Xatech International Ptd Ltd
ABN 14 065 203 581

12th August 2024

ElectraNet Pty Ltd
52-55 East Terrace
Adelaide South Australia 5000

Attention: consultation@electranet.com.au

Dear Sir

Re: Managing the Risk of Hummock to Ardrossan West 132kV Line Failure
Project Specification Consultation Report Dated 19 July 2024
Epsilon HVCRC® Conductors

We refer to the Managing the Risk of Hummock to Ardrossan West 132kV Line Failure Project Specification Consultation Report dated 19 July 2024 detailing the credible option for the replacement of the Hummocks to Ardrossan West 132 kV transmission line in its entirety and to decommission the existing line by 2028. As indicated in the report we note that ElectraNet welcomes written submissions on the contents of the report, and we are pleased to submit the attached proposal based on the supply of Epsilon Cable HVCRC® High Voltage Conductors.

As highlighted in the proposal there are a range of benefits available to ElectraNet through the installation of HVCRC® Conductors including an immediate benefit of reduced line losses/ increased income, excellent corrosion resistance, flexibility in accommodating a wide array of power demand, future proofing through increased amperage without the need for addition transmission line construction including an opportunity to accommodate future renewable energy generating opportunities located within the region with only minimum infrastructure costs.

We trust the attached proposal is of interest and we would be pleased to provide any additional information that ElectraNet may require to assess the potential of this proposal for the project. In addition, we would be pleased to arrange an online technical meeting with the Epsilon Product Specialists based in France with your project team. We look forward to this opportunity to be of assistance to ElectraNet for this and future HV Transmission projects.

Kind regards
Xatech International Pty Ltd

David Knight

D.G.Knight

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PROJECT SPECIIFCATION CONSULTATION REPORT
MANAGING THE RISK OF HUMMOCK TO ARDROSSAN WEST 123 kV LINE FAILURE
PROPOSAL FOR NEXT TECHNOLOGY HTLS CONDUCTORS

Introduction

We refer to the ElectraNet document Managing the Risk of Hummock to Ardrossan West 132kV Line Failure Project Specification Consultation Report dated 19 July 2024 and the request contained therein for comments on proposed recommended solution. It is noted that the transmission line was commissioned in 1973 and the existing conductors are in poor condition and require replacement for both public safety and continuity of supply reasons.

The purpose of this submission is to present an option for the selection of latest technology advance conductors as the conductor of choice for the transmission line replacement project. Advanced conductors manufactured by Epsilon Cable and our partners under the brand name HVCRC® provide a range of operational and economic benefits to ElectraNet including future proofing to accommodate increased power demand and connection of renewable energy generation, improved corrosion resistance and grid resilience and reduced line losses when compared to equivalent ACSR/GZ Conductors.

Epsilon Cable are at the forefront of the development of advanced technology composite core high voltage conductors. This proven technology has been at the forefront of grid modernisation for the past two decades with more than 4,000 klms of Epsilon composite core conductors installed worldwide with a further 3,000 klms committed and currently in production. Epsilon Composite, the parent company, have in excess of 35 years' experience in carbon composite development and manufacture and were the pioneer in carbon fibre pultrusion, the core technology for the manufacture of the composite cores high voltage conductors.

Composite Core Conductors

Epsilon HVCRC® composite core conductors are classified as a Type 4 Conductor (CIGRE Technical Brochure 695) and consists of polymer matrix composite core with an annealed aluminium 1350 envelope. The properties of the composite core manufactured by Epsilon provides the inherent strength for the core to bear all the mechanical load of the conductor thus allowing the use of higher conductivity soft annealed aluminium in a compact trapezoidal configuration for the conductive layer. The results are a conductor that posses significantly improved properties including high temperature capability, low sag characteristics, low electrical resistance of the conductive layer, excellent corrosion resistance and low density.

The characteristics of composite core conductors provide many opportunities for upgrading of existing transmission networks providing increased capacities, greater operating flexibility and improved grid resilience during adverse weather conditions. With the doubling ampacity/weight ratio of the HVCRC® conductors, increased capacity is available within the same basic right of way corridor enabling the upgrading of existing transmission lines either by reconductoring where the existing towers do not require replacement or by the construction of a replacement transmission line within the existing ROW as proposed for this project.

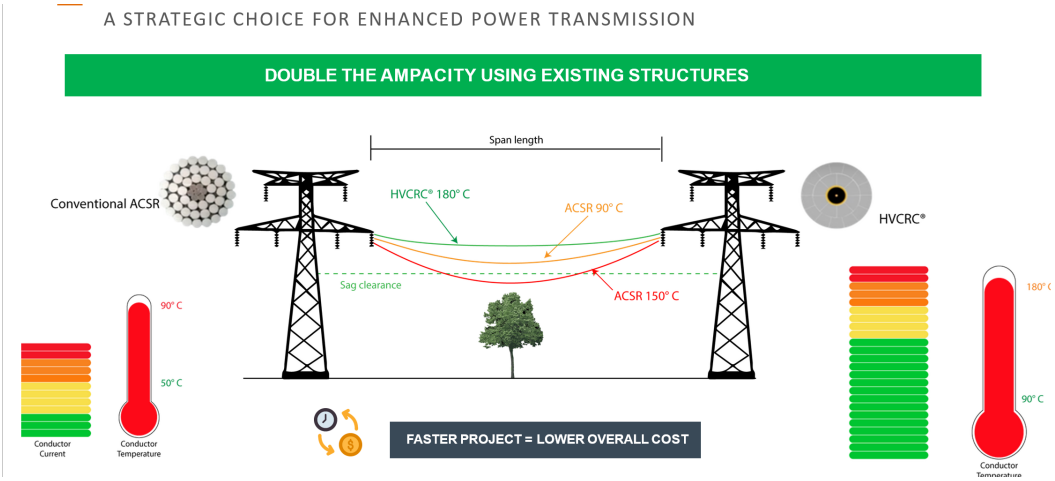
Advanced conductors have been deployed throughout the world including South-East Asia, Europe, USA, Middle East and Scandinavia and operate successfully under different environment conditions experienced in those locations. In high load locations the 30% extra strength of the composite core allows higher stringing tension to be used and for extra length spans such as river crossings etc specific conductor designs with high strength composite cores are available.

A recent project was completed in Montenengro where HVCRC® Conductors were installed on a 35 klm 110 kV Transmission Line. This reconductoring project resulted in 30% more energy being supplied to the end distribution system providing increased revenue to the system operator.

Advantages of HVCRC® Conductors

A significant factor in the design of Epsilon HVCRC® Conductors is the approximate doubling of ampacity with less line sag when compared to an equivalent ACSR Conductor. Where a TACSR Conductor is selected, operating at a maximum temperature of 150^{0}C, the equivalent HVCRC® conductor will still provide an additional 15% amperage with 20% less line sag.

The ability for the HVCRC® Conductor to accommodate increases in amperage provides a buffer to accommodate surges in renewable energy generation and/or provides spare capacity for the connection of additional renewable energy generation sources.



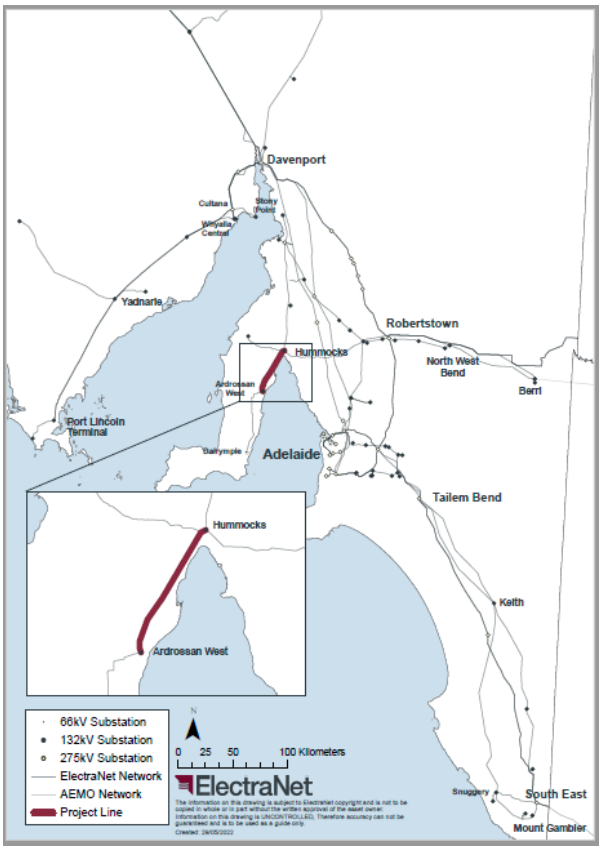
When operating at the same ampacity Epsilon HVCRC® Conductors will reduce line losses by up to 30% resulting in greater operating efficiencies and increased revenue for the operating utility. The reduction of line losses is due to several combined factors including compact trapezoidal shaped design

of the aluminium wires, enhanced conductivity resulting from the annealing process of the aluminium and the lower weight of the composite core allowing additional aluminium material for the same overall conductor weight.

In practical terms this means that using the Epsilon HVCRC® Conductors for either new or reconductoring transmission lines, provides the **necessary surge capacity** when renewable power generation and/or demand is high and **reduced energy losses** when demand is within design limits. A double benefit for the identified need.

F1803 Hummocks – Ardrossan West 132kV Transmission Line

It is noted that the Hummocks - Ardrossan West 132 kV line is located in the northern section of Yorke Peninsula adjacent to the St Vincent Gulf coastline.



As indicated in the PCSR the primary role of the transmission line is to provide power to the lower Yorke Peninsula and to enable the Dalrymple BESS and Wattle Point Windfarm to participate in the NEM (National Electricity Market). It is noted that Yorke Peninsula may also host addition renewable energy generation projects such as the Yorke Peninsula Energy Hub (previously Ceres Wind Farm) and future demand requirements such as the proposed Hillside Project Copper Mine.

Replacement Transmission Line Design Considerations.

It is noted that the current preferred conductors utilised by ElectraNet are typically ACSR specification. It is acknowledged that the use of ACSR technology was/is a cost-effective solution for transmission systems with a fixed design capacity, however with the increased introduction of variable renewable generation such as wind and solar PV has highlighted the limitations of this technology.

These limitations include:

- Lack of flexibility to accommodate surges in renewable generation without damage
- High transmission losses
- Corrosion issues with steel core, and
- Potential line failure through thermal expansion/ increased line sag at high conductor temperatures caused by surges in renewable power generation

In preparing this submission the following design considerations have been considered.

Corrosion

The transmission line route is predominantly located in a C4 corrosion zone. The definition of a C4 zone is Calm Seashore that can extend up to 1 klm inland subject to prevailing winds and local conditions. C4 zones have a high corrosivity rating with a steel corrosion rate of 50 – 80 Microns/year. The steel core of the ACSR/GZ Conductor will be subject to this corrosion rate with due allowance required to be included for the expected life of the conductor.

The composite core of the HVCRC® conductor is **not subject to corrosion** and therefore the effective life of the conductor will exceed that of an equivalent ACSR/GZ Conductor.

Weather Conditions.

Whilst wind speeds are generally mild (wind force 4 – 5 – Beaufort Scale) the highest wind speed recorded at Ardrossan was 101.9 km/h (wind force 10) on 24 January 2019. High wind conditions affect the performance of conductors particularly on days with medium to high temperatures. The principal concern under these conditions includes arcing caused be clashing of conductors and/or conductors coming into contact with vegetation.

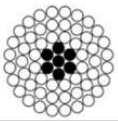
Clashing of conductors can occur as a result in increased line sag caused by elongation of the steel core because of high wind loads and increased operating temperatures.

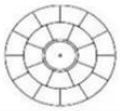
Epsilon recently undertook a comparison assessment between TACSR/AW Hawk (ø21.8mm) and HVCRC® Hawk (ø21.8mm) of the effects of wind load on line sag and ampacity versus temperature.

The parameters used in the comparison assessment:

- Ruling span 300m
- 30^0C temperature of line set-up

- Both conductors strung at same tension of 20%RTS of TACSR Hawk = 17.34 kN
- Wind speed 150 klm/hr equates to a category three Cyclone.





		TACSR/AW HAWK (Ø21.8mm)		HVCRC HAWK (Ø21.8mm)			
Status?	Temp (°C)	Sag (m)	Ampacity (A)	Sag (m)	Ampacity (A)	Sag enhancement at high temp(%)	Amp enhancement at high temp(%)
At installation	30	6,2	/	6,04	/		
After wind load **Wind speed : 41,6701 m/s (150 Km/hr)**	15	6,09	/	7,67	/		
	30	6,65	/	7,69	/		
	45	7,2	292	7,72	340		
	60	7,74	494	7,74	575		
	75	8,25	627	7,76	728	-6%	+16%
	90	8,75	732	7,79	847	-11%	+16%
	120	9,51	894	7,83	1032	-18%	+15%
	160	10,15	1062	7,9	1220	-22%	+15%
	180	/	/	7,93	1300		

Calculations based on 30°C ambient temperature, 0.61 m/sec wind transverse to conductor, Clear atmosphere, 0.5/0.6 coefficients of emissivity and absorption, solar radiation 1000W/m2

Whilst it is acknowledged that wind speeds in the Yorke Peninsula area do not reach the level of the comparison undertaken, the above chart demonstrates the resilience of the Epsilon HVCRC® conductors under high wind loads. As indicated in the above chart the comparison also highlights the lack of thermal elongation of the composite core versus steel reinforced conductors.

Line Sag

Apart from the factors above the selection of a suitable conductor is also dependent on the design parameters for acceptable line sag under varying operating conditions. The factors that are considered when assessing line sag include maximum conductor operating temperature, transmission tower design, span lengths and stringing tensions.,

For ACSR/GZ conductors line sag will increase with operating temperature due to the thermal properties of the steel core. Whilst operating temperatures remain within design limits line sag is manageable, however should operating temperature exceed design limits, which can occur with surges in renewable power generation, then the issue of line sag exceeding design limits becomes an issue.

It is noted that once an ACSR/GZ conductor exceeds design operating temperatures the steel core does not contract fully when the temperature reduces (creeping due to plasticity of metals) resulting in a permanent incremental increase in line sag. This increased line sag can contribute to potential line outages during adverse whether events, which we note are becoming more common, and under certain conditions initiate bushfires with resultant damage to infrastructure and private property exposing transmission line operators to potential claims for damages.

As the composite core of the Epsilon HVCRC® Conductors does not expand under thermal load, line sag always remains within design limits. In addition, the inherent strength of the composite core also allows stringing tensions to be increased by up to 50% further reducing line sag conditions. Alternatively, the reduced sag characteristics enables increased span widths reducing the number of transmission towers required which can be ~10% of the total requirement of a typical installation based on ACSR conductors.

Transmission Tower Design

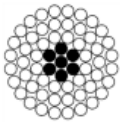
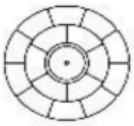
Dependent on the selection of conductor the HVCRC® Conductor are designed to accept 50% more tension than the equivalent ACSR Conductors. By utilising this attribute in the design of the transmission line and associated transmission towers, opportunities exist to provide flexibility in design including reduce line sag, increase the span between towers or decreasing the height and width of the towers or a combination of all three. It is estimated that by increasing stringing tension a saving of between 10 – 15% on the cost of construction of transmission towers can be achieved.

Where the option is taken to utilise the low sag capabilities of the HVCRC® Conductor to reduce the number or size of the transmission towers then apart from construction cost reductions other benefits include reduced right of way requirements and less visual impact, an important consideration in the current environment for acceptance of new transmission line capacity.

Conductor Selection

The following is a conductor selection based on an equivalent to the existing conductor which is noted as Wolf ACSR/GZ 30/7/107. The actual selection of the appropriate HVCRC® conductor would depend on ElectraNet's design specifications with regards to tower design and conductor performance.

ElectraNet - Replacement Hummock to Ardrossan West 132 kV Transmission Line

		WOLF ACSR/GZ 30/7/107	HVCRC® GDANSK 250-28	Diff (%)
Dimensional/ mechanical specs	Schematics	 Al: 30/Ø2.50 St: 7/Ø2.50	 Ø5.97 core 6+10 TW	
	Ø conductor (mm)	18,13	19,21	+6%
	Linear mass (kg/km)	726	735,8	+1%
	Aluminium section (mm²)	158,1	247,5	+57%
	Rated Stregnth (kN)	69,2	74,7	+8%
Electrical specs - capacity	Max Operating Temp (°C)	90	180	+100%
	Comparative Ampacity at 90°C*	556	709	+28%
	Max ampacity at max temp*		1077	+94%
Electrical specs - losses reduction	DC resistance at 20°C (ohm/km)	0,1788	0,1131	-37%
	AC resistance @ 90°C (ohm/km)	0,2295	0,1459	-36%
	Mean ampacity	500A (hypothesis ~90% ACSR load)		
	T° conductor @ 500A	78,7	61,7	
	AC resistance @ T°	0,2214	0,1329	
	Losses per year (kWh/km)*	484866	291051	
	Yearly savings (kWh/km)	/	193815	
Financials - rapid ROI*	Yearly savings (AU$/km)*	/	38763	
	Price difference gap (AU$/km)	/	10000	
	ROI (Return of Investment, years)	/	0,3	
Financials - long term benefits	Yearly savings, example for single circuit 100km project (MAU$)	/	11,63	
	Estimated savings for a 40years lifetime after ROI achieved (MAU$)	/	462,2	

Notes:

1. Ampacity calculated based on IEEE Standard 738-2023 with following parameters: 30^0C ambient temperature, 0.61m/sec wind transverse to conductor, clear atmosphere, 0.5 coefficients of emissivity and absorption, solar radiation 1000W/m^2, 50 Hz
2. Losses per year calculation based on CIGRE Technical Brochure TB265
3. Yearly Ampacity savings based on generation cost at 0.2AU$/kWh
4. Price difference estimated cost difference between alternative conductors.

As indicated the carrying capacity of the HVCRC® Gdansk Conductor at maximum operating temperature is basically double that of the existing Wolf conductor whilst remaining with line sag design limits. When operating at an equivalent operating temperature the HVCRC® Gdansk Conductor reduces line losses by greater than 30% resulting in increased operating efficiencies and increased revenue for ElectraNet. Based on this improved efficiency and assuming operating at maximum capacity of the Wolf specification the estimated period for the recovery of increased cost of the HVCRC® conductor is less than 1 year. After recovery of the additional cost of the conductor long term ongoing efficiency savings will be to the benefit of ElectraNet.

Company and Product Details

Epsilon Cable

Epsilon Cable is a division of Epsilon Composite, a world recognised company that focusses on the development and manufacture of Carbon Composite products. Epsilon Composite was established in 1987 and is headquartered in Gaillan Medoc France. The company turnover across all divisions is Forty Five Million Euro (€45 Million). We advise that Xatech International Pty Ltd are the appointed representative in Australia.

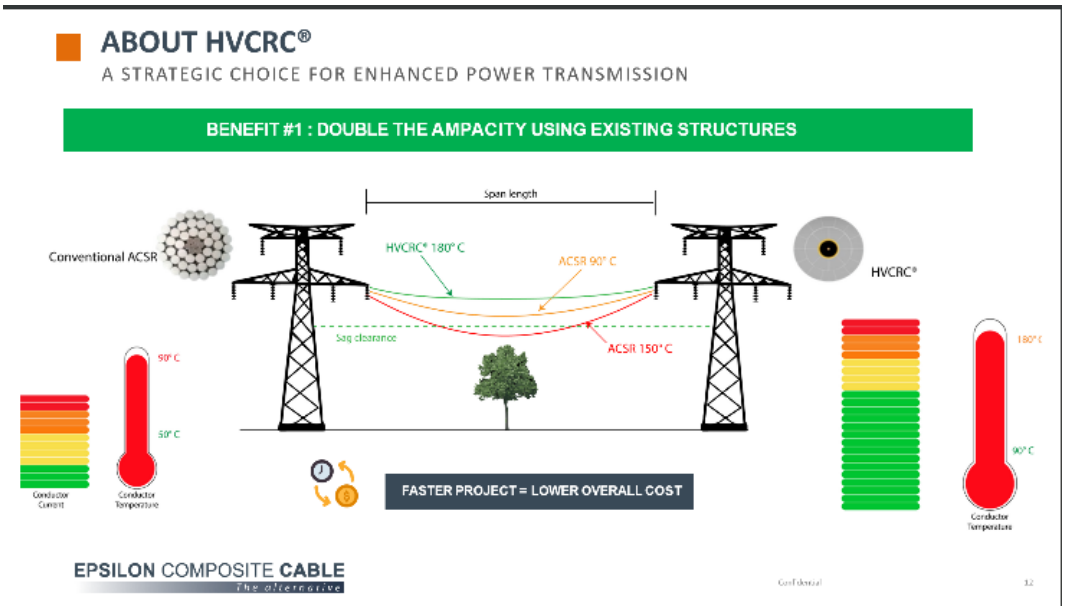
Epsilon Composite is a pioneer in carbon fibre pultrusion with more than 80% of production exported worldwide. The company continues to undertake extensive research and development financed by 10% of turnover with more than 100 patents secured. This excellence in R&D, Manufacture and Quality Control Systems is internationally recognised with Epsilon Composite being selected to participate in the technical committee's currently reviewing and upgrading of ASTM B987 and developing new international standards for the manufacture and installation of High Voltage Composite Core Conductors.

The Epsilon HVCRC® Conductor is at the forefront for the modernisation of high voltage transmission lines worldwide achieving savings in carbon emissions necessary to achieve nett zero by 2050 in accordance with SDG 7 (affordable and clean energy) and SDG 9 (industry, innovation and infrastructure). We advise in excess of 4,000 klms of Epsilon composite core conductors have been installed worldwide with a further 3,000 klms committed and currently in production.

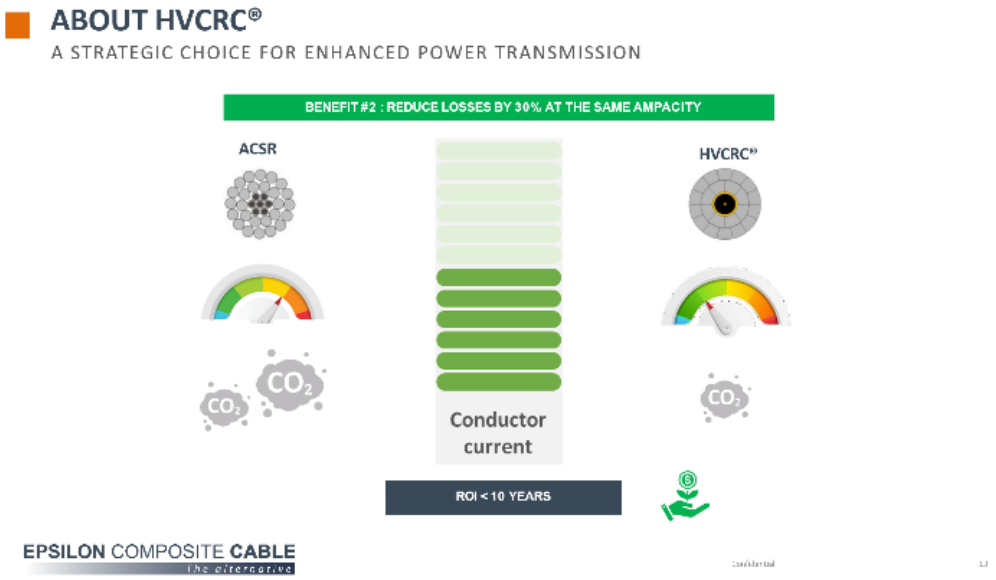
HVCRC® Technology

Epsilon HVCRC® Conductors are a complete range of high capacity/ high temperature low sag HV conductors manufactured with a strong lightweight composite core and trapezoidal aluminium wires, designed to improve line ampacity, reduce sag and to reduce electrical losses on transmission lines.

The advantages of the High Temperature/Low Sag HVCRC® conductors when compared to traditional conductors include;



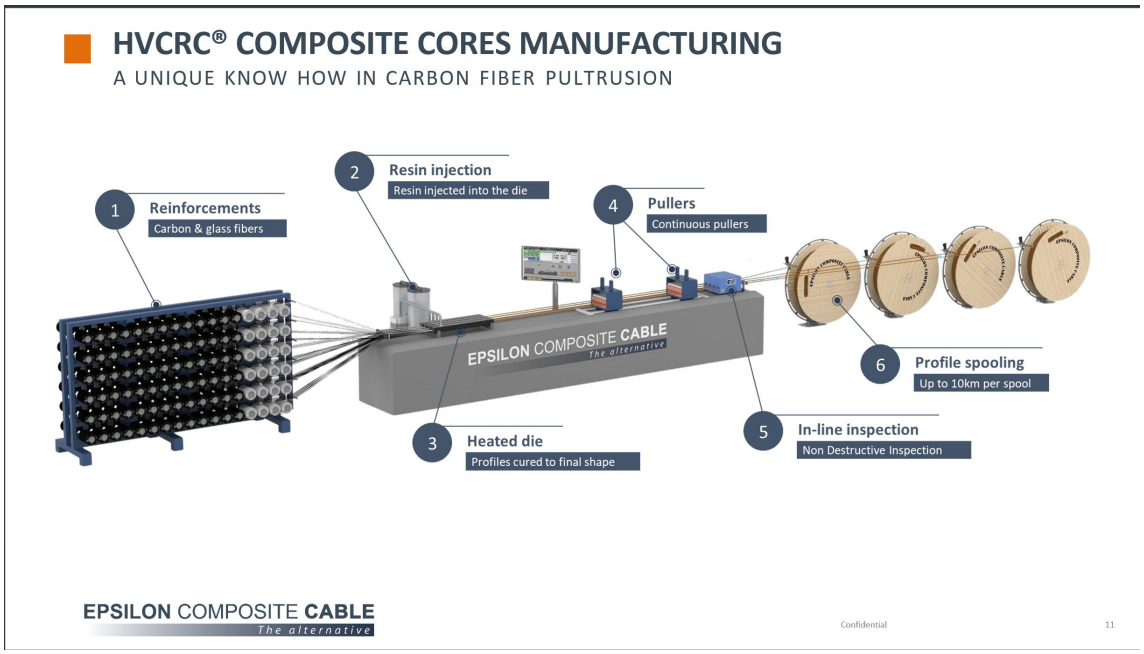
or,



HVCRC® conductors electrical conductivity is ensured by trapezoidal strands made of highly conductive 1350-0 annealed aluminium. The composite core is manufactured by Epsilon at their facility in France with stranding of the conductors undertaken by selected manufacturing partners each of which has been assessed through a strict qualification process demonstrated by their quality and manufacturing performance.

Epsilon Composite Cable manufactures the **HVCRC®** composite cores in pultrusion using Aerospace grade carbon fibres and specific resins to ensure the highest performance and durability.

Each composite core includes a microcore and an electrically insulated glass fibre layer to increase the core performance and flexibility and to also protect the aluminium strands from galvanic corrosion.



All **HVCRC®** cores are qualified according to **ASTM B987-20**. **ASTM B987** is currently the only existing standard for Carbon Composite Cores used in High Tension Low Sag Conductors. Qualification against this standard guarantees the performance and durability of the composite core to withstand extreme environmental conditions during design life.

HVCRC® conductors are designed to be installed using conventional compression tools and accessories. This reduces installation costs and complexity together with reduced training costs for installation crews.

Epsilon have extensive experience in ensuring the quality of the composite cores manufactured. The implemented Quality Assurance system includes tight control of all process parameters including assessment of raw materials, physical-chemical testing (Tg/ DMA, DSC, microscopic observations etc) and mechanical testing (tensile/compression tests, bending, fatigue, ILSS) on composite materials and metals.

The company maintains a laboratory fitted with the latest technology and staffed by trained personnel. This facility enables **Epsilon** to test the performance of the materials developed by the company and to verify the consistency of predictive simulations through real tests. These tests simulate ageing or environmental aggressions such as UV, high temperatures, humidity, aggressive and contaminant fluids.

Type testing is undertaken to **ASTM B987** with certification provided on different core sizes for both **HVCRC®** and **HVCRC®ULS** (Extra High Strength Grade).

Training and Support

Epsilon provide a full suite of support to Transmission Authorities including assistance in the onsite training of local installation contractors and the provision of training videos.

Technical assistance provided by the company includes engagement with client design teams for the selection of the relevant conductor to meet the specified requirements of a electrical transmission project. The company uses industry standard design software **(PLS CADD)** to ensure best performance on the project including sag, maximum ampacity, conductor temperature and catenary parameters etc.

Net Zero

Epsilon as a company, has strong credentials in achieving nett zero emission for its manufacturing and supply chain activities. The company actions 10 main sustainable development goals as defined by the United Nations and has implemented procedures and reporting based on ISO Standards to achieve internal targets.

Epsilon's carbon footprint is regularly assessed, taking into account direct and indirect emissions of their manufacturing process. These assessments cover all aspects of their supply chain and incorporate a rigorous and respectful waste and recycling system with a target of 90% for repurposing waste by 2030.

As a result of policies and actions implemented by Epsilon, scope three emissions incurred by ElectraNet through the supply of HVCRC® Conductors will either be comparable or significantly less than conductors sourced from other manufacturers. In addition, in comparison to ACSR Conductors on a like for like basis, transmission line losses will be up to 30% lower with the use of HVCRC® Conductors further reducing emissions that impact on ElectraNet annual emission reporting.

Summary

The construction of new transmission line as a replacement of the Hummocks - Ardrossan West 132 kV line with Epsilon HVCRC® Conductors provides ElectraNet with a range of benefits including the immediate benefit of reduced line losses/ increased income, flexibility in accommodating a wide array of power loads, future proofing through increased amperage without the need for addition transmission line construction and an opportunity to accommodate future renewable energy generating opportunities located within the region with minimum infrastructure costs.

It is acknowledged that the selection of the Epsilon HVCRC® Conductor would be the first installation in South Australia and therefore apart from concerns on the suitability and performance of the conductors under Australian conditions, technical assistance would be required to develop appropriate design and construction solutions. Epsilon technical personnel would be made available to assist in the development of these solutions for the Hummock – Ardrossan West Transmission replacement and other transmission projects planned by ElectraNet. Epsilon uses standard design software (PLS CADD) to assist in the design of projects to achieve best performance including sag limits, maximum ampacity, conductor temperature and catenary parameters etc.

Apart from design assistance Epsilon will also provide technical and supervisory assistance during installation of the conductors. Epsilon preferred partners for conductor accessories (Sicame Group) and stringing equipment (Tesmec) are also present in Australia to support the installation of the conductors.

We confirm that Epsilon and our partners have the experience and expertise to support ElectraNet in undertaking this project including the supply of the HVCRC® conductors in accordance with an agreed delivery schedule, provision of quality assurance during all aspects of the manufacturing process and support to ElectraNet selected installation contractor through training and provision of an expert installer to assist during the installation process.

We trust that this proposal is of interest and we confirm that Xatech/Epsilon are committed to provide the resources and expertise to ensure the installation of HVCRC® Conductors is a long-term success for ElectraNet.