



A50WE019

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TWO COMPONENT STRUCTURAL ADHESIVE RESIN SYSTEM

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TWO COMPONENT STRUCTURAL ADHESIVE RESIN SYSTEM

1. SCOPE

- 1.1. This specification provides the functional requirements for the two component adhesive resin system used as a structural adhesive in the construction of wind turbine rotor blades.

2. APPLICABLE DOCUMENTS

- 2.1. The following documents shall form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue shall apply.

2.1.1. American Society for Testing and Materials

E1640	Standard Test Method for Assignment of the Glass Transition Temperature by Dynamic Mechanical Analysis
D3056	Standard Test Method for Gel Time of Solventless Varnishes
D3163	Standard Test Method for Determining Strength of Adhesively Bonded Rigid Plastic Lap-Shear Joints in Shear by Tension Loading

2.1.2. International Standard Organization

ISO 1675	Plastics – Liquid resins – Determination of density by the pycnometer method
ISO 2555	Plastics – Resins in the liquid state or as emulsions or dispersions – Determination of apparent viscosity by the Brookfield test method
ISO 6721	Plastics – Determination of dynamic mechanical properties – Part 2: Torsion – Pendulum method
ISO 75-2	Plastics - Determination of temperature of deflection under load – Part 2: Plastics and ebonite (Method A, using a flexural stress of 1.80 MPa)
ISO 4587	Adhesives – Determination of tensile lap-shear strength of rigid-to-rigid bonded assemblies



2.1.3. DIN (The German Institute for Standardization)

DIN 53479	Testing of plastics and elastomers: Determination of density
DIN 53283	Testing of adhesives for metals: Determination of the shear strength of single lap joints by tensile test
DIN EN 1465	Adhesives – Determination of tensile lap-shear strength of rigid-to-rigid bonded assemblies
DIN 53292	Testing of sandwiches: Tensile test perpendicular to the face

3. DEFINITION/NOMENCLATURE

3.1. Personnel

- 3.1.1. Purchaser - GE Wind Energy or its Business Associate.
- 3.1.2. External Supplier - The corporation, company, partnership, sole proprietorship or individual engaged to perform the process covered by this Specification.
- 3.1.3. Internal Supplier - Any GE Wind Energy Manufacturing Department.
- 3.1.4. Supplier - As used herein, unless specifically designated, refers to either an External or an Internal Supplier.

3.2. Specification Deviation Documents

3.2.1. Applicable to External Supplier

- 3.2.1.1. Supplier Deviation Request (SDR) - A method for the documentation, approval and control of a waiver for materials, processes, or dimensions that deviate from Purchase Order documents (drawings, specifications, engineering instructions, etc.).

3.2.2. Applicable to Internal Supplier

- 3.2.2.1. Non-Conformance Report (NCR) - GE Manufacturing Department non-conformance report initiated during processing through the factory. Used by Manufacturing to document non-conformance to governing documents and request corrective action.

3.3. Documentation



- 3.3.1. Manufacturing Process Plan (MPP) – A GE approved, detailed, step-by-step list of operations by which the parts are planned to be processed, tested and inspected.
- 3.3.2. Qualification Package – First Piece Qualification documentation containing the results of the test and inspections performed on the first Piece and required for qualification.

3.4. Terms

- 3.4.1. Lot/Batch - A Batch is all the material produced during one shift of production where the lot of each component is the same throughout. When a batch process is used, a Lot is all the material processed through a single cycle.
- 3.4.2. Room Temperature - Room temperature is defined as $23\pm3^{\circ}\text{C}$ ($73\pm3^{\circ}\text{F}$).
- 3.4.3. Sample – A quantity of material in cured or uncured state depending on required testing.
- 3.4.4. Cure Cycle – Curing cycle is defined as 10 hours at 70°C in order to ensure T_g of the resin system higher than 70°C (158°F).
- 3.4.5. Neat resin – Prepare, per a proper test standard, mechanical test coupon assemblies that are bonded together with 100% neat adhesive resin system with. Follow curing cycle described in 3.4.4.

4. FUNCTIONAL REQUIREMENTS

Particularly suitable for bonding laminate structures as well as for filling gaps, this two component, epoxy-based adhesive resin system is used for various applications in the construction of wind turbine blades.

4.1. Properties

Type	Epoxy-based adhesive
Density (g/cm^3 , at 20°C)	1.2 – 1.4
Viscosity (at 25°C)	Thixotropic
Pot life (minute, at 20°C to 40°C)	60 – 240

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Glass transition temperature (°C, minimum)	70
Operational temperature (°C, after heat treatment)	-60 to +100

4.2. Neat resin mechanical properties

Ultimate tensile strength, Mpa (psi), minimum	15 (2,175)
Ultimate tensile shear strength, Mpa (psi), minimum	10 (1,450)

4.3. Manufacture

- 4.3.1. It shall be the responsibility of the Supplier to understand thoroughly the work scope and all documentation needed to complete the work. This responsibility shall apply to the prime Supplier for any or all operations performed by sub-tier Supplier (s).
- 4.3.2. Manufacture shall be conducted in accordance with a documented Frozen MPP. The Supplier shall monitor the actual process, compare the process to the MPP and report to the Purchaser any variances using the SDR/QCR.
- 4.3.3. Deviations – Any deviation from the requirements of this Specification shall be submitted by SDR/QCR for Engineering disposition before the item is shipped.
- 4.3.4. Shelf Life – The components shall retain the properties required by this specification for 1 year when stored in their original closed container at room temperature, 23±3°C (73±5°F).
- 4.3.5. Defects - The material shall be free of dirt, metallic particles, crystals, unmixed liquids and other contaminants.

5. QUALIFICATION REQUIREMENTS

- 5.1. First Piece Qualification - A comprehensive evaluation for First Piece Qualification (FPQ) shall be required of a new Supplier, or when there is a significant change in the approved MPP or if a Supplier has not performed this process within the two years prior to Purchase Order placement. FPQ shall, as a minimum, include the following:
 - 5.1.1. An MPP approved by the Purchaser prior to initiation of the FPQ.
 - 5.1.2. Test data.
 - 5.1.3. Certificate of conformance.



5.1.4. Qualification samples – FPQ samples shall be provided as requested.

5.2. Qualification Package - The Supplier shall submit two (2) copies of the FPQ documentation for review/approval.

5.3. Frozen MPP - Upon receipt of written notification for FPQ, the Supplier is approved for production of the qualified part. The MPP shall be "FROZEN", is not to be changed without approval of a new MPP.

5.4. Factory Trials - Final Supplier qualification and approval to supply components manufactured to this specification are subject to factory trials by the Purchaser.

5.5. This material must be Germanischer Lloyd approved (qualified).

6. QUALITY ASSURANCE PROVISIONS

6.1. Inspection and Test Requirements

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6.1.1. Visual - Every lot shall be inspected for visual defects in accordance with paragraph 4.3.5.

6.1.2. Viscosity - Measure viscosity of each lot.

6.1.3. Pot Life – Determine the pot life of each lot.

6.1.4. Glass Transition Temperature – Measure the T_g of each lot.

6.2. Referee Methods

6.2.1. Viscosity – Viscosity on the catalyzed resin shall be measured using a Brookfield viscometer either per ISO 2555.

6.2.2. Pot life – Allow both resin and hardener to stabilize at the test temperature, 24 to 26°C (75 to 79°F), separately, for a minimum of 24 hours. Mix a total of 100g resin and catalyst in a laboratory glass cup. Measure time versus temperature from completion of mixing until exotherm is complete by using a thermocouple or IR device. Report the time from initial mixing until the resin/catalyst mix's temperature rises to 50°C (122°F).

6.2.3. Gel time – Use Sunshine Gel Timer Model 22A and test per ASTM 3056. Allow instrument to equilibrate at testing temperature for a minimum of 30 minutes. Mixed sample will be 10g of resin. Testing temperature will be 100°C (212°F).



6.2.4. Glass transition temperature – Perform test per ISO 6721-2. Report the midpoint T_g .

6.2.5. Mechanical properties

6.2.5.1. Neat resin tensile and tensile lap-shear properties (strength) - Perform tensile and tensile lap-shear tests per DIN 53292 and DIN 53283 (or DIN EN 1465 or ISO 4587), respectively. All stocks for specimens are to be manufactured and cured per section 3.4.5 and 3.4.4, respectively. Take a minimum of 3 measurements of width and thickness, averaging these for use in calculations. Calculate tensile and tensile lap-shear strengths using proper test methods and equations. A minimum of 6 samples is to be tested for material qualification.

6.3. Certificate of Test

6.3.1. Internal Supplier - When requested, the Internal Supplier shall promptly submit the Certificate of Test to Manufacturing Quality Assurance.

6.3.2. External Supplier - When requested, the External Supplier shall promptly submit the Certificate of Test to the Purchaser address shown on the Purchase Order.

6.3.3. When requested, a Certificate of Test shall be submitted for each batch stating that the components were processed in accordance with the requirements of this Specification and other applicable documents. The Certificate shall be signed and dated by an authorized Supplier Representative and shall, as a minimum, include the following information:

Supplier Name, Address and GE (External) Supplier Code
GE Purchase/Shop Order Number and date
MPP Identification Number, Revision Level and Revision date
SDR(s)/QCR(s)
GE Specification
Date of Manufacture
Test and Inspection Data (per section 6.1 of this document)

6.4. Audit - The Purchaser reserves the right to periodically audit the Supplier's facilities and practices. Such audits shall not relieve the Supplier from the responsibility of producing the material in a suitable condition.

7. PREPARATION FOR DELIVERY



7.1. Packing and Marking

7.1.1. Material shall be shipped in standard commercial containers, which are suitable to meet DOT and carrier regulations, and to protect against material contamination or damage during shipping and storage. Material to be marked as follows:

7.1.2. Each container shall be legibly labeled and include the following:

- Purchase Order Number
- GE Specification Number
- Manufacturer's Name
- Quantity
- Lot Number
- Manufacturing Date
- Appropriate safety and hazard information

8. NOTES

8.1. This material must be Germanischer Lloyd approved (qualified).