GE Energy

Materials and Processes Engineering

COMPOSITE WIND BLADE SUPPLIER QUALIFICATION REQUIREMENTS

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REV.	DESCRIPTION	SIGNATURE	REV. DATE
-	PROVIDES THE TECHNICAL REQUIREMENTS A SUPPLIER OF GE WIND TURBINE BLADES MUST MEET AS PART OF QUALIFICATION; DCI NO. 08018242. (J. TESTA)	CR TRIPEPI	

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COMPOSITE WIND BLADE SUPPLIER QUALIFICATION REQUIREMENTS

1. SCOPE

1.1 This specification provides the Engineering Requirements for qualification of a composite wind blade supplier.

1.2 This specification is applicable to qualification of new suppliers, new manufacturing facilities, new blade design introduction, and new mold introduction at an existing facility. It is the responsibility of the qualification team to decide which requirements must be met for each situation.

1.3 This specification provides the Engineering Requirements for the following sub-sections of supplier qualification:

1.3.1 Manufacturing Production Plan (MPP)

1.3.2 Supplier's Work Instructions

1.3.3 Risk Assessment

1.3.4 Product Quality Plan (PQP)

1.3.5 First Piece Qualification (FPQ)

1.3.6 Pilot Lot Qualification (PLQ)

1.3.7 Functional Testing Requirements

1.3.8 Post-Qualification Data Reporting

1.4 Communication

1.4.1 External Supplier (See Definition)

1.4.1.1 General Electric Company - GE Energy Sourcing is the authorized interface for all communication between GE and the External Supplier. All questions or requests for additional information shall be submitted to Sourcing for clarification. Conflicts between applicable Specifications and/or drawings shall be submitted to Sourcing for resolution by Engineering.

1.4.2 Internal Supplier (See Definition)

1.4.2.1 All communication, including questions or requests for additional information, shall be submitted to GE Wind Energy Design Engineering.

1.5 Requests For Deviations - Requests for deviations to the requirements of this specification shall be submitted as follows:

1.5.1 External Supplier - To GE Energy Sourcing by SDR.

1.5.2 Internal Supplier - To the appropriate Engineering personnel by QCR.

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 General Electric Company

P3C-WE-0003	Ultrasound Inspection of Composite Wind Blades
P6C-WE-0001	Painting of Wind Turbine Rotor Blades
P7D-WE-0001	Bonding of Wind Turbine Rotor Blades
P12A-WE-0001	Dry Finishing of Wind Turbine Rotor Blades
P12A-WE-0002	Wet Finishing and Cure of Wind Turbine Rotor Blades
P14A-AL-0220	General Requirements - High Strength Fasteners
P14B-WE-0001	Resin and Adhesive Mixing
P15D-WE-0001	Spar Cap and Bond Cap Manufacturing
P15D-WE-0002	Blade Shell Construction and Infusion
P20B-WE-0001	Static Balancing of Wind Turbine Rotor Blades
P23E-AL-0255	General Requirements - Marking, Preservation, Packaging and Shipping

P28A-AL-0001	Critical to Quality (CTQ) Process Capability Data Collection
P28A-AL-0002	Supplier Quality Requirements
P29A-WE-0001	Defect Acceptability Limits for Wind Turbine Blades
CCOE-133	Supplier Qualification Templates
SPS-PSSQM-0310	Supplier Qualification
SPS-PSSQMF-0160	Supplier Frozen Process Change Request Form

3. DEFINITIONS

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

3.2.2 Applicable to Internal Supplier

3.2.2.1 Quality Control Report (QCR) - GE Manufacturing Department non-conformance report initiated during processing through the factory. The QCR used by Manufacturing to document non-conformance to governing documents and request disposition and 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 - All technical documentation, verification, and validation required for qualification of a GE Wind Turbine Blade Supplier.

3.3.3 Product Quality Plan (PQP) - The Product Quality Plan is a detailed step-by-step list of operations and requirements by which a supplier identifies a process of how, what, why, when and whom will perform tests and inspections.

3.3.4 First Piece Qualification (FPQ) - The process by which a supplier produces an initial piece, set, lot or provides a service as an element of the qualification process. Completion of first piece qualification does not qualify a supplier; qualification is granted only when all requirements of the qualification plan are met.

3.3.5 Pilot Lot Qualification (PLQ) - The process by which a supplier produces multiple parts, sets or lots to evaluate process capability. The PLQ is completed after First Piece Qualification and is required before granting certification as a qualified supplier.

3.3.6 Frozen Process - A manufacturing method, process, procedure or control or any other item considered qualified by the appropriate GE qualification team members for a specific component or service. A “Frozen Process” cannot be changed without formal approval by the appropriate qualification team members.

3.3.7 Frozen Process Change - Any significant change in process methodology (including documentation updates and revisions) has to be requested to GE qualification team prior to its implementation. To proceed with such a request, the supplier has to submit, electronically, an equivalent of form SPS-PSSQMF-0160.

3.3.8 Key Control Parameters - Critical dimensions, conditions, or procedures that ensure a component or sub-component is produced correctly. Key Control Parameters may or may not be identified as CTQs on GE Design Drawings and Process Specifications.

3.3.9 Failure Mode and Effects Analysis (FMEA) - A procedure for analysis of potential failure modes within a system for the classification by severity or determination of the failure's effect upon the system.

3.3.10 CAV Form - A Characteristic Accountability and Verification (CAV) form is a record of actual product characteristic values verified against applicable drawing and specifications in order to determine production product inspection levels and acceptance requirements. The characteristics may be in the form of dimensions, form, function, note compliance, NDE results, etc.

3.3.11 Quality Record - Document on which all test and inspection measurements, observations, and comments are recorded.

3.3.12 Traveler - Collection of all Quality Records for a given blade.

3.3.13 Tollgate - System by which appropriate checks and signoffs are made at critical steps of the blade manufacturing process.

3.3.14 Manufacturing Process Flow Chart - Sequence of processes required to produce a GE Wind Turbine Blade. Must be included as part of the MPP.

3.3.15 Quality Process Flow Chart - Sequence of every inspection and test performed during production of a GE Wind Turbine Blade. Must be included as part of the PQP.

3.4 Terms

3.4.1 Glass transition temperature (Tg) - The temperature at which an amorphous solid, such as a polymer, exhibits rubbery behavior. Tg is typically measured with Differential Scanning Calorimetry (DSC), with values reported from the mid-point of the heating curve.

3.4.2 Thermocouple (TC) - A device used to measure the temperature of a component.

3.4.3 Aspect ratio (A/R) - In an essentially two-dimensional rectangular structure (e.g., a panel or part), the ratio of the long dimension to the short dimension. Typically used to define the severity of a wave.

3.4.4 Unidirectional glass fabric (UD) - A glass fabric in which substantially all of the fibers are oriented in the same direction.

4. QUALIFICATION REQUIREMENTS

4.1 General Requirements:

4.1.1 As part of the Qualification Package the Supplier must meet all Technical Requirements specified herein, unless otherwise agreed upon with the GE qualification team. GE qualification team reserves the right to add requirements not listed in this document.

4.1.2 Supplier shall submit the following documentation, in English, for review and approval by GEWE Design Engineering and GEWE Supplier Quality Engineering prior to start of First Piece Qualification:

4.1.2.1 Manufacturing Production Plan (MPP)

4.1.2.2 Supplier Work Instructions

4.1.2.3 Product Quality Plan (PQP)

4.1.2.4 Risk Assessment (FMEA)

4.1.3 Upon approval of MPP, all processes and the sequence in which they occur are considered Frozen Processes.

4.1.4 Supplier Work Instructions may be modified during qualification process without GE approval, with the exception of Frozen Processes. A change to a Frozen Process requires GEWE Design Engineering and GEWE Supplier Quality Engineering notification and written approval.

4.1.5 Upon approval of FPQ by GEWE Design Engineering and GEWE Supplier Quality Engineering, Supplier may proceed to complete Pilot Lot Qualification and Functional Testing requirements.

4.2 MPP Requirements:

4.2.1 The MPP shall include the following information:

- Supplier Name, GE (External) Supplier Code Number.
- Date.
- MPP Number, Revision Level, Revision date.
- Applicable Drawing Numbers (GE, Supplier, if applicable).
- All Material and Process Specifications (GE, ASTM, other), including revision level.
- Supplier documentation reference (Work Instruction document numbers).

- Sub-tier Suppliers (as applicable).

4.2.2 The MPP must include a Manufacturing Process Flow Chart, defining the sequence of processes required to produce the component.

4.2.3 The Manufacturing Process Flow Chart must reference all Supplier Work Instruction document numbers applicable to each step of the process.

4.2.4 Key Control Parameters must be identified for each process in the MPP.

4.2.5 All MPP process steps and the sequence in which they occur are considered Frozen Processes.

4.2.6 The following manufacturing steps are considered Frozen Processes and must be included on the MPP. See Appendix A. The qualification team may identify additional Frozen Processes.

4.3 Work Instruction Requirements:

4.3.1 Supplier must provide a complete set of work instructions, as listed in the MPP.

4.3.2 In addition to normal shop processes, Work Instructions are to be written for standard repair procedures.

4.3.3 All Work Instructions are required to be written in English as well as local language if applicable.

4.3.4 All Frozen Processes, as stated on the MPP, must be included in the Work Instructions. Frozen Processes must be clearly marked within the work instructions.

4.3.5 Frozen Process steps or items cannot be changed without GE written approval.

4.3.6 All Key Control Parameters must be stated in the Work Instructions and in accordance with the MPP.

4.3.7 The sequence of operations containing specific Frozen Process steps or items, are not to be changed without GE written approval.

4.3.8 Other than noted above, changes can be made by the supplier and GE is to be notified.

4.3.9 Work Instructions should include sections covering Personal Protective Equipment (PPE), materials, tooling & equipment, and detailed step-by-step procedures.

4.4 Risk Assessment Requirements:

4.4.1 Prior to start of First Piece Qualification, the Supplier must complete a risk assessment of critical processes, in the form of an FMEA.

4.4.2 During PLQ, the Supplier must re-evaluate the FMEA and assess additional risk not initially accounted for. Supplier must address high-risk processes with a risk abatement plan.

4.5 Product Quality Plan Requirements

4.5.1 Test and Inspection Definition

4.5.1.1 Supplier must define all tests and inspections to be performed as part of the PQP.

4.5.1.2 All CTQs located on GE Drawings, Process and Material Specifications must be measured as part of PQP.

4.5.1.3 All Key Control Parameters stated in the MPP must be measured as part of the PQP.

4.5.2 Test and Inspection Procedures

4.5.2.1 Supplier must provide detailed instructions describing how to perform the measurement. Details must include sample size, sample location, number of samples per inspection, and step-by-step procedure.

4.5.2.2 Supplier must define equipment or technique used to make the measurement.

4.5.2.3 Supplier must provide verification of test equipment capability (i.e. gage R&R).

4.5.3 Test and Inspection Frequency

4.5.3.1 Supplier must define the time in the process at which every inspection and test procedure must occur. A Quality Process Flow Chart must be provided as part of the PQP.

4.5.3.2 Supplier must define frequency of every test and inspection (i.e. per blade, per lot, every five blades, etc.).

4.5.4 Test and Inspection Responsibility

4.5.4.1 Supplier must define organization responsible for inspection (i.e. Quality Control, Operations Leader, etc.).

4.5.5 Quality Records

4.5.5.1 All measurements, observations and comments shall be made on a Quality Record, which shall be a separate document from the Work Instructions.

4.5.5.2 The Quality Record shall be contained in a Traveler, which remains with the blade during the entire manufacturing process. The Traveler will ultimately contain all Quality Records for a given blade.

4.5.5.3 The Quality Record must contain measurements of all CTQs for a given process. The Quality Record must also include the nominal values and tolerances for each CTQ as stated on the GE Drawings and Process Specifications.

4.5.6 Tollgates

At the start or completion of a GE defined critical process the Supplier must pass a Tollgate. All Tollgates shall be reflected in the Quality Process Flow Chart, defined previously. See Appendix B for Required Tollgates.

4.5.7 Tollgate Approval Requirements

4.5.7.1 All previous and applicable Quality Records must be present in the Traveler prior to Tollgate approval.

4.5.7.2 Previous Quality Records must be reviewed by Quality Control prior to Tollgate approval.

4.5.7.3 All non-conformances from previous processes must be recorded, addressed and resolved prior to Tollgate approval.

4.5.7.4 Quality Control and Operations Team Leader signoffs are required to officially approve Tollgate.

4.6 First Piece Qualification Requirements

4.6.1 Equipment Certification

4.6.1.1 Certification is required for the specific pieces of equipment listed below. See Appendix C for detailed Technical Requirements for each piece of equipment.

4.6.1.1.1 Blade Molds plus positioning fixtures

4.6.1.1.2 Prefab Molds (i.e. - spar caps, shear webs, etc.)

4.6.1.1.3 Ovens

4.6.1.1.4 Machine plus holding fixtures

4.6.1.1.5 Auxiliary Heating Equipment

4.6.1.2 Raw data files for each individual mold or part shall be reported according to the following requirements:

4.6.1.2.1 File format shall be spreadsheet .xls or .csv.

4.6.1.2.2 One file per individual mold.

4.6.1.2.3 Data coordinate system and origin shall be same as GE model.

4.6.1.2.4 Data shall be compensated for offset (offset removed).

4.6.1.2.5 Column order shall be: point ID, x, y, z.

4.6.1.2.6 Once the first point is listed, there shall be only point data until all data points are listed. There are no blank rows allowed. None-point data is not allowed within point listing.

4.6.1.3 Supplier shall provide equipment certification reports according to the format in Appendix D. The following details shall be included in reports if applicable:

4.6.1.3.1 List each individual point that exceeds profile tolerance by point ID (applies to pattern, individual molds, and blade).

4.6.1.3.2 Separately list tolerance deviations associated with maximum thickness, overbite, and chord length (molded blade only).

4.6.1.3.3 Provide a summary table as follows: maximum positive deviation in the population (nominal plus), maximum negative deviation in the population (nominal minus), deviation range (absolute value between maximum positive and maximum negative), average deviation, standard deviation, number of data points, percentage in tolerance, percentage out of tolerance, listing of data points out of tolerance.

4.6.1.3.4 Provide measurements of all tooling balls.

4.6.1.3.5 Provide measurements of section markings, root start marking and tip end marking (if applicable).

4.6.1.4 Out of tolerance dimensions shall be summarized separately in the report. Further local evaluation should be described in the report.

4.6.2 Material Certification

4.6.2.1 Supplier must provide a list of all materials used for FPQ.

4.6.2.2 Materials list must include supplier name, product number, and product description.

4.6.2.3 Supplier must provide supplier certification documents for all materials used for FPQ.

4.6.2.4 Material Certification must be approved by GE Materials & Processes Engineering.

4.6.3 CAV Requirements:

4.6.3.1 Supplier must complete a full CAV form during First Piece Qualification.

4.6.3.2 GEWE Supplier Quality Engineering must provide CAV form to Supplier prior to FPQ start.

4.6.3.3 CAV form must be signed and dated by GE SQE and responsible party from Supplier.

4.6.4 Blade Cut-Up Requirements

4.6.4.1 After completion and approval of Equipment Certification and the CAV form, the blade produced during FPQ must be destructively evaluated. The purpose of this evaluation is to validate the laminate plan of composite lay-ups, the configuration of shell sections, bond line thicknesses, cure state of the composites and overall quality and fit-up of the part. For detailed Requirements see Appendix E.

4.6.4.2 General Requirements

4.6.4.2.1 Cutting Plan - The Supplier shall provide for approval a detailed sketch of the part detailing the specific cut locations proposed.

4.6.4.2.2 Cut Surface Finish - Surface inspection is used to count plies and determine quality level (i.e. - wrinkles, porosity, etc.). Surface finish of the cut must be such that individual plies are distinguishable from one another.

4.6.4.2.3 Report - Supplier shall provide a report that provides the results according to the requirements. For Tg, report both first and second thermal scan readings.

4.6.4.2.4 Blade Preparation - The blade shall be fully trimmed and finished along the LE, TE and Tip.

4.6.4.2.5 Acceptance Criteria - Visually inspected parts must meet the GE Design Drawing and Process Specification requirements for ply count, wave aspect ratio, FWF and Tg. Any non-conformances, such as ply delamination, dry glass, bond gap voids must be recorded. An e-SDR must be submitted for each non-conformance.

4.7 Pilot Lot Qualification Requirements

4.7.1 After approval of FPQ by GEWE SQE & GEWE Design Engineering, Supplier must complete a full PLQ.

4.7.2 PLQ will consist of a minimum of eight (8) blades, unless determined otherwise by the GE qualification team.

4.7.3 The CAV form must be complete for all eight (8) blades as part of PLQ.

4.7.4 Acceptance Criteria - Supplier must demonstrate the capability to meet all requirements on the CAV form by the last blade produced as part of the Pilot Lot.

4.8 Functional Testing Requirements

4.8.1 Functional testing of the second blade produced during PLQ is required, unless otherwise agreed upon with GE qualification team. The functional testing requirements are as follows:

4.8.2 Static Testing

- Blade Natural Frequency
- Positive Flapwise
- Positive Edgewise
- Negative Flapwise
- Negative Edgewise

4.8.3 Fatigue Testing

- Flapwise
- Edgewise

4.8.4 Post-Fatigue Static Testing

- Positive Flapwise
- Positive Edgewise
- Negative Flapwise
- Negative Edgewise

4.8.5 Upon completion of static, fatigue, and post-fatigue static testing the blade must be destructively evaluated. Blade cut up shall follow requirements in Para. 4.6.4.

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. 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 Deviations - Any deviation from the requirements of this Specification shall be submitted by SDR/QCR for Engineering disposition before the item is shipped.

6. INSPECTION/TEST PROCEDURES AND REQUIREMENTS

6.1 Certificate of Conformance

6.1.1 Internal Supplier - Shall promptly submit the Certificate of Conformance to Manufacturing Quality Assurance.

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

6.1.3 A Certificate of Conformance shall be submitted for each component/fabrication stating that the component/fabrication was 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
- GE Serial Number
- SDR(s)/QCR(s)

6.2 Audit

6.2.1 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.

6.3 Post-Qualification Data Reporting

6.3.1 All CTQs must be measured and recorded.

6.3.2 CTQ data must be reported in process capability charts

7. NOTES

None

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APPENDIX A - FROZEN PROCESSES

A-1. Glass and Foam Kitting

A-1.1 Glass kit drawings/foam kit drawings

A-2. Resin Mixing

A-2.1 HLU Resin Mixing Ratio
A-2.2 Infusion Resin Mixing Ratio
A-2.3 Paste Mixing Ratio

A-3. Spar Cap Manufacturing

A-3.1 HLU Spar Cap Lamination Plan (if applicable)
A-3.2 Infused Spar Cap Consumable Placement (if applicable)
A-3.3 Infused Spar Cap Process Parameters (if applicable)
A-3.4 Spar Cap Cure Cycle Plot
A-3.5 Lifting Process
A-3.6 Storage

A-4. Shear Web Manufacturing

A-4.1 HLU Lamination Plan (if applicable)
A-4.2 Infusion Consumables Placement (if applicable)
A-4.3 Infusion Parameters (if applicable)
A-4.4 Vacuum Level
A-4.5 Cure Cycle Plot

A-5. Pre-Fabricated Root Manufacturing

A-5.1 Consumables Placement
A-5.2 Infusion Parameters
A-5.3 Cure Cycle Plot

A-6. Shell Manufacturing

A-6.1 Consumables Placement
A-6.2 Infusion Parameters
A-6.3 Shell Cure Cycle Plot
A-6.4 Pre-Bonding Surface Preparation
A-6.5 Shear Web Adhesive Application
A-6.6 Shear Web Paste Cure Cycle (open mold)
A-6.7 Dry Fit Process
A-6.8 Mold Closing and Clamping

A-6.9 Closed Blade Cure Cycle Plot

A-7. Blade Finishing

A-7.1 De-molding
A-7.2 Wet Finish
A-7.3 Edge Finishing
A-7.4 Post Cure Cycle Plot
A-7.5 Blade Cutting
A-7.6 Closeout Lamination
A-7.7 Hardware Instillation
A-7.8 Painting
A-7.9 Weighing
A-7.10 Balancing
A-7.11 Lifting/Transportation
A-7.12 Storage

A-8. Packaging

A-8.1 Identification

APPENDIX B – PRODUCT QUALITY TOLLGATES

B-1 Inspection of mold surface and tooling prior to shell lay-up.

B-2 Inspection of pre-fabricated root prior to placement in mold.

B-3 Inspection of spar cap prior to placement in mold.

B-4 Inspection of fabric lay-up and consumable placement prior to shell infusion.

B-5 Inspection of shell infusion quality after cure and removal of consumable materials.

B-6 Inspection of shear web prior to bonding into blade shell.

B-7 Inspection of LE, TE, Main Shear Web and TE Shear Web bond gaps during dry fit process.

B-8 Inspection of bond paste temperature and profile prior to blade closure.

B-9 Review of all temperature profiles prior to removal of blade from mold.

B-10 Inspection of general blade quality (dry glass, waves, cracks, etc.) prior to wet finish and machining.

B-11 Inspection of blade surface quality prior to painting.

B-12 Inspection of blade dimensions prior to weighing and balancing.

B-13 General inspection of blade prior to invoice.

APPENDIX C – EQUIPMENT QUALIFICATION REQUIREMENTS

C-1. Mold Dimensional Reports

C-1.1 Tolerances - Mold surface shall be 60% of blade tolerance. The TE thickness tolerance of the blade mold assembly shall be 80% of the Blade tolerance.

C-1.2 Point Density - For Blade Mold Surfaces the point density shall meet the following minimum averages: from 0% to 62% span, entire surface, 1 point/10cm2 minimum; from 62% to 90% span, 90-100% chord, 1 point/1cm2 minimum; from 62% to 100% span, 0-10% chord, 1point/cm spanwise minimum and 1point/mm chordwise minimum; from 62% to 90% span, 10% - 90% chord, 1 point/5cm2 minimum; from 90% to 100% span, 90-100% chord, 1point/1cm spanwise minimum and 1 point/0.5cm chordwise minimum; from 90% to 100% span, 10-90% chord, 1 point/2cm^2 minimum. Prefab Molds shall be 1 point/10cm^2 average.

C-1.3 Mold Surfaces - Provide report per Appendix D, chapter 1.

C-2 Blade Mold Assembly (Blade Molds Only) - Provide report per Appendix D, chapter 2. Spacing and Alignment in closed position every 500mm minimum.

C-3 Positioning Fixtures - Provide report per Appendix D, chapter 3. Includes Spar Cap, Shear Web and Core Positioning Fixtures. Measure actual versus nominal location of each fixture. Provide ID markings on all fixtures. Provide pictures or drawing of attachment features for Spar Cap and Shear Web Fixtures.

C-4 Mold Visual Inspection - Provide report containing mold identification number, date of inspection, and inspector signature. Visually evaluate the mold for the following issues:

C-4.1 Structural Evaluation (Frame) – visually mark areas that require repair.

- FPI weld joints for cracks
- Visually inspect all weld joints for cracks
- Visually inspect all structural members for bent, scratched, dented damage

C-4.2 Facesheet Evaluation

- Browning (aging), cracks, delamination, surface finish, peeling, markings.

C-4.3 Platform Evaluation

- Plywood flooring deflection, support frame cracks, wheels, locks, grounding attachment.

C-4.4 Functional Evaluation
- Alignment system, clamping system, vacuum system, heating system.

C-5. Vacuum Validation

C-5.1 Record vacuum level at time=0 minutes and every 10 minutes for 1 hour.

C-5.2 Verify vacuum gauge is within calibration cycle and has at least an incremental reading of 0.1% of full vacuum.

C-5.3 If mold equipped with heaters, heat mold to 40°C.

C-5.4 Put breather over 100% of mold surface, then vacuum bag.

C-5.5 After sealing, isolate vacuum bag from pump, turn off pump.

C-5.6 The requirements to be satisfied are (independently), a) min vacuum level 20mbar (equivalently pr≤20mbar), and b) Maximum vacuum loss over 1 hour is 1% of full vacuum.

C-5.7 Follow Appendix D, chapter 6 format.

C-6. Mold Thermal Scanning - IR photographs and recorded temperatures. See detail requirements in Appendix D, chapter 7):

C-6.1 Heat Mold to 40°C, soak, IR photos at 40°C hold.

C-6.2 Heat mold to 70°C, soak, IR photos at 70°C hold.

C-6.3 Follow Appendix D, chapter 7 format.

C-7. Thermal Validation - First Blade (Blade Molds)

C-7.1 Data Collection from heating zones plus special TCs.

C-7.2 Detailed Test Requirements in Appendix D, Chapter 6.

C-7.3 Install TCs prior to infusion.

C-7.4 Record data during infusion and cure.

C-7.5 Install TCs during Main Shear Web installation.

C-7.6 Install TCs during close.

C-7.7 Report format: Follow Appendix D, chapter 8 format.

C-8. Thermal Validation - First Part (prefab molds)

C-8.1 Install TCs on the bag side of the part in thin and thick part regions.

C-8.2 Record data along with control TC.

C-8.3 Report control and part TCs along with map showing location of part TCs.

C-9. Dry Fit Report - no shear webs, Blade Molds

C-9.1 With Suction and Pressure skins infused, no shear webs in place, close molds and measure spacing along LE and TE, and measure for core crash at spacing locations.

C-9.2 Report: Follow Appendix D, chapter 4 format.

C-10. Dry Fit Report - with shear webs, Blade Molds

C-10.1 With Suction and Pressure skins infused and shear webs installed in one side, close molds and measure spacing along Main and TE Shear Webs.

C-10.2 Report: Follow Appendix D, chapter 4 format.

C-11. Blade Dimensional Report

C-11.1 With finished blade supported, measure airfoil surface.

C-11.2 Follow Appendix D, Chapter 1 format. Include description of how blade was supported during inspection.

C-12. Blade Assembly Report

C-12.1 For three (3) production blades, measure and record gap between spacers, TE Thickness and LE/TE Alignment.

C-12.2 Report: Follow Appendix D, chapter 5 format.

C-13. Cutting Machine

C-13.1 Measure and record installed positions of blade supports relative to machine index.

C-13.2 Provide report showing layout of blade supports with dimensions recorded.

C-14. Oven - First Blade

C-14.1 Using TCs from Thermal Validation (Section C-7, record part TCs along with oven TCs.

C-14.2 Report TC data along with layout of oven and blade position.

C-15. Auxiliary Process Heating Equipment

C-15.1 Controller with feedback TC is required.

C-15.2 Set controller to 70°C and turn machine on.

C-15.3 After equilibrium is reached, independently validate the output temperature.

C-15.4 Report controller temperature and independent temperature value.

APPENDIX D - EQUIPMENT QUALIFICATION REPORTING

D-1. Chapter 1 - Dimensional Profile Report Format

D-1.1 Purpose

Include mold identification (include both designations of Pressure/Suction and Fixed/Turning), measuring equipment used, specify data file name (data file should be write-protected).

D-1.2 Reference Documents

Include part drawing revision used for baseline geometry, blade assessment procedure used (list software ID/Rev if applicable), measurement process (differentiate between mold/blade).

D-1.3 Procedure

Describe relevant process information used to analyze and present the data. In particular, describe if the data was gathered at different times due to mold rework or other reason. Define which data was gathered at which time.

Show with pictures the characteristics and orientation of + and – directions associated with measurements for each individual assessment criteria.

D-2. Chapter 2 - Blade Mold Assembly Report Format

D-2.1 Purpose

Include mold identification, measuring equipment used, specify data file name (data file should be write-protected).

D-2.2 Reference Documents

Include part drawing revision used for baseline geometry, blade assessment procedure used (list software ID/Rev if applicable), measurement process.

D-2.3 Procedure

Describe relevant process information used to analyze and present the data. In particular, describe if the data was gathered at different times due to mold rework or other reason. Define which data was gathered at which time.

Show with pictures the characteristic and orientation of + and – directions associated with measurements.

Describe the closing procedure. Include type of closing (hoist, power hinge, etc.), alignment mechanisms (include type and location), and type of clamping including tension control mechanism.

D-2.4 Results

Provide clamp and spacer locations per Figure D-2.4.1. Provide Assembly data per Figure D-2.4.2. Describe in words and provide additional information for each value outside tolerance. Provide raw data in electronic format.

Figure D-2.4.1 - Clamp and Spacer Locations

All dimensions in mm

LE Clamp Locations (z, mm)	LE Spacer Locations (z, mm)	Spacer Type

TE Clamp Locations (z, mm)	TE Spacer Locations (z, mm)	Spacer Type

Figure D-2.4.1 - Assembly Data

All dimensions in mm

Z position	Spacer Gap, mm	TE Thickness		LE Gap		TE Flange Spacing		LE Flange Spacing		Overbite	
		Nominal	Actual	Nominal	Actual	Nominal	Actual	Nominal	Actual	LE	TE

D-3. Chapter 3 - Positioning Fixtures Report Format

D-3.1 Purpose

Include mold identification, measuring equipment used, specify data file name (data file should be write-protected).

D-3.2 Reference Documents

Include part drawing revision used for baseline geometry, blade assessment procedure used, measurement equipment.

D-3.3 Procedure

Describe relevant process information used to analyze and present the data. In particular, describe if the data was gathered at different times due to mold rework or other reason. Define which data was gathered at which time.

Show with pictures or drawings of the attachment feature of the Spar Cap and Shear Web positioning fixtures to the frame. Attachment points shall be constructed such that fixture has a positive locking feature. Excess play between fixture and frame attachment point is not allowed.

Provide evidence that each individual fixture has a permanent marking which indicates the applicable blade mold set, type of fixture, applicable location attachment point.

Show with pictures or drawings the characteristic and orientation of + and – directions associated with measurements.

D-3.4 Results

Provide dimensional results per Figure D-3.4.1. Describe in words and provide additional information for each value outside tolerance.

Figure D-3.4.1 - Dimensional Results

Shear Web Fixtures (for 2 webs with 1 fixture, show value for each web)

Fixture ID	Z Position (mm)	Measured Value (mm)	Nominal Value (mm)	Difference (mm)	Vertical Alignment (degrees)

Spar Cap and Core Position Fixtures

Fixture ID	Z Position (mm)	Measured Value (mm)	Nominal Value (mm)	Difference (mm)

D-4. Chapter 4 – Dry Fit Report Format

D-4.1 Purpose

Include mold identification, measuring equipment used, specify data file name (data file should be write-protected).

D-4.2 Reference Documents

Include part drawing revision used for baseline geometry, blade assessment procedure used (list software ID/Rev if applicable), measurement process (differentiate between mold/blade).

D-4.3 Procedure

Describe relevant process information used to analyze and present the data. In particular, describe if the data was gathered at different times due to mold rework or other reason. Define which data was gathered at which time.

D-4.4 Results

Provide dimensional results per sketch #5 (for items not applicable denote 'NA'). Describe in words and provide additional information for each value outside tolerance.

Figure D-4.4.1 - Dimensional Results

All dimensions in mm

Z position	TE Bondline	LE Bondline	Main Shear Web Bondline (1)	TE Shear Web Bondline (2)	LE Bond Cap Bondline[2]

(1) If multiple webs, show each.

(2) If applicable

D-5. Chapter 5 – Blade Assembly Report Format

D-5.1 Purpose

Include mold identification (include both designations of Pressure/Suction and Fixed/Turning), measuring equipment used.

D-5.2 Reference Documents

Include part drawing revision used for baseline geometry and measurement process (differentiate between mold/blade).

D-5.3 Procedure

Describe relevant process information used to analyze and present the data. In particular, describe if the data was gathered at different times due to mold rework or other reason. Define which data was gathered at which time.

Show with pictures the characteristics and orientation of + and – directions associated with measurements for each individual assessment criteria (twist, shift, overbite, surface).

D-5.4 Results

Provide tables formatted in accordance with Figure D-5.4.1 (for both Pressure Side and Suction Side). Describe in words and provide additional information for each value outside tolerance.

Provide raw data in electronic format.

Figure D-5.4.1 - Blade Assembly Report Format

Blade Serial Number _____

Mold Spacer Data

LE Spacer Location	Gap (mm)

TE Spacer Location	Gap (mm)

Molded Blade Data (3)

Z Position	LE Overbite (mm)	TE Overbite (1) (mm)	TE Thickness (2) (mm)

(1) From 0 to widechord
(2) From widechord to tip
(3) Include graphs per sketch #1 for Overbites and Thickness also

D-6. Chapter 6 - Vacuum Validation Report Format

D-6.1 Purpose

Include mold identification (include both designations of Pressure/Suction and Fixed/Turning), measuring equipment used.

D-6.2 Reference Documents

Include part drawing revision used for baseline geometry and measurement process (differentiate between mold/blade).

D-6.3 Procedure

Describe relevant process information used to analyze and present the data. In particular, describe if the data was gathered at different times due to mold rework or other reason. Define which data was gathered at which time.

D-6.4 Results

Provide tables formatted in accordance with Figure D-6.4.1.

Describe in words and provide additional information for each value outside tolerance.

Provide raw data in electronic format.

Figure D-6.4.1 - Vacuum Validation Report Format

Pressure side

Time, (minutes)	Pressure, (mbar)
0	
10	
20	
30	
40	
50	
60	

Suction side

Time, (minutes)	Pressure, (mbar)
0	
10	
20	
30	
40	
50	
60	

D-7. Chapter 7 - Mold Thermal Scanning Report

D-7.1 Test Requirements

D-7.1.1 Emissivity (Blade Molds Only) - Verify the emissivity values before measuring mold face temperatures. For each mold, report the selected emissivity of the pyrometer. Emissivity shall be verified by checking against actual temperature at z=1m. A suggested procedure is as follows. When mold set point is at 40°C, stick a tape with known emissivity, i.e. a black electrical tape with emissivity of 0.96, onto the target (mold surface at z=1m) and turn the emissivity setting to 0.96. Then point to untapped surface; adjust emissivity to give the same reading.

D-7.1.2 Surface Temperature Variation at 40°C - For all zones, set the feedback temperature (set point) to 40°C. After reaching set point, wait 30 minutes and then collect mold surface temperature. The allowable surface temperature variation is ± 5°C over the entire surface.

D-7.1.3 Ramp rate Variation (Blade Molds Only) - Set the ramp rate to 1°C/min (or 30 minutes ramp time) with initial and final temperatures (controller feedback temperatures) of 40°C and 70°C, respectively. Acquire and report mold controller feedback temperatures over the ramp time and up to 15 minutes after 70°C is reached. Simultaneously, measure mold surface temperatures at three (3) different points along chord (LE 100mm from split line, TE 100mm from cut line, and at the center of the main spar cap) at every 3-meter increments of span. Make sure that one set of surface temperatures is recorded at time=0 (start of ramp time). The allowable deviation from the nominal ramp rate is ±0.2°C/minute (or ±20% deviation, or 25 to 38 minutes ramp time). Then compile a table (in Excel) with column headings of Time, Controller ID, Controller feedback temperature, controller program (segment), mold surface temperature. Attached the Excel file as a supporting document.

D-7.1.4 Surface Temperature Variation at 70°C - For all zones, set the feedback temperature (set point) to 70°C. After reaching set point, wait 30 minutes and then collect mold surface temperature. The allowable surface temperature variation is ±5°C over the entire surface.

D-7.2 Report Format

D-7.2.1 Purpose

Include mold identification, measuring equipment used, specify data file name (data file should be write-protected).

D-7.2.2 Reference Documents

Include part drawing revision used for baseline geometry, blade assessment procedure used, and measurement equipment.

D-7.2.3 Procedure

Describe relevant process information used to analyze and present the data. In particular, describe if the data was gathered at different times due to mold rework or other reason. Define which data was gathered at which time.

Describe the set up information - All data shall be gathered within the applicable range and settings appropriate. Provide a listing of Camera Manufacturer, Model Number, and list the basic settings used to collect data. There should also be a calibration check prior to collecting data.

Describe and report the value of emissivity and the process of its validation. For example, state; Mold set point, Type of method, e.g. tape or TC, Emissivity of tape (if tape), Temperature of tape, Emissivity before and after adjustment

D-7.2.4 Results - Thermographs

For each report, indicate date, inspector's name, and adjusted emissivities.

For the blade molds, photo shall not exceed 8 meters in length.

Image Presentation - Provide thermograph information as for example Figure D-7.2.4.1.

Each image must present a header indicating the section number and span location.

Scale - The scale must be shown in image or next to thermograph image. The scale must be set so that visual differences can be seen by eye in 5°C increments. The color bar legend must be adjusted such that it'd show the set point in the middle of the range.

Local Readings - Local readings shall be included in the thermograph image. This shall include minimum and maximum readings for the zone being evaluated.

Average Reading - For a given section, use the software to calculate average, median, maximum, minimum temperature. These values should be shown next to the image.

D-7.2.5 Results - Ramp Rate

Report the time/temperature data in an X-Y plot similar to the as for example Figure D-7.2.5.1. Select the legend such that there are no graphs with duplicate legends - if necessary breakdown into three, four or multiple plots. In addition to that, populate an Excel table (as for example Figure D-7.2.5.2.) with raw data from all controllers. Attach the Excel file to report as a supporting document.

Report the corresponding the surface temperatures in table similar to Figure D-7.2.5.3.

Figure D-7.2.4.1 - Image Presentation

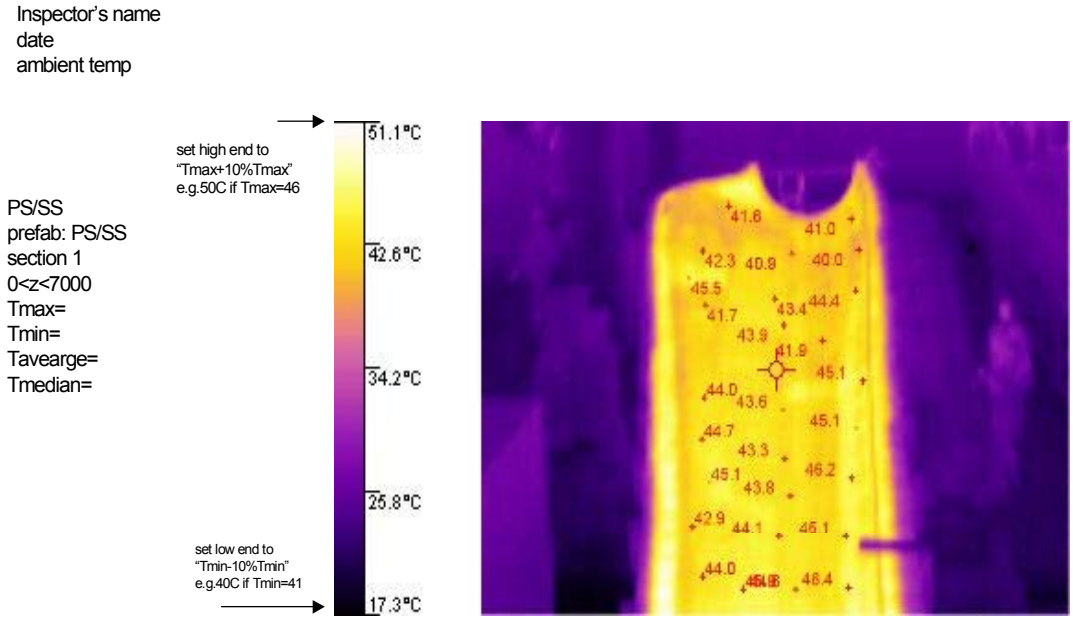

Figure D-7.2.5.1 - Ramp Rate

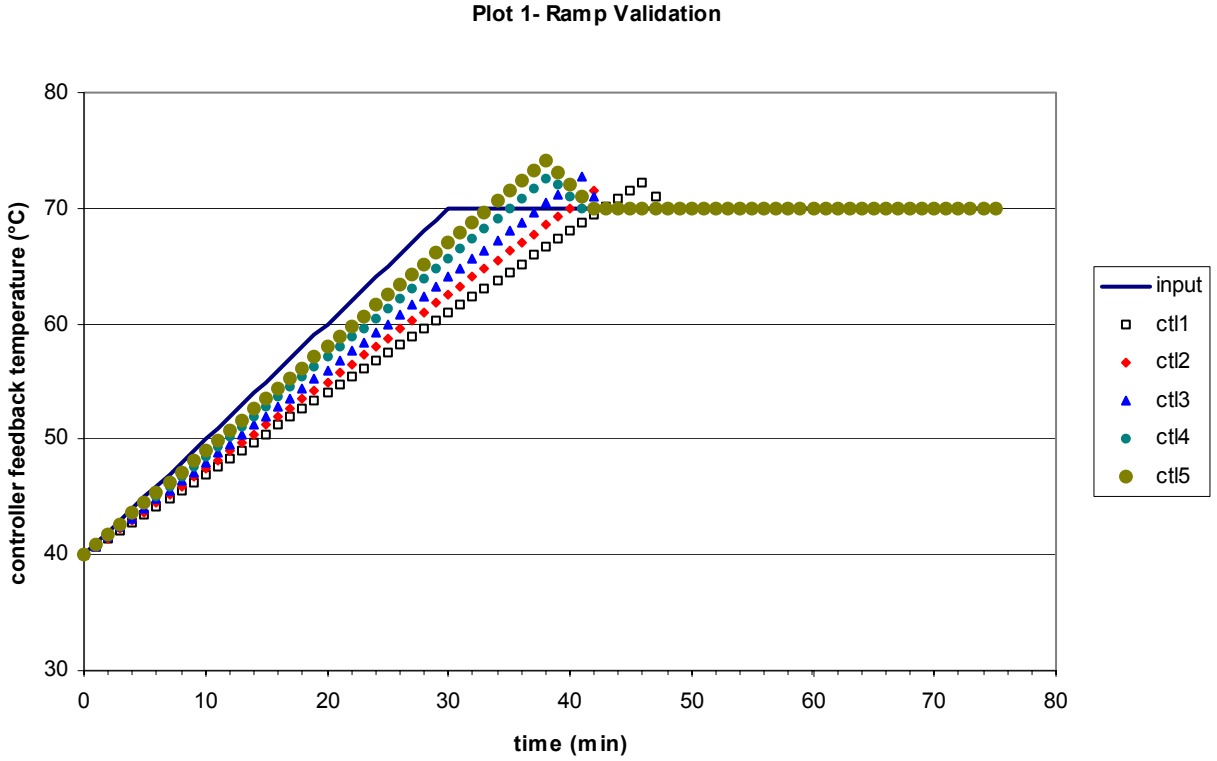

Figure D-7.2.5.2 - Excel Data

Figure D-7.2.5.3 - Ramp Rate Report

Time, (minutes)	Control Point No.1	Temperature (°C)
0		
1		
2		
3		
…		
…		
…		
30		
…		
…		
…		
60		

z, span (mm)	x, chord	Time, h:m	Temperature (°C)
300	100 from LE		
	center of spar cap		
	100 mm from TE cut line		
3000	100 from LE		
	center of spar cap		
	100 mm from TE cut line		
6000	100 from LE		
	center of spar cap		
	100 mm from TE cut line		
9000	100 from LE		
	center of spar cap		
	100 mm from TE cut line		
12000	100 from LE		
	center of spar cap		
	100 mm from TE cut line		
	Etc.		

D-8. Chapter 8 - Blades and Prefabs Thermal Validation

D-8.1 The following instructions apply to the first blade that is produced in a new or modified mold.

D-8.2 Temperature data from the PS and SS and Prefab molds' surfaces: prior to lay up in molds, apply surface thermocouples (TC) onto the molds' surfaces. The TCs are to be placed at:

z = 9000mm, 400mm from LE split line (Z=200mm, at the bottom center, for Root Prefab molds)

z = 18,000mm, 400mm from TE cut line.

D-8.3 Acquire the data from said thermocouples electronically during shells infusion, procure and during post cure.

Temperature data from blade: Tables D-8.3.1-4 list TCs that shall be installed prior to close. Acquire data from these Tc during post cure and up to de-mold of the blade.

Table D-8.3.1- On the rotating side (1)

z (mm)	TE adhesive	LE adhesive	Main Shear Web adhesive, – rotating side bond
9,000	-	-	One TC
15,000	-	-	One TC
20,000	-	-	One TC
25,000	-	-	One TC
30,000	-	-	One TC
35,000	-		One TC
40,000	-	-	One TC
45,000	-	-	One TC

(1) Install all TCs before close and before adhesive has hardened.

Table D-8.3.2- On the fixed side (1)

z (mm)	TE adhesive	LE adhesive	Main Shear Web adhesive, – rotating side bond
9,000	One TC	One TC	One TC
15,000	One TC	One TC	One TC
20,000	One TC	One TC	One TC
25,000	One TC	One TC	One TC
30,000	One TC	One TC	One TC
35,000	One TC	One TC	One TC
40,000	One TC	One TC	One TC
45,000	One TC	One TC	One TC

Table D-8.3.3- On the rotating side (2)

z (mm)	Chord
2,300	100mm from main spar cap, TE side of Main Shear Web
9,000	400mm for LE split line
18,000	400mm for TE cut line
23,000	200mm for LE split line
25,000	300mm for TE cut line
30,000	200mm for LE split line
35,000	300mm for TE cut line
40,000	200mm for LE split line
45,000	300mm for TE cut line

(2) Install before close - on the laminate.

Table D-8.3.4 - On the rotating side (2)

z (mm)	Chord
2,300	100mm from main spar cap,TE side of Main Shear Web
9,000	400mm for LE split line
18,000	400mm for TE cut line
23,000	200mm for LE split line
25,000	300mm for TE cut line
30,000	200mm for LE split line
35,000	300mm for TE cut line
40,000	200mm for LE split line
45,000	300mm for TE cut line

Acquire the data from said TCs electronically during entire processing, starting with lay up.

D-8.4 Report Format

D-8.4.1 Purpose

Include blade identification, measuring equipment used, specify data file name (data file should be write-protected).

D-8.4.1.1 Reference Documents

Include part drawing revision used for baseline geometry, blade assessment procedure used, and measurement equipment.

D-8.4.1.2 Procedure

Describe relevant process information used to analyze and present the data. In particular, describe if the data was gathered at different times due to mold rework or other reason. Define which data was gathered at which time.

D-8.4.1.3 Results

For the Blade mold surface TC (at z=9,000 and 18,000mm) and Root Prefab mold surface TC (at z=200mm), plot the data as in Figure D-8.4.1. Additionally, present electronic version of the data in an Excel file similar to Figure D-8.4.2.

For the blade bondlines, laminate and mold surface temperatures, plot the data similar to Figures D-8.4.3, D-8.4.5, and D-8.4.7 respectively. Additionally, present electronic version of the data in an Excel file similar to Figures D-8.4.4, D-8.4.6, and D-8.4.8 respectively.

Figure D-8.4.1
PS or SS Mold Surface Temperature During Infusion and Precure

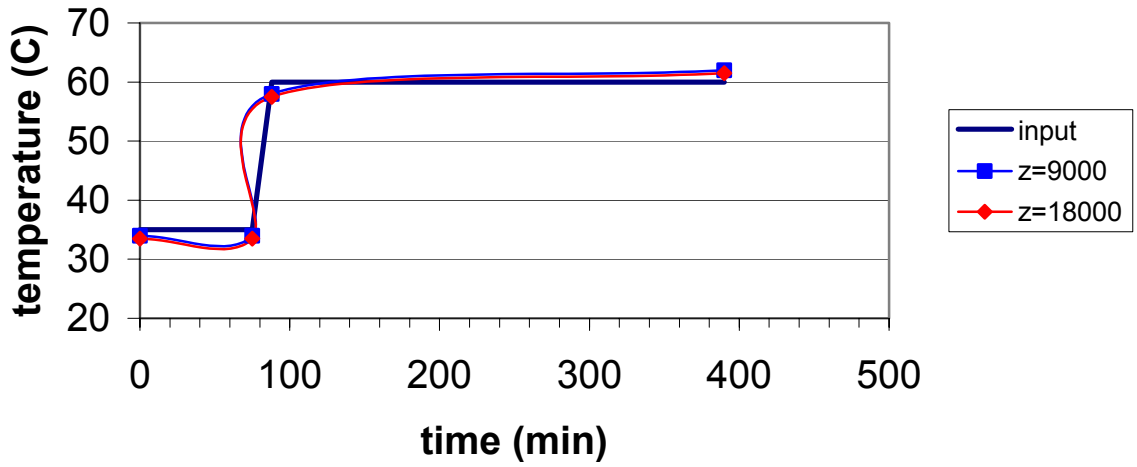

Figure D-8.4.2- Mold Surface During RIM and Pre-Cure

Time (minutes)	Temperature (°C), at z=9000	Or prefab mold temperature, (°C) at z=200	
1			Start of RIM
2			
3			
…			
…			
…			
…			End of pre-cure.

Figure D-8.4.3
PS or SS Adhesive ("paste")Temperature

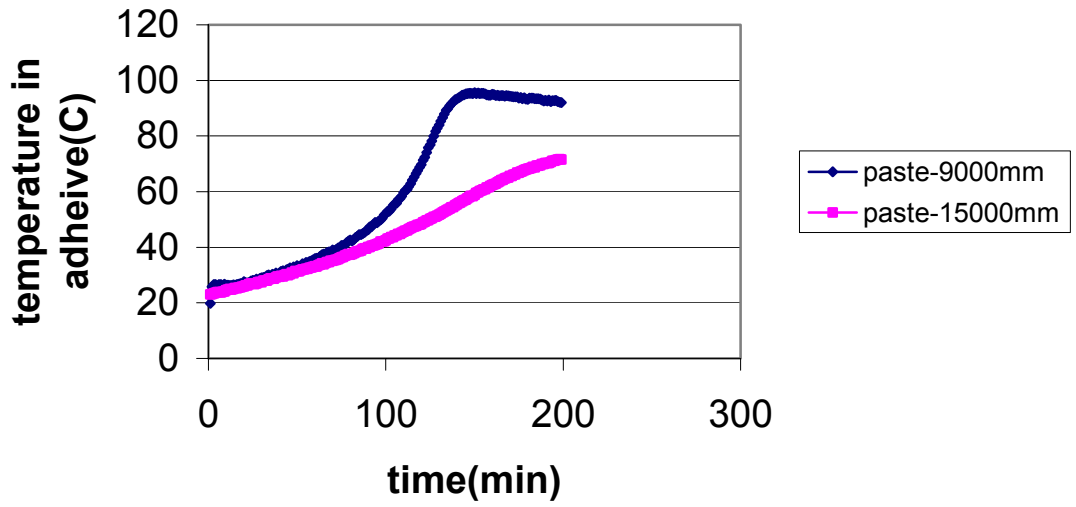

Figure D-8.4.4 - Adhesive Temperature

Time, minutes	Adhesive at 9,000mm (°C)	Adhesive at 15,000mm (°C)	
1	19.8	23	Start of post cure
2	25.8	23.2	
3	26.6	23.4	
4	26.6	23.6	
5	26.1	23.8	
.			
.			
.			De-mold

Figure D-8.4.5
PS or SS- Laminate Temperature

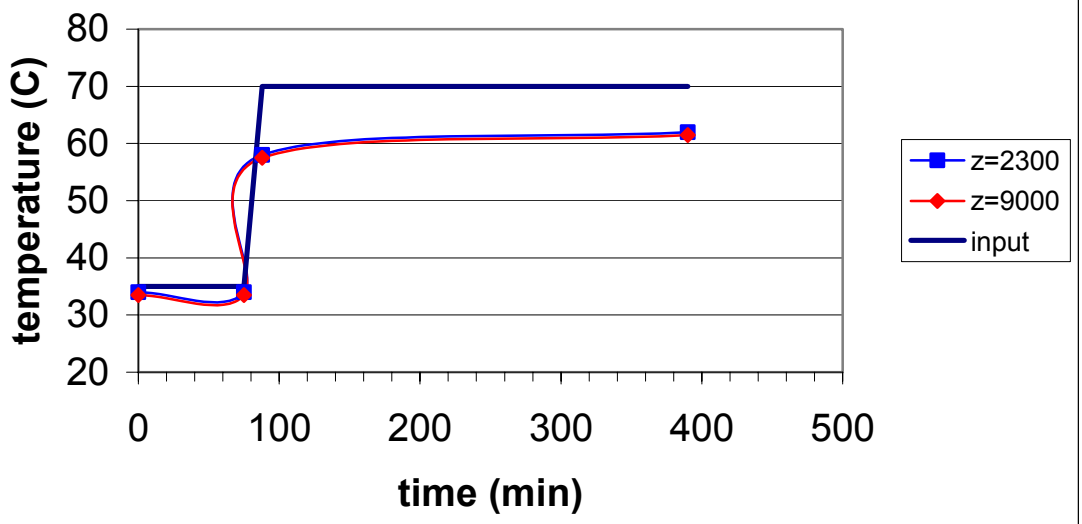

Figure D-8.4.6 - Laminate Temperature During Post-Cure

Time (minutes)	Temperature (°C), at z=2300	Temperature (°C), at z=9000	
0			Start of post-cure
1			
2			
3			
…			
…			
…			End of post-cure

Figure D-4.8.7

PS or SS Mold Surface Temperature during Post cure

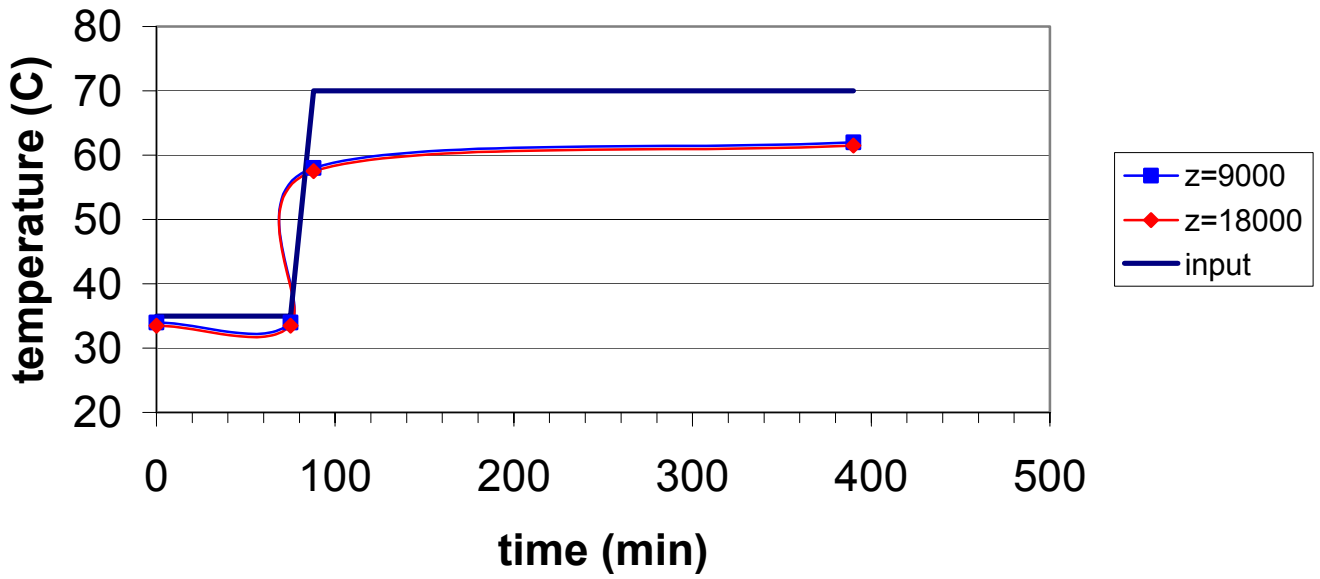

Figure D-8.4.8 – Mold Surface Temperature During Post-cure

Time (minutes)	Temperature (°C), at z=9000	Temperature (°C), at z=18,000	
0			Start of post-cure
1			
2			
3			
…			
…			
…			End of post-cure

APPENDIX E – BLADE CUT-UP REQUIREMENTS

E-1. Root Evaluation

E-1.1 Cut Ring - Circumferential cut a ring between the tip end of barrel nuts and the beginning of the spar cap, spanwise thickness 20mm minimum.

E-1.2 Mark ring - With a visible maker, identify LE, TE, and Z position. Identify quadrants by number. Photograph prior to further cutting and include in report.

E-1.3 Cut Quadrants - Divide the ring in quadrants with the LE at 3 o'clock and the TE at 9 o'clock. Cut into 4 quadrants.

E-1.4 Validate number of plies - count and record the number of plies in each quadrant. Note any variation in the report on the number of plies.

E-1.5 Defect review - Record in the report the maximum A/R within each quadrant along with the circumferential distance from the LE or TE. Note any other defects (porosity, foreign material, etc.) along with the circumferential distance from the LE or TE.

E-1.6 Properties - From the center of each quadrant, measure the Fiber Weight Fraction per GE Design Drawings. From the inner surface (bag side) of each quadrant, measure the Tg per GE Material Specifications. Evaluate pre-fab root/infused root interface. Record data in the report.

E-2. Root Transition Evaluation

E-2.1 Cut Ring - Circumferential cut a ring from 50 mm minimum before the beginning of the core until 50 mm minimum after the full core thickness is obtained.

E-2.2 Mark ring - With a visible maker, identify LE, TE, Z position and quadrants by number. Photograph prior to further cutting and include in report.

E-2.3 Cut Quadrants - Cut a spanwise strip in each quadrant at least 20mm wide the full length of the ring.

E-2.4 Validate number of plies - Count and record the number of plies in each strip. Note any variation in the report on the number of plies.

E-2.5 Defect review - Record in the report the maximum A/R within each quadrant along with the spanwise distance. Note any other defects

(porosity, foreign material, etc.) along with the circumferential distance from the LE or TE. Evaluate overlaminates for number of plies and waves.

E-2.6 Properties - From an area with the thickest core in each strip, measure the Fiber Weight Fraction per GE Design Drawings. From the inner surface (bag side) of each strip, measure the Tg per GE Material Specifications. Evaluate pre-fab root/infused root interface. Record data in the report.

E-3. Spar Caps Evaluation

E-3.1 Mark Spars - With a visible maker, Z position of each section prior to cutting.

E-3.2 Cut Spars - Cut in spanwise direction full length and visually inspect for wrinkles.

E-3.3 Validate number of plies - Count and record the number of plies (if applicable) in each section and measure the thickness. Note any variation in the report on the number of plies.

E-3.4 Defect review - Record in the report the maximum A/R within each quadrant along with the spanwise distance. Note any other defects (porosity, foreign material, etc.) along with the circumferential distance from the LE or TE.

E-3.5 Properties - From an area with the thickest spar laminate, measure the Fiber Weight Fraction per GE Design Drawings. Record data in the report.

E-4. TE UD Evaluation

E-4.1 Mark TE UD - With a visible marker, Z position of each section prior to cutting.

E-4.2 Cut TE UD - Cut in spanwise direction full length and visually inspect for wrinkles.

E-4.3 Validate number of plies - Count and record the number of plies in each section and measure the thickness. Note any variation in the report on the number of plies.

E-4.4 Defect review - Record in the report the maximum A/R within each quadrant along with the spanwise distance. Note any other defects

(porosity, foreign material, etc.) along with the circumferential distance from the LE or TE.

E-4.5 Properties - From an area with the thickest TE UD laminate, measure the Fiber Weight Fraction per GE Design Drawings. Record data in the report.

E-5. Bond Line Evaluation

E-5.1 Mark Z Position - With a visible maker, Z position of each section prior to cutting.

E-5.2 Cut Bondlines - Cut a chordwise section approximately every 2 meters and approximately 100mm wide (spanwise).

E-5.3 Validate Bond Line Thickness - For each section and location, record in report Z position, BL Type (LE/TE/SW), maximum and minimum thickness at each BL.

E-5.4 Defect review - Record in the report any defects (porosity, foreign material, etc.) along with the Z position and BL type.

E-5.5 Properties - For each BL Type, extract a Tg sample from the middle of the thickest bondline. Record in the report BL Type, Z position, BL Thickness, and Tg.

E-6. Core Fit-up

E-6.1 Mark Z Position - With a visible maker, Z position of each section prior to cutting.

E-6.2 Cut Sections - Cut a chordwise section approximately every 2 meters and approximately 100mm wide (spanwise).

E-6.3 Validate Fit-up - For each section, both LE and TE sides, and location, record in report Z position, Core maximum thickness, Core maximum gap, Fiberglass maximum A/R, and core edge distance.

E-6.4 Defect review - Record in the report any defects (porosity, foreign material, etc.) along with the Z position and BL type.

E-7. TE Spar Cap Evaluation

E-7.1 Mark TE Spar - With a visible marker, Z position of each section prior to cutting.

E-7.2 Cut TE Spar - Cut in spanwise direction full length and visually inspect for wrinkles.

E-7.3 Validate number of plies - Count and record the number of plies in each section and measure the thickness. Note any variation in the report on the number of plies.

E-7.4 Defect review - Record in the report the maximum A/R within each quadrant along with the spanwise distance. Note any other defects (porosity, foreign material, etc.) along with the circumferential distance from the LE or TE.

E-7.5 Properties - From an area with the thickest spar laminate, measure the Fiber Weight Fraction per GE Design Drawings. Record data in the report.

E-8 Other Items - Down conductor attachment points, lightening receptor position.