Quality Performance Report
Electricity Transmission

An assessment of
Transpower New Zealand Limited's performance
for the
2018, 2019 and 2020
Disclosure Years

for
The Commerce Commission

Final Report
October 2021

Preface

Strata Energy Consulting Limited specialises in providing services relating to the energy industry and energy utilisation. The Company, which was established in 2003, provides advice to clients through its own resources and through a network of associate organisations. Strata Energy Consulting has completed work on a wide range of topics for clients in the energy sector in both New Zealand and overseas.
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Executive Summary

1. This Quality Performance Report provides Strata Energy Consulting Limited's (Strata's) opinions and advice to the Commerce Commission (the Commission) in relation to instances where Transpower's contravened its Individual Price-Quality Determination 2015 Quality Standards for the 2018, 2019 and 2020 disclosure years (DY).
2. The Commission monitors Transpower's performance against Quality Standards, which include 20 quality measure subcategories recorded annually and a further 3 quality measures that are recorded for 5-year performance.
3. A target, cap and collar were set for each quality measure subcategory. The Commission asked Strata to investigate the reasons for where Transpower's performance had contravened the collar for particular quality measures. The Commission applied its discretion to only pursue contraventions that involved the exceedance of the collar levels of the quality measures.[1]

Instances where Transpower's performance exceeded the collar levels

4. During DY2018, DY2019 and DY2020, Transpower contravened 40% of its annual quality measures and all 3 of its periodic (five-year) asset health quality measures. The following lists set out the quality measures and DY in which Transpower exceeded its collar levels.

   For Grid Performance Measures:
   - the number of unplanned interruptions - Standard (in DY2018);
   - average duration of unplanned interruptions - High Priority (in DY2018 and DY2020), Standard (in DY2018), Generator (in DY2018), and N-Security (in DY2018 and DY2019); and
   - duration of P90 unplanned interruptions - Standard (in DY2018 and DY2019), Generator (in DY2018) and N-Security (in DY2018 and DY2019).

   For Asset Performance Measures:
   - HVDC availability (in DY2020); and
   - HVAC availability (in DY2018, DY2019 and DY2020).

   For Asset Health Grid Output Measures:
   - number of transmission towers refurbished (in DY2019 and DY2020);
   - number of grillage foundations replaced (in DY2018, DY2019 and DY2020); and
   - number of insulator sets replaced (in DY2018, DY2019 and DY2020).

   For Periodic (five-year) Asset Health Grid Output Measures:
   - number of outdoor circuit breakers commissioned;
   - number of power transformers commissioned; and
   - number of outdoor to indoor conversions commissioned .
5. Strata's review covered the above areas and also referred to, and built on, the previous review Strata completed for DY2016 and DY2017.

[1] Warning letter to Transpower New Zealand Limited, 12 September 2019

Grid Performance Measures

We found no evidence of underlying asset deterioration

6. Corrected and updated interruptions data supplied by Transpower enabled us to analyse the causes and drivers of the number and durations of interruptions, and the contribution towards collar exceedance.
7. We found that:
    - the data confirmed Transpower's explanations that a relatively small number of periodic adverse weather events and one-off equipment failure events were the primary causes of it exceeding the grid performance measure collars for both number and duration of unplanned interruptions;
    - the number of unplanned interruptions has been decreasing and this is likely to indicate improving reliability;
    - the only instance in which Transpower exceeded the collar performance for Standard number of unplanned interruptions was in DY2018 and this was due to the impact of significant weather events that were outside of its control;
    - unplanned interruption duration has been increasing above pre-RCP2 levels and it appears Transpower has not previously identified and analysed this;
    - the average interruption duration quality measure is sensitive to long duration outages, especially those that occur towards the end of the disclosure year; and
    - for categories that have low numbers of interruptions, when high duration events are removed, average interruption duration would have reduced the average duration closer to, but still exceeding the collar.
8. We found no evidence in the data that underlying asset deterioration contributed to instances in which Transpower exceeded its collar level. However, we have been unable to exclude asset deterioration as a contributor, due to the absence of definitions for secondary cause codes in the data set supplied by Transpower.
9. Our analysis indicates that mitigation of the impact of long duration events could have improved the average interruption duration and P90 performances. This is the reason why we consider that comprehensive post-event reviews are critical to improving performance. From the evidence provided on reviews undertaken prior to and during the period covered by this review, we consider that Transpower could improve the reviews it undertakes following interruptions. Regarding this opinion, we consider that Transpower's investment in the introduction of Condition Based Risk Management (CBRM) systems and practices should include improved interruption event information capture, analysis and review.

Asset Performance Measures

HVAC availability collar levels were set at an unachievable standard

10. The primary cause of results in which Transpower failed to meet the collar level for HVAC availability in DYs 2018, 2019 and 2020 was that the collar level had been set at an unrealistically high percentage.
11. For DY2020, the long duration outages required to respond to the Rangitata river flood (unplanned outage) and the Clyde circuit breaker replacement (planned outage) meant that it was inevitable that Transpower would fail to achieve the collar level.
12. We have formed the following conclusions on Transpower's HVAC availability performance for the 5 RCP2 Disclosure Years:

- unplanned outages were not a material contributing factor to Transpower's exceedance of its collar level in DY2018;
- planned circuit outages were the main contributing factor to Transpower's exceedance of its collar level in DY2018, DY2019 and DY2020;
- the collar set for HVAC availability was inappropriately high because some significant planned works had not been identified at the time the collar was proposed, meaning that it was inevitable Transpower would exceed its collar level;
- in the absence of clearly identified initiatives to lift availability performance, Transpower set its RCP2 target at an overly optimistic level;
- because Transpower identified to the Commission that its proposed quality measures for RCP2 were 'prototype', in our view it was unreasonable to conclude that Transpower acted inconsistently with good electricity industry practice when proposing them; and
- for planned outages, we found that Transpower undertook detailed planning including risk-based prioritisation of work on the 27 selected circuits. We did not identify concerns regarding Transpower's work planning and prioritisation, other than failing to include all planned outages when proposing RCP2 quality measures.

We found that Transpower acted consistently with good electricity industry practice when managing and mitigating its HVDC asset availability during DY2020

13. We considered Transpower's explanation that its breach of the HVDC availability collar to circuit and pole outages related to essential reconductoring work on the OTB-HAY A sections of the HVDC assets.
14. Based on the evidence provided by Transpower and our knowledge of the events we agree with Transpower that its exceedance of the availability collar for circuit and pole outages was due the reconductoring work on the OTB-HAY A (Churton Park section 45A -68) HVDC assets.
15. We consider that Transpower:
    - provided evidence that it had identified the impact that the project would have at an early stage;
    - had kept the Commission informed[2] on the implications for its HVDC availability performance prior to the outage;
    - mitigated the need for future outages by bringing the substation work forward to coincide with the reconductoring; and
    - managed the project to plan, and maintained good communications with, stakeholders throughout the project.
16. Accordingly, we found that Transpower acted consistently with good electricity industry practice when managing and mitigating its HVDC asset availability during DY2020.

Asset Health Grid Output Measures

Reduced number of transmission towers refurbished reflected external impacts and the effects of an improvement initiative

17. Transpower attributed its below-collar tower painting performance in DYs 2019 and 2020 to a combination of external impacts and the effects of improvement initiatives.

[2] Transpower 29 January 2021 letter to the Commission titled 2018 -2020RY CONTAVENTIONS: S98 INVESTIGATION, paragraph 56

18. For DY2019, Transpower attributed its below collar performance primarily to its introduction of the Minimum Approach Distance (MAD) to tower painting. The MAD initiative targeted efficiency gains in tower painting by completing a total tower painting (i.e., MAD non-MAD sections) during a single operation rather separately. We found that the MAD initiative was well conceived and implemented. We also consider that Transpower did remarkably well in falling only marginally below its collar in DY2019 especially given the efficiency gains that it achieved in this period through painting complete structures during a single operation.

19. Regarding the impact in DY 2020 attributable to the Tower Corrosion Challenge improvement initiative, we consider that Transpower had good reason to be confident that it could manage the implications of tower painting deferrals and remain within its collar level. However, the poor weather in June DY2020 would have meant that it would probably have exceeded the collar level even if the Covid-19 restrictions had not been imposed.

20. We agree with Transpower that it had no way of mitigating the restrictions due to Covid-19 other than trying to recover the shortfall when restrictions eased at Level 2. However, following the easing of restrictions, Transpower would have had insufficient time to recover the lost volume before the end of DY2020, and the June weather event would have exacerbated this position.

21. In our opinion, Transpower performed extremely well in progressing its tower refurbishments to the extent it did during a very difficult Disclosure Year. We have concluded that Transpower could have done little to mitigate the events that were outside its control.

22. Also worthy of comment is the tower to pole programme that will emerge from Transpower's Tower Corrosion Challenge. We agree with Transpower that this initiative should result in improved efficiencies in its future pole refurbishment programmes. In our opinion, the improvement initiative reflects good electricity industry practice.

Transpower's reduced grillage refurbishments reflect improved asset management

23. We found that Transpower is continuing to improve and develop its approach to the management of grillage foundations and, as a result of the development of its revised strategy, Transpower's number of grillage foundation replacements failed to meet its collar.

24. We have concluded that Transpower's development of its grillage foundation strategy is sound and based on good electricity industry practice. We also acknowledge that the application of the revised strategy has realised savings whilst at the same time resulted in prioritising programmes on the basis of criticality.

Transpower's reduced insulator replacements reflect improved condition information

25. We found that Transpower had not provided sufficient evidence that it had included appropriate risk assessments alongside its proposal to reduce the number of initial insulator replacements in its business case (BC 453) documentation. However, we accept Transpower's explanation that, because the reduced volumes proposed in BC 453 did not fall below the collar level, the risk would be likely to have fallen within an acceptable range.

26. We also accept Transpower's point that because the initial reduction in insulator volumes did not exceed the collar level, the initial reduction did not contribute to its contravention of the Quality Standard. Because the additional deferrals were supported by improved condition information and a business case approval, we consider that in making these deferrals, Transpower acted in accordance with good electricity industry practice.

Five-year Periodic (five-year) Asset Health Grid Output Measures

Reducing outdoor circuit breaker replacements are attributable to CBRM introduction

27. Transpower has adopted an Ofgem[3] model for its rollout of Condition Based Risk Management (CBRM) and it is immediately realising the benefits of reduced capex requirements in RCP2.

28. We consider that the Commission should acknowledge the benefits that Transpower is realising through the adoption of CBRM and refer electricity distribution businesses that refute the benefits available from adoption of CBRM, to Transpower's experience.

Reducing power transformer replacements are attributable to a revised strategy

29. Transpower has transformed its power transformer asset class strategy to be aligned with international practices. This is consistent with improved practices we have seen in our reviews of transmission businesses in Australia, and to a lesser extent in Asia.

30. Whilst Transpower did not provide a specific business case document supporting the development and implementation of the revised Asset Class Strategy (e.g., projecting net benefits and mitigating risks etc.), we consider that the merits of the change in strategy have been established in practice.

31. We recommend that the Commission accepts Transpower's explanation that its below collar performance for power transformer replacements is attributable to the implementation of an improved and more cost-efficient strategy for its power transformers.

Our assessment of Transpower's explanation for OD/ID conversions

32. Transpower has continued to develop and improve its strategy and associated plans and projects related to Outdoor/Indoor (OD/ID) conversions. The adoption of the new strategy resulted in reduced OD/ID conversions and a resulting below-collar performance, but with reduced cost and risk management benefits. Transpower also demonstrated that it had included its customers in the decisions that affected their service.

33. We recommend that the Commission accept Transpower's explanation for its failure to meet the collar level in respect of OD/ID conversions and recognise that this approach appropriately realised cost and risk management benefits from the strategic changes.

[3] Ofgem is the energy regulator for Great Britain

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1. The Commission's requirements

1. The Commerce Commission has asked Strata Energy Consulting (Strata) to provide its expert opinion and advice in relation to instances where Transpower's quality measure performance failed to meet the collar for DY2018, 2019 and 2020 in the form of a Quality Performance Report.
2. Strata must ensure that it obtains the necessary information to prepare the Quality Performance Report, including through:
    (a) holding discussions with relevant Transpower staff; and
    (b) reviewing relevant information and documentation held by Transpower.
3. The Quality Performance Report must be prepared in a way that provides credible and reliable evidence of the matters it is required to consider.

1.1. What Strata has been asked to do

4. As specified by the Commission, the Quality Performance Report describes, in Strata's expert opinion, the causes of Transpower's failures to comply with the collar value for the grid output measures set out in the Transpower Individual Price Path (IPP)[4] (Transpower's failures). The description is required to include an assessment of the extent to which:
    1. Strata agrees with the causes stated by Transpower for Transpower's failures; and
    2. each of the causes of Transpower's failures contributed to Transpower's outside collar performance.
5. The Commission also requires that this Quality Performance Report, for each of the causes of Transpower's failures, sets out Strata's expert opinion on whether, and the extent to which, Transpower failed to comply with good electricity industry practice.
6. In considering whether Transpower failed to comply with good electricity industry practice, the Quality Performance Report should consider whether in relation to any undertaking and any circumstances, Transpower exercised the degree of skill, diligence, prudence and foresight which would reasonably and ordinarily be expected from a skilled and experienced operator engaged in the same type of undertaking under the same or similar circumstances.

1.2. This Quality Performance Report provides our findings and opinions

7. This report provides discussion on Transpower's performance against its Quality Standards for the DY2018, DY2019 and DY2020.
8. Strata has previously provided the Commission with advice and opinions on Transpower's performance during previous Disclosure Years in various reports and papers:
    - in November 2018, Strata submitted a Draft Stage 1 Report to inform the Commission of potential areas of interest for additional investigation to be completed in Stage 2;

[4] Transpower Individual Price-Quality Path Determination 2015 [2014] NZCC 35 (as amended).

- in February 2019, Transpower supplied the Commission with a report that it had commissioned from GHD/Synergies to provide a peer review of Strata's Draft Stage 1 Report;
- in March 2019, the Commission asked Strata to provide comments on the GHD/Synergies Report and review the initial findings in its Draft Stage 1 Report;
- on 12 August 2019 Strata included advice on the GHD/Synergies Report in its Final Stage 1 Report provided to the Commission;[5]
- in October 2019, the Commission asked Strata to provide its expert opinion and advice in relation to Transpower's quality measure performance for DY2018 and that the findings from the Final Stage 1 Report for DY2016 and DY2017 would be factored into the DY2018 Report; and
- on the 5th July 2020, Strata submitted a Briefing Report to the Commission on its findings and opinions relating to Transpower's DY2018 performance.

1.3. Strata's previous advice is not duplicated in this report

9. As discussed and agreed with the Commission, Strata has not duplicated the discussions provided in its Quality Performance Reports for DY2017 and DY2018. Where relevant to DYs 2018/2019/2020, information in previous papers and reports has been drawn on and referred to.

10. This Quality Performance Report does not replace Strata's views and opinions provided to the Commission in its Stage 1 Quality Performance Report for DY2016 and DY2017.

1.4. The structure of this report is aligned with the Commission's requirements.

11. We have structured this report to align with the Commission's requirements and provide a logical progression of findings and assessments.

12. In the second section, we provide an overview of Transpower's performance against its Quality Standards and identify the measures where performance has exceeded the collar level. We have also included a high-level summary of Transpower's explanations of its performance across the three relevant Disclosure Years.

13. In the following three sections, we provide our detailed assessment for each Grid Output Measure:

    (a) Section 3 provides our assessment of Grid Performance Measures;

    (b) Section 4 provides our assessment of Asset Performance Measures;

    (c) Section 5 provides our assessment of Asset Health Grid Output Measures; and

    (d) Section 6 provides our assessment of Periodic (five-year) Asset Health Measures.

[5] https://comcom.govt.nz/__data/assets/pdf_file/0030/175782/Strata-Energy-Consulting-Limited-Report-on-Transpower-New-Zealand-Limiteds-performance-for-the-2016-and-2017-disclosure-years-12-August-2019.pdf

1.5. Information relied on for the review

14. For this review we have considered information from the following sources:

- publicly available information including information Transpower and the Commission have made available on their respective websites;
- information provided by the Commission, primarily documents and spreadsheets that Transpower supplied to the Commission in response to the Commission's requests for information which included;
    - (a) information provided during Strata's 2018 review of Transpower's performance against its Quality Measures during DY 2017 and DY 2018;
    - (b) Information provided in response to the Commission's February 2020 s 98 request for information, including information provided by Transpower in;
        - (i) Tranche 1, 27 March 2020
        - (ii) Tranche 2, 17 April 2020;
    - (c) Information provided in response to the Commission's 2 February 2021 and 12 March 2021 information request letter to Transpower, including information packs provided on:
        - (i) 1 February 2021;
        - (ii) 14 February 2021;
        - (iii) 12 March 2021;
        - (iv) 8 April 2021;
- information Strata has obtained from other sources.

15. Where information has been quoted directly or referred to in this report, we have provided a footnote identifying the source of the information and/or data.

1.6. Transpower corrected its original data

16. In its Briefing Paper to the Commission, Strata identified apparent inconsistencies in data that Transpower had provided. Specifically, Strata identified that:

- in the Interruptions data, the number of unplanned interruptions recorded for the 'Standard' category was 42 which was six fewer than the 48 that Transpower had reported in its Grid Outputs Report 2018;
- 27 of the total unplanned interruptions were attributed to environmental causes, whereas Transpower's Grid Outputs Report 2018 states that there was a total of 30:
- in its compliance and information reporting under the IPP for RY2018 and the Grid Outputs Report 2018, Transpower refers to the 1,540 minute Berwick N-Security interruption in May 2018, but this interruption does not appear to be present in the Interruptions data; and
- the Interruptions data included event IDs 101058 and 102520 which occurred in September and November 2017 and had final durations of 1,886 and 1,620 minutes respectively. Neither of these events appear to be included in Transpower's document entitled "2017 18 Major Events Details", in which Transpower provided a summary of the major events it experienced in DY2018;

17. Subsequently, the Commission sought an explanation from Transpower for these discrepancies and Transpower responded in its 6 April 2021 letter to the Commission.

18. Transpower confirmed that the 48 interruptions recorded in the Grid Outputs Report 2018 is the correct number of unplanned interruptions in the 'Standard' category for regulatory reporting purposes. Transpower identified that in the data provided:

    (a) two interruptions were included that should not have been; and

    (b) 13 interruptions were not included in the dataset but should have been.

19. Transpower provided a corrected dataset to the Commission in *RCP2 Interruptions for Reporting - 5 Years.xlsx*. Strata has used this dataset for the analysis undertaken for this report.

20. Transpower believes that the reason for the discrepancy was that the information in the Interruptions data had been extracted before the end of the relevant RCP2 year and therefore did not include a completed year. This led to a misalignment with regulatory reporting standards and the audited information disclosed in Grid Output Reports.

21. On the issue related to the fourth bullet point at paragraph 18 above, Transpower explained that:

> *The "2017-18 Major Event Details" file Transpower provided was prepared principally to illustrate the impact that normalisation would have on major events in the relevant disclosure year. In order to prepare that file, initial analysis was undertaken for 74 events on the grid to create a list of events that were potential candidates for normalisation. The spreadsheet titled "2017-18 Major Event Details" listed 10 events that were then assessed for normalisation.*

22. Transpower also confirmed that the two events identified by Strata had been excluded from the dataset it provided but that this had a marginal effect:

> *The two events, 101058 and 102520, had final durations of 1,886 and 1,620 minutes, respectively, but were not included in the shortlist. These two events had initial durations of 381 and 71 minutes respectively, and initial durations is what is reported for GP2 and GP3, and therefore affects compliance. The 102520 event duration of 71 minutes is below the collar and this is likely the reason why it was not included in the shortlist. The 101058 event of 381 minutes is above the collar but is still not particularly long. Excluding this event changed the compliance result only marginally: it reduced the normalised GP2 by three minutes. Because it did not contribute significantly to the normalised compliance result, we did not include it in this analysis.*

23. Clause 16.3.2 of the Commission's IPP determination for RCP2 states the following requirement for recording and disclosing duration of unplanned interruptions:

> *for GP2A, GP2B, GP2C, GP2D and GP2E, the sum of the durations (minutes) of all unplanned interruptions in the relevant disclosure year divided by the total number of unplanned interruptions in the relevant disclosure year*[6]

24. Clause 16.4 states that:

> *For the purposes of clauses 14.2.2, 14.2.3, 16.3.2 and 16.3.3, the duration of an unplanned interruption means the elapsed time (in minutes, rounded*

[6] Consolidated-Transpower-individual-price-quality-path-determination-2015-28-November-2018

to the nearest whole minute) from the start of the interruption until the earlier of either:

16.4.1 restoration; or

16.4.2 seven days after the interruption started.

25. We note that Transpower's explanation indicates that it excludes certain interruption event data because the minutes recorded for the interruption are below a collar. Presumably this collar filters smaller interruption events from Transpower's disclosed interruptions data.

26. We have found no reference to such a collar in the Commission's IPP determination for RCP2. We are therefore concerned that Transpower may be excluding data for events that should otherwise be included.

27. Transpower's letter indicates that for events 101058 and 102520, durations were reduced from a total of 3,506 to the initial outage durations of 452 minutes. Transpower considers this to have made only a marginal difference to the total data provided.

28. The above is relevant to Transpower's analysis of the impact of normalisation as there already appears to be a material reduction in the number of minutes recorded for certain events. This subject is discussed further in section 2.

2. Transpower's performance against the Quality Standards

29. Transpower's performance against the Quality Standards is recorded annually against 20 subcategories of performance measures. There are a further three periodic measures that are recorded for five-year performance.

30. During the 2018, 2019 and 2020 Disclosure Years, Transpower contravened 40%[7] of its annual performance measures and all three of its five-year periodic measures.

31. The focus for this review is on performance measures where Transpower's performance exceeded the collar in any of the three disclosure years (i.e., it either above, or failed to meet the relevant quality measure collar). These areas are as follows:

32. For Grid Performance Measures:

- the number of unplanned interruptions - Standard (DY2018);
- average duration of unplanned interruptions - High Priority (DY2018 and DY2020), Standard (2018), Generator (2018), and N-Security (DY2018 and DY2019); and
- duration of P90 unplanned interruptions - Standard (DY2018 and DY2019), Generator (DY2018) and N-Security (DY2018 and DY2019).

Table 1: Transpower's performance against Grid Performance Measures

Grid output measure	Quality measure	Category / Circuits	Ref.	above/below collar				
				2016	2017	2018	2019	2020
Grid performance measures	Number of unplanned interruptions	Standard	GP1C			✓		
		Generator	GP1D		✓			
	Average duration of unplanned interruptions	High Priority	GP2A			✓		✓
		Important	GP2B		✓			
		Standard	GP2C			✓		
		Generator	GP2D			✓		
		N-security	GP2E	✓	✓	✓	✓	
	Duration of P90 unplanned interruptions	Important	GP3B		✓			
		Standard	GP3C			✓	✓	
		Generator	GP3D			✓		
		N-security	GP3E	✓	✓	✓	✓	

Sources: Commerce Commission CSO[8]

Note: Cells with ticks indicate measures were exceeded in that disclosure year

[7] Transpower contravened 24 out of 60 annual performance measures

[8] 3879605_AoG CSO - Strata Energy Consulting - Transpower investigation 2018, 2019, 2020, page 3

33. For Asset Performance Measures

- HVDC availability (DY2020); and
- HVAC availability (DY2018, DY2019 and DY2020).

Table 2: Transpower's performance against Asset Performance Measures

Grid output measure	Quality measure	Category / Circuits	Ref.	above/below collar				
				2016	2017	2018	2019	2020
Asset performance measures	HVDC availability	-	AP1					✓
	HVAC availability	Selected circuits	AP2	✓	✓	✓	✓	✓

Sources: Commerce Commission CSO[9]

Note: Cells with ticks indicate measures were exceeded in that disclosure year

34. For Asset Health Grid Output Measures

- number of transmission towers refurbished (DY2019 and DY2020);
- number of grillage foundations replaced (DY2018, DY2019 and DY2020); and
- number of insulator sets replaced (DY2018, DY2019 and DY2020).

Table 3: Transpower's performance against Asset Health Grid Output Measures

Grid output measure	Quality measure	Category / Circuits	Ref.	above/below collar				
				2016	2017	2018	2019	2020
Asset health grid output measures	Number of transmission towers refurbished/replaced	-	AH1				✓	✓
	Number of grillages commissioned	-	AH2	✓	✓	✓	✓	✓
	Number of insulators commissioned	-	AH3	✓	✓	✓	✓	✓

Sources: Commerce Commission CSO[10]

Note: Cells with ticks indicate measures were exceeded in that disclosure year

35. For Periodic (five-year) Asset Health Grid Output Measures

- number of outdoor circuit breakers commissioned;
- number of power transformers commissioned; and
- number of outdoor to indoor conversions commissioned.

[9] 3879605_AoG CSO - Strata Energy Consulting - Transpower investigation 2018, 2019, 2020, page 3

[10] 3879605_AoG CSO - Strata Energy Consulting - Transpower investigation 2018, 2019, 2020, page 3

Table 4: Transpower's performance against Periodic (five-year) Asset Health Grid Performance Measures

Grid output measure	Quality measure	Category / Circuits	Ref.	above/below collar				
				2016	2017	2018	2019	2020
Periodic (five-year) asset health grid output measures	Number of outdoor circuit breakers commissioned	-	AH4		-			✓
	Number of power transformers commissioned	-	AH5		-			✓
	Number of outdoor to indoor conversions commissioned	-	AH6		-			✓

Sources: Commerce Commission CSO[11]

Note: Cells with ticks indicate measures were exceeded in that disclosure year

36. This report has been structured to cover each Grid Output Measure in turn with focus applied to the specific annual quality measure in each Disclosure Year where Transpower's performance was outside the collar level.

37. In section six we discuss the review findings on Transpower's performance against the three periodic (five year) Asset Health Measures.

2.1. Transpower's overview of its Performance

38. Transpower provided to the Commission[12] its views on

(a) the reasons for its contraventions of quality standards in DY2018, DY2019 and DY2020;

(b) the relationship between the DY2018, DY2019 and DY2020 contraventions and the earlier contraventions in DY2016 and DY2017;

(c) its general network performance and asset health trends over RCP2; and

(d) the continuous improvement actions it was taking in relation to network performance and asset health.

39. On point b) Transpower advised[13] the Commission that in its view, there are no new contributing factors that should prompt the Commission to adopt a different view when it evaluates the relevant contraventions for the remaining years of RCP2.

40. On point c), Transpower considers that its performance has generally improved over DY2018, DY2019 and DY2020 and that it has:

> *demonstrated good electricity industry practice in its management of the grid performance, asset performance and asset health measures and its actions have not resulted in reasonably avoidable material detriment to consumers.*[14]

41. Regarding its outside collar performances in the Asset Health measures during DY2018, DY2019 and DY2020, Transpower considers that it demonstrated good

[11] 3879605_AoG CSO - Strata Energy Consulting - Transpower investigation 2018, 2019, 2020, page 3

[12] Transpower 29 January 2021 letter to the Commission titled 2018 -2020RY CONTAVENTIONS: S98 INVESTIGATION

[13] Ibid, page 2

[14] Ibid

electricity industry practice and that the contraventions have not resulted in material detriment to consumers.

42. We assess Transpower's explanations in further detail in the relevant sections of this report.

3. Assessment of Transpower's performance against Grid Performance Measures

43. In this section, we commence with a general overview of Transpower's performance in the relevant Grid Performance Measures over the twenty-year timeframe for which Transpower provided data. Our intention in using this timeframe is to highlight trends and outlying areas and provide perspective and context to our assessment of the specific areas where Transpower exceeded its collars in DYs 2018, 2019 and 2020. We note that Transpower also applied twenty-year analysis in its letters and presentation to the Commission.

44. In the following sections we provide our assessments related to the specific Grid Performance Measures where Transpower's performance exceeded its collar.

3.1. Overview of trends in performance

45. The three annual quality measures for grid performance are:

    1. number of unplanned interruptions;
    2. average duration of unplanned interruptions; and
    3. 90th percentile (P90) duration of unplanned interruptions in minutes.

46. Grid quality measures and associated targets, caps and collars were applied to four categories to reflect the variability in customer expectations on supply. The categories are high-priority, important, standard, generator, and N-Security.

47. In the following subsection, we provide an overview of relevant performance data for unplanned interruptions. This information is relevant to our reviews of each grid performance category (average duration of planned interruptions for N-Security sites and the duration of P90 unplanned interruptions for N-Security sites).

48. Transpower exceeded eight of the fifteen individual grid quality measures in DY2018, three in DY2019, and one in DY2020.

49. Table 5 shows that for number of unplanned interruptions, Transpower exceeded its collar only once in DY2018 for Standard sites out of the total of fifteen quality measures set for DY2018 toDY2019. Whilst the exceedance of collar in DY2018 for Standard sites was 55% above the collar, for most other unplanned interruption measures, Transpower was a significantly below its collar.

Table 5: Number of unplanned interruptions against collar levels

Number of unplanned interruptions

	2018	2019	2020
High Priority	1	2	2
Important	10	3	6
Standard	48	16	16
Generator	7	13	2
N-Security	51	30	19

Number of unplanned interruptions against collar

	2018	2019	2020
High Priority	-3	-2	-2
Important	-4	-11	-8
Standard	17	-15	-15
Generator	-9	-3	-14
N-Security	-23	-44	-55

Number of unplanned interruptions % of collar

	2018	2019	2020
High Priority	-75%	-50%	-50%
Important	-29%	-79%	-57%
Standard	55%	-48%	-48%
Generator	-56%	-19%	-88%
N-Security	-31%	-59%	-74%

Sources: Data sourced from Transpower's annual IPP Disclosures

Note: Negative values indicate performance within collar

50. Table 6 shows that for duration of unplanned interruptions, Transpower exceeded its collar six times during the three Disclosure Years. This included a significant exceedance of collar for N-Security sites occurring in DY2019 when Transpower exceeded its collar by 261%.

51. Tables 5 and 6 indicate that exceedance of interruption duration quality measures was a larger issue for Transpower during the three Disclosure Years rather than the number of interruptions for each category in each Disclosure Year.

Table 6: Average duration of unplanned interruptions against collars

Average duration of unplanned interruptions

	2018	2019	2020
High Priority	141	9	113
Important	40	55	81
Standard	164	96	78
Generator	229	183	134
N-Security	188	415	81

Average duration of unplanned interruptions against collar

	2018	2019	2020
High Priority	31	-101	3
Important	-130	-115	-89
Standard	34	-34	-52
Generator	19	-27	-76
N-Security	73	300	-34

Average duration of unplanned interruptions % of collar

	2018	2019	2020
High Priority	28%	-92%	3%
Important	-76%	-68%	-52%
Standard	26%	-26%	-40%
Generator	9%	-13%	-36%
N-Security	63%	261%	-30%

Sources: Data sourced from Transpower's annual IPP Disclosures

Note: Negative values indicate performance within collar

52. Table 7 shows that for duration of P90 unplanned interruptions, Transpower exceeded its collar five times during the three Disclosure Years. N-Security quality measures recorded a significant exceedance of collar for N-Security sites occurring in DY2019.

53. However, when we consider the percentages where Transpower did not exceeded its collar for average duration of P90 unplanned interruptions, it can be seen that the percentages for periods when the collar was exceeded were relatively small, other than the N-Security measure in DY2019.

Table 7: Average duration of P90 unplanned interruptions against collars

Duration (minutes) of P90 unplanned interruptions

	2018	2019	2020
High Priority	141	10	146
Important	65	118	98
Standard	202	225	145
Generator	588	342	178
N-Security	381	473	182

Duration (minutes) of P90 unplanned interruptions against collar

	2018	2019	2020
High Priority	-19	-150	-14
Important	-245	-192	-212
Standard	2	25	-55
Generator	148	-98	-262
N-Security	121	213	-78

Duration of P90 unplanned interruptions as % of collar

	2018	2019	2020
High Priority	-12%	-94%	-9%
Important	-79%	-62%	-68%
Standard	1%	13%	-28%
Generator	34%	-22%	-60%
N-Security	47%	82%	-30%

Sources: Data sourced from Transpower's annual IPP Disclosures

Note: Negative values indicate performance within collar

54. The above tables indicate that the material quality performance issue is the duration of unplanned interruptions for N-Security sites in DY2018 and DY2019.

3.2. Overview of Transpower's track record for number of unplanned interruptions

55. Figure 1 provides an eighteen-year perspective of unplanned interruptions for each of the Grid Output Measures. The number of unplanned interruptions indicates that Transpower has improved its performance and that the RCP2 Disclosure Years experienced relatively low unplanned interruptions compared with historical levels and the twenty-year average.

56. Whilst interruption numbers trended upwards between DY2016 and DTY2018, the final two Disclosure Years of RCP2 were in the four lowest DYs of the twenty-year period.

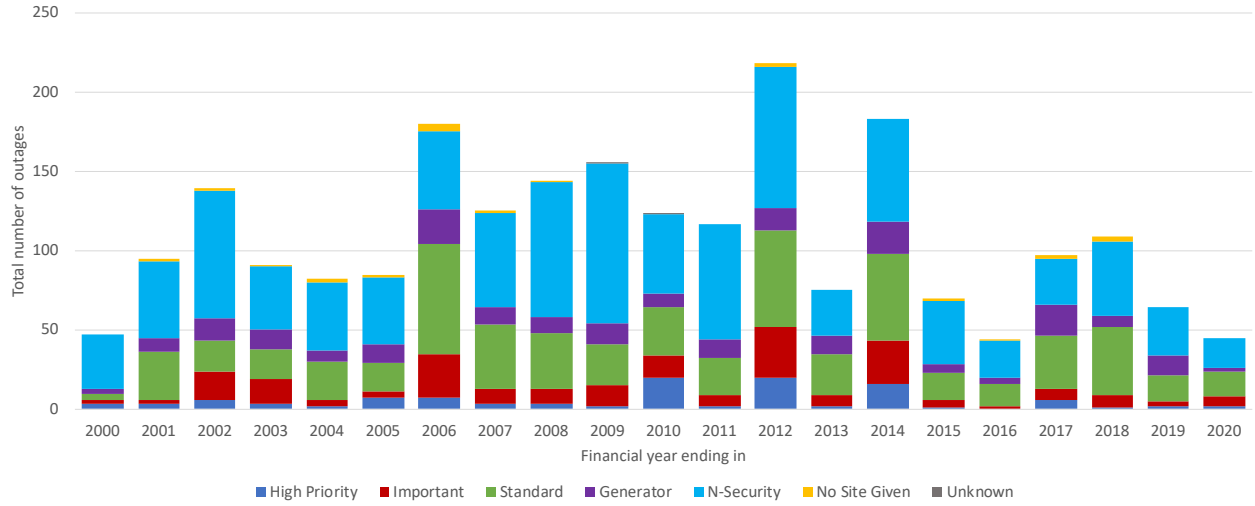
57. In our view, the performance for the number of unplanned interruptions in RCP2 does not raise concerns that the transmission network is underperforming against historical

levels. In particular, the chart indicates that Transpower has significantly reduced the number of unplanned interruptions for N-Security. This is especially positive because an N-Security interruption normally results in loss of supply to electricity consumers.

58. The chart also indicates that Transpower has improved data quality, this is indicated by the reduction in 'no site given' interruption records.

59. Other than the above, there are no indications that trends in a specific category are attributable to Transpower's DY2018 performance.

Figure 1: Number of unplanned interruptions by Quality Measure



Source: Strata analysis of Transpower data[15]

60. Using data Transpower supplied to the Commission, we identified the Level 1 causes Transpower attributed to unplanned interruptions. The dataset enabled a twenty-year perspective to be gained. The resulting chart is provided in Figure 2.

61. The number of interruptions indicates that during RCP2 Transpower achieved a material reduction in the number or interruptions attributable to human error. Transpower also significantly reduced the number of cause unknown interruptions which indicates that it either introduced improved identification of interruptions and/or actually reduced the number of interruptions due to unknown causes.

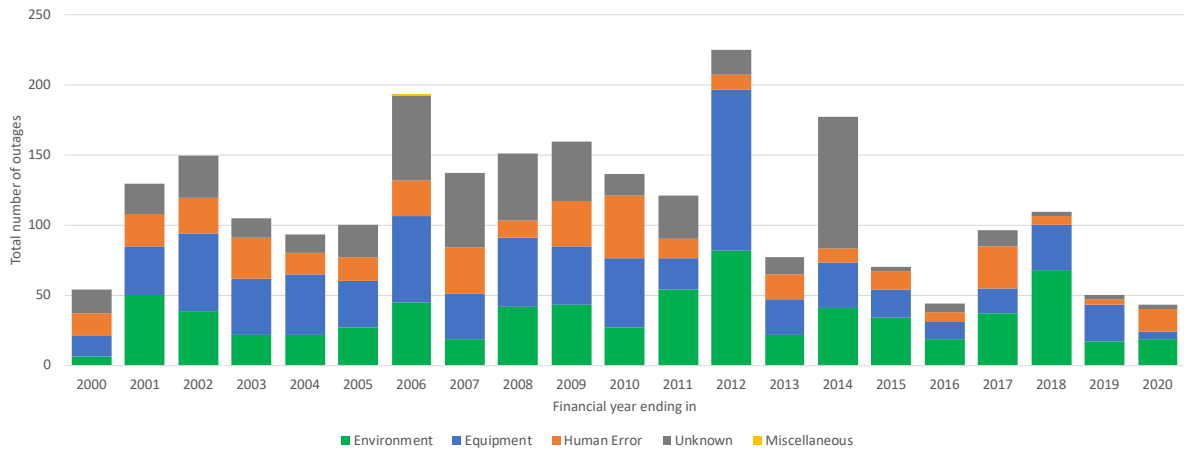
62. Reduction in unknown causes can have both positive and negative effects. It is positive because the data provides improved information for asset managers. It can be negative if truly unknown events have been attributed to a cause without specific evidence.

63. Given the fall in unplanned interruptions since 2015, we consider that Transpower's reduction in unknown events is likely to be positive.

64. Over the twenty-year period, Transpower has reduced the number of interruptions attributed to equipment failure. The lower levels of interruptions attributable to equipment failure can clearly be seen in Figure 2 to have occurred in RCP2.

[15] Strata combined the interruptions data from four Excel workbooks it provided to the Commission, these are; RCP2 Interruptions 1718, RCP2 Interruptions 1819, RCP2 Interruptions 1920 and Transpower 2020 IPP Disclosures

Figure 2: Number of unplanned interruptions by level 1 cause classification



Source: Strata analysis of Transpower data

3.3. Transpower concluded that its performance has improved

65. Transpower concluded that its performance for the numbers of unplanned interruptions measure had improved over the twenty-year period and:

> *with the exception of RY2018's outlier result, the number of interruptions at RCP2 classified points of services has been steadily trending down. The result in RY2018 is largely explained by extreme weather events. There is no evidence of deteriorating performance in terms of the number of interruptions.*

66. Transpower concluded that DY2018 was an outlier in terms of number of unplanned interruptions experienced:

> *environmental causes disproportionately contributed to interruptions in RY2018….. RY2018 is therefore not representative of the underlying reliability performance of Transpower's network.*[16]

67. On unplanned interruption duration, Transpower did not provide an explanation for the trend of increasing duration minutes and average duration over the same twenty-year period.

3.4. Interruption duration is a more significant contributor to exceedance of collar

68. Whilst the number of unplanned interruptions contributed to only one instance of exceedance of collar performance, the average duration of interruptions contributed to six instances and for average duration of unplanned outages, an additional five instances for P90 duration minutes.

69. As indicated in Tables 6 and 7, the duration of unplanned interruptions for N-Security and P90 measures were the primary Grid Performance Measures where Transpower's performance exceeded collar. This is particularly the case for N-

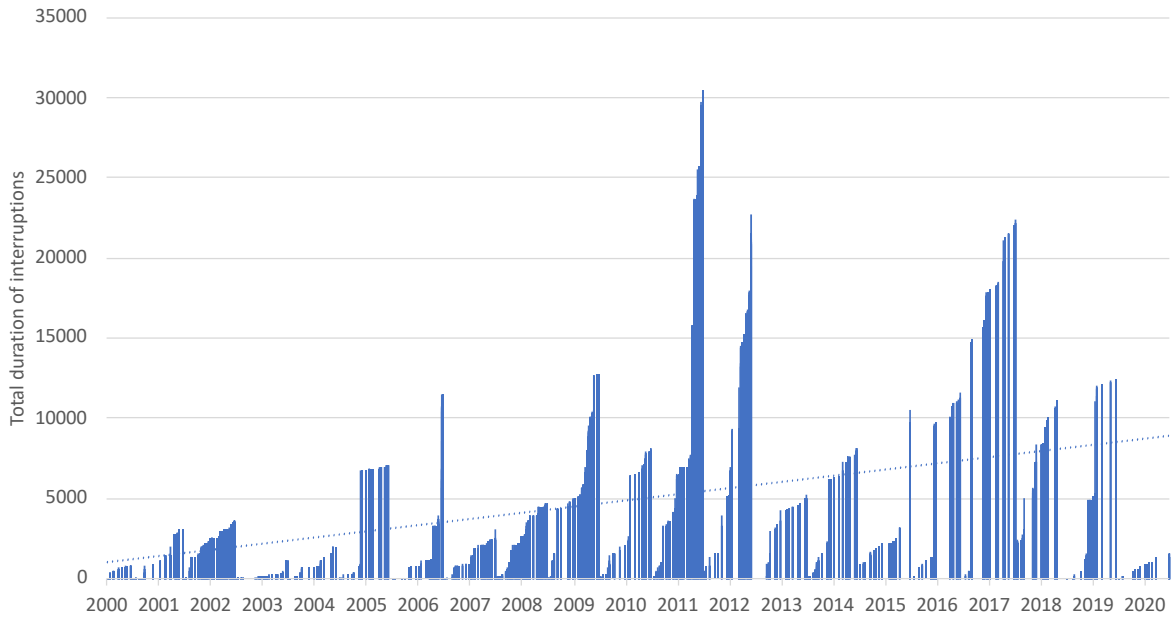
[16] Transpower 29 January 2021 letter to the Commission titled 2018 -2020RY CONTAVENTIONS: S98 INVESTIGATION , pages 6 and 7

Security and P90 measures in DY2018 and DY2019 where performance significantly exceeded collar.

70. An upward trend in duration of unplanned interruptions for N-Security from 2007, can be observed in Figures 3 and 4. Figure 3 shows the total duration minutes and Figure 4 the average duration minutes. This, combined with the observation that unplanned interruption numbers have trended downwards, indicates that, on average, Transpower is taking longer to respond to and restore assets following unplanned events. Appendix C provides similar charts for all categories.

71. Transpower's data included a single event entry of 87179 minutes (60-day interruption) for event number 58441 which occurred on 12/06/2006. This data point was 6 times greater than the next longest duration event and 15 times greater than the third longest duration event. We removed this single data point in Figures 3 and 4 as it is not relevant to our assessment of the three relevant Disclosure Years and adds a distortion when considering long term trends.

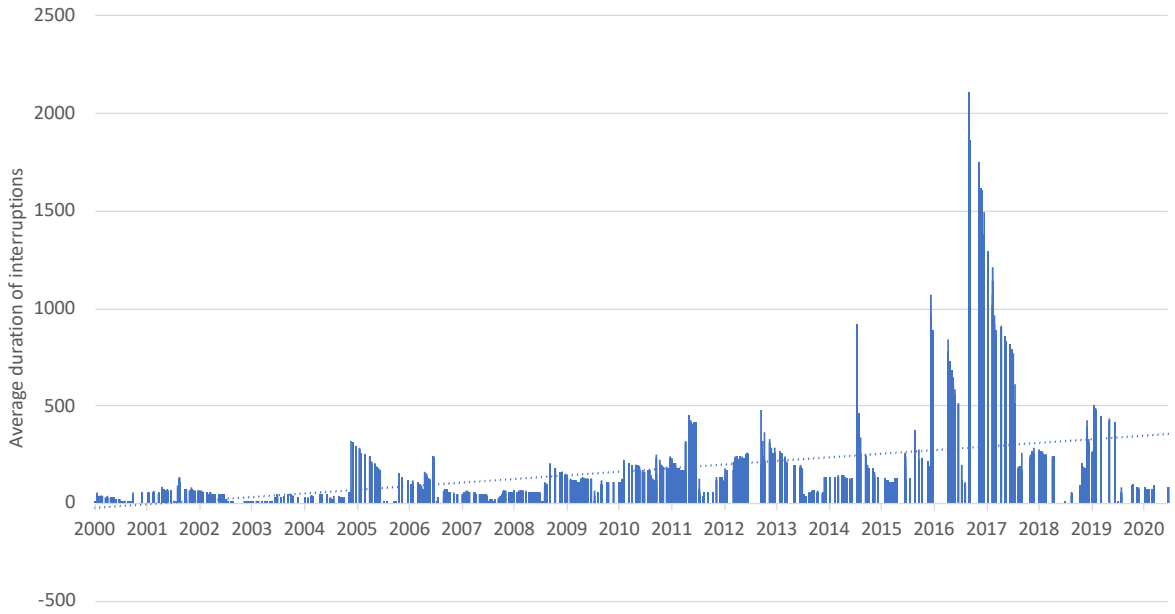
Figure 3: Total N-Security unplanned interruptions duration (minutes)



Source: Strata analysis of Transpower interruptions data

Note A material outlier datapoint for 2006 of 87179 minutes was removed due to scaling issues.

Figure 4: Rolling averages of N-Security unplanned interruptions duration (minutes)



Source: Strata analysis of Transpower interruptions data

Note A material outlier datapoint for 2006 of 87179 minutes was removed due to scaling issues.

72. We discuss contributors to unplanned interruption further when addressing the above collar average duration of unplanned interruptions performances for High Priority, Standard, Generator and N-Security sites.

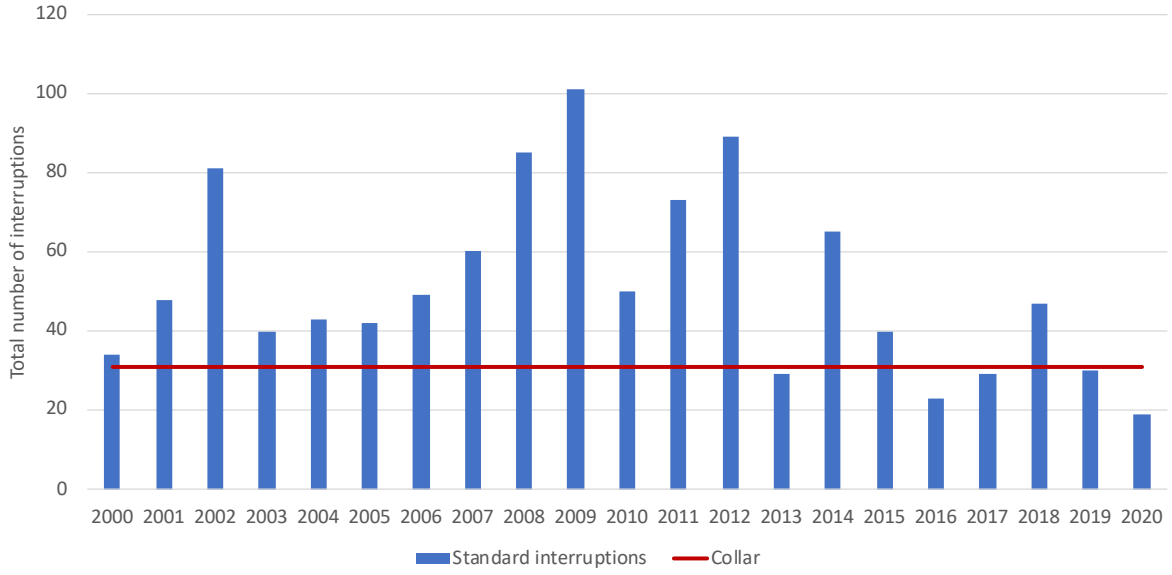
3.5. Number of unplanned interruptions for Standard sites in DY2018

73. Table 5 indicates that in DY2018, Transpower exceeded its collar by 55%. The number of unplanned interruptions for this category were 108% higher than in DY2017 and 243% higher than in DY2016. We have sought to identify reasons for the significant increase and the upward trend in numbers of unplanned interruptions for Standard sites seen between DY2016 and DY2018.

74. Figure 5 provides the twenty-year data for standard category unplanned interruptions together with the RCP2 targets, caps and collars. Interestingly, Transpower remained within the cap and collar in only five of the twenty Disclosure Years. Four of the five Disclosure Years in which Transpower's performance was below its collar level (i.e. met the quality measure) were during RCP2.

75. This provides a clear indication that Transpower has significantly improved its performance above historical levels for the number of interruptions measure in RCP2.

Figure 5: Standard category number of unplanned interruptions

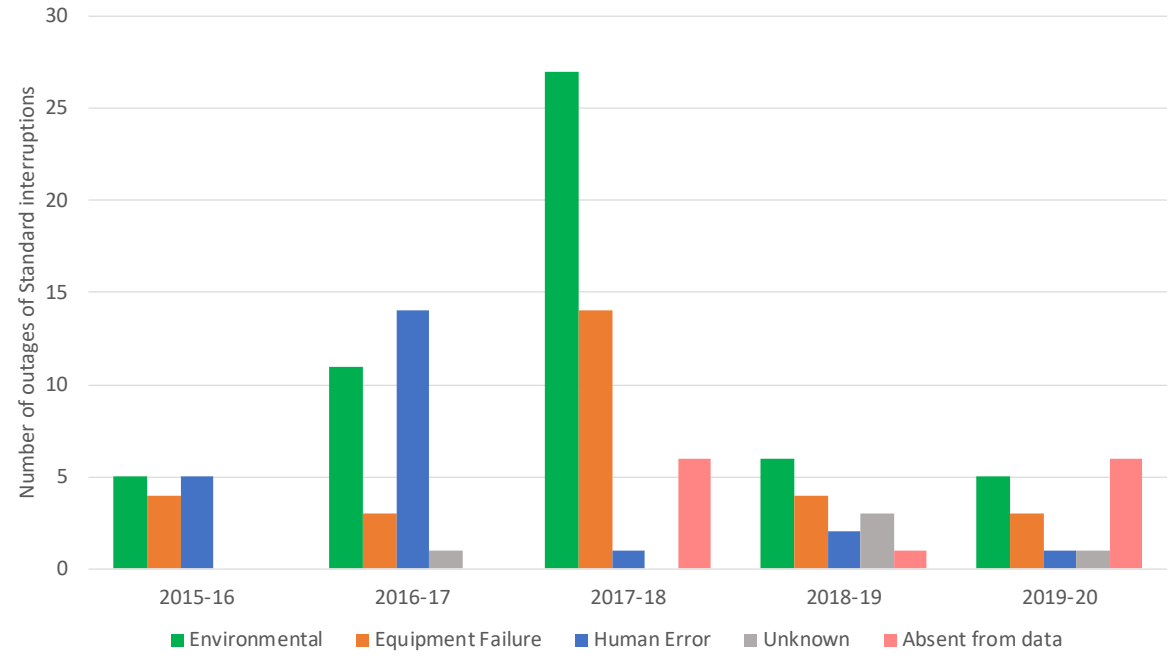


Source: Strata analysis of Transpower interruptions data

Note: Note that 6 fewer interruptions were seen in the dataset than in Transpower's disclosure.

76. Figure 6 provides further perspective of the specific contributary causes of unplanned interruptions for the Grid Output Measure. Especially significant for DY2018 are contributions from environment and equipment related failures.

Figure 6: Number of Standard unplanned interruptions by level 1 cause classification



Source: Strata analysis of Transpower data

Note: Absent from data means interruptions where Transpower did not provide a level 1 clause in the inte dataset.

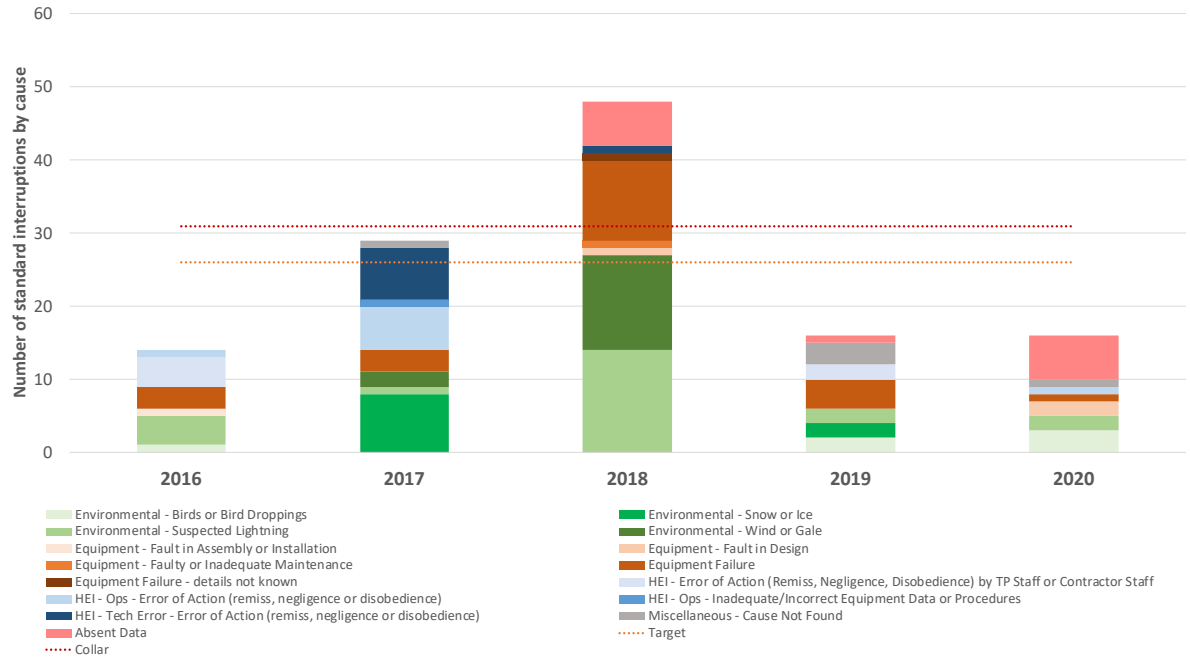
77. Transpower also noted that the biggest contributor to the number of Standard interruptions was environmental causes (30 of the 48 interruptions). For DY2018, the main contributors are 'suspected lightning' and 'wind and gale', factors which are clearly representing the impact of extreme weather events during that Disclosure Year.

78. Figure 7 indicates that primary contributors to environmental interruptions are Wind or Gale (13 interruptions) and Suspected Lightning (14 interruptions), whilst in previous years, Snow or Ice and Suspected Lightning were leading causes of environmental interruptions.

79. Due to the absence of definitions for secondary cause codes in the data set supplied by Transpower, we are unable to identify the underlying causes for equipment failure. However, Figure 7 shows that we can eliminate faulty or inadequate maintenance, fault in design, and faulty assembly or installation as primary contributors to the above collar performance in DY2018.

80. In DY2018, lightning and wind causes were the highest recorded in the twenty-year dataset provided by Transpower. It is also likely that most cause unknown events during DY2018 were environmental.

Figure 7: Standard unplanned interruptions by Level 1 and 2 causes



Source: Strata analysis of Transpower interruptions data

Transpower's explanation for the outside collar result in DY2018 for standard unplanned interruptions

81. In its DY2018 compliance statement, Transpower supplied the following explanation:

> *The biggest contribution to the number of Standard interruptions was environmental causes (30 of the 48 interruptions). With environmental causes we see an increase in the number of interruptions caused by one event: a strong Canterbury wind in November 2017 caused eight interruptions in the top of South Island and on the West Coast. Similarly, in*

February 2018 a strong wind caused three interruptions to the West Coast points of service.

Lightning also caused four points of service interruptions in April 2018 on Stratford–Taumarunui (SFD–TMN) circuits. The number of Standard interruptions caused by equipment failures was 14 of the 48 interruptions.[17]

82. Transpower noted the following components of the environmental disruptions that occurred in DY2018:

- a strong Canterbury wind in November 2017 caused eight interruptions in the top of the South Island and on the West Coast;
- in February 2018 a strong wind caused three interruptions to the West Coast points of service; and
- lightning caused four points of service interruptions in April 2018 on Stratford-Taumarunui (SFD-TMN) circuits.

83. Transpower provided additional information for two of these events:

November 2017 event

8 November 2017 event occurred at 02:43am on the ISL_WPR_CUL_KIK2 circuits when tripping occurred due to clashing conductors caused by strong winds. Primary areas affected were Stoke, Argyle, Culverden, Murchison, Atarau, Dobson, Blenheim, Greymouth, Robertson St, Reefton and Kikiwa.[18]

84. We found that NIWA recorded the following in its Highlights and Extreme Events summary for November 2017:

On 8 November, houses in the Monaco and Tahunanui areas of Nelson were flooded by storm surge as a powerful low moved across the South Island. A group of campers on waterfront reserve area in the Mapua and Ruby Bay area were given help to evacuate, citing water to 'knee-level.'

On 8 November, 773 children had the day off school with snow and floodwaters closing seven schools and two early learning services in Otago and Southland. Farther north, children had to be helped to school by police in Thames after flooding and broken powerlines left a road impassable.[19]

February 2018 event

HKK-OTI-2 tripped, high winds in the area. 01Feb2020 1050 HKK_OTI2 tripped from red phase to yellow phase fault caused by conductors down. Severe weather storm (ex-cyclone Fehi) caused the damage. Tripping of this circuit and of HKK_KUM1 (at 1030) resulted in LOS to HKK. KUM_OTI1 RFS for safety clearance work on HKK_OTI2. There was interruption of generation at KUM during this period. High winds - couldn't send technicians to fix issue[20]

[17] Grid Outputs Report 2018, page 31
[18] Annex 1; 2018 event 3
[19] https://niwa.co.nz/sites/niwa.co.nz/files/Climate_Summary_November_2017_revised.pdf
[20] Annex 1; 2018 event 7

April 2018 event

85. Transpower supplied details of the 10 April 2018 07:15 event attributed to a lightning strike on Stratford - Taumarunui circuit 1. Restoration of Stratford- Taumarunui circuit 1 was completed by auto-reclosure of circuit breakers within a minute.

86. The event also caused the tripping of the Taumarunui T5 traction transformer which led to a partial interruption of supply to KiwiRail Holdings Ltd at Taumarunui which caused an interruption duration of four minutes. Following restoration, the interruptions data records that a second event attributed to lightning strike occurred at 07:40 which also caused four minutes of interruption of supply to KiwiRail Holdings Ltd.

87. Transpower's interruption data records eight lightning related interruptions on the 10 April 2018. Four of these records related to interruptions affecting the KiwiRail Holdings Ltd supply point. The first event no 115241 is recorded at 7:31am, the second event 115250 occurred at 7:50am. Both events were limited to four minutes.

88. Transpower provided one System Fault and Interruption Report (SN18095) related to event number 115241. SN18095 confirms the suspected lightning strike and restoration in four minutes to the Kiwi Rail Limited supply. SN18100 which covers event number 115250 was not included in the information provided by Transpower.

Our assessment of Transpower's explanation for Standard sites in DY2018

89. Figure 2 indicates that unplanned interruptions for the Standard category are variable between disclosure years and that environmental impact is a primary cause of this variability. Based on historical data, it was highly likely that Transpower's performance would be outside its caps and collars at some point during RCP2. It has however met its measures in four Disclosure Years of RCP2.

90. This indicates the difficulty in setting performance measures for numbers of unplanned interruptions. For EDB Quality Standards, normalisation has been used to reveal underlying performance by reducing the effects of major events; Transpower's RCP2 measures do not have this facility.

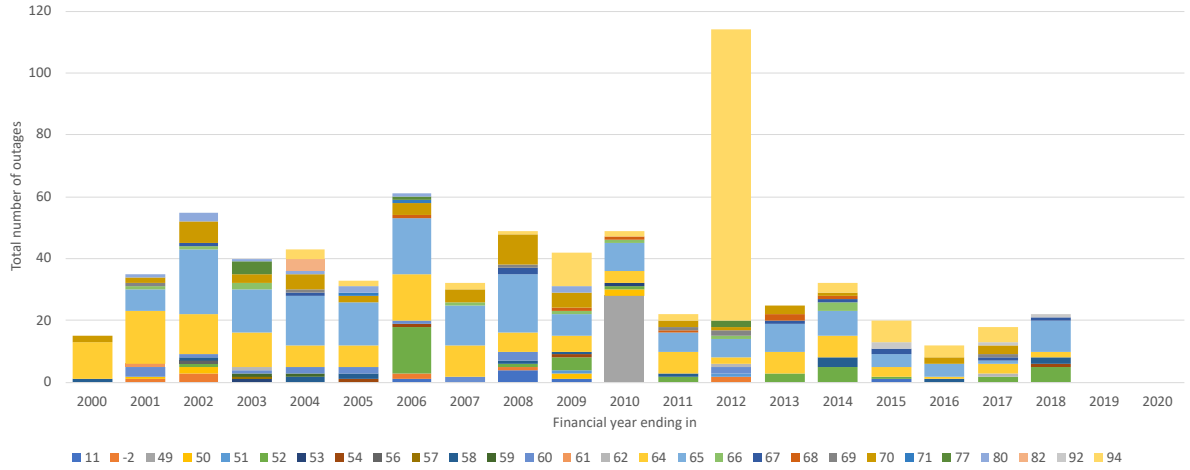
91. Transpower's data shows that, while multiple interruptions were linked to the same event, there were also a larger number of events in DY2018 than in the other RCP2 Disclosure Years. The interruptions data indicates that the increase in environment and equipment failure were material differences in DY2018 with a reduction seen in interruptions attributed to human error.

92. Figure 8 shows the breakdown of unplanned interruptions attributable to equipment failure by secondary cause code number. Unfortunately, Transpower has not supplied the descriptions associated with the cause codes. We could only determine that the highest contributor to equipment failure interruptions in DY2018 was cause code 65.

93. To overcome this, we used the Primary Cause Description 2 field in Transpower's data set to provide an alternative view of the cause of unplanned interruptions. The results, in Figure 9, shows that most of the cause descriptions are given as not available (N/A). This means that the secondary cause code data will not provide information needed to understand the actual causes of the underlying equipment failure.

94. For example, in DY2018 there are eleven events recorded as Cause Code 65. Ten of the events have N/A recorded in the Primary Cause Description 2 field. The single event where a Cause Description 2 is added states *Fault in Design*, which is identical to the primary cause code.

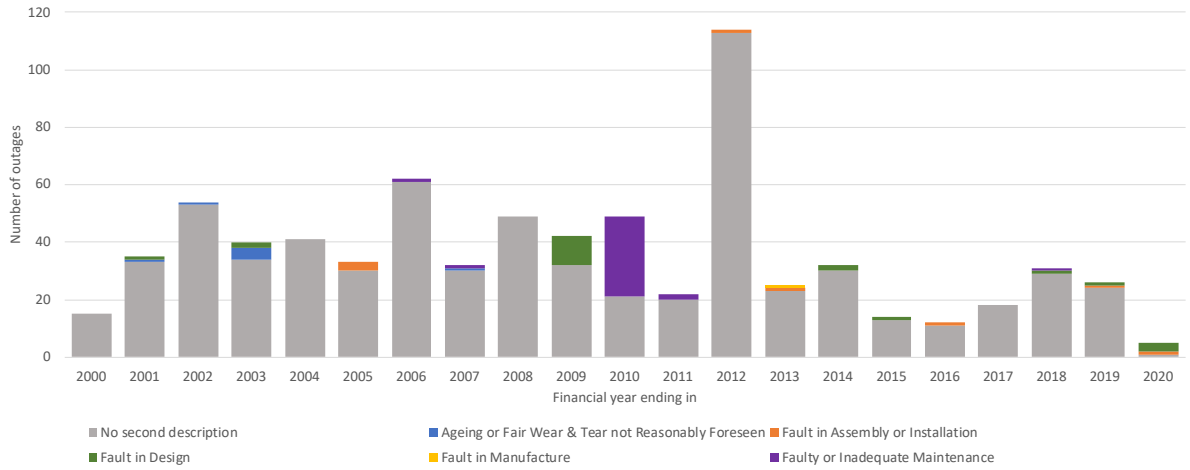
Figure 8: Interruptions attributed to equipment failure



Source: Strata analysis of Transpower interruptions data

Note: The breakdown for DYs 2019 and 2020 could not be presented because the data Transpower provided gave to the Commission for those DYs did not include data for these cause codes. Also, whilst the Commission previously requested a list of descriptions linked to the cause codes, Transpower did not provide this information.

Figure 9: Interruptions attributed to equipment failure by Primary Cause 2



Source: Strata analysis of Transpower interruptions data

Note: The grey values indicate the extent of the absence of cause 2 information in the dataset.

95. We have concluded that the dataset supplied by Transpower to the Commission provides only high-level information on the causes of interruptions and is unsuitable for gaining insights into the underlying causes of interruptions.

96. We note that in its letters and presentation to the Commission, Transpower relied on high-level data. It did not provide any analysis indicating the underlying causes of interruptions. If this is representative of the data Transpower uses when obtaining an understanding of the performance of its assets, we consider this to be not good electricity industry practice.

97. Using the high-level dataset fields, Strata identified several clusters of interruptions (see Figure 10).

98. In November 2017, one event contributed 8 interruptions (30.8% of Transpower's interruption target for standard interruptions). This event is consistent with

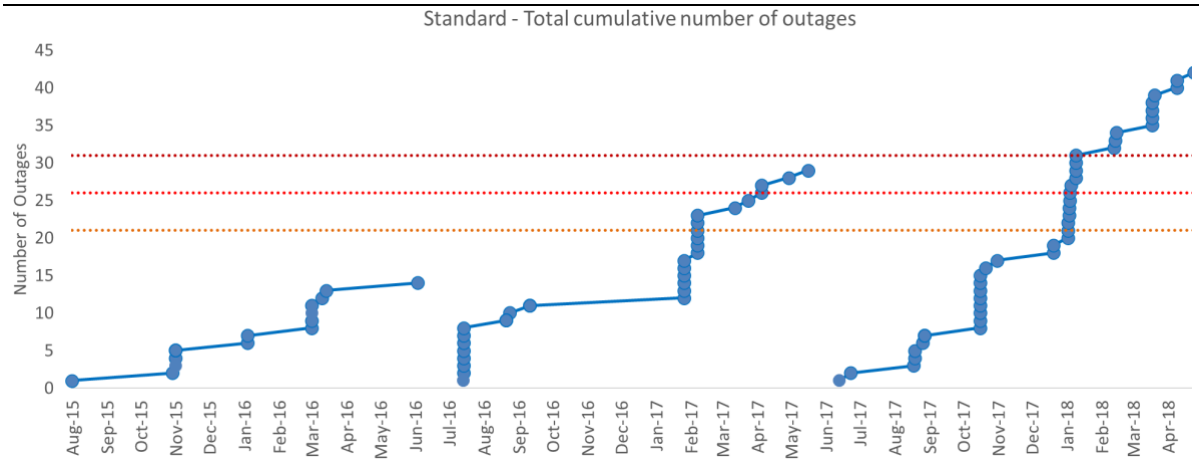
Transpower's explanation of the strong Canterbury wind event causing interruptions in the top of the South Island and on the West Coast.

99. The most significant event occurred in January/February 2018 when 9 events contributed 12 interruptions (46.2% of the interruption target for standard interruptions). This is consistent with Transpower's identification of strong winds on the West Coast and lightning in the central North Island.

100. In April 2018, 4 events contributed 4 interruptions on one day (15.4% of Transpower's interruption target for Standard interruptions).

101. Our analysis supports Transpower's view that clusters of interruptions, such as those occurring on major event days (MEDs) made a significant contribution to its exceedance of collar in DY2018. For these periods, the data indicates that most interruptions in DY2018 were attributable to wind, lightning and equipment failure; this is consistent with Transpower's explanations.

Figure 10: Cumulative duration profiles for Standard interruptions



Source: Strata analysis of Transpower interruptions data

102. Extracts from the dataset for the interruption clusters we identified is summarised below.

Interruption cluster 1 – November 2017 - Environmental
Event ID: 102259 contributed 8 interruptions to Transpower's 2017/18 interruption total on the 8th of November 2017 at 2:43 am.

(a) This event occurred across site codes: BLN (Marlborough), CUL (Mainpower), DOB (Westpower), GYM (Westpower), ORO (Buller Electricity), RFN (Westpower), and STK (Network Tasman).

(b) The cause of the event was 'Environmental – Wind or Gale', ISL-KIK-2 & 3 trip-clashing, major West Coast loss of service.

Interruption cluster 2 – January/February 2018
Nine events contributed 12 interruptions to Transpower's 2017/18 interruption total between the 25th of January 2018 and the 2nd of February 2018:

(a) event ID: 114183, contributed 3 interruptions on the 25th of January due to equipment failure;

(b) five events between the 26th and 28th of January contributed 5 standard interruptions at the site code TMN (KiwiRail) and were attributed to 'Environmental – Suspected Lightning'; and

(c) two events between the 1st and 2nd of February contributed 4 interruptions at the site codes HKK and KUM (both Westpower) and were attributed to 'Environmental – Wind or Gale'.

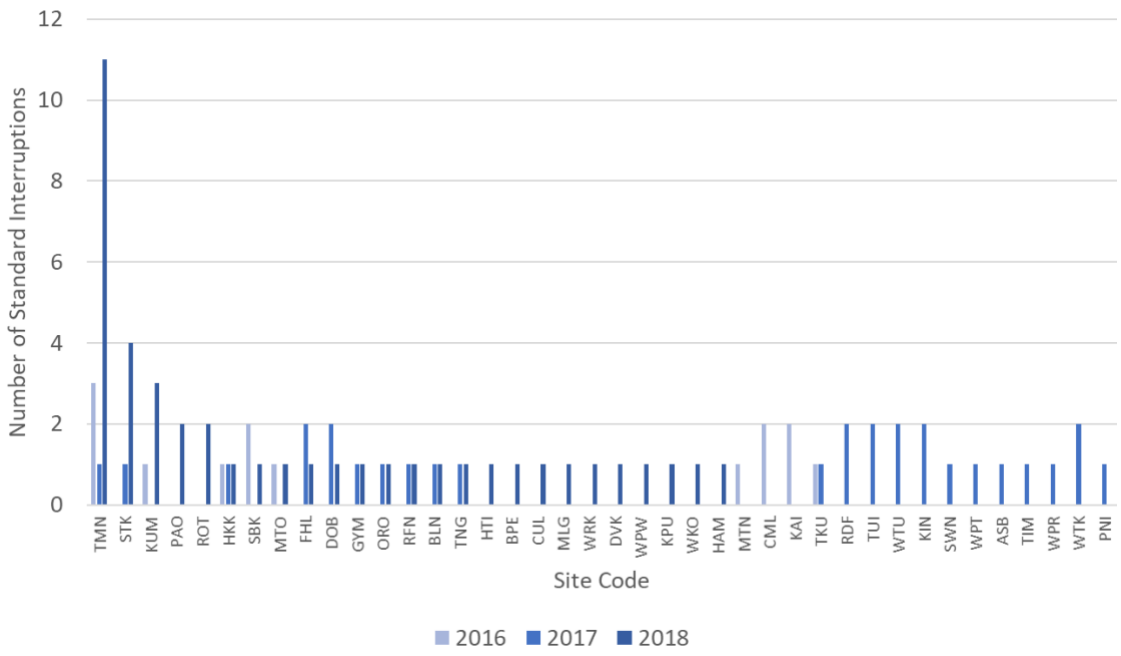
Interruption cluster 3 – April 2018 – Environmental
Four events contributed 4 interruptions to Transpower's 2017/18 interruption total on the 10th of April 2017:

(a) These events occurred at the site code TMN (KiwiRail) and were attributed to 'Environmental – Suspected Lightning'.

103. Eleven standard interruptions in DY2018 occurred at TMN. This amounts to 23% of the 48 standard interruptions disclosed by Transpower in DY2018 and all were due to Suspected Lightning.

104. Figure 11 shows the number of standard interruptions by location (site code). This suggests they are the worst performing locations. TMN can clearly be seen as a major problem in DY2018.

Figure 11: Total number of events for Standard interruptions, by site code



Source: Strata analysis of Transpower interruptions data

Note: Transpower did not provide the site codes in its DY2019 and 2020 data sets

105. We found that excluding all lightning strikes at TMN and all wind events that occurred on the 8th of November reduces the number of standard interruptions for DY2018 to 29; this is below the collar of 31 but still above the target of 26.

106. In Transpower's Asset Management Plan (AMP), we searched for, but did not identify, any discussion of this event nor any options to reduce risks of future similar interruptions. We searched for post-event reviews for this event in the information Transpower supplied to the Commission in its s98 response Tranches 1 and 2 but did not find any.

Application of normalisation to Standard number of interruptions

107. In its January 2020 letter to the Commission, Transpower set out its analysis and views regarding the application of normalisation to its data. The objective of this analysis was to demonstrate the sensitivity of its performance to the impact of significant events.

108. We consider that our analysis of numbers of interruptions has demonstrated that some form of normalisation is likely to have removed the single instance in RCP2 where Transpower exceeded the collar level in DY2018 for standard unplanned interruptions.

109. We have not considered if the normalisation Transpower applied in its analysis is reasonable. If used appropriately, normalisation would be applied when setting the targets, caps and collars, as well as to the interruption data. Our high-level review of Transpower's normalisation approach suggests that normalisation was only applied to the latter.

110. However, Transpower pointed out that the Commission intentionally excluded high impact low probability (HILP) interruption events from the historic data set when setting the RCP2 measures of Grid Performances. The result is that Transpower was required in RCP2 to report performance on a different basis to that used by the Commission to derive the quality standards. Transpower's view is that this approach made its annual performance unduly sensitive to major exogenous events, including severe weather and major equipment failure.

111. If Transpower's point on the inconsistent basis for setting targets and measuring performance is correct, then this adds weight to the results of its normalisation analysis. However, as Transpower's normalisation analysis indicates, the single incidence of above collar performance for the Standard quality measure in DY2018 would still have occurred, but by a reduced margin.

Significant weather events caused Transpower’s exceedance of its collar

112. We agree with Transpower that DY2018 was an exception; were it not for significant weather events, its performance would have been close to its collar for Standard number of unplanned interruptions. We found no evidence that the exceedance of collar performance for this measure related to Transpower failing to act in accordance with good electricity industry practice.

3.6. Average duration of unplanned interruptions for High Priority, Standard, Generator and N-Security sites, and duration of P90 sites

113. Table 6 indicates that Transpower exceeded its average interruption duration collar in four categories:

- for High Priority sites, average interruption duration was above the collar by 28% in DY2018 and 3% in DY2020;
- for Standard sites, average interruption duration was 26% above the collar in DY2018;
- for Generator sites, average interruption duration was 9% above the collar in DY2018; and
- for N-Security sites, actual duration was above the collar by 63% in DY 2018 and 261% in DY2020.

114. Table 7 indicates that Transpower exceeded its collar for P90 average durations in five categories:

- for Standard sites, actual duration exceeded the collar by 1% in DY2018 and 13% in DY2019;
- for Generator sites, actual duration was 34% above the collar in DY2018; and
- for N-Security sites, actual duration was above the collar by 47% in DY2018 and 82% in DY2019

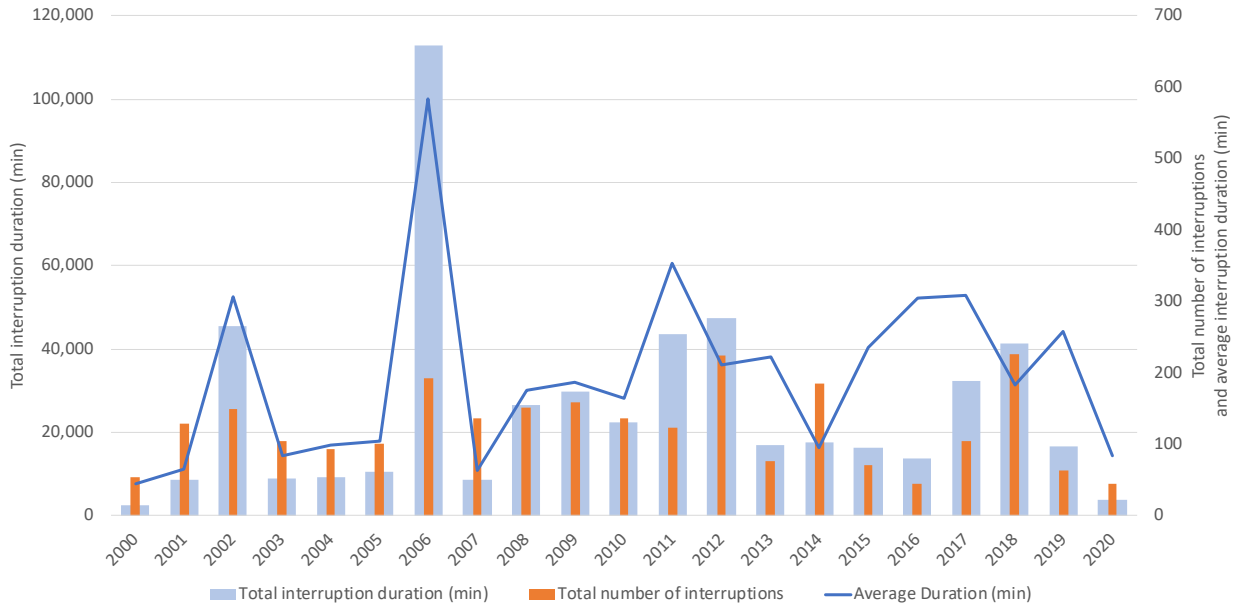
115. Because Transpower's explanations for P90 sites were common to the other average interruption duration quality measures, we have considered and assessed them together in the following subsection.

Average duration of unplanned interruptions has been increasing

116. Figure 12 provides a twenty-year perspective of the relationship between the number and total and average duration of unplanned interruptions. Figure 13 presents the same data but with the 2006 outlier event removed. These charts clearly indicate that, whilst the number of unplanned interruptions has trended downwards, the average duration of interruptions has been increasing over the twenty years.

117. Figure 13 indicates that, with the outlier removed, DY2018 had the fourth highest out of the twenty-year set of average interruption durations. DY2019 was in the mid-range and DY2020 the second lowest of the twenty-year interruption duration data.

Figure 12: Number and duration of unplanned interruptions



Source: Strata analysis of Transpower interruptions data

Figure 13: Number and duration of unplanned interruptions (outlier removed)

Source: Strata analysis of Transpower interruptions data

118. We considered the information and views Transpower provided in its letters, compliance statements and other documentation to identify if this adequately explained the interruption duration performance seen in the charts above.

Transpower's explanation for the increase in the average duration of unplanned interruptions

119. Transpower noted[21] that its average interruption duration (all causes) had trended upwards over twenty-years, but also considered that it was variable. Transpower also presented[22] a chart of twenty-year average duration of interruptions attributable to equipment failure. This chart showed that a clear upwards trend had occurred.

120. Transpower applied a normalisation adjustment to its DY2018 data and found that this reduced its above collar performances in average interruptions in one out of the four GP2 quality measure collar breaches and one out of the three GPS quality measure collar breaches. As we noted in section 3.6, we have not assessed Transpower's normalisation analysis in detail.

121. The results of Transpower's normalisation are reproduced in Figure 14. This indicates that for DY2018, with major interruption events reduced through normalisation, the instances where the collar was exceeded would have reduced from four to three. For P90 durations, exceedance of collar would have reduced by one instance.

[21] Presentation to the Commerce Commission, Transpower Quality Standards: RY18 – 20 4 February 2021, slide 8
[22] Ibid, slide 9

Figure 14: Number and duration of unplanned interruptions (outlier removed)

Measure	Category	RY2018 Actual	RY2018 Normalised	Collar	Comments
GP1: Number of interruptions (p.a.)					
	High Priority	1	1	4	
	Important	10	10	14	
	Standard	48	37	31	Marginally exceeds collar
	Generator	7	7	16	
	N-security	51	44	74	Further improvement
GP2: Average duration of interruptions (min)					
	High Priority	141	141	110	
	Important	40	40	170	
	Standard	164	100	130	No longer exceeds collar
	Generator	229	229	210	
	N-security	188	158	115	Improved, but still exceeds collar
GP3: P90 Longest durations (min)					
	High Priority	141	141	160	
	Important	65	65	310	
	Standard	202	174	200	No longer exceeds collar
	Generator	588	588	440	
	N-security	381	301	260	Improved, but still exceeds collar

Source: Transpower letter to the Commission[23]

122. Based on the above analysis, Transpower concluded that:

> *A 'normalised' view of RY2018 (as above, note 22) supports the conclusion that Transpower's reliability performance has not deteriorated over the period but, rather, has improved over the five years.*

123. Transpower did not provide any discussion on how it had reached the above conclusion. To have reached this view, Transpower would have had to apply normalisation to the historical data to ensure that comparison of DY2018 and the historical data was on the same basis. Our understanding is that Transpower's analysis compares normalised DY2018 data with raw (i.e., pre-normalised data) for historical disclosure years.

124. Based on our understanding we do not accept that Transpower has demonstrated that its reliability performance, in terms of interruptions duration, had improved over the five RCP2 years.

Explanations for High Priority quality measure interruption duration events

125. For High Priority sites, in its IPP disclosure Transpower provided the following explanation for its exceedance of collar in DY2018:

> *There was only one High Priority interruption at Opunake substation for 141 minutes due to equipment failure (Circuit Breaker)……. Because there was only a single interruption at a High Priority site, the average duration is equal to the length of the single interruption that occurred.*[24]

[23] Transpower 29 January 2021 letter to the Commission titled 2018 -2020RY CONTAVENTIONS: S98 INVESTIGATION , page 7

[24] IPP Disclosures 2017-18 (final published) and Grid Outputs Report 2018

126. The above event occurred on 13 June 2017.

127. For High Priority sites, Transpower provided the following explanation for its above collar performance in DY2020.

> *There were two interruption events for the high priority sites during RY2020. One was the Northland event on 27 November for 72 minutes….and the other was the Opunake Bus event on 29 March for 154 minutes…. The average duration of these two events exceeded the collar.*
>
> *The Opunake bus event, which ultimately caused the contravention, was most likely caused by twigs dropped by a bird, for which there was evidence of burnt twigs found dangling from the bus near the insulator where flash over markings were found.*[25]

Explanations for Standard category interruption duration and P90 events

128. For the exceedance of the Standard interruption duration collar in DY2018, Transpower provided the following explanation:

> *The longest Standard Interruption duration was at Hokitika substation for 3,000 minutes due to high winds which damaged the transmission line resulting in the conductor on the ground. The repair time was delayed due to the high wind.*
>
> *The other significant event was at Hamilton substation for 1,475 minutes due to low Voltage Transformer oil level……the majority of the remaining underlying incidents were due to environmental causes that affected multiple Points of Supply. Where responses were required on site, we have set response times for service providers.*[26]
>
> *The P90 for Standard is high due to a low number of interruptions in 18/19 (16 interruptions), with only two of the 16 interruptions being over 225 mins falling within the P90. The longest one was when Wairakei Transformers T29 and T30 tripped resulted in blackout in Taupo and Rotorua regions for a [sic] nine hours.*[27]

Explanations for Generator category interruption duration events

129. For Generator category interruption duration performance in DY2018, Transpower provided the following explanation:

> *There were seven Generator interruptions, with the largest contribution to exceeding the collar for average duration and P90 of duration at Generator sites being a 1336 minute interruption at Rangipo substation caused by a Disconnector fault. Rangipo substation has GIS equipment installed, which can take longer to find fault and repair than normal equipment. Absent the Rangipo interruption, the average and P90 duration would have been 45 and 78 minutes which would have met the collars. Three incidents were lightning related and were automatically returned within an average of 38 minutes. Where fault responses were required our Service Provider's [sic] were on site within their target response times.*[28]

[25] Transpower 29 January 2021 letter to the Commission titled 2018 -2020RY CONTAVENTIONS: S98 INVESTIGATION , page 7 and Transpower 2020 IPP Disclosures.xlsx, Tab 16
[26] IPP Disclosures 2017-18 (final published) and Grid Outputs Report 2018
[27] IPP Disclosures 2018-19 Final_Oct2019
[28] Ibid

Explanations for N-Security category average duration and P90 interruption events

130. For N-Security interruption duration and P90 quality measure in 2018, Transpower provided the following explanation:

> *There were three long duration interruptions at N-Security sites that have a large impact on average and P90 durations. Interruption at Mataroa substation for 1,734 minutes due to snow and ice loading on conductor on Mataroa-Ohakune circuit in July 2017, at Berwick for 1,540 minutes due to Disconnector fault in May 2018 and at National Park substation due to lightning on Ohakune-National Park-Ongaroe circuit in November 2017. Without of these three interruptions, the average would have met the collar at 109 minutes.*
>
> *The July 2017 Central Plateau snow storm caused 2300 mins across 3 substations, including the largest duration at Mataroa, we also experienced 7 interruptions at 7 POS totalling 690 mins caused by high winds in Canterbury in November 2017. Nearly a third of all the interruption duration in the year was caused by the snow storm and the Canterbury high winds.*[29]

131. For N-Security interruption duration and P90 quality measure in 2019, Transpower provided the following explanation:

Event 1

> *At Maraetai a protection relay failed.*
>
> *The make and model (SEL321) had a known issue being RAM failure and our program of fast track replacements had not yet addressed Maraetai.*
>
> *Shortly after the failure occurred, the planned works for the bus split project started…. The replacement of the relay was then scheduled within the bus split project to ensure the works were completed efficiently and hence the unplanned interruption was the length of the project outage. (5716min).*

Event 2

> *The Current Transformer (CT) at McKee suffered an explosive failure (3096min).*
>
> *This was the third failure of that make and model, which has a vulnerability with respect to the rubber bellows cracking and moisture entry due to New Zealand's humidity. The CT was replaced with a spare unit and nearby units tested before returned to service.*

Event 3

> *The Castle Hill 11kV disconnector insulator failure (802min) was caused by a design fault that allows water to enter which can freeze and cause failure. The long duration was due to the decision to replace all nine insulators of this type on the disconnector and not just the one that failed. The remoteness of this site is also a contributing factor. There are no remaining insulators of this type at Castle Hill now.*

[29] IPP Disclosures 2017-18 (final published) and Grid Outputs Report 2018

P90 events

> *…only two of the 16 interruptions being over 225 mins falling within the P90. The longest one was when Wairakei Transformers T29 and T30 tripped resulted in blackout in Taupo and Rotorua regions for a nine hours (535 mins). However, average duration of Standard was relatively manageable at 96 mins, significantly less than the collar of 130 minutes.*

132. Transpower's explanations for its average duration interruptions and P90 duration interruptions can be condensed into the following events:

High Priority exceedance of collar in DY2018 and DY2020	• an interruption at Opunake substation for 141 minutes due to equipment failure (Circuit Breaker); • Northland event on 27 November 2019 for 72 minutes; and • Opunake Bus event on 29 March for 154 minutes.
Standard exceedance of collar in DY2018 and 2019	• an interruption of 3,000 minutes at Hokitika due to high winds; • an event that led to an interruption of 1,475 minutes at Hamilton substation; and • tripping of Wairakei Transformers T29 and T30.
Generators exceedance of collar in DY2018	• an interruption of 1,336 minutes at Rangipo due to equipment failure.
N security exceedance of collar in DY2018	• an interruption of 1,734 minutes at Mataroa substation due to snow or ice;[30] • one interruption of 1,540 minutes at Berwick due to equipment failure; • one interruption of 1,058 minutes at National Park due to lightning; • a protection relay failure at Maraetai; and • an explosive failure of a current Transformer at McKee; and • failure of an11kV disconnector insulator failure at Castle Hill caused by a design fault.

133. We have added notes containing further information on the Transpower's explanation of these events in Appendix B.

[30] One of 10 interruptions associated with Event ID 100153 – overall average of 230 minutes.

Our assessment of Transpower's explanations

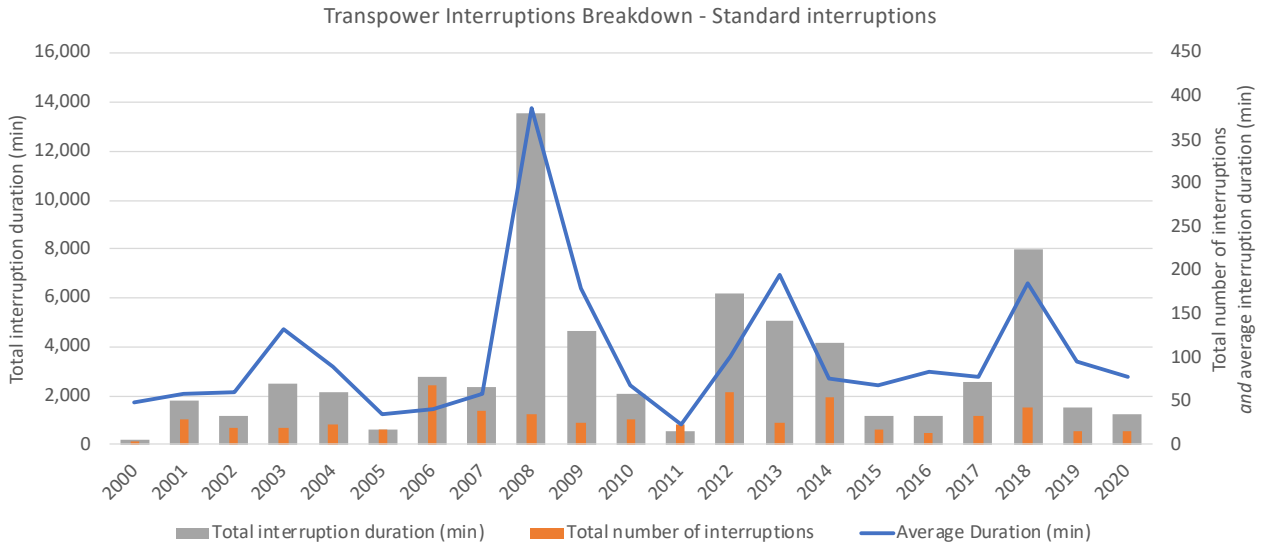
134. We have reviewed additional information and data supplied by Transpower relating to each of the above events. This information was supplied by Transpower in response to the Commission's periodic requests for information in 2019, 2020 and 2021.

135. We used the interruptions data supplied by Transpower to analyse the effect that longer interruptions had on average interruption duration for DY2018.

Average interruption duration at Standard sites

136. Figure 15 shows compares total and average interruption duration with the number of interruptions for Standard. The impact on the number and average duration resulting from the DY2018 performance can clearly be seen as affecting RCP2 results.

Figure 15: Standard interruption number and duration long term performance



Source: Strata analysis of Transpower interruptions data

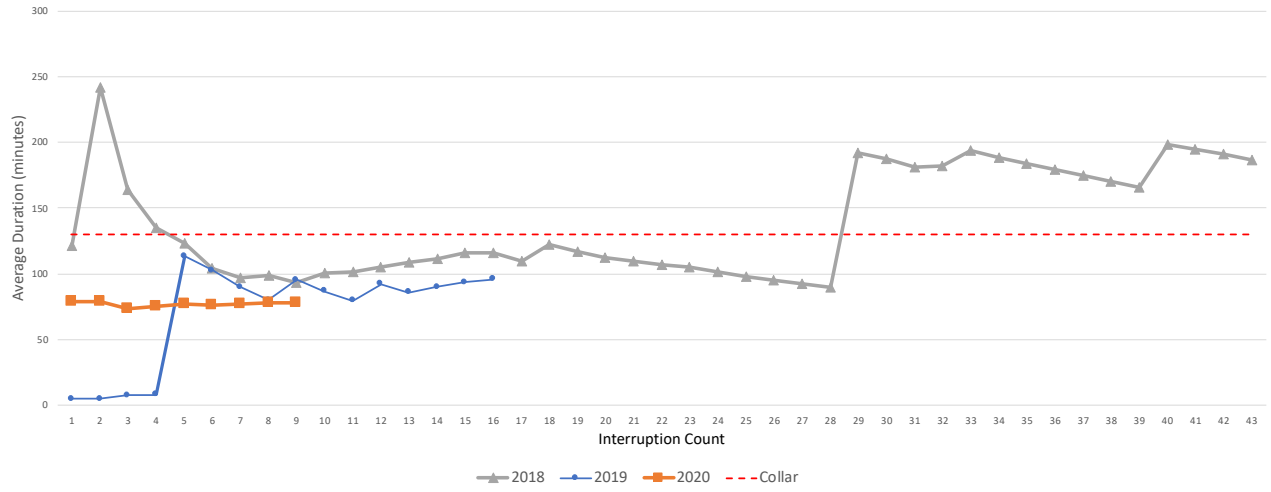
137. The chart in Figure 16 shows the development over time of the average interruption duration as it progresses through each DY.

138. For DY2018, long duration interruptions early in the Disclosure Year caused large increases that were relatively quickly reduced by subsequent, shorter interruption events while large increases later in the year caused less dramatic changes but took longer to reduce. This means that long duration outages close to the end of the disclosure year cause a step up that cannot be reduced over time.

139. The much shorter plots for DY2019 and DY2020 indicate far fewer interruptions events. For DY2019, the average for a single long duration event (event 5) drove the average towards the collar; however, the absence of further large events during DY2019 resulted in an end of Disclosure Year that was under the collar level.

140. DY2020 shows the effect of a Disclosure Year that had few events and none of long duration.

Figure 16: Standard average interruption duration development for DYs 2018,19,20



Source: Strata analysis of Transpower interruptions data

141. Five events stand out as contributing the most to increasing the DY2018 average duration for standard interruptions. These are 100174, 102697, 114255, 114704 and 115273. Summaries from the interruption data for these events are provided below:

    1. event 100174 occurred on the 16th of July 2017 and had a total interruption duration of 363 minutes due to 'Equipment Failure;'
    2. event 102697 occurred on the 23rd of November and had a total interruption duration of 350 minutes due to 'Equipment Failure;'
    3. event 114255 occurred on 1st February 2018 and was linked to three different interruptions; one of these had an interruption duration of 3066 minutes due to 'Environment - Wind or Gale;'
    4. event 114704 occurred in March 2018 and had a total interruption duration of 582 minutes due to 'Environmental – Suspected Lightning Strike;' and
    5. event 115273 occurred in April 2018 and had a total interruption duration of 1,475 minutes due to 'Equipment Failure.'

142. The Hokitika event 114255 is highlighted by Transpower in its Grid Output Report explanation, and Hamilton is the site of event 114704.

143. Excluding event 114255 would reduce the average interruption duration to 117 minutes, within the 130 minute collar; while events 115273 and 114255 need to be removed, or reduced to below 200 minutes in order to reduce the P90 duration for Standard interruptions to below the collar.

144. This supports Transpower's explanation that these two events were material contributors to its exceedance of the collar for both average duration and P90 duration for Standard sites.

145. This is also relevant to Transpower's exceedance of the collar for the number of Standard interruptions because the 'clusters' of interruptions we identified as contributing to the large number of interruptions include 2 of the 5 events (114255 and 114704) identified above.

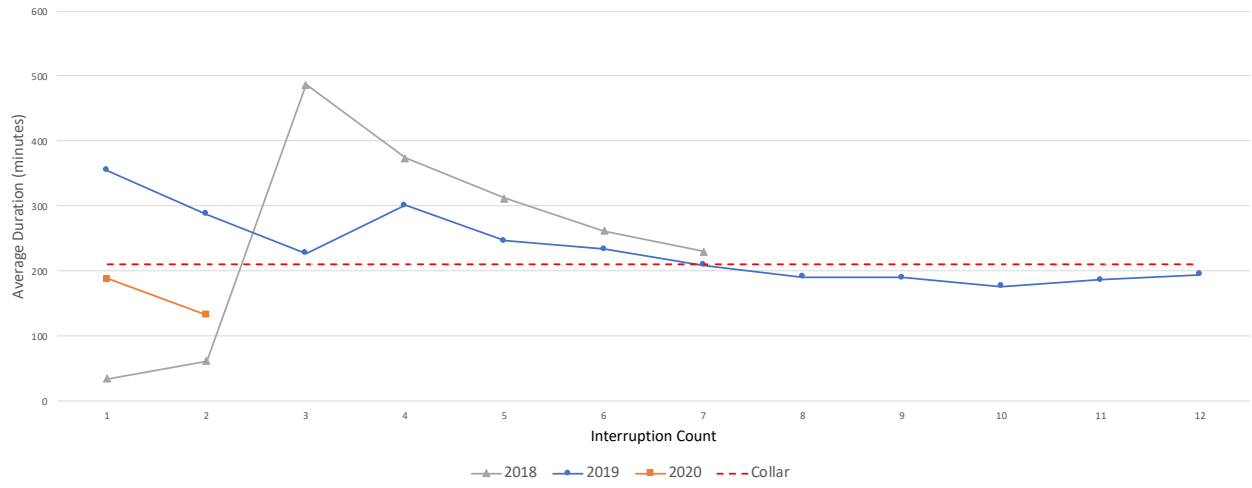
Average and P90 interruption durations at generator sites

146. One event stands out as contributing to Transpower's exceedance of its DY2018 average duration collar for Generator interruptions. That event number is 115010.

147. Event 115010 recorded 1,336 minutes due to equipment failure on the 29th of March 2018 at site code RPO - "RPO-DS-667 fault 220kV bus tripping, LOC Genesis". This is the Rangipo hydroelectric power station owned and operated by Genesis Energy.

148. Figure 17 shows the evolution of average interruption duration for Generator sites as it progresses through each Disclosure Year.

Figure 17: Standard average interruption duration development for DYs 2018,19,20



Sources: Strata analysis of Transpower interruptions data

149. The impact that event 115010 had on the average interruption duration and the P90 duration is clearly visible. In DY2018 there were seven Generator interruptions with the second longest Generator interruption lasting eighty nine minutes. The Rangipo interruption lasting 1,336 minutes near to the final quarter of the disclosure year had a significant impact on the average and was the reason why Transpower exceeded its P90 average duration collar for generator interruptions.

150. Ironically, if Transpower had experienced two additional short (less than 100 minute) interruptions in DY 2018, its P90 average duration for Generator interruptions would have been below the collar. This brings into question the value of this measure, as a higher number of interruptions would improve performance; therefore the measure has to be taken in context with the number of interruptions, which for DY2018 were fewer than half the collar value for the Generator category.

151. Because of the relative infrequency of generation related interruptions, a single, long duration event can lead to non-compliance. This was the case in DY2018. In DY2019 it took several smaller events to counteract a few larger duration events.

152. This supports Transpower's view that the duration measures are sensitive to a small number of larger events. They are also sensitive to the timing of larger events, and the number of smaller duration events in the Disclosure Year.

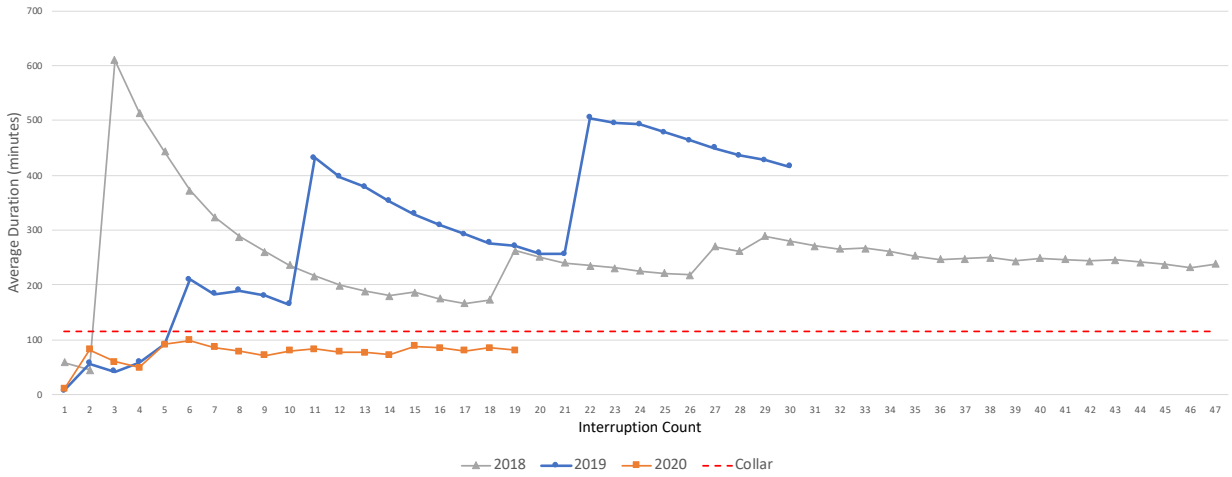
Average and P90 interruption durations at N-Security sites

153. Figure 18 shows the evolution of the average interruption duration for N-Security sites as it progresses through each period.

154. The plot for DY2018 shows that the early large events proved difficult to recover over the remainder of the Disclosure Year. As was identified by Transpower, in the absence of the large event, performance would have been closer to collar.

155. DY2019 was quite different to DY2018 with three significant uplifts during the Disclosure Year having a cranking effect on the average interruption duration. The latter event occurring on 14th January 2019 could not be reduced by number of interruptions during the remaining months.

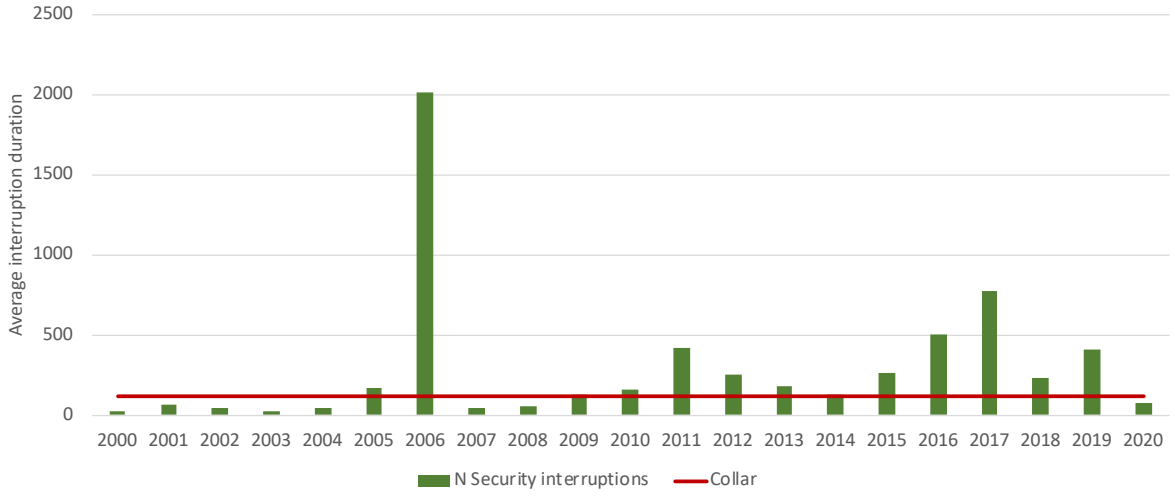
Figure 18: N-Security average interruption duration development for DYs 2018,19,20



Source: Strata analysis of Transpower interruptions data

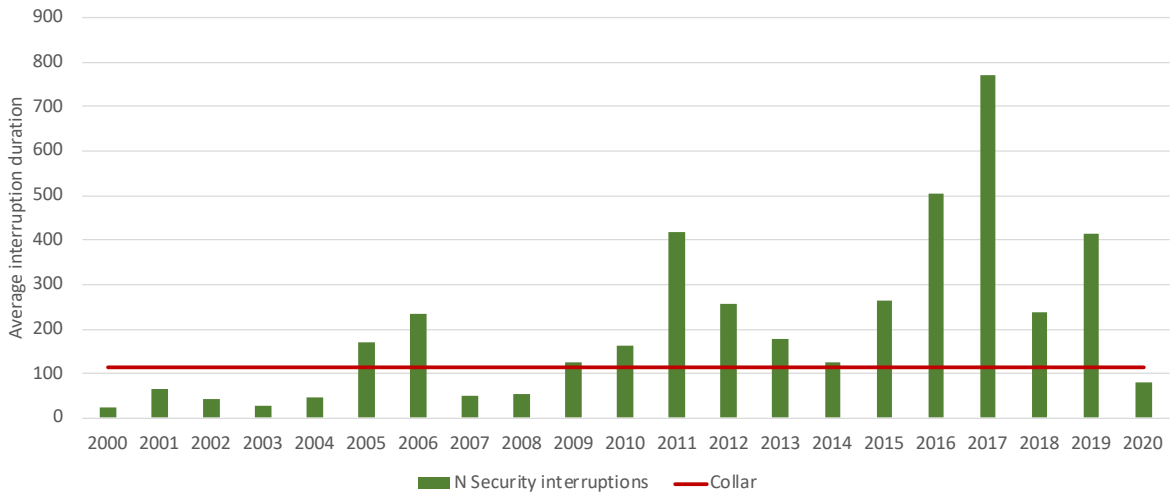
156. Figures 19 and 20 below indicate that Transpower's performance results for N-Security average interruption duration have trended upwards.

Figure 19: N-Security average interruption duration long term performance



Source: Strata analysis of Transpower interruptions data

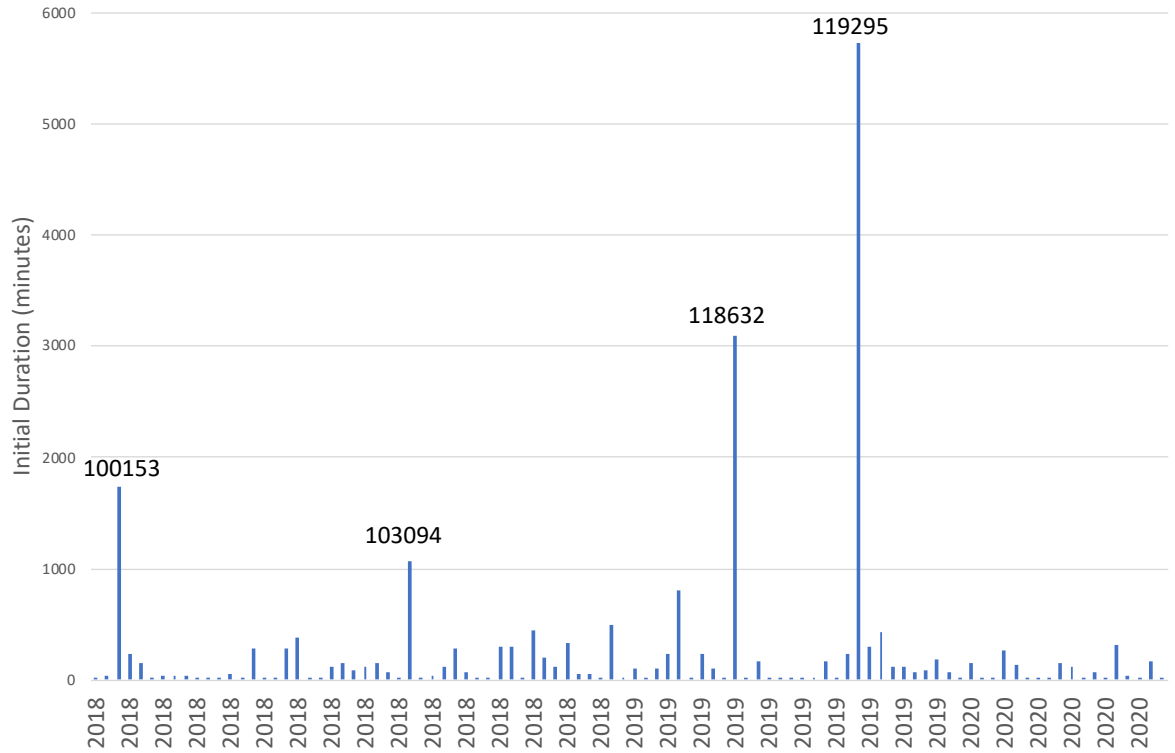
Figure 20: N-Security average interruption duration long term performance (2006 outlier removed)



Source: Strata analysis of Transpower interruptions data

157. Figure 21 shows that four events stand out as contributing over 1,000 initial duration minutes each to the N-Security interruption durations. The IDs for these events are 100153, 103094, 118632, 119295. Figure 21 indicates the duration of these interruptions compared to other N-Security interruptions occurring within the three Disclosure Years.

Figure 21: Initial duration of N-Security interruption events for DYs 2018/19/20



Source: Strata analysis of Transpower interruptions data

158. Event 100153 (SN17124) occurred on the 13th July 2017 and is linked to 10 interruptions due to 'Environmental – Snow or Ice'.

159. Event 103094 (SN17228) occurred on the 13th November 2017 Ohakune - National Park - Ongarue circuit 1 tripped for a blue phase to earth fault probably caused by a lightning strike.

160. Event 118632 (SN18291) occurred on 28th November 2018 Motunui – McKee – Stratford circuit 1 tripped for a blue phase to earth fault when a McKee 110kV current transformer CT102 manufactured in 2011 exploded. SN 18291 records that the equipment failure was caused by water ingress through the top cap and perished rubber bellows located in the head of this current transformer. Transpower issued a service instruction to carry out condition-based assessments of its entire fleet of similar CTs to determine the extent of the issue on the grid.

161. Event 119295 (SN19011) occurred on 14th January 2019 Maraetai CB92 (Maraetai - Waipapa circuit 1) tripped a relay for no apparent reason. Subsequently, the Maraetai relay was replaced as it was part of a batch identified as having potential failures.

162. There were no events with initial durations above 100 minutes in DY2020.

163. The two equipment failure events do not indicate that there were known systemic issues on the network that Transpower could have addressed and therefore avoided non-compliance. The System Fault and Interruption Report for these two events provided sufficient evidence to conclude that Transpower undertook a sound engineering evaluation of the events and determined appropriate actions to avoid similar future events.

164. We have found no reason to conclude that the average and longest interruption durations and P90 non-compliance were the result of Transpower failing to act in accordance with good electricity industry practice.

3.7. Improvements can be made to Transpower's analysis and reviews

165. In our previous review for the Commission of Transpower's exceedance of collar in seven grid quality measures (two in DY2016 and five in DY2017), we concluded that:

1. Transpower's explanation for the events and the manner in which it managed outage duration has not raised any concerns nor identified areas where Transpower acted inconsistently with good electricity industry practice;
2. explanations for the outside collar performance were not given within the context of historical performance. As a result, we had no means of establishing if performance was deteriorating over time and what the reasons for this might be; and
3. average duration of unplanned interruptions rather than number of unplanned interruptions had likely been increasing, and if this was the case, analysis of the underlying causes will be valuable in understanding how the situation can be managed.

166. We noted that unavailability of historical data impeded both our understanding of historical trends and of whether exceedance of collars was due to unusual years. Because of this, we formed an initial view that, in not undertaking such analysis prior to the review, Transpower did not act consistently with good electricity industry practice.

167. We also noted that, for the unplanned outages, Transpower had undertaken detailed post-event reviews that included identification of opportunities to reduce future impacts from similar factors and causes. We also recognised that Transpower has

implemented the improvement initiatives that it identified. We concluded that this was consistent with good electricity industry practice.

168. A February 2019 paper[31] drafted for Transpower by GHD/Synergies confirmed our concern that Transpower had not undertaken sufficient analysis of its interruptions data. GHD/Synergies undertook the analysis as part of its peer review of Strata's report and in doing so, concluded that:

> *Transpower's outage data over the past seven years does not appear to show a worsening performance trend regarding the duration or number of outages, as implied by Strata, but rather shows the adverse effect of significant one-off periodic events in 2015/16 and 2016/17 adverse effect of significant one-off periodic events in DY2016 and DY2017.*
>
> *GHD also concluded that the potential worsening of grid performance in these two years warrants examination.* [32]

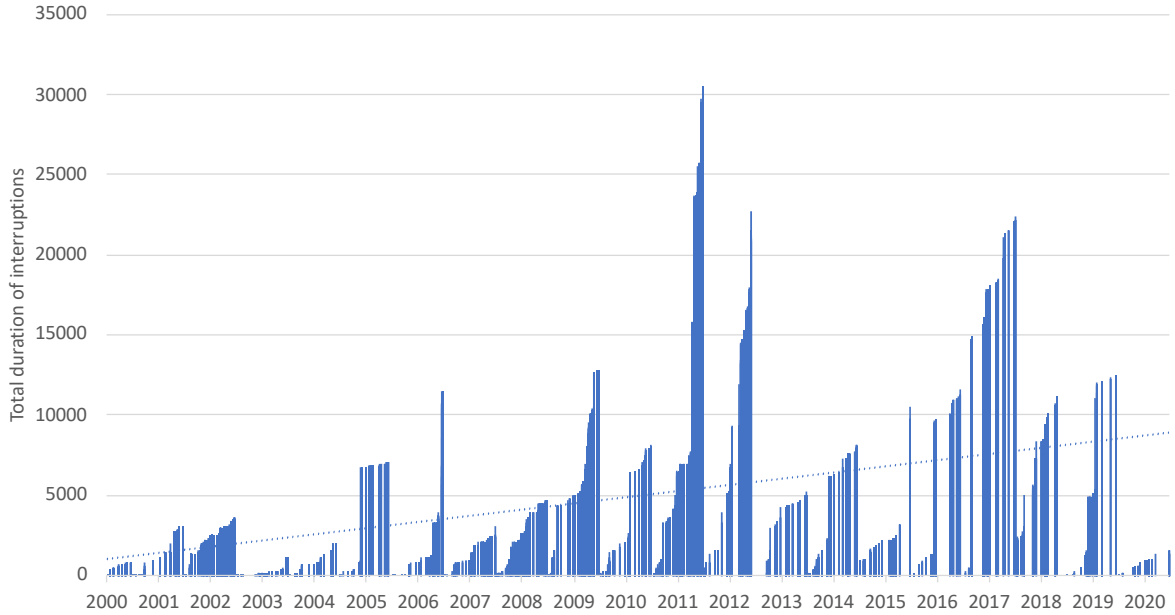
169. In its s 98 notices, the Commission asked Transpower for the data it had provided to GHD/Synergies together with the outputs from the examination referred to by GHD/Synergies. In its response, Transpower supplied the interruptions data which we used in our analysis for this review but it did not provide evidence that it had undertaken the examination that GHD/Synergies recommended.

170. However, in its response to the Commission's January 2021 "Summary of Information Request", contrary to GHD/Synergies' findings, Transpower provided information confirming that its more recent analysis had shown that interruption duration had trended upwards over time.[33]

171. We undertook further analysis of the additional data Transpower supplied to the Commission in February 2021. We found that the interruption data does indicate a worsening trend in interruption duration for Standard, High Priority and N-Security categories. For Generator and High Priority categories there was a downwards trend (see Appendix C for the charts from our analysis). For example, in Figure 22 the upward trend can clearly be seen for N-Security interruption duration.

[31] Response to Strata Report on Transpower's Service Quality Performance_Revised Final_050219
[32] Ibid, page 5
[33] Transpower presentation to the Commission, 4 February 2021, Slide 8

Figure 22: Total N-Security unplanned interruptions duration (minutes)



Source: Strata analysis of Transpower interruptions data

Note A material outlier datapoint for 2006 of 87179 minutes was removed due to scaling issues.

172. A summary of our understanding of the information supplied by Transpower is:

- Transpower had not undertaken analysis of its interruption duration data prior to our review of its performance for DY2016 and DY2017;
- GHD obtained the data from Transpower and undertook analysis but did not identify a worsening trend in three categories;
- Transpower's recent analysis of the data found increasing interruptions duration occurred over the most recent twenty-year period;
- Transpower did not provide analysis of the underlying reasons for the upward trend but focussed on explaining the impact major events.

173. Because of data quality issues and the low level of granularity of the data fields (i.e. limited to high level causes), we consider that Transpower should undertake a review of the information it collects during and following interruptions. In addition, we consider that Transpower should also review and identify improvements that can be made in the level of analysis that it performs on its interruption data. For example, improving the data to include the type of asset and the mode of failure so that analysis can highlight emerging trends.

174. We understand from several documents supplied by Transpower[34] that it has, and is continuing to invest in its Condition Based Risk Management (CBRM) systems and approach to asset management. CBRM includes capturing data and undertaking analysis and consideration of asset failures including mode type failures and the causes and impacts of interruption events. Transpower clearly recognises the value of CBRM:

[34] CBRM Phase 3 - Transmission Lines - Delivery Business Case, CP_ISB_GI_00_00 Condition Based Risk Management - Need Registration, CBRM Phase 2 - Delivery Business Case, Power Systems Asset Risk Tool (PSART) - Delivery Business Case

> *CBRM is viewed as is a critical enabler for Transpower to improve its business wide performance as a mature asset manager. CBRM provides Transpower with a tool to make more effective, consistent, repeatable asset planning decisions that balance risk, service levels, and investment in asset management planning which will help us to meet Commerce Commission expectations for process improvements following RCP2.*[35]

175. If Transpower successfully implements its CBRM rollout, our expectation is that it will include improved information collection from interruption events, including how assets perform due to environmental and equipment failure interruption causes.

Evidence of investigations and post-event reviews for DY2018, DY2019 and DY2020

176. In its s98 notice[36] related to performance in DY2018 the Commission required Transpower to provide:

> *all documents dated within the 2018 disclosure year providing assessments of the performance and management of Transpower's assets during or following adverse weather events;*
>
> *information about all documented investigations or analysis initiated by Transpower in the 2018 disclosure year and the 2019 disclosure year on asset performance, asset failures or concerns regarding deteriorating asset condition.*

177. Transpower responded by providing documents in two folders, Tranche 1 14.2 and 14.3. Neither of these folders included assessments of performance of network assets nor analysis following adverse weather events occurring in DY2018.

178. In Tranche 1, 14.10 (d) Transpower supplied a list of investigations it submitted to its National Event Review Group (NERG); none of the major events that Transpower attributed to its exceedance of the grid performance measures appears to have been considered by NERG.

179. We searched the information supplied by Transpower but found no evidence that it had undertaken post-event reviews for the major interruptions events in DY2018. We considered this to be surprising given Transpower's June 2019 statement that:

> *We investigate all unplanned interruptions to identify causes and contributing factors. This includes examining the cause of the interruption itself as well as factors that contributed to the duration of the interruption. We identify improvements to our risk controls as the risk consequences or the causal probabilities become better understood, improving our future performance. We constantly review our interruption data and statistics to identify trends (both positive and negative), seeking to identify improvements and refine our control measures. Anticipating risks that have not yet manifested allows us to be pro-active in our management, which is particularly important for high impact low probability (HILP) risks.*
>
> *We believe our underlying management of unplanned interruption risk is sound. We feel we are taking adequate steps to manage our unplanned interruption performance and the risks associated with these events. Our*

[35] CBRM Phase 2 - Delivery Business Case, page 3 (business case related to CBRM models for Indoor Switchgear, Instrument Transformers and Power Cables)
[36] Section 98 Notice - Transpower 44066, issues on 5 February 2020

processes demand that we identify and deliver cost effective improvements that can prevent or mitigate these risks.[37]

180. Given the above, Transpower should have been able to provide clear and detailed documented evidence that it had:

- undertaken post-event reviews of events identified as being material to exceedance of grid performance collars in DY2018; and
- taken actions to learn from the events and mitigate risks of similar future events.

181. Transpower did provide evidence that its Grid Management Team (GMT) had undertaken a review of loss of supply events over 12 years of data.[38] This review provides analysis of the drivers of outages and considers trends in performance. The paper also considers mitigation options, albeit at a relatively high level. The information provided did not indicate that Transpower had included the mitigation actions identified in the paper in a forward plan which monitored progress towards completion of the actions and the benefits realised.

182. In its January 2021 summary information request to Transpower, the Commission requested Transpower provide the following:

Information on post-event reviews: Transpower has not provided specific and detailed post-event reviews for significant contributors to interruptions and interruption durations for DY2018. The Commission requires that Transpower provide information relating to its post-event reviews if these documents exist for DY2018, DY2019 and DY2020.[39]

183. In its response, Transpower stated that it reviews all incidents and captures lessons from them in its post-incident reports.[40] Transpower added that it held reviews of asset failure events which drive change in its asset management strategies and portfolio management plans.[41]

184. In the information supplied to the Commission Transpower included:

- fifteen System Fault and Interruption Reports (SFIR); and
- an Excel workbook evidencing analysis of major events. [42]

185. We consider that the SFIRs are good practice engineering reports providing evidence that Transpower undertakes reviews following each interruption event. We found evidence that the SFIR include consideration of improvements that can be undertaken post-event, e.g., programmed replacement of similar type and age components.

186. The SFIR Transpower supplied do not include consideration of how the management of interruptions events can be improved, e.g., whilst there is a description of how the event was technically managed, we found no consideration of how improvements could be made to how response times could be improved.

187. The Excel workbook Transpower supplied providing its analysis of major events did offer evidence that it undertakes post-event reviews of major events. However, the Excel file supplied was created by Transpower on 19 February 2020, and appears to have been created to support Transpower's views on normalisation. Therefore, the

[37] Unplanned Interruptions - causation 20190619
[38] GMT Review of Loss-of-Supply Events 2005-2017
[39] Commerce Commission - summary of info request, paragraph 11.2
[40] Transpower 29 January 2021 letter to the Commission titled 2018 -2020RY CONTAVENTIONS: S98 INVESTIGATION , page 14
[41] Ibid, page 22
[42] 2017_18 Major Events Details

workbook appears not to be evidence that Transpower previously conducted reviews of major events.

188. The workbook does not provide any analysis on whether the events could have been prevented or the impact reduced by actions Transpower could have, but did not, take. The workbook does not identify any actions that Transpower could take post-event to reduce the risk of future related or similar events.

189. We have reproduced the summary tab in Appendix D.

3.8. Our findings on the reasons for Transpower's exceedance of the collar

190. Corrected and updated interruptions data supplied by Transpower enabled us to undertake further analysis of the causes and drivers of the number and durations of interruptions, and the contribution towards collar exceedance.

191. We found that:

1. the data confirmed Transpower's explanations that a relatively small number of periodic adverse weather events and one-off equipment failure events were the primary causes of its exceedance of the grid performance measure collar levels for both number and duration of unplanned interruptions;
2. the number of unplanned interruptions has been decreasing and this is likely to indicate improving reliability;
3. Transpower's single performance in which it exceeded the collar for Standard number of interruptions in DY2018 was due to the impact of significant weather events that were outside its control;
4. interruption duration has been increasing above pre RCP2 levels and Transpower appear not to have previously identified and analysed this; and
5. the average interruption duration measure is sensitive to long duration outages especially those that occur towards the end of the disclosure year; and
6. for categories that have low numbers of interruptions, when high duration events are removed, average interruption duration would have reduced the average duration closer to collar.

192. We found no evidence in the data that underlying asset deterioration contributed to the outside of collar performances.

193. Our analysis indicates that mitigation of the impact of high duration events could have improved the average interruption duration and P90 performances. This is the reason why we consider that comprehensive post-event reviews are critical to improving performance. From the evidence Transpower has provided, we remain unconvinced that the reviews prior to and during the period covered by this review have been sufficiently rigorous.

194. We consider that Transpower's investment in the introduction of CBRM systems and practices should include improved interruptions event information capture, analysis and review. If this is the case, Transpower will significantly improve its ability to learn from interruptions events.

3.9. Our assessment of whether Transpower acted consistently with good electricity industry practice

195. The evidence supplied to support Transpower's claim that post-event reviews were undertaken was of importance when forming our view on whether Transpower applied good electricity industry practice because:

- statements made by Transpower confirm that it understands both the importance of post-event reviews and monitoring the completion of actions arising from them;
- understanding and learning from events is a critical component of good electricity industry practice risk management and is required in both ISO:31000 Risk Management and ISO: 550001 Asset Management standards;
- if Transpower did not undertake such reviews prior to DY2018, it would not meet a good electricity industry practice standard; and
- if Transpower did not undertake such reviews during DYs 2018, 2019 and 2020 it would not meet a good electricity industry practice standard.

196. We consider that the SFIRs are good electricity industry practice engineering reports following interruption events. The documents supplied by Transpower support a conclusion that these reviews were undertaken prior to and during the three Disclosure Years covered by this report.

197. The SFIRs contain insufficient information to be considered good practice post-event reviews; they do not examine broader systemic and operational improvements that could reduce future risk and impacts. In addition, they are not linked with analysis of asset data, including performance and health.

198. Transpower has provided sufficient evidence that its GMT initiated reviews of interruption performance including risk mitigation actions. We did not identify evidence that the implementation of actions to improve interruption performance had been monitored by its management.

199. In our opinion, the above indicates gaps in Transpower's post-event reviews.

200. In addition, Transpower's analysis[43] of major events indicates that good electricity industry practice was not met in relation to several major events (see appendix D). In not undertaking appropriate post event reviews Transpower failed to act at good electricity industry practice.

201. Transpower's introduction of CBRM systems and practices should address the gaps we have identified and provide improved data and analysis tools to enable improved understanding of the underlying causes of interruptions and ways of mitigating the effects. The gaps that CBRM will address are related to Transpower's ability to analyse its asset performance data and identify the actions needed to maintain performance within its cap and collar settings.

[43] 2017_18 Major Events Details, summary tab

4. Assessment of below collar performance against Asset Performance Measures

202. Two Asset Performance Measures were set for RCP2. These measures relate to the impact that asset availability can have on access to the lowest cost mix of generation.

203. For RCP2, two Asset Performance Measures were set for Transpower:

(b) availability of the inter-island high-voltage direct current (HVDC) system and;

(c) the availability of selected high-voltage alternating circuits (HVAC).

204. A cap and collar were established around a target value for each of the performance measures. The Commission exercised its discretion to only pursue contraventions that included exceedance of the collar level of the Quality Measures. Therefore, for the purposes of this review, to remain compliant, Transpower had to remain within the cap and collar boundaries.

205. For HVAC availability, Transpower's performance was outside the collar in DY2018, DY2019 and DY2020.

206. For HVDC availability, Transpower's performance was within the collar in DY2018 and DY2019, but outside the collar in DY2020.

4.1. HVAC circuit availability

207. In its RCP2 proposal, Transpower noted the importance of both the availability of its critical circuits and the reliability of information it provided to the electricity market on planned outages:

> *The availability of our key transmission lines is important to electricity market participants as it affects generator access to the market. Reduced availability due to outages can lead to constraints that impact the dispatch of generation and may lead to locational price risk.*
>
> *Financial Transmission Rights (FTR) are financial products used to hedge against locational price risk in wholesale electricity markets. These products provide electricity companies with a tool to manage the risk of large, unpredictable price movements. They were introduced to the New Zealand electricity market in 2013.* [44]

208. Transpower supplied the following description of how it developed the availability measures:

> *Our Asset Performance Measures are based on the availability of selected circuits that have the largest potential impact on the electricity market. Circuit availability affects generators' ability to supply the market and potentially wholesale electricity prices.*
>
> *To support the introduction of FTR, we are developing longer-range maintenance and Capex delivery plans to facilitate a 24-month outage plan. In addition, we have set circuit availability targets with financial incentives as part of our service performance measures*[45]

[44] Transpower's RCP2 Regulatory proposal, page 16
[45] Transpower's RCP2 Regulatory proposal, page 121

209. Transpower also noted that changes to its outage plans are mainly attributable to weather events and access and resource constraints:

> *Most of our Capex and maintenance works need network outages. Outages are currently forecast (changes to the outage plan occur because of adverse weather, access constraints, and availability of resources).*[46]

210. The HVAC availability is measured as the percentage of time that a selected set of 27 220 kV circuits was available during a year. The selection of the circuits was based on the potential impact that outages on these circuits could have on wholesale prices in the electricity market:

> *Our Asset Performance Measures are based on the availability of key Grid circuits. Reduced circuit availability, due to either planned or unplanned outages, can impact on a generator's ability to supply the market, which may affect market prices. Availability is, therefore, an aspect of our performance that is important to generators and to end-consumers.*
>
> *The impact of outages on the market will vary depending upon the circuits affected. Our Asset Performance Measures are based on the availability of those circuits that have the most impact*[47]

211. Table 8 shows that in DY2018 the HVAC availability for selected circuits was below the collar by 0.2%. This was also the case in DYs 2016 and 2017. For DYs 2019 and 2020 respectively Transpower recorded performances of 0.5% and 1.8% below the collar.

212. Table 8 also indicates the target that Transpower subsequently set for this measure in its 2017/18 Statement of Corporate Intent (SCI). Transpower's SCI states[48] that the SCI target is set on the same basis[49] as the HVAC availability measure in the Quality Standards.

213. There are differences between the SCI and the Quality Standard measures. This indicates a potential issue with either the targets that were set for this measure, or with Transpower's subsequent understanding of whether performance within them was realistically achievable. For DY2019 and DY2020, the gaps between performance and collar widened. Also, Transpower's performance fell below its SCI target in DY2020.

Table 8: Where Transpower was below its HVAC availability collars

	HVAC selected circuits				
	Target	SCI Target	Cap	Collar	Actual
2018	99.6%	98.7%	100%	99.2%	99.0%
2019	99.6%	98.7%	100%	99.2%	98.7%
2020	99.6%	98.7%	100%	99.2%	97.4%

Source: Transpower Compliance Reports 2018, 2019 and 2020

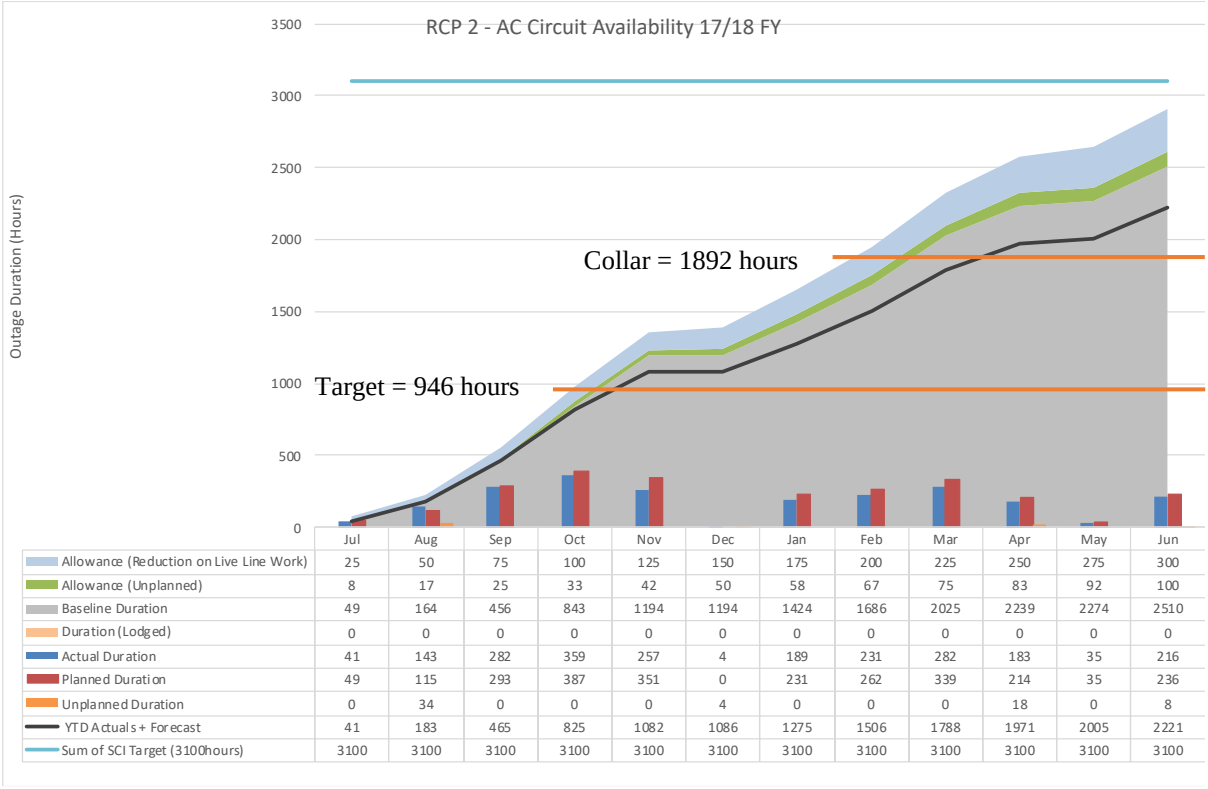
[46] Transpower's RCP2 Regulatory proposal, page 121
[47] Transpower's RCP2 Regulatory proposal, page 127
[48] TP Statement of Corporate Intent 1 July 2019, page 10
[49] Key (i.e., market-sensitive) circuits within Transpower's HVAC networks.

214. Figure 23 shows Transpower's HVAC availability performance in DY2018 relative to the target and collar that was set for this measure.

215. Figure 23 also shows that unplanned outages are not a significant contributor to the HVAC availability results. It is also worth noting that Transpower has provided its assessment of the contribution due to changes in its live line working practices which responded to revisions in the Health and Safety at Work Act 2015. However, even if these factors are removed, Transpower still exceeded its collar.

216. The columns in Figure 23 indicate that in DY2018 Transpower was achieving lower actual monthly unavailability duration than it had planned. As Transpower noted in its RCP3 Proposal: *there should be no punishment for early restoration as this is almost always a positive impact for consumers.*[50] We agree that swifter restoration of circuits into service is normally the preferred outcome.

Figure 23: Transpower's HVAC performance in DY2018



	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Allowance (Reduction on Live Line Work)	25	50	75	100	125	150	175	200	225	250	275	300
Allowance (Unplanned)	8	17	25	33	42	50	58	67	75	83	92	100
Baseline Duration	49	164	456	843	1194	1194	1424	1686	2025	2239	2274	2510
Duration (Lodged)	0	0	0	0	0	0	0	0	0	0	0	0
Actual Duration	41	143	282	359	257	4	189	231	282	183	35	216
Planned Duration	49	115	293	387	351	0	231	262	339	214	35	236
Unplanned Duration	0	34	0	0	0	4	0	0	0	18	0	8
YTD Actuals + Forecast	41	183	465	825	1082	1086	1275	1506	1788	1971	2005	2221
Sum of SCI Target (3100hours)	3100	3100	3100	3100	3100	3100	3100	3100	3100	3100	3100	3100

Source: Transpower RCP Availability AC Circuits 17_18 FY - Final

Note RCP2 Availability Target of 99.6% equates to 946 Hours
Collar at 99.2% equates to 1892 Hours

217. The following assessment of factors leading to Transpower's circuit availability falling below the collar focuses on the relevant years and on the contribution made for planned and unplanned circuit outages.

Transpower's explanation for its HVAC availability performance

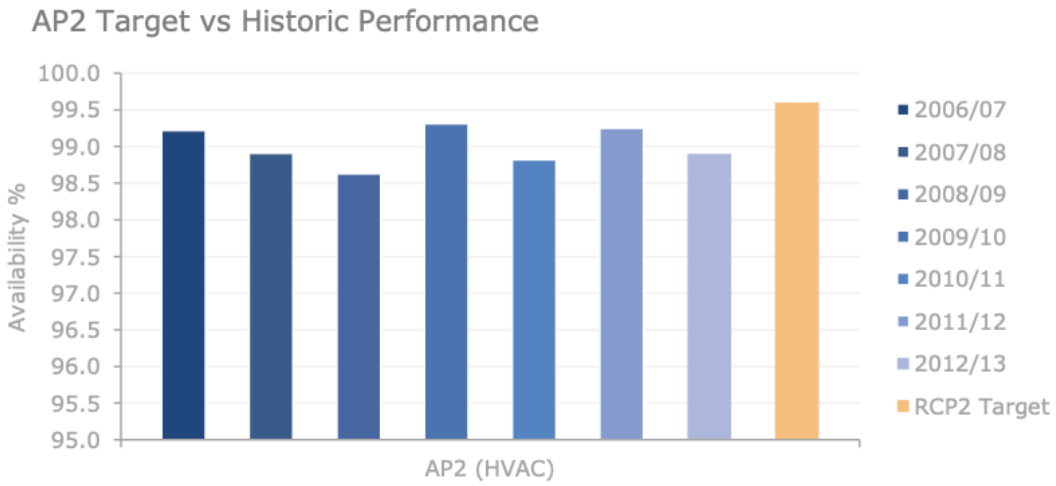
218. In its explanation for DY2016 and DY2017 Transpower claimed that its availability performance prior to RCP2 was better than previously achieved, and that when setting its RCP2 target it:

[50] AP3 Return to Service Measure RCP 3 report, page 3

- applied logic that was too optimistic;
- applied only high-level analysis using a fundamentally top-down approach; and
- set the target at an aspirational level relative to historical availability performance.[51]

219. Data provided by Transpower (Figure 24) supported the view that its expectation for RCP2 HVAC availability performance target for RCP2 was set higher than it had historically achieved. However, the data did not explain why Transpower proposed a target and collar at these levels.

Figure 24: Transpower's historical HVAC availability performance



Source: Transpower RCP2 Regulatory Proposal[52]

220. Transpower provided the following explanation for the HVAC availability performance in its 2018 financial year:

> *As a result of large continuous outages on selected circuits in the southern South Island, we have missed our collar for AP2 HVAC Availability for 27 selected circuits. Most outages were planned outages for RCP2 projects, together with routine maintenance to maximise the outages. The five longest planned outage (RCP2 and maintenance) durations were on: Tekapo B–Twizel circuit 1 for 10,677 minutes; North Makarewa–Tiwai Circuit 2 for 7,572 minutes; North Makarewa–Tiwai Circuit 1 for 7,488 minutes; Ashburton–Timaru–Twizel circuit 2 for 6,462 minutes and Clyde–Roxburgh circuit 2 for 6,335 minutes.*[53]

221. Transpower explained that during DY2018 and DY2019, the most significant outages affecting availability performance were planned outages to complete planned work that it had assessed as being necessary for the long-term benefit of consumers.

222. In its letter, Transpower identified the following notable circuit outages that occurred in DY2018:

- Tekapo B-Twizel Circuit 1 (10,677 minutes);
- North Makarewa-Tiwai Circuit 2 (7,572 minutes);

[51] Strata 2018 Transpower review report (8 Nov), page 22
[52] Transpower RCP2 Regulatory Proposal, section 10.4.3
[53] Grid Outputs Report 2018, page 34

- North Makarewa-Tiwai Circuit 1 (7,488 minutes);
- Ashburton-Timaru-Twizel Circuit 2 (6,462 minutes); and
- Clyde-Roxburgh Circuit 2 (6,335 minutes).

223. These five projects added a total of 38,534 minutes (642 hours) to Transpower's HVAC availability result. As noted in Figure 23, the RCP 2 HVAC availability of 99.6% equates to 946 Hours; therefore, the five circuit outages contributed 68% of the outside collar performance in DY2018.

224. Transpower identified the following notable interruption projects that occurred in DY2019:

- Invercargill-Manapouri Circuit 2 (6,363 minutes);
- Ohakuri-Wairakei Circuit 1 (6,323 minutes);
- North Makarewa - Tiwai Circuit 2 (6,303 minutes);
- Rangipo-Tangiwai Circuit 1 (6,272 minutes); and
- Invercargill-Manapouri Circuit 2 (6,266 minutes).

225. These five projects added a total of 31,527 minutes (525 hours) to Transpower's HVAC availability result; therefore, the five circuit outages contributed 55.6% of the outside collar performance in DY2019.

226. Transpower explained[54] that DY2020 was substantially affected by an unplanned outage attributed to the Rangitata River flooding event in December 2019 which destroyed eight towers on the Roxborough-Islington line. Transpower noted that this event impacted availability from December through to March. A planned replacement of a Clyde circuit breaker was also a material contributor to reduced availability.

227. Transpower noted that excluding the above two outages, availability would have been 99.244%, which is just above its collar. Transpower also noted the Manapouri-Tiwai tower painting project which was an additional, lengthy, planned outage in DY2020.

228. In summary, Transpower attributed[55] its below collar results for DYs 2018, 2019 and 2020 to:

- re-insulator and tower painting work on the MAN-TWI Circuit in DY2018, DY2019 and DY2020 that was not anticipated when Transpower prepared its RCP2 IPP proposal;
- the Rangitata River flood in December 2019; and
- the replacement of the circuit breaker at Clyde in DY2020.

Our previous assessment of Transpower's explanation

229. We previously found[56] that Transpower did not provide analysis on underlying factors relating to the historical years, and explanation as to why these factors were not taken into account when it proposed the RCP2 target, cap and collar.

230. Whilst data supported the view that Transpower proposed a target and collar on the expectation that its RCP2 availability performance would be higher than it had historically achieved, it did not explain why it had proposed a target and collar at these levels.

[54] Transpower 29 January 2021 letter to the Commission titled 2018 -2020RY CONTAVENTIONS: S98 INVESTIGATION , page 1
[55] Ibid, page 15
[56] Strata 2018 Transpower review report (8 Nov) 2018, page 27

231. The DY2016 and DY2017 planned work included groups of projects that required significant planning and preparation. We considered that the need for this work would have been identified as part of Transpower's forecasting for RCP2 works, and planning would have commenced at least 12 months prior to the required work being undertaken.

232. Given the significance of the planned works in the lower South Island, we expected that any top-down target setting process would have taken this future work into account.

233. During our previous review, we noted that in its 2017 Services Report, Transpower proposed that a target for HVAC availability of 98.7 % would be considered more appropriate than its RCP2 target of 99.6%:[57]

> *The HVAC availability target for RCP2 has proven difficult to meet and may be further impacted by our decision regarding live line work. In response, we have worked to an internal target of 98.7% that better balances need for HVAC availability with the need for lines to be de-energised for planned maintenance. We will refine this target for RCP3 so that it better reflects this balance.*

234. We concluded that the reduced target proposed was below the DY2016 and DY2017 actual performance of 99.0%, and 0.5% below the RCP2 collar, and therefore likely to be generous.

Information Transpower provided to support its explanation

235. In its s 98 notice, the Commission required Transpower to provide:[58]

> *all documents relating to any changes Transpower has made to manage its within cap and collar performance on HVAC availability for the 27 selected circuits during the 2018 disclosure year. This should include the expected and realised benefits from the changes made.*

236. In its response, Transpower supplied:

- eight monthly tables recording changes made to specific outages. These changes included cancelled or delayed work and circuits returned to service earlier or later than expected. The information in the tables did not provide any indication of actions to proactively manage performance to meet the HVAC availability target:
- two PowerPoint slide packs relating to the setting of RCP3 targets; and
- three Excel workbooks containing HVAC availability data and analysis for DY2016, DY2017 and DY2018.

237. The Excel workbooks were useful in gaining an understanding of the contributors to HVAC availability. However, the information provided no evidence that Transpower had initiated changes to manage its performance against the cap and collar. Based on this, we have concluded that Transpower has not undertaken such initiatives.

238. For DY2019 and DY2020, in its letter to the Commission, Transpower gave explanations for its HVAC availability results. It also provided Asset Performance Reports for January and March 2019 and June 2020. These reports provided summaries and some analysis of performance against the Quality Standards.

[57] Transpower Availability Draft V2, section 3 – see Strata 2018 Transpower Review Report (8 Nov), page 25
[58] Section 98 Notice - Transpower 44066, paragraph 14.6

Our assessment of Transpower's explanation

239. Transpower clearly understands and appreciates the importance of the availability of its selected 27 circuits to electricity market participants. Whilst it does not have a role in managing wholesale market prices, it does have a responsibility for providing accurate and reliable information on circuit outages and availability. In our view, Transpower should apply the same level of assurance when setting and proposing HVAC availability measures, targets, caps and collars.

240. Nothing has changed our view that, when proposing its RCP2 HVAC availability targets and collars, Transpower made a significant error by not undertaking an alignment with its proposed capital works programme.

Other information we considered

241. We reviewed the relevant Grid Outputs Reports (GRP) that Transpower supplied in response to the Commission's s 98 notice. Every GRP recorded the same explanation Transpower gave in its Compliance Statement. There was no further explanation of any steps Transpower had taken to manage the impact of its breaches of the collar.

242. We also reviewed relevant AMPs and various documents Transpower had supplied to the Commission in response to paragraph 14.6 of its s 98 notice.

243. We considered the information and data Transpower provided in its 29 January 2021 Letter to the Commission and in its response to the Commission's Summary of information the Commission is likely to request from Transpower.

244. Transpower informed the Commission that, in its view, there are no new contributing factors to those identified in DYs 2016 and 2017, *that should prompt the Commission to adopt a different view when it evaluates the relevant contraventions for the remaining years of RCP2.*[59]

Our findings on the reasons for Transpower's exceedance of the collar

245. The primary cause of under collar results for HVAC availability in DYs 2018, 2019 and 2020 was that the collar had been set at an unrealistically high percentage. Transpower has not been able to provide a reasonable explanation for this other than the targets and collar were aspirational; the fact that availability results for DYs 2018 and 2019 were consistent with historical levels, and the largest contributing events were not indicating asset deterioration issues indicates that Transpower achieved normal rather than aspirational levels of performance.

246. For DY2020, the long duration outages required to respond to the Rangitata river flood (unplanned) and the Clyde circuit breaker replacement (planned) made it inevitable that Transpower would fail to achieve its collar.

247. We have formed the following conclusions on Transpower's HVAC availability performance for the five RCP2 Disclosure Years:

- unplanned outages were not a material contributing factor in DY2016 and DY2017; we have found that this was also the case for DY2018;
- planned circuit outages were the main contributing factor in DY2016 and DY2017; this is also the case for DY2018, DY2019 and DY2020;

[59] Transpower 29 January 2021 letter to the Commission titled 2018 -2020RY CONTAVENTIONS: S98 INVESTIGATION , Page 2

- the collar set for HVAC availability was inappropriately high because some significant planned works had not been identified at the time the collar was proposed;
- in the absence of clearly identified initiatives to lift availability performance, Transpower set its RCP2 target at an overly optimistic level;
- because Transpower identified performance measures for RCP2 as 'prototype', in our view, it was unreasonable to conclude that Transpower acted inconsistently with good electricity industry practice when proposing them; and
- when implementing its planned outages, we found that Transpower undertook detailed planning including risk-based prioritisation of work on the 27 selected circuits, and we did not identify concerns regarding Transpower's work planning and prioritisation.

Our assessment of whether Transpower acted consistently with GIP

248. We consider that the significant error Transpower made when proposing its RCP2 HVAC availability targets and collars, was not good practice. However, given that the Quality Measures are unique to Transpower, the good electricity industry practice benchmark is not appropriate.

249. We note that Transpower has fully reviewed and revised the structure of its HVAC availability measure for RCP3. This indicates that Transpower has addressed the error that it made when setting the RCP2 HVAC availability targets and collars.

250. Our review has not raised any departures from good electricity industry practice relating to the manner in which Transpower plans for, and manages, outage duration.

251. We found evidence that in DY2019 and DY2020 Transpower was measuring its performance on duration of planned outages on the 27 selected circuits' and excluding the major outage events, that the underlying HVAC availability appears to be improving. This reflects good electricity industry practice.

4.2. HVDC circuit availability

252. In its RCP2 proposal, Transpower noted the importance of both the availability of its critical circuits and the reliability of the information it provided to the electricity market on planned outages:

> *HVDC link and selected HVAC circuits The availability of our key transmission lines is important to electricity market participants as it affects generator access to the market. Reduced availability due to outages can lead to constraints that impact the dispatch of generation and may lead to locational price risk.* [60]
>
> *The impact of outages on the market will vary depending upon the circuits affected. Our Asset Performance Measures are based on the availability of those circuits that have the most impact.*[61]

253. Transpower supplied the following description on how it developed the availability measures:

> *The proposed target for HVAC availability is 99.6% during RCP2. This is based on reductions below 100% availability taking into account:*

[60] Transpower's RCP2 Regulatory proposal, page 16
[61] Ibid, page 127

1) *approved construction outages during the period;*

2) *preventive maintenance outages required to meet service specifications;*

3) *an allowance for corrective maintenance; and*

4) *an allowance for forced outage unavailability.*

254. Transpower's HVDC availability measures and results are provided in Table 9. Transpower achieved better than collar and target availability in DYs 2018 and 2019, but fell below the collar for DY2020.

Table 9: Transpower's HVDC availability performance measures and results

	HVDC				
	Target	SCI Target	Cap	Collar	Actual
2018	98.5	98.7%	99.5%	97.5%	98.8%
2019	98.5	98.7%	99.5%	97.5%	99.1%
2020	98.5	98.7%	99.5%	97.5%	88.3%

Source: Transpower Compliance Reports 2018, 2019 and 2020

255. For HVDC, Transpower initially proposed[62] an availability target of 98.5% which was higher than it had historically been achieving, and the Commission set the collar at 1% lower than the target.

Transpower's explanation for its HVDC availability performance in DY2020

256. Transpower attributes its breach of the availability collar to circuit and pole outages related to reconductoring work on the OTB-HAY A (Churton Park section 45A -68) of the HVDC assets.[63]

257. Transpower informed the Commission in June 2019[64] that it was likely to breach its HVDC availability target. The reason for this was the need to undertake reconductoring work on OTB-HAY A. According to Transpower, OTB-HAY A was a listed project in its RCP2 IPP proposal, and was approved by the Commission in October 2018.

258. Transpower also undertook other Haywards and Benmore substation work that coincided with the reconductoring project. The objective of doing this was to avoid the need for future outages.

259. In a 27 May 2019 letter, Transpower explained to the Commission that it had acted for the long-term benefit of consumers when undertaking the project.

260. In December 2019, The Electricity Authority (Authority) engaged Strata to complete a review of Transpower's planned four bi-pole outages of the HVDC during the first quarter of 2020. The Authority requested the review due to the increased security of supply risk arising from the fourth outage which coincided with a planned outage of the Pohokura gas field. There had also been concerns raised regarding Transpower's performance in managing previous events.

[62] Transpower RCP2 Regulatory Proposal, section 10.4.3
[63] Transpower 29 January 2021 letter to the Commission titled 2018 -2020RY CONTAVENTIONS: S98 INVESTIGATION Page 2
[64] Ibid, page 16

261. Strata's review report was submitted to the Authority in February 2020.[65]

262. Strata's review concerned Transpower's compliance with the requirements set out in the Electricity Industry Participation Code (the Code).The Authority asked Strata to assess what Transpower *must do under the Code, what Transpower says it does to meet its Code obligations, and what Transpower has done in practice to meet its obligations*.[66] Strata's assessments in relation to the grid owner were that:

- the grid owner's outage planning policy and how it has been applied and used in its contingency planning for the outages aligns with the requirements of the Code; and
- the grid owner's Contingency Management Plans followed a risk-focused process that aligns with its Outage Planning Policy, and the grid owner demonstrated that detailed risk identification and assessments have been completed and these are frequently reviewed and updated.

263. Whilst Transpower states[67] that Strata's report supports its view that good electricity industry practice was applied to planning the HVDC outages, the review's focus was far tighter than Transpower implies.

Our assessment of Transpower's explanation

264. We consider that the Commission should accept Transpower's explanation for the HVDC availability performance result for DY2020.

265. We agree with Transpower that its exceedance of the availability collar for circuit and pole outages was due the reconductoring work on the OTB-HAY A (Churton Park section 45A -68) HVDC assets.

266. We have formed this view because Transpower:

- provided evidence that it had identified the impact that the project would have at an early stage;
- had kept the Commission informed on the implications for its HVDC availability performance prior to the outage;
- mitigated the need for future outages by bringing the substation work forward to be coincident with the reconductoring; and
- managed the project to plan and maintained good communications with stakeholders throughout the project.

267. Accordingly, we found that Transpower acted consistently with good electricity industry practice.

[65] A review of Transpower's planning for the 2020,
[66] Ibid
[67] Transpower 29 January 2021 letter to the Commission titled 2018 -2020RY CONTAVENTIONS: S98 INVESTIGATION , Page 17

5. Assessment of below collar performance against Asset Health Measures

268. Three annual Asset Health Measures were set for RCP2. The measures related to the following asset classes:

- total number of grillage foundations commissioned within Transpower's asset replacement and asset refurbishment programme during a disclosure year; and
- total number of insulators commissioned within Transpower's asset replacement and asset refurbishment programme during a disclosure year.

269. In addition, three five-year Asset Health Measures were set for (1) total number of outdoor circuit breakers: (2) power transformers; and (3) outdoor to indoor substation conversions commissioned within Transpower's asset replacement and asset refurbishment programme during the regulatory period.

270. A cap and collar were established around a target value for each of the performance measures. To remain compliant, Transpower had to remain within the cap and collar boundaries.

5.1. Number of grillage foundations commissioned

271. The condition of transmission tower foundations is critical to the integrity of a tower, and failure can result in safety hazards and potential interruption of electricity supply to consumers.

272. In DY2016 and DY2017 Transpower delivered a significantly lower number of grillages commissioned than the collar for both Disclosure Years. As Table 10 shows, this level of performance has continued in the remaining RCP2 Disclosure Years.

Table 10: Transpower's performance for Grillage Refurbishments

Grillage Foundations Volume Measure Performance				
	Target	Cap	Collar	Actual
DY2018	408	439	377	323
DY2019	390	421	359	226
DY2020	377	408	346	174

Source: Transpower Compliance Reports 2018, 2019, 2020

273. Steel grillage and concrete plug (also known as concrete pile) are the main types of foundation used by Transpower to support its steel lattice towers. Because they are steel structures buried in the ground, grillages are susceptible to corrosion. The primary strategy to address grillage corrosion has been to encase the steel structure in concrete, this is known as concrete over grillage (CoG). During RCP 2, Transpower adopted an additional refurbishment Cathodic Protection (CP) method. This is an electrochemical process that maintains the levels of galvanising coating on steelwork.

274. The adoption of the hybrid refurbishment strategy is the primary reason given by Transpower for its reduction in the volume of grillages commissioned.

Transpower's explanation for the reduced volumes of grillages commissioned

275. In its 2018 IPP Disclosures and the Grid Outputs Report 2018, Transpower notes that the change in refurbishment strategy was the reason for the reductions in grillage foundation commissioned volumes:

> *The grillage encasement strategy has been through a significant review and update since the 2016 AMP and the result of this has been a reduction in the volume of work forecast to be completed in RCP2. The structures and insulators replacement program is constantly reviewed taking into account new condition assessment data and refinements to health modelling. Because of this the forecast for insulator replacement in RCP2 has reduced.*[68]

276. Transpower's grillage foundation targets, caps and collars for RCP2 were set on the basis of its assumptions of asset condition and tower failure risk.

277. In DY2016 and DY2017 Transpower attributed the reduced volumes of grillage replacements to:

    (a) a deliberate slowdown of replacements to allow time to investigate and implement a number of efficiency measures aimed at reducing the cost of grillage installations; and

    (b) a review of the grillage encasement strategy which has further been amended to incorporate Transpower's criticality framework.

278. Documents supplied by Transpower provide evidence that the roll-out of its revised refurbishment strategy is continuing, resulting in grillage encasements falling below its collar. There is evidence that Transpower is continuing to develop options for extending grillage life and reducing costs; this includes the installation of cathodic protection where considered appropriate.

279. Transpower's DY2017 and DY2018 Grid Outputs Reports recorded that it had increased confidence in the positive outcomes from the revised strategy:

> *Tower Grillage Foundations: Our grillage encasement strategy has changed since the start of RCP2. This has resulted in a significant reduction in total number of grillages to be encased each year. The major change from the previous strategy relates to the low to medium criticality suspension towers (approximately 60 per cent of towers with grillage foundations), for which we have changed the intervention level. We are more confident in our assumptions that the interface is representative of the buried steel grillage and therefore can reduce the margin that we have used previously. This is resulting in deferment of these structures and the number of commissioned grillages falling below the collar.*[69]

Transpower's recent explanation reconfirmed the reasons for reduced replacement volumes

280. In its January 2021 letter, Transpower confirmed to the Commission that the major change to its previous refurbishment strategy was due to a change in the intervention point[70] of the low to medium criticality suspension towers. Medium criticality suspension towers represent around sixty percent of the towers with grillage foundations.

281. Transpower stated that it has gained confidence in the assumptions supporting its change in strategy and its decision to reduce replacement volumes. It also stated that the replacement strategy is more cost effective (reducing network capex) and has not changed the risk profile for its grillage fleet.

[68] Grid Outputs Report 2018, page 34
[69] Grid Outputs Report 2018, page 34
[70] The intervention point is when Transpower undertakes actions to address corrosion

Information Transpower provided to support its explanation

282. In its response to the Commission's 2019 s 98 notice[71] Transpower supplied additional information supporting its explanation for the reduced grillage foundation volumes. These documents included studies and reports supporting the continuing implementation and development of the revised strategy.

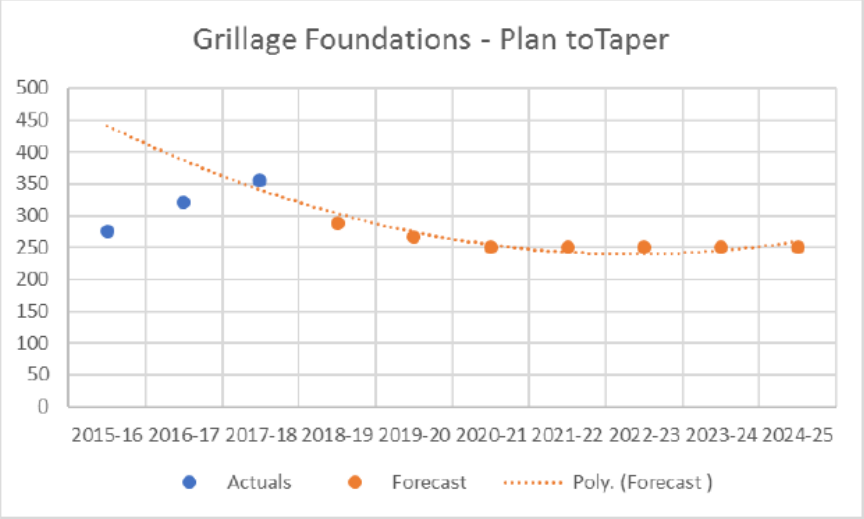
283. Transpower provided evidence that in August 2016, it had revised its Asset Class Strategy for grillage foundations[72] which was approved on 30 January 2017. The revised approach was based on expert advice Transpower received from BECA following its study on the practicality and risk of adopting three hypothetical approaches to grillage replacements. Transpower's 2017 Asset class strategy tower foundations described the changes in its approach to grillage replacements:

> *Before the present CoG regime was implemented, alternatives such as grillage replacement and cathodic protection were the accepted intervention methods. Grillage replacements are still carried out, where considered the least lifecycle cost intervention. Going forward, we will review other foundation refurbishment methods, and look for opportunities to trial these, especially where the CoG for any particular site is not judged to be cost-effective. In addition, we will review the present condition assessment criteria being used, and look to introduce a structural utilisation assessment to aid with prioritising site for refurbishment.*[73]

284. Implementation of the strategy occurred during the 2016-17 calendar year and, following a period of catch up on deferrals, Transpower projected a revised long run volume of 250/year grillage replacements for the remaining 2 years of RCP2 (i.e., DY2019 and DY2020).

285. Transpower's 2017 forecast grillage foundations for DY2018 and beyond (Figure 25) indicates that grillage replacements will be lower than in previous years due to its revised strategy and expected application of cathodic protection.

Figure 25: Transpower's 2017 forecast of grillage replacements



[71] Section 98 Notice - Transpower 44066
[72] Transmission Lines Foundations (foundations strategy)
[73] TP.FL 01.02 Asset class strategy tower foundations Nov 2017, page 1

Source: Transpower Grillages (Final Issued)[74]

286. Transpower also provided a copy of a May 2019 Transpower Grillage Portfolio Delivery Business Case 2020-2021 demonstrating how it is applying its current strategy for grillage foundations:

> *The preferred refurbishment is for concrete encasement (CoG) or Cathodic Protection (CP), subject to the condition of the legs as per Transmission Line Foundation Asset Class Strategy (TP.FL 01.02) and the Grillage Foundation refurbishment standard TP.DL 01.05. Where the cost of CoG exceeds the typical cost for an equivalent site by 30% or greater, Cathodic Protection shall be considered.*[75]

287. The business case provides evidence that Transpower is investing according to its revised strategy and that the savings being achieved are in line with its earlier expectations and are material:

> *Invest $9,918.1 by June 2021 to refurbish 192 grillage foundations using concrete encasement, and 110 grillage foundations using cathodic protection (total deliverables 302), on transmission lines assets nationally*

288. The 2019 business case document forecast 2020/21 work on grillage foundations at 330 units. This is aligned with grillage foundation work completed in the 2018 DY but higher than numbers completed in DY2019 and DY2020.

289. Transpower's January 2020 Letter to the Commission did not provide a specific explanation for the differences in grillage replacement rates across Disclosure Years, and in particular the much lower replacements during DY2020.

290. In its Transpower 2020 IPP Disclosures ,Transpower gave the following explanation for the DY2020 replacement volumes:

> *We delivered 166 refurbished grillages which was below the 346 collar for the 2020 disclosure year. As per previous years, our grillage encasement strategy has changed since the start of RCP2. This has resulted in a significant reduction in total number of grillages to be encased each year. The major change in strategy is for the low-to-medium criticality suspension towers (approximately 60 per cent of towers with grillage foundations). We are more confident in our assumptions that the interface is representative of the buried steel grillage and this is resulting in deferment of these structures and the number of commissioned grillages falling below the collar.*[76]

291. An explanation for the varying quantities was provided by Transpower in a copy of its TL Grillages 2020 Asset Class Plan supplied to the Commission in February 2021. Figure 26 reproduces the 2020 Grillage Foundation contained in the Asset Class Plan.

[74] Tranche 2, 14.10 (c)
[75] Transition Portfolio Savings Phase 1 back to the business - Asset Strategy and Design, page 5
[76] Transpower 2020 IPP Disclosures, Tab 16 – note that there is an inconsistency between the text and table in Tab 16 with replacement numbers given as 166 (text and 174 (table).

Figure 26: Transpower's 2020 forecast quantities for the grillage refurbishment programme for RCP2, 3, and 4.

	RCP2					RCP3					RCP4				
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
CoG Units	271	353	365	165	220	190	120	120	120	120	120	120	120	120	120
CP Units			0	48	60	110	180	180	180	180	180	180	180	180	180

Source: Transpower 2020 Grillages Asset Class Plan[77]

Note: COG is Concrete Over Grillage which is a method of encasing grillages in concrete to extent expected life.
CP is Cathodic Protection which is a method using electrolysis method for maintaining the galvanised coating on grillages

292. The Asset Class Plan gave the following explanation for the variation in actual and forecast volumes:

> *CoG was the preferred steel grillage refurbishment option at the beginning of RCP2. CP was implemented from 2019. This is reflected in a nominal 108 CP installations completed in the last 2 years of RCP2. CP interventions are planned for wider deployment in RCP3 and are reflected in the shifting balance of 60% CP and 40% CoG interventions annually.*
>
> *In addition, the revision of the RCP2 plan and latest AH model forecasting, there has been a revision of programme quantities and spend with a forecast for RCP2 of $48.2 million delivering 1374 CoG encasements and 78 CP installations.*[78]
>
> *With the revision of the grillage portfolio and planned introduction of cathodic protection, expenditure is forecast to reduce initially to $44.4 million in RCP3 and further reduction to $38.9 million in RCP4 and RCP5. These forecasts are based on the implementation of cathodic protection providing a reduction in the quantity of CoG encasements. The expenditure reduction between RCP3 and RCP4 is based on anticipated gains from the programme of CP installations.*[79]

293. Whilst the Asset Class Plan provides an explanation for the reduced forecast volumes to around 300 in each Disclosure Year, it does not provide a specific explanation for why the volumes reduced below 300 in DYs 2019 (226 refurbishments) and 2020 (174 refurbishments).

Our previous assessment of Transpower's explanation

294. When concluding our review of Transpower's DY2016 andDY2017 performance against its Grillage Foundation asset health measure, we found that the long-term strategic actions that Transpower took in response to its identification of increasing costs, were appropriate. We found that Transpower had:

- undertaken monitoring of regulatory compliance performance through the CGT structure which provided an early escalation pathway for the issues to be resolved and a governance framework through which actions taken could be monitored;

[77] TL Grillages 2020 Asset Class Plan, Page 12
[78] Ibid, Page 11
[79] Ibid, Page 12

- initiated a Portfolio Savings Initiative resulting in the revised foundations strategy and grillage replacement forecast;
- engaged an independent expert (BECA) to study the options; and
- continued to focus on further options to improve its approach to grillage management through the use of a cathodic protection solution.

295. We concluded that Transpower had responded appropriately to the increasing costs of its grillage replacements and refurbishments and acted consistently with GIP.

296. We noted that documents provided by Transpower contained references to the concept of an RCP2 'allowance' for Grillage replacement and refurbishment (R&R) quantities and expenditure. This raised a concern that Transpower may not have been interpreting and applying the Commission's decision for RCP2 as intended. The RCP2 decision includes a single allowance for expenditure (capex and opex) and does not set expenditure 'allowances' for individual components such as grillage foundations and insulators. The intention is to enable Transpower to apply substitution of expenditure between asset classes as it responds to changes in requirements and revisions to original forecasting.

297. On investigation, we found that Transpower had established a substitution approval process that should allow it to take advantage of the ability to substitute expenditure between asset classes. Transpower provided no evidence that it considered substitution as an initial response option to the increasing cost of grillage R&R.

298. Our only concern with the approach Transpower had taken was based on a lack of evidence. This lack of evidence indicated that Transpower had not undertaken a risk assessment when the initial volume reduction was made, and that failing to undertake such a risk assessment is inconsistent with good electricity industry practice.

Our findings on the reasons for Transpower's reduced grillage refurbishments in DY2018, DY2019 and DY2020

299. Consistent with our findings for DY2016 and DY2017, we have found that Transpower is continuing to improve and develop its approach to the management of grillage foundations.

300. As a result of the development of its revised strategy, the number of grillage foundation replacements has fallen below Transpower's collar.

301. We consider that Transpower has appropriately aligned its grillage foundation management with good electricity industry practice including:

- continuing to review and develop its strategy for extending asset life and reducing costs;
- applying critical assessment techniques to provide risk-based prioritisation of its grillage foundation management; and
- continuing to develop and apply options to reduce costs exemplified by its development and application of cathodic protection applications.

302. Our conclusion is that Transpower's development of its grillage foundation strategy is sound and based on good electricity industry practice. We acknowledge that the application of the revised strategy has realised savings whilst at the same time prioritising programmes on the basis of criticality.

303. Our only concern regarding the volume replacements is the dip in refurbishments seen in DY2019 and DY2020. We suspect that the causes will be attributable to the implementation of the revised strategy and potential Covid 19 delays in DY2020.

However, it would have been useful if Transpower had provided an explanation in its 2019 and 2020 IPP Disclosures for the dip in refurbishments in these two periods.

5.2. Number of insulators replaced

304. Transpower has approximately 210,000 insulator strings comprising 53,670 insulator circuit sets (46,322 suspension sets, 6,262 strain sets, and 1,086 of unknown type)[80]. Transpower's 2019 Asset Class Strategy[81] for insulators states the following objective for its replacement programme:

> *Our overarching objective for our insulators and fittings is that they operate safely and reliably, at least whole-of-life cost. Our key objectives are set out below.*
>
> *Safety: Zero injuries caused by insulator and fitting failures.*
>
> *Service Performance: Average annual unplanned outage rate for all causes (expressed in events for each 100 cct-km each year) less than 4.0 for 110 kV lines and 1.5 for 220 kV lines1. Historical average is 4.0 and 1.6 over past 10 years.*
>
> *Cost Performance: Average outturn cost of insulator and fitting replacements tracks at or below forecasts used in business case approvals, taking into account systematic step changes that influence our outcomes.*[82]

305. Transpower set out the following key strategies for insulators:

- *Aim to replace glass and porcelain insulators and fittings when condition assessment shows that they have reached their replacement criteria (i.e. at CA 20).*
- *Replace composite insulators and fittings based on age, prior to their normal expected life, or sooner where condition dictates.*
- *Install composite insulators in extreme and very severe corrosion areas, and in sensitive areas where audible noise is an issue. Install glass cap and pin insulators in all other areas.*[83]

306. Most of Transpower's insulators are glass and composite: some remaining porcelain insulators will be phased out through replacement. Transpower's assessment of the life expectancy of its insulators depends on location and environment; expected life varies between 7 to 80 years. Transpower considers that the overall health of the insulator asset class is reasonably good due to the volume of annual re-insulation.[84]

307. Transpower uses asset health index (AHI) to determine the annual replacement volumes provided in its AMP. An AHI of 8 indicates quantities/volume requiring replacement. The 2018 AMP identified that 3% of the total insulator population was at AHI 8 or above (i.e., requiring replacement). Transpower's AMP provides the following explanation on how it uses asset health to determine a condition assessment rating (CA):

[80] FL 02.01 Transmission Line - Insulators and Fittings, page 4
[81] FL 02.01 Transmission Line - Insulators and Fittings, page 1
[82] Ibid
[83] Ibid
[84] Asset Management Plan 2018, page 274

> *We use asset health for forecasting quantities of insulator replacement and refurbishment work. The inputs to our asset health model for insulators is inferred age, condition assessment scores, and expected degradation based on corrosion zone and on insulator type. Our asset health models are reviewed regularly with actual CA data to improve modelling and to improve forecast accuracy. Our current asset health model is based on degradation curves determined from historical data, categorised by corrosion zone.*[85]

308. The 2018 AMP also notes that Transpower did not at that time apply a criticality adjustment to its forecast insulator volumes:

> *Criticality is used to calculate asset condition-based risk, however it is not currently used in either the replacement or forecasting of insulators. Our current re-insulation strategy is to intervene at CA20, therefore all insulators, regardless of their criticality, are replaced when this score is reached.*

309. Based on the above explanation, we would expect to have seen annual replacements of insulator sets at approximately 3% of the 53,200 in service as given in the 2018 AMP. This would be 1,596. This is 47% higher than the insulator replacements Transpower actually completed in DY2018.

310. Table 11 shows actual replacement volumes against Transpower Quality Standard Measures.

Table 11: Insulator replacement performance

Insulator replacement volume measure performance				
	Target	Cap	Collar	Actual
DY2018	1402	1517	1287	844
DY2019	1315	1430	1200	644
DY2020	1375	1490	1260	874

Source: Transpower Compliance Reports 2018, 2019, 2020

311. For DY2018, Transpower was 40% below its target and 34% below its collar. This was similar to the replacement levels achieved in DY2016 and DY2017.

312. The low replacement volumes against the 2018 AMP forecast continued in DY2019 and DY2020.

Transpower's explanation for the reduced volumes of insulator replacements

313. Transpower's explanation for the lower replacement numbers provided in its DY2018 Compliance Statement is that:

> *more recent condition assessment information was utilised in an improved asset health model to identify a lower volume that could be delivered without increasing the asset risk.*

314. Transpower's view is that there are two contributing factors to the volume reduction: [86]

- isolated low quality condition assessment results affected its view on RCP2 volumes; and
- changes it made to calibrate the asset health model with actual insulator replacement practice.

[85] Asset Management Plan 2018, page 275
[86] Grid Outputs Report 2018, page 34

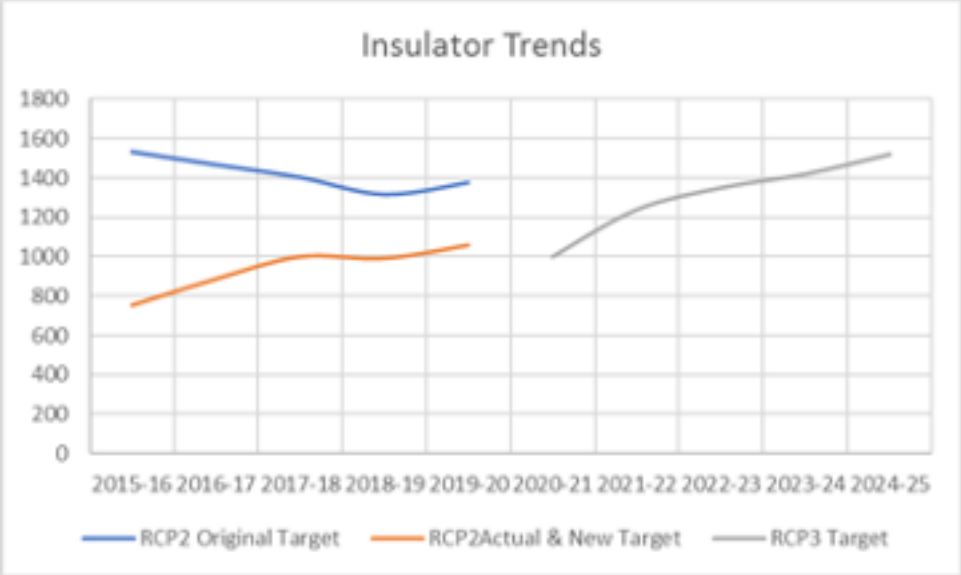
315. The explanation is the same as that provided by Transpower in its DY2017 compliance statement.

316. Transpower also provided an explanatory note that provided further information supporting the reduction in replacement volumes:

> *The combination of improved Asset Health modelling, and the removal of the allowance for potentially poor CA, has resulted in a lower volume of insulator replacements being undertaken in 2015-16 and 2016-17, with the forecast also reducing in the remaining years of RCP2….*
>
> *It is hard to attribute the reduction to any one cause as the improvements in modelling and process interact. But we can see in Graph 1.0 that the trend after the reforecast of RCP2 and the expected plan for RCP3 are now consistent, and the original RCP2 target is more of an outlier.*[87]

317. Transpower's Graph 1.0 is reproduced below in Figure 27; it indicates that it would have, or would be, completing around 1000 insulator replacements during the remaining years of RCP2.

Figure 27:Transpower's 2017/18 forecast of insulator replacements



Source: Insulators (FinalDraftv6)

318. The forecast replacement rates for the remainder of RCP2 are consistent with the forecast units set out in Transpower's 2018 AMP (see Figure 28).

Figure 28: RCP2 allowance and forecasted units, and expenditure in $m for insulators and hardware

	15/16	16/17	17/18	18/19	19/20	Total
Allowance units	1532	1466	1402	1315	1375	7090
Forecast units	755	887	998	990	1055	4685*
Expenditure forecast	4.1	4.9	5.0	4.3	4.8	23.1

[87] Insulators (FinalDraftv6)

Source: Transpower 2018 Asset Management Plan, table 98

319. Transpower did not provide an explanation as to why its actual insulator replacements for DY2018 were 15% below its most recent forecasts and only 1.6% of its insulator circuit sets.

320. Transpower's 2017 AMP condition information indicated that it could make only a slight reduction in its forecast replacement volumes:

> *The Structures and Insulators replacement programme is constantly reviewed accounting for new condition assessment data and refinements to health modelling. Because of this the forecast for Insulator replacement in RCP 2 has slightly reduced…...*[88]

321. In its January 2021 letter to the Commission, Transpower referred to the improved data on asset condition as the reason for the reduced insulator replacement volumes:[89]

> *As regards insulators, we have continued to use updated condition assessment information in an improved asset health model to identify a lower volume that can be delivered without increasing the risk for that asset class.*

322. Transpower also supplied to the Commission its 2020 Asset Class Strategy for Insulators. This document provided the following explanation for the revised replacement volumes:

> *Due to the volumetric nature of the Insulator portfolio, our original RCP2 submission detailed the quantity for investments, as shown in table 3. However, condition assessments performed indicated that our assets were in better condition than initially thought. As a result, in the first two years we completed significantly less re-insulation and earthwire hardware replacement projects than forecasted and have also reinsulated lower quantities than forecasted.*

323. Table 3 referred to in the above statement is reproduced in Figure 29. The table records a 42% reduction in insulator replacements over RCP2 against the original forecasts. In all documents and information it has provided, Transpower attributes this reduction to improved asset condition information that was obtained at the time its RCP2 submission was being prepared for submission.

Figure 29: RCP2 allowance and forecasted units, and expenditure in $m for insulators and hardware

	15/16	16/17	17/18	18/19	19/20	Total
Allowance units	1532	1466	1402	1315	1375	7090
Forecast units	723	1007	845	689	872	4,136
Expenditure forecast	4.3	5.1	4.8	5.4	4.7	24.2

Source: Transpower 2020 Insulator Asset Class Strategy

[88] 2017 published AMP, page 127
[89] Transpower 29 January 2021 letter to the Commission titled 2018 -2020RY CONTAVENTIONS: S98 INVESTIGATION , Page 18
[89] Ibid

Our previous assessment of Transpower's explanation

324. In our previous report on Transpower's insulator replacement volumes we identified the following issues:

- Transpower's initial failure to manage the quality of the condition assessment provided by its service provider, that it claimed led to over forecasting, was not good electricity industry practice;
- Transpower's failure to identify the adjustment in its RCP2 TL Insulators Portfolio Overview Document was a significant omission; and
- this failure, combined with Transpower's omission to advise the Commission of the potential overestimation prior to the final establishment of the targets, caps and collars indicates that it did not follow good electricity industry practice in regard to disclosure of information to a regulator.

325. We advised the Commission that, to meet good electricity industry practice, changes in operational practices would require a comprehensive business case and revisions to the relevant asset fleet strategy. At the time of our previous review, Transpower had not provided such analysis or documentation. In addition, the presentations and minutes of the CGT gave no indication that the required depth of analysis and justification had been reached. We considered that the lack of analysis and supporting documentation indicates that Transpower had not met good electricity industry practice when it made significant changes to its operational practices.

Additional information relevant to DYs 2018, 2019 and 2020 insulator replacements

326. In the information provided in response to the Commission's s 98 notice, Transpower provided a business case for its 2016/17 insulator replacement volumes that had been approved in September 2015. This document identifies that Transpower had an issue balancing the cost and volumes of its insulator replacements.

327. Attached to the business case is a memorandum from Transpower's CEO to its GM Grid Development. The memorandum and the CEO's notes give approval for a strategy to reduce insulator replacement volumes:

> *I have approved the business case BC543: Re-insulation Volumetric 16/17 based on further discussions and information from you and Roy satisfying me that we are not increasing the risk profile to the business in approving less work that planned for in our year 1 RCP2 allowance (92% on volume basis).*
>
> *I note from our discussions we will have a much more robust business case for 17/18 and a much improved review our full programme and targets for the full RCP2 period:*
>
> - *We are working towards improved risk base decision making with implementation of the GOM, the decision function, and the SQRA work. We will be in a better position and have improved information for the 17/18 year, and this will improve over the RCP2 period.*
> - *The fleet strategies/ standards are conservative and we expect to be able to sharpen them as we improve our asset management practices.*
> - *We will have more timely CA data for 17/18 and we will have up to date building block and cost data from our SPs.*

- *We will optimise the portfolio over the 5 year RCP2 period — we are only in year 1 and have flexibility to move work between years to manage risk.*[90]

328. The business case notes that expected volumes are forecast to be lower:

> *Based on a review of the latest asset condition information, our Service Specification requirements and Fleet Strategy, approval sought is for 185 less deliverables than the RCP2 allowance total. The average FYI 6/17 unit cost is slightly higher than in the RCP2 submission. This greater unit cost is driven by a higher forecast of 220kV strain insulators requiring replacement in FY16/17 than was initially planned in our RCP2 submission. These are more expensive to replace due to more intensive hoisting, access and stropping requirements and also due to the higher material cost. Presently available CA data does not indicate there will be a substantial increase in 220kV strain insulators requiring replacement throughout RCP2 compared to the original submission. Over the RCP2 period this cost increase is expected to balance out with fewer 220kV strain insulators being replaced in subsequent years.*

329. However, the planned replacements for insulators were forecast to be within the collar for 2016/17:

> *The TL Insulator grid output measure target for FY16/17 is 1466 deliverables, the collar is 1351 and the cap is 1581. The total approval sought is just above the collar figure. Historically there are a number of urgent replacements needed each year due to defects, accelerated corrosion and out of date or inaccurate CA data. This will allow for the inclusion of this urgent work, any additional work will be approved under separate business cases as necessary and the Portfolio Manager shall ensure he total allowance is not exceeded.*

330. We note that a condition assessment discrepancy had been discovered in 2013 and so would have been taken into account in the September 2015 business case as Transpower also stated:

> *the combination of improved Asset Health modelling, and the removal of the allowance for potentially poor CA, has resulted in a lower volume of insulator replacements being undertaken in 2015-16 and 2016-17.*[91]

331. This also indicates that the improved asset health modelling would have been known and relied upon when the September 2015 business case for the 'reduced' insulator replacement volumes was approved.

332. A September 2015 memorandum from Transpower's Chief Financial Officer to its General Manager Grid Development, identifies that, the initial reduction in insulator replacement volumes was driven by higher unit costs rather than being due to improved condition assessment information:[92]

> *For BC453 we are forecasting costs already to be ahead of those assumed in the preparation of RCP2 proposal, and therefore we are not forecasting to meet the assumed deliverable levels, but instead have structured our cost*

[90] BC453 Re-insulation Volumetric 16-17 (Copy) memorandum from Transpower's CEO to its GM Grid Development
[91] Insulators (FinalDraftv6)
[92] BC453 Re-insulation Volumetric 16-17, 30 September 2015 internal memorandum, Chief Financial Officer to GM Grid Development, copied to Transpower's CEO

> *estimates to deliver just over the collar amount under the Commerce Commission volumetric targets*
>
> *We have discussed that on the basis of the CA data we already have, there is limited ability to defer the some of the work even though costs are already estimated to be over the adjusted RCP2 allowance for this work and may increase with the building block and service provider cost updates.*
>
> *Accordingly, I would propose that in approving this business case we look to see what other efficiencies we can introduce at the relevant portfolio level.*

333. The Chief Financial Officer also noted that:

> *given that the BC is approved for a certain $ amount, should the cost increases from the building block and service provider rate reviews be sufficiently high as to infer we would need to drop under the Commerce Commission collar amount for the BC, then the BCA requesting this adjustment would also be required to be sent through to the BC approver (in these cases Alison as CEO) for review and sign-off.* [93]

334. The memorandum also noted that the reduced volumes provided for in the business case (BC453) did not include urgent replacement insulators required to address issues identified during inspection. The Chief Financial Officer recommended that a separate business case should be produced to cover these expected reactive replacements based on historical levels. The memorandum notes that:

> *there is no specific allowance for these replacement insulators in the RCP2 allowance amount for the portfolio and accordingly, we should but [sic] an estimate for this cost (based on historic experience) into the TL Insulator portfolio capex forecast. This is so that we can capture this issue and work on other efficiencies at the portfolio and super-portfolio level to mitigate this additional spend.* [94]

335. The additional information provided in Transpower's response to the Commission's 2019 s 98 notice clearly identifies that the primary issue Transpower was responding to when reducing its insulator replacement volumes was the management of unit costs that were higher than it had estimated.

336. Notwithstanding the reasons given in Transpower's 2015 business case for reduced insulator volumes, in important documents, Transpower was reporting that the reduction was due to improved condition information:

> *For the Deliver 2019/20 base capex plan measure, delivering the plan will likely result in a breach of five quality standards. Our maturing asset management practices and better condition data mean we are delivering lower quantities for most of these portfolios. As a result, we expect to breach 2 of the yearly measures (insulators and grillage) in 2019/20 and the three 5-yearly collars.*[95]

337. In its March 2021 information request to Transpower, the Commission sought further explanation on apparent inconsistencies in information regarding reasons for below collar insulator replacement volumes. In a 6 April 2021 letter to the Commission,[96] Transpower supplied its explanation and supporting materials.

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[93] Ibid
[94] Ibid
[95] TRA_COM_001.00009 Transpower 2019 Business Plan
[96] Confidential_Transpower_Letter_to_Commission_6_April_2021

338. Transpower's explained that there had been two distinct stages when reducing insulator replacement volumes:

- the first stage involved reducing volumes in response to an emerging issue regarding increased unit costs experienced at the commencement of RCP2; and
- the second stage involved reducing volumes in response to improved asset condition information.

339. Transpower also explained[97] that:

> *the breach of the quality standards was the result of Transpower's subsequent decision to reduce replacement volumes to 887, based on updated asset condition information supporting that lower level of replacements.*

340. On the first stage Transpower explained that:

> *the BC453 memorandum sought approval to replace 1356 insulators in RY2017, which represented a reduction on the RCP2 total allowance, but would have exceeded the collar of 1351. The business case was based on a range of factors, including – importantly – the risk profile of that level of replacement. This planned level of replacement would have complied with the quality standard.*

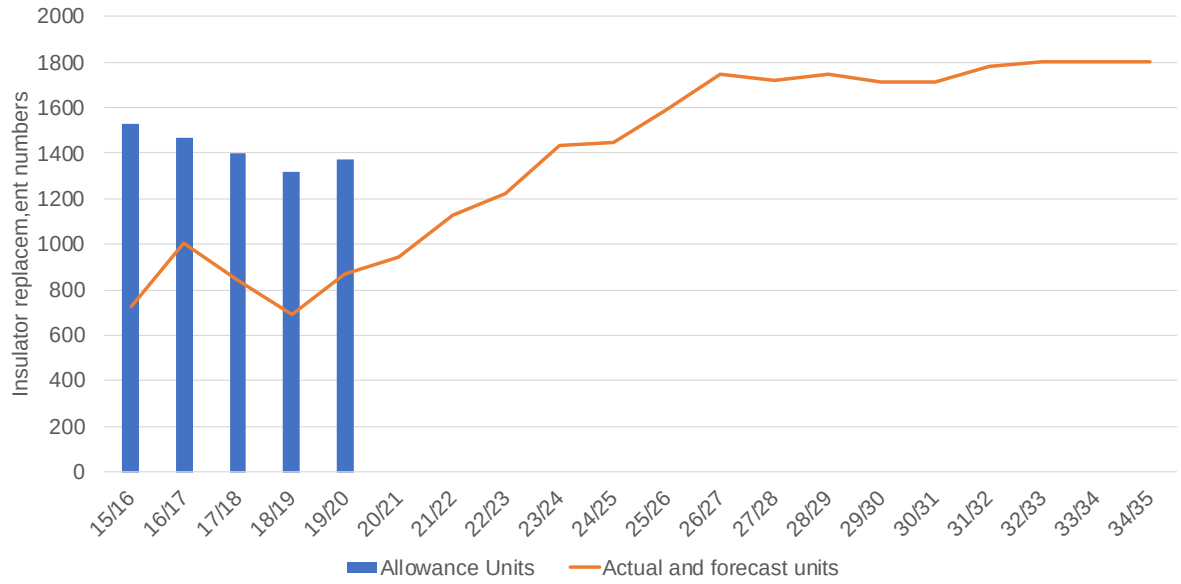
341. Transpower also referred to a copy of BC453 that included memoranda from its CEO and CFO authorising the first stage of insulator reductions.

Our findings on the reasons for Transpower's reduced insulator replacements

342. Transpower made significant changes to its planned insulator replacements shortly after submitting its RCP2 IPP proposal. Figure 30 shows the impact that these changes made to the RCP2 and future insulator replacement volumes. The future volumes clearly indicate that the reduced replacement volumes seen in RCP2 will not continue, and levels will increase beyond 1600 units per year in RCP4.

[97] Ibid

Figure 30: RCP2 allowance and forecasted units, and expenditure in $m for insulators and hardware



Source: Strata chart sourced from Transpower data[98]

343. Transpower's deferral of insulator replacements on the basis of improved condition assessment has clearly moved replacements initially planned for RPC2 out to future RCPs. Transpower's business cases and Fleet Strategy documents have demonstrated that the deferral is economically efficient and can be managed within an acceptable level of risk.

344. However, additional information contained in the Fleet Strategy documents have led us to reconsider the conclusions we had previously reached for the DY2015 and DY2017. We now consider that the reduction in insulator replacement volumes seen as a below collar performance in DY2018 was not fully attributable to a 2013 data error correction and improved asset condition data. Specifically, the explanations Transpower has provided in its RCP2 IPP Disclosures are inconsistent with and did not record the reductions for cost reasons contained in BC453. Transpower's information shows that the initial reduction in insulator volumes was made in response to financial constraints rather than improved condition assessments.

345. In DY2017 and DY2018, actual insulator replacement volumes fell below those approved in the 2015 approved business case; we found no documents explaining this variation and how Transpower has managed the associated risks. In our opinion, Transpower should have undertaken a detailed risk analysis prior to its initial reduction in its replacement volumes to control its increased costs.

346. In response to the Commission's request for evidence of risk assessments Transpower had undertaken, Transpower's response was:

> *Transpower undertook extensive asset and risk assessment work in the early RCP2 period, the outcome of which flowed into the releant [sic] RCP2 business cases and which, in some cases, resulted in lower delivery volumes based on the assessed better than expected asset condition data. Our general processes for assessing asset performance are set out in our previous letter to the Commission dated 17 April 2020.*

[98] TL Insulator 2020 Portfolio Management Plan

We have no recorded risk assessment documentation, beyond what has already been provided, which is specific to the management of insulator replacement volumes.[99]

347. The additional information provided by Transpower has failed to satisfy our concerns that it had not included appropriate risk assessments when proposing the initial insulator replacement reductions in BC 453. However, we accept Transpower's explanation that because the reduced volumes proposed in BC 453 were within the collar, the risk would have fallen within an acceptable range.

348. We also accept Transpower's point that because the initial reduction in insulator volumes was within its collar, the initial reduction did not contribute to its contravention of the Quality Standard. Accordingly, the contravention was ascribed to reductions attributable to deferrals supported by improved condition information. We consider that in making these deferrals, Transpower acted in accordance with good electricity industry practice.

5.3. Number of transmission towers painted

349. Table 12 shows the targets caps and collars for the DY2018, DY2019 and DY2020 together with the actual number of transmission towers painted.

Table 12: Tower painting performance

Transmission tower painting volume measure performance				
	Target	Cap	Collar	Actual
DY2018	517	557	477	532
DY2019	558	598	518	508
DY2020	555	595	515	474

Source: Transpower Compliance Reports 2018, 2019, 2020

350. Transpower was within collar for DY2018 but fell short of its collar number in DY2019 and DY2020.

Transpower's explanation for its tower painting performance

351. Transpower pointed out that for the total RCP2 tower refurbishments, it had exceeded the RCP2 collar of 2,380 by delivering 2502 refurbished towers. For the three DYs 2018, 2019 and 2020, Transpower delivered 1,514 refurbishments against a total collar volume for the three years of 1,510; 14 above the collar.

352. In its 2019 IPP Disclosures and 2019 Grid Outputs Report,[100] Transpower gave the following explanation for the DY2019 replacement volumes:

Delays as a result of our focus on Minimum Approach Distance tower painting combined with some weather and access issues resulting in a number of tower refurbishment works taking longer than anticipated leading to a lower number being commissioned in the year.

353. In its explanation to the Commission,[101] Transpower attributed its below collar performance primarily to its introduction of the Minimum Approach Distance (MAD) to tower painting. The MAD initiative targeted efficiency gains in tower painting by completing a total tower painting (i.e. MAD non-MAD sections) during a single

[99] Confidential_Transpower_Letter_to_Commission_6_April_2021
[100] Transpower 2019 IPP Disclosures, Tab 16, Grid Outputs Report 2019, page 21
[101] Transpower letter of explanations January 2021, paragraphs 68 to 71

operation rather separately. Implementing this approach during DY2029 resulted in an increase of MAD volume painting of 45%. However, completing increasing numbers of complete tower structures incurred longer delivery timeframes and subsequently reduced overall numbers, which for DY2019 was ten towers below its 518 collar.

354. In its 2020 IPP Disclosures,[102] Transpower gave the following explanation for the DY2020 replacement volumes:

> *We painted 474 towers which was below the 515 collar for the 2020 disclosure year. During the Covid-19 lockdown, tower painting was deemed non-essential and as a result we saw a number of months with low or zero towers painted. This lead to a lower number being commissioned in the year.*

355. During DY2020, Transpower supplied the following three reasons for its below collar performance:

- *embedding the Tower Corrosion Challenge;*
- *the COVID-19 lockdown; and*
- *weather.*[103]

356. The objective of Transpower's Tower Corrosion Challenge in 2019 was to undertake more efficient methods for maintaining the steel lattice tower structures. Transpower says that the Challenge *identified the potential opportunity to replace a significant portion of the smaller tower structures with a modern equivalent steel pole structure*.[104] In January 2021, Transpower had still to verify the concept it had developed before taking steps to implement a towers to poles structure replacement programme. Transpower expects the design, proof of concept and initial field installations *to be completed in the next few years.*

357. As part of the Challenge, Transpower explained that it had:

> *…..removed 86 towers from its DY2020 painting plan. The RY2020 programme was then back-filled with new deliverables aligning with the updated strategy criteria, so the total tower paining [sic] plan would meet the quality standard collar of 515 towers.*[105]

358. For the Covid-19 lock-down period, tower painting was deemed to be non-essential work. This caused cessation of tower painting for six weeks with an overall impact of eight weeks due to regional travel restrictions during Level 3. According to Transpower, this reduced the number of towers to be painted under the tower painting programme to 483.

359. Whilst the Covid-19 lockdown deferred site works directly affected the schedule for 6 weeks, Transpower noted that the total impact was 8 weeks due to restrictions on travel at level 3 (regional travel only). This included time required for re-establishment of sites during usual peak delivery months. As it would have been unlawful to continue and undertake any work during Covid-19, this resulted in DY2020 forecast being reduced to 483 towers.

[102] Transpower 2020 IPP Disclosures, Tab 16
[103] Transpower 29 January 2021 letter to the Commission titled 2018 -2020RY CONTAVENTIONS: S98 INVESTIGATION , Page 19
[104] Ibid, Page 20
[105] Ibid

360. A prolonged period of poor weather was experienced during June 2020 which prevented completion of painting for nine towers resulting in a total of 474 towers refurbished during DY2020.

Our assessment of Transpower's explanations for its tower painting performance

361. Transpower's explanations are a combination of external impacts and the effects of an improvement initiatives.

362. For the MAD initiative, Transpower did remarkably well in falling only marginally below its collar in DY2019 especially given the efficiency gains that it had achieved in this period through painting complete structures during a single operation.

363. For the Tower Corrosion Challenge improvement initiative, Transpower had good reason to be confident that it could manage the implications of tower painting the June DY2020 deferrals and remain within collar. With the deferrals attributable to the improvement initiative removed, it would still have met its collar.

364. The deferrals attributable to the poor weather in June DY2020 meant that Transpower would probably have been just under collar for DY2020.

365. The subsequent Covid-19 constraints resulted in a significant backlog of tower painting resulting in Transpower being 8% below its collar in DY2020, Transpower had no way of managing the restrictions due to Covid-19 other than trying to recover the shortfall when restrictions moved to Level 2. However, at this point, there would have been no time left to recover the lost volume and the June weather event would have exacerbated this.

366. In our opinion, in DY2020 Transpower performed extremely well in progressing its tower refurbishments to the extent it did during a very difficult Disclosure Year. We have concluded that Transpower could have done little to mitigate the impact of the events that were outside its control.

367. In our opinion, the primary contributors to Transpower's contravention of its Quality Measure for transmission tower painting were the:

- reduced volumes that resulted from its improvement initiative, which was within Transpower's control;
- effects of the June 2020 adverse weather event which was outside Transpower's control;
- constraints attributable to Covid-19 restrictions during DY2020, which was outside Transpower's control.

368. We have concluded that contravention of its Asset Health Quality Measure for Tower Painting in DY2019 and DY2020 was not a result of Transpower failing to meet a good electricity industry practice standard,

369. Also worthy of comment is the tower to pole programme that will emerge from Transpower's Tower Corrosion Challenge. We agree with Transpower that this initiative should result in improved efficiencies in its future pole refurbishment programmes.

6. Assessment of above collar performance against Periodic (five-year) Asset Health Measures

370. Table 13 shows the targets caps and collars for the DY2018, DY2019 and DY2020 together with the actual number of assets for each of the three Periodic (five-year) asset health measures.

371. Transpower contravened its collar in all three measures.

Table 13: Periodic (five-year) Asset Health Measure results

Asset replacement volume measure performance	Target	Cap	Collar	Actual
Circuit Breakers	141	153	129	113
Power Transformers	26	28	24	19
OD/ID Conversions	15	16	14	11

Source: Transpower Compliance Reports 2018, 2019, 2020

6.1. Outdoor circuit breakers

372. Transpower delivered 113 replacement outdoor circuit breakers which was below the collar of 129 for RCP2.

Transpower's explanation for why it contravened the Collar for circuit breaker replacements

373. As part of its adoption of CBRM, in 2017 Transpower updated its asset health model. When making this change it extended the 35-year expected life of its fleet of SF6 circuit breakers by ten years. The effect of this was to reduce the volume of circuit breakers scheduled for replacement in RCP2.

Our assessment of Transpower's explanation for circuit breaker replacement

374. We have previously advised the Commission that the introduction of CBRM by electricity network businesses (distribution and transmission) is likely to deliver the network capex required for asset refurbishment and replacement. Primary sources we used to support our advice were EA Technology and Ofgem.

375. Transpower has adopted an Ofgem model for its rollout of CBRM and it is immediately realising the benefits of reduced capex requirements in RCP2, which Transpower says has flowed through to RCP3. The benefits Transpower is achieving are aligned with our knowledge of those being realised internationally.

376. We consider that the Commission should acknowledge the benefits that Transpower is realising through the adoption of CBRM and refer electricity distribution businesses that refute, the benefits available from adoption of CBRM, to Transpower's experience.

6.2. Power transformers

377. Transpower delivered 19 replacements which was below the collar of 24 for RCP2.

Transpower's explanation for why it was under the Collar for circuit power transformer replacements

378. Transpower developed and introduced a revised Power Transformers Asset Class Strategy[106] during RCP2. Transpower says that a short form version of the strategy was introduced in July 2017 with it becoming fully effective in January 2019.

379. Transpower had used a replacement forecast formed on *unquantified asset health (essentially, reliability) and criticality*,[107] on which it says the RCP1 and RCP2 replacement forecasts had been built. The January 2019 strategy moved power transformer planning on to a site-specific, risk-based options analysis tool used to assess each transformer on a site basis.

380. Transpower says[108] that for the new strategy it adopted a detailed analysis tool to develop its long-term plan and replacement programme. Transpower says that this increased the number of transformer life extension work which in turn deferred the need for replacements during RCP2 and RCP3.

381. The 2019 Asset Class Strategy acknowledges the trade-off that the change in strategy was making between replacement and life extending works.

> *When compared with age-based replacement, this strategy defers CAPEX replacement for many ageing power transformers, but requires investment in specific risk mitigations such as bushing replacements.*[109]

382. Transpower quantified the trade-offs made in RCP2:

> *Although adopting the new asset class strategy has meant under-performance against the measure we have, in addition to the 19 replacements, undertaken 34 bushing replacements to extend the life of older units where the quantified benefits approach has shown this to be the lowest whole of life cost option.*[110]

Our assessment of Transpower's explanation for power transformer replacements

383. We consider that Transpower has transformed its power transformer asset class strategy to be aligned with international practices we have seen in our reviews of transmission businesses in Australia, and to a lesser extent in Asia.

384. Whilst Transpower did not provide a specific business case document supporting the development and implementation of the revised Asset Class Strategy (e.g. projecting net benefits and mitigating risks etc.), we consider that the merits of the change in strategy have been established in practice through the work completed to date.

385. However, if the revised Asset Class Strategy is not supported by a documented and approved business case, we consider that Transpower would have not met good electricity industry practice when adopting the revised strategy. In particular, an

[106] Transpower supplied its 2018 and 2019 Power Transformers Asset Class Strategies
[107] Transpower 29 January 2021 letter to the Commission titled 2018 -2020RY CONTAVENTIONS: S98 INVESTIGATION Page 20
[108] Ibid
[109] Power Transformers 2019 Asset Class Strategy
[110] Transpower 29 January 2021 letter to the Commission titled 2018 -2020RY CONTAVENTIONS: S98 INVESTIGATION, Page 21

absence of an approved business case would suggest that Transpower may not have fully considered the risks attributable to the change in strategy.

386. Because Transpower has demonstrated that it applied an improved and more cost-efficient strategies for the power transformers it deferred during RCP2, we recommend to the Commission that it accepts its explanation for under collar performance in power transformer replacements during the 5-year period covered by this Quality Measure.

6.3. Outdoor to indoor conversions

387. Transpower completed eleven OD-ID conversions which was below its collar of 14.

Transpower's explanation for why it performed under the collar level for OD/ID conversions

388. In RCP2, Transpower reviewed the OD/ID conversions programme, as it did for power transformer replacements. Transpower says that the revised programme resulted in it implementing a range of different investments from in its original RCP2 forecast.

389. A new asset class strategy for ACS Outdoor to Indoor Conversions Portfolio Management Plan and corresponding revised Outdoor 33 kV Switchyards Asset Class Strategy were adopted in January 2018 with implementation undertaken throughout the balance of RCP2.

390. The new strategy replaced a design-related safety and reliability programme with a programme that Transpower says uses an options evaluation strategy. Transpower set the following objectives for the revised strategy:

> *Our overarching objective for outdoor 33 kV switchyards is that they provide a safe working environment, and operate reliably, at least lifecycle cost.*
>
> *To achieve this, our key objectives are:*
>
> - *Asset Performance. Number of fault and forced outages caused by outdoor 33 kV equipment will be reduced to less than 5 per annum by 2025 (currently averaging approximately 15 events each year).*
> - *Safety. Zero fatalities and injuries causing permanent disability at outdoor 33 kV switchyards*[111]

391. Transpower described its plan was to:

- *convert outdoor 33 kV switchyards that do not meet current expectations for safety in design or reliability to modern equivalent indoor switchboards;*
- *decommission all outdoor 33 kV structures that have inadequate safety clearances and reliability characteristics and replace with a modern equivalent indoor switchboard;*
- *priorities switchyards with small safety clearances, complicated structures and buswork, and aged bulk oil circuit breakers.*[112]

392. Transpower's revised implementation strategy and related plan led to some sites that had been originally identified for OD-ID conversions to be replaced by new

[111] ACS Outdoor Indoor Conversions 2020 Asset Class Plan, Page
[112] Ibid

transformer feeder configurations. This achieved the key objectives at lower costs than the originally planned OD/ID conversions.

393. Transpower provided documents relating to the Haywards and Naseby outdoor 33kV switchyards for which the business case[113] records an avoidance of $4.239M capital expenditure on an ODID in RCP3. The business case provided the following overview of the original OI/ID and

> *Transpower had originally planned to replace the existing Ti and T2 with the two ex-Ashburton 220/33 kV transformers. In addition to the transformer replacement, the outdoor 33 kV was to be converted via an standard ODID project. As the NSY 33 kV bus supplies only two feeders to PowerNet's Ranfurly zone sub, Transpower proposed to PowerNet a lower cost busless 33 kV arrangement where each feeder is feed separately from one transformer.*[114]

394. The business case recorded additional benefits related to avoidance of asset stranding risk for other options. However, the example highlighted Transpower's engagement with its customer to develop a workable solution which was more cost efficient than the originally planned OD/ID conversion.

Our assessment of Transpower's explanation for OD/ID conversions

395. Transpower has demonstrated that it has continued to develop and improve its strategy and associated plans and projects related to OD/ID conversions. This is commendable and is aligned with good electricity industry practice. Transpower recognised that its adoption of the new strategy would result in reduced OD/ID conversions and a resulting below collar performance, but that the benefits would include reduced costs and improved risk management. Transpower also demonstrated that it had included its customers in the decisions that affected their service.

396. We recommend that the Commission accepts Transpower's explanation for its under collar result in OD/ID conversions, and recognise that Transpower appropriately realised cost and risk management benefits from the strategic changes it made during RCP2.

[113] Naseby T1 and T2 Replacement - Delivery Business Case
[114] Naseby T1 and T2 Replacement - Delivery Business Case

Appendix A Glossary

Act	Part 4A of the Commerce Act 1986
AHI	Asset health index
AMP	Asset Management Plan
AP	Assessment Period
Capex	Capital Expenditure
CIMS	Coordinated Incident Management System
CoG	Concrete over Grillage
Commission	The Commerce Commission
DY	Disclosure Year
DY2016	Disclosure Year 2015/16
DY2017	Disclosure Year 2016/17
DY2018	Disclosure Year 2017/18
DY2019	Disclosure Year 2018/19
DY2020	Disclosure Year 2019/20
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IPP	Individual Price Path
EDB	Electricity Distribution Business
GEIP	Good electricity industry practice
GMT	Grid Management Team
GRP	Grid Outputs Reports
MAD	Minimum Approach Distance
MWh	Megawatt-hour, a unit of electrical energy
NERG	National Event Review Group
HSWA	The Health and Safety at Work Act 2015

ICP	Installation Connection Point
ID	Information disclosure
kV	Kilovolts (= 1000 volts), a unit of electrical voltage
MVA	Megavolt-ampere, a unit of electrical power
MW	Megawatt, a unit of electrical power
OLTC	Online Tap Changer
OOU	Onset of unreliability
Opex	Operational expenditure
R&R	Replacement and renewal
SFIR	System Fault and Interruption Report
Strata	Strata Energy Consulting Limited
Transpower	Transpower New Zealand Limited
VoLL	Value of Lost Load

Appendix B Information Transpower provided to support its explanations of major events during DY2018

Information Transpower provided to support its explanation

397. In its response to the Commission's February 2020 s 98 notice, Transpower provided a summary of the major events it experienced in for DY2018.[115] The following are extracts that add further detail to Transpower's explanations in its disclosures and Grid Outputs report.

398. For the interruption experienced at Hokitika, Transpower the following information:

(a) Faulted component: Twisted cross arms and conductor down due to trees.
Severe storm caused damage to circuit, HKK_OTI2.

(b) HKK_OTI2 tripped from red phase to yellow phase fault caused by conductors down. Severe weather storm (ex-cyclone Fehi) caused the damage. Tripping of this circuit and of HKK_KUM1 (at 1030) resulted in LOS to HKK.

399. With regards to the interruption at Hamilton substation, Transpower provided the following information:

(a) Faulted component: Suspect low oil in VT8
HAM feeder trip suspected as caused by overload in KiwiRail's network.

(b) Maintenance contractor advised one phase of VT8 had low oil level. Later it was determined VT8 always had low oil in said phase and a top up was not required.

400. With regards to the interruption at Rangipo, Transpower provided the following information:

(a) Faulted Component: Red phase not fully closed so flashed-over in its SF6 compartment – human error by service provider.

Unable to close DIS667 via electrical control as it may not have been in state to meet interlocking requirements. Service provider operated DIS 667 with manual crank which failed to fully close. NGOC observed a MIDPOS alarm for DIS667 and service provider was advised.

Service provider observed the indication on mechanism box, attempted to close the DIS further using a crank handle and looked through sight glass to observe position of primary contact. They advised NGOC DIS667 seemed to be closed.

Decided to investigate MIDPOSE alarm at later date and was manually overridden (NIS) at time equipment was returned to service.

Investigation determined RPO DIS667 red phase contact not correctly closed by service provider.

401. For the interruption at Mataroa, Transpower provided the following information:

[115] 2017_18 Major Events Details.xlsx

(a) Faulted component: Snow and ice loading on conductors.
Snow or ice loading on conductors when offloaded, the conductors clashed.
Relay at OKN maloperated and tripped CBs 92, 72, 82, 38 which was caused by a setting error.

(b) Snow or Ice has been an issue at Mataroa (Rangitikei) on other occasions.[116]

402. For the interruption at Berwick, Transpower provided the following information:

(a) Faulted component: BWK DIS194 yellow phase insulator damaged - bird streaming & flashover
Line patrol found a damaged yellow insulator on BWK DIS caused by either bird strike or streaming.

(b) A copy of the Berwick Substation Inspection January 2019.

403. For the interruption at National Park, Transpower provided the following information:

(a) Faulted component: Snow and ice loading on conductors.
Snow or ice loading on conductors when offloaded, the conductors clashed.
Relay at OKN maloperated and tripped CBs 92, 72, 82, 38 which was caused by a setting error.

(b) Snow or ice has been an issue at National Park on other occasions.

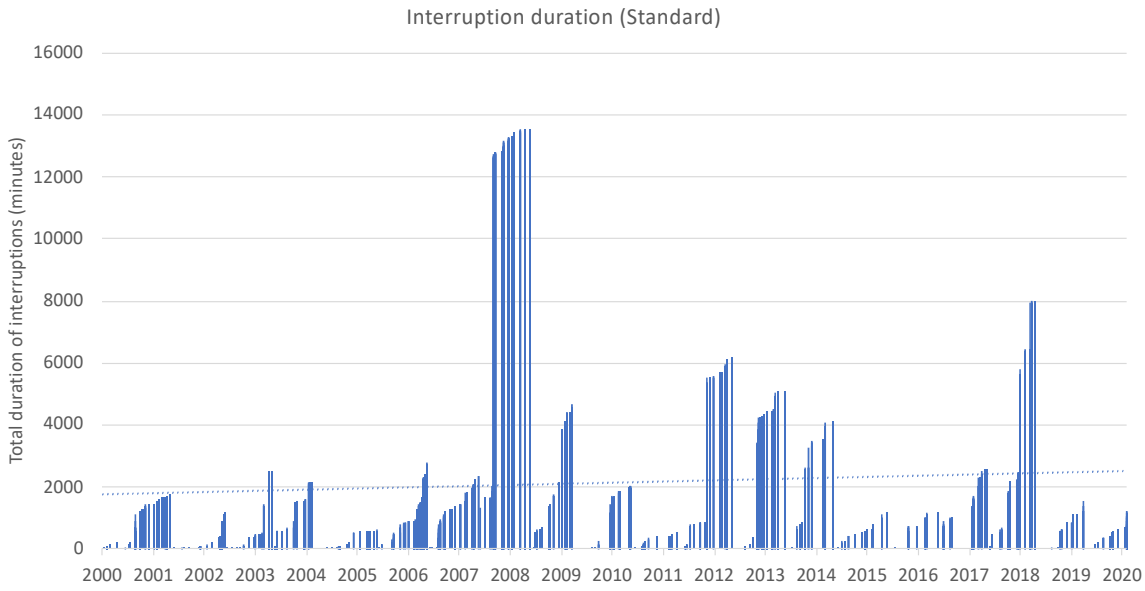
[116] Extract for the interruptions data entry states:13Jul17 0759 BPE_MTR1 tripped and AR for red to blue phase fault due snow loading. Top red phase conductor on span 170-171 found broken and was replaced."

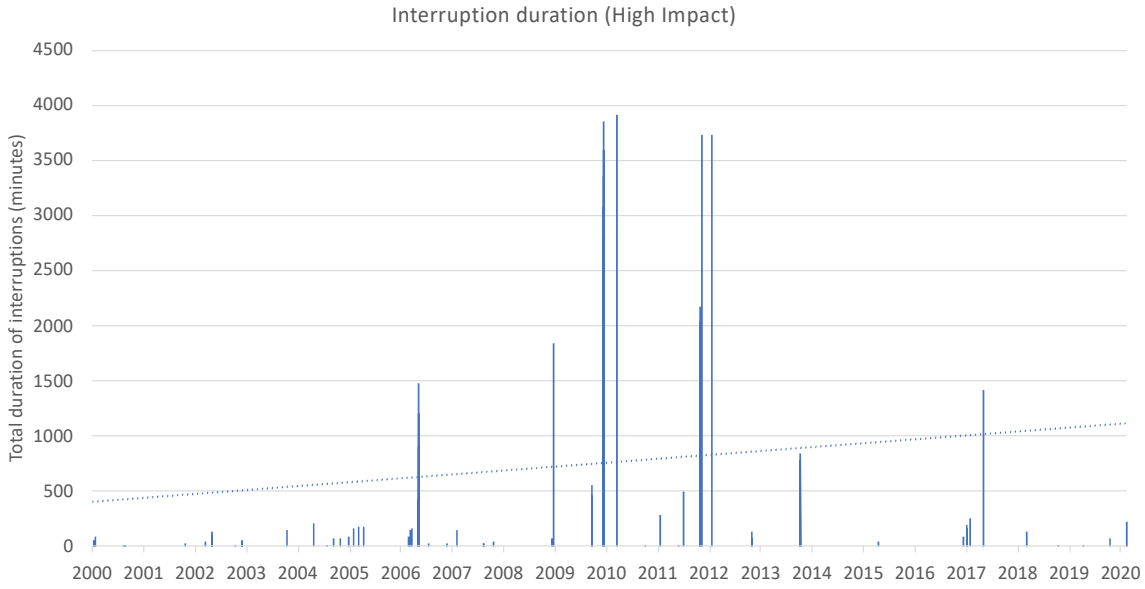
Appendix C Unplanned interruption duration trends

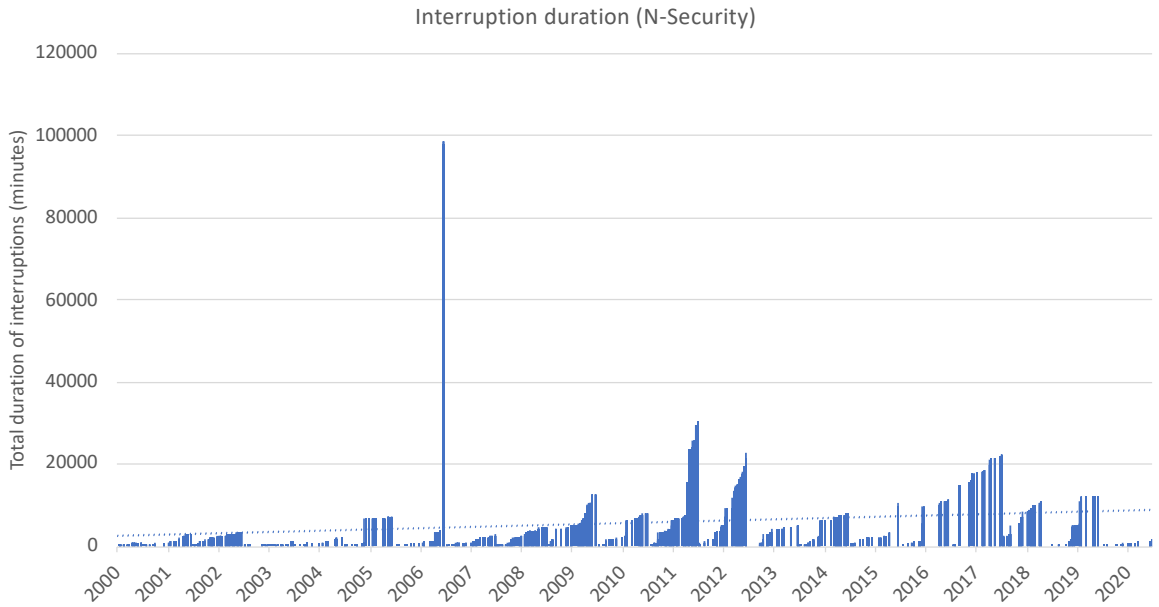
C.1 The following charts show the total unplanned interruption durations for each Grid Performance Measure category.

C.2 We have added linear trendlines to the to the charts to provide an indication of whether the duration if interruptions has been increasing or decreasing over the twenty-years of available data.

C.3 The charts indicate that unplanned interruption duration has trended upwards for Standard, High Impact and N-Security categories but downwards for Generator and important categories. Because the Standard and N-Security have the greater number of unplanned interruptions, there will be an upwards trend for total category interruption duration.


Interruption duration (Standard)
Total duration of interruptions (minutes)
16000
14000
12000
10000
8000
6000
4000
2000
0
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020


Interruption duration (High Impact)
Total duration of interruptions (minutes)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020


Interruption duration (N-Security)
Total duration of interruptions (minutes)
120000
100000
80000
60000
40000
20000
0
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
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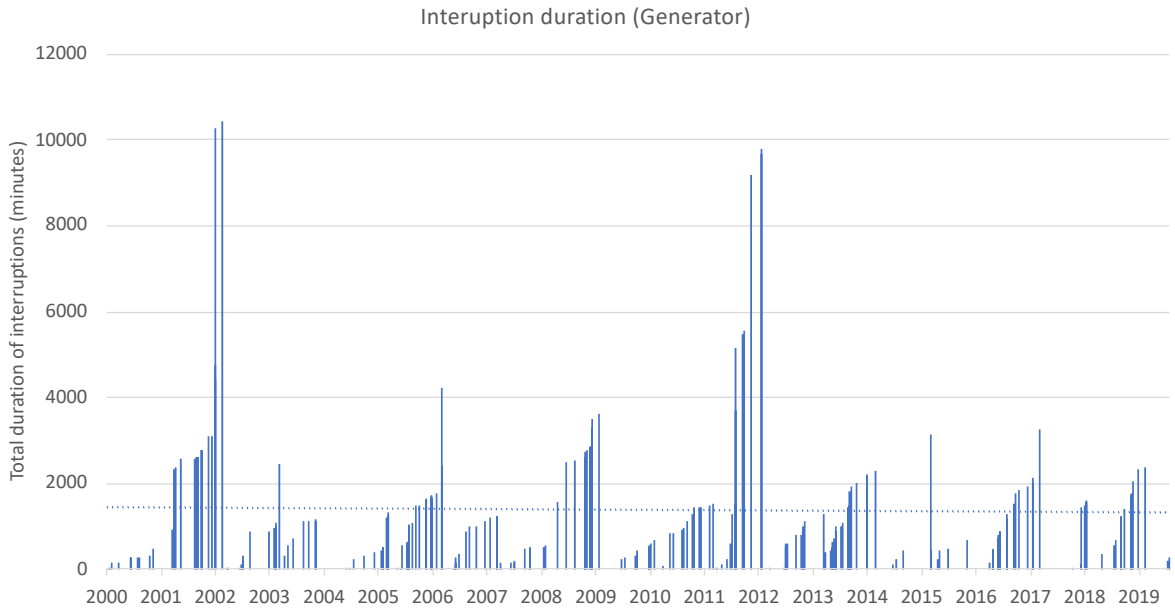
2017
2018
2019
2020


Interuption duration (Generator)
Total duration of interruptions (minutes)
12000
10000
8000
6000
4000
2000
0
2000
2001
2002
2003
2004
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2006
2007
2008
2009
2010
2011
2012
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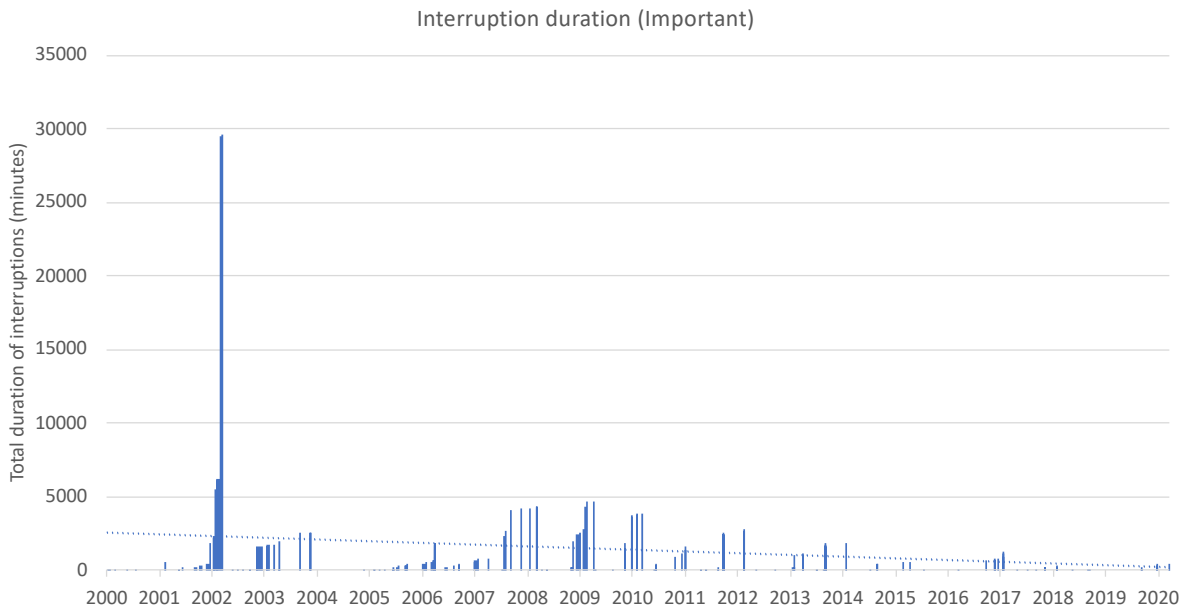
2017
2018
2019


Interruption duration (Important)
Total duration of interruptions (minutes)
35000
30000
25000
20000
15000
10000
5000
0
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020

Appendix D Transpower's review of major events

D.1 In its 14 February 2021 Information Pack, Transpower supplied the Commission with an Excel workbook containing its analysis of eleven major interruption events.

D.2 The table below is a reproduction of the summary tab from Transpower's workbook

Event	Comment	More than Collar	Notes	Normalisation	GEIP	Comment
114255	HKK-OTI-2 tripped, high winds in the area.	Y	NIWA: Ex Cyclone Fehi	Y		
114384	OAM-BPT-WTK-1 tripped, irrigator hit circuit	Y	Third party	Y		
116051	BWK-DS-194 faulty,BAL-BWK-HWB-1 tripped, LOC	Y	Disconnector training. Refurbish with graphite. Poor past performance.	Y		
102259	ISL-KIK-2 & 3 trip-clashing, major West Coast LOS	Y	High winds causing conductor clashes. No previous interruptions in 20yrs for conductors.	Y		
99864	HWA T2 & T4 tripped, HEI, technician error, LOS	N	11Jul2017 technicians carrying out phasing checks between VT107 and VT87 in switchyard failed to plug leads into multimeter and instead connected VT87 to VT107 directly. At 1755 HWA T2 and T4 tripped via residual voltage protection.	N	N	Testing HEI
100153	MTR-OKN-1 trip, OKN-NPK-ONG1 trip, cct faults LOS	Y	Faulted component: Unknown. Loose wire in anti-pump circuit. Tripping of OKN_NPK_ONG1 circuit probably caused by lightning strike. Investigation on NPK CB222 found wire not properly clamped in a terminal of CB222's anti-pump cct. This wire was re-terminated in the terminal. Service provider commented this was a manufacturing fault.	N	?	Procurement or installation
103094	OKN-NPK-ONG-1 trip, lightning, B-E fault LOS@NPK	Y	Snow or ice loading on conductors when offloaded, the conductors clashed. Relay at OKN maloperated and tripped CBs 92, 72, 82, 38 which was caused by a setting error.	N	N	Protection Setting Error
114183	HAM-110kV bus LOS, HAM-P-TF-T6 faulty when T9 RFS	N	A similar tripping occurred at HAM_T2 (29May2015) due to faulty relay case which was replaced. The event duration isn't longer than the collar but affected multiple sites. Site investigation identified issue with connections between relay and the case. Yellow and blue phase contacts had not fully made contact. Likely soon after T9 was removed from service, increase in T6 load was enough to allow relay 482Dif1 to operate due to current imbalance due to the poor contacts in relay.	N	?	Procurement or installation
115010	RPO-DS-667 R-E fault 220kV bus trip, LOC Genesis	Y	Planned outage did not involve DIS667. However, when the circuit on outage was to be RTS on 28Mar18, DIS667 would not close properly using its electrical control. Service provider operated DIS667 with manual crank that failed to fully close. A MIDPOS SCADA alarm went off and NGOC advised service provider. The service provider attempted to close the disconnector further and looked through sight glass to confirm position of contact. NGOC was advised DIS 667 seemed closed. The manual closure process was a HEI and eventually resulted on 29Mar18 the RPO 220kV bus being tripped via bus zone differential protection when DIS 667 red phase contact flashed over to earth.	N	N	Operation override HEI
115273	HAM-TF-T8 RFS for low VT8 oil level check	Y	HAM-TF-T8 RFS for low VT8 oil level check, LOS to Kiwi Rail, (Note T7 still O/S) also tripping at 0934 was a feeder fault. 12Apr18HAM 55kV feeder 1532 tripped for suspected overload in Kiwi Rail's network. Maintenance contractor advised one phase of VT8 had low oil level. Later it was determined VT8 always had low oil in said phase and a top up was not required.	N	N	Practice HEI
115282	KAW-CB-2762 tripped, relay settng error	N	KAW-CB-2762 tripped on overload, relay settng error, The protection design consultant made a mistake by overlooking the request from Horizon Energy for the 800Amps setting	N	N	Protection Setting Error