

Equipment Technical Specification

Composite crossarms

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Equipment Technical Specification

ASSET STANDARDS & DESIGN

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ETS 0107 COMPOSITE CROSSARMS

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1.0 PURPOSE

To specify the requirements for composite crossarms for use on Endeavour Energy's electrical network.

2.0 SCOPE

This specification covers the design, engineering, manufacture, testing, supply and delivery of composite crossarms installed as part of Endeavour Energy's electrical networks.

3.0 REFERENCES

Internal

Company Policy (Network) 9.2.5 – Network Asset Design
Company Policy (Network) 9.7.1 – Network Asset Construction
Annexure 1 – Specified items
Annexure 2 – Additional/Supplementary Drawings
Annexure 3 – Bolted connection test

External

AS 1824.1 – Insulation co-ordination – Definitions, Principles and rules AS/NZS 2947.1 – Insulators – Porcelain and glass for overhead power lines – Voltages greater than 1000 Vac, Part 1: Test methods – insulator units
AS 4435.1 – Insulators – Composite for overhead power lines – Voltages greater than 1000 Vac – Definitions, test methods and acceptance criteria for string insulator units
AS 5577 – 2013 – Electricity network safety management systems
AS/NZS 7000:2016 – Overhead Line Design Standard
AS/NZS ISO 9001 – Quality Management Systems – Requirements
AS/NZS ISO 14001 – Environmental Management Systems – Requirements with guidance for use
ASTM D2303 – Standard test methods for liquid containment, inclined plane tracking and erosion of insulating materials
ASTM D635 – Standard test method for rate of burning and/or extent and time of burning of plastics in a horizontal position.
ASTM E84 – Standard test method for surface burning characteristics of building materials
ASTM D570 – Standard Test Method for water absorption of plastics
ASTM G154-16 – Standard practice for operating fluorescent ultraviolet (UV) lamp apparatus for exposure of non-metallic materials
ASTM D8019-15 – Standard test methods for determining the full section flexural modulus and banding strength of fibre reinforced polymer crossarms assembled with centre mount
Electricity Supply Act 1995 (NSW)
Electricity Supply (Safety and Network Management) Regulation 2014
ENA Doc 012 – Crossarm supply and performance specification
ENA National Electricity Network Safety Code (Doc 01-2008)
Eurocomp Design code and handbook – Structural design of Polymer Composites
IEC 60093 – Methods of test for volume resistivity and surface resistivity of solid electrical insulating materials

IEC 60587 – Electrical insulating materials used under severe ambient conditions – Test methods for evaluating resistance to tracking and erosion.

National Electricity (NSW) Law 1997 National Electricity Rules

4.0 DEFINITIONS AND ABBREVIATIONS

AS	Australian Standard
FMEA	Failure Mode Effects Analysis
GP	General Purpose
NATA	National Association of Testing Authorities
NZS	New Zealand Standard
SP	Structural Purpose
LEL	Lower exclusion limit. This is calculated as the mean of the sample size minus 1.65 times the standard deviation.

5.0 ACTIONS

The following sections detail the requirements that composite crossarms are required to meet when installed in the Endeavour Energy Network.

5.1 General requirements

5.1.1 Service conditions

All crossarms supplied must be able to operate under the conditions outlined in Table 1 – Environmental conditions, below.

Table 1 – Environmental conditions

Condition	Environmental Limits
Ambient Temperatures	Maximum: 50°C Minimum: -15°C
Solar Radiation Levels	1100 W/m ² with high ultraviolet content.
Precipitation	Maximum annual rainfall range 1800 – 2400mm. Minimum annual rainfall range 0 – 100mm.
Humidity	Extreme range of relative humidity from 10% to 100%.
Pollution levels	Pollution level – IV very heavy Areas of coastal salt spray and/or industrial pollution with equivalent salt deposit densities up to 3.0 g/m ² .
Isokeraunic level	Maximum of 60 thunder storm days per year.

5.2 Technical requirements

5.2.1 Electrical Requirements

Table 2 – Electrical Requirements

Condition	Reference Standard	Limits
Basic insulation level (BIL)	IEC 60071-1	Minimum 300 kV/m
Electrical Resistance	IEC 60093	10kΩ/m

5.2.2 Mechanical Requirements

5.2.2.1 Strength Requirements

The crossarm must be capable of resisting dead, tensile, live and wind loads.

After applying the following strength reduction factors, the composite crossarm must have a minimum rating of the equivalent timber crossarm strength, in the y and z directions, listed in Annexure 1 – Specified items.

- Short term overloading: 0.75
- Everyday loading: 0.3

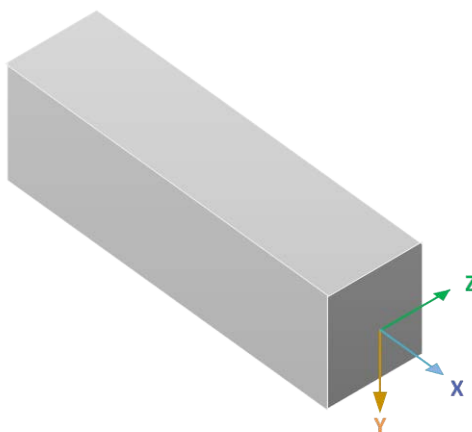


Figure 1 - Crossarm orientation

Where suppliers use alternate strength reduction factors, these must also be submitted. However, all products submitted will be assessed on the above factors applied.

5.2.2.2 Crossarm modifications

Endeavour Energy requires crossarms as per the standard sizes / drilling patterns shown in Annexure 1 – Specified items.

In addition to these, crossarms are required to be modified on an ad-hoc basis to suit the needs to brownfield and non standard constructions. The supplier is required to specify whether the crossarms can be drilled for this purpose, or whether an attachment is required.

A preference is given to crossarms which can be drilled, however, the supplier must prove that:

- There are no harmful by-products from drilling. The supplier must provide details of any PPE or procedures which are required when drilling;
- The strength is not compromised;
- The drilling does not cause moisture ingress. The supplier must provide a procedure to mitigate moisture ingress due to drilling.

Suppliers must provide detailed drilling procedures and/or details and testing of additional fittings (where drilling is not an option) to indicate their ultimate mechanical strength, use and limitations.

5.2.2.3 Deflection

The deflection of the crossarm under maximum dead loads must be limited to a maximum of 5% of the bendable length.

5.2.3 Maintenance Requirements

All crossarms supplied must be designed to achieve a maintenance free design life of at least 50 years.

5.2.3.1 Failure Mode Effects Analysis (FMEA)

The supplier must supply Endeavour Energy a failure mode, effects analysis (FMEA) of the crossarm. The FMEA must indicate experienced failures of the crossarm, and also the mean time between failures (MTBF), and the recommended maintenance regime and maintenance tasks and intervals.

5.2.3.2 Repairs

Endeavour Energy reserves the right to reject any crossarm having a substantial defect, such as dents or distortions, damage to the outer coating of the crossarm, incorrect positioning of holes, or defects of any other kind. If repairs are deemed appropriate, they may be carried out only with prior approval from Endeavour Energy. The service life and strength of repaired crossarms must be no less than undamaged crossarms.

The supplier must also provide a methodology and any products required when minor damages (such as scratches and dents) occur in the field.

5.2.3.3 Disposal / End of Life requirements

The supplier must provide disposal details for their product. Products which can be reused/recycled is preferred.

5.2.4 Crossarm Material

The crossarm must be a re-enforced polymer fibre construction. The resin must be thermosetting resin such as epoxy or vinyl ester resin and manufactured using the pultrusion process. The resin must contain additives that act as a flame retardant and provide low shrinkage.

Boron free ECR fibreglass (Electronic corrosion resistant glass) is preferred due to its acid resistance and high temperature resistance properties.

All sharp edges must be removed.

5.2.4.1 Crossarm coating and colouring

The crossarm must have a protective coating material which must be durable and have excellent electrical insulation and tracking resistance properties and low toxicity for everyday conditions, during the design life of the crossarm. It must be resistant to UV, stress cracking, adverse weather conditions, detergents, salt spray and typical airborne pollutants.

The coating must add flame retardancy to the product.

The coating must be maintenance free and last for the design life of the crossarm.

The supplier must provide the following details on the coating used for the crossarm: material; thickness; method of coating; electrical resistance; dielectric strength; water absorption; and, toxicity index.

The preference for crossarms colour is 'green-grey' colour to be in line with CCA timber poles. Crossarms of alternative colours may also be considered.

The surface finish must be glossy with a smooth finish and should have water absorption of <0.03% as per ASTM D570.

If the supplier can provide the provision of a non-slip coating on the top layer of the crossarm, this should be offered.

5.2.5 Dimensions and Tolerances

The composite crossarm must meet the dimensions specified in Annexure 1 of this instruction and the tolerances specified in the following table. Designs which can reduce the total number of required crossarms will be preferred. The current spacing between the drill holes is the minimum accepted distance. If the current spacing cannot be met, with the proposed length crossarm, the supplier must submit an alternative sized crossarm.

Table 3 – Tolerances

Condition	Tolerance
Width	± 3mm
Depth	± 3mm
Length	-0mm, +25mm
Corner radius	Minimum of 6mm

5.2.6 End caps

The crossarm must be end capped with a suitable non-conductive cap that is impact resistant, permanently fixed and must not degrade during the service life of the crossarm. It must remain secured to the crossarm under the service conditions outlined in Table 1 – Environmental

conditions and under forces applied during transport, movement, installation or the influence of birds or animals.

The end cap must prevent the ingress of moisture.

Details of the end cap and how it is fixed / sealed to the crossarm must be provided for review.

5.2.7 Durability requirements

The following section details the five durability parameters.

5.2.7.1 Resistance to corrosion

The crossarm must be made of materials that provide the best corrosion performance in the wide range of environments, especially the conditions set out in Table 1 – Environmental conditions.

The supplier must demonstrate the crossarm is suitable for all environmental conditions.

5.2.7.2 Fire performance

The crossarms must have a good fire resistance to both bushfires and pole top fires. Tests must be conducted on composite crossarms to compare fire performance with untreated durability class 2 hardwood crossarms. Refer to Table 6 – Other type test requirements for details.

5.2.8 Compatibility and interchangeability

The composite crossarm must be compatible and interchangeable with current crossarms and hardware. The dimensions and sizing of current crossarms are given in Annexure 1 – Specified items.

5.2.9 Weight

The weight of the crossarm must be provided with the offer. Preference will be given to crossarms that are lighter.

5.2.10 Workability and Material Safety Data Sheets (MSDS)

The supplier must submit MSDS for the composite crossarms and all other materials used within it (for example, coatings, fillers) and outline any precautions to be taken when cutting or drilling composite crossarms in the need for modifications on site.

5.2.11 Marking / Identification

The crossarm must have permanent marking which will indicate:

- The name of the manufacturer; and
- The month and year of manufacture.

The marking must be of height, so the identification can be read from a distance of 12 metres and be located on the bottom of the crossarm. Alternate positions will be considered.

5.2.12 Handling

All crossarms covered by this specification must be constructed to allow handling, erection and transport without causing damage to the crossarm. In particular, the manufacturer must supply details of preferred lifting techniques, including any special equipment required, and recommended storage methods.

Where a lifting sling is required, a non-permanent mark must be provided to indicate the point of attachment.

5.2.13 Delivery requirements

All items supplied must be suitably packaged to deliver the items undamaged, giving due consideration to the methods and distance of transportation and handling.

Each delivery document must be provided with the following information:

- Manufacturer's name;
- Purchaser's name (that is, Endeavour Energy);
- Order number;
- Item description;
- Quantity; and
- Total mass (kg).

5.3 TESTING REQUIREMENTS

5.3.1 General test requirements

Where a crossarm has been tested to a standard different to those listed in the following sections, or where the supplier believes an alternate test demonstrates a similar characteristic of the crossarm, the supplier must submit documentation on how the proposed standard/test differs from the indicated standard.

5.3.2 Equivalent type test requirements

5.3.2.1 Mechanical tests

Type tests must be provided for each type (length and construction type) of crossarm offered. A crossarm of one length or one construction type (that is, suspension or termination) does not qualify a crossarm of a different length or construction type.

Tests must be conducted both with and without the appropriate sized gain block (refer to Endeavour Energy drawing 240872 or 240379). Where the crossarm member fails before the gain block, then only one set of tests is required to be submitted.

5.3.2.2 Electrical tests

Only one set of electrical tests detailed in Table 5 – Electrical type test requirements, are required for a set of crossarms.

5.3.3 Type tests

The type tests required to be submitted with the offer are listed in Table 4 – Mechanical type test requirements, Table 5 – Electrical type test requirements and Table 6 – Other type test requirements.

Table 4 – Mechanical type test requirements

Test Reference	Test Name	Test Description	Pass Criteria
ENA Doc 012 Clause 5.2	Sudden load release test	The crossarm will be subject to 5 sudden load releases when subjected to a dead/tensile load of 30% of the average failing load.	No breakages must occur.
ASTM D8019-15	3-Point Bend Test Termination and Suspension Point load testing	5 samples will be tested for Termination and Suspension construction types until failure. Record flexural modulus, calculated moment at failure, calculated stress at failure, and crossarm deflection must be recorded.	The 5% lower exclusion limit (LEL) of the samples must have a strength greater than the strength requirements shown in Annexure 1. Deflection of crossarm under load must not exceed 5%.
-	Bolted connection capacity test	Test the capacity of the bolt connections in both the vertical and horizontal directions, as detailed in Annexure 3.	Report only.
-	Crush resistance test	20mm bolt installed in the crossarm with a 60mm round washer, tightened to a torque value of 220Nm (grade 5.8 equivalent).	There should be no signs of bowing and/or cracking under test.

Table 5 – Electrical type test requirements

Test Reference	Test Name	Test Description	Pass Criteria
AS/NZS 2947.1 and ENA Doc 012 Clause 5.3	Dry lightning impulse withstand test and 50% flashover voltage tests	Lightning pulse will be applied to a 1m length of the crossarm and the impulse and 50% flashover voltage recorded.	No damage must occur.

Test Reference	Test Name	Test Description	Pass Criteria
AS 4435.1 Appendix ZZ and ENA Doc 012 Clause 5.4	Power arc test	Increase voltage until an arc is initiated on the crossarm.	The crossarm must not cracked or bow post the test.
IEC 60093	Electrical Resistance	The resistance of 1m crossarm must be measured at 20°C.	The resistance must be a minimum of 10kΩ/m
IEC 60587 (Method 2), ASTM D2303	Inclined plate tracking test	Test specimens must be tested to 2.5kV for 1 hour and increased to 2.75kV for 1 hour as per Method 2.	Current in the high voltage circuit does not exceed 60mA or the specimen does not display any holes from erosion.

Table 6 – Other type test requirements

Test Reference	Test Name	Test Description	Pass Criteria
ASTM E84 and ASTM D635	Fire resistance test	Crossarms to be subjected to the tests indicated in ASTM E84 and D635. Whether the material sustains a flame when the heat source is removed must be recorded. Tests must also indicate whether there are any hazards present in the final residue when the composite is burnt.	Time to extinguish fire must be less or equal to a timber crossarm. (It is preferable to be tested against Australian timber crossarm)
ASTM G154	Accerlated UV test	Specimen (with coating) must be tested for a minimum of 10000 hours. Changes to colour, roughness and appearance must be noted.	No fibre blooming of the specimens will be accepted.

5.3.4 UV testing requirements

In addition to the accelerated UV test detailed in Table 6 – Other type test requirements, the supplier must also submit documentation to demonstrate that the mechanical strength of the crossarm(s) offered is not compromised when exposed to the Australian environment over the life of the asset.

5.3.5 Test accreditation and reporting requirements

All type tests must be carried out by a testing authority/laboratory holding accreditation:

- by NATA Australia; or
- by an accreditation authority recognised by NATA Australia.

Tests from other testing authorities may be accepted at the discretion of Endeavour Energy.

All type test reports must be accompanied by copies of the accreditation certificate(s) issued to the testing laboratory. The accreditation certificate(s) must be valid for the relevant test(s) and for the duration of the test(s).

Type tests must be less than ten years old. Type tests beyond this limit may be submitted provided sufficient information to demonstrate that the manufacturing process, raw materials, design and quality control processes have not significantly changed since the original test date is also submitted with the offer.

All documentation submitted (including reports, tests, testing procedures/policies, calibration certificates and the like) must be in English.

Type test certificates must specify the overall dimensional details of the crossarms, test assembly, procedure, test requirement and test results. Test certificates only indicating that the items have passed without listing the test conditions above will be deemed non-compliant.

5.3.6 Batch Testing

Batch tests must be carried out on every batch of crossarms produced to demonstrate quality assurance of items supplied.

Batch test certificates must be supplied with each order/delivery and specifies that the crossarms meet the requirement of this specification. All routine and batch tests may be conducted at the manufacturing facility's test laboratory on the condition that sufficient evidence is provided with the offer to demonstrate the testing facility's capability to perform the specified tests. As a minimum, the following information must be provided:

- Qualifications/experience of testing staff;
- Test procedures for all routine/batch tests;
- Testing facility quality control procedures; and
- Test instrument calibration certificates/procedures.

As part of the assessment proves, Endeavour Energy will specify in writing if they accept the routine/batch tests being conducted at the manufacturing facility's test laboratory.

The supplier must propose the frequency and type of tests to be performed as part of the batch testing.

6.0 AUTHORITIES AND RESPONSIBILITIES

The **General Manager Asset Management** has the authority and the responsibility for:

- Approving technical specifications, including any variations.

The **Manager Asset Standards & Designs** has the authority and responsibility for:

- Reviewing technical specifications and making recommendations to the General Manager Asset Management; and
- Making recommendations concerning compliance with this Specification.

The **Mains Assets Manager** has the authority and responsibility for reviewing all test reports submitted and making recommendations to the Manager Asset Standards & Design.

The **Manager Procurement & Logistics** is responsible for checking that all crossarms purchased by Endeavour Energy comply with the requirements of this instruction.

7.0 DOCUMENT CONTROL

Documentation Content Coordinator : Mains Assets Manager

Documentation Distribution Coordinator : Branch Process Coordinator

Annexure 1 – Specified items

The following table lists the crossarms to be supplied to Endeavour Energy.

Table 7 – Details of current timber crossarms

Item No.	Timber Crossarm code	Crossarm description	Timber crossarm Dimensions in mm (length x depth x height)	Endeavour Energy Drawing	Minimum strength required y-axis (kN)	Minimum strength required z-axis (kN)
1	XA010	LV	2100 x 100 x 100	332003 Sh 1	6.50	5.01
2	XA020	HV	2100 x 100 x 100	332003 Sh 1		
3	XA030	HV	2100 x 150 x 100	332003 Sh 1	14.63	7.51
4	XA040	HV, Recloser	2700 x 100 x 100	332003 Sh 1	4.80	4.12
5	XA050	LV Sub Box	1465 x 100 x 100	332003 Sh 2	6.50	5.01
6	XA055	HV Sub Platform	1800 x 200 x 100	332003 Sh 2		
7	XA060	HV Sub standoff	1800 x 100 x 100	332003 Sh 2		
8	XA065	LV Sub Urban	2700 x 100 x 100	332003 Sh 2	4.8	4.12
9	XA070	LV Sub Coastal	3000 x 125 x 100	332003 Sh 2	3.67	-
10	XA075	Crossarm regulator	4000 x 150 x 100	332003 Sh 2	-	-
11	Type 2	Transmission Type 2	2100 x 125 x 100	079042	-	10.48
12	Type 3	Transmission Type 3	3300 x 150 x 125	079043	12.40	-
13	Type 4	Transmission Type 4	2700 x 125 x 100	079044	-	8.26
14	Type 5	Transmission Type 5	1800 x 100 x 125	079045	-	14.02
15	Type 6	Transmission Type 6	6300 x 200 x 125	079046	22.05	-
16	Type 7	Transmission Type 7	3300 x 100 x 125	079047	-	8.37
17	Type 8	Transmission Type 8	3300 x 100 x 125	079048	-	8.37
18	Type 9	Transmission Type 9	2400 x 100 x 125	079049	-	6.00
19	Type 10	Transmission Type 10	2400 x 100 x 125	079050	-	14.18
20	C1	"Steel Long Span" C1	3300 x 65 x 125	052797	Refer to Drawing	
21	C2	"Steel Long Span" C2	2300 x 65 x 125	052785	Refer to Drawing	
22	C3	Steel Termination C3	3000 x 152 x 152	052796	Refer to Drawing	
23	H2	H-Pole Crossarm H2	9000 x 200 x 75	074148	Refer to Drawing	
24	H3	H-Pole Crossarm H3	9500 x 200 x 200	076615	Refer to Drawing	

Notes: 1 – Composite crossarms must meet the minimum ratings displayed after the strength reduction factors have been applied to the crossarm.

Annexure 2 – Additional/Supplementary Drawings**Table 8 – Drawings associated with this specification**

Drawing Number	Amendment	Drawing Title
240872	A	Wood Pole crossarm mounting bracket detail (Gain block)
240379	A	Concrete Pole crossarm mounting bracket detail (Gain block)
063900	E	Overhead construction pole mounted bolts
078116	C	Gang Nail plate fabrication detail

Annexure 3 – Bolted connection test

The following test is a mechanical test designed to determine the breaking limit of a pin type construction and for kingbolt assemblies.

Test set up

The test must comprise of a 200mm sample of the composite crossarm, with an appropriate sized hole for a M20 sized bolt, shown in Figure 2a.

This will be placed into a custom made test jig, Figure 2b, which must be designed such that when the crossarm sample is placed in the jig, the crossarm is not resting on the jig. This is so the mechanical stress is transferred through the crossarm, to the high tensile rod and through the jig supports.

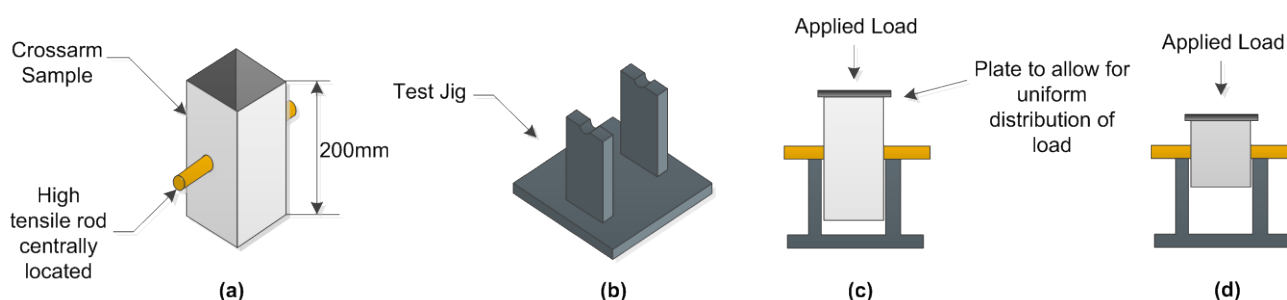


Figure 2 – Test set up. (a) Sample (b) Test Jig (c) test in vertical direction (d) test in horizontal direction

Procedure

A uniformly applied load must be gradually placed on the crossarm via a metal plate, until failure occurs.

The force at which failure occurs and the way in which the failure occurs must be recorded.

The test must be repeated on ten (10) different samples for each direction, shown in Figure 2c and Figure 2d.

Results

The following must be calculated from the 10 results:

- The mean (μ) value (kN);
- The standard deviation (σ) (kN);
- Minimum failure value (kN);
- Coefficient of variation ($\frac{\sigma}{\mu}$);
- 95th Percentile ($\mu - 1.65\sigma$);
- The characteristic value – which will be the lesser of:
 - o 95th Percentile / 1.10;
 - o Minimum value / 1.10.