Cost pass through application – 500kV Transmission Line Tower Collapse

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Contents

1 Executive Summary

This is an application by AusNet Transmission Group Pty Ltd (AusNet Services), pursuant to clause 6A.7.3(a) of the National Electricity Rules (NER). The application seeks approval from the Australian Energy Regulator (AER) to pass through the additional costs AusNet Services incurred to restore transmission services and replace collapsed 500kV dual circuit transmission line towers near Cressy in south western Victoria as a result of extreme weather that occurred on 31 January 2020. The towers bear the Moorabool – Mortlake and Moorabool – Haunted Gully 500kV transmission lines, which are critical elements in the national grid, forming part of the Heywood interconnector to South Australia, supplying the Portland aluminium smelter and connecting gas and wind generators in South Western Victoria to the NEM.

Extreme weather was experienced across South Eastern Australia on 31 January 2020. It began with record temperatures, followed by severe thunderstorm activity with near-record winds recorded near Melbourne. Flooding occurred in parts of South Australia.

The transmission line was restored to service via a bypass line using the Emergency Restoration System, a set of temporary structures and conductor attachment hardware that are held as a contingency in the case of such an improbable, catastrophic collapse of towers. In a very complex planning, design, logistics and construction operation, the two circuits of the transmission line were returned to service on 17 February and 3 March respectively. The dedication of staff and delivery partners, and provision of materials and other support from interstate transmission businesses are acknowledged as crucial to early restoration.

Applying regular capital project processes, work is now proceeding to replace the temporary structures with new permanent towers as soon as is practicable. This requires the steel members for the towers to be specified, ordered, manufactured and delivered, as well as the foundation and tower erection works in the field. This is due to be complete by October 2020.

Restoration of the transmission line, including the replacement towers yet to be installed, will incur additional costs totalling $25.04 million for AusNet Services. These costs are not accounted for in its 2017 – 2022 transmission determination. Given the nature of the event and magnitude of the cost impacts, AusNet Services considers it appropriate for these additional costs to be recovered via the cost pass through provisions set out in section 6A.7.3 of the NER.

AusNet Services considers that the AER should approve its proposed positive pass through amount as:

- the tower collapse event meets the relevant requirements to qualify as a nominated pass through event, specifically a natural disaster event;
- the costs incurred as a result of the tower collapse amounts to 2.1% and 2.3% of AusNet Services' annual revenue requirement for the 2019-2020 and 2020-2021 regulatory years, thus satisfying the materiality requirement in the NER for the pass through event to be a positive change event;
- the application addresses the requirements set out in clause 6A.7.3(c); and
- has been submitted within the extended timeframe for making a pass through application approved by the AER.

The application also addresses the matters listed in clause 6A.7.3(j) that the AER must take into account in determining the approved pass through amounts. We consider that this will enable the AER to determine that the amounts proposed by AusNet Services should be approved for pass through.

AusNet Services is proposing that the positive pass through amount be recovered in the final year of the current regulatory control period, i.e. the regulatory year ending March 2022. The pass through amount constitutes a small proportion of the actual costs, as the capital incurred was for long lived assets and will be recovered over 60 years. However, in the absence of this pass through application, AusNet Services would have been liable for a penalty amounting to 30% of capital expenditure incurred ($6.94m FY2022 real, or $7.4m nominal) under the Capital Efficiency Sharing Scheme, in the 2017-22 regulatory control period.

In Victoria, transmission charges make up approximately 5 per cent of the bill for a typical residential customer. As an indication, the pass through amounts to an increase in the annual transmission costs of $2.36 million (smoothed) for the year ending March 2022. The pass through amount is equivalent to $0.75 per Victorian electricity customer.

AusNet Services considers that approving this pass through application is consistent with the revenue and pricing principles in the National Electricity Law, as such approval provides AusNet Services with a reasonable opportunity of recovering at least the efficient costs of providing prescribed transmission services.[1]

[1] National Electricity Law, s7(A)(2)(a) and (b).

2 Cost Pass Through Framework

The cost pass through provisions, contained in Chapter 6A of the NER, allow TNSPs to seek approval from the AER to recover (or pass through) the increase in costs of providing prescribed transmission services if those increases meet the requirements specified in clause 6A.7.3.

2.1 AusNet Services' written statement

To seek approval from the AER to pass through the increase in costs, the NER require a TNSP to submit a written statement to the AER within 90 business days of the relevant positive change event occurring. This statement must address the matters outlined in clause 6A.7.3(c), namely:

- The details of the positive change event.
- The date on which the positive change event occurred.
- The eligible pass through amount in respect of the positive change event.
- The positive pass through amount AusNet Services is proposing in relation to the positive change event.
- The amount of the positive pass through amount that AusNet Services proposes should be passed through to Transmission Network Users in the regulatory year in which, and each regulatory year after that in which, the positive change event occurred.
- Evidence:
  I. of the actual and likely increase in costs referred to in clause 6A.7.3(c)(3) of the NER;
  II. that such costs occur solely as a consequence of the positive change event.
- Such other information as may be required under any relevant regulatory information instrument.

2.2 Framework for AER assessment

If the AER determines that a positive change event has occurred, it must then make a determination on:

- the approved pass through amount; and
- the amount of that approved pass through amount that should be passed through to transmission network users in the regulatory year in which, and each regulatory year after that in which the positive change event occurred.

In making this decision, the AER must take into account the factors listed in clause 6A.7.3(j) of the NER.

In addition, the NEL requires the AER, in exercising its economic regulatory function and powers, to exercise its powers in a manner that will or is likely to contribute to the achievement of the National Electricity Objective (NEO).

The NEL also specifies revenue and pricing principles. Of relevance to this application is the principle that a regulated network service provider should be provided with a reasonable opportunity to recover at least the efficient costs it incurs in providing prescribed transmission services and complying with a regulatory obligation or requirement or making a regulatory payment.

3 Outline of AusNet Services' Written Statement

This document and the accompanying attachments constitute a written statement pursuant to clause 6A.7.3(c) of the NER, seeking the AER's approval to recover a positive pass through amount totalling $25.04 million. The written statement complies with clause 6A.7.3(c) of the NER as it provides the details necessary to enable the AER to determine that a positive change event occurred as well as information about the eligible pass through amount, positive pass through amount and evidence of the increase in AusNet Services' costs. This statement also addresses the matters that the AER must take into account in deciding the approved pass through amount, being the matters listed in clause 6A.7.3(j) of the NER.

We note clause 6A.7.3(c)(7) of the NER requires AusNet Services to provide such other information as may be required under any relevant regulatory information instrument. No such instrument has been issued by the AER at the time of submitting this statement. However, clause 6A.7.3(e1) provides scope for the AER to request from AusNet Services such additional information as the AER requires for the purpose of making a determination on this application and AusNet Services must comply with such request within the time specified by the AER. Accordingly, we would welcome any necessary information request and consultation from the AER in the course of its consideration of this application.

For the purposes of the pass through determination process, the date on which the positive change occurred is 31 January 2020. On this date, extreme weather was experienced across South Eastern Australia, including record temperatures initially, followed by severe thunderstorm activity with near-record winds recorded near Melbourne. Flooding also occurred in parts of South Australia.

The extremely unusual weather patterns on that day and resulting phenomena caused the failure of seven dual circuit 500kV transmission line towers near the township of Cressy in south western Victoria (six transmission towers collapsed and the seventh was severely damaged). The towers bear the Moorabool–Mortlake and Moorabool–Haunted Gully 500kV transmission lines, which are critical elements in the national grid, forming part of the Heywood interconnector to South Australia, supplying the Portland aluminium smelter and connecting gas and wind generators in south western Victoria to the NEM.

In the normal course of events, this written statement would be required to be submitted to the AER by 11 June 2020, being 90 business days from 31 January 2020 (inclusive). However, in April 2020, AusNet Services proposed to the AER an alternative to pass through. This was to exclude the costs arising from the towers collapse from the Capital Efficiency Sharing Scheme (CESS). This approach would enable AusNet Services to recover the majority of costs, and absorb a small amount of the cost. Such an administratively simple approach was considered to have merit on account of constrained working arrangements applicable to AusNet Services and the AER during the COVID-19 pandemic. The price impact would be lower, smoothed and back-ended for customers, relative to the pass through process.

On 27 May 2020, the AER advised that it had given careful consideration to the CESS exemption approach but had concluded that the CESS applied in the AusNet Services' 2017 revenue determination only allows adjustments in a limited set of circumstances which would not allow it to accept the proposal. However, in consideration of the passage of time whilst the AER considered the proposed approach, the AER approved an extension under clause 6A.7.3(k) of the NER to allow any relevant pass through application to be submitted no later than 31 July 2020. The requirement in clause 6A.7.3(c) in relation to the time for submitting the written statement is therefore satisfied.

AusNet Services' written statement comprises this document and the accompanying attachments. This document addresses the requisite matters in the following sections:

- ***Section 4: Positive change event*** – demonstrates why the 500kV Transmission Line Tower Collapse satisfies the definition of a positive change event and is supported by evidence provided in Attachments 3 and 4.

- ***Section 5: Cost incurred*** – outlines the costs AusNet Services has incurred as a result of the tower collapse event. These costs resulted from the activities we undertook to respond to the impact of the tower collapse event and to restore our network. Further evidence to support the costs is provided in Attachment 6.
- ***Section 6: Pass through amount*** – specifies the eligible pass through amounts and positive pass through amounts in relation to the tower collapse event.

We also have provided at Attachment 2 a compliance checklist that outlines the sections of AusNet Services' written statement that address the various NER requirements for a pass through application. We have also provided confidential and non-confidential versions of the written statement, and a confidentiality template in accordance with the AER's confidentiality guidelines.

4 Positive Change Event

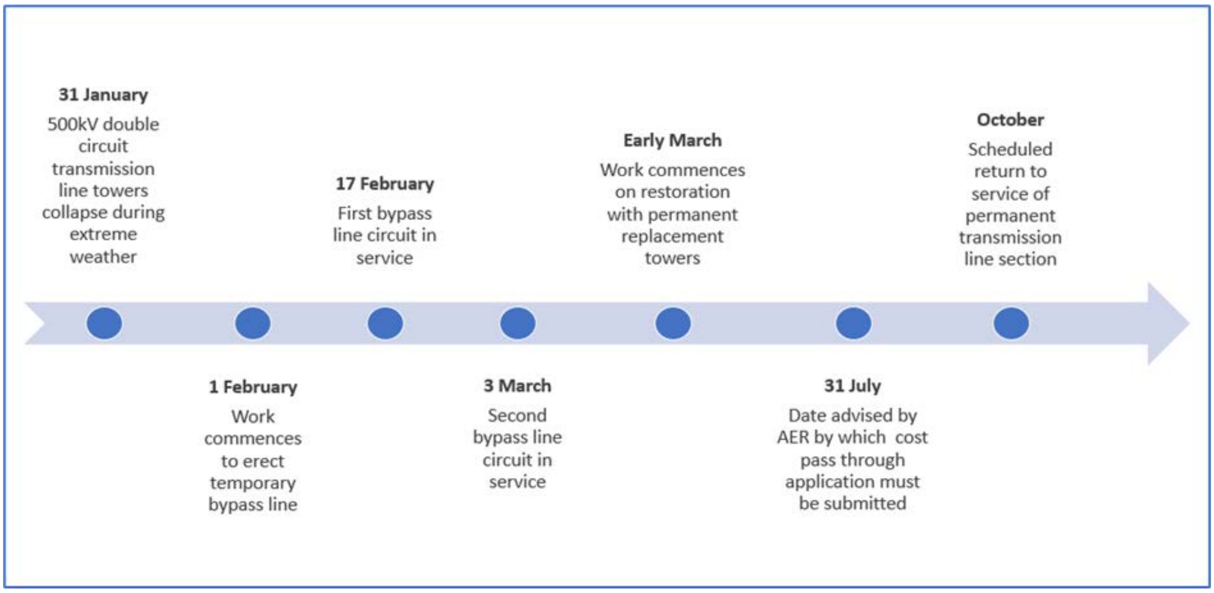
4.1 Qualification as a pass through event

In order to make a pass through application, AusNet Services must establish that a positive change event has occurred. A positive change event is defined in the NER as:

> *"a pass through event which entails the Transmission Network Service Provider incurring materially higher costs in providing direct control services than it would have incurred but for the event, but does not include a contingent project or an associated trigger event."*

The positive change event that is the subject of this application is the occurrence of a convective downburst weather phenomenon on 31 January 2020, which caused the catastrophic failure of six towers and severe damage to a seventh tower, on the dual circuit Moorabool–Mortlake and Moorabool–Haunted Gully 500kV transmission lines near Cressy, in south western Victoria. Immediately after the event, a significant project was initiated to restore transmission services and replace the failed towers. Figure 1 summarises the course of events relating to the weather event and this application.

Figure 1: Timeline of Significant Events Relating to the Event



This section demonstrates how this extreme weather event meets the requirements of a positive change, namely that:

1) it was a pass through event;
2) the event resulted in materially higher costs;
3) the costs were incurred in providing prescribed services; and

A 'pass through event' means, for a transmission determination, the events specified in clause 6A.7.3(a1). The clause specifies each of the following to be a pass through event:

1) a regulatory change event;
2) a service standard event;
3) a tax change event;
4) an insurance event; and

5) any other event specified in a transmission determination as a pass through event for the determination

6) …

This application is in respect of a pass through event provided for under clause 6A.7.3 (a1)(5). The relevant transmission determination for the 2019-2020 regulatory year, during which the weather event and tower collapse occurred, is AusNet Services' 2017 – 2022 determination made by the AER. The AER's Final Decision on AusNet Services' transmission determination specifies that a 'natural disaster event' is a nominated pass through event for the 2017–2022 regulatory control period. A 'natural disaster event' is defined by the AER's final decision in this way:

> *Natural disaster event means any natural disaster including but not limited to fire, flood or earthquake that occurs during the 2017 – 2022 regulatory control period and that increases the costs to AusNet Services in providing prescribed transmission services, provided the fire, flood or other event was not a consequence of the acts or omissions of the service provider.*

The definition of a 'natural disaster event' in the Final Decision notes that in assessing a natural disaster event pass through application, the AER will have regard to, amongst other things, whether AusNet Services has insurance against the event and the level of insurance that an efficient and prudent NSP would obtain in respect of the event. These matters are addressed in this application.

This section of the written statement demonstrates AusNet Services' eligibility to pass through the costs associated with the weather event causing the tower collapse event to transmission network users by establishing that the occurrence of the event is a positive change event. Specifically, this section demonstrates that the event meets the NER requirements to constitute a positive change event as:

- the weather event causing the towers to collapse was a 'natural disaster', in the normal meaning of the phrase, and not a consequence of the acts or omissions of AusNet Services. Details of the tower collapse event are outlined in section 4.2;
- the event is not a contingent project or trigger event, for the reasons discussed in section 4.3; and
- the event resulted in AusNet Services incurring materially higher costs in providing direct control services for the reasons discussed in section 4.4.

4.2 Details of the event

4.2.1 Towers collapse occurrence

The dual circuit 500kV transmission line traversing south western Victoria connects Moorabool Terminal Station (near Geelong) to the Heywood Terminal Station and the interconnector to South Australia, and to the Portland aluminium smelter. The transmission line route is 275km in length and comprises 628 towers. The dual circuit line was constructed in 1981, and there have subsequently been four generator connection points built along the route. In the area where the towers collapsed, the circuits are named according to the adjoining terminal points, such that the impacted lines are identified as the Moorabool Terminal Station–Mortlake Power Station 500kV transmission line and the Moorabool Terminal Station–Haunted Gully Terminal Station 500kV transmission line.

On 31 January 2020, extreme weather was experienced across south eastern Australia, including an initial period of record high temperatures, followed by severe thunderstorm activity, with near-record winds recorded near Melbourne[2]. Flooding occurred in parts of South Australia[3]. Severe thunderstorm conditions, gusty damaging winds, rain and lightning were reported in the area where the towers failed at the time of the incident. A report prepared by the Bureau of Meteorology (BOM) on the meteorological aspects of the thunderstorm activity in the vicinity of the towers that failed (provided as Attachment 3) confirms the severity of the weather conditions.

The failure of the transmission towers on this day is the only tower failure experienced on this or any other 500kV line in Victoria.

The transmission line was designed and constructed in conformance to the applicable standards of the time, being the published standards of the Standards Association of Australia.

There was no evidence of contributory factors such as poor asset condition.

AusNet Services conducts line and easement inspections at set intervals to ensure that defects are identified, assessed to defined action priority coding and rectified in a timely manner. Table 1 provides a summary of the scheduled transmission line inspection program.

Table 1: Summary of Schedule Transmission Line Inspections

Inspection Name	Description	Frequency
Line and Easement Inspection	To identify line and easement defects. Focussed on the clearance space around the transmission line, transmission line component faults and easement issues.	Yearly
Vegetation Inspection	Conducted by LiDAR (a mix of aerial and ground) Focused on vegetation around the transmission line.	Yearly
Condition Assessment Inspection	Detailed inspection and condition assessment to identify line, conductor spacing and easement defects and to assess the serviceability of all elements of the line and easements.	Three, six or nine yearly
Non-invasive inspection	Conducted using specialised equipment such as thermovision camera, corona camera, radio frequency interference, etc.	Three yearly
Smart Aerial Image Processing (SAIP)	Image capture using helicopter-mounted high-resolution video to capture a continuous stream of digital images which are processed by specialised software to identify defects.	Six yearly

The towers had a condition assessment inspection in March 2019 with the overall tower condition classified as 'C2', which indicates that the towers are in a good condition and not affected by corrosion. The major work undertaken to date has been surface treatment of the tower legs at ground level as they enter the footings, to prevent weakening through corrosion.

[2] On-line reporting - 'the Age' https://www.theage.com.au/national/victoria/heat-to-hit-melbourne-by-lunchtime-peak-at-4pm-20200131-p53wdv.html, ABC - https://www.abc.net.au/news/2020-02-01/wild-weather-victoria-continues-across-victoria/11920502

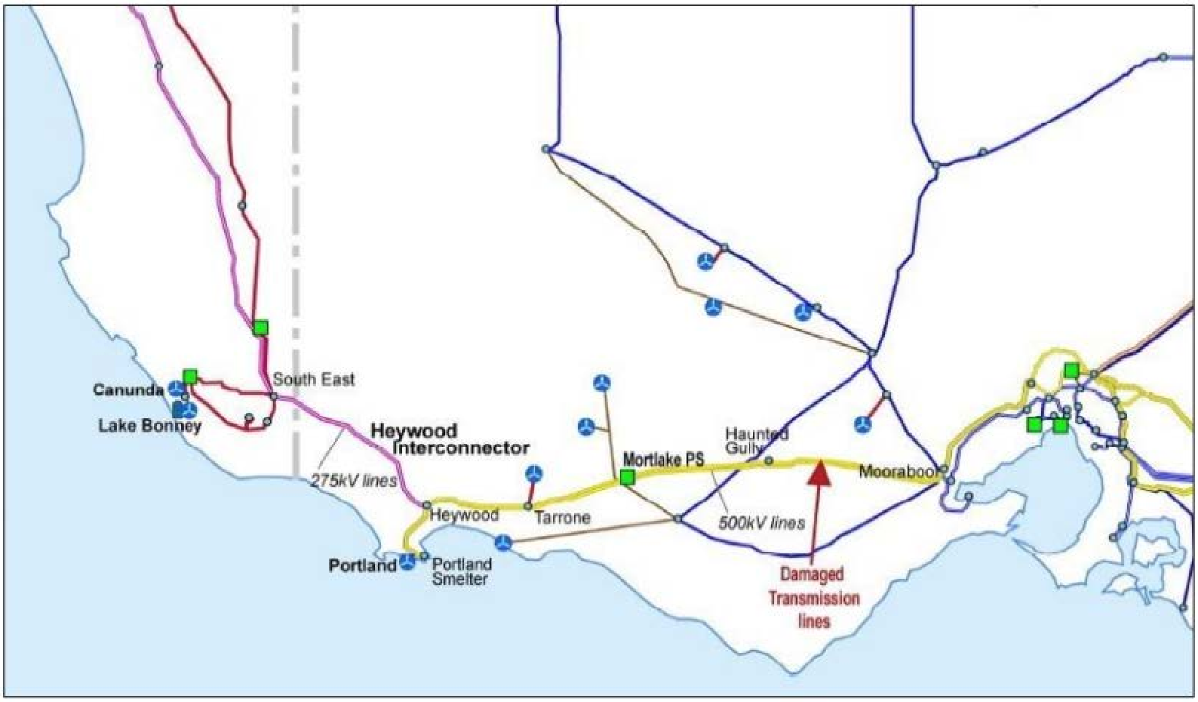
[3] On-line reporting - ABC https://www.abc.net.au/news/2020-01-31/power-cut-to-royal-adelaide-hospital-amid-severe-storms/11918354

AusNet Services notes that this treatment has been effective and this has been confirmed for the towers that collapsed.

Figure 2: One of the collapsed 500kV double circuit towers

The route of the transmission line through south western Victoria is shown by the yellow line in Figure 3, which also locates the area where the towers collapsed (near Cressy) and the nearby terminal points (Moorabool, Mortlake and Haunted Gully) which give the transmission line(s) their identity.

Figure 3: 500kV dual circuit transmission line route, south western Victoria



Source: AEMO

The specific weather event phenomenon that impacted the transmission line and caused collapse of the towers, appears to have been a localized storm event, specifically a severe convective 'downburst'. Given the significant impact of the event, BOM investigated the meteorological aspects of the thunderstorm activity in the vicinity and produced a report on its findings[4], provided as Attachment 3. The BOM report, page 21, concludes:

> *The convective environment and relevant observations of the severe thunderstorm near Cressy on Friday 31 January 2020 suggest a severe convective downburst near electricity transmission infrastructure contributed to the observed damage. Available evidence indicates the thunderstorm produced damaging winds (over 90 km/h) and potentially produced destructive winds (over 125 km/h). Further evidence is required to conclude winds greater than 125 km/h were produced by this thunderstorm. Available evidence indicates the storm did not produce a tornado. Considering the storm motion (NNW to SSE) was roughly perpendicular to transmission lines (east-west orientation), damage from a tornado would necessarily be confined to a very small path (20-100m) and therefore be unable to directly topple multiple transmission towers. The extent of the damage along an extended segment of the line supports the conclusion that a severe convective downburst over a few kilometres is responsible.*

This phenomenon is consistent with the weather patterns that developed across South East Australia that day, in particular the conditions that led to the build-up of severe thunderstorms. While there was not a weather station within sufficient proximity of the fallen towers that could measure the actual conditions, the BOM report concludes that a severe convective downburst over a few kilometres was responsible. The BOM's conclusion is also supported by the fact that trees and other structures in the vicinity of the affected towers sustained severe damage,

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[4] Bureau of Meteorology, Report into the meteorological aspects of severe thunderstorm impacts near Cressy, Victoria on 31 January 2020

and each of the six towers failed in a similar manner, i.e. fell completely transversal/perpendicular to the wind direction.

In these circumstances, the weather phenomena and particular thunderstorm activity that emerges can be very localised. Therefore, it is common that geographically isolated weather events may not be specifically identified in high level BOM forecasts or observations, which is the case in this instance. The phenomenon of a downburst is described in a BOM brochure on hazardous weather phenomena, focusing on thunderstorms. This is provided in Attachment 4.

The US National Oceanic and Atmospheric Administration has also prepared an information sheet describing the phenomenon[5], and is included in Attachment 4. This fact sheet explains that the localised strong winds of downbursts from thunderstorm activity blow horizontally over an area up to $10km^2$, and can reach speeds of up to 270km/hr. The downburst will last for only 2 to 5 minutes. Downbursts have proven treacherous for aircraft, and much of the exploration of the phenomena relates to mitigating the risk for air transport.[6]

The weather event near Cressy caused seven consecutive towers in the transmission line to fail. Six of the towers collapsed and the seventh was severely damaged. This occurred on Friday, 31 January 2020 at 13:24 hrs (AEST), the recorded time that the transmission lines tripped. Line crews immediately undertook an aerial patrol of the transmission lines and identified the failed towers. Employees of the regional distribution network service provider, Powercor, were present in the area and they also alerted AusNet Services to the location of the incident.

4.2.2 Immediate services impact

The failure of the towers caused the loss of both the Moorabool–Mortlake and the Moorabool–Haunted Gully 500 kV transmission lines, resulting in the separation of the Victoria and South Australia regions. Immediately after the incident, the Mortlake Power Station (MOPS) generating units and the Alcoa Portland (APD) aluminium smelter remained connected to the South Australia region but disconnected from the rest of Victoria. At the same time, both pot lines at the Portland smelter tripped, resulting in the loss of around 450 MW of load.

A mode of power system operation was urgently devised by AEMO and NEM participants, which had not previously been configured, to use MOPS (the only thermal generator located to the west of the damaged transmission towers) to restore supply to APD while maintaining the secure and reliable operation of the South Australian power system. To ensure a secure operating state could be maintained until the interconnector was returned to service, the plan was continually refined to incorporate various operational actions.

AEMO is required to conduct a review into ‘reviewable operating incidents’ (defined in clause 4.8.15(a) of the NER) and, for this interconnection separation event, subject to clause 4.8.15(b) and (c) of the NER, released a preliminary report in April 2020. The preliminary report provides more complete information on the power system impacts of the event and the immediate system restoration actions[7].

4.2.3 Characterisation of tower collapse event as a natural disaster

The AER has defined a natural disaster event in the following way:

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[5] https://www.weather.gov/jetstream/wind_damage Information Sheet is included as Attachment 4.

[6] Ibid.

[7] https://aemo.com.au/-/media/files/electricity/nem/market_notices_and_events/power_system_incident_reports/2020/preliminary-report-31-jan-2020.pdf?la=en

"Natural disaster event means any natural disaster including but not limited to fire, flood or earthquake that occurs during the 2017-22 regulatory control period and that increases the costs to AusNet Services in providing prescribed transmission services, provided the fire, flood or other event was not a consequence of the acts or omissions of the service provider"[8].

AusNet Services submits that the impact of the meteorological event satisfies the meaning of 'natural disaster'. The term 'natural disaster' involves two criteria, as follows:

- the event is an event occurring in nature – this is demonstrated through the discussion in this section on the meteorological conditions arising across the region on 31 January 2020; and
- the event may be described as a disaster – in areas with high population density, housing and infrastructure, there is increased likelihood of injury and loss of life in communities, and severe damage to infrastructure directly affecting the population. In this case, the broadacre farmland environment where the transmission line towers collapse occurred, population and infrastructure are sparse. However, the major infrastructure present (i.e. the transmission line) was destroyed and has required an immediate recovery strategy and costly permanent asset restoration plan for the impacted transmission services.

4.2.4 AusNet Services' response to loss of the transmission lines

The transmission lines affected by the natural disaster event are critical elements of the national grid, forming the interconnection between Victoria and South Australia, connecting significant renewable generation to the grid, and supplying the aluminium smelter at Portland. AusNet Services assesses the value of transmission elements to the National Electricity Market routinely, in conducting economic evaluation of asset risk for asset management planning, including regulatory proposals and regulatory investment tests. The criticality of these lines is assessed to be amongst the highest in the network.

The NER, via clause 5.16.3(a)(1) exempts the investment to restore services from application of the regulatory investment test for transmission, on the grounds of the project being required to address an urgent and unforeseen network issue. In the circumstances AusNet Services assessed the practical options via internal processes.

The transmission line was restored to service using the Emergency Restoration System (ERS), which is a set of temporary guyed mast structures and conductor attachment hardware that are held as a contingency in the case of an improbable, catastrophic collapse of towers, such as occurred near Cressy. Figure 4 shows the ERS masts being erected.

Other TNSPs also possess ERS structures, so there is a pool of resources and TNSPs are able to support each other if the number of temporary structures required in an event exceeds the number held by the affected TNSP. For this event, other TNSPs' ERS masts were not required. However, the assistance of interstate TNSPs in providing other materials, such as conductor and technical support, were crucial to achieving an expedited temporary restoration effort.

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[8] AER, AusNet Services' transmission determination 2017-22, April 2017, page 19

Figure 4: ERS mast structures being erected

The temporary transmission line sections were built consecutively to minimise the time to return the first line to service and mitigate risk for network users. The first line was returned to service on 17 February, just two and a half weeks after the failure. The second line was returned to service within similar time period, on 3 March. The restoration demonstrated the immense value in having response plans in place and being prepared and skilled to respond to improbable contingencies such as experienced in this case.

Figure 5: 2nd bypass line being constructed

Figure 6: Completed temporary construction

4.2.5 Permanent restoration of the transmission lines

The temporary ERS structures cannot be retained as a permanent solution for the following reasons, all of which are consistent with their purpose of facilitating prompt service restoration in emergency situations:

- The ERS structures are not designed to survive all environmental conditions that may be expected. The structures have a design working life of 6 months and a one in twenty chance of failure each year. There is a significant risk of subsequent failure and heightened transmission service risk if they are not replaced by permanent structures as soon as practicable. The risk is costed at around $6M per annum whilst the temporary structures are in place;
- The on-going maintenance cost for the temporary structures is significantly higher than for permanent towers. The permanent towers are subject to a 9-year tower climbing inspection cycle, whilst the temporary towers require six-monthly re-tensioning and annual re-alignment. It is estimated that servicing the 14 temporary structures would cost an additional $84,000 per year;
- Retaining the ERS structures on these transmission lines compromises their intended use as being for emergencies generally, including for potential further failure on these lines, and deprives them of their shared use by other TNSPs who also place some reliance on the availability of these assets. The emergency response capability would need to be supplemented if these ERS structures are unavailable indefinitely; and
- The footprint of the structures, taking into account the mast guy systems necessary to

support them, exceed the width of the easements allowed for transmission lines and would impact on private land usage.

AusNet Services conducted an economic benefits assessment of three options to confirm the installation of permanent towers as soon as practicable following temporary service restoration was the preferred economic solution. The options were:

a) Immediately replace temporary with permanent towers (lowest PV economic cost and accordingly preferred);

b) Delay tower replacement by 5 years; and

c) Retain temporary towers as a permanent solution.

For completeness, a 'services not restored' option was also assessed. However, as expected, this resulted in an extremely significant adverse economic cost due to market impact and is the lowest ranked option.

Present value analysis of the options is provided at Attachment 5.

The tower replacement project will erect seven new double circuit towers at the locations of the failed towers. Recognising the continuing risk to transmission services, AusNet Services is seeking to ensure that permanent tower restoration is achieved as quickly as is practical. Mid-October 2020 is currently scheduled for service of the new towers. Figure 7 shows the foundation works underway for the new towers.

Figure 7: Foundation works for the permanent replacement towers

5 Costs incurred as a result of the natural disaster event

One of the thresholds that must be satisfied in order for the AER to approve a positive pass through amount is that the cost to the TNSP of providing prescribed transmission services must increase "materially" as a result of the pass through event.

Chapter 10 of the NER states that the increase is material:

> *if the change in costs (as opposed to the revenue impact) that the [TNSP] has incurred and is likely to incur in any year of a* regulatory control period*, as a result of the event, exceeds 1 per cent of the* annual revenue requirement *for the [TNSP] for that* regulatory year.[9]

This section of the written statement addresses this matter.

5.1 Material change in the costs of providing prescribed transmission services

AusNet Services will incur materially higher costs in providing prescribed services as a result of the failure of the 500kV transmission line towers. Given that the affected transmission lines are key elements of the national grid, early, temporary restoration of service using ERSs was AusNet Services' initial priority as soon as the site was made safe. These costs are already incurred costs.

The project to replace the 7 failed towers with new permanent towers is in progress, and costs for this phase include already incurred costs and forecast costs, applying AusNet Services detailed project cost estimating approach. This phase contains the significant proportion of the total costs that AusNet Services will incur as a result of the positive pass through event.

The following sections demonstrate that the increase in the costs of carrying out these activities meets the materiality threshold.

The cost impact of positive pass through event are broadly divisible into four categories:

- Emergency response, comprising the steps taken by AusNet Services immediately following the event;
- Technical investigation and legal advice;
- Construction of temporary bypass transmission lines; and
- Rebuilding permanent replacement towers and removing the bypass lines.

5.1.1 Emergency response

First responders reached the collapsed towers and section of line within hours of the event occurring and reported the extent of damage to the transmission line. Important safety and security activities were initiated, including:

- traffic management and security arrangements at the location of each of the failed towers;
- obtaining closure of affected roads;
- earthing the out of service transmission line sections;
- posting security personnel at the Moorabool and Mortlake terminal stations along the

[9] Chapter 10 of the NER defines 'materiality' as the change in costs (as opposed to the revenue impact) that a distributor has incurred, and is likely to incur, in any year of a regulatory control period. The change in costs must exceed 1 per cent of the annual revenue requirement for the distributor for that regulatory year.

affected transmission lines; and

- visiting affected landowners to advise them of the incident and inform them of the immediate steps AusNet Services was taking in response.

5.1.2 Technical investigation and legal advice

We undertook an internal review of technical and legal aspects of the event, including for the purpose of responding to enquiries from ESV and AEMO.

5.1.3 Build temporary bypass lines using ERS

AusNet Services began mobilising crew and plant on site to make the site safe and start the restoration works on 1 February. An immediate task was to secure the conductors at both ends of the fallen section of line before any clean up works could begin. Design work for the bypass line using the ERS system was being performed in parallel with site preparation. Some of the key activities that were undertaken to build the bypass lines were:

- Transporting containers containing the ERS masts and associated hardware from Melbourne to site;
- Clearing vegetation affecting the bypass route, and forming access tracks to sites for the rebuild;
- Installing anchors for guying ERS masts and assembling ERS masts on the ground;
- Sourcing and delivering to site all line conductor and hardware to be used for bypass lines;
- Sourcing and delivering all plant and equipment required on site to build the bypass lines;
- Erecting ERS masts, stringing conductor and reconnecting conductors to the sound transmission line towers at either end to reform the transmission lines; and
- Clearing the site of debris from collapsed section of line, such as glass, towers steel and line conductor.

The first circuit was energized on 17 February and the second circuit on 3 March 2020.

5.1.4 Rebuild permanent towers and remove bypass lines

This component of the works involves procurement and erection of 7 new transmission towers, including foundations, and stringing new conductor to reform the circuits as a permanent transmission line section.

Significant progress has already been made on the rebuild project. Works commenced on the permanent tower rebuild immediately following the restoration of the second circuit. Site survey works were carried out in early March and geo-technical works commenced in late March. Access tracks and crane pads were constructed in May.

The key activities that are currently underway or planned for this phase of the work include:

- Working closely with local landowners and stakeholders to keep them informed, receive their input, and arrange access to the site;
- Undertaking design and development work for new footings and towers;
- Procuring steel sections to build the new towers and founds for each site once fully specified;
- Procuring key materials such as conductors and line hardware; and
- Obtaining resource commitments from delivery partners to carry out installation works at site in sequential manner, commencing early July with foundations works.

Once the line is energised via the rebuilt permanent tower pathway, the conductor on the ERS bypass line will be recovered and ERS masts dismantled, re-packed into containers and returned to storage.

5.2 Assessment of materiality

The materiality threshold is the criterion used to determine whether an NSP's pass through application is of sufficient magnitude that, under the arrangements set out in its regulatory determination, the costs claimed can be passed through to customers. The materiality threshold does not pre-determine the amount that is approved to be recovered from customers or the timeframe for recovery.

The drafting of the NER makes clear that materiality is not assessed by reference to the revenue impact of the positive change event. It expressly distinguishes the 'costs' of the event from the 'revenue impact' of the event on the NSP as the basis for the materiality assessment. Since the introduction of the Capital Efficiency Sharing Scheme (CESS) in 2013, it is even more important that materiality is assessed by reference to cost, rather than revenue, to ensure that NSPs continue to receive the same level of protection against uncontrollable costs that was embedded in the regulatory regime prior to the introduction of the CESS, and that this protection is equivalent for opex and capex.

In the CESS Guideline Explanatory Statement, the AER set out its expectation that NSPs would manage the risks and impacts of uncontrollable costs by using the pass through mechanism to avoid a CESS penalty.[10] The intended interaction between the CESS and the pass through regime mirrors the arrangements for operating expenditure and the Efficiency Benefit Sharing Scheme (EBSS), whereby an NSP can apply to pass through uncontrollable opex incurred as a result of a positive pass through event in accordance with the NSP's distribution determination. If the application is successful, the approved opex is incorporated into the NSP's opex baseline for the purpose of assessing its EBSS performance. This means the NSP is not penalised for the uncontrollable cost. To satisfy the materiality threshold, the NSP must incur opex costs in excess of 1% of maximum annual revenue – in AusNet Services' case, approximately $5.6 million.

However, if revenue impact (i.e. the foregone revenue) rather than expenditure is used to determine if materiality threshold is satisfied, the expenditure necessary to meet the threshold is significantly higher where the pass through event requires capital expenditure. This is because the capital costs are returned through revenue earned over the life of the asset(s) constructed from this expenditure. In many cases, the asset lives are very long. For instance, the replacement transmission towers that are the subject of this pass through application have a 60 year asset life. In addition, the capital expenditure will roll into the RAB at the start of the next regulatory period.[11] Therefore, the revenue impact of a pass through event in the regulatory control period in which the event occurs is much lower that if it resulted in an equivalent amount of opex. In fact, in order to reach a materiality threshold of $5.6m of revenue in any one year, AusNet Services would need to incur capital expenditure of approximately $60-70m. However, as is the case with operating expenditure and the EBSS, unless the capex impact of an uncontrollable event is recovered through the cost pass through mechanism, the NSP will incur a CESS penalty amounting to approximately one-third[12] of the

[10] AER, *Explanatory Statement – Capital Expenditure Incentive Guideline for Electricity Network Service Providers*, November 2013, 39.

[11] Subject to the AER being satisfied that the expenditure meets the requirements of clause 6A.6.1 and Schedule 6A.2 of the NER, including that no grounds exist for reducing the expenditure in accordance with clause S6A.2.2A.

[12] The exact amount of the CESS penalty depends on the timing of the expenditure.

incurred expenditure.

To avoid exposing NSPs to material revenue risks associated with unforeseen events (particularly those that result wholly or substantially in significant capital expenditure) and creating a bias towards opex solutions, it is essential that the materiality threshold be applied using a plain reading of the definition of 'materially' in Chapter 10; that is, the threshold must be based on an assessment of the cost impact of a pass through event, not the revenue impact.

An alternative (but not the preferred) approach is that the AER include the expected CESS penalty in its assessment of the revenue impact of the pass through event. In the present case, the CESS penalties AusNet Services expects to incur as a result of the towers collapse are set out in table 2.

Table 2: CESS Penalty without pass-through

Real $m FY2022	2022-23	2023-24	2024-25	2025-26	2026-27	Total
CESS penalty	1.39	1.39	1.39	1.39	1.39	**6.94**

5.3 Materially higher costs

AusNet Services has incurred a material increase in costs as a result of the towers collapse.

The additional operating expenditure (opex) and capital expenditure (capex) required because of the towers collapse is compared to the annual revenue requirement established in the PTRM from the AER's 2017-2022 revenue determination. Table 3 shows the additional opex and capex costs incurred by AusNet Services as at 31 May 2020 and the further costs forecast to be incurred in replacing the temporary structures with permanent towers. The majority of costs will be incurred in the regulatory years ending March 2020 and March 2021, since the replacement towers are scheduled to be in service by November 2020 and the dismantling of the ERS and other associated works due for completion by March 2021.

Table 3: Additional costs incurred / yet to be incurred

$ Million (real $21)	Incurred Costs	Costs yet to be incurred	Total
Opex	$0.52	$0	**$0.52**
Capex	$11.24	$13.27	**$24.51**
Total	**$11.76**	**$13.27**	**$25.04**

The costs that AusNet Services has incurred or is likely to incur as a result of the towers collapse constitutes a material increase in the cost of providing prescribed transmission services when compared to the annual revenue requirements determined by the AER for AusNet Services' 2017-22 regulatory control period.

The annual revenue requirement and the change in AusNet Services' costs resulting from this pass through event in the regulatory year ending March 2021, are set out in Table 4. The table shows that the change in costs exceeds the materiality threshold of 1 per cent of the annual revenue requirement.

Table 4: Demonstrating material change in costs

$ Million (nominal)	Regulatory year ending Mar	
	2020	2021
Annual revenue requirement (ARR) (unsmoothed)[13]	$556.61	$566.79
Total costs	$11.76	$13.27
Materiality of pass through event	2.1%	2.3%

[13] Build up of ARR provided in PTRM, refer Attachment 8

6 Eligible and proposed pass through amounts

6.1 Eligible pass through amount

Clause 6A.7.3(c)(3) of the NER requires AusNet Services to specify the eligible pass through amount.

The 'eligible pass through amount' is relevantly defined in Chapter 10 as:

> ...the increase in costs in the provision of *prescribed transmission services* that, as a result of that *positive change event*, the *Transmission Network Service Provider* has incurred and is likely to incur (as opposed to the revenue impact of that event) until:
>
> (a) unless paragraph (b) applies – the end of the *regulatory control period* in which the *positive change event* occurred; or
>
> (b) if the transmission determination for the *regulatory control period* following that in which *the positive change event* occurred does not make any allowance for the recovery of that increase in costs (whether or not in the forecast operating expenditure or forecast capital expenditure accepted or substituted by the AER for that *regulatory control period*) – the end of the *regulatory control period* following that in which the *positive change event* occurred.

Applying this definition, the eligible pass through amount constitutes the increase in actual and future opex and capex costs that AusNet Services incurs in providing prescribed transmission services as a result of the pass through event. The eligible pass through amount for this application is the costs set out in tables 6 and 7 in section 6.2 below.

Attachment 8 provides a buildup of the costs incurred to determine the eligible pass through amount. It identifies the costs AusNet Services has already incurred and the forecast of the costs yet to be incurred.

6.2 Evidence of the costs for the eligible pass through amount

Clause 6A.7.3(c)(6)(i) of the NER requires AusNet Services to provide evidence of the actual and likely costs that comprise the eligible pass through amount.

Table 6 and Table 7 provide a breakdown of the opex and capex making up the eligible pass through amount. The costs include both actual costs to date and forecast costs to install seven new permanent 500kV towers. The expenditure is categorised by activity.

Table 6: Operating expenditure

$ Millions (nominal)	Regulatory year ending Mar	
	2020	2021
Emergency response	$0.17	-
Technical investigations and Legal advice	$0.30	$0.04
Total opex	**$0.47**	**$0.04**

Table 7: Capital expenditure

$ Millions (nominal)	Regulatory year ending Mar	
	2020	2021
Stage 1 - ERS Rebuild & Associated Works	$7.45	$-
Stage 2 - Permanent Dismantle & Rebuild	$2.61	$14.28
Total Capex	**$10.06**	**$14.28**

The actual costs incorporated in Table 6 and Table 7 were extracted from AusNet Services' enterprise resource planning and accounting system (SAP). AusNet Services engaged KPMG to review its recording of costs to provide assurance that the actual costs incurred were solely as a consequence of the positive change event. This included recording of costs incurred up to end of April 2020, which covers the whole of emergency response and temporary bypass line erection phases. KPMG's report is provided as Attachment 8 (confidential attachment).

AusNet Services has prepared cost forecasts for on-going work or work that is yet to begin.

The works to rebuild the transmission line section with permanent towers and remove the temporary line necessarily contains significant forecast expenditure. The costs for the project were initially forecast in the business case prepared for the project, and have been continually refined as actual expenditure displaces forecasts and as forecasts for future work become more certain, such as through confirmed agreements with suppliers for materials and construction work.

Attachment 6 includes a breakdown of the residual costs forecast as well as costs incurred to date.

The eligible pass through amount of $2.36m (smoothed) is derived from the unsmoothed amounts set out in Table 8.

Table 8: Breakdown of the eligible pass through amount

$ Million (Nominal Unsmoothed)	Regulatory year ending Mar			Total
	2020	2021	2022	
Return on capital	-	$0.58	$1.385	**$1.97**
Return of capital	-	-$0.07	-$0.17	**-$0.24**
Operating expenditure	$0.47	$0.05	$0.01	**$0.53**
Tax	**-**	-	$0.01	**$0.01**
Building block revenue	**$0.47**	**$0.56**	**$1.23**	**$2.27**

6.3 Costs included in eligible pass through amount are incurred solely as a consequence of the positive change event

Clause 6.7.3(c)(6)(ii) of the NER requires AusNet Services to provide evidence that the actual and likely increase in costs included in the eligible pass through amount occurred solely as a consequence of the positive change event. Similarly, clause 6.7.3(j)(5) requires the AER, in determining the approved pass through amount and the amount to be passed through to users in each regulatory year, to ensure the TNSP recovers only the actual or likely increase in costs that is solely attributable to the positive change event.

In calculating the eligible pass through amount, AusNet Services included only the incremental costs for those activities it incurred solely as a result of the positive change event.

AusNet Services captured the actual expenditures it incurred in response to the towers collapse event in a manner consistent with its accounting framework. It used its accounting system to clearly record and track the costs incurred as a consequence of the positive change event by creating specific project codes in SAP, for each of the three work streams.

Monitoring of project progress and cost performance to date (in this case 31 May 2020) enables the most recent assessment of the rebuild project capital expenditure forecast (the project costs remaining at that date) to be included. To ensure confidence in the accuracy of the actual transactions recorded in our financial system, and as discussed in section 6.2, AusNet Services has had the actual financial records of the early phases of the work reviewed based on agreed upon procedures by KPMG (refer Attachment 8).

AusNet Services also confirms there is no work that has been avoided or deferred as a result of responding to the collapse of the transmission towers. The project established in response to the event is stand-alone.

6.4 Efficiency of eligible pass through amount

Clause 6A.7.3(j)(3) of the NER requires the AER, in determining the approved pass through amount and the amount to be passed through to users in each regulatory year, to take into account the efficiency of AusNet Services' decisions and actions in relation to the risk of the positive change event. This includes whether AusNet Services' actions minimised the magnitude of the eligible pass through amount.

AusNet Services' preparedness for a tower failure incident, in particular its strategy of establishing and maintaining the ERS for such a low probability but foreseeable and significantly disruptive event, is a clear demonstration of an efficient and prudent response strategy. Ownership of the ERS itself provides cost-effective insurance against a prolonged loss of a transmission line and mitigates the economic impact of the event during that time.

The temporary line sections were constructed by an AusNet Services' transmission services major delivery partner. AusNet Services entered into a Strategic Portfolio Services Panel Agreement (SPSPA) with this provider and four other providers following a competitive tender process, initiated in July 2018.

This major delivery partner was appointed to undertake the emergency works given its experience in delivering similar projects involving ERS. The firm had the necessary skills and resources to be able to commit to delivering the re-build project according to the required timeframes. This work was priced using the market-tested unit rates agreed under the SPSPA, which have not changed since July 2018.

With confidence in the rapid and reliable temporary recovery of the transmission lines using the ERS, AusNet Services was able to direct significant focus to planning the installation of the permanent towers. For example, with confidence in the temporary solution, AusNet Services was in a sound position to negotiate with potential suppliers for the procurement of the permanent replacement assets. This has enabled AusNet Services to ensure that the arrangements put in place for delivery of the project are effective and efficient.

AusNet Services has divided the permanent works into three stages: creating access tracks; building footings and foundations; and tower construction and line stringing. AusNet Services has engaged the same major delivery partner to undertake these works.

The first two stages of work are being competitively tendered by the delivery partner. AusNet Services has full visibility over this tender process and is working with the delivery partner to select the contractor. The costs will be passed through at cost to AusNet Services for work conducted by the delivery partner and as per the service provision agreement for sub-contractor costs. The delivery partner's oversight costs are priced at unit rates set under a competitive process in 2018.

The construction activity for the third stage of the project will be delivered by the delivery partner. This work will be priced using the unit rates set under the competitive process in 2018. AusNet Services has provided the delivery partner with a scope of works and is working with them to benchmark and refine their cost estimate based on our experience in delivering other tower replacement or repair works. For example, AusNet Services is cross-checking aspects such as the required resourcing (labour and plant and equipment) and expected productivity to erect and string towers, against projects that it has previously undertaken.

AusNet Services is sourcing the materials required to deliver the tower construction and line stringing works through competitive tender processes. This includes all the steel sections for the towers, conductor, insulator strings and line hardware.

The approach to putting arrangements in place for the restoration project confirms that AusNet Services is adopting efficient procurement and delivery approaches for each phase of work.

The final category of costs incurred in response to the tower collapse event are the costs of investigating the event. AusNet Services is certified to International Standard ISO 55001 - Asset Management. The standard and its application guidelines require that a compliant asset management system establish, implement and maintain processes for the handling and investigation of nonconformities, functional failures and incidents associated with assets. In accordance with good practice and its own asset management system, investigative processes were triggered by the event.

Insurance considerations

In accepting a 'natural disaster event' as a nominated pass through event in AusNet Services' transmission determination for the 2017-2022 regulatory control period, the AER's final decision notes that[14]:

> *In assessing a natural disaster event pass through application, the AER will have regard to, amongst other things:*
>
> *(i) whether AusNet Services has insurance against the event; and*
>
> *(ii) the level of insurance that an efficient and prudent NSP would obtain in respect of the event.*

AusNet Services does not hold insurance cover for damage caused to the transmission lines of the network by a natural disaster. The cost of holding this insurance is assessed when AusNet Services routinely reviews its insurance needs and renegotiates insurance arrangements.

Through these reviews and by keeping abreast of trends in insurability, AusNet Services can confirm that obtaining insurance cover for transmission lines (more generically poles and

[14] AER, Final Decision, AusNet Services' transmission determination 2017 to 2022, April 2017

wires) from third party insurers is not an efficient approach to managing the risk of damage to or loss of these assets. There are several contributing reasons for this view:

- The insurance capacity available is extremely low in comparison to the value of the assets, and the value that may be impacted by one natural disaster event;
- The premium for insuring against damage to transmission towers and lines is a significant proportion of the payout cap, as is the deductible; and
- If a claim was made under such cover, it is expected that the premium would be increased by as much as 50%. This reflects the insurer's assessment of the likelihood of this risk being realised. With an apparent increase in other events of nature, in particular wildfires, impacting in environments around the world, it is not clear that such insurance cover would currently even be available.

The lack of insurance cover for transmission lines (and poles and wires of the electricity distribution networks in general) at economic rates was again confirmed by AusNet Services' insurance broker, who detailed that none of their utility clients within Australia hold this form of cover. The broker explained that underwriters attempting to write this form of cover experience re-insurance issues as reinsurers do not have appetite for this risk. It is understood their concerns stem from loss scenarios as a result of catastrophic weather events (fire, storm and cyclone) which may result in large insurance payouts. Thus, the few underwriters who have previously quoted cover for poles and wires provide small aggregate limits with prohibitively expensive premiums. Payback periods calculated by underwriters are typically in the range of 5 years, thus a $10m limit in cover would attract a $2m premium. This quantum was confirmed by a previous review of this risk in March 2017.

Other network operators face similar 'whole of network' insurance considerations. AusNet Services has checked the current approaches of peer network operators and this confirms AusNet Services' practice of not insuring this risk is consistent with those operators contacted.

As such, pass through cover in the regime is the cheapest form of insurance for customers in the long run.

6.5 Positive pass through amount

Clause 6A.7.3(c)(4) of the NER requires AusNet Services to specify the positive pass through amount that it proposes in relation to the positive change event. The positive pass through amount is defined as an amount not exceeding the eligible pass through amount.[15]

AusNet Services proposes a positive pass through amount of $2.36 million (Nominal) to be recovered in the regulatory year 1 April 2021 to 31 March 2022. We propose that the remaining asset value will roll into the Regulated Asset Base from 1 April 2023.

AusNet Services has calculated the proposed positive pass amount as the change in its required revenues for the 2017-22 regulatory control period as a result of the positive change event. That is, AusNet Services' proposed positive pass through amount incorporates the opex and return on and of capital for the 2017-22 regulatory control period arising from the incremental costs incurred in responding to the towers failure event, as well as the impact of the incremental costs on the cost of corporate income tax building block.

The PTRM used to calculate the pass through amount is included with this application as Attachment 7.

6.6 Pass through amount in each regulatory year

Clause 6A.7.3(c)(5) of the NER requires AusNet Services to specify the amount that it

[15] National Electricity Rules, Chapter 10.

proposes to pass through to customers in the year, and each regulatory year after that, in which the positive change event occurred.

AusNet Services proposes to recover the proposed positive pass through amount of $2.36 million (Nominal) in the final year of the current regulatory control period, i.e., the regulatory year ending 31 March 2022.

7 Attachments list

Attachment 1	Confidentiality template
Attachment 2	Compliance checklist
Attachment 3	Bureau of Meteorology Report
Attachment 4	Meteorological agency information sheets on thunderstorm phenomena
Attachment 5	Economic analysis of service restoration options
Attachment 6	Buildup of Costs Incurred [separate spreadsheet]
Attachment 7	Post Tax Revenue Models (PTRM)
Attachment 8	KPMG review of AusNet Services' costs [CONFIDENTIAL]

Attachment 1 Confidentiality template

Attachment 1 - Confidentiality template

Title, page and paragraph number of document containing the confidential information	Description of the confidential information.	Topic the confidential information relates to (e.g. capex, opex, the rate of return etc.)	Identify the recognised confidentiality category that the confidential information falls within.	Provide a brief explanation of why the confidential information falls into the selected category. If information falls within 'other' please provide further details on why the information should be treated as confidential.	Specify reasons supporting how and why detriment would be caused from disclosing the confidential information.	Provide any reasons supporting why the identified detriment is not outweighed by the public benefit (especially public benefits such as the effect on the long term interests of consumers).
Attachment 8 KPMG report on AusNet Services' costs	The Agreed Upon Procedures report by KMPG is released to the AER on the basis that it is kept confidential, as outlined in the transmittal letter.	Capex and opex incurred	Other	Confidentiality of the report was a condition on which the audit was conducted. Due to the tight timelines in which to lodge this cost pass through application, it was not possible to seek an alternative arrangement during this time.	Publishing this report will breach the terms on which it has been shared.	This report is intended to provide the AER with additional confidence in the accuracy of the actual transactions recorded in our financial system that resulted from the bushfire event. The AER will publish its conclusions in its determination on this matter – this is not an area that will, or can, benefit from public debate. The costs incurred have been made publicly available in the application. The report does not contain any additional relevant information that would assist stakeholder review of the application.

Attachment 2 - Proportion of confidential material

Submission Title	Number of pages of submission that include information subject to a claim of confidentiality	Number of pages of submission that do not include information subject to a claim of confidentiality	Total number of pages of submission	Percentage of pages of submission that include information subject to a claim of confidentiality	Percentage of pages of submission that do not include information subject to a claim of confidentiality
Cost pass through application – 500kV transmission line tower collapse	**3**	**27**	**30 (not including other attachments)**	**10%**	**90%**

Attachment 2 Compliance checklist

This report provides a reference on the compliance of AusNet Services' application for pass through with the NER pass through provisions, set out in Cl 6A.7.3, and to the location of relevant information in the application.

NER Cl	Requirement	Information provided	Section
6A.7.3(a1)	Identification as a pass through event An event allowing for pass through of costs may be specified in the transmission determination (sub 5)	The application confirms that the towers collapse event meets the 'natural disaster' event specified in AusNet Services' transmission determination	4.2.1, 4.2.3
6.7.3 (a)	A TNSP may seek AER approval for the pass through for a positive change event To qualify as a positive change event the TNSP must have incurrent materially higher costs (NER defined) in providing prescribed transmission services	The application confirms that AusNet Services incurred materially higher costs in providing direct control services, and accordingly the event qualifies as a positive pass through event	5.3
6A.7.3 (c)	A TNSP must submit a statement (interchangeable term being application) within 90 business days of the relevant positive change event occurring	The application notes that the AER advised an extension for this submission under clause 6A.7.3(k) of the NER, 31 July 2020. The requirement of 6A.7.3(c) in relation to the time for submitting the written statement has therefore been satisfied	3
(c) (1)	The statement must specify: • The details of the positive change event	The details of the positive change event, being the scale and impact of the storm phenomena resulting failure of the towers is set out in the application	4.2.1
(c) (2)	• The date on which the positive change event occurred	31 January 2020	3, 4.1
(c) (3)	• The eligible pass through amount, being the increase costs in the provision of prescribed transmission services as a result of the positive change event	The application provides detail on the sources of cost increases and the cost attributed for each, which constitutes the eligible pass through amount	6.1, 6.2

NER Cl	Requirement	Information provided	Section
(c) (4)	• The positive pass-through amount proposed	The application proposes a positive pass through amount	6.5
(c) (5)	• The amount proposed to be passed through in the regulatory year in which the event occurred in in subsequent regulatory years	The application proposes amounts to be passed through in the final year of the current regulatory control period	6.6
(c) (6) (i)	Evidence of: • the actual and likely increases	Records from AusNet Services' SAP system as presented in the cost build up, and KPMG report. The basis of the forecast capital cost is advised.	Att 6 and Att 8 6.2, 6.3
(6) (ii)	• that the costs occur solely as a consequence of the positive change event	The application describes the cost capture process which ensures that costs included occur solely as a consequence of the positive change event. A review based on agreed upon procedures by KPMG is also provided	6.3 and Att 8
(c) (7)	• other information as required under any relevant regulatory instrument - The AERs final decision on AusNet Services' transmission determination 2017 – 2022 notes that in assessing a natural disaster pass through application, it will have regard to the insurance held and whether that is efficient amount a prudent NSP would hold[16]	The application discusses insurance considerations for natural disaster events such as the extreme weather induced towers failure.	6.4

[16] AER, Final decision, AusNet Services' distribution determination 2016 – 2020, Attachment 15 – Pass through events, May 2016, page 15-7

Attachment 3 Bureau of Meteorology report

Australian Government
Bureau of Meteorology

Report into the meteorological aspects of severe thunderstorm impacts near Cressy, Victoria on 31st January 2020


Image courtesy: Dylan McConnell

Contact details

Energy & Resources Program
Bureau of Meteorology
PO Box 1289 Docklands VIC 3008
Email: energy@bom.gov.au

05 February 2020
This report supersedes any previously provided interim information on this event.

Image credits

The image on the cover page was provided by Dylan McConnell. It was taken on Sunday 2 February 2020 north of Cressy, Victoria.

The satellite image shown in figure 10 is from the Himawari 8 satellite, operated by the Japan Meteorological Agency.

Contents

1 Introduction

The purpose of this report is to provide a brief account of severe thunderstorm conditions over southeastern Australia on Friday 31st January 2020. Of the many thunderstorms across the region, one produced damaging to destructive winds across electricity transmission infrastructure north of Cressy in western Victoria, resulting in multiple tower collapses and separation of this transmission link. This report details the atmospheric conditions across eastern South Australia and western Victoria, severe thunderstorm forecasts and warnings issued that day and relevant observations available at the time of writing to inform an interpretation of the specific causes of the impacts near Cressy.

1.1 Terminology and units

Except where noted, times are quoted as Australian Eastern Daylight Time (UTC + 11 hours). Wind speeds are 10-minute averages measured in kilometres per hour (km/h) and measured at a standard height of 10 metres above ground level. Wind gusts represent the maximum measured wind speed (3 second average) over the preceding 10-minutes. Wind directions refer to the direction from which the wind is coming and are given in 16 points, or degrees, of the compass as indicated. Temperatures and dew point temperatures are measured in degrees Celsius (°C). Precipitable water, measured in mm, is a measure of atmospheric moisture and represents the depth of water in a column of the atmosphere, were all the water in that column were precipitated as rain. Location maps showing Victorian observation sites mentioned in this report are shown in Figure 1.

Figure 1: Location of Bureau Automatic Weather Stations across Victoria.

The Bureau of Meteorology issues severe thunderstorm warnings when any of the following conditions are expected:

Phenomena	Criteria (Victoria & South Australia)
Large hail	Between 2cm and 5cm diameter
Giant hail	Greater than 5cm diameter
Damaging wind gusts	Between 90km/h and 125km/h
Destructive wind gusts	Greater than 125km/h
Heavy rainfall which may cause flash flooding	Approximated by rainfall amounts equalling or exceeding a 10% Average Exceedance Probability (AEP)
Tornadoes	Evidence of rotation on radar or based on a reliable report

Table 1: Severe Thunderstorm Warning Criteria applied in Victoria and South Australia

2 Weather conditions

On 31st January 2020, a high-pressure system over the Tasman Sea and an approaching cold front (figure 2), resulted in strengthening north to northwest winds and very hot and humid conditions across southeast Australia. Maximum temperatures reached the low to mid 40s across many locations in Victoria, with the highest maximum temperature of 46.2°C recorded at Kyabram and Rutherglen. Figures 3 and 4 show maximum temperature analyses over Victoria and South Australia (respectively) for that day.

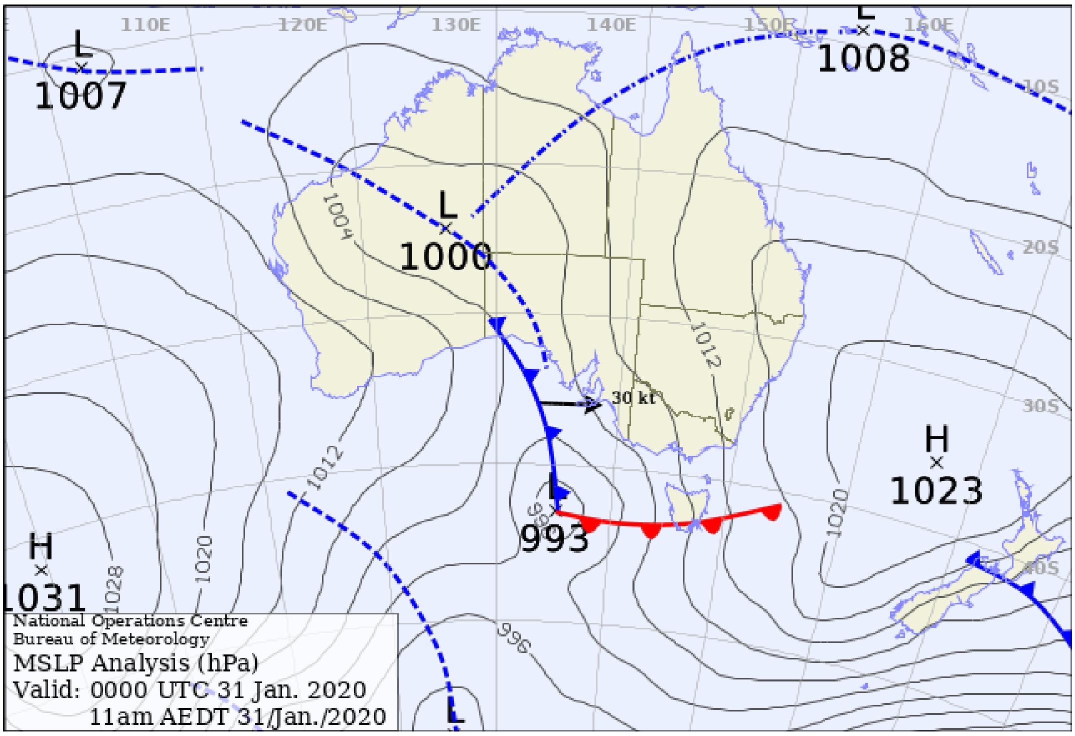


Figure 2: Mean Sea Level Pressure (MSLP) analysis for 1100 AEDT 31 January 2020

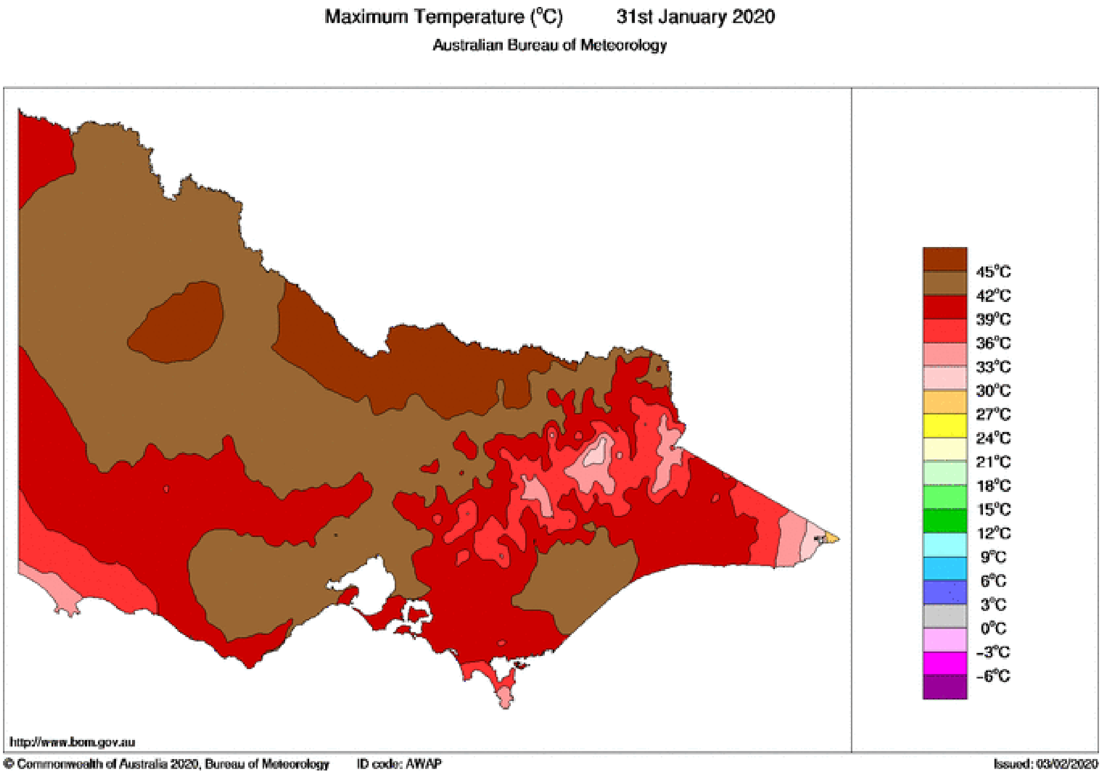


Figure 3: Maximum Temperature analysis for Victoria, Friday 31 January 2020

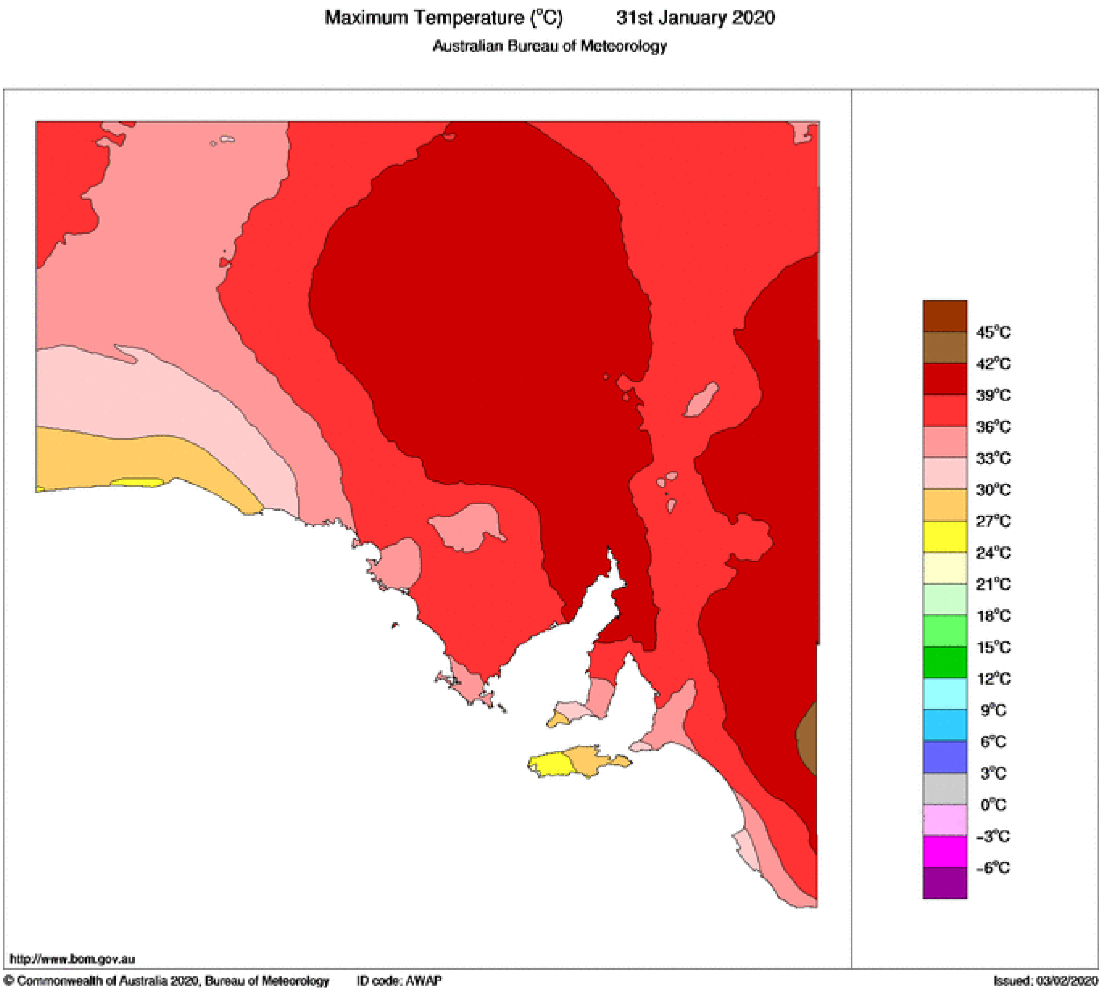


Figure 4: Maximum Temperature analysis for South Australia, Friday 31 January 2020

The northerly winds transported moist air from a slow-moving low-pressure system over central Australia towards the southeast. The very hot and humid airmass resulted in unstable conditions across southeast Australia, particularly over western Victoria during the Friday afternoon. Figures 5-7 show the aerological diagrams for Woomera, Adelaide Airport and Melbourne Airport at 2300 UTC on 30 January 2020 (i.e. 0930 ACDT / 1000 AEDT on 31 January 2020). The Woomera and Adelaide Airport diagrams depict very high moisture content throughout the depth of the troposphere as indicated by precipitable water (PW) values of approximately 60-65 mm. The 66 mm PW observation at Adelaide Airport exceeded the previous record of 61.2 mm. The instability of the airmass is indicated by the steep lapse rates (i.e. warm lower levels and cool upper levels). In contrast, the Melbourne Airport diagram shows drier air in the low levels and an 'inverted V' below 600hPa / 4km above ground level. This thermodynamic feature is often associated with severe convective downbursts. Northerly winds in the low levels are 30-40 knots (approximately 55-75 km/h) at each of the three sites.

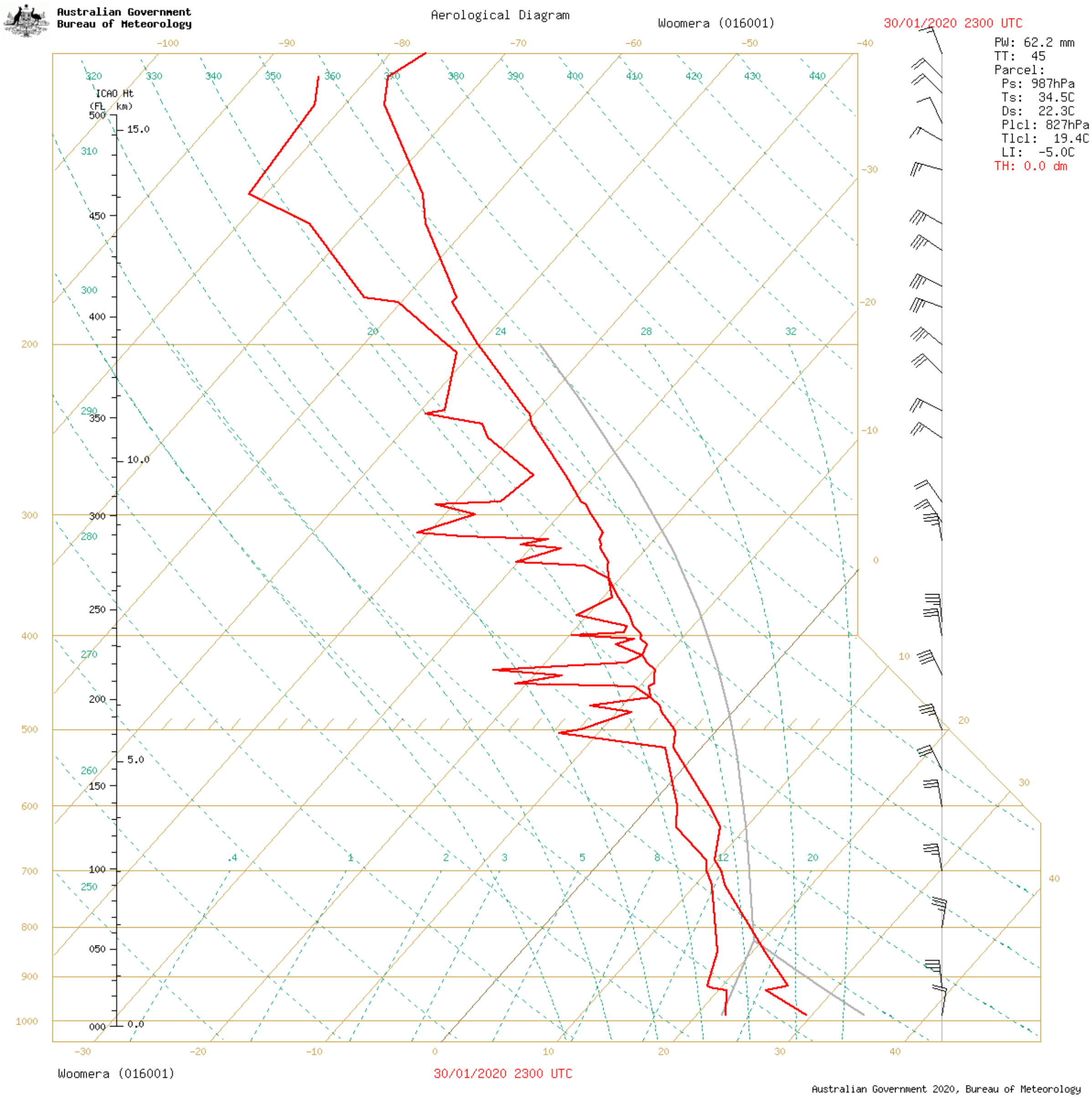


Figure 5: Aerological diagram for Woomera commencing 0930 ACDT 31 January 2020

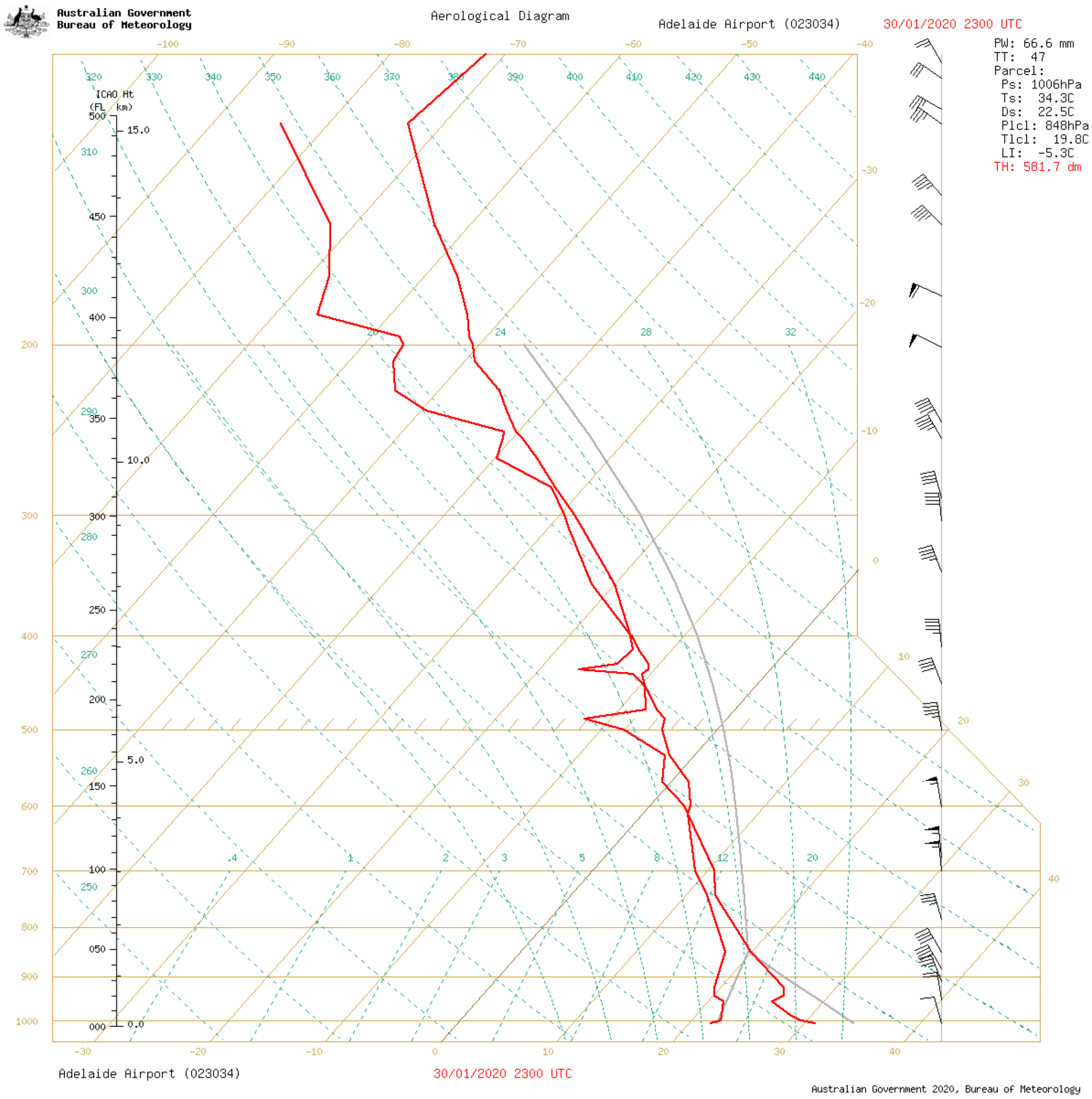


Figure 6: Aerological diagram for Adelaide Airport commencing 0930 ACDT 31 January 2020

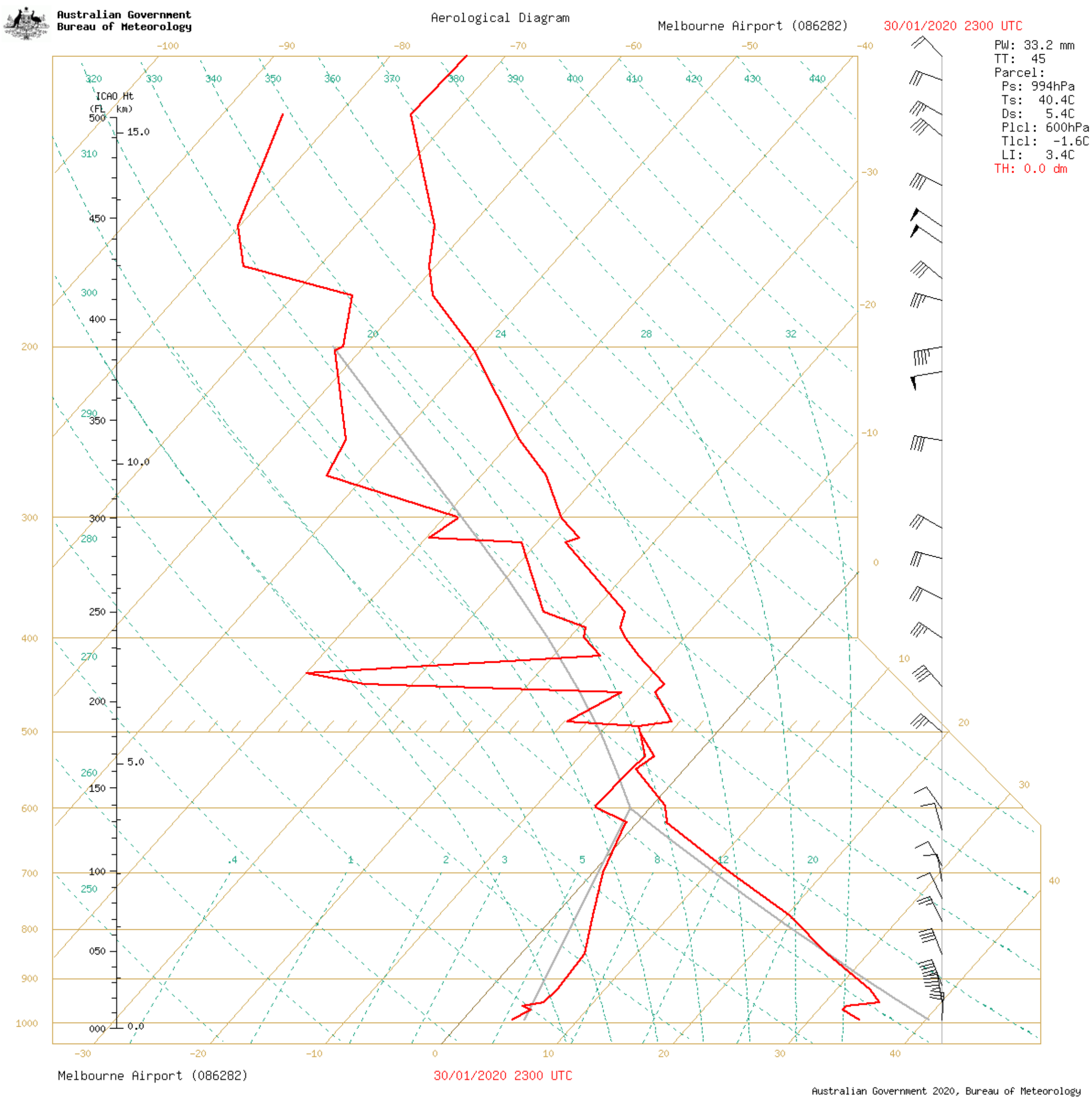


Figure 7: Aerological diagram for Melbourne Airport commencing 1000 AEDT 31 January 2020

3 Thunderstorm Forecasts

Dry, high based thunderstorms were forecast to develop over western and central Victoria Friday afternoon, with the risk of severe thunderstorms bringing damaging winds initially, and then later heavy rain and possibly hail as the moisture continued to increase. Figures 8 and 9 show the thunderstorm forecasts issued by the Victorian and South Australian forecast offices respectively on the day, indicating a high risk of severe thunderstorms over western Victoria and central and southeast South Australia.

IDV21031
Australian Government Bureau of Meteorology

Thunderstorm Forecast

Issued at 1:28 am Friday, 31 January 2020,
Valid until midnight on Friday, 31 January 2020.

Increasing humidity and instability is expected on Friday leading to thunderstorms possible over most of Victoria, mainly during the afternoon and evening. There is the potential for damaging winds with any thunderstorms, though the risk is less likely over the northeast.

Further to the damaging wind risk, heavy rainfall is also possible with thunderstorms over the west and is most likely over the southwest where available moisture levels are highest. There is also a risk of more organised convection in this area with large hail and possibly some extreme rainfall rates during the late afternoon and evening.

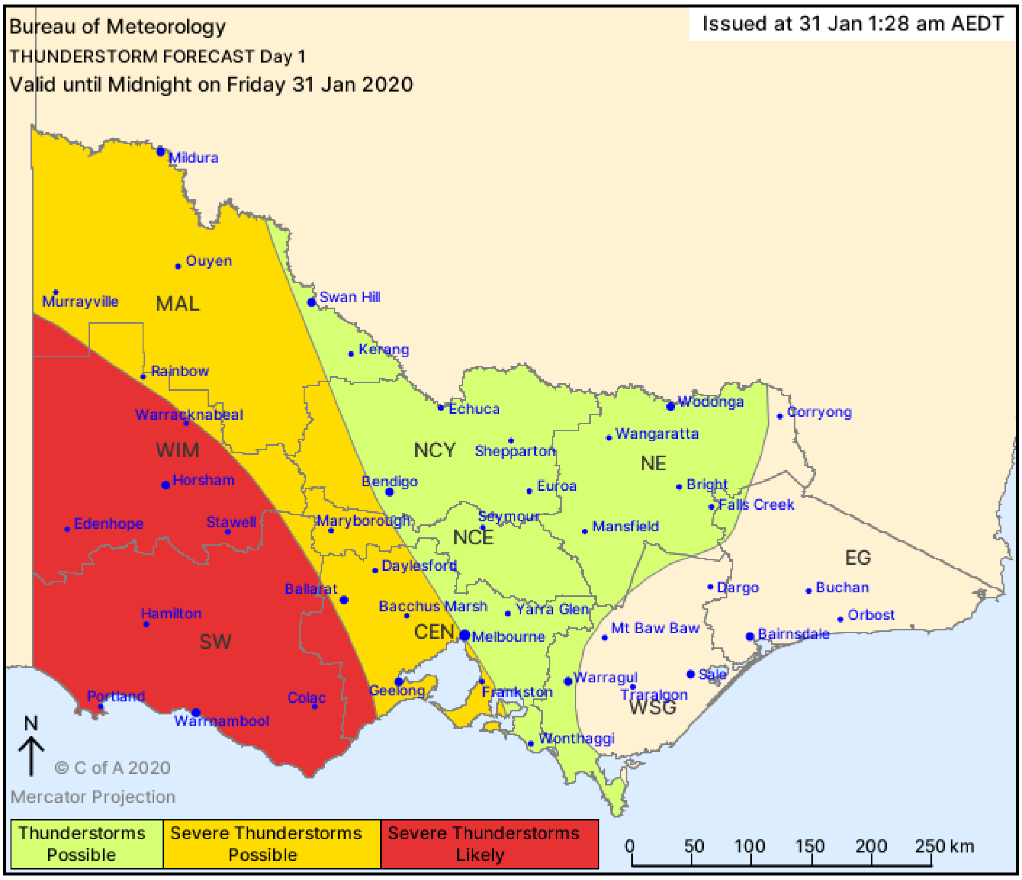


Figure 8: Thunderstorm forecast for Victoria for Friday 31 January 2020 issued at 1:28am

IDS21031
Australian Government Bureau of Meteorology

Thunderstorm Forecast

Issued at 11:18 am [ACDT] Friday, 31 January 2020,
Valid until midnight on Friday, 31 January 2020.

A tropical airmass streaming south ahead of a trough and front will result in an unstable atmosphere for much of SA on today. Isolated thunderstorms increasing to scattered over large areas during this afternoon and evening. Exceptionally high moisture levels will result in a high risk of heavy rainfall leading to flash flooding, with the greatest potential in a zone through central and southeastern parts. With any training effect of thunderstorms over a localised area, there is also a possibility of intense rainfall. Damaging wind gusts are also a risk with any thunderstorms. The potential for large hail is generally low, but cannot be completely ruled out if supercells develop. The most likely area for this to occur is over the Murraylands and South East districts.

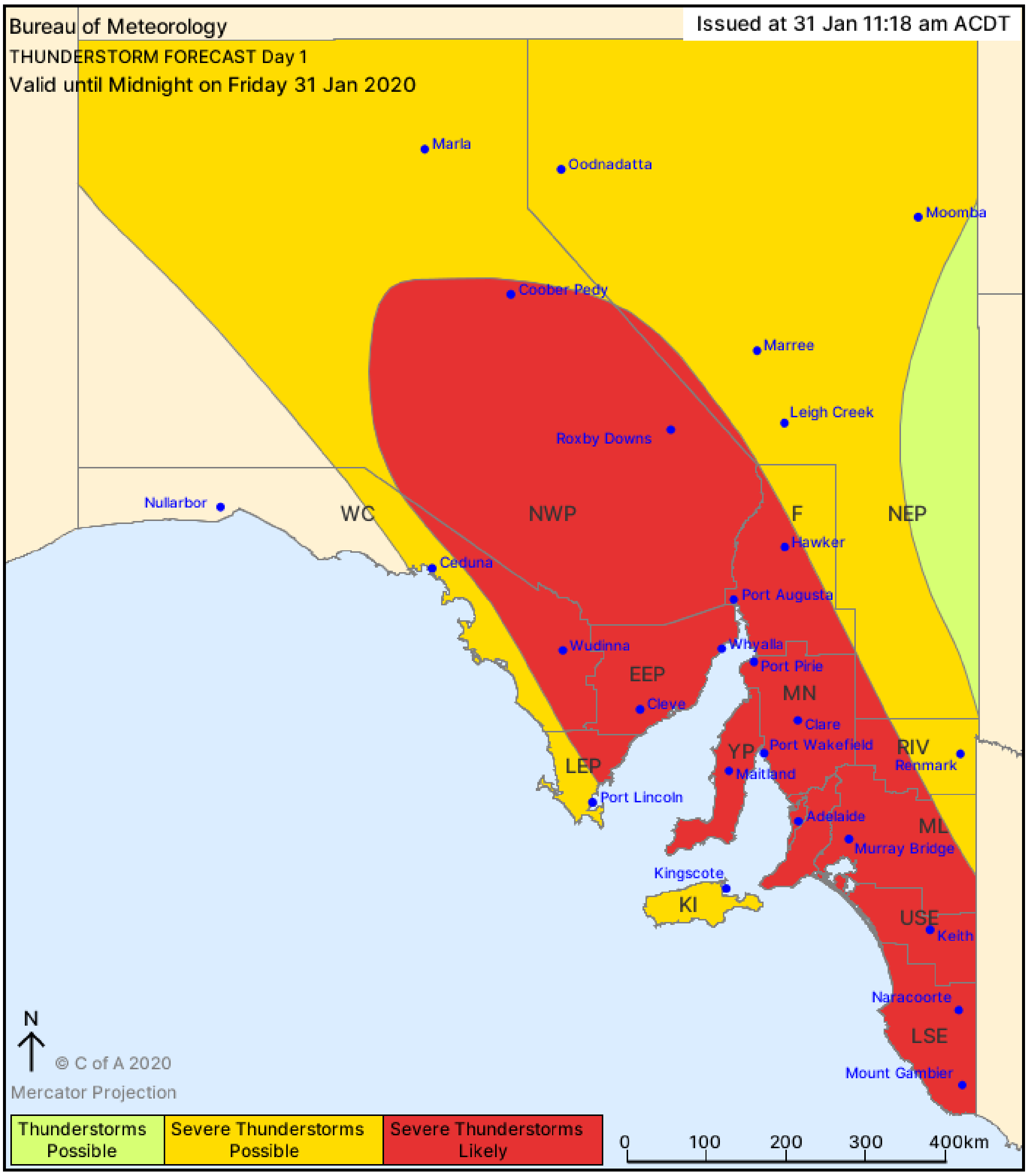


Figure 9: Thunderstorm forecast for SA for Friday 31 January 2020 issued at 11:18am (ACDT)

4 Thunderstorm Warnings

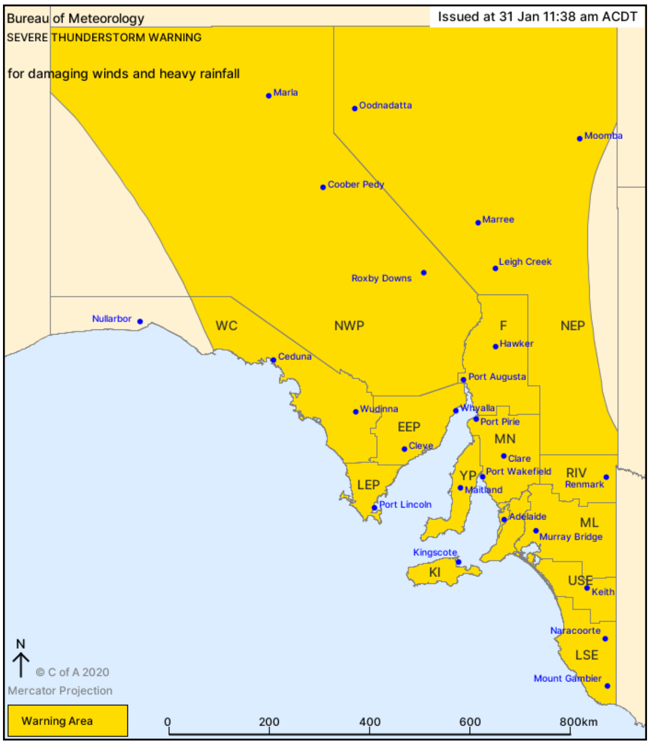
The following severe thunderstorm warnings were issued by the South Australian and Victorian forecast offices during the late morning and early afternoon on 31 January 2020. Each warning is represented graphically with accompanying abridged warning text (i.e. emergency services advice removed for simplicity). Each South Australian and Victorian warning contain the following community advice (respectively):

South Australia	**Victoria**
The State Emergency Service advises that people should:	The State Emergency Service advises that people should:

• Secure or put away loose items around your property. • Move cars under cover or away from trees. • Keep clear of fallen power lines. • Don't drive, ride or walk through flood water. • Keep clear of creeks and storm drains. • Stay indoors, away from windows, while storms are nearby.	• Be aware that trees that have been damaged by heat or fire may be unstable and more likely to fall when it is windy or wet. • Check that loose items such as outdoor settings, umbrellas and trampolines are safely secured and move vehicles under cover or away from trees. • Stay indoors and away from windows. • If outdoors, move to a safe place indoors. Stay away from trees, drains, gutters, creeks and waterways. • If driving conditions are dangerous, safely pull over away from trees, drains, low-lying areas and floodwater. Avoid travel if possible. • Stay safe by avoiding dangerous hazards, such as floodwater, mud, debris, damaged roads and fallen trees. • Stay away from fallen powerlines always assume they are live. • Stay informed monitor weather warnings, forecasts and river levels at the Bureau of Meteorology website, and warnings through VicEmergency.

Table 2: community advice statements issued within severe thunderstorm warnings based on phenomena expected this day.

Warning Graphic	Abridged Warning Text



Severe Thunderstorm Warning
for DAMAGING WINDS and HEAVY RAINFALL

For people in Adelaide Metropolitan, Mount Lofty Ranges, West Coast, Lower Eyre Peninsula, Eastern Eyre Peninsula, Yorke Peninsula, Flinders, Mid North, Kangaroo Island, Riverland, Murraylands, Upper South East, Lower South East, North West Pastoral and North East Pastoral districts.

Issued at 11:38 am [ACDT] Friday, 31 January 2020.

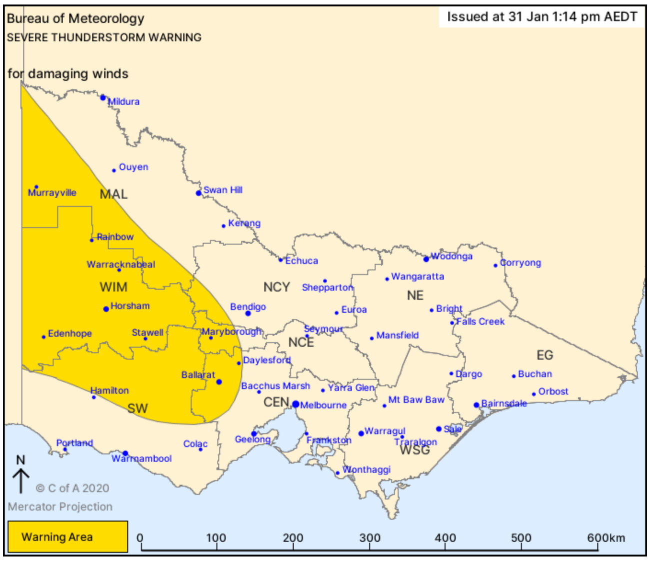
Weather Situation: Exceptionally humid and unstable conditions across most of South Australia will lead to scattered thunderstorms this afternoon and continuing overnight.

Thunderstorms are occurring in the west and are expected to develop over the rest of the warning area during this afternoon.

Some of these thunderstorms are likely to be severe, with damaging wind gusts in excess of 90 km/h and heavy rainfall that may lead to flash flooding. Locations which may be affected include Ceduna, Wudinna, Roxby Downs, Whyalla, Port Augusta, Adelaide, Renmark and Naracoorte.

Note a Flood Watch is also current. Rainfall totals are expected to be in the range 20 to 80 mm with isolated falls up to 100 mm.

The next warning is due to be issued by 2:40 pm [ACDT].



Severe Thunderstorm Warning
for DAMAGING WINDS

For people in Wimmera and parts of Central, Mallee, South West, Northern Country and North Central Forecast Districts.

Issued at 1:14 pm Friday, 31 January 2020.

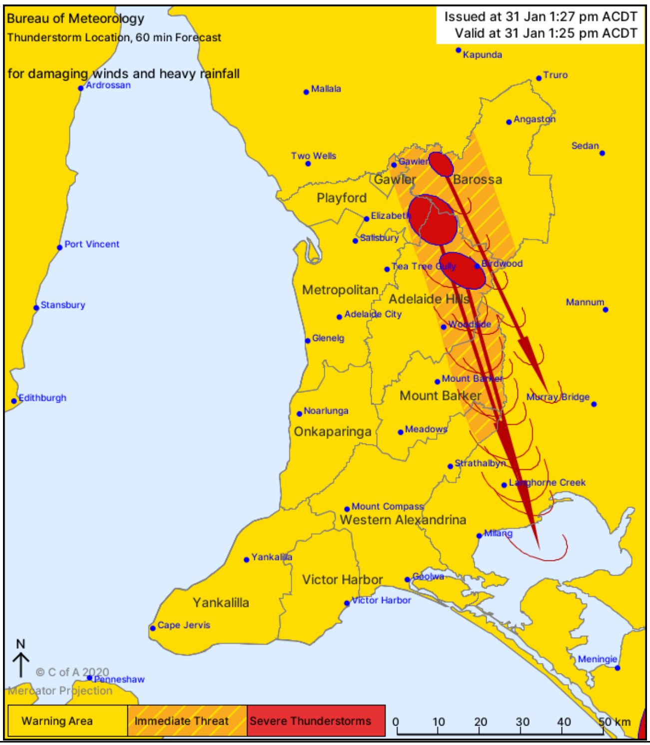
Severe thunderstorms developing over western Victoria.

Weather Situation: Very hot and humid north to northwesterly winds are extending across western Victoria

Severe thunderstorms are likely to produce damaging winds in the warning area over the next several hours. Locations which may be affected include Horsham, Stawell, Ararat, Maryborough, Ballarat and Daylesford.

A wind gust of 89 km/h was recorded at Longerenong at 12:40pm.

The next warning is due to be issued by 4:15 pm.



Severe Thunderstorm Warning - Adelaide Region
for DAMAGING WINDS and HEAVY RAINFALL

For people in parts of Barossa, Mount Barker, Adelaide Hills, Gawler, Western Alexandrina and Playford council areas.

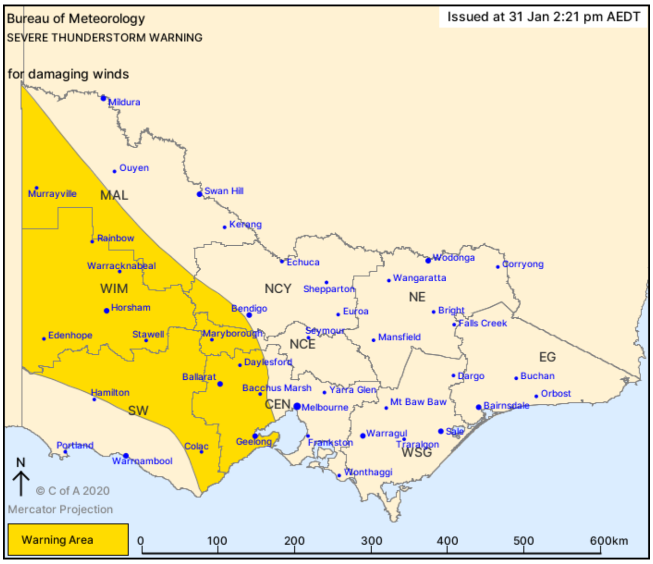
Issued at 1:27 pm [ACDT] Friday, 31 January 2020.

Weather Situation: Exceptionally humid and unstable conditions are producing scattered thunderstorms this afternoon and continuing overnight.

The Bureau of Meteorology warns that, at 1:25 pm [ACDT], severe thunderstorms were detected on the weather radar near Birdwood, One Tree Hill, Lyndoch and Williamstown. These thunderstorms are moving towards the south to southeast. They are forecast to affect Lobethal, Woodside and Callington by 1:55 pm [ACDT].

Damaging winds and heavy rainfall that may lead to flash flooding are likely.

The next warning is due to be issued by 2:30 pm [ACDT].



Severe Thunderstorm Warning
for DAMAGING WINDS

For people in Wimmera and parts of Central, Mallee, South West, Northern Country and North Central Forecast Districts.

Issued at 2:21 pm Friday, 31 January 2020.

Severe thunderstorms over western and central Victoria.

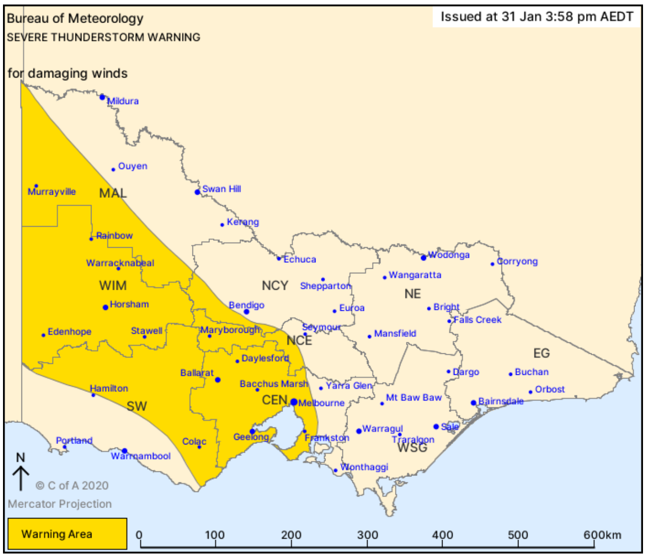
Weather Situation: Very hot and humid north to northwesterly winds are extending across western Victoria

Severe thunderstorms are likely to produce damaging winds in the warning area over the next several hours. Locations which may be affected include Horsham, Maryborough, Kyneton, Ballarat, Geelong and Bacchus Marsh.

Severe wind gusts of 93km/h was recorded at Ballarat and Westmere at 2:05pm and 90 km/h was recorded at Stawell at 1:15pm.

A near severe wind gust of 89 km/h was recorded at Longerenong at 12:40pm.

The next warning is due to be issued by 5:25 pm.



Severe Thunderstorm Warning
for DAMAGING WINDS

For people in Central, Wimmera and parts of Mallee, South West, Northern Country and North Central Forecast Districts.

Issued at 3:58 pm Friday, 31 January 2020.

Severe thunderstorms over western and central Victoria.

Weather Situation: Very hot and humid north to northwesterly winds are extending across western Victoria

Severe thunderstorms are likely to produce damaging winds in the warning area over the next several hours. Locations which may be affected include Horsham, Maryborough, Ballarat, Geelong, Melbourne and Bacchus Marsh.

Severe wind gusts of 119km/h was recorded at Mt Gellibrand at 2:45pm, 94km/h was recorded at Melbourne Airport at 3:45pm, 93km/h was recorded at Ballarat and Westmere at 2:05pm and 90 km/h was recorded at Stawell at 1:15pm.

A near severe wind gust of 89 km/h was recorded at Longerenong at 12:40pm.

The next warning is due to be issued by 7:00 pm.

Warnings were updated regularly during the afternoon as the dynamic event unfolded. The thunderstorms developed quickly, and lightning and thunderstorm cells were observed in the Lismore, Cressy and Colac area soon after the first warning was issued. Figure 10 is a satellite image valid at 1440 AEDT with recent lightning (orange and red dots) and the location of transmission lines (yellow) shown. The red shaded area within dashed lines indicates the area of the severe thunderstorm warnings current at the time the image was captured from a Bureau operational system (i.e. after the 3:58 pm warning was issued by the Victorian office).

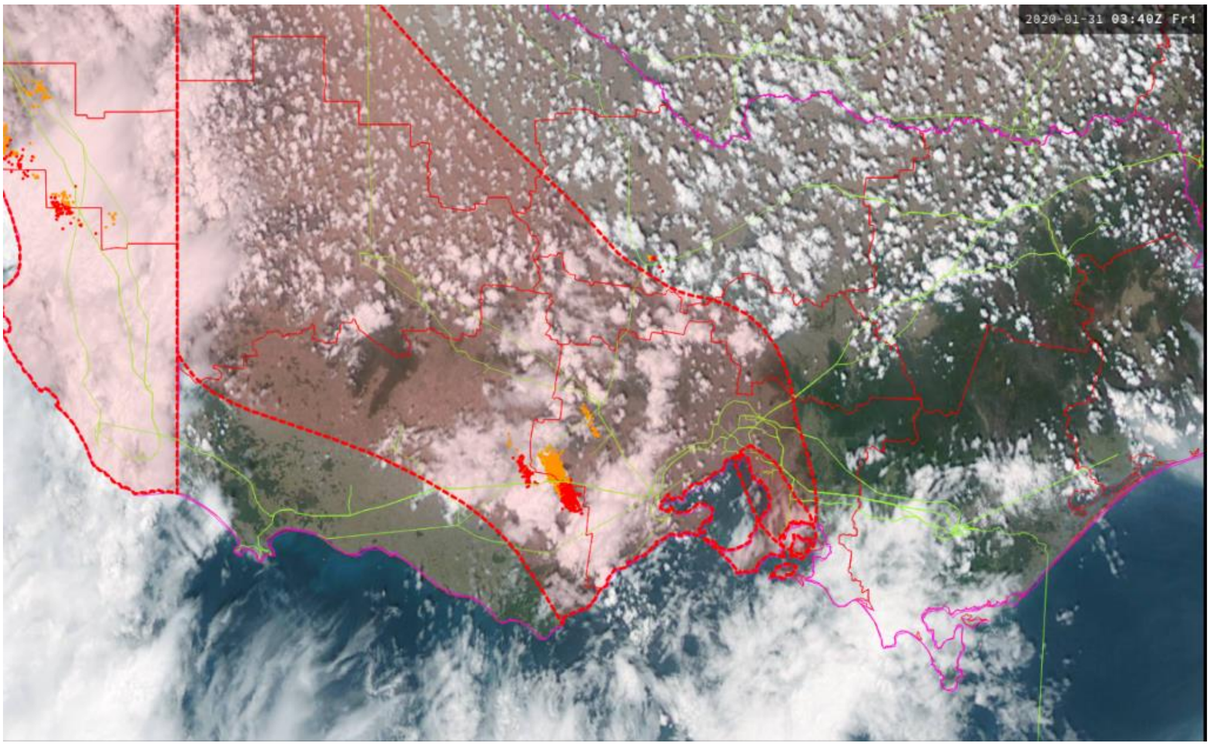


Figure 10: Visual satellite image overlaid with lightning (orange and red dots) and transmission lines (green) at 03:40 UTC, Friday 31 January 2020. The red dashed overlay corresponds to the severe thunderstorm warning area current at the time this image was captured (i.e. after 3:58pm).

5 Detailed analysis of the Cressy storm

5.1 Convective environment analysis

The low to mid-levels of the troposphere were very warm and simultaneously unusually moist. The environment was not conducive to supercell development (i.e. rotating, organised thunderstorms) which are typically required to produce destructive wind gusts during the warm season. Damaging or potentially destructive wind gusts from thunderstorm downbursts are possible in this environment, though destructive gusts are rare in this region and particularly rare for environments in which supercells are not expected.

Thunderstorm downbursts result when the descending core of a thunderstorm accelerates towards the ground through continued evaporative cooling. A descending thunderstorm core would also transport momentum from strong mid- and low-level winds to produce damaging or destructive gusts at the surface.

The environment was not expected to generate or support tornadoes. High relative humidity and marked variation in the direction and speed of the winds through the low levels of the atmosphere are required to generate rotating supercell thunderstorms and tornadoes. Such conditions were not present at the time of the Cressy event.

5.2 Radar analysis

Melbourne (Laverton) radar data is presented and analysed below. Cressy is marked CSY on the figures and is approximately 100km to the WSW of this radar.

The 03:20 UTC (14:20 AEDT) reflectivity scan is shown in figure 11. The top panel shows the plan position indicator (PPI) at 2.4-degree elevation (corresponding to an elevation of approximately 4km above the ground within this storm). The bottom panel shows a cross section corresponding to the aqua line on the PPI panel. This cross section shows reflectivity through the storm from NNW (left) to SSE (right) aligned with the storm motion. The storm is therefore moving from left to right on the bottom panel. The data shows high reflectivity (corresponding to a high concentration of raindrops and potentially hail) suspended in the mid-levels at the leading edge of the storm and reaching the ground at the tail edge of the storm.

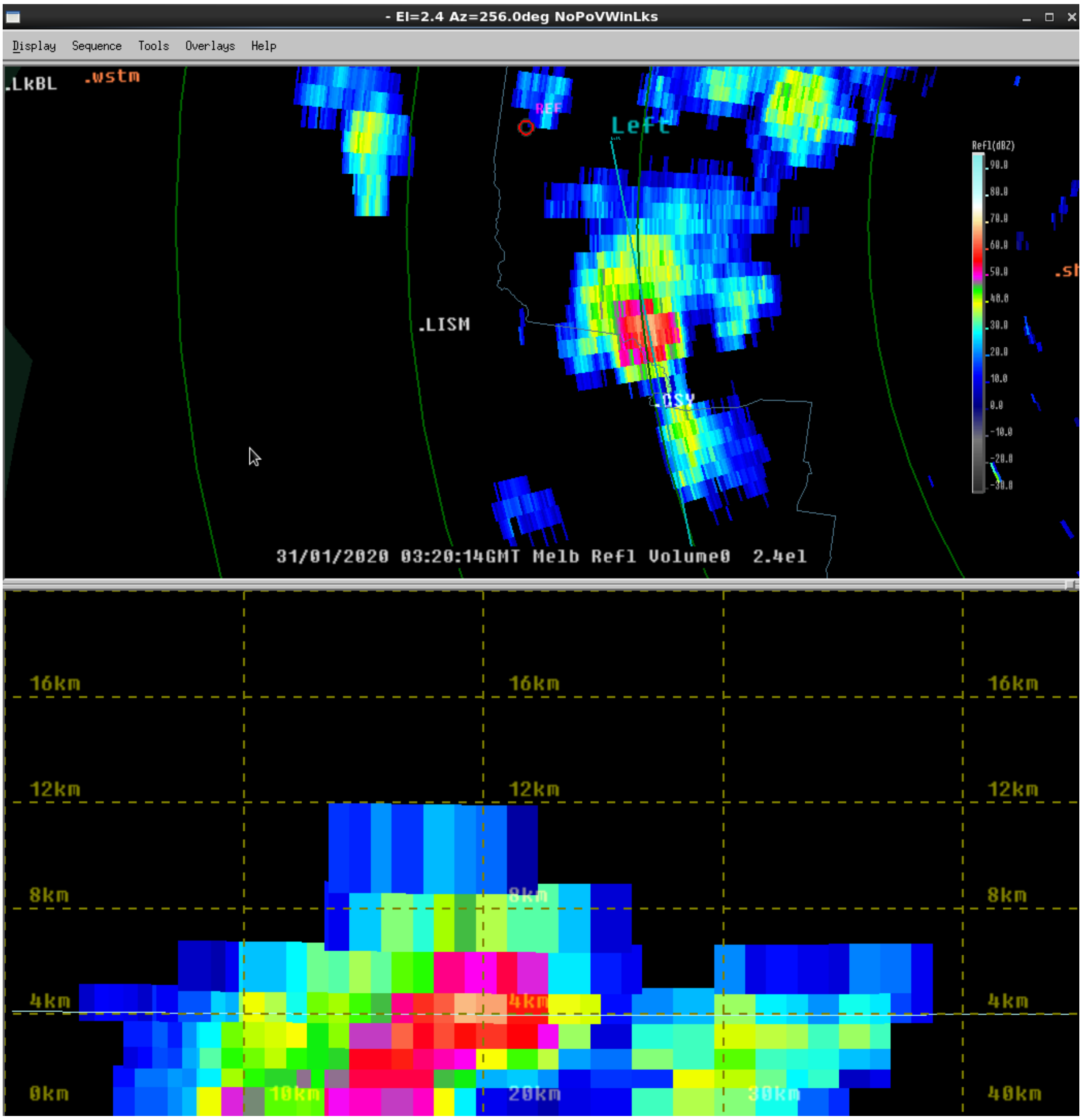


Figure 11: Radar reflectivity plan position indicator (top) and NNW-SSE cross section (bottom) for 03:20 UTC, Friday 31 January 2020

Figure 12 shows equivalent data for the 03:26 UTC (14:26 AEDT) radar scan. The thunderstorm core has largely collapsed to the surface at this time, corresponding to when the damage was sustained by the transmission infrastructure.

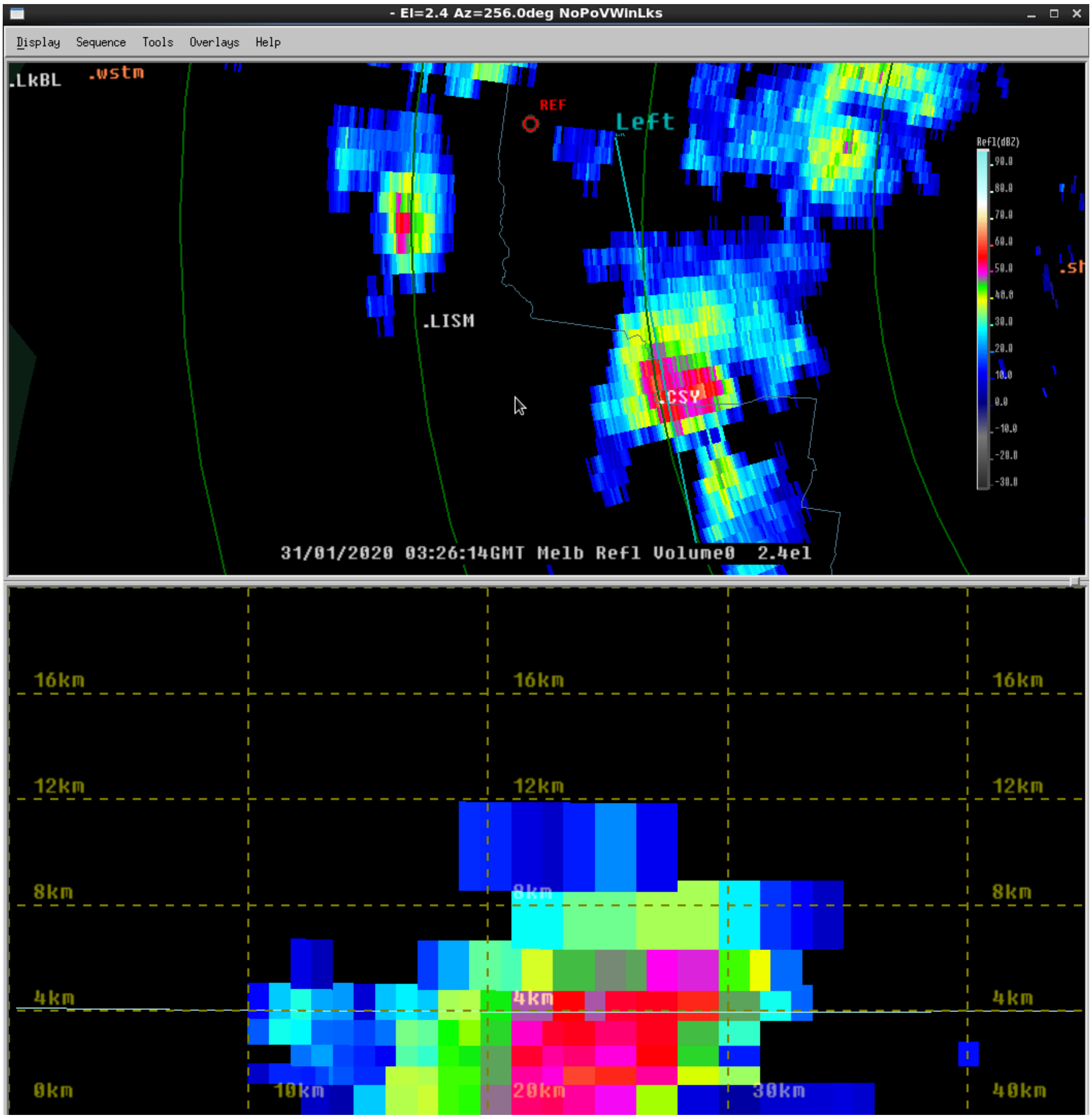


Figure 12: Radar reflectivity plan position indicator (top) and NNW-SSE cross section (bottom) for 03:26 UTC, Friday 31 January 2020

Figure 13 shows the doppler radial wind velocities at 03:26 UTC, corresponding to figure 12. The winds near Cressy at this time are tangential to the radar, limiting the ability to directly measure wind gust speeds using doppler. However, the doppler winds provide useful evidence of a lack of rotation associated with the thunderstorm, confirming expectations that tornadoes were unlikely to form during this event. The PPI (top panel) shows convergence in the mid-levels of the storm, indicated by stronger inbound radial winds to the west of the storm (darker blue) compared to the weaker inbound radial winds to the east (lighter blue). Mid-level convergence provides further evidence of convective downburst being the most likely cause of the observed impacts.

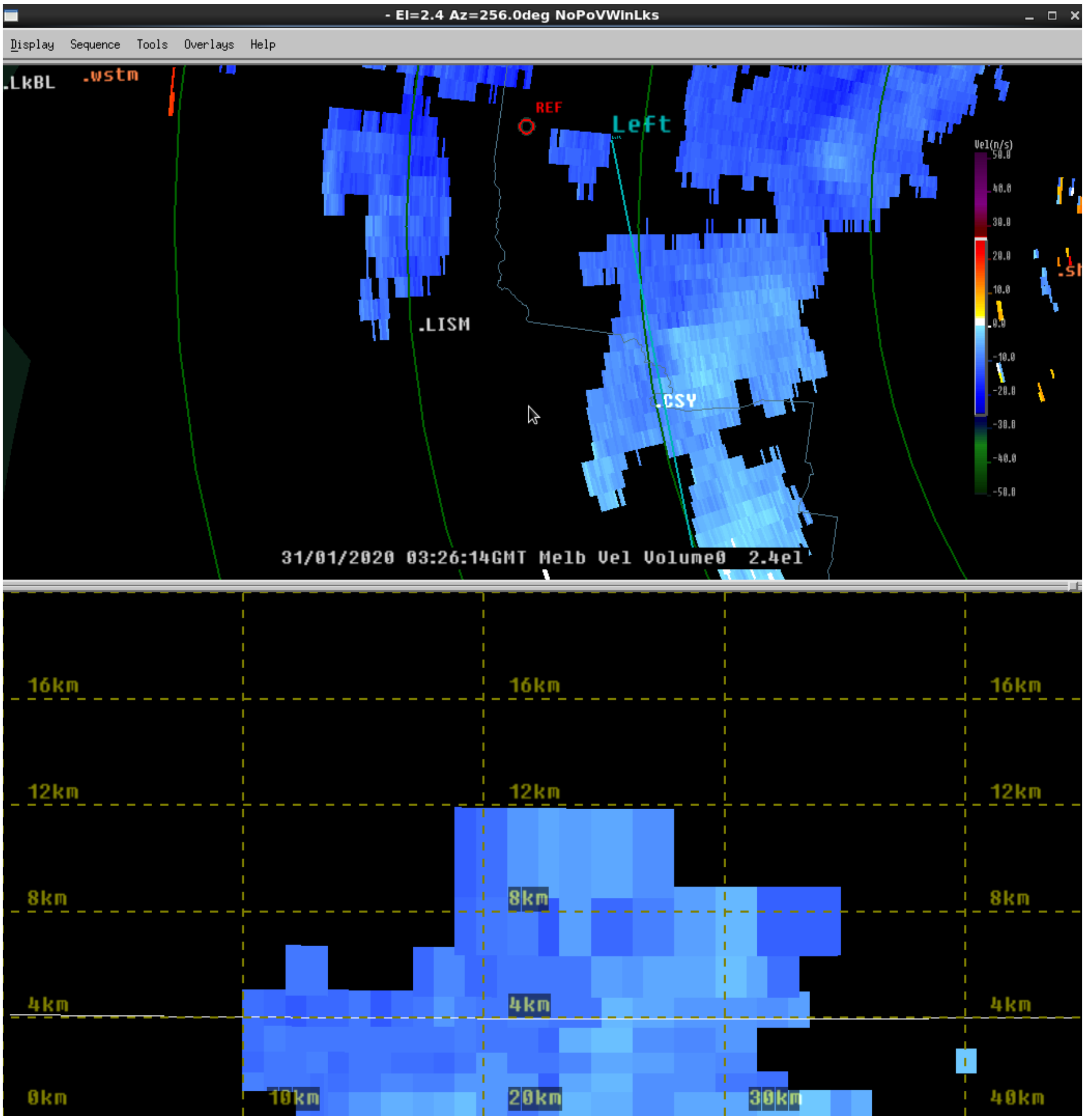


Figure 13: Radar velocity plan position indicator (top) and NNW-SSE cross section (bottom) for 03:26 UTC, Friday 31 January 2020

5.3 Mount Gellibrand Automatic Weather Station Observations

The following observations (table 3) were recorded at Mount Gellibrand Automatic Weather Station (AWS), approximately 30km to the SSE of the transmission line impact, between 9am and 9pm on Friday 31 January 2020. Observations are typically reported every 30 minutes, but more frequently when conditions change rapidly. The near-destructive wind gusts reported between 1445 and 1451 validate evidence considered above for the storm near Cressy and provide additional indirect insight into the weather conditions that impacted the transmission infrastructure 20-25 minutes earlier.

The near-destructive northwest winds at Mount Gellibrand were accompanied by a rapid decrease in temperature (14°C in 10 minutes), accompanied by a sharp increase in humidity and small amount of rainfall. The convective downburst over this AWS illustrates the effect of evaporative cooling as air descends and accelerates through the thunderstorm core towards the surface. It appears that horizontal momentum aloft has combined with latent heat energy absorption to generate damaging to destructive winds from the storm at the surface.

Mount Gellibrand

Station ID: 090035
Lat: -38.23 Lon: 143.79
Height: 261.0m above sea level

Time (AEDT)	T °C	Td °C	RH %	Wind Spd km/h	Wind Dir degrees	Wind Gust km/h	Rainfall since 9am mm
0900	31.3	6.4	21	20.5	10	29.5	0
0930	33.7	6.9	19	29.5	10	35.3	0
1000	37.3	6.3	15	33.5	360	46.4	0
1003	37.6	4.5	13	35.3	360	59.4	0
1017	37.4	4.4	13	57.2	360	64.8	0
1030	37.4	5.4	14	55.4	360	70.2	0
1054	37.8	10.2	19	50	360	70.2	0
1100	37.9	10.3	19	59.4	360	81.4	0
1130	36.7	10.8	21	59.4	360	85.3	0
1145	36	8.7	19	38.9	20	42.5	0
1200	35.8	7.8	18	31.3	10	37.1	0
1230	37.6	9.2	18	40.7	360	51.8	0
1300	39	10.4	18	42.5	350	57.2	0
1330	41.2	11.3	17	42.5	330	55.4	0
1345	40.8	12.6	19	51.8	310	70.2	0
1400	40.6	12.5	19	48.2	320	70.2	0
1430	39.5	12.4	20	46.4	310	64.8	0
1438	36.6	9.2	19	37.1	250	44.3	0
1441	36.8	9.4	19	29.5	280	37.1	0
1442	36.3	10.5	21	29.5	300	50	0
1443	35.8	13.9	27	38.9	330	50	0
1444	33	16.8	38	48.2	330	92.5	0
1445	31.4	17.7	44	83.2	330	114.8	0
1448	22.6	20.9	90	90.7	340	118.4	0.6
1451	22.9	22.9	100	85.3	340	118.4	1.8
1453	23.9	23.9	100	27.7	350	50	2.4
1500	26.1	26.1	100	5.4	320	9.4	2.6
1509	31.1	31.1	100	11.2	280	20.5	2.6
1516	30.2	30.2	100	37.1	280	42.5	2.6

1520	28.7	28.7	100	42.5	280	61.2	2.6
1529	28.3	18.4	55	27.7	250	38.9	3.2
1530	28.4	18.8	56	25.9	260	38.9	3.2
1548	33.5	22	51	13	270	16.6	3.4
1600	35.9	22.5	46	13	260	20.5	3.4
1630	39.1	17.8	29	9.4	260	14.8	3.4
1700	37.9	16.2	28	7.6	310	14.8	3.4
1730	38.9	16.5	27	9.4	350	16.6	3.4
1800	38.2	17.6	30	11.2	10	14.8	3.4
1819	38.2	15.9	27	35.3	340	40.7	3.4
1821	37.8	16.7	29	40.7	340	111.2	3.4
1823	35.4	17.6	35	94.3	300	120.2	3.4
1827	33.5	18.4	41	74.2	290	87.1	3.4
1830	32.1	19.7	48	72.4	280	90.7	3.4
1834	29.8	19.8	55	83.2	240	94.3	3.4
1839	27.8	19.6	61	74.2	240	94.3	3.4
1843	27.1	20.2	66	51.8	230	66.6	3.4
1900	26	21.2	75	48.2	230	61.2	3.4
1912	25.7	21.6	78	42.5	230	61.2	3.4
1922	25.7	22	80	35.3	190	40.7	3.4
1930	25.5	22	81	27.7	160	33.5	3.4
2000	26.6	24.3	87	29.5	190	33.5	3.4
2030	26.5	24.2	87	20.5	210	24.1	3.4
2100	26	24.6	92	18.4	220	24.1	3.4

Table 3: Mt Gellibrand AWS Observations for 31 January 2020 from 9am to 9pm AEDT, with 100+ km/h wind gust observations highlighted. Note, these observations had not been quality controlled at the time of extraction

6 Conclusions

The convective environment and relevant observations of the severe thunderstorm near Cressy on Friday 31 January 2020 suggest a severe convective downburst near electricity transmission infrastructure contributed to the observed damage. Available evidence indicates the thunderstorm produced damaging winds (over 90 km/h) and potentially produced destructive winds (over 125 km/h). Further evidence is required to conclude winds greater than 125 km/h were produced by this thunderstorm. Available evidence indicates the storm did not produce a tornado. Considering the storm motion (NNW to SSE) was roughly perpendicular to transmission lines (east-west orientation), damage from a tornado would necessarily be confined to a very small path (20-100m) and therefore be unable to directly topple multiple transmission towers. The extent of the damage along an extended segment of the line supports the conclusion that a severe convective downburst over a few kilometres is responsible.

Wind gusts observed at nearby Mount Gellibrand soon after the impact near Cressy provide further consistent evidence of the physical processes inferred from the convective environment and radar observations near Cressy. Other damaging and destructive wind gusts recorded at Victorian AWSs on Friday 31 January 2020 (table 4) demonstrate the widespread nature of similar conditions experienced during this event.

Maximum gust (km/h)	Location	Time
146	Fawkner Beacon (Port Phillip Bay)	16:06
119	Mount Gellibrand	14:48
120	Mount Gellibrand	18:23
107	St Kilda Harbour	16:00
94	Melbourne Airport	15:49
94	Longerenong	16:31
94	Westmere	14:20
93	Ballarat Aerodrome	14:06
91	Stawell Aerodrome	13:16
91	Wallan	17:23
91	Essendon Airport	15:53

Table 4: highest maximum wind gusts reported at Victorian AWS sites for 31 January 2020

Attachment 4 Meteorological agency information sheets on thunderstorm phenomena

HAZARDOUS WEATHER PHENOMENA

Thunderstorms

A thunderstorm is a cumulonimbus (CB) cloud in which electrical discharge can be seen as lightning and heard as thunder. A thunderstorm is potentially the most violent and destructive meteorological phenomenon confronting general aviation pilots.

Thunderstorm Development

A thunderstorm is essentially a cloud that produces lightning. The lightning is a gigantic spark created when an enormous imbalance of positive and negative charge occurs. It greatly heats the surrounding air to many thousands of degrees, causing the air to expand violently, resulting in the crashing noise known as thunder.

For a thunderstorm to form, moist air must be able to rapidly rise through the atmosphere. Three main ingredients are necessary for this to occur:

1. An unstable atmosphere (evidenced by a strong vertical lapse rate, i.e. temperature falls rapidly with height) which, when associated with high surface temperatures, provides a favourable environment for the strong vertical atmospheric motions that produce thunderstorms.

2. A lifting mechanism (to initiate the vertical motion) such as low level convergence of airstreams, a frontal system, orographic uplift or local differences in heating.

3. Sufficient moisture (water vapour) in the low levels of the atmosphere. As air rises it cools, causing the invisible water vapour to condense into visible water droplets that form the cloud. The condensation process releases latent heat into the atmosphere, making the rising air more buoyant, fuelling further cloud growth.

Types of Thunderstorms

The type and severity of any thunderstorm will depend largely on the instability (buoyancy) of the rising air within the thunderstorm and the structure of the wind within the atmosphere. Wind generally tends to increase in speed and change direction with increasing altitude. This change in wind direction and/or speed with height is known as vertical wind shear.

The most severe thunderstorms occur in an environment with strong instability and strong wind shear.

Australian Government
Bureau of Meteorology

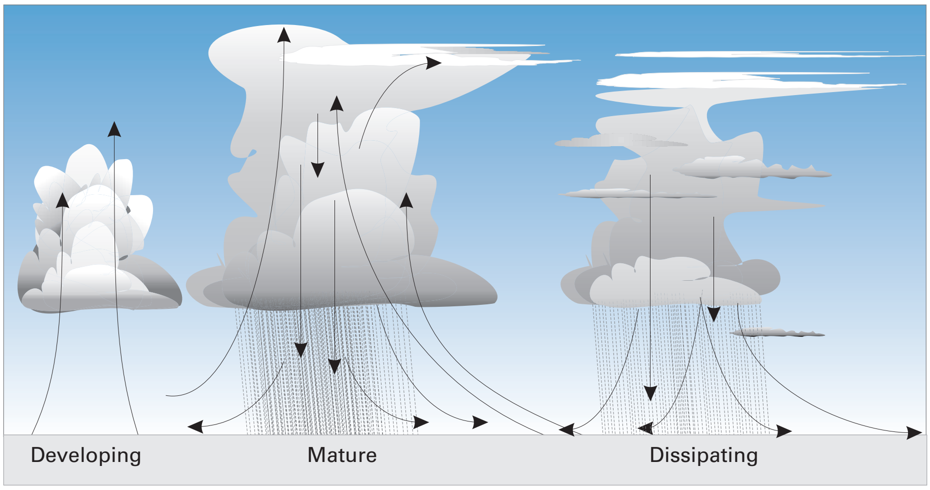
The dynamical building block of a thunderstorm is the convective cell, which is a compact region of strong vertical motion. Research has shown that convective cells, as observed visibly and on radar, often evolve in identifiable patterns. The most commonly observed storm types are classified as the **ordinary cell**, the **multicell** and the **supercell**.

The Ordinary Cell Thunderstorm

This is the most basic and common thunderstorm type, forming in an environment of weak vertical wind shear. It is a relatively weak weather system which initially consists of a single updraft which rises rapidly through the troposphere producing large amounts of water droplets and ice particles. When the water and ice become too heavy for the updraft to support, they begin to fall, creating a downdraft that quickly replaces the updraft. As the downdraft mixes with drier air in the lower troposphere, strong evaporative cooling may occur, accelerating the downdraft (because of negative buoyancy) which spreads out horizontally on reaching the surface.

The life cycle of an ordinary thunderstorm cell may be divided into three stages determined by the magnitude and direction of the predominating vertical motions. These stages are:

- the developing (or cumulus) stage, which is characterised by an updraft throughout the cell.
- the mature (or cumulonimbus) stage, which is characterised by both updraft and downdraft, at least in the lower half of the cell. This is the stage of maximum lightning activity.
- the dissipating stage which is characterised by downdrafts throughout the cell.



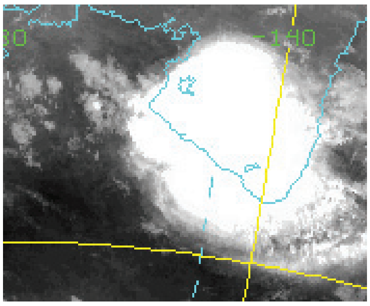
The ordinary cell is normally 5–10 km in horizontal extent and usually short-lived (15-30 minutes) in its mature stage as the downdraft eventually completely replaces the updraft, depriving the storm of its source of warm, moist air. It has been observed that the ordinary thunderstorm cell can sometimes produce severe weather (high winds, hail, weak tornadoes) for a short time if the updraft or downdraft is strong enough.

The Multicell Thunderstorm

Most thunderstorms are multicellular, i.e. a cluster of short-lived ordinary cells moving as a single unit with each cell in a different stage of the thunderstorm life cycle. The cold outflows from each combine to form a large gust front which provides a lifting mechanism for new updraft development, which can then lead to new cells forming. The degree of organisation of this thunderstorm type gives it a relatively long life and a greater chance of producing severe weather over a broad area. They tend to form in environments with moderate vertical windshear. They are more potent than single cell thunderstorms but considerably less so than supercells.

In terms of organisation, two types of multicellular thunderstorms are the squall line and the meso-scale convective complex.


Squall line thunderstorms.


Meso-scale convective complex over the Gulf of Carpentaria.


Supercell thunderstorm.


Roll cloud.


Shelf cloud.


Wall cloud.

A **squall line** is a multicell thunderstorm where the cells are arranged in a long line. The adjacent cells are so close together that they form a continuous line of thunderstorms accompanied by a continuous, and often strong, surface gust front at the line's leading edge, hence the name squall line. They develop along a linear lifting mechanism such as a cold front or a pre-frontal trough and also within the inter-tropical convergence zone.

Squall lines can be particularly dangerous to aircraft in flight since they can present a wall of severe weather which is too wide, high and long to negotiate. Cloud bases can change rapidly and are often very low. Flying beneath the cloud is an extremely hazardous procedure due to the high probability of encountering strong downdrafts, hail, rain, poor visibility, severe turbulence and low cloud.

A **meso-scale convective complex** is a nearly circular cluster of many interacting thunderstorm cells at various stages of development, covering an area that can exceed 500 kilometres in diameter. They have the potential to produce severe weather in the form of moderate-sized hail, weak tornadoes and heavy rainfall.

The Supercell Thunderstorm

As a general rule, the greater the altitude of the top of the thunderstorm, the more likely it is that the system will produce severe weather. The supercell, characterised by a single rotating updraft reaching great vertical extent, is relatively rare but is the most destructive and long-lasting of all thunderstorms. It is a well-organised cell that forms in an environment of strong vertical wind shear, strong instability and large moisture supply. The essential factor in its development is the presence of the strong vertical wind shear which favours a long-lasting vigorous updraft by organising the wind flows such that the precipitation falls alongside, not into, the updraft; and a strong inflow of moist boundary-layer air feeding into the storm is maintained. A supercell thunderstorms can thus persist for several hours (up to seven hours has been observed) in its mature stage.

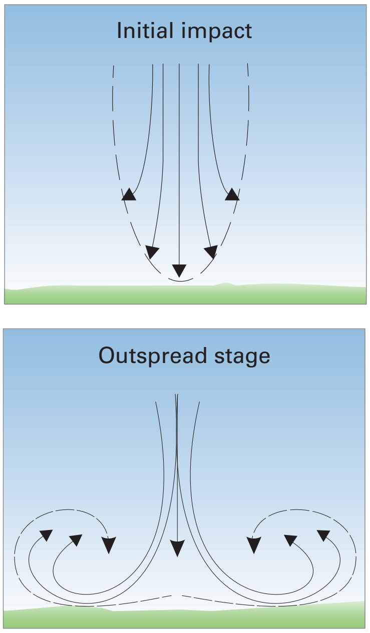
The rotating updraft is thought to be dependent upon the presence of wind speed shear in the mid levels which can cause a rolling about the horizontal axis of this mid-level air which, if lifted into the vertical by convection, can result in the updraft rotating. Any low-level shear that may exist will contribute to the rotation if it is lifted into the updraft through the storm's inflow. This rotating updraft can lead to the formation of tornadoes.

The dividing line between the cold downdraft and the warm updraft at the surface is called a gust front. In some cases the gust front can be identified at a distance from the supercell by the presence of a detached (horizontal, tube-shaped) **roll cloud** that is situated directly behind the gust front. These clouds are seldom accompanied by severe weather. However, damaging winds may occur under a **shelf cloud** (also known as arcus cloud) which can form on the edge of the gust front. It is an elongated wedge-shaped cloud attached to the leading edge of the supercell where the cold downdraft forces warm moist air upwards. A rotating **wall cloud** may form in the rain-free updraft area towards the rear of the thunderstorm. It occurs in the area of strongest updraft which entrains moist cool air from the nearby downdraft, allowing condensation at altitudes lower than that of the ambient cloud base. Most tornadoes form within wall clouds.

Aviation-related Hazards Associated with Thunderstorms

All thunderstorms have the potential to be hazardous to aviation no matter what their size or intensity. These hazards include:

- severe wind shear and turbulence
- severe icing
- hail
- downbursts
- lightning
- tornadoes
- heavy rain
- poor visibility
- low cloud
- rapid air pressure changes



Schematic of downburst.

Downbursts

The outflow from a storm's downdraft will occasionally produce winds of destructive force. When precipitation falls into drier air inside or below a thunderstorm, it immediately begins evaporating. This evaporation cools the surrounding air, increasing its density, causing it to accelerate downwards. A downburst is a concentrated downdraft, typically lasting five to fifteen minutes, and is of unusually high speed such that it can cause damage on, or near, the ground. The term **microburst** is used to describe a downburst which causes damage over an area with horizontal dimensions of less than four kilometres.

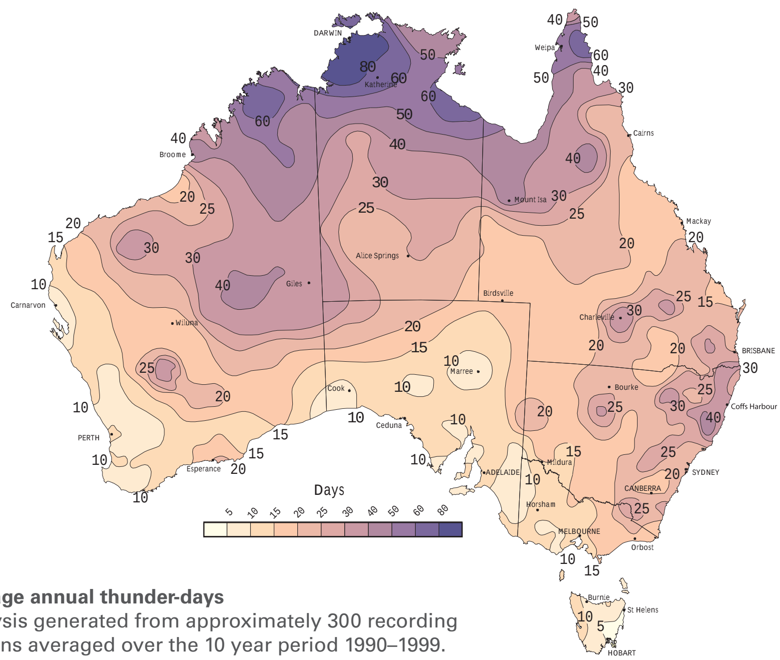
Downburst winds originate from the cloud base and diverge when they make contact with the ground. The rapid change in wind speed and direction associated with downbursts poses a threat to aircraft during take-off and landing phases, during which an aircraft will first encounter a strong headwind, then a downdraft which is the vertically descending section of the downburst, and finally a region of strong tailwind. If a pilot was to over-compensate for the lift experienced in the headwind, a dangerous drop in altitude may occur when the lift disappears in the downdraft and tailwind regions.

A microburst can be characterised as wet or dry. A wet microburst, which can occur with a range of thunderstorm types, is accompanied by significant precipitation at the surface. It develops in environments characterised by weak vertical wind shear and deep moisture capped by a dry layer.

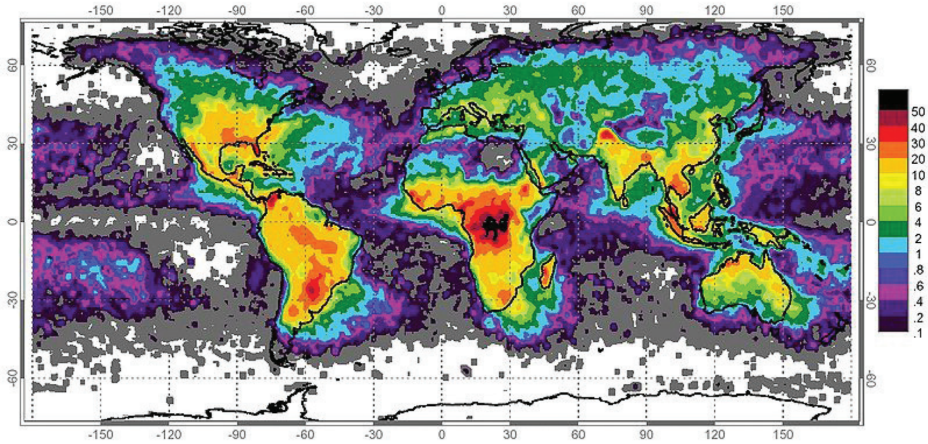
In a dry microburst, precipitation at the surface is either very light or does not occur at all, although virga (precipitation falling from a cloud but evaporating before reaching the ground) may be present. They develop in environments with weak vertical wind shear, dry low levels and moist mid levels. The dry microburst is initiated by evaporative cooling. If the air underneath a cloud is relatively dry then rain and ice crystals falling from the cloud will quickly evaporate and chill the air. The cooled air will be heavier than the surrounding environmental air and will therefore accelerate downward. Dry microbursts can develop in the absence of lightning and thunder. High-based cumulus and altocumulus have been observed to produce damaging dry microbursts.

Location & Seasonal Variations

Thunderstorms are most frequent over the northern half of the country, and generally decrease southward, with lowest frequencies in southeast Tasmania. A secondary maximum is apparent in southeast Queensland and over central and eastern New South Wales, extending into the northeastern Victorian highlands. Thunderstorm frequency does not, in general, appear to vary in any consistent way with rainfall.



Average annual thunder-days
Analysis generated from approximately 300 recording stations averaged over the 10 year period 1990–1999.



Global lightning frequency, data from space-based optical sensors. Image, NASA.

Tropics

Meteorological conditions over the northern half of Australia are very favourable for thunderstorms in the warmer months of October through to March. During this time, low pressure lies across northern and central Australia (giving rise to the low level convergence and vertical motion that favour thunderstorm development), and high moisture levels exist particularly in coastal areas. The peak frequency for thunderstorms is in the vicinity of Darwin with over eighty thunder-days per year. Thunderstorm frequency is far less for the remainder of the year due to the dry and stable conditions associated with the subtropical high-pressure belt which normally lies over the continent during the period April to September.

Thunderstorm frequency decreases in the southern parts of the tropics and the adjacent desert areas of central Australia. This is because the air, though often very hot, is generally drier. The exception is over inland Western Australia where a wide area experiences over thirty thunder-days per year. However, many of these are so-called 'dry' thunderstorms, with little or no rain, because of the lack of moisture in the low levels of the atmosphere which acts to evaporate any falling precipitation. Again, thunderstorms are heavily concentrated in the summer half-year.

There is a low frequency of thunderstorms (less than 25 days per year) along parts of the Queensland coast, especially in the very wet section between Cooktown and south of Innisfail. This is the wettest part of Australia, yet thunder-days are less frequent than in most remaining areas of the tropics. This is due to the combination of the orographic influences driving rainfall (the steering flow being unfavourable for thunderstorms tracking over the eastern coastline), and the stability of the southeast trade winds for much of the year.

Mid-latitudes

The secondary thunderstorm maximum over New South Wales occurs mainly during the summer months. The frequency of thunderstorms is largely due to the influx of moisture from the Coral and Tasman Seas combined with low level convergence into low pressure troughs. Orography also plays a part, with local maxima over the Great Dividing Range, and favourable steering flow tracking thunderstorms toward the coast. Instability over this area is often accentuated by strong wind-shears and/or upper atmospheric cold pools which have originated from higher latitudes.

Thunderstorms are less frequent in Victoria, Tasmania, and the southern parts of Western and Southern Australia, with less than 10 days per year in some areas. This is partly because of the relatively lower incidence at these latitudes of the warm and humid air masses favourable for thunderstorm development. It is also because during the potentially favourable warmer months, the subtropical high pressure belt lies over or near this area, giving rise to stable conditions unconducive to thunderstorm development. There is a local maximum of activity over the high country of northeastern Victoria and the Snowy Mountains, which appears to be mainly an orographic effect. Thunderstorms are again most frequent in the warmer months, but some occur in association with active cold frontal systems in winter and spring.

In contrast with most other parts of Australia, Perth experiences a winter maximum in thunderstorm frequency. This reflects the prevalence at this time of active frontal systems, which produce a winter rainfall maximum along the southwest coast, whereas the summer months are generally hot and dry. A similar feature is apparent in western Tasmania, also experiencing a weak maximum in winter activity. By contrast, Hobart, shielded by topography from the frontal systems of the winter westerlies, experiences a summer maximum. In fact thunderstorms in Hobart are rare in the cooler months, with an average of less than one thunder-day for the entire April-September period.

Detection & Monitoring

The primary tool for detecting and monitoring thunderstorms is the weather-watch radar, which may be accessed through the Bureau of Meteorology website www.bom.gov.au/weather/radar. The site includes valuable information on how to interpret radar images. Some aircraft are also equipped with radar for detecting and avoiding thunderstorms.

Satellite pictures also provide useful information, particularly in areas not covered by radar, by giving the pilot a broad understanding of where thunderstorms are developing and the horizontal extent of those cells, noting that high level cloud will often mask the true placement of the cell(s) below.

A pilot in command of an aircraft must advise Air Traffic Services (ATS) promptly of any hazardous weather encountered or observed either visually or by radar. Whenever practicable, those observations should include as much detail as possible, including location and severity of the hazard. Hazardous weather includes, in particular, thunderstorms, severe turbulence, hail, icing, line squalls, and volcanic ash cloud (AIP Gen 3.5 Section 6.2). Moreover, a pilot in command should make a special AIREP when requested or as soon as practicable after encountering any SIGMET phenomenon, or any other meteorological condition which is likely to affect the safety or markedly affect the efficiency of other aircraft (AIP Gen 3.5 Section 11.1).

Forecasts & Warnings

Thunderstorm forecasts are included in Area Forecasts, Trend Forecasts (TTF) and Aerodrome Forecasts (TAF). Cumulonimbus clouds are forecast in Significant Weather (SIGWX) charts. Warnings issued for thunderstorms include Airport Warnings for some locations, AIRMETs and SIGMETs.

An AIRMET will be issued for the occurrence or expected occurrence of isolated or occasional thunderstorms affecting the layer below FL185 if the thunderstorms have not previously been mentioned in a current Area Forecast.

SIGMET for thunderstorms are issued when they are:

- obscured (OBSC) by haze or smoke,
- embedded (EMBD) within other cloud layers,
- frequent (FRQ), i.e. with little or no separation between clouds and covering more than 75% of the area affected, or
- squall line (SQL) thunderstorms along a line of about 100 nautical miles or more in length, with little or no separation between clouds.

Australian Government
Bureau of Meteorology

Airservices Australia is the official distributor of aviation forecasts, warnings and observations issued by the Bureau of Meteorology. Airservices' flight briefing services are available at www.airservicesaustralia.com. Telephone contact details for elaborative briefings are contained in Airservices' Aeronautical Information Publication Australia (AIP), which is available online through their website.

Other brochures produced by the Bureau of Meteorology's aviation weather services program can be found at www.bom.gov.au/aviation/knowledge-centre.

NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

(http://www.weather.gov)

Thunderstorm Hazards - Damaging Wind

Damaging wind from thunderstorms is much more common than damage from tornadoes. In fact, many confuse damage produced by "straight-line" winds and often erroneously attribute it to tornadoes.

The source for damaging winds is well understood and it begins with the **downdraft**. As air rises, it will cool to the point of condensation where water vapor forms tiny water droplets, comprising the cumulus cloud we see.

Near the center of the updraft, the particles begin to collide and coalescence forming larger droplets. This continues until the rising air can no longer support the ever-increasing size of water drops.

Once the rain drops begin to fall friction causes the rising air to begin to fall towards the surface itself. Also, some of the falling rain will evaporate. Through evaporation heat energy is removed from the atmosphere cooling the air associated with the precipitation.

As a result of the cooling, the density of the air increases causing it to sink toward the earth. The downdraft also signifies the end of the convection with the thunderstorm and its subsequent decrease.

When this dense rained-cooled air reaches the surface, it spreads out horizontally with the leading edged of the cool air forming a gust front. The gust front marks the boundary of a sharp temperature decrease and increase in wind speed. The gust front can act as a point of lift for the development of new thunderstorm cells or cut off the supply of moist unstable air for older cells.

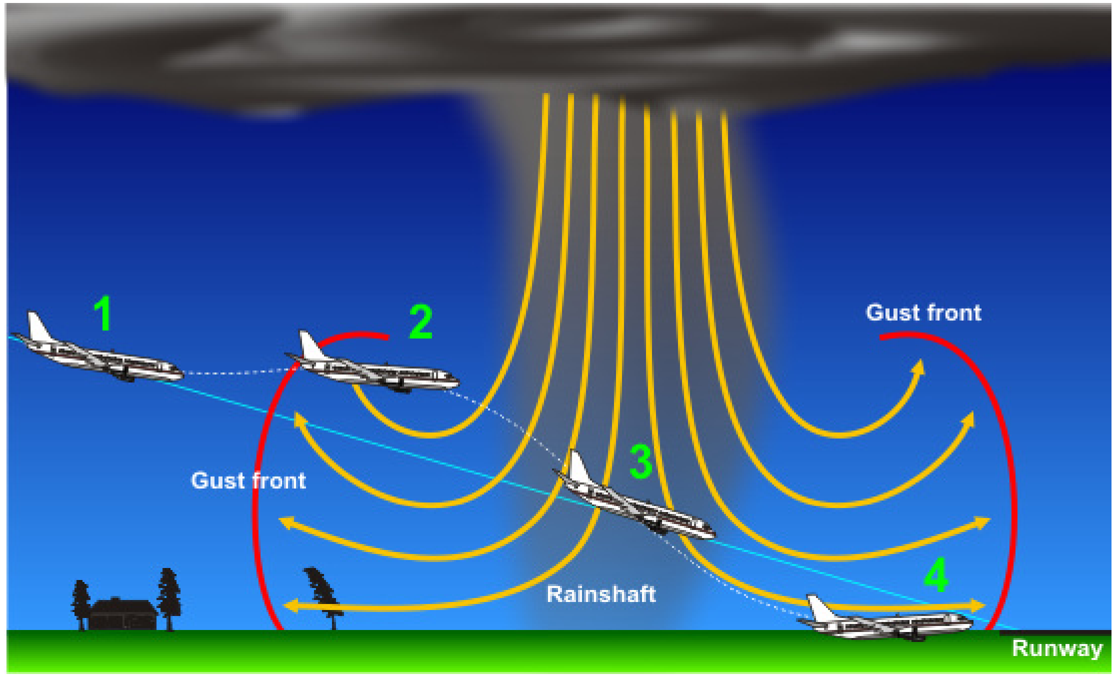
Thunderstorms

Downbursts are defined as strong winds produced by a downdraft over a horizontal area up to 6 miles (10 kilometers). Downbursts are further subdivided into **microbursts** and **macrobursts**.

Microbursts and Macrobursts

A microburst is a small downburst with an outflow less than 2½ miles (4 kilometers) in horizontal diameter and last for only 2-5 minutes. Despite their small size, microbursts can produce destructive winds up to 168 mph (270 km/h). Also, they create hazardous conditions for pilots and have been responsible for several disasters. For example,

1. As aircraft descend (below) into the airport they follow an imagery line called the "glide slope" (solid light blue line) to the runway.
2. Upon entering the microburst, the plane encounters a "headwind", an increase in wind speed over the aircraft. The stronger wind creates additional lift causing the plane to rise above the glide slope. To return the plane to the proper position, the pilot lowers the throttle to decrease the plane's speed thereby causing the plane to descend.
3. As the plane flies through to the other side of the microburst, the wind direction shifts and is now a "tailwind" as it is from behind the aircraft. This decreases the wind over the wing reducing lift. The plane sinks below the glide slope.
4. However, the "tailwind" remains strong and even with the pilot applying full throttle trying to increase lift again, there may be little, if any, room to recover from the rapid descent causing the plane to crash short of the runway.



How a downburst can impact a landing aircraft.

Since the discovery of this effect in the early to mid-1980's, pilots are now trained to recognize this event and take appropriate actions to prevent accidents. Also, many airports are now equipped with equipment to detect microbursts and warn aircraft of their occurrences.

A **macroburst** is larger than a microburst with a horizontal extent more than 2½ miles (4 km (kilometers)) in diameter. Also, a macroburst is not quite a strong as a microburst but still can produce winds as high as 130 mph (210 km/h). Damaging winds generally last longer, from 5 to 20 minutes, and produce tornado-like damage up to an EF-3 scale.

In wet, humid environments, macrobursts and microbursts will be accompanied by intense rainfall at the ground. If the storm forms in a relatively dry environment, however, the rain may evaporate before it reaches the ground and these downbursts will be without precipitation, known as **dry microbursts**.

In the desert southwest, dust storms are a rather frequent occurrence due to downbursts. The city of Phoenix, AZ typically has 1-3 dust storms each summer due to the cooler dense air spreading out from thunderstorms.

On July 5, 2011, a massive dust storm resulted in widespread areas of zero or near zero visibility in Phoenix. The wind that produced this storm was generated by downbursts from thunderstorms with winds up to 70 mph (110 km/h).

Wall of dust approaching the NWS Forecast Office in Phoenix July 5, 2011

Heat Bursts

Dry downbursts are responsible for a rare weather event called "Heat Bursts". Heat bursts usually occur at night, are associated with decaying thunderstorms, and are marked by gusty, and sometimes damaging, winds combined a sharp *increase* in temperature and a sharp *decrease* in dew point (humidity).

The process of creating a dry microburst begins higher in the atmosphere for heat bursts. A pocket of *cool* air aloft forms during the evaporation process as for any downburst. But as the precipitation falls it evaporates before reaching the ground. The cool dense air sinks by the pull of gravity but since there is no rain drops to absorb heat, the air then warms due to compression.

In fact, it can become quite hot and very dry. Temperatures generally rise 10 to 20 degrees in a few minutes and have been known to rise to over 120°F (49°C) and remain in place for several hours before returning to normal. One such heat burst occurred in Wichita, KS on June 9, 2011 (https://www.weather.gov/ict/event_heatburst2011).

Derechos

If the atmospheric conditions are right, widespread and long-lived windstorms, associated with a band of rapidly moving showers or thunderstorms, can result. The word "derecho" is of Spanish origin, and means straight ahead. A derecho is made up of a "family of *downburst* clusters" and by definition must be at least 240 miles in length. Learn more about derechos (derecho_intro).

Previous (hail) Next (tornado)

Attachment 5 Economic analysis of service restoration options

Economic analysis of service restoration options

Options considered

Three options were considered as part of Net Present Value (NPV) assessment.

Option	Description Summary
1	Do nothing – transmission infrastructure / services not restored
2	Establish permanent towers – install ERS structures and replace towers
3	Install ERS structures and delay tower replacements

The duration of analysis for all considered options is over 50 years from FY20 to FY70.

Given the criticality of the affected transmission lines, and the availability of the ERS which AusNet Services holds to restore service in the event of such contingency, the 'restore' options each include an initial and immediate restoration response using the ERS.

1. Do nothing – transmission infrastructure / services not restored

This option was included in the assessment for completeness.

Although the option incurs no opex or capex costs, it carries significant market criticality risk (MCR) due to two critical 500kV lines being out of service for a long time. There would also be significant corporate impact resulting from NEM operational impacts, and impact on the connected generators, and the aluminium smelter at Portland.

This option involves highest Present Value (PV) cost $5.3B Hence, this option is not viable and is not recommended.

A short summary of various risks/costs values from economical modelling for this assessment is provided in the table below.

Capex and Opex	There are no opex or capex costs associated with the option. It is assumed that under this scenario no rectification works would be carried out to restore supply.
Community Costs & Benefits	Annual combined MCR cost for No. 1 and No. 2 line is $240M/year for 50 years. This is based on the current market criticalities of $22,461/hour and $4,925/hour for MOPS-TRTS No.1 500kV and MLTS-MOPS No. 2 500kV lines respectively. Estimated annual potential corporate impact is $10M/year.

2. Establish permanent towers – install ERS structures and replace towers

This is the preferred option, with lowest PV cost, at $35M.

The preferred option replaces seven failed towers with 14 temporary ERS structures to restore supply and replaces the temporary 14 ERS structures with seven permanent structures. This option significantly reduces the MCR cost on both lines. Further, opex and MCR cost of restoring supply using ERS structures as a permanent measure is significantly higher than replacing towers making this option more economical.

Capex and Opex	The option incurs an opex cost. Maintenance of ERS structures is $80k/year in the first 2 years. Capex solution to establish supply will incur an expenditure estimated at $26.4M.
Community Costs & Benefits	Annual community benefit gained through ensuring energy security on both lines is $240M/year. Since the permanent replacement will take 12 months to be completed and temporary structures are susceptible to failures the following risks are still present in FY20 and FY21: • MCR of 5M/year for first 2 years • Estimated corporate impact risk of 500k/year for first 2 years
Incentive Benefits	Since the MCR benefit/cost significantly outweighs any incentive benefits, it has not been considered in the analysis.

3. Install ERS structures and delay tower replacements

This option is same as 5.2 except the permanent structure replacement is delayed by five years. Although, ERS structures are suitable for temporary restoration of transmission lines however, due to their short design life and lower strength ratings they are not an alternative to permanent structures. Permanent structures provide higher level of network security while temporary structures are more susceptible to extreme weather events. As a result, ERS structures have a higher failure rate than the permanent structures thus potentially resulting in further supply risks.

Further, this option could leave the transmission network significantly constrained if there is subsequent failure on the network as emergency restorations may not be possible due to unavailability of ERS structures.

This option will have significant OPEX and CAPEX costs while incurring a high MCR, making this option uneconomical compared to the preferred option. The PV cost of this option is $53M.

Capex and Opex	Annual OPEX cost to maintain supply is $85k/year for first 5 years. The OPEX involves routine inspections and maintenance of temporary structures. CAPEX cost for option 3 is $26.4M with an expected service life of 80 years.
Community Costs & Benefits	While significantly reducing the MCR (compared to BAU option) this solution still presents following risks during the deferral period of 5 years: • MCR of $5M/year for fist 5 years • Estimated corporate impact risk of $500k/year for first 5 years
Incentive Benefits **(Electricity only)**	Since the MCR benefit/cost significantly outweighs any Incentive Benefits, it has not been considered in the analysis.

4. Install ERS structures as permanent solution

This option was considered but not assessed in detail due to the short operational life design basis for the ERS structures and it therefore effectively representing a capital project for both replacement with permanent towers and the need to replace the ERS assets as well, in the short term. There would also be the further and extended impact on the national electricity market upon the anticipated occurrence of a future failure of the ERS assets. It is clear based on the economic analysis for the other options that this would be the least preferred restoration solution.

Attachment 6 Buildup of costs incurred

This attachment comprises a separate spreadsheet

Attachment 7 Post tax revenue models

This attachment comprises a separate spreadsheet

Attachment 8 KPMG report on AusNet Services’ costs

[confidential attachment]