

Effective Date – 21 December 2021

I certify that this document is a correct copy of the AUFLS technical requirements report incorporated by reference into the Electricity Industry Participation Code 2010 on 21 December 2021 by the Electricity Industry Participation Code Amendment (Automatic Under-Frequency Load Shedding Systems) 2021.

Dated at Wellington this 09 day of November 2021



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1. DEFINITIONS AND INTERPRETATIONS

1.1 Definitions

In this **report**, unless the context otherwise requires:

Asset owner demand is the total demand served by a **connected asset owner** in the North Island, or a **grid owner** in the South Island, as calculated in Section 5 of this **report**;

AUFLS demand is the electrical load measured in MW which will be shed upon an **AUFLS system** operation. It comprises of an **automatic under-frequency load shedding** component and may include an **interruptible load** component if any **interruptible load** is connected downstream;

AUFLS requirement means the summation of the **automatic under-frequency load shedding** components of **AUFLS demand** that must be electrically disconnected by the operation of all **AUFLS systems**, expressed as a percentage of the **asset owner demand**;

AUFLS scheme means the settings including **automatic under-frequency load shedding** blocks making up the **AUFLS requirement**, relay settings, and response times, as set by the **system operator** in accordance with this **report**. For the purposes of section 4 of this **report**, **AUFLS scheme** includes a scheme that complies with clauses 7(6) or 7(6A) of Technical Code B, Schedule 8.3 of the Code;

AUFLS system means assets used to automatically shed electrical load when frequency falls below a preset frequency, or falls at a rate, specified in this **report**;

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**;

guard frequency means a frequency **set point** in Hertz 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;

post-event demand is **asset owner demand** averaged for 5 minutes after a system event that triggers, or should trigger, an **AUFLS system**, and before any load is restored;

pre-event demand is the **asset owner demand** averaged for 5 minutes before a system event that triggers, or should trigger, an **AUFLS system**;

rate of change of frequency means the rate, in Hertz per second, at which frequency is changing;

report means this AUFLS Technical Requirements Report;

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**; and

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

1.2 Interpretation

Terms used in this **report** which are defined in Part 1 of the **Code** and which are not defined in this **report**, have the same meaning as given in the **Code**. In the event of any inconsistency or conflict between the provisions of this **report** and the rest of the **Code**, the rest of the **Code** shall prevail.

2. TECHNICAL REQUIREMENTS

2.1 The **AUFLS system** must electrically disconnect demand:

- (a) for the primary under-frequency settings:
 - (i) within 0.3 seconds of the **instantaneous frequency** falling below the frequency **set point**; or
 - (ii) with the **rate of change of frequency** reaching the **set point** whilst below the **guard frequency**,

as shown in A to E in figure 1;

- (b) for the secondary under-frequency settings within 15 seconds of the **instantaneous frequency** reaching the **set point** as shown in A to E in figure 1; and
- (c) in accordance with the relay setting requirements set out in clause 2.5, and using logic set out in figure 2, of this **report**.

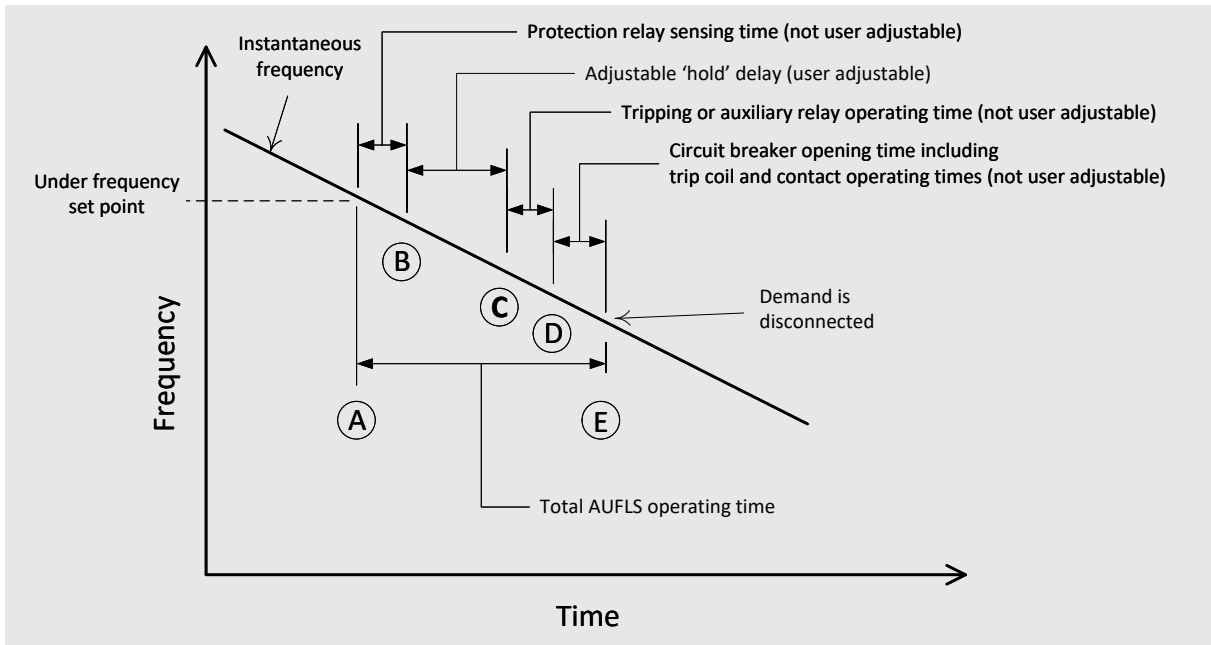
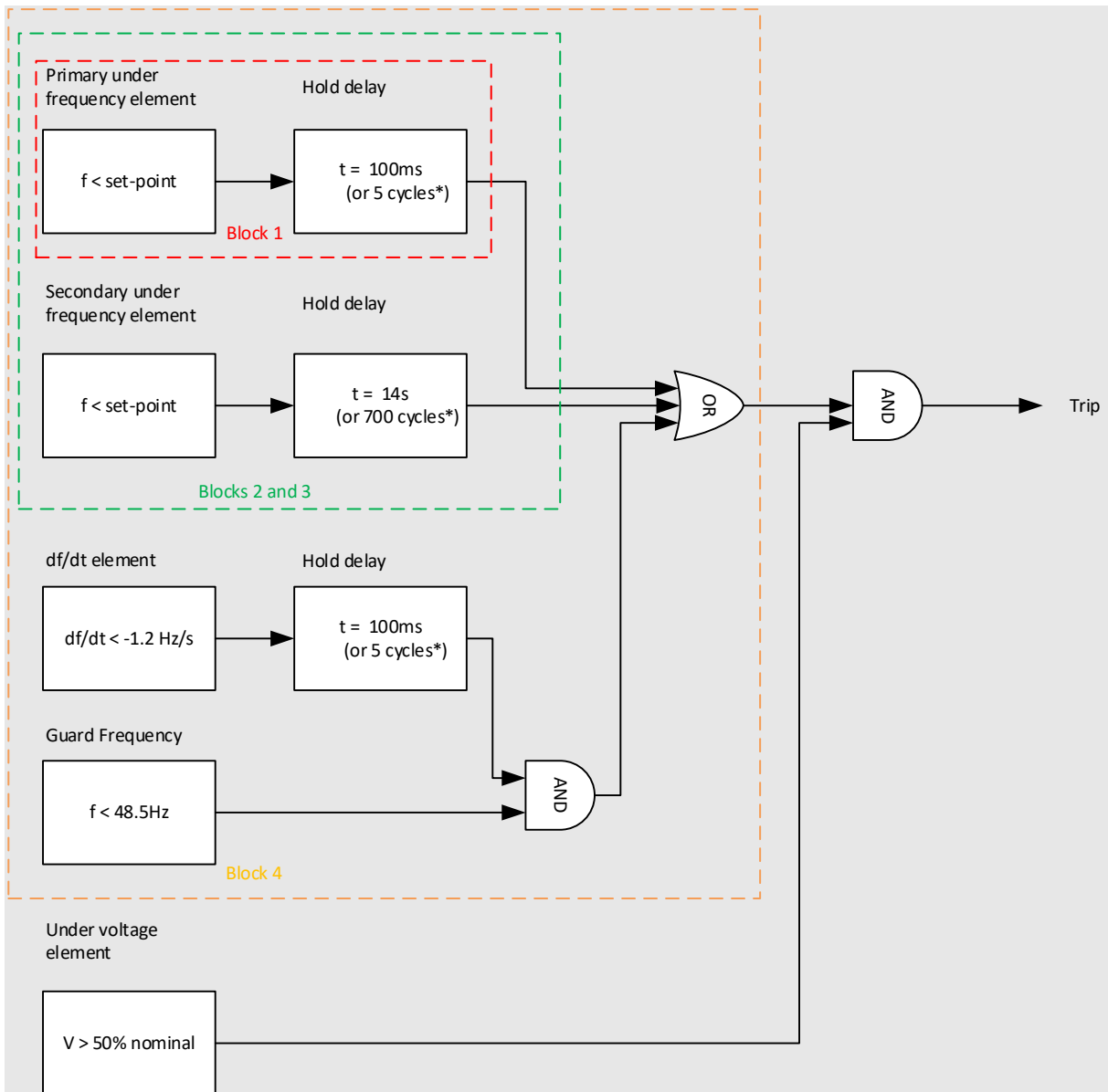


Figure 1. Under-frequency trip timing diagram (typical)



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

Figure 2. Logic diagram for AUFLS Blocks

2.2 The relays used to provide the **AUFLS system** must send a trip signal to electrically disconnect demand:

- (a) for the primary and secondary (where applicable) under-frequency settings:
 - (i) when the **calculated frequency** has remained below the frequency **set point** for the duration of the **hold delay**; and
 - (ii) the grid voltage remains greater than 50% of nominal system voltage;
- (b) for the **rate of change of frequency** detection (where applicable) setting:
 - (i) when the **rate of change of frequency** has remained below the rate of change of frequency **set point** for the duration of the **hold delay**;
 - (ii) the **calculated frequency** is less than the **guard frequency**; and

(iii) the grid voltage remains greater than 50% of nominal system voltage.

2.3 The **AUFLS scheme** must include the **hold delay** setting with the value specified in:

- (a) milliseconds where the relay uses a time element to set its timers; or
- (b) cycles where the relay uses cycles to set its timers.

2.4 The relays used to provide **rate of change of frequency** detection (where applicable) must have:

- (a) at least 1 **rate of change of frequency** element;
- (b) a setting range that is capable of being set between -1.0 and -2.0 Hertz per second;
- (c) a setting resolution of at least 0.1 Hertz per second;
- (d) an adjustable time delay of between 0 and 0.5 seconds;
- (e) customisable logic capable of achieving the settings specified in Section 3 in this **report** for **rate of change of frequency**; and
- (f) capability to remote enable/disable the **rate of change of frequency** element without the need for expert technical assistance.

2.5 Relay Settings

Block	Under-frequency setting type	Frequency Set point	Hold time (second) ¹	Guard Frequency (Hertz)
Block 1	Primary	47.9 Hertz	0.1	
Block 2	Primary	47.7 Hertz	0.1	
	Secondary	47.9 Hertz	14	
Block 3	Primary	47.5 Hertz	0.1	
	Secondary	47.7 Hertz	14	
Block 4	Primary	47.3 Hertz	0.1	
	Secondary	47.5 Hertz	14	
	Rate of change of frequency	-1.2 Hertz per second	0.1	48.5

Table 1: 4-block AUFLS Relay Settings

¹ Shown graphically as B to C in Figure 1

3. PERFORMANCE REQUIREMENTS

3.1 In the North Island an **AUFLS system** must enable, at all times, automatic electrical disconnection of demand as follows:

4 blocks of **demand** (with each block disconnecting no less than the specified percentage of the **asset owner's pre-event demand**, unless agreed otherwise with the **system operator**), with:

- (i) block 1 electrically disconnecting 10% of the **demand** within 0.3 seconds after the frequency reduces to, and remains at or below, 47.9 Hertz;
- (ii) block 2 electrically disconnecting 10% of the **demand**:
 - A. 15 seconds after the frequency reduces to, and remains at or below, 47.9 Hertz; and
 - B. within 0.3 seconds after the frequency reduces to, and remains at or below, 47.7 Hertz;
- (iii) block 3 electrically disconnecting 6% of the **demand**—
 - A. 15 seconds after the frequency reduces to, and remains at or below, 47.7 Hertz; and
 - B. within 0.3 seconds after the frequency reduces to, and remains at or below, 47.5 Hertz; and
- (iv) block 4 electrically disconnecting 6% of the **demand**—
 - A. 15 seconds after the frequency reduces to, and remains at or below, 47.5 Hertz;
 - B. within 0.3 seconds after the frequency reduces to, and remains at or below, 47.3 Hertz; and
 - C. within 0.3 seconds after the frequency falls, and remains falling at 1.2 Hertz/second, and the frequency is below 48.5Hz.

4. DATA REQUIREMENTS

4.1 After an **automatic under-frequency load shedding** event, each North Island **connected asset owner** and each South Island **grid owner** should gather **AUFLS scheme** data as soon as possible after any **automatic under-frequency load shedding** operation to make it available to the **system operator** without delay in accordance with this clause 4.1. Initial contact should be made to compliance@transpower.co.nz, if file sizes are too large alternative arrangements for delivery will be made.

(a) Delivery

Data from the **AUFLS scheme** must be submitted to the **system operator** within 30 business days of any **automatic under-frequency load shedding** operation.

(b) Data set for each AUFLS System

For **AUFLS system** performance, three time series .csv files are required:

- (i) Measured MW, which should include a text comment indicating if any **interruptible load** or downstream generation is thought to have been connected;
- (ii) Measured frequency (Hertz); and
- (iii) AUFLS scheme trigger signal (binary 0,1).

(c) Data Quality

Each data set should be recorded:

- (i) Pre-trigger 5 – 10 seconds;
- (ii) Post-trigger 60 seconds;
- (iii) Resolution 100 ms or better; and
- (iv) GPS time-stamped or Network Time Protocol.

4.2 Profile information submitted annually

Each North Island **connected asset owner** must submit **AUFLS scheme** profile information to the **system operator** annually:

- (a) On or before 1st April into the Transpower Operations Customer Portal for the previous calendar year (1st January to 31st December); and
- (b) Using the data templates and user guides available on the **system operator's** website.

4.3 Additional Information

The **system operator** may at any time request additional information from the **connected asset owner** including single line diagrams marked up with **AUFLS system** components.

5. AUFLS REQUIREMENT CALCULATION

Figure 3 and Table 2 below illustrates how AUFLS block sizes are calculated from **connected asset owner** historic profile data supplied to the **system operator** as described in Section 4.2 above.

The following principles must be followed:

- 5.1 When **connected asset owner** supply is served from more than one GXP, block size quantities used in the calculation take on the algebraic sum over those GXP's;
- 5.2 For **connected asset owners** in the North Island, Block 3 and Block 4 will be accounted for separately in the same way that Block 1 and Block 2 are calculated in this example;
- 5.3 **Generating unit net** injecting into the **connected asset owner** assets upstream from any **AUFLS System** and at or below the GXP that the **connected asset owner** connects to contributes to that **asset owner's demand** at that GXP; and
- 5.4 To avoid doubt, the demand calculated to comprise **automatic under-frequency load shedding blocks** must be net of any **interruptible load** procured by the **system operator**. Any **interruptible load** served by the **connected asset owner**, whether upstream or downstream of any **AUFLS system**, will be excluded from AUFLS block calculations.

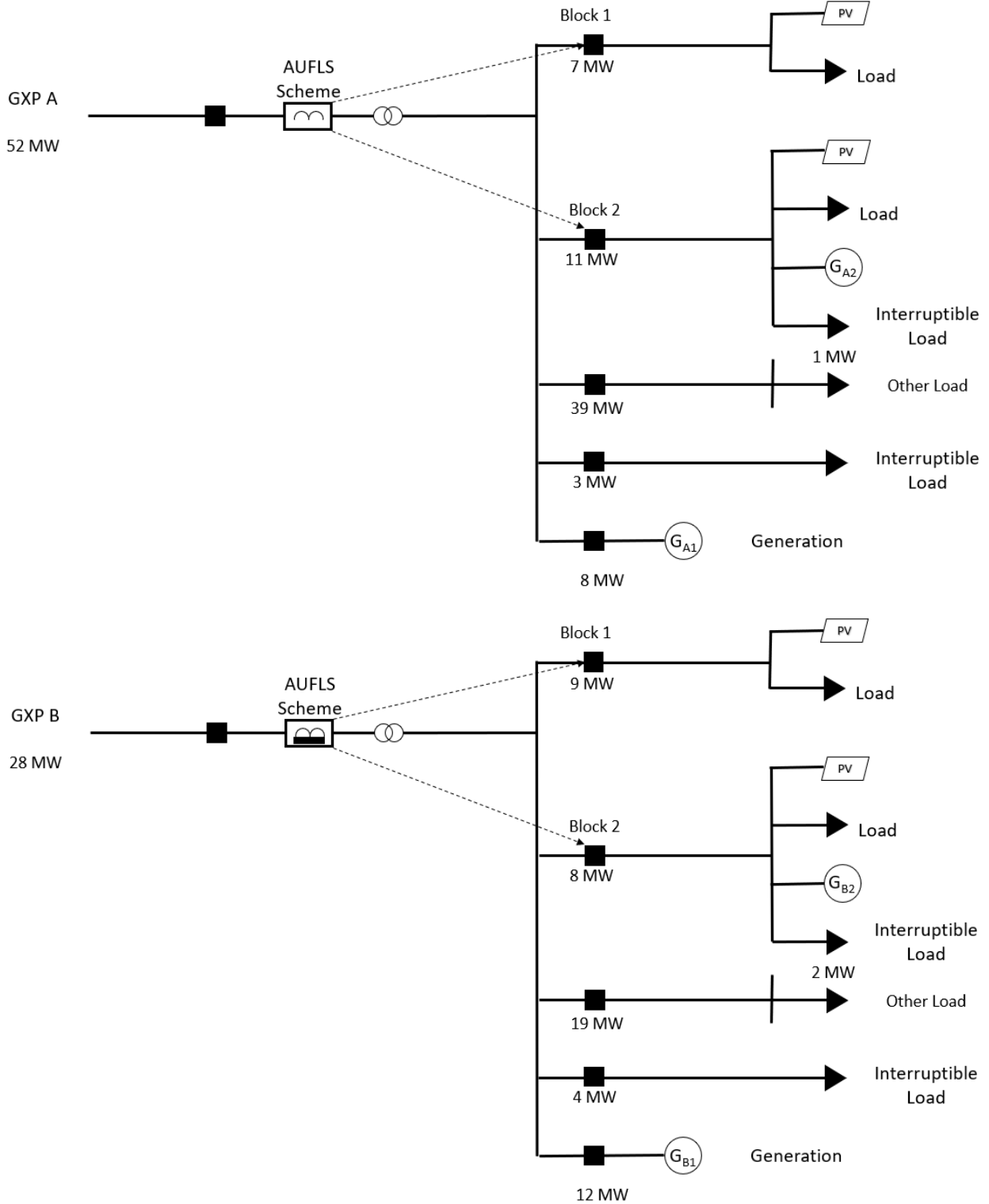


Figure 3 AUFLS Scheme example

	GXP A (MW)	GXP B (MW)	Across all GXP's (MW)	Percentage of Asset Owner Demand
GXP Load	52	28	80	
Generation	<u>8</u>	<u>12</u>	<u>20</u>	
Asset Owner Demand	<u>60</u>	<u>40</u>	<u>100</u>	
Block 1	7	9	16	16%
Block 2 (less downstream IL)	10	6	16	16%
Other Load	39	19		
Interruptible Load (total)	<u>4</u>	<u>6</u>		
Asset Owner Demand	<u>60</u>	<u>40</u>	<u>100</u>	

Table 2 Sample compliance calculations