



GE Power & Water
Materials and Processes Engineering

PROCESS SPECIFICATION

P14A-AL-0218

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GE CLASS II (INTERNAL CRITICAL)

**ACCEPTANCE REQUIREMENTS FOR ZINC FLAKE CORROSION
RESISTANT COATING FOR WIND TURBINE FASTENERS**

DOCUMENT REVISION STATUS: DETERMINED BY THE LAST ENTRY IN THE "REV" AND "DATE" COLUMN

REV.	DESCRIPTION	SIGNATURE	REV. DATE
-	THIS SPECIFICATION GIVES THE ACCEPTANCE REQUIREMENTS FOR A CORROSION RESISTANT ZINC-ALUMINUM FLAKE MICRO LAYER CORROSION RESISTANT COATING LIKE DELTA MKS AND SIMILAR GOOD UP TO 150C(302F) SERVICE. THIS COATING IS APPLICABLE TO GE WIND HIGH STRENGTH STEEL FASTENERS WHEN SPECIFIED IN DRAWINGS. CURRENT APPLICATIONS INCLUDE FASTENERS FOR BLADE AND PITCH BEARING. USE OF THIS COATING SHALL REQUIRE DESIGN ENGINEERING APPROVAL; DCI NO. 06009902. (TA BHAT)	CR TRIPEPI	
A	ADDEED GEOMET 321 + L BLACK AS AN APPROVED ZINC FLAKE COATING SYSTEM. EDITORIAL CHANGES TO REPLACE MANUFACTURER SPECIFIC COATING SYSTEM DESIGNATION TO GENERIC ZINC FLAKE SYSTEM. ECR3038587 (J RIDGE)	JL SMITH	2013 SEP 11

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PREPARED BY:

T.H. BHAT

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ACCEPTANCE REQUIREMENTS FOR ZINC FLAKE CORROSION
RESISTANT COATING FOR WIND TURBINE FASTENERS

1. SCOPE

- * 1.1 This specification gives the acceptance requirements for zinc-aluminum flake micro layer corrosion resistant coatings, which are good up to 150°C (302°F) service. This coating is applicable to GE Wind high strength steel fasteners when specified in drawings.

Current applications include fasteners for blade and pitch bearing. Use of this coating shall require Design Engineering approval.

- 1.2 This specification contains the following classes:

Class A Coating with inorganic zinc-aluminum base coat and topcoat.


Class B Coating with inorganic zinc-aluminum without top coat

- 1.3 Communication

- 1.3.1 If work is being performed under a General Electric Company purchase order, GE Energy Sourcing is the authorized interface for all communication. All questions or requests for additional information shall be submitted to GE Energy Sourcing for clarification. Requests for deviations to this specification shall be submitted to GE Energy via Supplier Deviation Request (SDR).

- 1.3.2 If work is being performed for a non-GE customer, all questions or requests for additional technical information shall be submitted to GE Energy Materials & Processes Engineering (MPE) for clarification.

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2. APPLICABLE DOCUMENTS

* 2.1 In the case of conflicts between applicable documents requirements, unless otherwise agreed to in an additional written document, prevalent requirements are as follows (decreasing importance order):

- Contract / Order Tech-Qual. Attachment.
- Applicable Drawing.
- Material Specification.
- Applicable GE Procedure.
- Applicable EN and ASTM Standards or Others

2.2 The following documents shall form an integral part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue shall apply:

2.2.1 General Electric Company

- | | |
|--------------|--|
| P14A-AL-0220 | General Specification for Wind Fasteners |
| P28A-AL-0001 | Critical to Quality Process Capability Data Collection |
| P28A-AL-0002 | Supplier Quality Requirements |

2.2.2 American Society for Testing and Materials

- | | |
|-----------|---|
| ASTM B117 | Standard Practice for Operating Salt Spray (Fog) Test Apparatus |
|-----------|---|


2.2.3 ISO, EN and DIN Standards

- | | |
|-----------|---|
| ISO 10683 | Fasteners-Non-electrolytically applied zinc flake coatings |
| ISO 8504 | Preparation of steel substrates before application of paints and related products – Surface preparation methods |
| ISO 9227 | Corrosion tests in artificial atmospheres-Salt spray test |
| ISO 2178 | Non-magnetic coatings on magnetic substrates – Measurement of coating thickness – Magnetic method |

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3. DEFINITIONS

3.1 Personnel

- 3.1.1 Purchaser - The GE Power & Water, 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 Supplier - As used herein, unless specifically designated, refers to an external supplier, whom GE Power & Water places a Purchase Order.
- 3.1.4 Subtier Supplier - The entity that a supplier outsource a process to.


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 which deviate from Purchase Order documents (drawings, specifications, engineering instructions, etc.).

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.
 - 3.3.1.1 MPP Submission-The MPP may be submitted as part of the overall MPP in the case of a sub-tier supplier.
- 3.3.2 Qualification Package - First Piece Qualification documentation containing the results of tests and inspections performed on the First Piece as required for qualification. This may be submitted as part of the overall qual package.

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3.4 Coating Technical Terms

- 3.4.1 Chip - A loss in coating revealing the silver colored primary coating or the base metal.
- 3.4.2 Dimples - Circular depressions on the surface. They are usually caused by localized depressions in surface of base metal.
- 3.4.3 Fisheye - Depressions on surface of coating which are crater-like in appearance. They are caused by contaminants on the surface or in the coating equipment.
- 3.4.4 Freckle (silvery spot) - Discoloration due to local absence of topcoat.
- 3.4.5 Pimples - Hemispherical protrusions from the surface. These are formed from agglomerates of coating material and are deposited as lumps during the coating process.
- 3.4.6 Pinhole - A local defect in coating which extends to the base metal.
- 3.4.7 Water Spots - Local discolorations caused by droplets of water in the topcoat.
- 3.4.8 Flake/Delamination - Coating which is peeling off or non-adherent.
- 3.4.9 Crack- Discontinuity in coated surface with length.

4. QUALIFICATION REQUIREMENTS


- * 4.1 All subtier suppliers shall be audited and qualified by the Direct supplier and supply the documentation to GE for review.
 - * 4.1.1 Any subtier supplier engaged in special processes shall be approved for those special processes / specifications.
 - * 4.1.2 Subtier suppliers will have a mutual non-disclosure agreement with the Supplier. The supplier receiving the PO from GE is responsible to ensure that all its subtier supplies have the current specifications and drawing revisions.

4.2 An approved MPP shall be in place before initiating FPQ as follows:


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- 4.3 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:
- 4.3.1 An MPP approved by GE Materials and Process Engineering (MPE) and Sourcing Quality prior to initiation of the FPQ. The supplier shall demonstrate the ability to comply with the requirements of this specification by completing a pilot qualification lot of 100 pieces.
 - 4.3.2 Materials and Process Data.
 - 4.3.3 Visual Examination Results.
 - 4.3.4 Thickness measurement method and results (10 randomly chosen parts).
 - 4.3.5 Curing test result (10 randomly chosen parts).
 - 4.3.6 Hit test result (10 randomly chosen parts).
 - 4.3.7 Electrical conductivity data (for information & when requested only).
 - 4.3.8 Microstructure (one part).
 - 4.3.9 Corrosion test result (one part).
 - 4.3.10 Surface finish measurement method and data (10 randomly chosen parts).
 - 4.3.11 Repair and touch up method/process.
 - 4.3.12 CTQ data (coating thickness).
 - 4.3.13 Gauge R&R on all measurement instruments per P28A-AL-0001.
- 4.4 Qualification Package - The Supplier shall submit two (2) copies of the FPQ documentation in CD or electronically for review/approval.

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4.5 Upon receipt of written notification for First Piece Qualification, the Supplier is approved for production of the qualified part. The MPP shall be "FROZEN," and not to be changed without MPE-MAE and SQE approval of a new MPP.

5. PRODUCTION PROCESS REQUIREMENTS

5.1 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).

5.2 This process shall be conducted in accordance with a documented Frozen MPP and PQP. The Supplier shall monitor the actual process, compare the process to the MPP and report to the Purchaser any variances using the SDR/QCR.

5.3 The MPP shall include as a minimum, the following information:

- Supplier Name, GE (External) Supplier Code Number (As applicable)
- Date
- eSMS Number, Revision Level, Revision Date
- Applicable Drawing Numbers (GE, Supplier, if applicable)
- All Material and Process Specifications (GE, other), including revision level
- * - Sketch showing location of thickness measurements.
- * - Details of processes such as part preparation, coating, baking and packaging.
- * - Equipment identification and location.
- Supplier documents (indicate proprietary, non-proprietary)
- Sub-tier Suppliers, as applicable
- * - All tests, measurement methods, and fit-up testing used to certify the part to drawing and specification.


5.4 Materials -Materials shall be procured from licensed and GE approved sources only.

5.4.1 Only material with lubricant additive that will produce a black colored coating shall be used, unless otherwise approved via MPP.

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5.4.2 The following Sources and Materials are currently approved.

1. Doerken Corporation: Delta Tone 9000 and Delta-Seal
2. Atotech: Zintek 200 and Techseal Black.
- * 3. NOF: GEOMET[®] 321 + Plus L Black

Alternate equivalent materials may be used with prior qualification and approval from GE Energy Engineering.

5.5 Surface Preparation

- 5.5.1 Surfaces to be coated shall be prepared per recommendation by Supplier of coating materials and approved via MPP
- 5.5.2 No acid pickling or any process which may cause hydrogen embrittlement shall be used in any step.
- 5.5.3 Should a prior coating require removal, the vendor shall submit the techniques proposed for the removal for approval by GE Energy (MPE and SQE).


5.6 Coating Application

- 5.6.1 The coating shall be applied in two steps using any of the following approved methods: Dip-Drain, Dip-Spin, Spraying, or Spinning.
- 5.6.2 Coating thickness requirements:
 - 5.6.2.1 Thickness shall be per ISO 10683 unless otherwise noted.
 - 5.6.2.2 The thickness shall be measured both in thread surfaces and at stud locations per a quality plan approved in MPP for FPQ and a surrogate sheet sample may be substituted for production lot. The referee method shall be metallography.

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* 5.6.2.3 Class A coatings - Total thickness for base and top coating shall be 15-45 μm (0.0006-0.0017 in) for M20 fasteners and above. Base coat shall be 10-25 μm (0.0004-0.0010 in.) and top coat 5-20 μm (0.0002-0.0008 in). Coating thickness shall be 15-25 μm (0.0005-0.0010 in.) for below M20. Base coat shall be 10-15 μm (0.0004-0.0006 in.) and top coat 5-10 μm (0.0002-0.0004 in).

* 5.6.2.3.1 Thickness for top silicate coating is 2-6 μm (0.00008-0.0002 in).

5.6.2.4 Class B coatings - Total thickness for single layer coatings shall be 12-25 μm (0.0005-0.0010 in.).

5.6.2.5 Coating thicknesses other than those mentioned above may be approved if sufficient technical data exists to support such requirement.

5.6.2.6 Process capability for thickness shall be established at bolt shanks and top ends.

5.7 Curing (Baking)

5.7.1 Solvent based coatings:

5.7.1.1 Processing temperature shall be 180-220°C (356-428°F) or as recommended by the coating material Supplier unless otherwise specified in drawing, in which case the drawing shall be the deciding factor.

5.7.1.2 Processing times shall be 30-60 minutes after primary coating application and again after top coating application. Curing shall be conducted in calibrated equipment, and all temperatures refer to surface metal temperature.


* 5.7.2 Water based coatings:

5.7.2.1 Base coat processing temperature shall be 296-332°C (565-630°F) and top coat 162-191°C (325-375°F), or as recommended by the coating material Supplier unless otherwise specified in drawing, in which case the drawing shall be the deciding factor.

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5.7.2.2 Processing times shall be 15-60 minutes after base coat application and 10-20 minutes for top coat application. Curing shall be conducted in calibrated equipment, and all temperatures refer to surface metal temperature.

5.8 Repair

5.8.1 Localized touch-up to repair unacceptable blemishes is permissible for Class A topcoat provided the coating requirements in Para. 6.1 are complied with.

5.8.2 Repair shall be by removal of coating followed by recoating and baking per Para 5.7 through 5.8 and as defined in approved MPP. **Only** processes which will not adversely affect the thread surfaces shall be used for stripping.

* 5.8.3 All repaired parts will each be remeasured and certified including fit-up testing.

6. INSPECTION/TEST PROCEDURES AND REQUIREMENTS

Requirements of ISO 10683 shall apply unless otherwise noted below.

6.1 Coating Requirements (As Cured)


6.1.1 Visual Requirements - The final cured coating shall be adherent to the base metal and shall have a continuous surface free from imperfections such as chips, cracks, pinholes, dimples, de-laminations, fisheyes and any mechanical damage, when viewed with naked eye. Minor cosmetic imperfections not detrimental to performance of coating are allowed e.g. freckle, fisheye and dimples less than about 2.5 mm (0.1 in) and less than 12 sq. cm (2 sq. in) area may be allowed.

6.1.2 Curing Test - The coating shall be evaluated for proper curing by Rub test as follows. A piece of cloth is wetted with MEK (Methyl-Ethyl-Ketone) and is pressed with the thumb with a force corresponding to 1 kg on the flat surface and rubbed along a short distance. If coating top layer is removed prior to achieving 10 double rubs, the coating is considered not cured. Slight discoloration due to surface coating polishing off is acceptable. Alternately an approved tape adhesion test may be used. An adhesion test should show no evidence of paint peeling or sticking to tape.

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6.1.3 Electrical Conductivity - For FPQ, when requested for information only. The cured coating shall be tested for electrical resistance between two test points separated by a distance of 25 mm (1 in). The test is prior to the application of the sealant topcoat for Class A. Electrical conductivity shall be measured at ambient temperature, on actual parts when feasible, using a commercially available resistance meter or other test equipment capable of measuring values to 1,000 ohms or higher. The electrodes shall be separated and used in such a manner as not to penetrate through the surface of the cured coating to the base metal. The test may be waived with customer approval.

6.1.4 Surface Finish - Surface finish shall meet drawing requirements and shall have a smooth finish.

* 6.1.5 Corrosion - There shall be no corrosion after being subjected to salt spray corrosion for 1000 hours for FPQ. The test shall be run in accordance with ASTM-B117 or ISO 9227. The part shall be scribed and no red rust caused by delamination or undercutting shall occur next to scribe.

6.1.6 Tap or Hit Test - Two bolts shall be tapped against each other with light manual force. Alternately the bolts shall be rubbed against each other with moderate manually applied force. In either case no coating damage shall appear. This is qualitative test and shall not be the only criterion for acceptance/rejection.

6.2 Acceptance Requirements

6.2.1 Production Test Requirements


The following are the recommended requirements, and the supplier may practice an alternate plan based on successful experience. Any such plan shall be approved by primary supplier, if applicable, and by GE Power & Water.

6.2.1.1 The supplier shall demonstrate continuing compliance to this specification during production; i.e., a sampling test plan shall be submitted and approved by GE Power & Water. This plan will include testing for curing, thickness, surface finish, and corrosion resistance of the coating. Also, one hundred percent of the coated parts shall be visually inspected.

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- 6.2.1.2 Thickness shall be tested on 3% of lot up to maximum of 10 parts per shift.
- 6.2.1.3 Curing test shall be conducted on 3% of lot up to maximum of 10 parts per shift.
- 6.2.1.4 Hit test shall be conducted on 1% of lot up to a maximum of 10 parts per shift.
- 6.2.1.5 Corrosion test shall be required for FPQ and for any significant process change.

6.3 Packaging and Marking Requirements

6.3.1 Packaging - Packaging shall not damage parts, packaging for shipment shall preclude contact of parts with one and other, and must be approved by the Purchaser's Quality organization.

6.3.2 Marking - Each production part shall have lot traceability.


6.4 Record Control

- * 6.4.1 When applicable all submitted data shall be in metric units.
- * 6.4.2 Forgings must be traceable using the serial number to the heat treat lot and to the raw material heat.

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6.5 Certificate of Conformance

6.5.1 External Supplier-Shall promptly submit a Certificate of Conformance to the Purchaser address shown on the Purchase Order.

6.5.2 A Certificate of Conformance shall be submitted for each lot of parts, stating that the lot was processed in accordance with 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
- eSMS Qual Identification Number, Revision Level and
- Revision date
- Part Drawing number and quantity
- SCR(s)/QCR(s)
- Documented results of all CTQ measurements/verifications

6.6 Audit

6.6.1 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.

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