Options Evaluation Report (OER)

132kV TLs - Low Spans
OER- **N2616** revision **2.0**

Ellipse project no(s):

TRIM file: [TRIM No]

Project reason: Reliability - To meet overall network reliability requirements

Project category: Prescribed - Replacement

Approvals

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Change history

Revision	Date	Amendment
0	10/11/2021	First Issue
1	12/10/2022	Revised Cost and Risk ($2021-22)
2	31/10/2022	Revision number updating

Executive summary

Overhead transmission lines are designed and constructed to achieve standard minimum electrical clearances to the conductor. The presently accepted industry standard AS/NZS 7000:2016 – Design of Overhead Lines takes into account a range of safety and environmental factors, including thermal expansion of the conductor (known as sag) and movement of the conductor position due to wind (known as blowout). The minimum electrical clearances that should be achieved when the conductor reaches its maximum operating temperature is commonly referred to as the line design temperature.

Several transmission lines with spans below AS/NZS 7000 minimum clearances, referred to as low spans, exist on TransGrid's network. The term "span" refers to the wire (conductor) between two poles or towers of a transmission line. When referring to the term "low spans", this means that the distance between the lowest point of the conductor and the land, vegetation and infrastructure is less than (lower) than the clearance distance requirement specified in the design standards. At 132 kV, the current AS/NZS 7000 clearances are the same clearance as the original design criteria of on these transmission lines.

Changes to the generation mix has resulted in large generation sources being connected to lines which were previously connected to supply points to service regional centres. Some lines can now be operated at temperatures above the previously assessed value, and accordingly, it is expected that additional low spans are required to be addressed. Further, significant connection inquires have identified that this could be an emerging issue on other lines by 2028.

The identified transmission lines are to have their low spans remediated to the design temperature of the line in accordance with the Low Span Risk Assessment Methodology. This will allow for their continued operation at their design rating while reducing the public safety risk associated with non-compliant conductor clearances.

The main driver of the need to remediate these issue is to:

- Manage network safety risk levels "As-Low-As Reasonably-Practicable" in accordance with the regulation obligations and TransGrid's business risk appetite. Under the Electricity Supply (Safety and Network Management) Regulation 2014 Section 5 'A network operator must take all reasonable steps to ensure that the design, construction, commissioning, operation and decommissioning of its network (or any part of its network) is safe.

The entire fleet of 132 kV and 220 kV lines were reviewed against previous low span remediation and current utilisation and connection interest. A total of twenty 132/220 kV lines from TransGrid's entire fleet were identified as having low spans based on the design temperature. The remediation of low spans has been prioritised based on the utilisation of the lines, which indicates the likelihood of breaching the clearance requirement under credible contingency scenarios on the network. The twelve 132 kV lines with high utilisation line that requires remediation are listed in Table 1 below.

Table 1: Lines potentially requiring low span remediation (N-1 long time contingency ratings)

Line	From	To	Utilisation (% of Line rating)
94K	Wellington	Parkes	100%
96R	Glen Innes	Tenterfield	88%
9U3	Gunnedah	Boggabri East	91%
9UH	Boggabri North	Narrabri	92%
96L	Lismore	Tenterfield	86%
973 & 9GL	Yass	Cowra (via Bango)	92%

Line	From	To	Utilisation (% of Line rating)
996	Wagga	ANM	87%
994	Wagga	Yanco	70%
949	Mt Piper 132	Orange North	72%
945	Molong	Wellington	112%
94T	Molong	Orange North	101%
9R3	Finley	Deniliquin	131%

The assessment of the options considered to address the need/opportunity appears in Table 2.

Table 2 - Evaluated options

Option	Description	Direct capital cost ($m)	Network and corporate overheads ($m)	Total capital cost[1] ($m)	Weighted NPV (PV, $m)	Rank
Option A	Remediate low spans in accordance with low span risk assessment methodology to the line design temperature – Existing load and forecast growth	17.06	1.57	20.07	25.43	3
Option B	Remediate low spans in accordance with low span risk assessment methodology to the line design temperature – Existing load and forecast growth and lines with high connection interest.	26.17	2.36	30.76	29.97	2
Option B1	Remediate low spans, on lines with high utilisation, per TransGrid's low span risk assessment methodology to the line design temperature	20.2	1.84	24.96	34.47	1

The preferred option is Option B1, as these lines are of a higher likelihood to breach clearance requirements, which are required to be addressed under TransGrid's ENSMS obligation to reduce safety risks to ALARP and to address the legacy non-compliant conductor clearance. Option B1 also has the highest weighted NPV result and is technically and commercially feasible. It is therefore recommended that Option B1 be scoped in detail and progressed from DG1 to DG2.

[1] Total capital cost is the sum of the direct capital cost and network and corporate overheads. Total capital cost is used in this OER for all analysis.

1. Need/opportunity

Overhead transmission lines are designed and constructed to achieve standard minimum electrical clearances to the conductor. The presently accepted industry standard AS/NZS 7000:2016 – Design of Overhead Lines takes into account a range of safety and environmental factors, including thermal expansion of the conductor (known as sag) and movement of the conductor position due to wind (known as blowout). The minimum electrical clearances that should be achieved when the conductor reaches its maximum operating temperature is commonly referred to as the line design temperature

Several transmission lines with spans below AS/NZS 7000 minimum clearances, referred to as low spans, exist on TransGrid's network. The term "span" refers to the wire (conductor) between two poles or towers of a transmission line. When referring to the term "low spans", this means that the distance between the lowest point of the conductor and the land, vegetation and infrastructure is less than (lower) than the distance specified in the design.

At 132 kV, the current AS/NZS 7000 has the same clearance with what these transmission lines were originally designed to.

Significant changes to the generation mix has resulted in large generation sources being connected to lines which were previously connected to supply points service regional centres. Some lines can now be operated at temperatures above the previously assessed value, and accordingly, it is expected that additional low spans are required to be addressed. Further, significant connection inquires have identified that this could be an emerging issue on other lines by 2028.

The identified transmission lines are to have their low spans remediated to the design temperature of the line in accordance with the Low Span Risk Assessment Methodology. This will allow for their continued operation at their design rating while reducing the public safety risk associated with non-compliant conductor clearances.

Four main factors are taken into consideration in determining the overall risk level of a particular low span which are:

1. Land use - Purpose to which the land cover is committed.
2. Violation temperature – the percentage of required operating temperature when the span first starts to go below the required minimum clearances.
3. Violation amount – how far below the minimum clearances a particular span is at the required operating temperature of the line.
4. Violation area – the size of the land/ground that is exposed to conductors below their minimum clearances at the required operating temperature.

Based on the above, the suggested risk treatment for each risk level is outlined below.

Table 3 - Risk level

Risk Level	Risk Treatment
High	Low span must be remediated to remove clearance violation
Medium	Low span must be remediated to remove clearance violation
Low	Low span to be remediated if the cost of doing so was considered reasonable for the benefit gained
Very Low	Low span to be remediated if the cost of doing so was considered reasonable for the benefit gained.

The primary driver for this need is to ensure the public safety risks from low spans are reduced to as low as reasonably practicable.

TransGrid's Electricity Networks Safety Management System (ENSMS) is designed to be in compliance with the NSW and ACT regulatory instruments, more specifically NSW's Electricity Supply (Safety and Network Management) Regulation 2014 (NSW). The primary objectives to be addressed by the ENSMS are, as taken from the regulatory instruments:

(a) the safety of members of the public, and
(b) the safety of persons working on networks, and
(c) the protection of property (whether or not belonging to a network operator), and
(d) the management of safety risks arising from the protection of the environment (for example, preventing bush fires that may be ignited by network assets), and
(e) the management of safety risks arising from loss of electricity supply.

Appendix B identifies other regulatory instruments, standards and guidelines that state the need to protect the safety of members of the public.Lines with high utilisation run hotter, causing the conductor to sag lower. Low spans in these situations are likely to occur. The critical threat of this hazard occurs under the scenario in which people accessing our transmission line easements in areas where low spans exist, encroach safe approach distances resulting in flashover. This could be to a vehicle or plant (such as a harvester) or a person in extreme cases.

There has been a rapid expansion of renewable energy connections being connected to the TransGrid network. Connection points on the 132 kV network previously having relatively low loads now have significant generation being connected, increasing the utilisation of the associated transmission lines.

The list of 132 kV lines require low spans remediation is listed in Table 4.

Table 4 – 132 kV Lines with Low Span Issues

Line	From	To	Max Design Rating (MVA)	Max Design Temperature (°C)	Utilisation (MVA)	Conductor Temperature at utilisation (°C)	Utilisation (% of Line rating)
994	Wagga	Yanco	137	85	96	72	70%
94K	Wellington	Parkes	143	85	143	85	100%
94P	Molong	Manildra	155	85	153	85	99%
96R	Glen Innes	Tenterfield	122	85	107	78	88%
996	Wagga	ANM	137	85	119	77	87%
99H	Jindera	ANM	247	120	146	62	59%
9R1	Wagga	Uranquinty	572	120	543	100+	95%
9R3	Finley	Deniliquin	138	85	181	100+	131%
9U3	Gunnedah	Boggabri East	82	85	75	80	91%
9UH	Boggabri North	Narrabri	82	85	75	80	92%

Line	From	To	Max Design Rating (MVA)	Max Design Temperature (°C)	Utilisation (MVA)	Conductor Temperature at utilisation (°C)	Utilisation (% of Line rating)
9W3	Raleigh	Coffs Harbour	138	85	63	50	46%
96L	Lismore	Tenterfield	136	85	117	78	86%
97L	Guthega	Jindabyne Pumps	69	65	69	65	100%
949	Mt Piper 132	Orange North	143	85	103	65	72%
945	Molong	Wellington	120	85	134	100+	112%
X3	Balranald	Buronga	461	85	231	55	50%
X5	Darlington Point	Balranald	461	85	221	53	48%
973 9GL	Yass	Cowra (via Bango)	137	85	126	82	92%
97D	Williamsdale	Cooma	225	85	72	66	32%
94T	Molong	Orange North	114	85	114	85+	101%

2. Related needs/opportunities

- Need 1556 – Low Spans Stage 2
- Need N2609 – Main Grid Low Spans
- The following 132kV lines have low spans included as part of their refurbishment projects:
  - Need N2583 – Line 978 Refurbishment
  - Need N2480 – Line 976/1 Refurbishment
  - Need N2612 – Line 976/2 Refurbishment
  - Need N2613 – Line 976/3 Refurbishment
  - Need N2479 – Line 977/1 Refurbishment
  - Need N2580 – Line 94M Refurbishment
  - Need N2606 – Line 963 Refurbishment
  - Need N2574 – Line 968 Refurbishment

3. Options

In developing the options to address this need, TransGrid considered the followings:

- A Base case for this assessment as a ‘do nothing’ scenario, where the low spans are left unaddressed and no control measures are implemented.
- Option A which targets addressing low spans in accordance with TransGrid’s low span risk assessment methodology to the line design temperature.

- Option B, which targets addressing low spans in accordance with TransGrid's low span risk assessment methodology to the line design temperature but also includes lines with a high level connection interest or forecast load growth.
- Option B1, which targets addressing low spans in accordance with TransGrid's low span risk assessment methodology to the line design temperature but also includes lines with a high level connection interest or forecast load growth. This option excludes some lines based on previous low span works and current utilisation

3.1 Base case

The base case is to 'do nothing', that is not to remediate the low spans. The safety risk cost comes from the consequence of electric shock from exposure to a low span with a clearance breaching the standard requirements.

Leaving all these low spans unaddressed will leave TransGrid at the risk of not meeting its obligations under legislation and regulation to operate a safe electricity network. Public safety risk management would also not be as low as reasonably practicable.

For lines with high utilisation, the likelihood of low spans existing is credible, a do-nothing option is not acceptable as TransGrid will not be compliant with the obligations set out in its ENSMS.

3.2 Options evaluated

Option A — Remediate low spans in accordance with low span risk assessment methodology to the line design temperature [NOSA N2616, OFS N2616A]

Option A involved remediation of low spans of the 132kV network not previously actioned or have become a risk due to increased due to increased line utilisation. This methodology only remediated spans where the risk was considered "medium" or above. Remediation can include mid-span structure installation, "dummy strain" insulator arrangements or landscaping. Remediating the low risk spans would be disproportionate and not meeting ALARP. Some individual spans may only marginally breach clearances so could be made safe by restricting vehicle access (which reduces clearance requirements), or installing warning signage.

It is estimated that this option would cost $20.07 million ± 25% ($2021-22).

Detail of lines is listed in Appendix C.

Option B — Remediate low spans in accordance with low span risk assessment methodology to the line design temperature – Existing Load and forecast growth and lines with high connection interest [NOSA N2616, OFS N2616B]

Option B includes the low span remediation in Option A but also lines which have a high connection interest. Detail of lines is listed in Appendix C.

It is estimated that this option would cost $29.97 million ± 25% ($2021-22).

The lines in Option B have been prioritised based on the expected maximum utilisation, likelihood of generator connection and location of the low spans. Whilst the increased in throughput had caused potential low spans to again materialise (increase in utilisation from last remediation), it was assumed that the risk on these "new" low spans was low where the increase in utilisation was marginal.

Option B1 — Remediate low spans, on lines with high utilisation, per TransGrid's low span risk assessment methodology to the line design temperature [NOSA N2616, OFS N2616B]

The following lines in have been screened out in Option B1:

- Line 94P – Further detailed analysis of the line survey has determined any spans are low risk.
- Line 99H – There has been little change in utilisation since previous low spans works.
- Line 9R1 – Further detailed analysis of the line survey has determined any spans are low risk.
- Line 9W3 – Minimal change in utilisation. One low span at design temperature. Large scale renewables not expected to be connected along this route.
- Line X3 – Previous remediation of spans low at 70°C, so worst low spans have been addressed. Line is in remote area with lesser human movement. Additional capacity will be enabled with Project Energy Connect.
- Line X5 – Previous remediation of spans low at 70°C, so worst low spans have been addressed. Line is in remote area with lesser human movement. Additional capacity will be enabled with Project Energy Connect.
- Line 97D – Previous remediation of spans low at 70°C, so worst low spans have been addressed. No connections have been committed.
- Line 97L – Previous remediation on spans low at 50°C, 60°C is required. However the lower ambient temperatures in the alpine areas would allow additional 50°C capacity. The areas is remote with low human movement.

It is estimated that a modified Option B would cost $24.96 million ± 25% ($2021-22). Detail of lines is listed in Appendix C.

The breakdown of low spans for the lines listed in the revised scope is shown in Table 5.

Table 5 - Option B1 (Modified) Line and Low Span Quantity Breakdown

Line Number	Number of spans in scope for remediation	Number of low risk low spans (no remediation)	Total Project Cost ($m)	2024-2028 Regulatory Period	2029-2033 Regulatory Period
996	11	3	0.65	0.65	
97L	15	6	1.21		1.21
994	11	2	1.40		1.40
94K	9	3	0.84	0.84	
96R	39	2	3.39	3.39	
9R3	2	1	0.49	0.49	
9U3	14	1	2.37	2.37	
9UH	16	8	1.90	1.90	
96L	10	2	1.29		1.29
949	41	10	3.69		3.69
945	8	1	1.79		1.79
973 & 9GL	51	22	4.59	4.59	
94T	4	1	1.36		1.36
Total	**231**	**62**	**24.96**	**14.22**	**10.74**

Remediation can include mid-span structure installation, “dummy strain” insulator arrangements or landscaping. Low risk low spans can be managed with signage and other similar measures.

3.3 Options considered and not progressed

Table 6: Options considered and not progressed

Option	Reason for not progressing
Remediate all low spans on selected lines to the line design temperature.	This option would have remediated all low spans to maximum operating temperature regardless of the risk. This would not be an efficient use of capital and would be disproportionate to the risk and therefore not commercially feasible.
Derating lines to extent where low span risk is acceptable	Derating lines would an unacceptable impact on the market for the lines with high utilisation. Option B1 is essentially an informal derating option, whereby lines with lower utilisation (and therefore lower rating requirement) are screened out.

4. Evaluation

4.1 Commercial evaluation methodology

An economic assessment undertaken for this project is not performed as the result does not impact TransGrid's decision to execute this project as it is required to satisfy network safety regulatory obligations.

The relevant parameters used in this commercial evaluation:

Table 7 Scenario parameters

Parameter	Parameter Description	Value used for this evaluation
Discount year	Year that dollar values are discounted to	2021/2022
Base year	The year that dollar value outputs are expressed in real terms	2021/2022 dollars
Period of analysis	Number of years included in economic analysis with remaining capital value included as terminal value at the end of the analysis period.	25 years
Expected asset life	Period of depreciation of the asset	35 years
ALARP disproportionality (repex only)	Multiplier of the environmental and safety related risk cost included in NPV analysis to demonstrate implementation of obligation to reduce to ALARP.	Refer to section 4.3 for details.

The capex figures in this OER do not include any real cost escalation.

4.2 Commercial evaluation results

The commercial evaluation of the technically feasible options is set out in Table 8. Details appear in Appendix A.

Table 8 - Commercial evaluation (PV, $ million)

Option	Capital Cost PV	Central scenario NPV	Lower bound scenario NPV	Higher bound scenario NPV	Weighted NPV	Ranking
Option A	17.01	20.44	2.06	58.77	25.43	3
Option B	29.97	23.39	-1.49	74.60	29.97	2
Option B1	21.12	27.94	4.07	77.93	34.47	1

The individual line assessments are listed in Appendix C.

4.3 ALARP evaluation

TransGrid manages and mitigates bushfire and safety risk to ensure they are below risk tolerance levels or 'As Low As Reasonably Practicable' ('ALARP'), per the regulatory obligations and TransGrid's business risk appetite Under the Electricity Supply (Safety and Network Management) Regulation 2014 Section 5 'A network operator must take all reasonable steps to ensure that the design, construction, commissioning, operation and decommissioning of its network (or any part of its network) are safe.' TransGrid maintains an Electricity Network Safety Management System (ENSMS) to meet this obligation.[2]

Further, as part of the ENSMS, TransGrid as a network operator should comply with industry standard and best practice. Where TransGrid chooses not to comply the alternative provisions applied must provide an equal or greater safety benefit.

It should also be noted that AS 5577 requires that the option that provides safety risk reduction benefit should be progressed irrespective of cost, until an acceptable level of residual risk is achieved.

4.4 Preferred option

The preferred option is the Option B1. The lines selected for remediation in this option are of a higher likelihood to breach clearance requirements, which need to be addressed under TransGrid's obligations in its ENSMS to reduce safety related risks to ALARP and address the legacy non-compliant conductor clearance

Capital and Operating Expenditure

The required capital expenditure is $24.96 million ($2021-22) with $14.22 million to be delivered in 2024-2028 Regulatory Period and $10.74 million to be delivered in 2029-2033 Regulatory Period.

Regulatory Investment Test

The program and estimate allow for the appropriate regulatory approvals as required.

5. Optimal Timing

In consideration of the delivery requirements and the economic benefit NPV analysis for the need, its optimal timing is 2024/2025.

The optimal timing approach undertaken assists in identifying the optimal commissioning year for the preferred option, where net benefits including avoided risk costs and safety disproportionality tests of the

[2] TransGrid's ENSMS follows the International Organization for Standardization's ISO31000 risk management framework which requires following hierarchy of hazard mitigation approach

preferred option, exceed the annualised costs of the option. The optimal timing assessment considers the delivery requirements of the project and the estimated delivery timeline in the Option Feasibility Study (OFS).

The commencement year is determined based on the required project disbursement to meet the commissioning year based on the OFS.

The results of optimal timing analysis is:

- Optimal commissioning year: 2024/2025
- Commissioning year annual benefit: $4.09 million
- Annualised cost: $1.62million

Based on the optimal timing, the project is expected to commence in the 2024-2028 Regulatory Period.

6. Recommendation

A total of twenty 132 kV lines from TransGrid's entire fleet were identified as having low spans based on the design temperature. The remediation of low spans has been prioritised based on the utilisation of the lines, which indicates the likelihood of breaching the clearance requirement under credible contingency scenarios on the network.

The preferred option to address these low spans is Option B1. The lines selected (12 lines) for remediation in this option are of a higher likelihood to breach clearance requirements, which need to be addressed under TransGrid's obligations in tis ENSMS to reduce safety related risks to ALARP.

It is therefore recommended that this option be scoped in detail. Total project cost is $24.96 million ($2021-22) with $14.22 million will be delivered in 2024-2028 Regulatory Period and $10.74 million will be delivered in 2029-2033 Regulatory Period.

Appendix A – Option Summary

Project Description	132kV Low Span		
Option Description	Option A - Remediate low spans in accordance with low span risk assessment methodology to the line design temperature – Existing load and forecast growth		
Project Summary			
Option Rank	*3*	Investment Assessment Period	*25*
Asset Life	*35*	NPV Year	2022
Economic Evaluation			
NPV @ Central Benefit Scenario (PV, $m)	20.44	Annualised CAPEX @ Central Benefit Scenario ($m)	Annualised Capex - Standard (Business Case) 1.30
NPV @ Lower Bound Scenario (PV, $m)	2.06	Network Safety Risk Reduction ($m)	Network Safety Risk Reduction 3.10
NPV @ Higher Bound Scenario (PV, $m)	58.77	ALARP	ALARP Compliant? Yes
NPV Weighted (PV, $m)	25.43	Optimal Timing	Optimal timing (Business Case) 2025
Cost (Central Scenario)			
Total Capex ($m)	20.07	Cost Capex (PV,$m)	17.01
Terminal Value ($m)	5.74	Terminal Value (PV,$m)	1.21
Risk (Central Scenario)	**Pre**	**Post**	**Benefit**
Reliability (PV,$m)	Reliability Risk (Pre) 0.00	Reliability Risk (Post) 0.00	Pre – Post 0.00
Financial (PV,$m)	Financial Risk (Pre) 0.38	Financial Risk (Post) 0.16	Pre – Post 0.22
Operational/Compliance (PV,$m)	Operational Risk (Pre) 0.00	Operational Risk (Post) 0.00	Pre – Post 0.00
Safety (PV,$m)	Safety Risk (Pre) 62.35	Safety Risk (Post) 26.32	Pre – Post 36.03
Environmental (PV,$m)	Environmental Risk (Pre) 0.00	Environmental Risk (Post) 0.00	Pre – Post 0.00
Reputational ($m)	Reputational Risk (Pre) 0.00	Reputational Risk (Post) 0.00	Pre – Post 0.00
Total Risk (PV,$m)	Total Risk (Pre) 62.72	Total Risk (Post) 26.48	Pre – Post 36.24
OPEX Benefit (PV,$m)			OPEX Benefit 0.00
Other benefit (PV,$m)			Incremental Net Benefit 0.00
Total Benefit (PV,$m)			Business Case Total Benefit 36.24

Commissioning year annual benefit ($k): 3114.92

Project Description	132kV Low Span		
Option Description	Option B - Remediate low spans in accordance with low span risk assessment methodology to the line design temperature – Existing load and forecast growth and lines with high connection interest.		
Project Summary			
Option Rank	*2*	Investment Assessment Period	*25*
Asset Life	*35*	NPV Year	2022
Economic Evaluation			
NPV @ Central Benefit Scenario (PV, $m)	23.39	Annualised CAPEX @ Central Benefit Scenario ($m)	Annualised Capex - Standard (Business Case) 2.00
NPV @ Lower Bound Scenario (PV, $m)	-1.49	Network Safety Risk Reduction ($m)	Network Safety Risk Reduction 4.07
NPV @ Higher Bound Scenario (PV, $m)	74.60	ALARP	ALARP Compliant? Yes
NPV Weighted (PV, $m)	29.97	Optimal Timing	Optimal timing (Business Case) 2025
Cost (Central Scenario)			
Total Capex ($m)	30.76	Cost Capex (PV,$m)	26.06
Terminal Value ($m)	8.79	Terminal Value (PV,$m)	1.86
Risk (Central Scenario)	**Pre**	**Post**	**Benefit**
Reliability (PV,$m)	Reliability Risk (Pre) 0.00	Reliability Risk (Post) 0.00	Pre – Post 0.00
Financial (PV,$m)	Financial Risk (Pre) 0.38	Financial Risk (Post) 0.09	Pre – Post 0.29
Operational/Compliance (PV,$m)	Operational Risk (Pre) 0.00	Operational Risk (Post) 0.00	Pre – Post 0.00
Safety (PV,$m)	Safety Risk (Pre) 62.35	Safety Risk (Post) 15.04	Pre – Post 47.31
Environmental (PV,$m)	Environmental Risk (Pre) 0.00	Environmental Risk (Post) 0.00	Pre – Post 0.00
Reputational ($m)	Reputational Risk (Pre) 0.00	Reputational Risk (Post) 0.00	Pre – Post 0.00
Total Risk (PV,$m)	Total Risk (Pre) 62.72	Total Risk (Post) 15.13	Pre – Post 47.60
OPEX Benefit (PV,$m)			OPEX Benefit 0.00
Other benefit (PV,$m)			Incremental Net Benefit 0.00
Total Benefit (PV,$m)			Business Case Total Benefit 47.60

Commissioning year annual benefit ($k): **4090.77**

Project Description	132kV Low Span		
Option Description	Option B1 - Remediate low spans in accordance with low span risk assessment methodology to the line design temperature – Existing load and forecast growth and lines with high connection interest		
Project Summary			
Option Rank	*1*	Investment Assessment Period	*25*
Asset Life	*35*	NPV Year	2022
Economic Evaluation			
NPV @ Central Benefit Scenario (PV, $m)	27.94	Annualised CAPEX @ Central Benefit Scenario ($m)	Annualised Capex - Standard (Business Case) 1.62
NPV @ Lower Bound Scenario (PV, $m)	4.07	Network Safety Risk Reduction ($m)	Network Safety Risk Reduction 4.06
NPV @ Higher Bound Scenario (PV, $m)	77.93	ALARP	ALARP Compliant? Yes
NPV Weighted (PV, $m)	34.47	Optimal Timing	Optimal timing (Business Case) 2025
Cost (Central Scenario)			
Total Capex ($m)	24.96	Cost Capex (PV,$m)	21.12
Terminal Value ($m)	7.13	Terminal Value (PV,$m)	1.51
Risk (Central Scenario)	**Pre**	**Post**	**Benefit**
Reliability (PV,$m)	Reliability Risk (Pre) 0.00	Reliability Risk (Post) 0.00	Pre – Post 0.00
Financial (PV,$m)	Financial Risk (Pre) 0.38	Financial Risk (Post) 0.09	Pre – Post 0.29
Operational/Compliance (PV,$m)	Operational Risk (Pre) 0.00	Operational Risk (Post) 0.00	Pre – Post 0.00
Safety (PV,$m)	Safety Risk (Pre) 62.35	Safety Risk (Post) 15.08	Pre – Post 47.27
Environmental (PV,$m)	Environmental Risk (Pre) 0.00	Environmental Risk (Post) 0.00	Pre – Post 0.00
Reputational ($m)	Reputational Risk (Pre) 0.00	Reputational Risk (Post) 0.00	Pre – Post 0.00
Total Risk (PV,$m)	Total Risk (Pre) 62.72	Total Risk (Post) 15.17	Pre – Post 47.55
OPEX Benefit (PV,$m)			OPEX Benefit 0.00
Other benefit (PV,$m)			Incremental Net Benefit 0.00
Total Benefit (PV,$m)			Business Case Total Benefit 47.55

Commissioning year annual benefit ($k): **4086.71**

Appendix B Regulatory Compliance Requirements

Identified need	*Common sources of identified needs*
Regulatory compliance examples (non-exhaustive)	**Network safety** - Obligation for network operators to ensure safety of transmission systems under: **Electricity Supply (Safety and Network Management) Regulation 2014 (NSW)** > Section 5: 'A network operator must take all reasonable steps to ensure that the design, construction, commissioning, operation and decommissioning of its network (or any part of its network) is safe.' **Utilities (Technical Regulation) (Electricity Transmission Supply Code) Approval 2016 (No 1) (ACT)** > 2.2 (3): Ensure the safe management of the electricity transmission network to avoid injury to any person or damage to property and the environment. > Section 5.1: An electricity transmission utility must have an electricity network safety management system consistent with the principles and requirements set out in AS 5577 Electricity Network Safety Management Systems. (2) These principles and requirements are summarised as, but are not limited to: (a) the protection of the electricity transmission network; (b) the safety of persons working on or near the electricity transmission network; (c) the safety of the public and the protection of any property near the electricity transmission network; > Section 5.2 (2): Planning and design considerations by the electricity transmission utility must include but are not limited to: (a) issues such as safety of persons; **Australian Standard AS5577-2013: Electricity Network Safety Management Systems** > Section 4.3.4.2 Industry/company codes If the Network Operator chooses not to comply with particular provisions of an industry or company code the Network Operator shall document – (i) The reason for the non-compliance with the code; and (ii) The alternative provisions for the design, construction, commissioning, operating, maintenance and decommissioning of the network assets that will ensure a level of safety in relation to those activities that is at least equal to or greater than the level of safety that would ensue from compliance with that code. > A3.1 Risk Identification:

	The Formal Safety Assessment shall identify electricity network hazards that could cause an electricity related incident and, as a minimum, consider – … (g) intentional and unintentional human activities. **Australian Standard AS7000-2013: Overhead Line Design** > Section 3: Electrical requirements Overhead lines shall be designed with electrical clearances from the energized conductor to surrounding objects to provide safe and reliable operation. These objects can be other energized conductors, structures, constructions, plant, vehicles or vessels (watercraft).

Appendix C – Low Span Remediation summary

Option	Transmission Line	Total Cost ($m)	Utilisation	Included in Option B1 Scope	Comments
A	TL 994	1.40	70%	2029-2033 Regulatory Period	Previously remediated to 67°C (spans low at 67°C remediated to 85°C). Renewable connections at Griffith has increased the required line temperature, now at 72°C. This line also has a high connection interest, so this required temperature is expected to increase
A	TL 94K	0.84	100%	2024-2028 Regulatory Period	No low span remediation has previously been completed on this line. Connection of Suntop, Parkes and Goonumbla solar farms nearby have impacted on this line's utilisation. This line has 100% N-1 utilisation.
A	TL 94P	No Remediation required			
A	TL 96R	3.39	88%	2024-2028 Regulatory Period	Previously remediated to 64°C (spans low at 64°C remediated to 85°C). With the increase of renewables has resulted in the N-1 utilisation increasing to 99%.
A	TL 996	0.65	87%	2024-2028 Regulatory Period	Previously remediated to 67°C (spans low at 67°C remediated to 85°C). This line has 87% N-1 utilisation, corresponding to approx. 77°C.
A	TL 99H	0.74	59%	N	Previously remediated to 64°C (spans low at 64°C remediated to 85°C). Whilst the utilisation has remained mostly unchanged at 59% this remaining capacity could be filled in a short timeframe should a generator want to connect.
A	TL 9R1	No Remediation required			
A	TL 9R3	0.49	131%	2024-2028 Regulatory Period	Previously remediated to 70°C (spans low at 70°C remediated to 85°C). Due to the rapid expansion of renewables, N-1 utilisation of this line is now 131%.
A	TL 9U3	2.37	91%	2024-2028 Regulatory Period	Low span work previously completed, but only to 56°C (spans low at 70°C remediated to 85°C). Since then N-1 utilisation has increased to 91% (about 80°C).
A	TL 9UH	1.90	92%	2024-2028 Regulatory Period	Low span work previously completed, but only to 56°C (spans low at 70°C remediated to 85°C). Since then N-1 utilisation has increased to 92% (about 80°C).
A	TL 9W3	0.31	46%	N	Was previously assessed to 63°C. There has been little change in utilisation since those works. There is one low span at design temperature.
A	TL 96L/1	1.29	86%	2029-2033 Regulatory Period	Low span work previously completed, but only to 60°C (spans low at 60°C remediated to 85°C). N-1 utilisation is now 86%, which corresponds to approx. 78°C.
A	TL 97L	1.21	100%	2029-2033 Regulatory period	Low span work previously completed, but only on spans low at 50°C. Line did not have a rating specified at that time. When the pumps are operating the line is running at 100% capacity. The line has been specified with a 60°C design temperature.

A	TL 949	3.69	72%	2029-2033 Regulatory Period	Low span work previously completed, but only to 60°C (spans low at 60°C remediated to 85°C). N-1 utilisation is now 72% corresponding to approximately 65°C. There are plans to increase the capacity of the network west of Orange. This would result in higher utilisation.
A	TL 945	1.79	112%	2029-2033 Regulatory Period	No previous low span works have been conducted on this line. N-1 utilisation is 112%.
B	TLX3	3.39	50%	N	Previously remediated to 70°C (spans low at 70°C remediated to 85°C). Since then three Solar Farms have been connected to Balranald, Silverton Windfarm and Broken Hill Solar farm connected to broken Hill.
B	TLX5	0.55	48%	N	Previously remediated to 70°C (spans low at 70°C remediated to 85°C). Since then three Solar Farms have been connected to Balranald, Silverton Windfarm and Broken Hill Solar farm connected to broken Hill.
B	TL973	3.19	92%	2024-2028 Regulatory Period	Previously remediated to 78°C (spans low at 78°C remediated to 85°C). Since those works Bango Windfarm (244 MW) has been commissioned. This area has significant connection interest. Structures 429 and 432 need to be replaced due to operational issues.
B	TL9GL	1.40			
B	TL97D	0.80	32%	N	Previously remediated to 70°C (spans low at 70°C remediated to 85°C). There has been no change in utilisation, however, there has significant connection interest.
B	TL94T	1.36	101%	2029-2033 Regulatory Period	Previously remediated to 64°C (spans low at 64°C remediated to 85°C). Line now has 101% N-1 utilisation. Overlap with Need-2162 – Increase capacity for generation in Molong to Parkes area