** under clause 13.110:
 - (f) **ancillary services** under clauses 8.6, 8.31(1)(a), and 8.68(1):
 - (fa) **extended reserves** under clauses 8.67A, and 8.68(3):
 - (g) payment of an amount under any **hedge settlement agreement**:
 - (h) for each **FTR** in respect of which the **participant** is registered as the holder of the **FTR**, the net amount of the **FTR acquisition cost** for the **FTR** minus the **FTR hedge value** for the **FTR**, if that net amount is positive:
 - (i) any amount owing in respect of the assignment of any **FTR** under clause 13.249(4):
 - (j) **GST**.
- (3) The **clearing manager** must specify the sum of the amounts referred to in subclause (2).

14.20 Amounts owing by clearing manager to participant

- (1) When advising a **participant** of amounts owing under clause 14.18(1)(b), the **clearing manager** must specify any amount owing by the **clearing manager** to the **participant** for—
 - (a) the relevant **billing period**, to the extent that the **clearing manager** has received the necessary information; and
 - (b) any prior **billing period** if the **clearing manager** receives the necessary information for that **billing period** after the date that amounts owing for that **billing period** were required to be advised by the **clearing manager**.
- (2) The **clearing manager** must specify any amount owing by the **clearing manager** to the **participant** in respect of the periods referred to in subclause (1) for the following:
 - (a) **electricity** sold under clauses 14.2 to 14.7:
 - (b) **constrained off compensation** under clause 13.201A:
 - (c) **constrained on compensation** under clause 13.212:
 - (d) a **washup** amount and any interest on that amount under subpart 6:
 - (e) **auction revenue** under clause 13.112:
 - (f) **ancillary services** under clause 8.55(a):
 - (fa) **extended reserves** under clause 8.68(4):

- (g) payment of an amount under any **hedge settlement agreement**:
 - (h) for each **FTR** in respect of which the **participant** is registered as the holder of the **FTR**, the net amount of the **FTR hedge value** for the **FTR** minus the **FTR acquisition cost** for the **FTR**, if that net amount is positive:
 - (i) any amount owing in respect of the assignment of any **FTR** under clause 13.249(7):
 - (j) **GST**:
 - (k) **loss and constraint excess** and **residual loss and constraint excess** under clause 14.16(7).
- (3) The **clearing manager** must specify the sum of the amounts referred to in subclause (2).

...

14.56 Calculation of revised amount owing for general amounts

- (1) The **clearing manager** must apply any amount available for the settlement of general amounts in accordance with the following order of priority:
 - (a) to satisfy any liability to pay **GST** and other governmental charges or levies, that are payable by the **clearing manager** in respect of the amounts owing and payable under subparts 4 to 6, taking into account any **GST** input tax credits available to the **clearing manager** in respect of payments under paragraphs (b) to (e):
 - (b) to satisfy any amount owing to **extended reserves providers** for **extended reserves** under clauses 8.55(2) and 8.68(4):
 - (b) to satisfy any amount owing to the **system operator** for **ancillary services** under clauses 8.6, 8.31(1)(a), and 8.55 to 8.67:
 - (c) to satisfy any amount of **loss and constraint excess** to be applied to the settlement of **FTRs** under clause 14.16(4) or (5):
 - (d) to satisfy any amount owing to each **grid owner** for any **loss and constraint excess** in accordance with clause 14.16(7)(a):
 - (e) to satisfy any other general amount owing by the **clearing manager** to a **participant**.
- (2) If there is an insufficient amount available for the settlement of general amounts, the **clearing manager** must calculate the revised amounts owing by the **clearing manager** to **participants** in respect of general amounts as follows:

- (a) first apply the full amount available to satisfy each amount owing in the order of priorities in subclause (1);
- (b) if there is an insufficient amount to satisfy the full amount owing under any of paragraphs (a) to (e) of subclause (1), calculate the revised amount owing to each **participant** under that paragraph according to the following formula:

$$AO_{CM \text{ (revised)}} = AO_{CM \text{ (general)}} \times (A_{\text{general}}/R_{\text{general}})$$

where

$AO_{CM \text{ (revised)}}$ is the revised amount owing by the **clearing manager** to the **participant** in respect of the general amounts

$AO_{CM \text{ (general)}}$ is the amount owing by the **clearing manager** to the **participant** in respect of that **billing period** under the relevant paragraph in subclause (1)

A_{general} is the total amount available for the settlement of amounts owing by the **clearing manager** in the relevant **billing period** under the relevant paragraph in subclause (1)

R_{general} is the sum of all amounts required to settle those amounts in respect of the **billing period**

Changes to Part 14A

14A.18 System operator to provide information

The **system operator** must provide the **clearing manager** with the following information immediately upon becoming aware of the information:

- (a) any likely significant change to any amount to be allocated to a **participant** in respect of **ancillary services** or extended reserves;
- (b) the amount incurred by a **participant** as a result of the **participant** causing an **under-frequency event**.

...

Schedule 14A.1

9 Calculating clearing manager's outstanding financial exposure to participant

- (1) The expected amount of the **clearing manager's** outstanding financial exposure to a **participant** on any **trading day** is an estimate of all unsettled amounts owing by the **participant** to the **clearing manager** and by the **clearing manager** to the **participant**

to the end of the previous **trading day**, including the **clearing manager's** estimate of the following amounts:

- (a) the amount owing to or by the **participant** for purchasing and selling **electricity**:
 - (ab) the amount owing to or by the **participant** in relation to **extended reserves**:
 - (b) the amount owing to or by the **participant** in relation to **ancillary services**:
 - (c) the net amount owing to or by the **participant** in respect of any **hedge settlement agreement** lodged with the **clearing manager** under clause 14.8:
 - (d) the amount of any **GST** payable by the **participant** in respect of the above amounts.
- (2) The **clearing manager** must use **final prices** in calculating amounts under subclause (1) unless—
- (a) **final prices** are not available, in which case the **clearing manager** must use **interim prices**; or
 - (b) neither **final prices** nor **interim prices** are available, or an **undesirable trading situation** has been claimed in respect of a **trading period** or **trading day** that is included in the **clearing manager's** estimate, in which case the **clearing manager** must use the price calculated in accordance with clause 10(2)(c) that is used in the methodology for determining the exit period prudential margin.
- (3) The **clearing manager** must take **washup** amounts that have been calculated by the **clearing manager** into account in estimating the amounts described in this clause.

10 Exit period prudential margin

- (1) The exit period prudential margin for a **participant** is the **clearing manager's** estimate of the amount that the **participant** will incur and earn during the prudential exit period for the **participant** in respect of the following:
- (a) the sale and purchase of **electricity**:
 - (ab) **extended reserves**:
 - (b) **ancillary services**:
 - (c) any **hedge settlement agreement** lodged with the **clearing manager** under clause 14.8:
 - (d) any **GST** payable in respect of the above amounts.
- (2) The estimated amounts to be incurred and earned by the **participant** in respect of the sale and purchase of **electricity** under subclause (1)(a) are based on—

- (a) the number of **trading days** in the prudential exit period for the **participant** determined under clause 14A.22(3); and
- (b) the expected value of **electricity** to be purchased by the **participant** minus the expected value of **electricity** to be sold by the **participant** during that period based on the prices in paragraph (c); and
- (c) the sum of the following amounts:
 - (i) the prices of **electricity** expected to apply during the quarter to which the calculation relates in accordance with subclauses (3) and (4);
 - (ii) an amount determined as set out in subclause (5).
- (3) In determining the prices under subclause (2)(c)(i), the **clearing manager** must use prices of **electricity** futures products that are available and that the **clearing manager** considers provide a reasonable estimate of the average price of **electricity** for the relevant quarter.
- (4) The **clearing manager** must determine the prices under subclause (2)(c)(i)—
 - (a) for each quarter beginning 1 January, 1 April, 1 July, and 1 October; and
 - (b) no later than 2 months before the beginning of each quarter.
- (5) The amount determined under subclause (2)(c)(ii) must—
 - (a) be an amount expressed in \$/MWh of not less than \$0/MWh; and
 - (b) be determined on the basis that the exit period prudential margin for a hypothetical **purchaser** that purchases a constant proportion of total **electricity** purchased from the **clearing manager** for every **trading period** is greater than the general exit period exposure for the **purchaser** on 75% of the days in the relevant quarter in a modeling period of 3 to 10 years selected by the **clearing manager**.
- (6) The **clearing manager** must determine the amount under subclause (2)(c)(ii)—
 - (a) for each quarter in a calendar year; and
 - (b) no later than 2 months before the beginning of each calendar year.
- (7) The methodology must specify how the clearing manager will estimate the initial amount of security for **ancillary services** for a new **participant**.
- (8) The expected amounts to be incurred and earned by the **participant** in respect of a **hedge settlement agreement** must be based on the price determined by the **clearing manager** under subclause (2)(c).

Changes to Part 17

17.45 Redistribution of automatic under frequency load shedding

~~An agreement to redistribute automatic under frequency load shedding quantities between grid exit points under clause 6.4 of technical code B of schedule C3 of part C of the **rules** that was in force immediately before this Code came into force, is deemed to be an agreement under clause 7(8) of **Technical Code B** of Schedule 8.3.~~

17.48A Transitional provisions for extended reserves

- (1) Despite the replacement of Schedule 8.3, **Technical Code B**, clause 7(1) by [insert name of amendment], each North Island **distributor** that was required to comply with [that clause] before [insert date] must continue to comply with that clause as if [insert name of amendment] had not been made until the earlier of—
 - (a) [insert date]; or
 - (b) the date on which an implementation plan approved by the **system operator** under clause 8.54K comes into force in respect of the **distributor**.
- (2) Despite the replacement of Schedule 8.3, **Technical Code B**, clause 7(2) by [insert name of amendment], each South Island **grid owner** that was required to comply with [that clause] before [insert date] must continue to comply with that clause as if [insert name of amendment] had not been made until the earlier of—
 - (a) [insert date]; or
 - (b) the date on which an implementation plan approved by the **system operator** under clause 8.54K comes into force in respect of the **grid owner**.
- (3) However, subclause (2) applies as if Schedule 8.3, **Technical Code B**, clause 7(6)(d)(ii) was amended from [insert date] by replacing "45.5 Hertz" with "46.5" Hertz.

Appendix C Cost-benefit analysis

Introduction

- C.1 This appendix analyses the costs and benefits of the alternative procurement options for implementing the system operator's recommended technical design for the North Island (four blocks of load on AUFLS in the ratio of 10%:10%:6%:6% with block four being on a df/dt relay).
- C.2 In other words, all options assume a change from the status quo in that
- (a) significant changes are going to have to be made anyway to implement this revised technical design; and
 - (b) all options will require participants to provide information ex-ante to the system operator of the amount of load they have armed for AUFLS.
- C.3 This appendix is based on the cost benefit in the October 2012 consultation updated to account for submissions and for the implications of the further development of the proposed central optimisation approach.

Evaluated options

- C.4 Section 2.3 sets out three broad families of options, with sub-options within each family
- (a) **1. Common percentage obligation**
 - (i) 1.a) Using standard Code mechanisms to deal with special cases, particularly relating to small lines companies or direct connects who would find it impractical or very costly to provide the full four blocks.⁴⁹ This is the current approach to AUFLS procurement, except that for this cost-benefit analysis temporary exemptions are assumed to have ended. The existing exempted stakeholders have to rely on existing technical and commercial equivalence arrangements where it is impractical or costly to meet the obligation themselves. Lines companies may not have incentives or legal rights to enter into commercial arrangements to provide AUFLS to direct connects. In this case some direct connects may be forced to withdraw MW from the IR or dispatchable demand markets. In other cases, due to load divisibility issues, it may be expensive or

⁴⁹ There are approximately 21 (16 lines companies and 5 direct connects) stakeholders in the North Island. Of these, 14 (9 lines companies and the 5 direct connects) would be considered "small". These account for around 25% of the North Island load, with 75% in the 7 "large" line companies.

impractical for direct connects or small lines companies to provide the four blocks in the required proportions. If commercial equivalence arrangements with lines companies are not feasible, then costly technical work might be required, or very high interruption cost load may need to be added for AUFLS

- (ii) 1.b) As above, plus using prioritised block coordination to deal with special cases, particularly relating to small lines companies or direct connects who would find it impractical or very costly to provide the full four blocks. In addition to technical and commercial equivalence there would be a central block co-ordination mechanism whereby small lines companies and direct connects would provide a prioritised set of feeders. Each would still be required to meet minimum 26% overall, but they would not be required to provide all the individual blocks in the specified proportions. The system operator would allocate these feeders to individual blocks to meet the overall scheme design and taking into account the feeder priorities
- (iii) 1.c) As above, plus using special exclusions for special cases, e.g. excluding direct connects or excluding stakeholders who are prepared to offer an equivalent level of IL with a maximum price
- (iv) 1.d) As above, plus using profiled obligations with minimum and maximum limits, would specify that stakeholders must arm feeders to achieve AUFLS supply between a minimum and maximum limit. This limit varies according to time of day, day type and season

(b) 2. Varying provision via optimisation

This option would enable AUFLS provision to vary by stakeholder according to the suitability of their load. Lines companies and direct connects would be obliged to offer units of load for allocation to AUFLS blocks, and these would be selected via an optimisation tool. The optimisation tool would select the combination of loads which minimises costs (relays and AUFLS load-shedding) while meeting the technical requirements for extended reserves as specified by the system operator. Sub-options in this family are:

- (i) 2.a) no compensation payments, plus central VoLL estimation of lines companies' loads
- (ii) 2.b) with compensation payments, plus central VoLL estimation of lines companies' loads
- (iii) 2.c) with compensation payments, plus lines companies' VoLL estimation of lines companies' loads

(c) 3. Voluntary AUFLS tender

This option would involve parties voluntarily offering their load into an AUFLS market. Sub-options in this family are

- (i) 3.a) Simple pay-as-bid tender
- (ii) 3.b) 'Sophisticated' AUFLS market

C.5 The consultation identified that a voluntary AUFLS market would be impracticable, in large part due to the lines companies not having the contractual rights under their use of system agreements with their customers to participate in such a market. All submitters to the consultation agreed on this point. Accordingly, detailed cost-benefit evaluation of option 3 approaches was not taken further.

Affected groups

C.6 Costs and benefits apply to different groups:

- (a) the system operator:
 - (i) responsible for operating and administering the systems required for each option. The system operator may use the grid owner as a service provider
- (b) the extended reserves manager (ERM):
 - (i) responsible for designing the selection methodology (including VoLL methodology) and running the selection process. This will be the Authority for the initial selection, but may be the system operator or another service provider in the future
- (c) the Authority
 - (i) responsible for Code changes required to implement the technical design and procurement arrangements
- (d) 16 North Island lines companies:⁵⁰
 - (i) responsible for meeting any obligations, maintaining and installing relays, providing information to the system operator, and liaising with end-use customers and providers of demand response products behind feeders
 - (ii) may face consequential costs or benefits relating to the handling of AUFLS costs/benefits by the Commerce Commission in relation to the regulation of revenues and

⁵⁰ For the reasons set out in section 5.10, this evaluation is solely focussed on the North Island, hence only the North Island lines companies are affected.

service levels. This will determine if and how any cost allocation is passed through to end-use customers

- (iii) may also be required as part of the AUFLS procurement process to develop methods for assigning VoLL to each feeder or to rank feeders according to relative VoLL
- (e) 5 North Island direct connect industrial customers:⁵¹
 - (i) also responsible for meeting obligations concerning installing and maintenance of relays and provision of information, but do not face flow on costs related to Commerce Commission regulation
 - (ii) gain the benefit of avoiding system collapse, but face the occasional loss of load to the extent they are on AUFLS relays. They may also face the cost of being inefficiently excluded or restricted from providing alternative demand product (such as IL)
- (f) end-use customers.
 - (i) these are represented by their lines companies and all gain the benefits of avoiding system collapse, but also face the costs of occasional loss of load if they are on AUFLS relays
 - (ii) depending on the AUFLS procurement option, end-use customers (as a group, or individually) may see a small benefit or cost association with the pass-through of AUFLS cost allocation or payments. These are treated as wealth transfers and do not contribute directly to the CBA.

C.7 While it is useful to identify the different stakeholders bearing costs or receiving benefits, the cost benefit analysis focuses on the net economy wide incremental benefits and costs ignoring wealth transfers.

Implementation costs

C.8 The following table summarises estimated implementation costs for the different procurement options. These are based on the estimates adjusted in light of comments received from submitters and in light of the proposed arrangements implementing the preferred optimisation approach (variants of option 2).

⁵¹ The 5 stakeholders are: Norske Skog, Pan Pac Forest Products, Winstone Pulp International, NZ Steel, and KiwiRail. There are a number of other large users (some of whom are larger loads than some of the above direct connects such as the NZ Refinery) who are embedded within lines companies.

Table 5: Indicative implementation costs

Implementation Costs		1. Common AUFLS percentage obligation				2. Varying AUFLS provision via optimisation		
		1a) standard Code mechanisms	1b) ... + block coordination	1c) ... + special exclusions	1d) ... + profiled min/max oblig	2a) no compensation + central VoLLs	2b) with compensation + central VoLLs	2c) with compensation + lineco's VoLLs
Num relays	num	500	485	485	500	450	450	450
% replaced	%	50%	48%	48%	53%	40%	40%	40%
"equivalence" or special agreements	Num	8	4	-	-	-	-	-
Cost to replace and test	\$m (1)	\$3.8	\$3.5	\$3.5	\$4.0	\$2.7	\$2.7	\$2.7
Cost to program and test	\$m (1)	\$1.3	\$1.3	\$1.3	\$1.2	\$1.4	\$1.4	\$1.4
Contingency (30%)	\$m (1)	\$1.50	\$1.4	\$1.4	\$1.5	\$1.2	\$1.2	\$1.2
Total Relay & Information Cost	\$m	\$6.5	\$6.1	\$6.1	\$6.7	\$5.3	\$5.3	\$5.3
Code & technical consultation	\$m (2)	\$0.2	\$0.5	\$0.5	\$0.5	\$0.6	\$0.6	\$0.6
Additional code & consultation for option 2	\$m					\$0.5	\$0.7	\$0.7
SO transition coordination	\$m (7)	\$0.2	\$1.0	\$1.0	\$1.0	\$1.4	\$1.4	\$1.4
SO setup operational systems & data base	\$m (6)	\$0.2	\$0.2	\$0.2	\$0.2	\$0.5	\$0.5	\$0.5
Parties consult/setup compliance systems	\$m (3)	\$1.3	\$1.3	\$1.3	\$1.3	\$1.9	\$1.9	\$1.9
Cost to provide initial feeder information	\$m (6)	\$0.5	\$0.5	\$0.5	\$0.5	\$1.0	\$1.0	\$1.0
Negotiate technical/commercial equivalence	\$m (4)	\$1.2	\$0.6					
SO develop/implement block allocation	\$m (5)		\$0.2	\$0.2	\$0.2			
ERM develop/test optimisation tool	\$m (5)					\$0.6	\$0.6	\$0.6
Cost to develop selection methodology	\$m					\$0.2	\$0.2	\$0.2
Changes to payments system	\$m						\$0.1	\$0.1
Additional cost for linecos to est VoLL	\$m							\$0.5
Parties cost for systems to meet profiled oblig	\$m				\$0.8			
Total Overhead/Transaction cost	\$m	\$3.6	\$4.3	\$3.7	\$4.5	\$6.8	\$7.1	\$7.6
Total Implementation Cost	\$m	\$10.1	\$10.4	\$9.8	\$11.2	\$12.0	\$12.3	\$12.8
	<i>Low</i>	<i>\$7.3</i>	<i>\$7.8</i>	<i>\$7.4</i>	<i>\$8.6</i>	<i>\$9.5</i>	<i>\$9.8</i>	<i>\$10.3</i>
	<i>High</i>	<i>\$13.4</i>	<i>\$13.4</i>	<i>\$12.5</i>	<i>\$14.0</i>	<i>\$15.0</i>	<i>\$15.4</i>	<i>\$15.8</i>
Incremental Cost	\$m		\$0.3	-\$0.3	\$1.1	\$1.9	\$2.2	\$2.7
	<i>Low</i>		<i>\$0.5</i>				<i>\$2.5</i>	
	<i>High</i>		<i>\$0.0</i>				<i>\$2.0</i>	
Notes:								
1: assumes \$15k for new relays installed and tested and \$5k to reprogram and test existing relays+ 30% contingency for special cases								
2: assumes extra \$0.1m for modifications to the payments and cost allocation system								
3: assumes 50 FTE days for 22 parties is 50% higher for optimisation								
4: allows \$30k for each party cost per agreement								
5: assumes a stand-alone tool for ad-hoc use annually.								
6: allows for cost to be 100% higher for optimisation								
7: allows for cost to be 50% higher for optimisation								

C.9 The costs set out in Table 5 above include:

- (a) Code amendment required to implement the technical design for options 1b,1c and 1d, including:
 - (i) AUFLS scheme design technical details (such as number of blocks, block sizes, technology and relay settings)
 - (ii) changes to the obligations to North Island distributors and South Island grid owners within the Asset Owner Performance Obligations of the Code
 - (iii) an obligation on the system operator to consult on and approve the technical requirements for extended reserves (AUFLS) in each island
 - (iv) code changes to enable the system operator to implement and enforce block co-ordination, given that this would involve the development of a methodology and would require rights to finally determine which feeders should be allocated to each AUFLS block
- (b) the code amendment and consultation required to implement the proposed arrangements for option 2, which include many elements required for option 1, but are more extensive. An extra \$0.1m cost is allowed for this
- (c) option 2 also requires consultation on the selection methodology and additional consultation steps each time a selection process is run. It is difficult to know what the additional cost of consulting on the selection methodology and schedule is relative to that required for a block coordination methodology, but it is assumed to be \$0.7m with compensation payments and \$0.5m without
- (d) it is assumed that the system operator will need 2 full time equivalents (FTE) for two years, and 800 hours to design compliance systems, procedures and databases and manage and implement the transition to the new AUFLS design under option 1, and twice this under option 2
- (e) technical or commercial equivalence arrangements are likely to be required in option 1 if exemptions or special exclusions are not introduced.⁵² These are not required in option 2. It is difficult to know how many special arrangements might need to be developed, however it is likely to be at least five (the current number of exemptions excluding Northpower) and could be as many as 16 (the

⁵² It is noted that there are doubts that lines companies have the legal rights and incentives to enter voluntary commercial equivalence arrangements, but some mechanism will be required.

number of direct connects and “small” lines companies). The cost benefit assumes there are eight arrangements required under a rigid “one-size-fits-all” obligation as small stakeholders will probably find it impractical to provide all four blocks in the required proportions, and four with block coordination. It is assumed that the cost to negotiate and document these agreements is \$150k (or \$75k for each of two stakeholders)

- (f) 400hrs for each of 21 obligated stakeholders and \$500/relay is allowed to consult and setup systems to provide initial compliance data including:
 - (i) historical half hourly data for feeders
 - (ii) information on the level of IL behind each feeder
 - (iii) information on relay type, verification of relay arming, disconnection dependencies etc.
- (g) the cost of providing initial information in option 2 is assumed to be twice⁵³ that required for option 1, given that information on more feeders is required and additional information (including estimated load shares) is required to estimate expected AUFLS interruption costs
- (h) it is assumed that there are around 500 relays⁵⁴ which will need to be reprogrammed to achieve the new AUFLS design. The portion that will need to be replaced is uncertain but could be in the range 50% ± 10%. A conservative \$15k per relay is allowed for replacement and testing with a modern df/dt capable relay and \$5k for reprogramming and testing. A 30% contingency is allowed for a range of additional unknown costs. Relay numbers and costs are likely to vary according to the procurement option, however:
 - (i) it is assumed that block coordination will reduce the number of relays required by 3%, compared with the “one size fits all” standard code approach. It is also assumed that the percentage of relays that need to be replaced to be reduced from 50% to 48%
 - (ii) an obligation for all stakeholders to arm feeders to achieve AUFLS supply between a minimum and maximum limit which

⁵³ Note that a part of the costs associated with providing the required information will be fixed for each company and a part will vary according to the size of the company and the number of feeders they have. Much of the information is likely to be available already. Once the systems are setup the on-going cost of providing information in the future will be much lower.

⁵⁴ The number of feeders on AUFLS is likely to be much higher than this as some relays are setup to trip a set of feeders.

varies according to time of day, day type and season, is likely to require more relays in total and a higher percentage of relays that need be replaced (possibly with timers). An extra 3% more relays and an extra 3% relay replacement is allowed

- (iii) the optimisation approach explicitly trades off the cost of resetting and replacing relays against the expected AUFLS load shedding cost and risk of system collapse. This approach can take advantage of economies of scale and scope available across the island (while recognising regional constraints). It is not known what cost savings may arise, but a $10\pm 5\%$ saving in the number of relays and $10\pm 5\%$ reduction in the percentage of relays needing to be replaced is feasible⁵⁵. The optimisation approach can achieve an AUFLS supply that better matches the ideal AUFLS profile by selecting feeders from of the full diversity available in the region, and by selectively using a small subset of feeders on timers as and when they are available
- (i) the cost of developing the selection methodology (including a methodology for VoLL estimation and schedules for relay costs and payments) is estimated to be \$200k
- (j) the additional costs for all lines companies to each develop, consult and apply their own VoLL methodology is not known with certainty, but could easily be \$30k each (on average), implying a $16 \times 30k = \$480k$.
- (k) the additional costs for lines companies and direct connects to each develop, plan and implement systems to achieve a tighter and more structured obligation required under option 1d is assumed to be \$50k each (on average), implying $20 \times 40k = \$800k$
- (l) the cost for the system operator of developing, testing, implementing and negotiating the block allocation methodology, as required for options 1b to 1d is estimated to be \$240k, based on 200 FTE hours

⁵⁵ It is recognised that the illustrative selection methodology includes an addition 10% requirement for flexible standby relays. Despite this, it is still expected that there should be a saving in relay costs as the optimisation will enable a number of relays with small loads to be replaced with relays with larger loads in situations where there is no additional VoLL cost incurred, and should enable the number of new relays required to be reduced somewhat. It should also be recognised that under the common obligation approach, there will still be some need for participants to have extra relays to cover future demand uncertainty and network changes, and by its nature an obligation which is expressed as a minimum requirement at all times is likely to result in a degree of over provision. Option 1, assume that some degree of over-provision is expected and this is accounted for by setting the minimum requirement to 26% in order to meet a average 32% requirement, but if history is a guide, the actual average level of provision could well be around 35% as indicated in Figure 7

- (m) the cost of development, testing and auditing of the optimisation tool is estimated to be \$500k.⁵⁶ This assumes that the optimisation tool is a stand-alone tool design for ad-hoc occasional use. It will use data that required from the compliance system. Although a prototype has already been developed, the final cost is uncertain and will depend on the functional and non-functional requirements. It is expected that the non-functional requirements will not be too extensive, given that the tool will be relatively independent from other systems and will only be used occasionally (once a year). A range of \$300k to \$1m is allowed to account for the potential uncertainty in this cost estimate, which has been based on the cost of developing similar such tools.
- (n) an \$100k allowance is made for the cost of implementing changes to the settlements system for options 2b,c and d.

Q17. Do you have comments on the indicative implementation costs used in the CBA?

On-going costs

- C.9.2 The following Table 6 provides estimated on-going operation costs under the different procurement options.

⁵⁶ A proof of concept prototype routine has been written in GAMS. Inputs to the tool include samples of half-hourly traces of load for each feeder from a full year, target AUFLS amounts to meet the security standard (differentiated by different times of the day and year), VoLL values for the different feeders, and IL load for each feeder. The objective function uses penalty functions on deviations from the desired total AUFLS level pattern and allocation to blocks. Other penalty functions can be incorporated to deal with within-island regional allocation issues, or other desired secondary objectives. Given that this tool would only be used occasionally the computational speed (it can take hours to run) is not considered to be an issue.

Table 6: Indicative on-going costs

Total on-going operating costs		1. Common AUFLS percentage obligation				2. Varying AUFLS provision via optimisation		
		1a) standard Code mechanisms	1b) ... + block coordination	1c) ... + special exclusions	1d) ... + profiled min/max oblig	2a) no compensation + central VoLLs	2b) with compensation + central VoLLs	2c) with compensation + lineco's VoLLs
Business as usual relay replacement	num/yr	10	10	10	10	10	10	10
Extra Relays reset from optimisation	num/yr	-	-	-	-	35	35	35
SO operation & compliance monitoring	\$m/yr (3)	\$0.3	\$0.3	\$0.3	\$0.3	\$0.6	\$0.6	\$0.6
Parties data/monitoring for compliance	\$m/yr (4)	\$0.4	\$0.4	\$0.4	\$0.9	\$0.6	\$0.6	\$0.6
Administer technical/commercial equivalence	\$m/yr	\$0.2	\$0.1					
Relay business as usual replacement cost	\$m/yr	\$0.2	\$0.2	\$0.2	\$0.2	\$0.2	\$0.2	\$0.2
Relay fixed operating and maintenance cost	\$m/yr	\$0.2	\$0.2	\$0.2	\$0.2	\$0.2	\$0.2	\$0.2
Future ERM consultation/selection	\$m/5yr (2)					\$0.5	\$0.7	\$0.7
Future parties consultation costs	\$m/5yr (2)					\$1.0	\$1.0	\$1.0
Extra relays re-set in optimisation	\$m/5yr (2)					\$0.2	\$0.2	\$0.2
Total ongoing cost	\$m/yr	\$1.3	\$1.2	\$1.1	\$1.6	\$1.9	\$1.9	\$1.9
Total ongoing cost (1)	\$m NPV	\$10.0	\$9.0	\$8.1	\$12.2	\$13.5	\$13.7	\$13.7
	<i>Low</i>	<i>\$7.8</i>	<i>\$7.2</i>	<i>\$6.7</i>	<i>\$10.7</i>	<i>\$11.5</i>	<i>\$11.7</i>	<i>\$11.7</i>
	<i>High</i>	<i>\$12.4</i>	<i>\$11.0</i>	<i>\$9.6</i>	<i>\$13.7</i>	<i>\$15.6</i>	<i>\$15.8</i>	<i>\$15.8</i>
Incremental Cost \$m			-\$1.0	-\$1.9	\$2.2	\$3.5	\$3.7	\$3.7
	<i>Low</i>		<i>-\$0.6</i>				<i>\$3.9</i>	
	<i>High</i>		<i>-\$1.4</i>				<i>\$3.4</i>	

Notes:

1: Assumes 8% discount rate over 15 years

2: allow s for 5 yearly selection after initial

3: allow s for SO cost to be 100% higher w ith optimisation

4: allow s for ongoing data costs to be 50% higher w ith optimisation

- C.10 A little over one full time equivalent is allowed for the system operator to operate and manage the compliance arrangements under option 1.
- C.11 It is assumed that the resources required for the system operator to utilise flexible AUFLS supply and administer and enforce the obligations created under the selection process in option 2 will be greater. The cost of 2 full time equivalents is allowed for this.
- C.12 150 hours for each of the 21 stakeholders is allowed to provide data and monitor compliance. This is likely to be similar each option 1a,1b,1c. It is assumed that the costs for option 2 are similar as the compliance data and other requirements are similar in each case. A 50% higher cost allowance is included to account for any additional documentation and processes required in option 2 compared to option 1.

- C.13 It is not clear what the extra costs would be for each stakeholder to comply with profiles and min max obligations as required for 1d, but it is likely to involve more careful and frequent relay adjustments and monitoring. An extra \$25k/yr per stakeholder is allowed.
- C.14 It is assumed that there will be an annual cost of \$10k to administer and deal with issues associated with each “equivalence” arrangement.
- C.15 The relay fixed operating, maintenance and business as usual replacement/testing/certification costs are assumed to be based on the number of relays required under each option.
- C.16 In option 2 there will be a new selection process approximately each 5 years. This will involve costs and consultation. If necessary there could be modifications to the technical requirements and selection methodology as well. These are unlikely to be as costly as the initial process. It is hard to predict what the costs of these developments and consultations will be but they could be significant. An allowance of \$1.7m (including \$200k for the system operator, \$500k for the ERM and 20*\$50k participants’ costs) each 5 years is included.
- C.17 It is possible that some relays may be reassigned at each 5 year selection. An allowance of \$180k is made for this, however it is the intention that the selection methodology will account for the costs associated with reprogramming or replacing relays. Changes would only be made if there was sufficient benefit to justify it.

Q18. Do you have comments on the indicative on-going costs assumed in the CBA?

Benefits

- C.18 The scale of indicative benefits is outlined in Table 7 below. These are made up of reliability benefits and allocative efficiency improvements. The modelling used to calculate these benefits is described later in this Appendix.
- C.19 All benefits are measured relative to the status quo (i.e. the current 2-block technical design coupled with the common percentage obligation procurement approach).

Table 7: Indicative benefits

Benefits		1. Common AUFLS percentage obligation				2. Varying AUFLS provision via optimisation		
		1a) standard Code mechanisms	1b) ... + block coordination	1c) ... + special exclusions	1d) ... + profiled min/max oblig	2a) no compensation + central VoLLs	2b) with compensation + central VoLLs	2c) with compensation + lineco's VoLLs
Reliability Benefit								
Reduction in collapse risk	% per event	4.0%	4.0%	4.0%	4.8%	5.0%	5.0%	5.0%
Optimised - Time zone target (timers)						5.2%	5.2%	5.2%
Optimised - Ideal target (timers)						5.4%	5.4%	5.4%
Optimised - Full dynamic supply						6.1%	6.1%	6.1%
Base Case Reliability Benefit	\$m NPV(1)	\$95	\$95	\$95	\$115	\$124	\$124	\$124
Optimised - Time zone target (timers)	\$m NPV					\$124	\$124	\$124
Optimised - Ideal target (timers)	\$m NPV					\$128	\$128	\$128
Optimised - Full dynamic supply	\$m NPV					\$145	\$145	\$145
Allocative Efficiency								
Reduction in expected AUFLS load shedding costs	\$m NPV					\$9	\$9	\$9
	Low					\$7	\$7	\$7
	High					\$14	\$14	\$14
Saving from avoiding "loss" of IL or DR	MW lost	45	23	-	-	-	-	-
	\$m NPV		\$15	\$30	\$30	\$30	\$30	\$30
	Low		\$6	\$11	\$11	\$11	\$11	\$11
	High		\$27	\$54	\$54	\$54	\$54	\$54
Total Base Benefit								
	\$m NPV	\$95	\$110	\$125	\$145	\$164	\$164	\$164
	Low	95	\$101	\$106	\$126	\$141	\$141	\$141
	High	95	\$122	\$149	\$169	\$194	\$194	\$194

Notes:

1: Assumes 8% discount rate over 15 years

2: assumes that the first selection targets a uniform 32%, but that future selections aim to achieve the ideal profile

Reliability benefits

- C.20 As described elsewhere, the ideal quantity of AUFLS to have armed on the system varies with system conditions. Thus at times of low demand a relatively high proportion of load armed for AUFLS is desirable, and vice versa.
- C.21 However, the profile, level and volatility of AUFLS provided can vary materially according to the procurement option. This impacts the risk and cost of system collapse per AUFLS event. This is quantified using risk curves derived from the system operator's technical analysis as set out in C.62 and assumes a \$1.5 billion cost of system collapse and a return period for AUFLS events of 5.4 years.
- C.22 The base level of reliability benefits assumes that the common percentage obligation is to achieve a minimum 26% AUFLS at all times, and that the optimisation targets a uniform 32% level on average. However, as described in paragraphs C.69 the amount of AUFLS provided varies from this ideal amount such that generally less than the target is provided at times of low demand, and more than the target at times of high demand. This deviation from the ideal will increase the risk of system collapse in an AUFLS event.
- C.23 It is feasible to better achieve the ideal AUFLS target at different times of the day and year under a common obligation approach if a more complex obligation is imposed on stakeholders. The table identifies the potential reliability benefit from imposing a minimum and maximum obligation limit around the desired 32%. Additional reliability benefits could be obtained by imposing profiled minimum and maximum limits which varied by time of day etc. It is assumed that 80% of the benefits from full optimisation can be achieved in this way.
- C.24 It is not known what the practicalities and compliance costs would be from imposing a min & max compliance requirement (particularly for smaller stakeholders and direct connects). However, there was considerable resistance from the interested parties to these more complex obligation structures being imposed across the board when they were discussed early on in the investigation.⁵⁷ This resistance may not be as great now that an ex-ante compliance approach is proposed.
- C.25 The optimisation approach allows for the benefit of this form of targeting to be achieved without having to impose any more onerous compliance requirements on stakeholders. As described in paragraph C.74 it achieves this through the selection of feeders whose combined diversified load closely matches the desired within-day and within-year shape of

⁵⁷ It was also assumed that this more complex obligation would require real-time monitoring and control which many stakeholders would find costly or difficult.

AUFLS. As further described in paragraph C.76, this can be improved further through taking advantage of timers on a small subset of feeders (supplied by stakeholders who are compensated for the costs involved) as and when they become available.⁵⁸

- C.26 The base reliability benefits assume that the technical requirements are expressed as a uniform 32% target for the first 5 year period. The additional flexible AUFLS supply should also provide additional reliability benefits. This is difficult to estimate, but could conservatively be a 0.1% reduction in the risk of system collapse.
- C.27 It is assumed that the technical requirements are modified to better reflect the ideal profile in 5 years' time and that the selection methodology is adjusted to account for this. In doing so it is assumed that it can use a subset of feeders with relays on timers.
- C.28 This is estimated to reduce the risk of system collapse per AUFLS event by up to an additional 0.4% (relative to the reduction achieved by targeting a uniform 32% requirement), (see Table 7 above). The value of this is \$0.95m per annum which equates to \$4.3m NPV assuming that the benefit arises after 5 years.
- C.29 This benefit would be increased \$2.9m to \$7.2m NPV if it were possible to include timers and introduce profiled AUFLS targets in the first selection process.

Allocative efficiency benefits:

- C.30 Allocative efficiency benefits include two separate components:
 - (a) The lower cost of AUFLS load-shedding: The optimisation approach can reduce the expected cost of AUFLS load shedding by around \$0.9 to \$1.6m/yr (or \$7 to \$14m NPV) relative to a common percentage obligation with standard Code mechanisms as described in C.83
 - (b) The lower cost of IL: A common percentage obligation approach has the potential to inefficiently exclude some direct connects from supplying alternative demand products (initially IL but potentially also DD or other DR products). The benefit of preventing this is estimated on the basis that the common percentage obligation with standard Code mechanisms could result in the loss of 25 to 60MW of IL at a cost of \$30m NPV and that 50% of this loss can be avoided with block coordination, and 100% can be avoided under the optimisation (and voluntary tender) options as set out in C.93.

⁵⁸ The use of timers was not explicitly considered in the earlier, but have the potential (subject to further investigation by the system operator) to provide additional reliability value without requiring real-time monitoring and control and without imposing significant additional costs.

Potential future benefits

- C.31 The system operator's technical study has identified the following developments which could further improve system reliability:
- (a) a move to a faster relay response time
 - (b) increasing the use of df/dt relays as confidence in their performance is gained through experience
 - (c) the use of dynamic monitoring and remote arming/disarming to adjust the level of load on AUFLS in response to changing conditions (including the dynamic use of demand response for other purposes). This use of flexible AUFLS providers is a feature of the proposed approach. This is used to allow for occasional changes within a 5 year time, however the same resource could be used more actively to obtain greater system security benefits and to provide other market benefits in the future.
- C.32 The compensation mechanism allows new services and technology to be adopted as they become available from those individual stakeholders who can provide them at low incremental cost. Some stakeholders have these capabilities already, or are planning them as a result of other initiatives or general infrastructure upgrading projects. Other stakeholders don't have the capabilities, or the scale economies to justify them. The optimisation or tender approach avoids the costs of imposing additional obligations on all stakeholders while enabling benefits to be obtained from utilising the additional capabilities from those stakeholders that can provide them at low incremental cost.

Future reliability benefits:

- C.33 The benefit from the use of timers to meet the ideal profile of AUFLS supply in 5 years has already been included in the base reliability benefit.
- C.34 More dynamic AUFLS monitoring and supply could potentially increase this reduction in the risk of system collapse per event by an additional 0.7%. The extra value of this is estimated to be \$2m/yr, or \$8m NPV assuming that the benefit arises after 6 years.

Future allocative benefits:

- C.35 If there is a move to more dynamic monitoring and supply of AUFLS then it is likely that a better coordination of the different potential uses (IL, DD, DR, AUFLS) for demand side-response can be achieved.
- C.36 The current proposal allows for a limited degree of co-ordination in that an estimated level of IL/DD/DR behind feeders is accounted for when feeders are selected for arming. This approach is likely to be somewhat conservative, and thus is likely to result in IL/DD/DR being restricted. If it is

possible to monitor the level of AUFLS and the requirements more dynamically then it is likely that additional demand response can be made available for dynamic supply as IL/DD/DR. In the extreme, it would be possible for AUFLS to be co-optimised with IL/DD in SPD. This would achieve the highest level of co-ordination.

- C.37 It is difficult to estimate the potential net benefit, but it is feasible that an additional 10-30MW of these products might be provided at a net value of \$6/MWh (based on the \$8/MWh price of FIR and SIR over the last 7 years minus an assumed interruption cost of \$2/MWh).
- C.38 This would provide \$0.5 to \$1.6m/yr net benefit or \$2 to 6m NPV assuming that the benefit arises after 6 years.

Future restructuring cost savings:

- C.39 There is a general move to greater use of dynamic demand-side products as discussed above, and technology is changing all the time. These changes can be relatively easily accommodated as they arise within the optimisation frameworks (particularly with compensation). However they are much more difficult and costly to accommodate under a common percentage obligation approach, as this will require that the common obligation be changed or a new approach to be taken. Any change in common obligation will affect all stakeholders and will need to be consulted on and negotiated with the interested parties. If past experience is a guide this is likely to be a time consuming and costly exercise.
- C.40 The potential future benefit of avoiding the need for this process is estimated to be between \$1-3m NPV assuming a \$1-\$3m cost saving in 6 years.

Q19. Do you have comments on the indicative base level and future benefits assumed in the CBA?

Summary cost benefit analysis

- C.41 The table below provides a summary of the costs and benefits of the different options.
- C.42 Note that this includes the risk and cost of potential delay in the implementation of the new AUFLS technical design if:
- (a) extra time is required for all stakeholders to meet more complex minimum and maximum percentage requirement, or
 - (b) profiled common obligations are required.

Table 8: Indicative costs and benefits summary \$M NPV

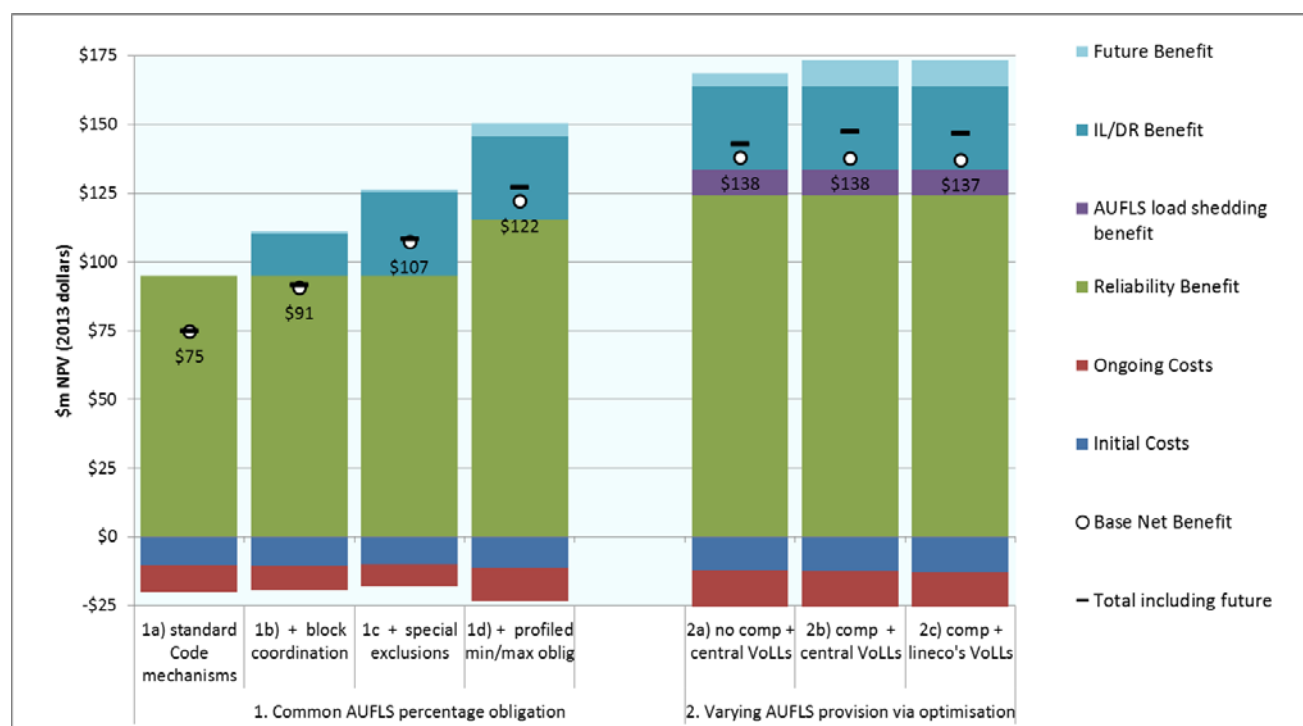
Summary Costs and Benefits	Procurement Option						
	1. Common AUFLS percentage obligation				2. Varying AUFLS provision via optimisation		
	1a) standard Code mechanisms	1b) ... + block coordination	1c) ... + special exclusions	1d) ... + profiled min/max oblig	2a) no compensation + central VoLLs	2b) with compensation + central VoLLs	2c) with compensation + lineco's VoLLs
Initial and Transitional Costs							
Total	\$10.1	\$10.4	\$9.8	\$11.2	\$12.1	\$12.3	\$12.8
On-going Costs							
Total	\$10.0	\$9.0	\$8.1	\$12.2	\$13.7	\$13.7	\$13.7
Base Benefits							
System Reliability	\$95.1	\$95.1	\$95.1	\$118.3	\$124.1	\$124.1	\$124.1
Cost of delay	\$0.0	\$0.0	\$0.0	-\$3.0	\$0.0	\$0.0	\$0.0
AUFLS load shedding efficiency	\$0.0	\$0.0	\$0.0	\$0.0	\$9.4	\$9.4	\$9.4
IL & DR allocative efficiency	\$0.0	\$15.2	\$30.4	\$30.4	\$30.4	\$30.4	\$30.4
Total	\$95.1	\$110.3	\$125.5	\$145.7	\$163.9	\$163.9	\$163.9
Potential Future Benefits							
Facilitates extra dynamic AUFLS supply	\$0.0	\$0.0	\$0.0	\$1.9	\$1.9	\$3.9	\$3.9
Facilitates dynamic demand side markets	\$0.0	\$0.0	\$0.0	\$2.1	\$2.1	\$4.1	\$4.1
Future restructuring avoided	\$0.0	\$0.8	\$0.8	\$0.8	\$0.8	\$1.6	\$1.6
Total	\$0.0	\$0.8	\$0.8	\$4.8	\$4.8	\$9.6	\$9.6
Summary Net Benefits							
Base net benefit	\$75	\$91	\$107	\$122	\$138	\$138	\$137
Total net benefit (inc future benefits)	\$75	\$92	\$108	\$127	\$143	\$147	\$147

Notes:

All amounts are in 2013 million dollar present value terms, assuming an 8% real pre tax discount rate and 15 year period.

- C.43 The components of these benefits and costs compared with the status quo are illustrated in Figure 4 below. This also shows the base net benefit (excluding future benefits) and the total net benefit including the present value of future benefits. This shows that there is a significant common net benefit of \$75m in going to the four block AUFLS design regardless of the procurement option. This arises because the reliability benefits significantly outweigh the costs. However, the common obligation with additional mechanisms and the optimisation approaches provide significant additional benefits.

Figure 4: Indicative costs and benefits compared to status quo

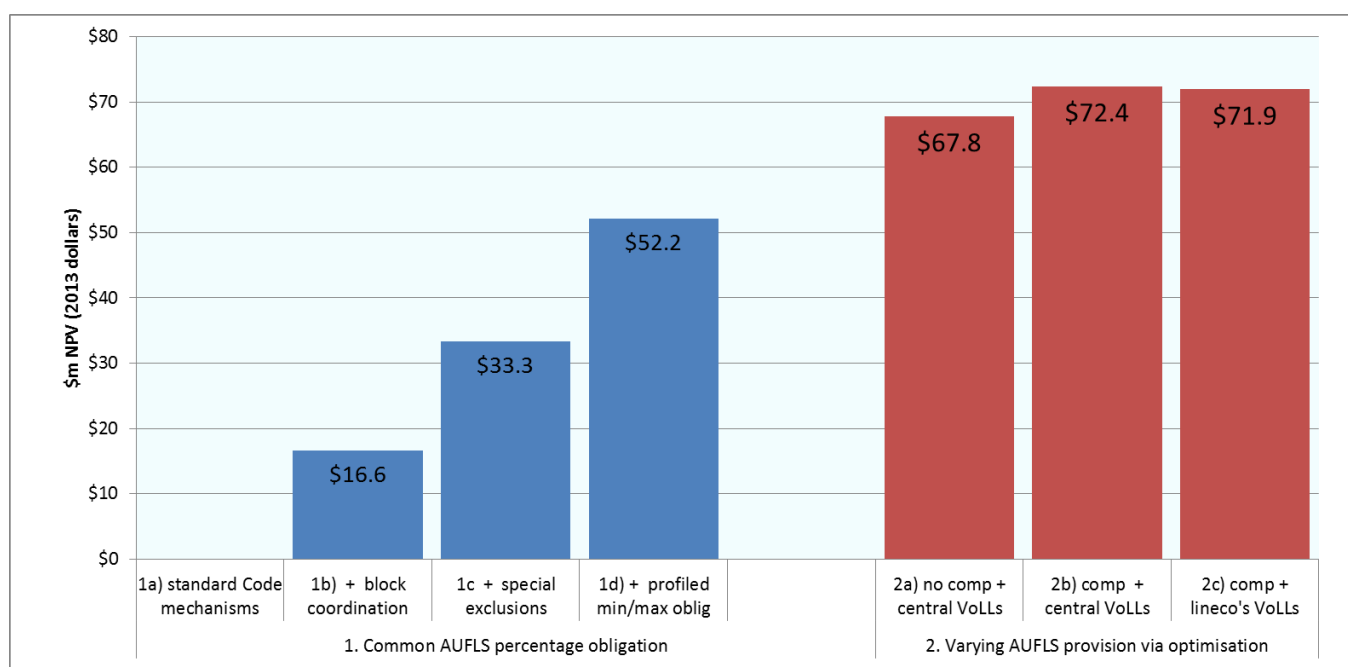


- C.44 The initial cost for option 1c is around \$2.5m NPV lower than that for option 2b. Options 2a to 2c provide savings in relay costs but these are offset by the additional systems and transactions costs associated with a more complex optimisation approach.
- C.45 Option 2b has an estimated \$56m NPV additional transaction and operations costs compared with option 1c. There are likely to be additional on-going compliance costs for stakeholders if a more complex profiled minimum and maximum common obligation is applied as per option 1d.
- C.46 From the analysis undertaken by the Authority, there is reliability, AUFLS load shedding and IL benefits (immediate and future) from options 2a to 2c compared with options 1a to 1d. The full IL benefit is common to options 1c, 1d and 2a to 2c. A portion of the additional reliability benefit available

from options 2a to 2c is available for option 1d which has more complex profiled, minimum and maximum obligations. The optimisation options 2a to 2c provide a small AUFLS load shedding benefit compared with options 1a to 1d. The optimisation options 2b and 2c provide higher future benefits.

- C.47 Figure 5 shows the indicative total net benefit (including future benefits) for the different variants *relative* to the common obligation with standard Code mechanisms option. This option is effectively the “do-nothing” *procurement* option, as it represents the current “one-size-fits-all” procurement approach that would have to be used to implement the new AUFLS technical design if there was no change in the procurement approach.

Figure 5: Indicative net benefits compared to “do-nothing” procurement factual



- C.48 The common obligation with block coordination mechanisms provides approx. \$17± 11m NPV net benefit.
- (a) This would increase by \$16m to \$33m NPV if dispensation, customised obligations or exemptions could be introduced to avoid any inefficient loss of IL/DR
 - (b) If, in addition, the common obligation were to include profiled minimum and maximum limits, then the net value would increase an estimated \$19m to \$52m NPV
 - (i) this arises from \$28m NPV (80% of the \$29m NPV increased reliability value and 50% of the potential future value available

under compensated optimisation) minus an extra \$25k/yr per participant compliance cost (=\$0.5m/yr or \$4.5m NPV), and a 6 month delay in implementing the new AUFLS design costing \$3m NPV ($\$77\text{m} \times 8\% / 2$).

- C.49 The optimisation option with compensation payments and Authority determined VoLL for lines companies provides $\$72.4 \pm 38\text{m}$ NPV benefit relative to the standard Code approach
- (a) if there were no compensation payments there could be some minor savings related to Code changes and administration of the payments system. These cost savings are likely to be modest (probably less than \$0.2m NPV) and more than offset by the lost benefits from no longer aligning incentives for direct connects, and not so easily facilitating the procurement of more dynamic and special AUFLS services in the future.
 - (b) if the 16 lines companies each determined VoLL for their own feeders rather than the Authority, there is potential for greater accuracy. However, this could only be achieved by surveying end-use customers. This has been shown to be expensive and time consuming and still produces highly uncertain estimates, with a significant risk of inconsistent estimates. A centralised, co-ordinated approach (based on information provided by lines companies and, potentially, from very large customers within lines company regions) will have a lower cost. This method is likely to provide reasonable estimates quickly and a much more consistent ranking of VoLL for feeders
 - (i) the additional cost of lines companies determining VoLL individually is estimated to be \$0.5m (\$30k per stakeholder) plus \$3m NPV ($\$77\text{m} \times 8\% / 2$) for a 6 month delay in implementing the new AUFLS design.
 - (c) the base case value for the optimisation includes the benefit of using timers on a subset of AUFLS feeders to target the ideal profile of AUFLS supply in 5 years' time. If this approach could be implemented in the first selection process the incremental net value would increase by around \$2.9m to \$75m NPV.

Approach to quantifying AUFLS load-shedding and system collapse costs

- C.50 The estimated benefits of reduced AUFLS load-shedding and system collapse costs for the options compared to the standard Code approach have been calculated through undertaking detailed modelling.

- C.51 Actual data is not available for all the AUFLS feeders by participant in the North Island and so benefits of reduced AUFLS load shedding and system collapse costs are estimated using synthetic data.
- C.52 While this data is not fully reflective of actual participant data, it is reasonably realistic and includes the range of different participant situations. It can be used to estimate the relativities and order of magnitude of costs expected under each procurement option.
- C.53 Costs have been estimated as follows:
- (a) establishing a common set of illustrative synthetic half-hourly data for 226 feeders based on GXP profiles from 2012 as discussed in section C.59 below
 - (b) simulating the selection of feeders for arming according to the procurement option:
 - (i) by manual selection in the individual obligation approach
 - (ii) by use of a prototype optimisation model for other options
 - (c) calculating the expected annual AUFLS load shedding and relay costs
 - (d) calculating the expected cost of system collapse taking into account the level and half hour variability of AUFLS supply for the procurement option as outlined in C.62.

Manual simulation - common percentage obligation option

- C.54 This option is manually simulated by allocating the illustrative feeders to meet the obligation of providing at least 26% at all times or around 32% on average over the year.
- C.55 The typical degree of conservatism observed from the past (systematic over-provision of AUFLS load) was factored in, so that around 35% AUFLS supply was made available overall. The assumed level of IL behind each feeder was accounted for.
- C.56 Where possible, feeders were allocated on the basis of assumed availability of existing relays, feeder size relative to block requirements, and VoLL ranking within participant. There was no attempt to fully optimise.
- C.57 Where there were an inadequate number of feeders to meet the requirements for all blocks, the overall 32% was allocated to 1 or 2 blocks as appropriate. Not all participants could achieve 26% at all times, and some has to provide more than the minimum due to lumpiness.

Software optimisation - rest of the options

- C.58 These options are optimised using the prototype optimisation tool, developed by the Authority. This accounted for VoLL and new relay costs as well as the assumed level IL behind each feeder. It was assumed that all feeders were made available for the optimisation to select. The objective function was set up to achieve the desired total island supply of AUFLS to achieve the lowest overall risk of system collapse. Two variants were tested, one aiming to achieve 32% on average at all times, and the other aiming to best meet the ideal profile (45%, 32% and 25% at low/middle/high load respectively, as derived by the Authority based on the system operator's technical report). In all cases the distribution of AUFLS between blocks was targeted to be in the proportions 10%:10%:6%:6%. Within-region constraints were not simulated in this prototype, but would need to be accounted for in the final model. This is not expected to substantially affect the conclusions.

Assumptions used in the analysis

Feeder data

- C.59 Data for actual feeders is not yet available. However, it is possible to come up with reasonable illustrative data derived from GXP profiles from the last year. The cost benefit analysis is based on an illustrative set of feeder participant data which reflects the range of different participant sizes and situations.

Table 9: Illustrative demand and feeder data

Participant	Avg MW in 2012	%	Num Feeder	Avg IL /DR MW	Avg VoLL \$/MWh
A	484	18%	14	84	\$18
B	342	13%	32	77	\$22
C	161	6%	30	14	\$21
D	143	5%	12	24	\$22
E	265	10%	18	36	\$18
F	98	4%	22	2	\$23
G	281	10%	30	10	\$22
H	222	8%	22	14	\$24
I	44	2%	4	4	\$17
J	134	5%	4	13	\$24
K	128	5%	8	12	\$22
Ind 1	63	2%	4	33	\$17
Ind 2	109	4%	4	34	\$16
Ind 3	67	2%	6	30	\$13
Ind 4	21	1%	2	9	\$18
Ind 5	30	1%	2	15	\$14
Ind 6	52	2%	2	18	\$13
Total	2,686	100%	226	453	\$21

C.60 Note that typically only 100 of the modelled 226 feeders are required to meet the AUFLS requirements in the North Island with this illustrative data. This is less than the current 460 AUFLS relays in the North Island, but serves to illustrate the potential benefits of the different approaches, and the results are not particularly sensitive to this assumption. Where appropriate, results from the illustrative data are scaled to reflect current number of feeder relays.

C.61 It is assumed that there is a varying quantity of IL or other demand response products behind each feeder. This is accounted for when feeders are selected to be armed for AUFLS. The assumed level of IL/DR is somewhat higher than current levels, but the results are not sensitive to this.

Cost of system collapse

C.62 The expected cost of system collapse is derived as follows:

expected cost = Cost of system collapse / AUFLS return period * risk of system collapse per AUFLS event.

C.63 The Authority has estimated the risk of system collapse per AUFLS event using the approach developed by the system operator as described in “AUFLS Scheme Design”, 7 Aug 2013 section 7.3.1. The risk is based on

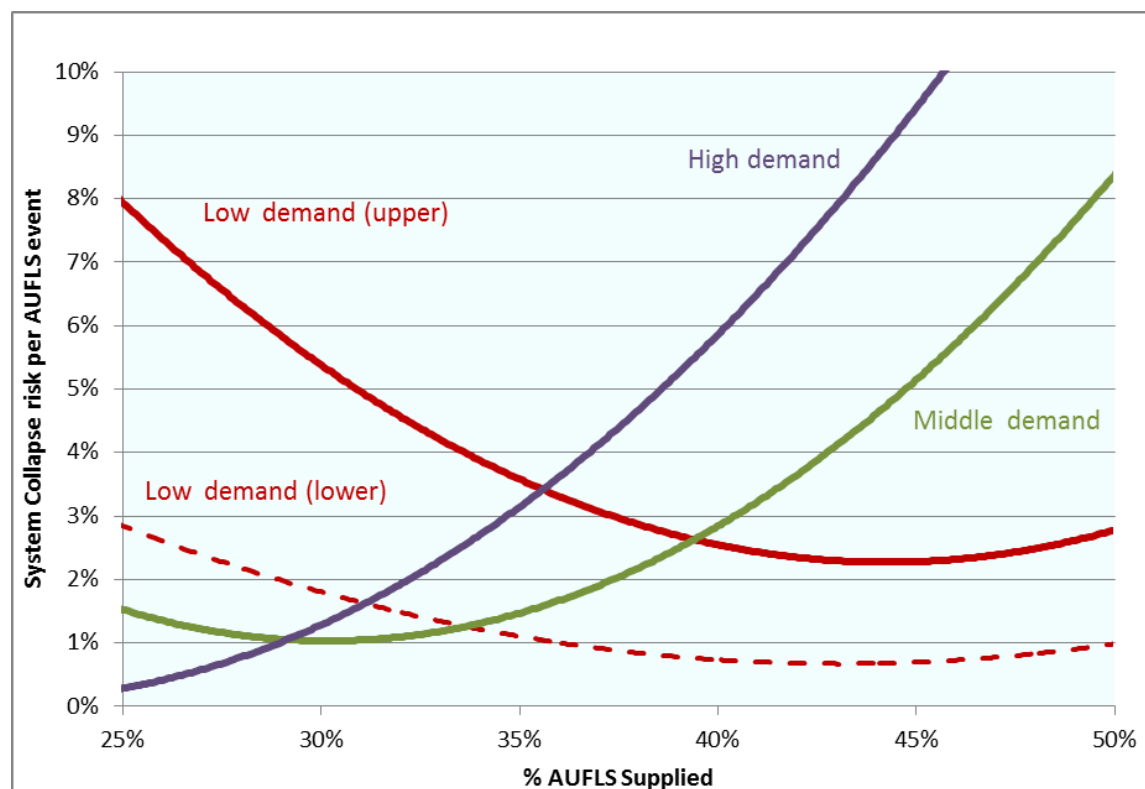
the chosen technical design, allowing for a 25% chance of non-performance of the df/dt component of the relays.

- C.64 The risk of system collapse is expressed as a function of the total level of AUFLS supplied, for 3 demand levels (low, middle and high). For the middle and high demand cases, the system operator simulated a wide range of disturbances for a DC risk (e.g. HVDC bi-pole), and an AC risk (using the proxy of the Huntly site which currently represents an AC risk of a similar magnitude to the DC risk). The AC risk was assumed to be four times less likely than the DC risk (bi-pole trip). For the low demand case the system operator considered the varying magnitude of an AC risk when the HVDC was not operating. This AC risk is considered to have similar consequences to a DC risk. Hence the same simulation can be used to represent either eventuality.
- C.65 These risk curves are sensitive to the assumptions concerning the probability distributions for both HVDC flows and Huntly site generation.
- C.66 For each procurement option the Authority has estimated an overall risk measure by deriving the risk for each half hour (accounting for the expected pattern and variability of AUFLS supply and linearly interpolating between the risk of system collapse curves) and then averaging over all half hours. The level and variability of AUFLS supply is estimated based on the feeders assumed to be armed for AUFLS under the procurement option and the historical half hourly data of load per feeder.
- C.67 This risk measure is then converted to an expected cost per annum and a NPV based on 15 years at an 8% pre-tax real discount rate and assumptions relating to the cost of system collapse and the AUFLS return period.

Table 10: System Reliability cost assumptions

Assumption	Middle Value	Low Value	High Value
Cost of system collapse	\$1.5 billion	\$1.0 billion	\$2.0 billion
AUFLS return Period	5.4 yrs	6 yrs	4 yrs
Risk of system collapse per AUFLS event	Risk curves derived by the system operator based on detailed simulation of a range of double and extended contingency risks.	Lower Risk (see Figure 6)	Upper Risk (see Figure 6)

Figure 6: Risk of system collapse curves



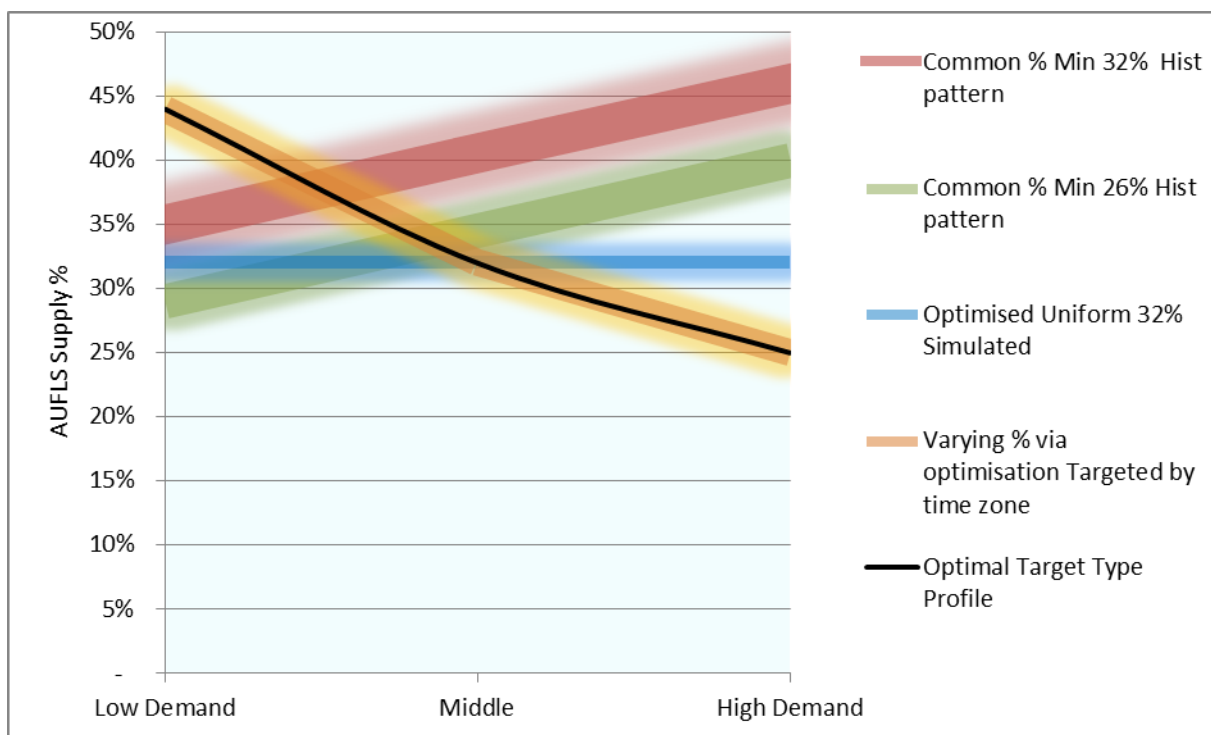
- C.68 The chart above indicates that the system collapse risk can be minimised by targeting around 45% AUFLS supply at times of low load, 25% at times of high load and 32% at times of medium load. These are used for illustrative analysis, but further work would be required from the system operator to confirm them.
- C.69 Thus the overall level of system collapse risk depends on the profile, level and variability of total AUFLS supply. This will vary depending on the procurement option and the selection of feeders which are armed for AUFLS. This is illustrated in Figure 7 below.
- C.70 The black line shows the ideal pattern of AUFLS supply as discussed above. This will deliver the lowest overall risk of system collapse at high, middle and load loads.
- C.71 It has been observed that the existing minimum 32% obligation has resulted in an overall level of AUFLS provision of around 35% at low loads and around 46% at high loads.⁵⁹ There is an additional random variation around this pattern as indicated by the thickness of the red line shown in the chart.

⁵⁹ See "SO report: AUFLS II – Appendix G", Aug 2011, page 6-7.

- C.72 If the common minimum percentage obligation procurement approach is continued, then the system operator has proposed that the minimum be lowered to 26% to reduce the risk of system collapse as a result of over provision at peak times. The resulting level of AUFLS supply is shown by the green line below.
- C.73 If the historical pattern of supply continues then there is a reduction on the risk of system collapse, but the pattern of supply is far from ideal. It is not entirely clear what is driving the observed historical profile, and this may change as a result of the move to an ex-ante compliance regime. The simulation of a 26% minimum obligation based on illustrative data indicates that a flat profile could emerge, but this is highly uncertain.
- C.74 A move to an optimisation procurement approach enables much greater certainty as to level and profile of AUFLS supply, as feeders can be chosen to target a desired profile and to minimise the variability in supply fully accounting for the diversity of load across the relevant region.
- C.75 Simulation studies using the illustrative feeder data shows that it is feasible to achieve a uniform 32% supply with a 92% percentile range of $\pm 1.7\%$ as illustrated by the blue line.
- C.76 However it would also be possible to achieve a pattern close to the ideal target. As shown by the orange line. This can be achieved by changing the mix of feeders which are armed, but at the expense of a higher AUFLS load-shedding cost. However if some feeders could be selectively armed for different time zones⁶⁰ then this ideal pattern could be achieved without increasing the AUFLS load-shedding cost.

⁶⁰ As can be achieved by having the AUFLS relays being automatically armed and disarmed using timers. The technology for doing this is understood to be relatively simple, but is not typically used in the North Island now, but is used by Orion in the South Island (although it is not known for what purpose). Further work would be required on the reliability and suitability of timers on AUFLS relays as this option was not explicitly considered by the system operator in their technical studies.

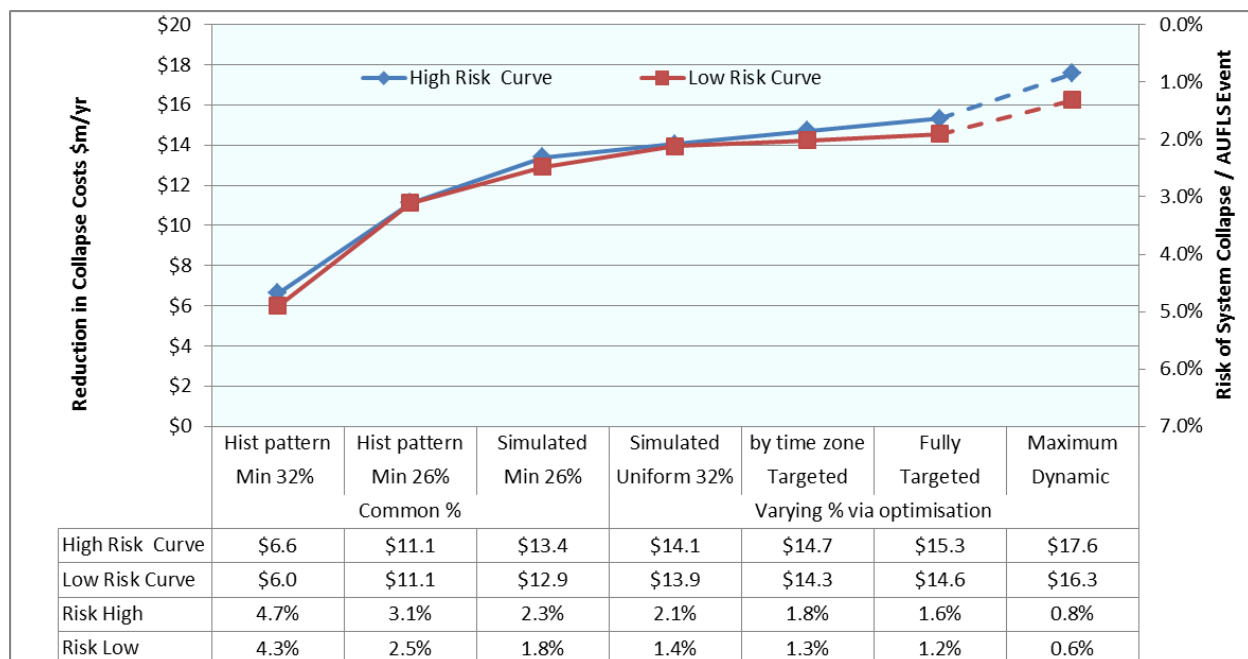
Figure 7: AUFLS supply shape and volatility



- C.77 The incremental benefit from reducing expected system collapse costs is shown in the following Figure 8.
- C.78 The blue and red lines show the incremental benefit resulting from applying the higher and lower risk of system collapse curves as shown in Figure 6.
- C.79 The incremental benefit is measured in \$m per annum saving in system collapse costs relative to the current standard code procurement approach. This involves a 26% minimum obligation at all times with the observed historical pattern of AUFLS supply – the second of the seven options shown in Figure 8 below.
- C.80 Also shown is the benefit of a 26% minimum obligation, if this could be achieved as a “flat” profile as simulated using the illustrative feeder data, would be \$1.8 to \$2.3m/yr.
- C.81 The incremental benefit for the optimisation approach depends on the desired target used in the optimisation tool. It is possible to the target to be set as uniform or varying by time zone. Optimising to a uniform 32% target would achieve a \$2.8-2.9m/yr benefit. This could be increased \$0.3 to \$0.7m/yr to \$3.1 to 3.6m/yr by optimising by time zone, or to a maximum of \$3.4 to 4.2m/yr by fully optimising to the ideal target (given by the black line above).

C.82 All of the analysis above assumes that AUFLS supply is inherently uncertain. The obligation and optimisation approaches reduce this level of uncertainty but do not eliminate it entirely. Hence there is a residual risk of system collapse of approximately 1.5% per event. In the future it may be possible to monitor AUFLS supply much more closely and to adjust the supply dynamically by remotely arming and disarming selected blocks of feeders as required. This has the scope to further reduce the risk of system collapse. It is difficult to know what the value of this is, but it is plausible that the residual risk could be halved. The incremental benefit of this is an extra \$2m/yr as indicated by the maximum dynamic point below.

Figure 8: Incremental reduction in system collapse costs \$m/yr



AUFLS load-shedding cost assumptions

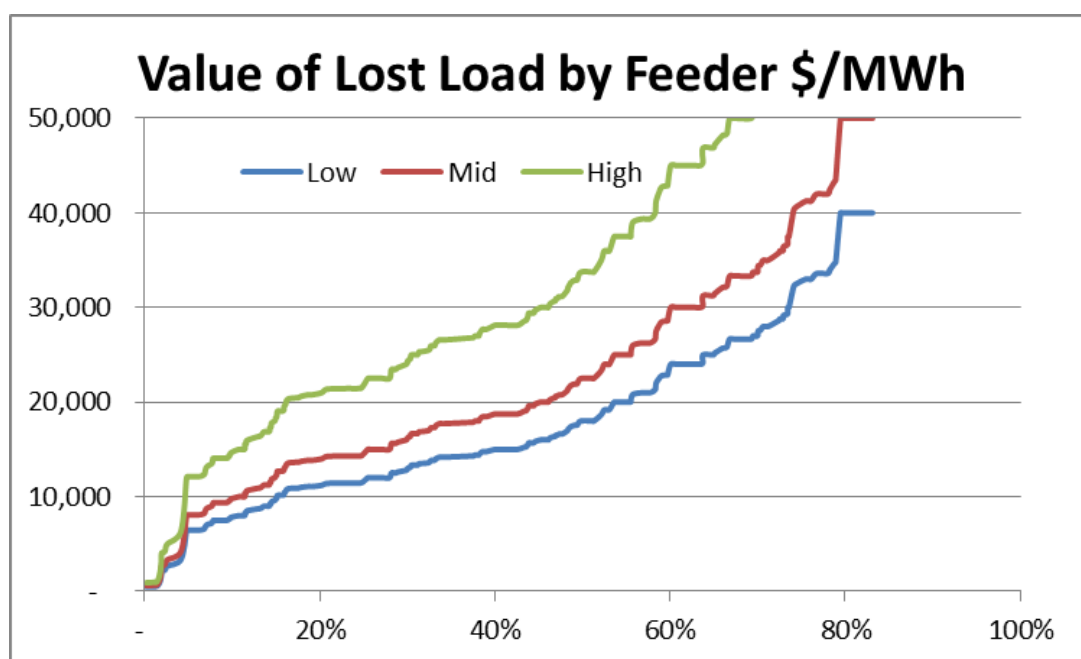
C.83 The expected AULFS load-shedding costs are estimated on the basis of a VoLL per feeder and the expected number of hours of AUFLS load-shedding per annum. The latter is expected to vary significantly by block number, as indicated in the table below.

Table 11: Assumed AUFLS block return periods⁶¹

	Return period yrs	Hours per event	Hours/yr
Block 1	5.4	1.4	0.250
Block 2	11.3	1.5	0.133
Block 3	27.0	1.8	0.067
Block 4	60.0	2.0	0.033

C.84 VoLL costs per feeder are not known at this stage, however the potential of alternative procurement options can be assessed by assuming an illustrative distribution of VoLL costs per feeder as illustrated in the figure below.

Figure 9: Assumed value of lost load



C.85 The expected AUFLS load-shedding costs have been calculated using the illustrative feeder data for 3 different procurement options:

- (a) the individual obligation approach

⁶¹ These return periods and durations are the indicative values assumed for the analysis. These are inherently difficult to assess and will involve a degree of judgement. These will need to be consulted on and agreed by the interested parties as they are an element of the proposed compensation payments system.

- (b) the optimisation approach targeting a uniform 32% level of AUFLS
- (c) the optimisation approach targeting the ideal AUFLS profile (but assuming that feeders are armed for the whole year rather than being switched on/off by time zone). The results are given in Table 12 below.

Table 12: Estimated incremental value from reduced AUFLS load shedding costs

		Common AUFLS percentage obligation	Varying AUFLS provision via optimisation	
		Min 26%	Uniform 32%	Targeted (no time switching)
	Hours /yr	AUFLS Avg MW		
Block1	0.250	309	270	301
Block2	0.133	320	270	301
Block3	0.067	155	162	180
Block4	0.033	158	162	180
Total		942	863	962
AUFLS Expected Load Shedding				
MWh/yr	VoLL	135	119	133
Avg VoLL	\$/kWh	\$17	\$10	\$14
Total VoLL	\$/yr	\$2.3	\$1.2	\$1.9
Incremental	\$/yr	\$0.0	\$1.1	\$0.4
High	\$/yr	\$0.0	\$1.6	\$0.6
Low	\$/yr	\$0.0	\$0.9	\$0.3
Middle	NPV \$m	\$0	\$9	\$4
High	NPV \$m	\$0	\$14	\$5
Low	NPV \$m	\$0	\$7	\$3

- C.86 As can be seen the potential reduction in total AUFLS load-shedding costs from the optimisation approach is of the order of \$0.9 to 1.6m/yr if the optimisation is set to meet a uniform 32%.
- C.87 This benefit would be reduced by around \$0.7m/yr if the “ideal” AUFLS profile was targeted without any time switched relays being available. But if these were available then the reduction would be negligible.
- C.88 The estimated \$0.9-1.6m/yr benefit assumes that the optimisation can choose from all feeders. In reality it is likely some feeders may be excluded from the optimisation (e.g. if they contain sensitive loads). This is unlikely to have significant impact on the estimated benefit since these feeders would have had a high VoLL assigned and would not have been selected in any event.

- C.89 The estimated benefit is also sensitive to the assumed level of “optimisation” achieved within each participant, and through the system operator allocation of feeders to blocks for small participants. The results in the table assume that the focus under the minimum obligation approach is to meet the required design quantities with minimum relay costs, rather than to minimise the load-shedding cost. If a more sophisticated approach was used by participants, the incremental benefit from central optimisation might be reduced by around \$0.5m/yr.
- C.90 The illustrative analysis suggested that most of the reduction in AUFLS load-shedding costs can be achieved using relatively crude assessments of feeder VoLL costs. There would be little additional value to be obtained by from the use of sophisticated or costly methods to determine VoLL.

Cost of “lost” interruptible load or other demand services

- C.91 Currently direct connects offer around 100-170MW of IL into the IR market. A number of these have indicated that due to issues such as other parts of their load having very high interruption cost, and/or divisibility of their load being constrained, they might have to reduce their offers into the IR market. This is if they were required to supply 32% (or at least 26%) of their load for AUFLS as required under a common obligation approach.⁶² They may also be restricted from participation in other demand response products such as DD.
- C.92 The impact could be a reduction of as much as 25 to 60 MW at peak times if the standard code mechanisms were used, and 13-30MW under the common obligation approach with block co-ordination. This assumes:
- (a) commercial equivalence arrangements are not a viable option due to lack of incentives
 - (b) limitations in UoSAs
 - (c) there are no exemptions, dispensations or modified obligations.
- C.93 The marginal value of this lost IL is estimated to be between \$8/MWh (the average price of FIR & SIR reserves over the last 7 years) and \$14/MWh (the incremental cost of new capacity). This represents a national cost of \$0.6 to 6.3m/yr if it is assumed that IL supplied by the direct connects has a low interruption cost of, say, \$2/MWh.⁶³

⁶² Informal discussions with Norske Skog, Pan Pac, Winstones, and NZ Steel resulted in the estimates used in this analysis. The stakeholders indicated that to give ‘firmer’ estimates of the likely impact would require detailed engineering studies.

⁶³ Or \$3,600/MWh for each IL event assuming 10/yr lasting 0.5 hrs.

Table 13: Incremental reduction in IR/DR costs

		Common AUFLS percentage obligation				Varying AUFLS provision via optimisation	Voluntary AUFLS tender
		standard Code mechanisms	... + block coordination	... + special exclusions	... + profiled min/max oblig		
Low	MW	25	13	-	-	-	-
Mid	MW	45	23	-	-	-	-
High	MW	60	30	-	-	-	-
Incremental Benefit							
Low	\$k/yr	\$0	\$657	\$1,314	\$1,314	\$1,314	\$1,314
Mid	\$k/yr	\$0	\$1,774	\$3,548	\$3,548	\$3,548	\$3,548
High	\$k/yr	\$0	\$3,154	\$6,307	\$6,307	\$6,307	\$6,307
IL MW Marginal Value		\$/MWh					
Low Value		\$8					
Mid Value		\$11					
High Value		\$14					
Marginal Cost		\$2					

- C.94 This inefficient loss of IL could be largely avoided if:
- (a) lines companies were willing and able to provide commercial equivalence
 - (b) current exemptions were continued
 - (c) dispensations or special exclusions could be introduced
 - (d) the obligation was modified to account for IL offers.
- C.95 However, none of the options are considered to be particularly desirable or practicable. Plus, none deliver the reliability and other benefits provided by the optimisation approach.
- C.96 The optimisation and AUFLS market tender arrangements will not result in any inefficient reduction of IL supply from direct connects.
- C.97 Note that this is not an issue with lines companies under the optimisation approach. Estimates of the IL behind each lines company feeder is taken into account by the optimisation and not counted towards AUFLS. This means lines companies will not need to remove any IL from feeders, even if they are required to provide AUFLS.

Q20. Do you have any other comments on the CBA?

Appendix D Technical requirements schedule – discussion and indicative example

- D.1 The Authority's proposed Code amendment requires the System Operator to publish an extended reserves technical requirements schedule (ERTRS) under clause 8.54B. To enable better understanding of the Authority's proposed Code amendment, an example of a possible extended reserves technical requirement schedule has been prepared. It should be noted that the contents of this schedule are draft and still in development. As the purpose for inclusion of the draft here is to provide an example, it is not the intention to consult on the content of the ERTS at this time as it is subject to change. There will be an opportunity to consult on the detail of the ERTS at a later stage of the extended reserves process.
- D.2 In principle the purpose of the technical requirement schedule is to set out the technical specification of extended reserves (which currently only relates to AUFLS) required by the system operator.
- D.3 The technical requirements schedule example outlines requirements for participants (such as the setting and testing requirements) and will be taken from the TRS and included in any terms and conditions which may be issued to individual participants as part of their statement of extended reserves obligation. Several of the requirements which were previously stated in the Code (Part 8, Technical Code B, Clause 7 (6)) are now included in the TRS.
- D.4 The technical requirements schedule example included here is based on the AUFLS scheme design report published in August 2013 and which is available on the system operator's website.⁶⁴ The system operator will consult directly with industry (in the near future) on the contents of a draft technical requirement schedule to ensure the requirements are achievable.
- D.5 The Code amendment being consulted on is drafted with the notion that the technical requirement schedule and the selection methodology would be developed sequentially. That is, the technical requirement schedule being published first followed by the publication of a selection methodology that has been developed to deliver the technical requirements. In practice however the system operator is of the view that it will need to work closely with the extended reserves manager before the publishing any schedule. Close collaboration will be required to ensure the outcome of the selection methodology delivers the technical requirements.

⁶⁴ <http://www.systemoperator.co.nz/aufls>

Indicative example of technical requirements schedule⁶⁵

This is the extended reserve technical requirements schedule, published by the system operator under clause 8.54D of the Electricity Industry Participation Code 2010 on [insert date]. It reflects the system operator's analysis of the technical requirements for extended reserves which is set out in the extended reserve technical requirements report is based.

The purpose of this schedule is to set out the technical specifications for extended reserves that the system operator requires in order to be able to comply with the principal performance obligations set out in Part 7 of the Code. It also specifies requirements for periodic testing of assets required to carry out extended reserves services.

X

[signature, name, position]

Interpretation

1. In this schedule, unless the context otherwise requires,—

automatic under-frequency load shedding (AUFLS) means **demand** which is automatically disconnected when frequency falls below the relevant preset frequencies specified in clause 9

AUFLS region means a group of **connection locations**, AUFLS regions are specified in Appendix A

AUFLS requirement means, for an **AUFLS region**, the total amount of **demand** that must be able to be disconnected by the operation of all **automatic under-frequency load shedding** systems in the **AUFLS region**, expressed as a percentage of pre-event **demand**, as set by the **system operator**

AUFLS scheme means, for an **AUFLS region**, the settings including **demand** blocks making up the **AUFLS requirement**, relay settings, and response times, as set by the **system operator** in accordance with the **policy statement**

⁶⁵ The contents of this schedule are draft and subject to change. The values provided here are to indicate the nature of the requirements. Note this version has not received legal review, so the quality of drafting should be regarded accordingly.

AUFLS system means assets used to automatically respond to an under-frequency event and accomplish the disconnection of demand in order to meet the requirements of the **AUFLS scheme**

calculated frequency means the value of frequency that results from the filtering or calculation method employed by most frequency relays to address the effects of voltage waveform distortion on the **instantaneous frequency**

extended reserves technical requirements report means the report **published** by the **system operator** under clause 8.54D on [insert date]

guard frequency means a frequency setpoint above which frequency relay functions are inhibited

hold delay means a timer used for the purpose of delaying the propagation of a trip signal following the activation of the **under-frequency element** in a frequency relay. Time delays are usually set in terms of 'seconds', however some relays use 'cycles' to specify a delay

instantaneous frequency is the actual frequency derived from a voltage waveform at any given time

rate of change of frequency means the rate, measured in Hz/s, at which frequency is changing

set point means a user-adjustable setting at which a frequency relay will detect that an event has occurred, as applied to any frequency relay function, including under-frequency and rate of change of frequency

under-frequency element means an internal signal inside a frequency relay that is activated when the **set point** has been breached.

Mechanisms available for provision of extended reserve

2. As specified in the **extended reserve technical requirements report** the mechanism identified by the **system operator** as being the most appropriate for the provision of **extended reserve** is **automatic under-frequency load shedding**.

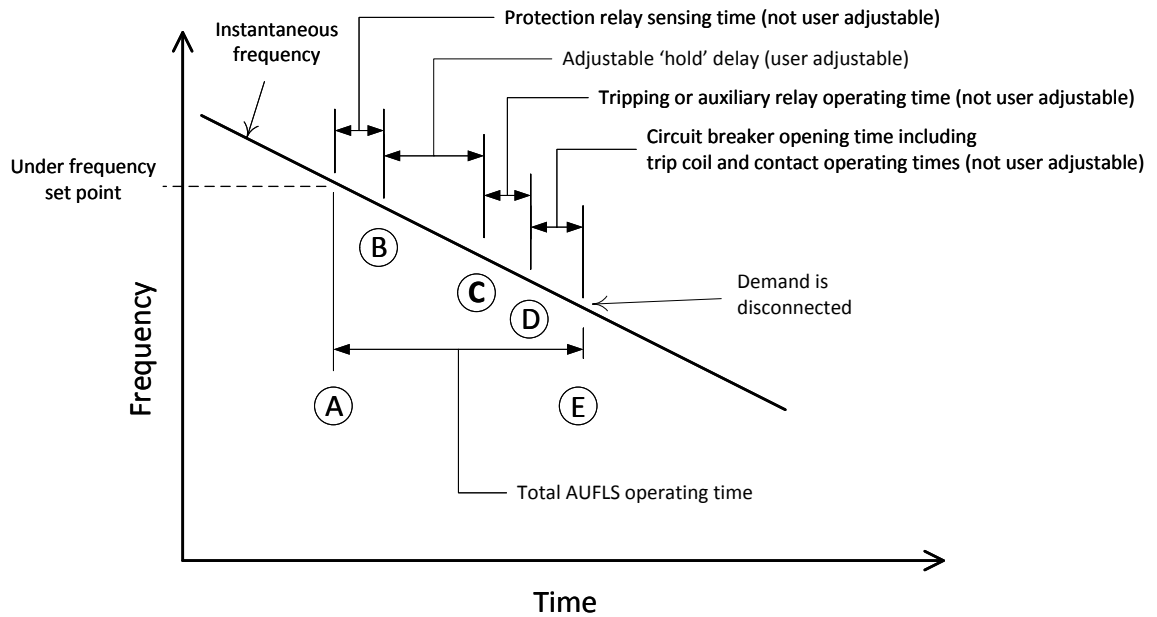
AUFLS requirement and AUFLS scheme design

3. Each **AUFLS region** must comply with the automatic under-frequency load shedding system requirements set out in **AUFLS requirement** and **AUFLS scheme**.
4. The **AUFLS requirement** to be provided at all times in each **AUFLS region** is as follows—
 - (a) in AUFLS Region 1, 2, and 3;

- (i) a target level of 32% of total pre-event **demand**;
 - (ii) a minimum of 28% of total pre-event **demand**;
 - (iii) a maximum of [#]% of total pre-event **demand**;
5. The **AUFLS scheme** to be provided in AUFLS Region 1, 2, and 3 must consist of the automatic disconnection of 4 blocks of demand sized as follows—
- (a) block 1 being a percentage of the total **pre-event demand** in the **AUFLS region** with—
 - (i) target level of 10%;
 - (ii) minimum of 9%;
 - (iii) maximum of [#]%;
 - (b) block 2 being a percentage of the total **pre-event demand** in the **AUFLS region** with—
 - (i) target level of 10%;
 - (ii) minimum of 9%;
 - (iii) maximum of [#]%;
 - (c) block 3 being a percentage of the total **pre-event demand** in the **AUFLS region** with—
 - (iv) target level of 6%;
 - (v) minimum of 5%;
 - (vi) maximum of [#]%;
 - (d) block 4 being a percentage of the total **pre-event demand** in the **AUFLS region** with—
 - (vii) target level of 6%;
 - (viii) minimum of 5%;
 - (ix) maximum of [#]%.
 - 6. The **AUFLS system** must disconnect demand-
 - (a) for the primary under-frequency settings set out in clauses 7 to 9 within 400ms of either the **instantaneous frequency** or the **rate of change of frequency** reaching the **set points** (A to E in figure 1); and

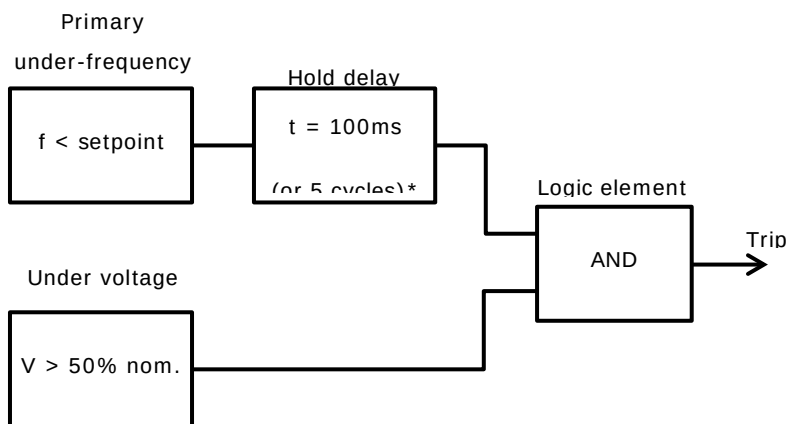
- (b) for the secondary under-frequency settings set out in clauses 7 to 9 within 15s of the **instantaneous frequency** reaching the **set points** (A to E in figure 1); and
- (c) in accordance with the setting requirements outlined in clause 7.

Figure 10: Under-frequency trip timing diagram (typical)



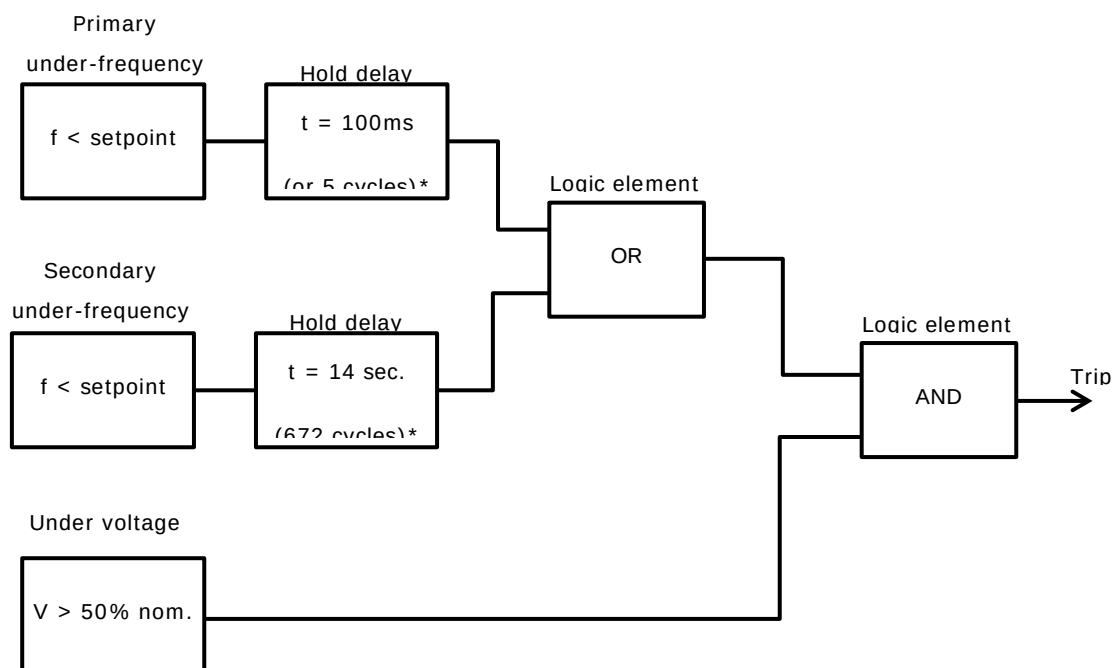
7. The relays used to provide the **AUFLS scheme** must send a trip signal to disconnect demand—
- (a) for the primary and secondary frequency settings specified in clause 9 and —
 - (i) when the **calculated frequency** has remained below the frequency **set point** for the duration of the **hold delay**; and
 - (ii) the **under-voltage element** remains greater than 50% of nominal system voltage

Figure 11: Logic diagram for block 1



* This is included for relays that use 'cycles' instead of seconds for their timers.

Figure 12: Logic diagram for blocks 2 and 3

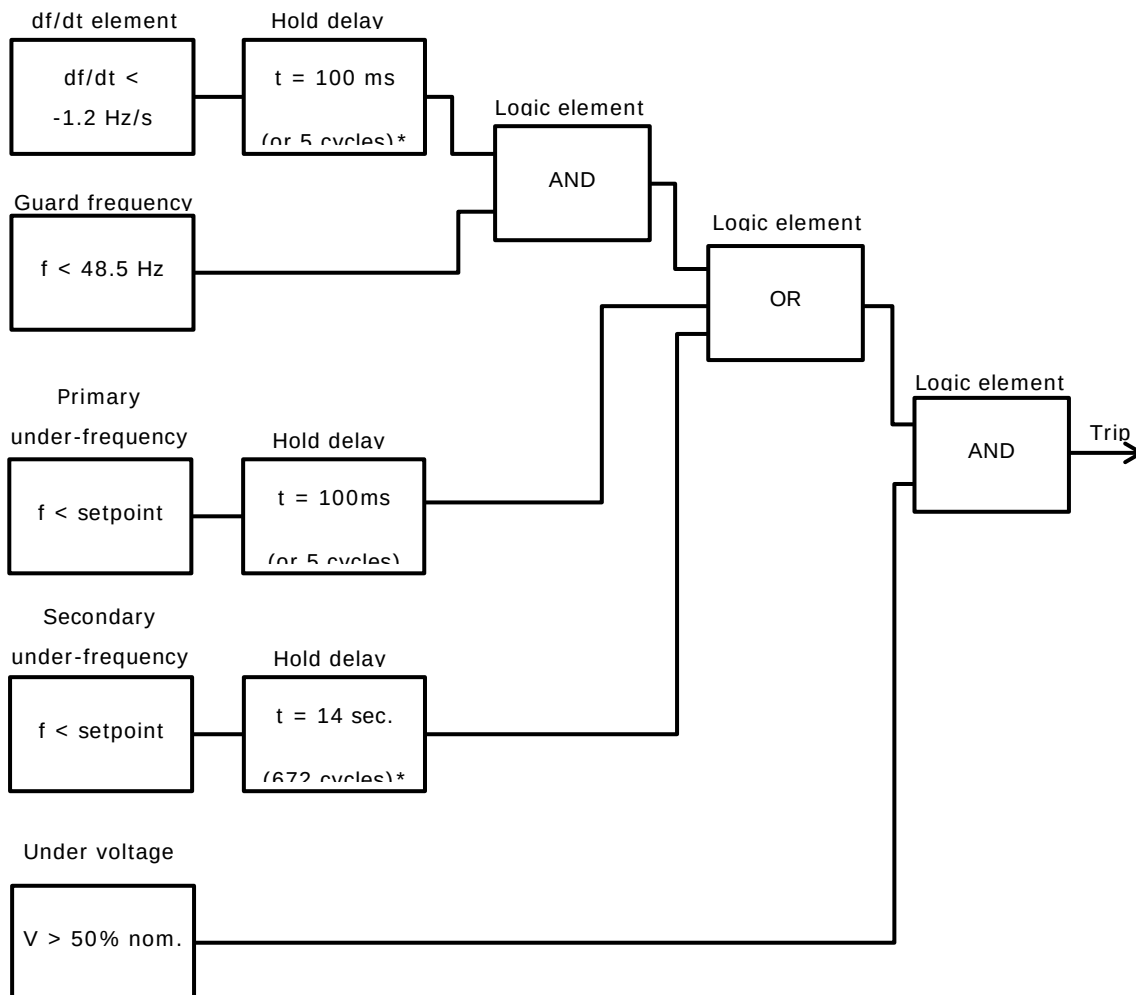


* This is included for relays that use 'cycles' instead of seconds for their timers.

for the rate of change of frequency setting specified in clause 9—

- (iii) when the **calculated rate of change of frequency** has remained below the rate of change of frequency **set point** for the duration of the **hold delay**; and
- (iv) the **calculated frequency** is less than the **guard frequency set point**; and
- (v) the **under-voltage element** remains greater than 50% of nominal system voltage;

Figure 13: Logic diagram for rate of change of frequency setting



* This is included for relays that use 'cycles' instead of seconds for their timers.

8. The relays used to provide the AUFLS scheme in accordance with clauses 6, 7, and 9 must set the hold delay with the value specified in—
 - (a) milliseconds where the relay uses seconds to set its timers; or
 - (b) cycles where the relay uses cycles to set its timers.

9. The relays used to provide the **AUFLS scheme** in AUFLS Regions 1, 2, and 3 must be set as follows:
 - (a) for block 1,—
 - (i) with a primary frequency setting which includes
 - (1) a **set point** of 47.9 Hertz; and
 - (2) a **hold delay** of 100 ms or 5 cycles:
 - (b) for block 2,—
 - (i) with a primary frequency setting that includes—
 - (1) a **set point** of 47.7 Hertz; and
 - (2) a **hold delay** of 100 ms or 5 cycles; and
 - (ii) with a secondary frequency setting that includes—
 - (1) a **set point** of 47.9 Hertz; and
 - (2) a **hold delay** of 14 s or 672 cycles:
 - (c) for block 3,—
 - (i) with a primary frequency setting that includes—
 - (1) a **set point** of 47.5 Hertz; and
 - (2) a **hold delay** of 100 ms or 5 cycles; and
 - (ii) with a secondary frequency setting that includes—
 - (1) a **set point** of 47.7 Hertz; and
 - (2) a **hold delay** of 14 s or 672 cycles:
 - (d) for block 4,—
 - (i) with a primary frequency setting that includes—
 - (1) a **set point** of 47.3 Hertz; and

- (2) a **hold delay** of 100 ms or 5 cycles; and
- (ii) with a secondary frequency setting that includes—
 - (1) a **set point** of 47.5 Hertz; and
 - (2) a **hold delay** of 14 s or 672 cycles; and
- (iii) with a rate of change of frequency setting that includes—
 - (1) a **set point** of -1.2 Hertz; and
 - (2) a **hold delay** of 100ms or 5 cycles; and
 - (3) a **guard frequency** of 48.5 Hertz.

Table 14: AUFLS Regions 1, 2, and 3 Scheme Design Requirements

				Primary freq. setting		Secondary freq. setting		Rate of Change of Frequency setting		
<u>Block</u>	<u>Target Size</u>	<u>Min Size</u>	<u>Max Size</u>	<u>Set Point (Hz)</u>	<u>Hold delay (ms / cycles)</u>	<u>Set Point (Hz)</u>	<u>Hold delay (s / cycles)</u>	<u>Set Point (Hz/s)</u>	<u>Freq Guard (Hz)</u>	<u>Hold delay (ms / cycles)</u>
<u>1</u>	<u>10%</u>	<u>9%</u>	<u>11%</u>	<u>47.9</u>	<u>100 / 5</u>	=	=	=	=	=
<u>2</u>	<u>10%</u>	<u>9%</u>	<u>11%</u>	<u>47.7</u>	<u>100 / 5</u>	<u>47.9</u>	<u>14 / 672</u>	=	=	=
<u>3</u>	<u>6%</u>	<u>5%</u>	<u>7%</u>	<u>47.5</u>	<u>100 / 5</u>	<u>47.7</u>	<u>14 / 672</u>	=	=	=
<u>4</u>	<u>6%</u>	<u>5%</u>	<u>7%</u>	<u>47.3</u>	<u>100 / 5</u>	<u>47.5</u>	<u>14 / 672</u>	<u>-1.2</u>	<u>48.5</u>	<u>100 / 5</u>

10. Each **extended reserve provider** must arm its **AUFLS system** at all times in accordance with clause 7(1) of Technical Code B unless otherwise agreed in writing with the **system operator**.
11. Each **extended reserve provider** providing an **AUFLS system** must use reasonable endeavours to ensure that at all times its **AUFLS systems** are maintained in accordance with clauses 6 to 9.
12. If, at any time, an **extended reserve provider** believes that an **AUFLS system** may not be capable of meeting the requirements of clauses 6 to 9, it must notify the **system operator** as soon practicable and provide any information that the **system operator** requests.
13. Each **extended reserve provider** providing an **AUFLS system** in accordance with clauses 6, 7, 8, and 9 must provide demand profile information to the system operator—
 - (a) in an updated **asset capability statement** at least once a year; or
 - (b) when requested by the **system operator**.
14. The information required under clause 13 must be in a form that enables the **system operator** to make a reasonable assessment of the total amount of demand available to be disconnected if **automatic under-frequency load shedding** blocks operate in accordance with clauses 6, 7, 8, and 9.
15. Any **interruptible load** provided within an **automatic under-frequency load shedding** block must not be counted toward the provision of the **AUFLS scheme** specified in clause 5.
16. Any **embedded generating station** with a capacity of greater than 1 MW connected to a distributor's local network must be included where available within the information provided under clause 13.
17. When calculating offtake, **extended reserve providers** (where the information has been made available) should use gross offtake which excludes any injection from an embedded generating station with a capacity greater than 1 MW connected to the extended reserve provider's local network.
18. On the operation of an **AUFLS system**, the relevant **extended reserve provider** must act in accordance with clause 7B of technical Code B. —

Periodic testing of assets

19. Each **extended reserve provider** selected to provide an **AUFLS system** with new frequency settings or rate of change of frequency settings must—
 - (a) test the operation of its **AUFLS system** in accordance with their implementation plans; and
 - (b) based on the test carried out in accordance with paragraph (a) provide a verified set of trip settings and time to disconnect demand in accordance with clauses 6, 7, 8, and 9 in an updated asset capability statement within 40 business days of the completion of each such test.
20. Each **extended reserve provider** selected to continue to provide an **AUFLS system** with frequency or rate of change of frequency settings must—
 - (a) test the operation of its **AUFLS system** if the test records supplied in its asset capability statement are no longer valid. Test results remain valid for -
 - (i) 5 years from the test date for analogue and non-self-monitoring digital **AUFLS system**; and
 - (ii) 10 years from the test date for self-monitoring digital protection **AUFLS system**
 - (b) based on the test carried out in accordance with paragraph (a), provide a verified set of trip settings and time delays to the **system operator** in an updated **asset capability statement** within 40 business days of the completion of each such test.
21. If a new relay is installed that will provide an **AUFLS system** with frequency or rate of change of frequency settings the **extended reserve provider** must—
 - (a) test the operation of its **AUFLS system**; and
 - (b) based on the test carried out in accordance with paragraph (a), provide a verified set of trip settings and time to disconnect demand in accordance with clauses 6, 7, 8, and 9 in an updated asset capability statement within 40 business days of the completion of each such test.
22. Testing guidelines are available on the **system operator** website to provide guidance on setting and testing relays.

Relay Specifications

23. The relays used to provide rate of change of frequency detection as specified clauses 6, 7, 8, and 9 must have—

- (a) at least 1 rate of change of frequency element; and
- (b) a setting range that is capable of being set between -1 to -2.0 Hertz/second; and
- (c) a setting resolution of at least 0.1 Hertz/second; and
- (d) an adjustable time delay of 0 to 500 ms; and
- (e) customizable logic capable of achieving the settings specified in clauses 6, 7, 8, and 9; and
- (f) capability to remote enable/disable the rate of change of frequency element without the need for expert technical assistance.

Appendix A – Regions

North Island

AUFLS region 1 comprises the following **grid exit points**:

<u>Code</u>	<u>Name</u>
ALB	Albany
BOB	Bombay
BRB	Bream Bay
DAR	Dargaville
GLN	Glenbrook
HEN	Henderson
HEP	Hepburn Rd
HOB	Hobson St
HPI	Huapai
KEN	Kensington
MNG	Mangere
MPE	Maungatapere
MTO	Maungaturoto
ROS	Mt Roskill
OTA	Otahuhu
PAK	Pakuranga
PEN	Penrose
SVL	Silverdale
TAK	Takanini
WRD	Wairau Rd
WEL	Wellsford
WIR	Wiri

AUFLS region 2 comprises the following **grid exit points**:

<u>Code</u>	<u>Name</u>
CBG	Cambridge
EDG	Edgecumbe
FHL	Fernhill
GIS	Gisborne
HAM	Hamilton
HTI	Hangatiki
HIN	Hinuera
HLY	Huntly
KMO	Kaitimako
KAW	Kawaerau
KIN	Kinleith
KPU	Kopu
LFD	Lichfield
MTM	Mt Maunganui
NPK	National Park
OKN	Ohakune
ONG	Ongarue
OWH	Owhata
PAO	Piako
RDF	Redclyffe
ROT	Rotorua
TRK	Tarukenga
TGA	Tauranga
TMU	Te Awamutu

TKH	Te Kaha
TKH	Te Kowhai
TMI	Te Matai
TKU	Tokaanu
TOB	Tokomaru Bay
WHU	Waihou
WKO	Waikino
WAI	Waiotahi
WRA	Wairora
WTU	Whakatu

AUFLS region 3 comprises the following **grid exit points**:

<u>Code</u>	<u>Name</u>
BRK	Brunswick
BPE	Bunnythorpe
CST	Carrington St
CPK	Central Park
DVK	Dannevirke
GFD	Gracefield
GYT	Greytown
HWA	Hawera
HAY	Haywards
HUI	Huirangi
KWA	Kaiwharawhara
LTN	Linton
MGM	Mangamaire
MTN	Marton
MST	Masterton
MTR	Mataroa
MLG	Melling
MNI	Motunui
OPK	Opunake
PRM	Paraparaumu
PNI	Pauatahanui
TKR	Takup Rd
TNG	Tangiwai
TMN	Tauramarunui

UHT	Upper Hutt
WPW	Waipawa
WGN	Wanganui
WVY	Waverly
WIL	Wilton
WDV	Woodville

Appendix E Selection methodology – description and indicative example

Introduction

- E.1 This appendix provides a description of the indicative **extended reserves selection methodology** document set out later in this Appendix.
- E.2 The methodology specifies the following:
 - (a) the participants required to provide information
 - (b) the timeframes for providing the information
 - (c) the information each participant must provide
 - (d) the selection methodology to be used
 - (e) the default terms and conditions
 - (f) the payments mechanism.
- E.3 An overview of the high level design is provided in paragraph 3.2.5. This appendix provides further detail on the design of the methodology.
- E.4 The indicative selection methodology is based on a current working position for each implementation detail, however these will be subject to on-going development work, including through discussions with industry stakeholders, and that there will be further formal consultation with industry on these aspects of the arrangements.

Technical requirements schedule

- E.5 This indicative methodology is based on the indicative technical schedule outlined in Appendix D , which outlines the details of the AUFLS scheme design including the technical specifications and the overall AUFLS requirements in each region in the North Island.

Participants

- E.6 The methodology covers distributors (which are defined in the code to cover lines companies and direct customers) in the North Island.
- E.7 For reasons set out in section 5.10, it is not proposed to change the arrangements in the South Island at this time, and so this appendix only considers the methodology for the North Island.

Extended reserves demand units

- E.8 It is proposed that information be provided for existing and potential extended reserve demand units (ER demand units).⁶⁶ AUFLS is a component of ER demand units. An AUFLS demand unit is a block of demand that can or could be automatically disconnected. Typically for a lines company this would be a feeder at a zone sub-station, however, it may be a group of feeders or a whole GXP depending on the situation of the network configuration. This is because it is important that the AUFLS demand unit is actually disconnected when the relay operates and not automatically replaced by other load as a result of loop automation or other network control systems that may mean that some feeders at a zone sub cannot be dropped independently of other feeders.
- E.9 The appropriate demand unit for a direct connect industrial consumer will depend on the configuration of its industrial site, and which major groups of load can be dropped independently.
- E.10 An existing AUFLS demand unit will already have a load disconnection system, but a potential AUFLS demand unit needs to be capable of having such a system installed. Information on existing ER demand units selected in a previous process (including those armed by distributors to meet the old obligation requirements specified in the Code), will be required for each new selection process so that the cost of changing the selection can be assessed, and to ensure a managed implementation from old settings to new settings. For the initial selection it is proposed that distributors are required to provide information on all demand units that are currently used for AUFLS (as at a specified date) unless they can't be retained as a result of intended network reconfiguration.
- E.11 These individual ER demand units are used in the selection process, the statement of obligation and the payments system.
- E.12 Distributors (i.e. lines companies and direct connects) are best placed to define the ER demand units, taking into account their own individual situations, and a mechanism is provided to deal with changes in these ER demand units as a result of normal network operations and investments.
- E.13 It is necessary that distributors provide information on a sufficient number of ER demand units to enable the technical requirement of the AUFLS scheme to be met in each AUFLS region, however it is recognised that it is costly to provide information and that some demand units are unsuitable for AUFLS and are unlikely to be selected. To account for this it is proposed that distributors are only required to provide information on ER demand units covering at least 60% of their load. For ease of compliance

⁶⁶ ER demand units are referred as AUFLS feeders elsewhere in this report.

assessment, this obligation is assessed on the basis of historical annual data for ER demand units and total metered offtake.

- E.14 These arrangements provide distributors with a degree of discretion to, for example, define a group of feeders as a demand unit if it is likely that future network re-configuration will result in such feeders needing to be interrupted as a contiguous group for AUFLS purposes.
- E.15 Note that there is no need to exclude whole demand units which contain customers that are offering IL as the selection methodology will automatically account for this based on information provided on the estimated percentage of load offering this service.
- E.16 Nor is there a need to exclude demand units which are currently assigned to rolling outages as discussed in E.50 below.
- E.17 It is not currently proposed to limit distributors' discretion in the definition of ER demand units, however this may be necessary if the exercise of discretion produces insufficient ER demand units to enable the design of the scheme and performance requirements to be met.

Information required for each AUFLS demand unit

- E.18 The information required for the selection process is the same technical and load profile information required for the ex-ante compliance approach that would apply under any procurement option, plus additional information related to expected interruption costs and other specific information relating to enhanced AUFLS services (e.g. flexible AUFLS supply, faster relay response, remote monitoring / programming / arming).

Load Profile data

- E.19 Even though information is used to select future AUFLS supply, it is proposed that profile information be based on historical data for reasons of simplicity and objectivity.
- E.20 Historical data only needs to be adjusted where a distributor has knowledge of a major [>50%] change that is expected within the following year.
- E.21 It is proposed that a full year's worth of historical half hourly data be provided where this is possible. This allows the selection methodology and security assessment to account for the differing profiles, correlations and variability of each AUFLS demand unit. It is recognised that revenue quality data may not be available and so SCADA data is acceptable provided that periods of missing or clearly erroneous data is identified. It is possible that data may not be available for all the ER demand units. In this case estimates will be acceptable provided that the estimation approach follows guidelines set out by the system operator. One approach may be

to use a profile from another relevant AUFLS demand unit or GXP and scale this appropriately.

- E.22 Despite inherent load variability and uncertainty, this approach of considering historical demand is considered to deliver target AUFLS load requirements to within good statistical levels of confidence given the diversity associated with the many hundreds of individual feeders. Indeed, needing to address the inherent load variability and uncertainty, and the ability to take advantage of the diversity benefits of lots of feeders, is one of the main drivers behind the proposed selection approach in that it is considered able to deliver the target level of AUFLS to higher confidence levels than other approaches considered to-date.

Alternative demand (only IL currently)

- E.23 At this stage only IL is accounted for explicitly. This may be expanded to include other forms of demand response in future selection processes once data availability and other issues are addressed.
- E.24 It is recognised that detailed information on the level of IL within each AUFLS demand unit may not be directly available initially. To account for this the requirement is to provide a reasonable estimate of the average percentage of load within the AUFLS demand unit that is offered as IL. To account for the fact that IL offers vary over the day and year it is proposed that separate estimates be provided for each of a number of time zones (e.g. winter, summer, day, night). If data is not available or if the % does not vary significantly then the same estimate can be applied to each time zone. Where possible, this estimate should be based on historical offer data for the previous year, otherwise a reasonable estimate is required (e.g. based on the offers at the GXP level).
- E.25 Code amendments are proposed that will place a requirement on providers of IL to provide information to the lines company about IL within the lines company's network.
- E.26 An alternative approach would be for the information on IL to be obtained from the ancillary services market administrator directly, rather than via the distributor. This could be achieved by requiring parties to provide information on location (e.g. GXP) of IL offers⁶⁷. This would match the requirement for energy offers, and would enable the IL offer data by GXP to be obtained. Large single site IL providers (greater than [#] MW) could be required to provide an AUFLS demand unit id number (obtained from its network company). IL aggregators and/or lines companies could be required to provide estimated factors to allocate the total GXP IL offer to each feeder supplied from the GXP. This information could then be used

⁶⁷ Currently IL offered by a load aggregator is often offered at a notional island node, rather than for a specified GXP.

to derive estimates of IL offers by AUFLS demand unit without further input from the distributor. However, other than for very large single sites, it may not be necessary to require this level of detail, and a simple pro-rata apportioning approach undertaken within the selection methodology itself may be appropriate. This will be the subject for further design consideration in conjunction with stakeholders.

Expected interruption cost information

- E.27 The proposed approach to deriving expected interruption costs for lines companies is to base these on a load weighted average of generic interruption costs for a number of individual customer groups. This ensures a consistent approach across lines companies.
- E.28 For this purpose it is proposed that costs be based on a standard 2hour outage, which could occur at any time without warning, expressed in \$/MWh of load disconnected.
- E.29 Direct consumers will provide their own estimates of this expected interruption cost.
- E.30 Other large users greater than 25 GWh per annum which are within a lines company's network will be given the opportunity to provide their own estimates of expected interruption costs and load to their network company.
- E.31 Lines companies will provide estimates of load shares by customer class by AUFLS demand unit. The indicative methodology includes 5 different customer classes, including a public health and safety group. Some of these load share estimates may already be available from the exercise lines companies will have undertaken to develop their participant rolling outage plans. The groupings may need to be changed or reduced, depending on the difficulty of obtaining reasonable estimates. This will be the subject for further design consideration in conjunction with stakeholders.
- E.32 The generic interruption costs for each customer groups will be provided as a schedule to the methodology. These will be based on the available information at the time the methodology is published and consulted on. It is intended that the Authority will be the party responsible for producing this schedule of interruption costs.
- E.33 The expected interruption cost for each lines company demand unit will simply be the load share weighted average over each of the generic customer classes plus the load share weighted contribution from any large user who has provided their own estimate.
- E.34 It is recognised that assessment of generic interruption costs is difficult and contentious. However the main requirement is for a consistent

approach to establish *relative* values, and a complex high cost approach to estimation can't be justified given the inherent uncertainties.

- E.35 It should be noted that the approach described above is just one of several viable alternatives including:
- (a) using more or less or different customer classes (e.g. the priority customer groupings used for rolling outage planning)
 - (b) using regionally varying generic interruption costs
 - (c) varying the "large user" threshold from [25] GWh per annum, up or down, or limit the right to provide their own estimates unless that they arrange to be allocated their share of the load interruption payments and cost allocation with their local network.
 - (d) using the rankings currently used for participant rolling outage plans (PROPs) to more simply derive a relative interruption cost measure.⁶⁸
- E.36 These viable alternatives will need to be considered when the selection methodology is consulted on.

Information relating to enhanced services

- E.37 The methodology includes the use of some enhanced AUFLS services including:
- (a) flexible AUFLS – which includes AUFLS which can be armed or disarmed at short [7 days] notice from the system operator. A flexible AUFLS demand unit which is not currently armed is deemed to be on 'standby'
 - (b) fast relay response capability – this includes relays (and associated circuit breakers) which can operate at 250ms rather than the minimum required 400ms.
- E.38 It is proposed that there be a pre-specified compensation payment for parties offering a flexible service. However it is recognised that it may be very costly or impractical for parties to provide a flexible service on all offered ER demand units. To account for this, parties are required to indicate if they can demonstrate that it is impractical to provide a flexible service, or if there are additional costs beyond the standard compensation rate.

⁶⁸ This could be based on assigning an interruption cost ranking (relative to residential) for each of the 6 priority customer classes. Each participant would then assign an interruption cost ranking to each AUFLS feeder (this would be set at the discretion of the participant, but ideally derived as the load share weighted average over the customer classes of the standard rankings). The interruption cost for each feeder could then be set equal to this ranking multiplied by a standard generic interruption cost for residential customers.

- E.39 Is also proposed that there be a pre-specified compensation payment for fast response relays. Parties will be required to indicate if they can demonstrate this additional capability and hence be eligible for the additional payment.
- E.40 Additional enhanced services may be selected in the future, for example:
- (a) dynamic AUFLS – flexible AUFLS which can be armed or disarmed at very short notice
 - (b) profiled AUFLS – AUFLS which can be programmed to be armed according to a pre-set rule (e.g. for a particular time zone only)
 - (c) remote monitoring – the provision of “real time” data for ER demand units.

Provider Obligations

- E.41 Once a participant has had an AUFLS demand unit selected or de-selected for service then it will be required to agree on a commencement or cessation date with the system operator.
- E.42 Participants will be subject to a number of default terms and conditions for all selected ER demand units.
- E.43 These cover technical and testing requirements and post AUFLS event obligations, as well as on-going information requirements, and conditions about how to address situations when a provider deems that an AUFLS demand unit is no longer suitable to be armed for AUFLS. They also set out the requirements on flexible providers to be able to arm or disarm as instructed by the system operator within a specified notice period.

Approach

- E.44 The general approach to provider terms and conditions is based on the fact that the selection methodology acknowledges that demands will vary over the year and into the future and that this variation has been taken into account in the selection process so as to provide the required confidence level that the AUFLS supply is within the required minimum and maximum levels based on historical data. The methodology also provides additional standby flexible AUFLS supply to deal with changes in circumstances over the following 5 years.
- E.45 In light of this there is no expectation that providers will be responsible for future variations in the net load on each selected AUFLS demand unit. Their responsibility is limited to ensuring that the load disconnection systems are installed, configured, tested and maintained as instructed so they can be relied on operating as required in an AUFLS event, and updating information.

Variations in obligations

- E.46 Although the obligations are specific to individual selected ER demand units, it is recognised that providers may have temporary outages or permanent network reconfigurations which significantly impact a particular AUFLS demand unit. This is accounted for by requiring providers to notify such changes (subject to de-minimis thresholds in terms of MW affected and duration) to the system operator when they occur.
- E.47 They then have the opportunity to provide reasonable replacement ER demand units.⁶⁹ If these are provided on a permanent basis then the system operator will adjust the central register of obligations to include the replacement demand units and to deactivate the replaced AUFLS demand unit. The default terms and conditions for replacement demand units will commence⁷⁰ once the replacement AUFLS demand unit is armed.
- E.48 If a provider notifies that it is not able to provide a reasonable replacement on a permanent basis then the system operator will update the central register of obligations to de-select the affected AUFLS demand unit. This will be notified to the Clearing Manager and result in payments to that provider ceasing.
- E.49 A provider is also required to notify the system operator if it believes that an AUFLS relay may not be capable of meeting the relevant technical requirements. In this case it must provide information to the system operator. If the provider can't demonstrate that the potential problem has been fixed, and a reasonable replacement has not been provided then the AUFLS demand unit will be de-selected.

Obligations during rolling outages

- E.50 The other significant issue relates to obligations during rolling outages.
- E.51 It is proposed that the only limitation placed on the use of selected ER demand units for rolling outages, is that this be such that the % savings targeted from all selected and armed ER demand units be not greater than that from other feeders in each AUFLS region. For example if there was a call for 20% saving from rolling outages in a particular period then the participant could include up to 20% of its ER demand units its rolling outage plan. This, combined with the ability to exclude up to 40% of load from the selection process should enable distributors to simultaneously meet both their AUFLS and their PROP obligations.
- E.52 There is no need for providers to completely exclude selected ER demand units from its rolling outage plans.

⁶⁹ Possibly including other selected AUFLS demand units which are providing a standby flexible service, but have not yet been armed.

⁷⁰ If they are not in place already.

- E.53 It is also proposed that providers are able to agree with the system operator to temporarily substitute some armed selected ER demand units with reasonable replacements during a rolling outage. This may enable a provider (with un-armed flexible capability) to lower the cost of rolling outages without affecting their AUFLS obligations.

On-going information obligations

- E.54 Although a provider is not responsible for the load on each selected AUFLS demand unit, it is required to provide:
- (a) updated load profile and IL information⁷¹ at least once a year
 - (b) other information reasonably requested by the system operator
 - (c) notice of any reasonable expected permanent change in average net load greater than [50] MW or [50%] that may affect selected ER demand units
 - (d) these de minimus thresholds may be varied, but are designed to avoid the need to provide information in situations where the impact on overall system security is negligible.

Alternative approach to obligations

- E.55 The approach to obligations outlined above is based on individual obligations in regard to each selected AUFLS demand unit.
- E.56 It is possible to adopt an alternative approach which takes the results from the selection and determines an aggregate obligation for each provider expressed as an overall % obligation on *parties* rather than specific demand units.
- E.57 This approach would still take advantage of the central optimisation approach to determine the relative suitability of parties to provide AUFLS and set varying obligations accordingly, but it may provide more discretion for each participant to accommodate such things as future network changes.
- E.58 However, it may not to be significantly different from the approach above in an administrative sense, given that the system operator is likely, under its ex-ante compliance approach, to require information on which individual ER demand units are available or armed, in order to monitor compliance and to assess security.

⁷¹ Noting that this information might be made available by the ancillary services administrator if the alternative approach to IL information provision was adopted.

Payments

E.59 The current proposal is for there to be a number of separate categories of payments (\$/yr) for each selected AUFLS demand unit:

Standard Payments – for minimum service

- (a) Relay Operating Payment – a standard value if selected.
- (b) Demand Unit Interruption Payment – an individual value expected interruption cost multiplied by the expected hours of interruption for the AUFLS block that the AUFLS demand unit is allocated to, if selected.
 - (i) for simplicity of settlements this assumes that the same load interruption payment is made each month for all selected demand units
 - (ii) a viable alternative approach would be to limit this payment to exclude flexible demand units which were not armed in the relevant payment month.
- (c) Relay Capital Payment – a payment that recovers cost of installing, configuring and testing a relay over 5 years, as directly required as a result of selection, based on a standard schedule of capital cost items:
 - (i) the capital recovery payment currently calculated using an annuity formula which accounts for a return on capital. It would be possible to adopt a simpler approach which simply recovered 1/5 of the capital cost each year
 - (ii) it is currently proposed that there be a terminal payment if a new selection process was run before a full 5 years of capital payments was made, so as to avoid the risk of stranded assets.
 - (iii) this need for a terminal payment could be avoided if the capital payment was made as a lump sum, however this would result in very high AUFLS costs during the implementation phase of the new AUFLS scheme
 - (iv) a viable alternative approach would be to provide a simple capital annuity that recovered the capital cost over, say 10-15 years, and not attempt to address issues related to the “stranding” of capex in the situation where a AUFLS demand unit was selected in one process (and as a result incurred capital costs), but was not selected in the subsequent selection process.

Enhanced Service Payments

- (a) Relay Flexibility Payment - a standard value + an individual additional cost, if selected as flexible.
- (b) Relay Fast Response Payment – a standard value if selected and the relay (and circuit breaker) can respond within 250ms.

- E.60 Note that payments for enhanced services would be based on a share of the estimated system-wide benefit of providing the enhanced service.
- E.61 Other enhanced service payments might be introduced in the future.
- E.62 It is proposed that monthly payments be calculated on the basis of information used in the selection process and that these be fixed for each selected AUFLS demand unit (i.e. not changed until the next selection process is run).
- E.63 These payments would be made each month from the commencement of service until the cessation date in the participant's implementation plan, unless the AUFLS unit was out of service and a reasonable replacement was not provided.
- E.64 This approach was adopted to avoid the complexity of adjusting payments during the 5 year period, but it would be possible to have the payments adjusted on an annual basis on the basis of updated information on historical load and proportion of load used for IL, or when there was a significant change (e.g. if a network was reconfigured).
- E.65 Note that the indicative methodology has a number of different capital cost elements; these could be aggregated or eliminated if they are not considered to be significant.
- E.66 The standard relay payments referred to above would be included in a schedule to the selection methodology and consulted on.

Methodology

- E.67 In order to meet the requirements of the extended reserves technical requirements schedule with adequate confidence over a 5 year period, the selection method also includes a requirement for [10%] of the target AUFLS⁷² supply to be available as flexible (i.e. able to be armed or disarmed with [7] days' notice), and for there to be an additional [10%] requirement for flexible standby AUFLS which would be available, but not initially armed.
- E.67.1 It should be noted that the primary role for flexible AUFLS is to deal with variations that the system operator becomes aware of each year as they get new data, and hence it is expected that the flexible suppliers will only

⁷² That is approx. 3% out of the target 32% total AUFLS supply.

be called occasionally during the selection term. However the flexible supplies can also be used on other occasions if there is a change in conditions large enough to justify it.

- E.68 The indicative methodology assumes that the technical requirements are for a uniform % requirement over the year. However it would be a simple matter to adapt the methodology to meet requirements that were profiled over the year (i.e. higher % during low load periods, and lower % during high load periods), should further work lead the system operator to a view that such an approach would deliver higher system reliability.
- E.69 The possibility of profiled AUFLS supply (i.e. demand units which are armed in selected time zones, such as over-night), has not been included but could easily be.
- E.70 The methodology only accounts for one form of flexible supply (i.e. arming or disarming with [7] days' notice), but could be extended to include more dynamic remote arming services (e.g. arming or disarming with a much shorter notice period).
- E.71 The indicative selection process involves 2 steps:
 - (a) Step 1: The selection of ER demand units for flexible and inflexible supply which meets the overall technical requirements, including an additional level of flexible supply which will initially be available but not armed
 - (b) Step 2: Determining which flexible ER demand units selected in step 1 will be armed initially so as to meet the base technical requirements.
- E.72 Each step has its own objective function. The basis for selecting ER demand units is to minimise the objective function to the extent reasonable, given the uncertainty of the inputs and the integer nature of the selection approach⁷³.
- E.73 The objective function includes the relay costs and the expected load interruption costs, the net system security benefit from fast response relays, and a number of penalty functions. The expected load interruption cost is a function of the individual expected interruption cost and the expected hours of interruption per annum for each AUFLS block. The latter will be provided in a schedule to the methodology and will be consulted on.
- E.74 This optimisation approach uses penalty values for deviations from the minimum, target and maximum AUFLS requirements which will be

⁷³ A number of techniques could be used to achieve this. The current prototype model has been written in GAMS and uses a mixed integer programming approach.

specified in a schedule to the selection methodology document and consulted on. This governs the trade-off between meeting the technical requirements and achieving the desired target requirements. The penalty values are calculated individually and summed over a sample of historical half hour periods to account for the different profiles, correlations and volatility of load data.

- E.75 The indicative methodology enables both the average level of AUFLS supply to be assessed and the likelihood that AUFLS supply is within minimum and maximum levels based on a sample of historical half hourly data. This likelihood will need to be sufficiently high to satisfy the system operator that it can meet is PPOs.

A possible hybrid methodology

- E.76 It would be possible to design a more decentralised approach more akin to the block coordination approach outlined for option 1b (as described in paragraph C.4 on Appendix C).
- E.77 This could still be accommodated within the proposed code, and may deliver a portion of the potential benefits of the full optimisation approach, but may be less costly to implement and operate in the first instance. There would still be the scope to go to a full optimisation methodology at a later date.
- E.78 This potential hybrid approach has not been fully developed but could operate as follows.
- (a) Participants would be required to select AUFLS feeders to meet a total common minimum obligation, say [26%] at all times, or [35%] on average, as determined by the system operator
 - (i) There may need to be special provisions for direct customers so as to avoid the risk that IL supply would be lost.
 - (b) Similar information would be required for each of these AUFLS feeder, but the expected interruption cost would be replaced by an AUFLS priority ranking index (maybe derived from the 1 to 6 feeder ranking used for rolling outage planning). Participants may also indicate which relays are already df/dt capable
 - (c) The objective function for the optimisation tool could be modified and the same optimisation approach could be used to allocate the offered feeders to AUFLS blocks based on meeting the minimum scheme design requirements, while also recognising each participant's priority ranking, and a preference for each participant to meet the scheme block design where this was possible

- (d) If necessary the block allocation might be run a number of times with parties being given the opportunity to modify their selection of feeders in order to meet the technical requirements overall
- (e) This would avoid the need for relay costs to be specified and agreed on and would avoid the need for payments and cost allocation in the first instance. It would reduce the information requirements and give participants more discretion as to which AUFLS feeders were selected, but would leave the selection process to allocate the offered AUFLS feeders to specific blocks.

E.79 Once the block allocation was complete each participant would be given an aggregated individual obligation specified by AUFLS region and AUFLS block which would be used in the ex-ante compliance regime.

E.80 Whether such a hybrid option is selected as the preferred approach for the first implementation of the new arrangements will depend on a detailed evaluation of the relative cost-benefit of the options based on information gathered from stakeholders in the detailed design phase of the selection methodology. This cost-benefit approach will use a framework based on the Authority's statutory objectives.

Indicative example of selection methodology

Extended reserves selection methodology⁷⁴

This is the extended reserve selection methodology, published by the extended reserve manager under clause 8.54G of the Electricity Industry Participation Code 2010 on [insert date]. It specifies how the extended reserve manager will procure extended reserve according to the extended reserve technical requirements schedule published by the system operator. This methodology is based on the principles set out in clause 8.54H of the Code.

Interpretation

1. In this methodology, unless the context otherwise requires,—

alternative demand means **interruptible load**

AUFLS block means a block of demand within the **AUFLS scheme** as specified in paragraph 5 of the **extended reserve technical requirements schedule**

AUFLS demand unit means a block of demand (including a feeder or group of feeders) which can or could be automatically disconnected using an **AUFLS system**

AUFLS participant means an asset owner identified in paragraph 2

AUFLS region means a group of **connection locations**, AUFLS regions are specified in Appendix A of the **extended reserve technical requirements schedule**

AUFLS relay means a relay used to provide the AUFLS scheme in accordance with paragraphs 7 to 8 of the **extended reserve technical requirements schedule**

AUFLS system means assets used to automatically respond to an under-frequency event and accomplish the disconnection of demand in order to meet the requirements of the **AUFLS scheme**

existing AUFLS demand unit means an **AUFLS demand unit** that was providing AUFLS as at [1 Jan 2014] for the first selection, or was selected in the

⁷⁴ The contents of this are based on the technical requirements schedule dated 4 Apr 14. It is draft and subject to change. The values and details of the methodology are indicative only. The drafting has not been subject to legal review.

previous **extended reserve procurement schedule** for subsequent selection processes.

flexible AUFLS demand unit means an **AUFLS demand unit** which has been selected for **flexible AUFLS supply**

flexible AUFLS supply is an **AUFLS relay** that can be armed or disarmed within [7] days of notification by the **system operator** and that be called up to [#] times a year

instantaneous frequency means the actual frequency derived from a voltage waveform at any given time

lines company means a **distributor** who is not a **direct consumer**

net demand means the total demand on an **AUFLS demand unit** excluding the estimated **alternative demand**

rate of change of frequency means the rate, measured in Hz/s, at which the frequency is changing

relevant future period means the period that the **extended reserve manager** notifies at the start of an extended reserve procurement process

relevant historical period means the period that the **extended reserve manager** notifies at the start of an extended reserve procurement process

relevant time zones means the list of time zones that the **extended reserve manager** notifies at the start of an extended reserve procurement process

selected AUFLS demand unit means an **AUFLS demand unit** which has been selected for **AUFLS supply** and allocated to an **AUFLS block**

set point means a user-adjustable setting at which a frequency relay will detect that an event has occurred, as applied to any frequency relay function, including under-frequency and rate of change of frequency

standby AUFLS demand unit means a **flexible AUFLS demand unit** that is not armed initially

standby AUFLS supply means **flexible AUFLS supply** that is not armed initially.

AUFLS participants that are required to provide information

2. Each North Island **distributor** (consisting of **lines companies** and **direct consumers**) is required to provide information to the **extended reserve manager** during an extended reserve selection process

3. The South Island **grid owner** is not required to provide information during an extended reserve selection process.

Information that AUFLS participants are required to provide

4. During an extended reserve selection process, each **AUFLS participant** must provide the information set out in Schedule 1 of this methodology to the **extended reserve manager**.

Timeframe within which information must be provided

5. An **AUFLS participant** must provide the information set out in paragraph 4 no later than [20 business days] after the **extended reserve manager** requests the information.

Basis on which extended reserve providers selected

6. In order to meet the requirements of the **extended reserve technical requirements schedule** with adequate confidence over a 5 year period, this selection methodology aims to :
 - (a) meet the target AUFLS requirements and AUFLS block requirements in each AUFLS region as specified in paragraph 3 of the **extended reserve technical requirements schedule**; and
 - (b) ensure that [10%] of the target requirements specified in paragraph (a) is from **flexible AUFLS supply**; and
 - (c) provide an additional [10%] of the target requirements set out in paragraph (a) as **standby AUFLS supply**; and
 - (d) ensure that the expected annual mean armed **AUFLS block** supply in any **AUFLS region** is between the minimum and maximum values specified in paragraph 5 of the **extended reserve technical requirements schedule**; and
 - (e) ensure that, in at least [#%] of trading periods, the expected total armed AUFLS supply in each **AUFLS region** is between the minimum and maximum values specified in paragraph 4 of the **extended reserve technical requirements schedule**; and
 - i. provide a preference for **AUFLS relays** capable of disconnecting demand within 250ms after the **instantaneous frequency** reduces

to the **set points** specified in paragraph 8 of the **extended reserve technical requirements schedule**.

7. To best meet the objectives set out in paragraph 6, the **extended reserve manager** will select **extended reserve providers** in each **AUFLS region** by:
 - (a) determining an allocation of potential **AUFLS demand units** to **AUFLS blocks** and **flexible AUFLS supply**, in order to seek to minimise the objective function set out as Item 1 of Schedule 4, and
 - (b) determining which of the **flexible AUFLS demand units** that have been allocated to **AUFLS blocks** will initially be armed, in order to seek to minimise the objective function set out as Item 2 of Schedule 4. The remaining **flexible AUFLS demand units** that have been allocated to **AUFLS blocks** will be designated to provide **standby AUFLS**.
8. In calculating the objective functions set out in Schedule 4, and in assessing the conditions set out in paragraph 6(d) and (e), the **extended reserve manager** may use demand data from a sample of historical trading periods in the **relevant historical period**.

Default terms and conditions

9. For the purposes of clause 8.54G(4)(f) of the Code, the default terms and conditions set out in Schedule 2 of this methodology apply to each **extended reserve provider**.

Payments for extended reserve

10. The standard monthly payments for extended reserve for each **extended reserve provider** is the sum of the Relay Operation Payment $ROP(j)$, the Relay Flexibility Payment $RFP(j)$, the Relay Fast Response Payment $RFRP(j)$, the Demand Unit Interruption Payment $DUIP(j)$ and the Relay Capital Payment $RCP(j)$ over all **selected AUFLS demand units** j belonging to that **extended reserve provider** that are in service.
11. Each **selected AUFLS demand unit** is considered to be in service between the commencement and cessation dates set out in the **extended reserve provider's** implementation plan as notified by the **system operator** to the **clearing manager**, unless the **system operator** advises the **clearing manager** that the **AUFLS demand unit** is out of service (either temporarily or permanently) under the terms and conditions of that **extended reserve provider's statement of extended reserve obligation**.

The Relay Operating Payment for **selected AUFLS demand unit j** is given by:

$$ROP(j) = RC(1)/12$$

where:

$RC(1)$ = Relay Administration Cost in \$/yr from Schedule 3 Part 4 item 1

The Relay Fast Response Payment for selected **AUFLS demand unit j** is given by:

$RFRP(j) = (RC(7))/12$ if j is selected and is capable of operating within 250ms as set out in paragraph 6(f), or

=0 otherwise.

where:

$RC(7)$ = Relay Fast Response Cost in \$/yr from Schedule 3 Part 4 item 7

The Relay Flexibility Payment for **selected AUFLS demand unit j** is given by:

$RFP(j) = (RC(2) + AFC(j))/12$ if j is selected for **flexible AUFLS service**, or

=0 otherwise.

where:

$RC(2)$ = Relay Flexible Cost in \$/yr from Schedule 3 Part 4 item 2

$AFC(j)$ = Additional Flexible Cost in \$/yr provided by distributor for **AUFLS demand unit j** as per Schedule 1 item 15.

The Demand Unit Interruption Payment for **selected AUFLS demand unit j** is given by:

$$DUIP(j) = (IC(j) * EIH(block(j)) * ANL(j))/12$$

where:

$IC(j)$ = the expected **AUFLS demand unit** interruption cost \$/MWh provided by distributor for j as per Schedule 1 item 14.

$block(j)$ = the **AUFLS block** number assigned to j in the selection process

$EIH(block(j))$ = the expected interruption hours /yr for $block(j)$ from Schedule 3 Part 2

$ANL(j)$ = the average **net demand** in MW for j

= the sum over all half hours, h , in the **relevant historical period** of $MW(j,h)$ as defined in Schedule 4 divided by the total number of half hours in the **relevant historical period**.

The Relay Capital Payment for **selected AUFLS demand unit** j is given by:

$RCP(j) = (RC(3)$ if the **AUFLS relay** on j is required to be *reconfigured*
 + $RC(4)$ if the **AUFLS relay** on j is required to be *tested*
 + $RC(5)$ if a new **AUFLS relay** is required to be *installed* on j
 + $RC(6)$ if the **AUFLS block** number assigned is 4 and a new **AUFLS relay** is required to be installed on j), or
 = 0 if the number of whole months between the commencement of providing **extended reserve** under the implementation plan and the payment month is greater than 60

where:

$RC(3)$ = Relay Configuration Cost in \$/yr from Schedule 3 Part 4 item 3

$RC(4)$ = Relay Testing Cost in \$/yr from Schedule 3 Part 4 item 4

$RC(5)$ = Relay Capital Cost in \$/yr from Schedule 3 Part 4 item 5

$RC(6)$ = Additional df/dt relay cost in \$/yr from Schedule 3 Part 4 item 6

The requirements for **AUFLS relay reconfiguration, testing, and new installation** are as a direct result of the selection for **extended reserve** supply taking into account the **AUFLS block** allocation and the **existing AUFLS demand unit** status and **AUFLS block** allocation.

12. If the **system operator** has notified the **clearing manager** that an **AUFLS demand unit**, j , which was in the previous, but not in the most recent, **extended reserve procurement schedule**, is to cease providing **extended**

reserve in the payment month, and the number of whole months, n , between commencement of **extended reserve** service under the previous implementation plan and the cessation under the current implementation plan is less than 60 then the **AUFLS participant** will also receive a one-off Relay Capital Terminal Payment $RCTP(j)$ in relation to that **AUFLS demand unit**.

where:

$$RCPT(j) = RCP(j) * USPVF([#]/12, (60 - n))$$

$USPVF(i, T)$ is the uniform series present worth factor for T months at rate i % per month.

$$= ((1+i)^T - 1) / (i * (1+i)^T)$$

Schedule 1

Information each AUFLS participant must provide for each AUFLS demand unit

At the start of an extended reserve selection process, the **extended reserve manager** will notify participants of the **relevant historical period**, the **relevant future period** and the **relevant time zones**.

Each **AUFLS participant** must provide the information set out in this schedule for **AUFLS demand units** to be made available for the current selection process , covering at least [60]% of its total **offtake** at **grid exit points**, in each **AUFLS region** over the **relevant historical period**. Information provided for items 1 to 11 must follow published guidelines relating to; data quality, treatment of missing data and estimation approach.

It must also provide items 1 to 8 of this schedule for **existing AUFLS demand blocks** if they are not available for the current selection process.

item	Information	Description
1	Participant ID -	Unique 4 letter code assigned to a participant under clause 15.39 of the Code.
2	GXP ID	3 Letter code from Transpower.
3	AUFLS demand unit ID	A unique code provided by the distributor.
4	AUFLS demand unit configuration	[zone substation, list of feeders in AUFLS group, etc
5	Selection Status	1 if available for current selection process, 0 otherwise
6	Existing AUFLS relay information	[None, Basic, electronic, trigger functionality, programming capability],]
7	Fast Response Capability	Set to 1 if the total AUFLS operating time as defined in paragraph 6 of the extended reserve technical requirements schedule , 0 otherwise
8	Existing AUFLS block	[0,1,2,3,4] – set to 0 for the first selection process
9	Existing AUFLS relay last test date	
10	Half hourly demand data in MW	This should generally be equal to the historical data sampled at half hourly intervals in the relevant historical period . SCADA data is acceptable and estimates are acceptable where historical data is not available. If the mean annual demand in the relevant future period is expected to vary from the mean annual demand in the relevant historical period by more than [50]% or [50]MW then the historical data should be adjusted to reflect this.

11	Estimates of the forecast alternative demand offered as a proportion of total demand in each relevant time zone .	Estimates on the basis of an AUFLS participant's own knowledge and the on the basis of information provided by ancillary service agents or others. This should be based on actual historical data in the relevant historical period , if available. If the forecast for the relevant future period is expected to vary by more than [50%] from the historical level then the estimates should be adjusted to reflect this.
12	Demand shares by customer class.	Lines companies are required to provide reasonable estimates of the shares of annual demand by each customer class (set out in Schedule 3 Part 3) for the AUFLS demand unit .
13	Large user demand share and expected interruption costs for a [2] hr outage in \$/MWh	This is only required if a lines company's AUFLS demand unit includes a large customers greater than [25] GWh/yr and this customer has provided (at their own cost) estimates for their annual demand and their own expected interruption costs for a [2] hr outage in MWh.
14	Expected interruption costs for a [2] hr outage in \$/MWh.	For lines companies this is the demand share weighted average expected interruption cost derived from the demand shares from item 12, the generic interruption costs by customer class set out in Schedule 3 Part 3, and if provided, the large customer demand share and expected interruption cost from item 13. For direct customers this is their own estimated expected interruption costs for a [2] hr outage in MWh.
15	Additional flexible cost \$/yr	This will be set to zero unless the AUFLS participant can demonstrate to the extended reserve manager that their actual costs to provide flexible AUFLS supply significantly exceeds the standard flexible AUFLS supply compensation rates set out in schedule 3.4. If the AUFLS participant can demonstrate that it is impractical to provide a flexible service then they will not be considered for flexible AUFLS supply .

Schedule 2

Default terms and conditions for extended reserve providers

Periodic testing requirements

1. The **extended reserve provider** must—
 - (a) test the operation of its **AUFLS system** in accordance with its implementation plan; and
 - (b) based on the test carried out in accordance with paragraph (a), provide a verified set of trip settings and time to disconnect demand in accordance with its **statement of extended reserve obligations** to the **system operator** in an updated asset capability statement within 40 business days of the completion of each such test.

2. The **extended reserve provider** must—
 - (a) test the operation of its **AUFLS system** if the test records supplied in its asset capability statement are no longer valid. Test results remain valid for —
 - (i) 5 years from the test date for analogue and non-self-monitoring digital **AUFLS system**; and
 - (ii) 10 years from the test date for self-monitoring digital protection **AUFLS system**
 - (b) based on the test carried out in accordance with paragraph (a), provide a verified set of trip settings and time delays to the **system operator** in an updated **asset capability statement** within 40 business days of the completion of each such test.

3. If a new relay is installed that will provide an **AUFLS system** with frequency or rate of change of frequency settings the **extended reserve provider** must—
 - (a) test the operation of its **AUFLS system**; and
 - (b) based on the test carried out in accordance with paragraph (a), provide a verified set of trip settings and time to disconnect demand in accordance with its **statement of extended reserve obligations** to the **system operator** in an updated asset capability statement within 40 business days of the completion of each such test.

4. Testing guidelines are available on the **system operator** website to provide guidance on setting and testing relays.

Ongoing information requirements

5. **The extended reserve provider** must give the **system operator** the following information for each **selected AUFLS demand unit**:
 - (a) profile information as specified in paragraphs 8 to 11 below; and
 - (b) notice of failure to meet its technical requirements and relevant information as specified in clause 7(2) of Technical Code B, Schedule 8.3; and
 - (c) notice of a reasonable expectation of a significant permanent change in average **net demand** greater than [50] MW or greater than [50] %; and
 - (d) notice of a planned or unplanned outage which will last longer than [14] days; and
 - (e) notice of permanent network reconfiguration affecting the selected **AUFLS demand unit**.
6. If the **extended reserve provider** notifies the **system operator** of an outage or permanent network reconfiguration under paragraphs 5(d) or 5(e), then the provider must seek to replace the affected **AUFLS demand unit** with another of its **AUFLS demand units** that it deems to be a reasonable replacement. The replacement **AUFLS demand units** can be **AUFLS demand units** which have not been selected, or, subject to **system operator** agreement, selected **flexible AUFLS demand units** that are not armed.
7. The **extended reserve provider** must notify the **system operator** within [14] days of the change in the **AUFLS demand unit** being provided, (including details of the replacement **AUFLS demand units**), or if it was not able to provide reasonable replacements, that it is unable to comply with its obligations in its **statement of extended reserve obligation** (as required by Schedule 8.3, Technical Code B, clause 7(2) of the Code). The **system operator** will amend the **extended reserve schedule** accordingly as required under clause 8.54P(3)(b) of the Code.

Profile information

8. The **extended reserve provider** must provide demand profile information to the **system operator**—
 - (a) in an updated **asset capability statement** at least once a year; or

- (b) when requested by the **system operator**.
- 9. The information required under paragraph 8 must be in a form that enables the **system operator** to make a reasonable assessment of the total amount of demand available to be disconnected if **automatic under-frequency load shedding** blocks operate in accordance with the **extended reserve technical requirements schedule**.
- 10. Any **embedded generating station** with a capacity of greater than [1] MW connected to a distributor's local network must be included where available within the information provided under paragraph 8.
- 11. When calculating offtake, the **extended reserve provider** (where the information has been made available) must use gross offtake which excludes any injection from an embedded generating station with a capacity greater than [1] MW connected to the **extended reserve provider's** local network.

Post event obligations

- 12. **The extended reserve provider** must comply with Schedule 8.3, Technical Code B, clause 7B of the Code following an AUFLS event.

Eligibility for extended reserve payments

- 13. A selected **AUFLS demand unit** is considered to be in service and is eligible for the monthly extended reserve payments between the commencement and cessation dates of the **extended reserve** service as specified in the **extended reserve provider's** implementation plan, unless
 - a) the **extended reserve provider** has notified the **system operator** of an outage on, or reconfiguration of, the **AUFLS demand unit**, and where it was not able to provide a reasonable replacement service, as set out in Schedule 2 paragraph 3, and where the net impact is greater than [5] MW.
 - b) the **extended reserve provider** has notified the **system operator**, under paragraph 5(b) that the **AUFLS relay** may not be capable of meeting the relevant technical requirements.

Obligations during rolling outages

- 14. **Extended reserve providers** must develop rolling outage plans which simultaneously achieve compliance with their **extended reserves statements of obligation** and their rolling outage obligations specified in Part 9 of the Code.

Schedule 3
Part 1
Penalty Function Values

		Penalty 1	Penalty 2	Penalty 3	Penalty 4
item	Applies	below minimum	below target	above target	above maximum
1	Total deviation penalty	[\$#/hh per %]	[\$20/hh per %]	[\$15/hh per %]	[\$#/hh per %]
2	Block deviation penalty	[\$#/hh per %]	[\$20/hh per %]	[\$15/hh per %]	[\$#/hh per %]
3	Flexible shortfall penalty	[\$#0/hh per %]	\$0/hh per %	[\$#/hh per %]	[\$#/hh per %]

[Penalty 2 and 3 are indicative values based on the Authority's interpretation of the system operator's assessment of the risk of system collapse per AUFLS event for the scheme design as a function of the level of AUFLS supply. Penalty values 1 and 4 are multiples of the penalty 2 and penalty 3 values. These values are apportioned between regions according to the average annual demand shares. Penalty values 1 and 4 may need to be adjusted so as to achieve the confidence levels specified in paragraphs 6(d) and 6(e)]

Part 2
Expected interruption hours per year by AUFLS block

b	ER Block	ElH(b) = Expected hours of interruption per year
0	Not selected	0
1	AUFLS Block 1	[0.250]
2	AUFLS Block 2	[0.133]
3	AUFLS Block 3	[0.067]
4	AUFLS Block 4	[0.033]

[These are the values used in the consultation paper, based on return period and expected duration.]

Part 3
Generic expected interruption cost of [2] hr unanticipated outage by customer class.

k	Customer Class	IC(k)= Expected Interruption Cost \$/MWh
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1	Residential	[\$#]
2	Small Non Residential < 0.2GWh/yr	[\$#]
3	Medium Non Residential 0.2 to 1.0 GWh/yr?	[\$#]
4	Large Non Residential - >1GWh/yr	[\$#]
5	Public health and safety (as per PROPS 1&2)	[\$#]

[These could be derived from the 2012 mail out survey - Weighted average of results for Auckland and Taranaki. Residential results for 2 hour outage is derived from 8 hour estimate scaled up in line with the survey ratio for small non-residential. See "Investigation into the Value of Lost Load in New Zealand", Electricity Authority, 23 July 2013.]

Part 4 Standard AUFLS relay cost compensation rates.

item	Relay Payment Item	AnnualCost(s) = \$/yr
0	No change required	0
1	Relay administration cost	[\$#/yr]
2	Relay flexible service cost	[\$#/yr]
3	Relay reconfiguring cost	[\$#/yr = \$#*CRF]
4	Relay testing cost	[\$#/yr = \$#*CRF]
5	Base relay capital cost	[\$#/yr = \$#*CRF]
6	Additional df/dt relay cost	[\$#/yr = \$#*CRF]
7	Relay fast response cost	[\$#/yr = \$#*CRF]

Where:

CRF = capital recovery factor = $1/USPVF([i\%],5)$

$USPVF(i, n)$ is the uniform series present value factor for n years at rate i % per annum

$$= ((1+i)^n - 1)/(i*(1+i)^n)$$

Part 5 Standard Relay Fast Response Benefit rates.

item	Relay Fast Response preference rate	
1	Gross system benefit for AUFLS relay responding within 250ms	[\$#/yr]

Schedule 4

Objective Function Specifications

Item	Objective function definition
1	Choose AB_i , F_i to minimise $\text{Obj1} = \text{relay_cost} + \text{flex_relay_cost} + \text{interruption_cost} + \text{AUFLS_penalty} + \text{block_penalty} + \text{flex_penalty} + \text{fast_relay_cost} - \text{fast_response_benefit}$
2	With AB_i and F_i fixed, choose AF_i to minimise $\text{Obj2} = \text{armed_interruption_cost} + \text{AUFLS_penalty} + \text{block_penalty} - \text{armed_fast_response_benefit}$

Where:

AB_j is 1 if **AUFLS demand unit j** is in **AUFLS block 1**, 2 if in block 2, 3 if in block 3, 4 if in block 4 or 0 if not assigned to one of the four **AUFLS blocks**

F_j is 1 if **AUFLS demand unit j** is assigned to provide **flexible AUFLS** or 0 if it is not (note that if $AB_j=0$ then F_j is undefined)

AF_j is 1 if **AUFLS demand unit j** is armed or 0 if it is not (note that if $F_j=0$ and $AB_j>0$ then AF_j must equal 1, while if $AB_j=0$ then AF_j must equal 0)

p is penalty item number from 1 to 4

h is a sampled half hour in the **relevant historical period**

z is the **relevant time zone** of the sampled half hour, h , in the **relevant historical period**

$sample$ is the set of sampled half hours in the **relevant historical period**

$srate$ = the total number of sampled half hour periods in the **relevant historical period**/17520.

r is an **AUFLS region** in the North Island as specified in Appendix A to the **extended reserve technical requirements schedule**

b is an **AUFLS scheme design block number**

$\text{AUFLS_penalty} = \sum_{p=1}^4 \sum_{r=1}^3 (\text{dev_penalty}(p) * \text{dev}(r,p) * \text{region_prop}(r) / \text{srate})$

$\text{block_penalty} = \sum_{p=1}^4 \sum_{r=1}^3 (\text{block_dev_penalty}(p) * \text{block_dev}(r,b,p) * \text{region_prop}(r) / \text{srate})$

$\text{flex_penalty} = \sum_{p=1}^2 \sum_{r=1}^3 (\text{flex_block_dev_penalty}(p) * \text{flex_dev}(r,b,p) * \text{region_prop}(r) / \text{srate})$

$\text{fast_response_benefit}$ = the sum over all **AUFLS demand units j** for which $AB_j>0$ of $\text{fast_response_credit}(j)$

$\text{armed_fast_response_benefit}$ = the sum over all **AUFLS demand units j** for which $AB_j>0$ and $AF_j = 1$ of $\text{fast_response_credit}(j)$

$$\begin{aligned}
 dev(r,1) &= \sum_{h \in sample} \text{Max}(0, AUFLS_min * X - \\
 &\quad AUFLS_supply(r,h)/region_demand(r,h)) \\
 dev(r,2) &= \sum_{h \in sample} \text{Max}(0, AUFLS_target * X - \\
 &\quad AUFLS_supply(r,h)/region_demand(r,h)) \\
 dev(r,3) &= \sum_{h \in sample} \text{Max}(0, AUFLS_supply(r,h)/region_demand(r,h) - \\
 &\quad AUFLS_target * X) \\
 dev(r,4) &= \sum_{h \in sample} \text{Max}(0, AUFLS_supply(r,h)/region_demand(r,h) - \\
 &\quad AUFLS_max * X)
 \end{aligned}$$

$dev_penalty(p)$ are the total deviation penalty values from Schedule 3 Part 1 item 1.

$$\begin{aligned}
 block_dev(r,b,1) &= \sum_{h \in sample} \text{Max}(0, block_min(b) * X - \\
 &\quad block_supply(r,b,h)/region_demand(r,h)) \\
 block_dev(r,b,2) &= \sum_{h \in sample} \text{Max}(0, block_target(b) * X - \\
 &\quad block_supply(r,b,h)/region_demand(r,h)) \\
 block_dev(r,b,3) &= \sum_{h \in sample} \text{Max}(0, block_supply(r,b,h)/region_demand(r,h) - \\
 &\quad block_target(b) * X) \\
 block_dev(r,b,4) &= \sum_{h \in sample} \text{Max}(0, block_supply(r,b,h)/region_demand(r,h) - \\
 &\quad block_max(b) * X)
 \end{aligned}$$

$block_dev_penalty(p)$ are the block deviation penalty values from Schedule 3 Part 1 item 2 .

$$\begin{aligned}
 flex_dev(r,b,1) &= \sum_{h \in sample} \text{Max}(0, flex_min(b) - \\
 &\quad flex_supply(r,b,h)/(block_target(b)*region_demand(r,h))) \\
 flex_dev(r,b,2) &= \sum_{h \in sample} \text{Max}(0, flex_target(b) - flex_supply(r,b,h)/ \\
 &\quad (block_target(b)*region_demand(r,h)))
 \end{aligned}$$

$flex_block_dev_penalty(p)$ are the flexible block deviation penalty values from Schedule 3 Part 1 item 3.

$fast_response_credit(j)$ is the credit for relay responding within 250ms as specified in Schedule 3 Part 5 item 1, if the AUFLS relay in **AUFLS demand unit j** can respond within 250ms as described in paragraph 6(f), or zero otherwise.

$relay_cost = 12 * (\text{the sum of the Relay Operation Payment } ROP(j), \text{ and the Relay Capital Payment } RCP(j) \text{ as defined in paragraph 11, over all AUFLS demand units } j \text{ for which } AB_j > 0.)$

$fast_relay_cost = 12 * (\text{the sum of the Relay Fast Reponse Payment } RFRP(j) \text{ defined in paragraph 11, over all AUFLS demand units } j \text{ for which } AB_j > 0)$

$\text{flex_relay_cost} = 12 \times (\text{the sum of the Relay Flexibility Payment } RFP(j) \text{ defined in paragraph 11, over all } \mathbf{AUFLS \text{ demand units } j} \text{ for which } AB_j > 0 \text{ and } F_j = 1.)$

$\text{interruption_cost} = \text{sum over } j \text{ for which } AB_j > 0 \text{ of } [12 \times \text{DUIP}(j) \text{ as defined in paragraph 11} \times (1 \text{ if } F_j = 0 \text{ or } \text{additional_flexible}/\text{flex_min} \text{ if } F_j = 1)]$

$\text{armed_interruption_cost} = \text{sum over } j \text{ for which } AB_j > 0 \text{ and } F_j = 1 \text{ of } [12 \times \text{DUIP}(j) \text{ as defined in paragraph 11} \times AF_j]$

$AUFLS_target$, $AUFLS_min$ and $AUFLS_max$ are the target, minimum and maximum total **AUFLS requirement**, expressed as proportions of total demand, in each AUFLS region r , as specified in paragraph 4(a) of the **extended reserve technical requirements schedule**

$block_target(b)$, $block_min(b)$ and $block_max(b)$ are the target, minimum and maximum total AUFLS requirement for each block b in the **AUFLS scheme design**, expressed as proportions of total demand, in each AUFLS region r , as specified in paragraph 5 of the **extended reserve technical requirements schedule**

flex_min = *flex_target* is the minimum proportion of the target demand on **AUFLS demand units** selected as **flexible AUFLS supply** as given by the sum of the flexible proportion specified in paragraph 6(b) and the additional proportion of the target level to be armed if notified as specified in paragraph 6(c)

additional_flexible = is the additional proportion of the target level to be armed if notified as specified in paragraph 6(c)

X = the factor by which targets are increased to provide additional **flexible AUFLS supply**

= $1 + \text{additional_flexible}$, for objective function 1, and

= 1 for objective function 2.

AUFLS_supply(r,h) = sum over *b* from 1 to 4 of *block_supply(r,b,h)*

block_supply(r,b,h) = the sum of *MW(j,h)* over all **AUFLS demand units** *j* in region *r* for which *AB_j*=*b* (when calculating the first objective function), or *AB_j*=*b* and either *F_j*=0 or *AF_j*=1 (when calculating the second objective function)

flex_supply(r,b,h) = the sum of *MW(j,h)* over all **AUFLS demand units** *j* in region *r* for which *AB_j*=*b* and *F_j*=1

region_demand(r,h) = the sum of all GXP MW offtakes in **AUFLS region** *r* in half hour *h*

region_prop(r) = the sum of all the GXP MWh offtakes in AUFLS region *r* during the **relevant historical period** divided by the sum of all the GXP MWh offtakes in the north island during the **relevant historical period** (so that sum over *r* of *region_prop(r)*=1)

MW(j,h) = (1-*alt_prop(j,z)*) multiplied by the MW demand on **AUFLS demand unit** *j* in half hour *h* as provided by distributors as per Schedule 1 item 10

alt_prop(j,z) = forecast alternative demand on **AUFLS demand unit** *j* for time zone *z*, as provided by distributors as per Schedule 1 item 11

Schedule 5
Extended Reserve Procurement Schedule Template

Variable	Units	Description
Participant_ID	Unique code	Extended Reserve Provider ID as per Schedule 1, item 1
DemandUnit_ID	Unique code	Selected AUFLS demand unit ID as per Schedule 1, item 3
Region_num	[1 to 3]	AUFLS region number
ANL	MW	Annual average net demand calculated as per paragraph 11
Block_num	[1 to 4]	Allocated AUFLS block
Selected_flag	[0,1]	1 if selected, 0 otherwise
Flexible_flag	[0,1]	1 if selected as flexible AUFLS , 0 otherwise
Armed_flag	[0,1]	1 if selected to be armed initially, 0 otherwise
Reconfig_flag	[0,1]	1 if selection requires AUFLS relay to be reconfigured, 0 otherwise
Test_flag	[0,1]	1 if selection requires AUFLS relay to be tested, 0 otherwise
New_flag	[0,1]	1 if selection requires a new AUFLS relay, 0 otherwise
ROP	\$/month	Relay Operating Payment calculated as per paragraph 11
RFP	\$/month	Relay Flexibility Payment calculated as per paragraph 11
RFRP	\$/month	Relay Fast Response Payment calculated as per paragraph 11
DUIP	\$/month	Demand Unit Interruption Payment calculated as per paragraph 11
RCP	\$/month	Relay Capital Payment calculated as per paragraph 11