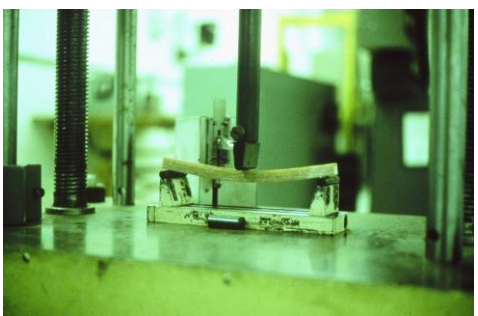




LAMINATE CERTIFICATION MANUAL

2017 Edition



**Fiberglass Reinforced
Plastics Institute, Inc.**

210 Park Avenue, #8
Worcester, MA 01609

508-380-2232 www.frpi.org

Copyright 2017

FOREWORD

The FRPI Laminate Certification Manual first came into being in 2004 out of need to help industry bridge gaps between Fiberglass Reinforced Plastic (“FRP”) chemical process equipment industry standards and regulate Manufacturer compliance with such standards as they compete under heavy commercial pressures to deviate from these contract requirements. The Manual is composed of Standard Practices, Laminate Specifications and Specification Bulletins. Standard Practice SP9000 Laminating Process (“Manufacturer”) Certification was introduced as a guidance document for vetting and qualification of a Manufacturer’s knowledge, capabilities and experience. Quantifying and certifying their breadth and depth of expertise. Standard Practice SP9100 Laminate (“Equipment”) Certification was introduced to provide guidance for auditing compliance of a Manufacturer’s FRP equipment against contract specifications and industry standards on a project by project basis. Ultimately endorsing their satisfactory execution against project requirements. Laminate Specifications were developed as initial industry efforts to standardize common FRP laminate designs and simplify laminate specification by use of alphanumeric references similar to how metals and thermoplastics are specified. Specification Bulletins had been written to provide minimum FRP laminate treatment requirements for specialized post-curing plus storage tank cleaning for water treatment chemical, foodstuff and pharmaceutical materials applications. As of this 2017 publication date, a very large coalition of Wastewater and Drinking Water Treatment Industry professionals have claimed through experience with FRPI certification per SP9000/SP9100 that these practices are Industry’s best practice for obtaining reliable FRP chemical storage tanks plus odor and air pollution control equipment. Pulp and Paper plus Chemical Processing industries have also begun utilizing practices governed by this Manual.

This Manual is a “Reviewed” document by the FRPI Board of Advisors, which is a balanced group of industry professionals including Owners (end users), Engineering Firms, FRP Consultants and Equipment Manufacturers. The FRPI website lists the individuals who currently make up the Board. With firsthand experience specifying and going through the FRPI Certification process plus owning Certified equipment, the original Board of Advisors reviewed and unanimously voted on acceptance of the FRPI Laminate Certification Manual as a “Reviewed” and accepted document on November 21, 2005. This initial document was called the 2004 Edition. The Board was staffed with seven (7) professional engineers, one (1) of which was the Chairman of the ASME RTP-1 committee for nine (9) years. Industry and the general public have continually been invited to contact FRPI and comment on the Certification processes controlled by the Manual. This invitation to industry for comments has been publicly offered on the FRPI website since 2005. Feedback has resulted in publication of the 2008 and 2017 editions, as well as multiple interim updates of SP9000 and SP9100 practices. Feedback has been obtained from a very large diverse ever-growing audience over the years, which has been put before the FRPI Board under various document reviews and helped develop the Manual contents to what it is today. All comments will be taken into consideration by the Board for future editions of the Manual.

The 2017 Laminate Certification Manual is an update to the 2008 Manual version, including revised Standard Practices SP9000 and SP9100, supplemental Laminate Specifications plus updated introductory pages and table of contents. FRPI thanks Industry and its Board of Advisors for their contributions to this Manual, interest in utilizing the practices contained herein and support resulting in sustainability of FRPI’s quality verification initiatives for years to come.

MANUAL CONTENTS

REF #	DESCRIPTION	PAGE #
	MANUAL COVER	1
	Foreword	2
	Manual Contents	3
	SECTION 1 – STANDARD PRACTICES	
	Standard Practices Introduction	5
SP9000	Laminating Process Certification	6
SP9100	Laminate Certification	28
	SECTION 2 – LAMINATE SPECIFICATIONS	
	Laminate Specifications Introduction	43
	Generic Resin Types	45
	Laminate Specification Series by Resin Type (more features listed in spec) –	
	<i>ISOPHTHALIC POLYESTER LAMINATES with CB SL:</i>	
LS100	(1) C-Glass veil and MEKP/CoNap cure system	46
LS110	(2) C-Glass veils and MEKP/CoNap cure system	50
LS120	(1) Synthetic Polyester veil and MEKP/CoNap cure system	54
LS130	(2) Synthetic Polyester veils and MEKP/CoNap cure system	58
	<i>FIRE RETARDANT HALOGENATED ISOPHTHALIC POLYESTER LAMINATES with CB SL:</i>	
LS200	(1) C-Glass veil and MEKP/CoNap cure system	62
LS220	(1) Synthetic Polyester veil and MEKP/CoNap cure system	66
	<i>CHLORENDIC ACID POLYESTER LAMINATES with CB SL:</i>	
LS300	(1) C-Glass veil and MEKP/CoNap cure system	70
LS310	(2) C-Glass veils and MEKP/CoNap cure system	74
LS320	(1) Synthetic Polyester veil and MEKP/CoNap cure system	78
LS330	(2) Synthetic Polyester veils and MEKP/CoNap cure system	82
	<i>BISPHENOL-A POLYESTER LAMINATES with CB SL:</i>	
LS400	(1) C-Glass veil and MEKP/CoNap cure system	86
LS410	(2) C-Glass veils and MEKP/CoNap cure system	90
LS420	(1) Synthetic Polyester veil and MEKP/CoNap cure system	94
LS430	(2) Synthetic Polyester veils and MEKP/CoNap cure system	98
	<i>BISPHENOL-A EPOXY VINYL ESTER LAMINATES with CB SL:</i>	
LS500	(1) C-Glass veil and MEKP/CoNap cure system	102
LS501	(1) C-Glass veil and MEKP/CoNap cure system with Brom Bis-A EVE SL	106
LS510	(2) C-Glass veils and MEKP/CoNap cure system	110
LS520	(1) Synthetic Polyester veil and MEKP/CoNap cure system	114
LS530	(2) Synthetic Polyester veils and MEKP/CoNap cure system	118

REF	DESCRIPTION	PAGE #
	SECTION 2 – LAMINATE SPECIFICATIONS (continued)	
	<i>BISPHENOL-A EPOXY VINYL ESTER LAMINATES with CB non-SL:</i>	
LS502	(1) C-Glass veil and MEKP/CoNap cure system	122
LS503	(1) C-Glass veil and MEKP/CoNap cure system with FR SL	126
LS514	(2) C-Glass veil and MEKP/CoNap cure system with 192 mil CB	130
LS515	(2) C-Glass veil and MEKP/CoNap cure system with 192 mil CB and FR SL	134
LS532	(2) Synthetic Polyester veils and MEKP/CoNap cure system	138
LS533	(2) Synthetic Polyester veils and MEKP/CoNap cure system with FR SL	142
LS572	(2) Synthetic Polyester veils and DMA-DEA/BPO cure system	146
LS573	(2) Synthetic Polyester veils and DMA-DEA/BPO cure system with FR SL	150
	<i>FIRE RETARDANT BROMINATED BISPHENOL-A EPOXY VINYL ESTER LAMINATES with CB SL:</i>	
LS600	(1) C-Glass veil and MEKP/CoNap cure system	154
LS620	(1) Synthetic Polyester veil and MEKP/CoNap cure system	158
	<i>FIRE RETARDANT BROMINATED BISPHENOL-A EPOXY VINYL ESTER LAMINATES with CB non-SL:</i>	
LS602	(1) C-Glass veil and MEKP/CoNap cure system, Dual Class Fire Rating	162
LS672	(2) Synthetic Polyester veils and DMA-DEA/BPO cure system with Bis-A EVE SL	166
LS673	(2) Synthetic Polyester veils and DMA-DEA/BPO cure system with FR SL	170
	<i>EPOXY NOVOLAC VINYL ESTER LAMINATES with CB SL:</i>	
LS700	(1) C-Glass veil and MEKP/CoNap cure system	174
LS710	(2) C-Glass veils and MEKP/CoNap cure system	178
LS720	(1) Synthetic Polyester veil and MEKP/CoNap cure system	182
LS730	(2) Synthetic Polyester veils and MEKP/CoNap cure system	186
	<i>FIRE RETARDANT BROMINATED EPOXY NOVOLAC VINYL ESTER LAMINATES with CB SL:</i>	
LS800	(1) C-Glass veil and MEKP/CoNap cure system, Class I Fire Rating	190
LS820	(1) Synthetic Polyester veil and MEKP/CoNap cure system, Class I Fire Rating	194
	<i>FURAN (“Furfuryl Alcohol”) LAMINATES with CB SL:</i>	
LS900	(1) C-Glass veil and Acidic Catalyst cure system	198
LS910	(2) C-Glass veils and Acidic Catalyst cure system	202
	SECTION 3 – SPECIFICATION BULLETINS	
	Specification Bulletins Introduction	206
SB01	Level I Engineered Post-Cure (Convection Oven)	207
SB02	Level II Engineered Post-Cure (Forced Dry Clean Hot Air)	211
SB03	Preparation for Food Grade and High Purity Product Contact (Cleaning)	215
	SECTION 4 – RIGHTS AND RESPONSIBILITIES	
	Rights and Responsibilities Introduction	218
	Standard Terms and Conditions of Sale	219
	Code of Ethics	220
	Privacy Policy	221

Section 1 – STANDARD PRACTICES

FRPI offers two (2) standard practices, “SP9000 Laminating Process (“Manufacturer”) Certification” and “SP9100 Laminate (“Equipment”) Certification”. These Standard Practices contain the requirements for Manufacturers to follow in order to obtain FRPI Certification for their Laminating Process and Laminates for specific projects on a job-by-job basis.

All of these Standard Practices are intended to be procedural specifications for managing material quality verification methods and are not intended to replace or be substitutes for industry equipment, inspection and testing standards. Proper manufacturing of FRP equipment is the Manufacturer’s responsibility, where published industry standards shall be followed.

 July 17, 2017	Fiberglass Reinforced Plastics Institute, Inc. www.frpi.org LAMINATING PROCESS CERTIFICATION	Standard Practice SP9000
--	--	--------------------------------

PART 1 GENERAL

1.1 PURPOSE AND SCOPE:

- A. The Fiberglass Reinforced Plastics Institute (“FRPI”) has made all of its publications and services available for the betterment of business conditions, with the use of these resources understood to be voluntary on everyone’s part. Additionally, specification of and involvement in the Laminating Process Certification is intended to be a voluntary initiative on the part of Owners, Engineers, Intermediaries and Manufacturers.
- B. This Standard Practice covers requirements that shall be met by a Manufacturer in order for them to obtain and hold a valid FRPI Laminating Process Certification.
- C. Laminating Process Certification is intended to assure that Fiberglass Reinforced Plastic (“FRP”) Equipment Manufacturers –
 1. Have adequate materials and mechanical engineering, production equipment, laminate manufacturing processes, inventory, secondary bonding methods, service plus quality control and assurance capabilities in place that are necessary for the production of laminates meeting all FRPI Laminate Specifications published at the time of their audit for Certification.
 2. Have demonstrated over five (5) years minimum experience manufacturing all FRPI laminate designs as specified within the FRPI Laminate Specifications, with the exception of Furan Laminate Specifications. This five (5) years of experience required includes any and all product manufacturing categories for which Laminating Process Certification is sought, as well as individual areas of the Manufacturer’s business that supports the laminating process as audited by the procedures within SP9000.
 3. Will deliver laminate quality as required by all FRPI Laminate Specifications, without any exclusion, exception or alternatives to Laminate Specifications required of either:
 - a. The Owner, Owner’s Agent, Engineer and/or Intermediary
 - b. Standard Practices, Laminate Specifications and Specification Bulletins published by FRPI
 4. Can fulfill the requirements of FRPI Laminate Certification Standard Practice SP9100 on a job-by-job basis.
- D. FRPI does not “approve”, “rate” or otherwise “endorse” any item, construction, proprietary device or activity other than as is represented within FRPI Standard Practices SP9000 and SP9100. Furthermore, FRPI Laminating Process and Laminate Certification shall not be interpreted to mean endorsement by FRPI of a Manufacturer’s technical capability to perform design work related to the equipment for which they were contracted to provide to the Owner, Owner’s Agent, Engineer and/or Intermediary.

- E. Certification is based upon a Manufacturers successful demonstration of their capability as outlined within this Standard Practice, which is initiated through –
 - 1. Submitting records for review plus samples for inspection, testing and analysis
 - 2. Facilitating an onsite audit of their records and laminating process capability
 - 3. Allowing FRPI to interview and test personnel instrumental to laminating
- F. FRPI offers to Manufacturers a Laminating Process Certification opportunity for one (1) or a combination of the following six (6) product component categories, wherein such category or categories manufacturing limitations may be imposed as detailed within the Manufacturer's Certified Laminating Process certificate issued at time of award –
 - 1. Tanks and Vessels only (Certification number is followed by the suffix “-T”)
 - 2. Odor and Air Pollution Control Vessels only (Certification number is followed by the suffix “-V”)
 - 3. Ductwork only (Certification number is followed by the suffix “-D”)
 - 4. Custom Pipe only (Certification number is followed by the suffix “-P”)
 - 5. Components only (Certification number is followed by the suffix “-C”)
 - 6. All Equipment (Certification number is not followed by a suffix)
- G. A candidate Manufacturer shall have all three (3) of the following laminating process capabilities in operation with over five (5) years' experience with each process in order to be considered for FRPI Certification –
 - 1. Hand Lay-up (“HLU”), rotating and stationary component molds.
 - 2. Spray-up (“SU”), rotating and stationary component molds.
 - 3. Filament Winding (“FW”), rotating molds.
- H. Only the specific laminating processes audited by FRPI may be used to produce candidate laminates for FRPI Laminate Certification.
- I. Laminating processes performed off of the Manufacturer's premises fall outside the scope of this FRPI Standard Practice SP9000.
- J. Manufacturers that operate an FRPI Certified Laminating Process are recognized as having capabilities in place that support the production of laminates that consistently meet the intent of the published FRPI Standard Practice for Laminating Process Certification.
- K. Laminating Process Certifications are valid for one (1) year from date of issuance.

1.2 DEFINITIONS:

- A. The following definitions shall apply to this Standard Practice –
 - 1. The Owner (“Owner”) is the company that takes possession of the new equipment.
 - 2. The Owner's Agent (“Owners Agent”) is the company that supports the Owner by offering their expertise on FRP related matters and/or performs FRP related work on the behalf of the Owner. The Owners Agent is also referred to as an Industry Consultant (“Consultant”) by FRPI, who is an individual employed by a company that primarily supplies advice, statistics, reports or other consultative services to the FRP industry.
 - 3. The Engineer (“Engineer”) is the company that performs project engineering on behalf of the Owner.
 - 4. The Intermediary (“Intermediary”) is either a Contractor (“Contractor”) or Original Equipment Manufacturer (“OEM”), where the Contractor performs facility construction and the OEM assembles and sells a complete process system incorporating the Manufacturer's equipment.

5. The Manufacturer (“Manufacturer”) is the company that manufactures the laminates and fabricates the equipment either directly for the Owner or an Engineer or Intermediary appointed by the Owner.
6. The Fiberglass Reinforced Plastics Institute (“FRPI”) is the Non-profit membership organization certifying compliance to this Standard Practice.

1.3 REFERENCE STANDARDS:

- A. The most recently published standards at the time a contract requiring Laminating Process Certification is entered into shall govern requirements imposed on the Manufacturer as they apply to the administration of this Standard Practice.
- B. In the event of conflict, inconsistency or ambiguity between these Reference Standards, the specific project requirements and/or FRPI requirements, the following Order of Precedence shall govern where laminate quality and conformance to FRPI requirements are questioned –
 1. FRPI requirements, as published in FRPI Standard Practices, Laminate Specifications and Specification Bulletins
 2. Specific project requirements, as documented in FRP equipment procurement contracts plus related drawings and specifications
 3. Reference Standards
- C. American Society for Testing and Materials (“ASTM”) –
 1. ASTM C582 - Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion Resistant Equipment
 2. ASTM D638 - Standard Test Method For Tensile Properties of Plastics
 3. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
 4. ASTM D2471 - Test Method for Gel Time and Peak Exothermic Temperature of Reacting Thermosetting Resin
 5. ASTM D2563 - Standard Recommended Practice for Classifying Visual Defects In Glass Reinforced Plastic Laminates
 6. ASTM D2583 - Standard Test Method for Indentation Hardness of Rigid Plastics By Means of a Barcol Impressor
 7. ASTM D2584 - Standard Test Method for Ignition Loss of Cured Reinforced Resins
 8. ASTM D2996 - Filament-Wound Reinforced Thermosetting Resin Pipe
 9. ASTM D3299 - Standard Specification for Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Chemical Resistant Tanks
 10. ASTM D3982 - Standard Specification for Contact Molded “Fiberglass” Duct and Hoods
 11. ASTM D4097 - Standard Specification for Contact-Molded Glass-Fiber Reinforced Thermoset Resin Chemical-Resistant Tanks
 12. ASTM D5421 - Standard Specification for Contact Molded “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) Flanges
 13. ASTM D6041 Standard Specification for Contact Molded “Fiberglass” Pipe and Fittings
- D. American Society of Mechanical Engineers (“ASME”) –
 1. ASME RTP-1 - Reinforced Thermoset Plastic Corrosion Resistant Equipment
- E. Fiberglass Reinforced Plastics Institute (“FRPI”) –
 1. FRPI SP9100 - Standard Practice for Laminate Certification

2. FRPI LS500 - Laminate Specification for series 500 Bis-A Epoxy Vinyl Ester Laminates with One (1) C-Glass Veil and MEKP/CoNap Cure System
3. FRPI LS2010 - Laminate Specification for series 2010 Brominated Bisphenol-A Epoxy Vinyl Ester Laminates Intended for Sodium Hypochlorite Service
4. FRPI SB01 - Level I Engineered Post-cure
5. FRPI SB02 - Level II Engineered Post-cure
- F. Occupational Safety and Health Administration (“OSHA”) –
 1. 29 CFR 1910 - Safety and Health Regulations for General Industry
 2. 29 CFR 1926 - Safety and Health Regulations for Construction

1.4 SUBMITTALS:

- A. All submittals shall be received by FRPI within thirty (30) days of the Manufacturer’s audit date, which has been confirmed by FRPI in writing.
- B. Submittals shall include –
 1. Transmittal Cover Sheet, with list of submittals enclosed
 2. Organization chart illustrating all positions currently filled, with position titles
 3. Resumes for the following positions:
 - a. President
 - b. Technical Leader
 - c. Employed and/or Outsourced Engineers
 - d. Inspector
 - e. Plant/Operations Manager
 4. Description of how Manufacturer goes to market (i.e. direct, original equipment manufacturers, independent sales representatives and/or distributors)
 5. References containing dimensions of permanent molds used to laminate major components for products Laminating Process Certification is sought for.
 6. Technical data sheets for primary resins, resin additives and reinforcements incorporated into equipment manufactured.
 7. Design basis laminates for laminate types Laminating Process Certification is sought for, including the following properties:
 - a. Tensile strength and modulus
 - b. Flexural strength and modulus
 - c. Glass content for structural layer with and without corrosion barrier included (corresponding with strengths of materials submitted)
 8. Shop and field operations quality control and assurance manual
 9. Shop operations safety manual, per OSHA 29 CFR 1910
 10. Field operations safety manual, per OSHA 29 CFR 1926
 11. Five (5) year procurement history of subcontracted engineering services if utilized, including name of engineering firm and annual expense.
 12. Estimated volume of clear unfilled and non-pigmented laminate that will be ready for the FRPI Auditor to inspect, which is in the process of being:
 - a. Laid up for major components manufactured by the Hand Lay-up, Spray-up and Filament Winding process. Estimate in pounds for each process, with component types and sizes in square feet per each stated.
 - b. Laid up for flanges. Estimate in number of flanges, with sizes stated.
 - c. Fabricated into equipment. Estimate in pounds.
 13. Copy of documentation for company and personnel achievements:
 - a. ISO 9000
 - b. ASME RTP-1 Accreditation

- c. ASME Section X Accreditation
 - d. NBIC ANSI/NB-23 “RP” Stamp
 - e. Employee ACMA Certifications
 - f. Formal supplier quality recognition
 - g. Other
14. Physical properties used in design for contact molded Type I and II plus filament wound Type X laminates, with demonstration substantiating such properties consistent with ASTM D638, D790, D2584 and C582 plus ASME RTP-1 2A-300 practices as proof of achievement.
15. Sample submittal from previous project within the past five (5) years per requirements of FRPI SP9100, to include:
- a. Engineering calculations
 - b. Fabrication drawings
 - c. Post-cure procedure
 - d. Three (3) cutouts
 - e. In process and final inspection records
 - f. Owning and operating manual
16. One (1) sample panel:
- a. The sample panel shall meet the latest requirements of –
 - 1) FRPI LS672 Laminate Specification for Manufacturer’s applying for either the Tanks and Vessels only, Odor and Air Pollution Control Vessels only, Custom Pipe only or All Equipment product component categories described in Section 1.1 F.
 - 2) FRPI LS602 Laminate Specification for Manufacturer’s applying for the Ductwork only or Odor and Air Pollution Control Vessels only product component category described in Section 1.1 F.
 - b. Panel shall be 12” wide by 12” long, +/- 1/16” on each side, square within +/- 0.3 degrees and flat edge to edge within 3/16”.
 - c. The structural layer shall be composed of five (5) layers of random strand mat alternated with woven roving, for a theoretical thickness of 0.195” per ASTM C582.
 - d. The cut edges of the panel shall be ground smooth. No resin finish coat shall be applied to cut edges.
 - e. A ¼” hole shall be drilled through the panel, a fastener shall join a label to the panel via the hole and the label shall have the Manufacturer’s name, specification number followed and date of completion written on it.
 - f. Inspection and testing shall follow FRPI Laminate Specification requirements and ASME RTP-1 2A-400, where visual acceptance under ASTM D2563 Air Bubble (void) Level II for Corrosion Barrier shall consider air entrapment down to a diameter of 0.4 mm (1/64-in).
 - g. A detailed drawing illustrating panel construction requirements per this practice shall be submitted to FRPI for acceptance prior to manufacturing sample(s). Such illustration shall be in accordance with FRPI SP9100 submittal requirements for fabrication drawings.
17. Sample stub flanges:
- a. Manufacturers shall submit samples representative of their products –
 - 1) Tanks and Vessels only Manufacturers submit only pipe samples.
 - 2) Ductwork only Manufacturers submit only duct samples.
 - 3) Custom Pipe only Manufacturers submit only pipe samples.

- 4) Odor and Air Pollution Control Vessels only plus All Equipment Manufacturers submit duct and pipe samples.
- b. Two (2) sample duct stub flanges shall be 8"ID and manufactured in accordance with the minimum requirements of ASTM D3982 –
 - 1) Samples shall include one (1) Flange on Pipe and one (1) Integral style stub flange, both with bolt holes per Referenced Standards.
 - 2) The sample stub flanges shall meet the latest requirements of FRPI LS602 Laminate Specification.
- c. Two (2) sample pipe stub flanges shall be 6"ID and manufactured in accordance with the minimum requirements of ASME RTP-1 –
 - 1) Samples shall include one (1) Flange on Pipe and one (1) Integral style stub flange, both with bolt holes per Referenced Standards.
 - 2) The sample flanges shall meet the latest requirements of FRPI LS672 Laminate Specification.
 - 3) The stub flange structural thicknesses shall be rated for 50 psig pressure at ambient temperature.
- d. Each sample stub flange submitted shall be –
 - 1) Cut into two (2) equal pieces, with the cut through the stub, hub and flange on major centerlines between boltholes.
 - 2) The cut edges shall be ground smooth. No resin finish coat shall be applied to cut edges.
- e. A ¼" hole shall be drilled through the stub in all pieces, a fastener shall join a label to the pieces via the hole and the label shall have the Manufacturer's name, specification number followed and date of completion written on it.
- f. Inspection and testing shall follow referenced industry standards and FRPI Laminate Specification requirements, where visual acceptance under ASTM D2563 Air Bubble (void) Level II and ASME RTP-1 Gaseous Bubbles or Blisters Level 1 and 2 for Corrosion Barrier shall consider air entrapment down to a diameter of 0.4 mm (1/64-in).
- g. A detailed drawing illustrating stub flange construction requirements per this practice shall be submitted to FRPI for acceptance prior to manufacturing sample(s). Such illustration shall be in accordance with FRPI SP9100 submittal requirements for fabrication drawings.

PART 2 GENERAL CONDITIONS FOR AUDIT

2.1 MINIMUM MANUFACTURER'S SIZE, EXPERIENCE AND VOLUME:

- A. A Manufacturer shall be capable of processing a volume of laminate typical for a quarter million-dollar equipment project such that it does not strain the quality capabilities of their laminating process.
- B. The following Manufacturer's minimum size and fiberglass reinforced plastics experience requirements have been established at time of audit –
 1. Average of no less than fifteen (15) fulltime employees maintained over three (3) year period.
 2. Greater than or equal to 95% of workforce directly employed fulltime by Manufacturer.
 3. Forty (40) years average combined fiberglass reinforced plastics experience of the President, Technical Leader, Inspector and Plant/Operations Manager.

- C. The following Manufacturer's minimum average volume of laminate produced over the last five (5) year period, as evidenced by invoices paid, shall be –
 - 1. 130,000 pounds of resin purchased per year.
 - 2. 1/4 gallon of dimethyl aniline (DMA) promoter purchased per year.
 - 3. 10 gallons of benzoyl peroxide (BPO) catalyst purchased per year.
 - 4. 16,000 square feet of synthetic polyester surface veil purchased per year.
 - 5. DMA/BPO and synthetic polyester surface veil experience does not apply to Ductwork only Manufacturers.

2.2 MANUFACTURING ACTIVITY REQUIRED AT TIME OF AUDIT:

- A. Minimum requirements for manufacturing activity have been established to help quantify scope of capability and extent of experience plus facilitate enough laminating activating that exemplifies the Manufacturer's process during the audit. All requirements covered in this Standard Practice shall be readied by the Manufacturer prior to the Auditor's arrival and available for witness during the audit.
- B. The Manufacturer is encouraged to properly prepare for and staff the audit, such that the Manufacturer can address unexpected requirements during the days of and on the evening between the two (2) day audit.
- C. Laminating activity required to be performed in the presence of the FRPI Auditor shall be in the range of the following mix of material as approved by the Auditor –
 - 1. The following volume of laminate with a clear unfilled and non-pigmented corrosion barrier shall be laid up and cured for major components:
 - a. 3,000 pounds for Hand Lay-up, with as an example one (1) component at least 200 sf or four (4) components at least 75 sf each.
 - b. 1,500 pounds for Spray-up, with as an example one (1) component at least 500 sf or four (4) components at least 125 sf each.
 - c. 1,200 pounds for Filament Winding, with as an example one (1) piece at least 500 sf or eight (8) pieces at least 30 sf each.
 - 2. Ten (10) flanges being laid up.
 - 3. 10,000 pounds of laminate components being fabricated.
- D. Management and leadership required to be available as needed during audit –
 - 1. President.
 - 2. Technical Leader.
 - 3. Inspector.
 - 4. Plant/Operations Manager.
 - 5. Purchasing.
 - 6. and others that the Manufacturer may choose.

2.3 ADDITIONAL TERMS AND CONDITIONS:

- A. The terms of agreement contained in the Code of Ethics, Privacy Statement plus Terms and Conditions of Sale published on the FRPI website, as well as within this Standard Practice and contained in FRPI price quotations to the Manufacturer, are considered to be mutually agreed upon by the Manufacturer and FRPI upon the Manufacturer's return of a signed FRPI quotation agreement and/or FRPI's collection of the audit fee as paid by the Manufacturer.
- B. Only FRPI approved auditors that utilize the FRPI audit procedures can conduct an audit of a Manufacturer's laminating process.

- C. Manufacturers who apply for Laminating Process Certification are required to purchase, understand and unconditionally agree with the contents and all provisions of the FRPI Certification Manual, which contains all of the Standard Practices, Laminate Specifications and Specification Bulletins at the time it ships. The Manual shall be purchased before a date can be agreed on for the FRPI audit.
- D. Any Manufacturer requesting an audit per this Standard Procedure by FRPI shall be deemed to have consented to the entry of the FRPI Inspector or their designated representative upon the premises during regular business hours of operation for the purpose of determining whether the Manufacturer satisfies the intent of the requirements contained in this Standard Practice. The auditor shall be granted free and open access to the facility, people and FRP components for two (2) consecutive week days totaling twenty (20) hours per audit. In the event a Manufacturer is awarded Laminating Process Certification, they also agree to at least two (2) annual unannounced audits by FRPI at FRPI's discretion for the purpose of verifying the Manufacturer still meets the requirements of FRPI SP9000.
- E. The Manufacturer shall have all individual and assembled fiberglass reinforced plastic components plus OSHA required permits and certifications available for inspection by The FRPI Auditor upon their arrival –
 - 1. The equipment shall be positioned to permit reasonable and safe access for inspection. This includes the Manufacturer's supply of such things as ladders, platforms and OSHA 29 CFR 1910 compliant permitting procedures required for access to inspect the inner and outer surfaces of the equipment.
 - 2. All components and assemblies shall be free of dust, clean and adequately illuminated for inspection purposes.
 - 3. Access to the interior of assembled components deemed to be a confined space shall be oriented in such a way as to facilitate a side entry. The Manufacturer, along with all personnel other than the entrant, shall provide all equipment necessary for confined space entry. OSHA compliant certification for specific personnel designated as the confined space entry team shall be furnished.
- F. The Manufacturer shall have available as needed and allow the FRPI representative to utilize all of their inspection tools for the purpose of inspecting the quality of FRP equipment.
- G. An audit is both a demonstration of capability by the Manufacturer and investigation into evidence by FRPI that substantiates Manufacturer's capability as demonstrated by systems, equipment, inventory, personnel, records and history of successful implementation. It is the Manufacturer's responsibility to demonstrate to the FRPI Auditor their capability as required by this standard practice, within the timeframe allotted herein. Backup information for all submittals shall be on hand during the audit for validation purposes.
- H. All Manufacturers shall demonstrate at the time of audit a minimum of five (5) years history of experience pertaining to FRPI SP9000 requirements in order to be eligible for certification, unless other such periods of time or measurements are otherwise stated elsewhere in SP9000.
- I. All laminating procedures and laminates on the Manufacturer's shop floor at the time of audit shall meet the minimum requirements of Referenced Standards and FRPI SP9000, unless the Manufacturer specifically identifies at the start of the audit such deviations and corrective action acceptable to the FRPI auditor.
- J. Manufacturers operating an FRPI Certified Laminating Process who perform Engineered Post-cure operations per FRPI SB02 agree to not substitute Level II Post-cure in place of a Level I per FRPI SB01 without the Owner, Owner's Agent, Engineer

- or Intermediaries prior written approval when Level I is exclusively specified as the Post-cure process.
- K. FRPI, FRPI Certified Manufacturers and FRPI Members are the only organizations or individuals that can use the FRPI Company, Trade and Service Names and/or Marks. Use of these Names and/or Marks by Manufacturers and Members shall only be permitted with written agreement from FRPI.
 - L. FRPI reserves the right to make changes to all publications and resulting Certification programs, as it deems appropriate. Such changes will become binding on Certificate holders upon SP9000 Laminating Process Certification renewal and entering into purchase agreement under SP9100 Laminate Certification.

PART 3 LAMINATING PROCESS CAPABILITY AUDIT

3.1 MATERIALS AND MECHANICAL ENGINEERING:

- A. Engineering personnel –
 - 1. The Manufacturer shall have a Minimum five (5) years experience with FRP materials and mechanical engineering, with submittal work prepared by either or all of the following:
 - a. Technical Leader, who may support Manufacturer's outsourcing of engineering services from time to time in order to meet requirements of given projects.
 - b. Engineer, with four (4) year degree in mechanical or structural engineering.
 - c. Engineer, with Professional Engineer license.
 - 2. Manufacturers that subcontract engineering services shall:
 - a. Utilize the services of an Outsourced Engineer who is commercially known to specialize in and routinely perform FRP equipment design consistent with most current industry standards and practices.
 - b. Demonstrate history of experience over past five (5) years purchasing Outsourced Engineering services, with at least five (5) separate projects completed.
 - 3. Where Manufacturer engages newly employed Technical Leaders, direct hired engineers and/or Outsourced Engineers in work pertaining to FRPI certification per SP9100 other than those vetted during SP9000 certification auditing, demonstration of such new individual's expertise shall be provided to FRPI in advance of performing such work in accordance with SP9000 requirements.
 - 4. Provide evidence showing licensed professional engineers utilized have sufficient expertise and responsible charge with appropriate direction over drawing content such that drawings accurately illustrate licensed engineer's work and their review of as evidenced by their stamp applied thereto. Evidence shall also substantiate the absence of conflict of interest between any interested parties. Expertise shall be shown to span a minimum of five (5) years as a fulltime professional practice, where sufficient proof of practice shall be provided.
 - 5. Technical Leaders, engineers, licensed engineers and Outsourced Engineers whose credentials are submitted by Manufacturer as a requirement of SP9000 and who may be utilized by Manufacturer on FRPI related projects shall be advised by Manufacturer of vetting conducted by FRPI as it pertains to their potential and actual project work associated with SP9000 and SP9100.

6. Technical Leader reports clearly and exclusively to President and/or Manufacturer's engineering department.
- B. Manufacturer's Technical Leader shall maintain a complete standards library for and demonstrate complete familiarity with –
 1. Manufacturer's company standards
 2. Industry standards:
 - a. ASTM Section 8 covering Plastics, as referenced within FRPI SP9000, SP9100 and related Laminate Specifications.
 - b. ASME RTP-1.
 - c. Manufacturer's preferred commercial building codes.
 - d. FRPI Standard Practices, Laminate Specifications and Specification Bulletins.
- C. Manufacturer shall demonstrate Technical Leader's and/or Outsourced Engineer's proficiency in designing laminate thicknesses and support or restraint requirements, which take into account the following loads where appropriate: pressure, temperature, chemistry, span, thermal expansion and contraction, snow/ice/liquid, wind and seismic. Evidence shall include previous project submittals including equations, calculations or computer programs used.
- D. Manufacturer shall demonstrate Technical Leader's and/or Outsourced Engineer's proficiency in one (1) of the following computer design programs –
 1. Lamination Analysis Program (i.e. Trilam, Superlam).
 2. Stress Analysis (i.e. Caesar II, Algor PipePak, CAEPIPE, TRIFLEX).
 3. Finite Elemental Analysis, with color plotting.
- E. Manufacturer's product proposals shall be derived from sound engineering methods, which are in accordance with the Reference Standards.
- F. Manufacturer shall demonstrate the capability to maintain an established and ongoing verification of material design basis and shall at time of SP9000 audit and continually thereafter demonstrate proof of properties utilized in design as condition of SP9000 Certification and as required for Certification per SP9100 –
 1. Mechanical properties verification per ASTM D638 and D790.
 2. Glass content and laminate sequence per ASTM D2584 and C582.
 3. Barcol Hardness per ASTM D2583.
 4. Written comparison of findings to engineered design.
- G. Manufacturer shall have computer drawing capability, with Auto CAD or equivalent.
- H. Manufacturer shall demonstrate they maintain an ongoing annual training and education program –
 1. In house training for at least two (2) of these groups:
 - a. Sales.
 - b. Engineers and designers.
 - c. Production.
 - d. Maintenance.
 2. Active membership maintained in and annual conference attendance at least one (1) of these organizations as condition of SP9000 Certification:
 - a. American Composites Manufacturers Association ("ACMA").
 - b. National Association of Corrosion Engineers ("NACE").
 - c. Technical Association of the Pulp & Paper Industries ("TAPPI").
 - d. American Society of Mechanical Engineers ("ASME").
 - e. American Society for Testing and Materials ("ASTM").

- I. Manufacturer's Technical Leader and Plant/Operations Manager shall take a test –
 - 1. The Technical Leader and Plant/Operations Manager take same test live together in same place or complete it online individually with correct answers from both tests combined by FRPI to determine score if in different locations.
 - 2. Closed door and open book with time limit.
 - 3. Conducted live during audit or online and scored at a later date.
 - 4. Minimum score of 80 percent out of 100 to pass.
 - 5. Actual score communicated with results of audit.

3.2 RESIN MIXING:

- A. The Manufacturer shall maintain a separate area for resin mixing operations plus demonstrate engineering control under direction of Technical Leader of resin formulation and utilization during laminating as dictated by engineering work performed and shown on corresponding drawings or other such documentation.
- B. A logbook shall be maintained, which includes traceability for –
 - 1. Quality control of incoming resin shall include a Certificate of Analysis from suppliers for all materials received.
 - 2. Quality control for other related chemicals.
 - 3. Temperature monitoring for mixing room and resin.
 - 4. Humidity monitoring for mixing room as condition of SP9000 Certification.
 - 5. Resin gel time testing per ASTM D2471 as condition of SP9000 Certification.
 - 6. Labeling of resin batch contents.
 - 7. Dating of materials received and mixed batches, with materials past their shelf life or expiration date clearly identified and located in a separate area.
- C. Scientific instruments and mechanical equipment typically found in a laboratory shall be in place to demonstrate capability for –
 - 1. Liquid measurement.
 - 2. Weight measurement.
 - 3. Mixing.
 - 4. Cleaning of equipment.
 - 5. Providing a safe, dry and temperature managed storage for all chemicals.
- D. No less than two (2) months of inventory shall be on hand to verify laminating volume requirements.

3.3 REINFORCEMENT LAYOUT AND CUTTING:

- A. The Manufacturer shall maintain a separate area for reinforcement layout and cutting operations plus demonstrate engineering control under direction of Technical Leader of reinforcement cutting and placement during laminating as dictated by engineering work performed and shown on corresponding drawings or other such documentation. Control shall include generating instructions for reinforcement cutting that reflects fiber orientation, laminate sequence, glass content, exotherm layers, surface area dimensions, total thickness, taper and overlaps within the finished laminate.
- B. Prepared reinforcement shall be identified for traceability to specific components and jobs.
- C. A clean area shall be maintained to minimize foreign inclusions.
- D. All reinforcement materials shall be stored in a dry area and kept clean.
- E. No less than two (2) months of inventory shall be on hand to verify laminating volume requirements.

3.4 MATERIAL STORAGE AND HANDLING:

- A. Manufacturers shall demonstrate sufficient raw material, and in process and completed equipment storage and handling procedures as required by this practice.
- B. Raw Material –
 - 1. All resins, additives, cure systems, reinforcements and other such materials that go into the manufacture of laminates shall be stored and handled in accordance with the material supplier's recommendations.
 - 2. Secondary containment shall be provided as required by law.
 - 3. Proper material transportation and dispensing equipment shall be evident.
- C. Equipment components and completed fabrications –
 - 1. Proper support and protection from damage shall be provided.
 - 2. Material handling apparatus and vehicles shall be evident.
- D. Storage and handling shall protect and preserve quality of materials received and manufactured.
- E. Outdoor storage shall sufficiently protect materials from weather, including precautionary measures addressing elements such as water, ice and snow removal, and anchoring.
- F. Prevent potential damage caused by excessive loads, vegetation growth, nearby traffic, and/or other neighboring stored materials.
- G. Inspect stored materials to be certain their stored state is safe, free from damage and environmentally sound.
- H. Clean stored materials to render in like new condition prior to use and/or shipment.

3.5 MOLDS, JIGS, FIXTURES AND TOOLING:

- A. Manufacturers shall have on hand a substantial amount of molds, jigs, fixtures and tooling necessary to laminate a complete line of typical components for the products for which they seek Laminating Process Certification.
- B. Molds, jigs, fixtures and tooling shall be of sound construction and in very good condition, such that they are capable of producing components within the tolerances and laminate quality specified in the Referenced Standards.
- C. Molds, jigs, fixtures and tooling shall be stored, setup and prepared for laminating so as to prevent or overcome surface deterioration that could compromise the consolidation and/or shape of the laminate and/or smoothness of finished laminate surfaces, resulting in distorted laminates with pits, porosity, air inclusions or other such visual defects that may compromise laminate performance.
- D. Molds, jigs, fixtures and tooling used for the manufacture of laminates for flange on pipe and integral flanges shall be such that the flanges meet the requirements of Reference Standards, with regards to sizes, dimensions and tolerances. Molds, jigs, fixtures and tooling used for integral flanges shall include sizes 2" thru 24" diameter.
- E. Tank and Vessel only plus Odor and Air Pollution Control Vessels only component Manufacturers tooling shall include as minimum –
 - 1. Horizontal and/or vertical rotating tooling meeting the size range and dimensions as per ASTM D3299 Part 8 Dimensions and Tolerances, including Table 7 Standard Tank Inside Diameter ("ID"). Additional tooling shall also include: 168" ID size. Where the ID tolerance shall be +/- 1%, including out of roundness. Tank sizes 24" and 30" may be stationary tooling, whereas all other cylinder sizes shall be rotating tooling.

2. Rotating cylindrical molds shall be at least 8' in length or height.
 3. Full-face flange molds for each size of cylindrical mold shall meet ASTM D3299 Table 2 and D4097 Table 4 Reinforcing Flanges for Open-Top Tanks plus ASME RTP-1 Table NM2-1 Typical Body Flange Dimensions.
 4. ASME flanged and dished, flat plus Toriconical (45 degree Cone head with ASME knuckle radius) head molds for each size of cylindrical mold. Shape and dimensions of all head mold shall equal those published in the Reference Standards, where ASME heads shall have crown radius equal to tank diameter and knuckle radius 6% of crown radius with straight flange. Conical section of 45 degree heads may be temporary tooling.
- F. Ductwork only component Manufacturers tooling shall include as minimum –
1. Horizontal rotating tooling shall meet the size range and dimensions as per ASTM D3982 Part 7 Dimensions, including Figure 4 Standard Duct Dimensions. Sizes 1 ¼", 1 ½" and 2 ½" are not required.
 2. Rotating cylindrical molds shall be at least 10' long.
 3. Full-face flange plus 45 and 90 degree sweep elbow molds for each size of cylindrical mold up to 48" diameter conforming to ASTM D3982 standard.
 4. Concentric and eccentric reducer molds for all transitions between each size of cylindrical molds ranging from 2" to 48" diameter conforming to ASTM D3982 standard, where ductwork shall also include 5:1 reduction. Reducers may be permanent or temporary tooling.
 5. Elbows, tees and laterals greater than 48" diameter may be fabricated from cylinder sections, but shall conform to ASTM D3982 standard.
 6. End cap molds for sizes ranging from 12" to 96" diameter shall be ASME dish with crown radius equal to duct diameter, knuckle radius equal to 6% of crown radius and straight flange.
 7. Capability to fabricate custom diameters, transitions and other shapes.
 8. Rectangular molds shall be provided with integral radius corner laminate designs.
- G. Custom Pipe only component Manufacturers tooling shall include as minimum –
1. Horizontal rotating tooling shall meet the size range and dimensions as per ASTM D2996 Table 4 and D6041 Part 8.1 Dimensions and Tolerances for Inside Diameter ("ID") Series Pipe. shall
 2. Rotating cylindrical molds shall be at least 10' in length for 1" and 1 ½" and 20' for greater than or equal to 2" ID pipe.
 3. Full-face flange molds for each size of cylindrical mold shall meet ASTM D5421 Part 7 Dimensions and Tolerances, including Table 3 Flange Dimensions through 48" diameter.
 4. Both 45 and 90 degree sweep elbow molds for each size of cylindrical mold up to 48" plus concentric and eccentric reducer molds for all transitions between each size of cylindrical molds ranging from 2" to 48" diameter shall all conform to ASTM D3982 standard Part 7 Dimensions, including Figure 4 Standard Duct Dimensions. Reducers may be permanent or temporary tooling.
 5. Elbows, tees and laterals greater than 48" diameter may be fabricated from cylinder sections, but shall conform to ASTM D3982 standard Part 7 Dimensions, including Figure 4 Standard Duct Dimensions.
 6. End cap molds for sizes ranging from 6" to 48" diameter shall be ASME dish with crown radius equal to pipe diameter, knuckle radius equal to 6% of crown radius and straight flange. ASME 2:1 elliptical heads with straight flange may be substituted.

- H. Manufacturers seeking certification for components of All Equipment shall have the following tooling or capability as minimum –
 - 1. Manufacturer shall meet the tooling minimums for each of the other classes: Tank and Vessels plus Odor and Air Pollution Control Vessels only, Duct plus Custom Pipe component Manufacturers as stated within this Standard Practice.
 - 2. All tooling shall meet the size range and dimensions as per the Reference Standards.
- I. Each class of component Manufacturers shall have an established inventory of or mold making capability for all other components Manufactured or supplied with equipment. Capability shall include one (1) or both of the following –
 - 1. Wood, sheet metal and/or other material fabrication shop
 - 2. Outsourcing

3.6 DEMOLDING AND COMPONENT HANDLING:

- A. Manufacturers shall demonstrate sufficient capacity to demold and handle laminated equipment components and final assemblies. Evidence of the capability shall include ownership of or established rental relationships with suppliers for –
 - 1. Cranes (i.e. bridge, jib or yard type)
 - 2. Fork lifts
 - 3. Dollies and carts
 - 4. Turning devices
 - 5. Winches and come-alongs
- B. Manufacturers shall demonstrate care in handling laminated equipment components. Evidence of the capability shall include –
 - 1. Nylon slings
 - 2. Dunnage and padding
 - 3. Shipping door dimensions that accommodate completed equipment fabrication

3.7 LAMINATE CONSTRUCTION AND ASSEMBLY:

- A. Flange and nozzle installations shall meet the Reference Standards –
 - 1. Flange, hub and neck construction details for thickness.
 - 2. Reinforcement orientation/placement.
 - 3. Bolt holes and back spot facing facilitating flat and parallel washers.
 - 4. Flange face flatness, warpage and cant.
 - 5. Cutout reinforcement when required.
 - 6. Integral stub flange manufacturing may be outsourced to FRPI Certified Manufactures, Importers and Distributors of these components. Such outsourcing shall not be FRPI Certified Manufacturer's sole means for supplying integral stub flanges incorporated into FRPI Certified equipment.
- B. Tank head and bottom knuckle radius plus cutout reinforcement shall meet the Reference Standards.
- C. Interior and exterior secondary bonds (welds) shall meet the Reference Standards.

3.8 POST-CURE:

- A. The Manufacturer shall have a Post-curing process in place that meets FRPI SB01 for Level I or SB02 for Level II Engineered Post-cure requirements.

- B. The Post-cure process shall be demonstrated to the FRPI Auditor, with proof of a minimum five (5) years' experience operating this process successfully.

3.9 QUALITY ASSURANCE/QUALITY CONTROL:

- A. The Manufacturer shall demonstrate that they have a formal inspection program for laminates that has been successfully followed by the Manufacturer for a minimum of five (5) years and includes the following –
1. A written Quality Assurance/Quality Control (“QA/QC”) policy manual that meets and/or facilitates all of the requirements written in FRPI Standard Practices, Laminate Specifications and Specification Bulletins published at the time of the Manufacturer’s audit.
 2. An inspection process that compares the Owner or Engineer approved Manufacturer’s shop drawing of the equipment detailing the components to the actual components Manufactured.
 3. A QA/QC procedure that requires all components receive in process inspection as well as final inspection of assembled laminates. Random sample inspection associated with large production runs of like ductwork and pipe fittings and cylinders is permitted where specifications specifically allow such practices.
 4. Proper inspection tools for measurements required proving conformance with the Reference Standards.
 5. Effective calibration methods and results documented for shop measuring equipment, patterns, templates and inspection tools.
 6. Designated materials evaluation and/or testing area.
 7. Designated hydro test area ready or can be readied with rented equipment to perform tests for:
 - a. Tanks and Vessels only, near full vacuum to 16.5 psig above hydrostatic head pressure
 - b. Odor and Air Pollution Control Vessels only, +/- 2 psig
 - c. Custom Pipe only, near full vacuum to 225 psig
 - d. or All Equipment, near full vacuum to 225 psig
 8. Inspector reports clearly and exclusively to President, Technical Leader and/or Manufacturer’s engineering department.
- B. Laminate inspection shall be covered in the QA/QC policy and shall include –
1. General traceability of raw material selections to final component laminate composition for resins, additives, cure systems and reinforcements.
 2. Visual inspection for allowable defects, with the Manufacturer’s practice providing a maximum of Level II visual defects per ASTM D2563.
 3. Visually inspecting corrosion barrier for visual defects after cure and prior to adding structural layers to the laminate.
 4. Barcol hardness per ASTM D2583.
 5. Acetone sensitivity tested for each component and overlay (weld). Test shall be performed with new clean acetone and cheesecloth or equivalent material satisfactory to the FRPI Auditor.
 6. Dimensions and tolerances measured for all components per the Reference Standards.
 7. Thicknesses of all components.
 8. Demonstrating history of experience over past five (5) years performing cutout and/or runout retention for manufactured components, with each suitably tagged for future traceability to equipment manufactured.

- C. The results of all inspections performed shall be recorded on a QA/QC inspection form for each component inspected. A process for identifying, documenting and correcting nonconformities shall be included in the QA/QC policy, with Manufacturer's successful implementation of the policy demonstrated during the FRPI audit.
- D. A corrective action report shall detail how the nonconformity was resolved and what the resulting quality was for the finished component. Any repairs performed shall restore the laminate to like new condition. Repairs shall not exceed the maximum quantity of repairs as allowed per ASME RTP-1 Table 6-1 guidelines or Owner/Engineer specifications for repair of visual defects in laminates, whichever is more stringent.

3.10 PACKAGING LAMINATES:

- A. The Manufacturer shall provide shop floor examples, detailed drawings and/or photographs of crating, saddles and other fabrications that illustrate engineered packaging supplied on previous projects and demonstrate to the FRPI Auditor's satisfaction that this capability will be used on future projects requiring similar care.
- B. The Manufacturer shall have adequate packaging equipment and materials in place to protect the laminates from damage during shipment to the installation site. Evidence of capability shall include having the following ample supply of materials and related equipment on hand –
 - 1. Crating lumber
 - 2. Strapping
 - 3. Padding (i.e. foam sheets, peas, shredded paper, rubber, etc.)
 - 4. Cardboard cartons
 - 5. Sufficient product labeling (i.e. Handle With Care, Fragile, required OSHA)
- C. Manufacturer shall maintain a designated packaging area.

3.11 FREIGHT TRANSPORTATION:

- A. The Manufacturer shall demonstrate experience with shipping laminates in such a way as to significantly reduce the likelihood of damage in transit. Evidence shall include –
 - 1. Use of trucks and trailers that have air suspension
 - 2. At least five (5) years FRP equipment hauling experience for oversized loads, where this requirement pertains only to Manufacturers seeking Laminating Process Certification for Tanks and Vessels only or All Equipment.
 - 3. Proper obstruction deflection devices are attached to oversized loads.

3.12 LAMINATE FIELD REPAIR AND MODIFICATION:

- A. The Manufacturer shall demonstrate that they have an emergency plan in place for the field repair and modification of new laminates manufactured by themselves that may be in need of service within the warranty period.
- B. Subcontracting repair or modification needs within the warranty period is not considered to be an acceptable plan per FRPI Standard Practices.
- C. A Manufacturer shall have a field safety manual and all equipment needed for field operations, including confined space entry.
- D. Proper equipment for heat, light, power, weather protection and laminating shall be on hand and readied for field service.

3.13 LAMINATING PROCESS OPERATION:

- A. The Manufacturer shall have a laminating process in operation that is reliably supported by the following –
 - 1. Adequate utilities:
 - a. Heating and/or air conditioning to maintain temperature between 65 and 95 degrees Fahrenheit in the laminating areas
 - b. Lighting –
 - 1) Average of 50 foot-candles (actual lumens per square foot)
 - 2) Task lights for in process laminating inspection by operators
 - c. Electrical service
 - d. Compressed air supply
 - 2. Access to mold surface for laminating activities (i.e. scaffolding, ladders, platforms, personnel lifts)
 - 3. Safety practices, including:
 - a. Explosion proof resin mixing area where required by local building code.
 - b. Grounded acetone containers
 - c. Respiratory program
 - d. Ventilation for grinding dust & laminating fumes
 - e. Compliance with the Environmental Protection Agency (“EPA”) and Department of Environmental Protection (“DEP”) requirements
 - 4. Housekeeping:
 - a. Reduced potential for foreign inclusions in laminates
 - b. Maintenance resulting in reliable operation of tools and equipment

3.14 SAFETY:

- A. The Manufacturer shall have a written safety policy in place for both manufacturing and field operations that includes the following –
 - 1. Personal Protective Equipment
 - 2. Portable Power Tools
 - 3. Electrical Safety
 - 4. Confined Space
 - 5. Lockout/Tagout
 - 6. Fire Prevention
 - 7. Portable Ladders
 - 8. Scaffolding
 - 9. Fall Prevention
 - 10. Hazard Communication
 - 11. Signs and Barricades
 - 12. Emergency Action Plan
 - 13. Maintenance and Storage of Safety Equipment and Tools
 - 14. Employee training and record keeping

PART 4 LAMINATING PROCESS CERTIFICATION

4.1 FRPI AUDIT LOGISTICS:

- A. FRPI will perform an objective audit of a Manufacturer’s laminating process with the intent of issuing a Laminating Process Certification at the request of an authorized Manufacturer’s employee.

- B. The audit will be conducted by one (1) FRPI representative or an FRPI authorized Consultant experienced in the manufacturer, testing, inspection and analysis of all FRP custom equipment per FRPI SP9000 and SP9100, including ASME RTP-1 stamped vessels with Level I allowable visual defects.
- C. Upon receipt of request for a laminating process audit, FRPI will issue a firm quotation for the costs associated with the process of seeking Certification and an estimated schedule date. The fee will be payable to FRPI by the candidate Manufacturer per the quotation plus standard terms and conditions of sale published on the FRPI website and otherwise contained within this Standard Practice.
- D. An audit of a Manufacturer's laminating process will be performed within two (2) weeks to six (6) months after receipt of the complete submittal and fee payment. The actual scheduled audit date is contingent upon availability at the time of order entry.
- E. FRPI will address appropriate questions to the best of their ability regarding –
 - 1. Audit preparation, up until one (1) week prior to the audit.
 - 2. Audit activity, within one (1) hour at the start of the audit.
 - 3. Audit findings, within one (1) hour at the end of the audit.
- F. The Manufacturer has the right to make one (1) last submittal of information that they would like taken into consideration during final review of their capability. This submittal shall reach the Auditor within one (1) week of the audit date.
- G. The Auditor will attach all information submitted by the Manufacturer to their written report, hold such information confidential, generate a written recommendation letter pertaining to Certification award or denial and send letter to the FRPI Board of Advisors. This letter will be written after final review of submittals and audit findings. The letter will be sent to the Board of Advisors within one (1) to three (3) weeks after the audit date.
- H. The Board of Advisors will review the Auditor's recommendation letter, then make a final decision by majority vote regarding the status of a Manufacturer's Certification. A decision will be reached and communicated to the Manufacturer within three (3) weeks after the Board of Advisors receives the Auditor's letter.
- I. If the conduct of the Auditor and/or decisions made by the FRPI Board of Advisors are unsatisfactory to the Manufacturer, then the Manufacturer may object. All objections shall be submitted in writing to the Board of Advisors of FRPI in the form of numbered questions, backed with any supporting information the Manufacturer would like FRPI to take into consideration when answering each question. The FRPI Board of Advisors will answer all questions to the best of their ability in as timely a manner as possible and in the presence of the Manufacturer if the Manufacturer desires to attend the hearing.

4.2 LAMINATING PROCESS CERTIFICATION AWARD:

- A. A Manufacturer that successfully demonstrated that their laminating process has the capabilities in place with the required experience per the requirements of this Standard Practice SP9000 will be awarded a Laminating Process Certification. The Manufacturer's scope of Certification may be restricted in areas such as laminating methods, size of equipment, laminate specifications and material treatments, whereas such limitations in scope will be noted on certificate issued. Upon demonstration of required waiting period completion or experience, limitations placed on Certification may be lifted at time of Certification renewal.
- B. Notification of award will be sent by register mail to the Manufacturer at the address provided on the initial request for a laminating process audit.

- C. An official certificate will be furnished by FRPI with notification as proof of award. The Certificate and Symbol are at all times the property of FRPI, shall be used in accordance with any and all FRPI requirements and shall be returned immediately to FRPI upon FRPI's request or when the Manufacturer ceases the nature of work as covered by the FRPI Laminating Process Certification.

4.3 DENIAL OF LAMINATING PROCESS CERTIFICATION:

- A. Manufacturers who are deemed to have not met all of the requirements covered within this Standard Practice SP9000 will be denied certification.
- B. FRPI reserves the right to poll industry Owners, Owner's Agents, Consultants, Engineers and Intermediaries to obtain written factual case histories of Manufacturers laminate quality performance over the past five (5) years and use any such information obtained in the determination of the Manufacturers capability to meet FRPI requirements. FRPI further reserves the right to deny a Manufacturer Laminating Process Certification on the sole basis of this information through a majority vote of the FRPI Board of Advisors.
- C. Manufacturers denied certification will receive a written report with detailed explanation and corrective actions required in order to bring their laminating process in line with the requirements of the FRPI SP9000 published at the time of their audit. This notification will be sent by register mail to the address provided on the initial request for a laminating process audit.
- D. If the Manufacturer wants to pursue FRPI Certification in the future, then they shall notify FRPI when the required capability that was not demonstrated during the audit has since been instituted and furnish proof of implementation with date satisfactory to FRPI. This notification shall be sent via registered mail to FRPI within two (2) weeks of the date the capability was instituted by the Manufacturer.
- E. Manufacturers that are denied or have limitations place on certification shall wait a predetermined period prior to submitting a subsequent Request for a Laminating Process Audit. Waiting periods for various types of denials or limitations are as follows –
 - 1. One (1) year for any and all deviations from minor requirements of SP9000 that result in Manufacturers denial of Laminating Process Certification, where minor requirements are any requirements that do not have a specific time based performance measurement and/or related to areas other than: 1.1F Equipment Category; 1.1G Laminating Process; 3.1A Engineering; 3.1G Drawing; 3.2 Resin Mixing; 3.3 Reinforcement Layout and Cutting; 3.6 Laminate Construction and Assembly plus 3.8 Quality Assurance and Control. This waiting period shall commence on the day the Manufacturer receives a notice of denial from FRPI.
 - 2. Two (2) years for any denial that results from an industry poll, as permitted within SP9000. This waiting period shall commence on the date of the notification letter to the Manufacturer.
 - 3. From one (1) to five (5) years for any and all deviations from more critical requirements of SP9000 that result in Manufacturers denial of Laminating Process Certification, where more critical requirements are any requirements that have a time based performance measurement and/or are related to: 1.1F Equipment Category; 1.1G Laminating Process; 3.1A Engineering; 3.1G Drawing; 3.2 Resin Mixing; 3.3 Reinforcement Layout and Cutting; 3.6 Laminate Construction and Assembly plus 3.8 Quality Assurance and Control.

This waiting period shall commence on the day the Manufacturer receives a notice of denial from FRPI and length thereof shall be determined based on proof satisfactory to FRPI auditor of when required capability was first established.

4.4 LAMINATING PROCESS CERTIFICATION RENEWAL:

- A. All Manufacturers desiring to renew their FRPI Laminating Process Certification shall submit a written request for a laminating process audit. FRPI shall be in receipt of the Manufacturer's request for an audit within ninety (90) days of the expiration date of the Manufacturer's current Laminating Process Certification.
- B. No "grandfather" or "retroactive" type clauses with respect to changes in FRPI certification requirements will be recognized when a Manufacturer requests future audits for the purpose of renewing the FRPI Laminating Process Certification.
- C. FRPI reserves the right to –
 - 1. Renew the Manufacturer's Certification without a physical audit if FRPI is able to otherwise substantiate their continued compliance with SP9000.
 - 2. Refuse to renew a Manufacturer's Laminating Process Certification.

4.5 TERMINATION OF LAMINATING PROCESS CERTIFICATION:

- A. There are two (2) ways that Manufacturer's Certification can be terminated by FRPI –
 - 1. The Manufacturer's Certification expires, see Part 4.5 B.
 - 2. A Manufacturer deviates from the requirements of the Laminating Process and/or Laminate Certification Standard Practices, see Part 4.5 C thru G.
- B. Certification automatically terminates upon expiration date, where date is as indicated on the certificate issued to the Manufacturer and as is posted on the FRPI website under the listing of FRPI Certified Manufacturers.
- C. There are two (2) categories of rules governing types and frequencies of deviations that immediately cause or lead to termination –
 - 1. Actions that result in immediate termination of Certification:
 - a. Manufacturer breaches certification purchase agreements with FRPI.
 - b. Manufacturer no longer meets the FRPI SP9000 and/or SP9100 requirements published at the time of the audit.
 - c. Manufacturer's capability changes notably, warranting recertification.
 - d. Manufacturer is proven to have deliberately misrepresented the scope of their Laminating Process Certification.
 - 2. Three (3) or more requirements not met that lead to immediate termination:
 - a. Deviation from currently published FRPI Standard Practices, Laminate Specifications and Specification Bulletins referenced in a contract to manufacturer FRP equipment.
 - b. Quality unbecoming of a Manufacturer operating an FRPI Certified Laminating Process.
 - c. Excessive errors, omissions, delays, noncompliance and/or other such circumstances associated with submittals made in accordance with SP9100 Part 1.4 resulting in undue FRPI certification effort, release delays and/or diminished goodwill.
- D. Rules for reporting deviations and quality complaints –
 - 1. Anyone detecting a deviation from the FRPI Standard Practices, Laminate Specifications and/or Specification Bulletins referenced in a contract where the

- FRP equipment is to be manufactured by a Manufacturer who operates an FRPI Certified Laminating Process is eligible and encouraged to report it.
2. Only Owners, Owner's Agents, Engineers and/or Intermediaries can report "Quality unbecoming of a Manufacturer operating an FRPI Certified Laminating Process".
 3. All reports shall be filed using the FRPI Certified Laminating Process Deviation Form if submitted through the FRPI website or using the FRPI Certified Laminating Process Deviation Report if submitted through regular mail. Forms and Reports are available on the FRPI website.
 4. Manufacturers will receive a copy of reports received that pertain to them.
- E. All deviation reports and quality complaints will be investigated by the FRPI Board of Advisors for applicability of claim(s) and authenticity. A decision stemming from this investigation includes either termination, suspension or no action against the claimed Manufacturer's Certification privileges. Any and all determinations made by the Board of Advisors are final.
- F. Notification of suspension or termination will be sent by register mail to the Manufacturer at the address provided on the initial request for a Laminating Process Audit within one (1) week of the Board of Advisors decision to suspend, terminate or take no action against the Manufacturer's Certification privileges.
- G. Upon notification of suspension or termination, the Manufacturer may object to the claims and resulting decision made. All objections shall be submitted in writing to the FRPI Board of Advisors in the form of numbered questions, backed with any supporting information the Manufacturer would like FRPI to take into consideration when answering each question. FRPI will answer all questions to the best of their ability in as timely a manor as possible and in the presence of the Manufacturer if the Manufacturer desires to attend the hearing.

4.6 OTHER GENERAL CONDITIONS:

- A. This Standard Practice SP9000 is intended to facilitate a quantitative and qualitative process for vetting Manufacturer capabilities and their experience level with meeting equipment specification requirements as demonstrated through Standard Practice SP9100 Laminate Certification protocol. FRPI reserves the right to interpret Manufacturer conformance with SP9000 requirements, to the best of its knowledge and through best efforts, in order to determine Manufacturer's perceived ability to meet equipment specification requirements as determined through fulfilling intent of SP9100 requirements, where such interpretations will be documented as a matter of record within report written as basis of FRPI auditor recommendation letter to Board of Advisors. Furthermore, FRPI reserves the right to suspend or reverse, with cause, any and all decisions pertaining to Certification of a Manufacturer's Laminating Process.
- B. A Manufacturer's SP9000 certification shall not be assigned or otherwise transferred to another business entity without written FRPI authorization following a SP9000 reinstatement audit conducted by FRPI in accordance with this Standard Practice. Evidence of such reinstatement shall be Manufacturer's FRPI SP9000 Laminating Process Certification certificate.
- C. All Manufacturers who enter into this voluntary certification process are deemed, as evidence of their involvement with FRPI, to be in complete agreement with all of the written terms and conditions associated with the FRPI process of denying and terminating their Certification. If a Manufacturer challenges a denial or termination

decision, the Manufacturer agrees to pay to FRPI any and all costs associated with FRPI's defense of such decision should the decision not be overturned by such challenge due to arbitrary or unsubstantiated allegations.

END OF STANDARD PRACTICE



July 8, 2017

LAMINATE CERTIFICATION

Standard
Practice
SP9100

PART 1 GENERAL

1.1 PURPOSE AND SCOPE:

- A. The Fiberglass Reinforced Plastics Institute (“FRPI”) has made all of its publications and services available for the betterment of business conditions, with the use of these resources understood to be voluntary on everyone’s part. Additionally, specification of and involvement in the Laminate Certification process is intended to be a voluntary initiative on the part of Owners, Engineers, Intermediaries and Manufacturers.
- B. This Standard Practice covers requirements that shall be met by a Manufacturer in order for them to obtain and use a valid FRPI Laminate Certification.
- C. Laminate Certification is intended to assure that Owners, Owners Agents, Engineers and Intermediaries receive Fiberglass Reinforced Plastic (“FRP”) process equipment that is manufactured with materials as per the laminate specifications provided. The Laminate Certification process facilitates this through FRPI’s direct involvement with assuring that –
 - 1. Laminate Specifications are suitable for the application.
 - 2. The Manufacturer’s submittals clearly detail and accurately represent the laminates specified for the project.
 - 3. Actual laminate composition for sampled equipment components is as specified and represented through the Manufacturer’s submittals.
 - 4. Laminates equal or exceed the quality requirements of SP9000 and SP9100.
- D. Laminate Certification is based upon a Manufacturers successful demonstration that their laminates for a specific project meet the intent of specifications provided.
- E. FRPI does not “approve”, “rate” or otherwise “endorse” any item, construction, proprietary devise or activity other than as is represented within FRPI Standard Practices SP9000 and SP9100. Furthermore, FRPI Laminating Process and Laminate Certification shall not be interpreted to mean endorsement by FRPI of a Manufacturer’s technical capability to perform design work related to the equipment for which they were contracted to provide to the Owner, Owner’s Agent, Engineer and/or Intermediary.
- F. Determination of laminate thickness is outside of the scope of FRPI Standard Practices, Laminate Specifications and Specification Bulletins.

1.2 DEFINITIONS:

- A. The following definitions shall apply to this Standard Practice –
 - 1. Parties involved with FRPI Certification:
 - a. The Owner (“Owner”) is the company that takes possession of the new equipment and operates it.

- b. The Owner's Agent ("Owners Agent") is the company that supports the Owner by offering their expertise on FRP related matters and/or performs FRP related work on the behalf of the Owner. The Owners Agent is also referred to as an Industry FRP Consultant ("FRP Consultant") by FRPI, who is an individual employed by a company that primarily supplies advice, statistics, reports or other consultative services to the FRP industry.
 - c. The Engineer ("Engineer") is the company that performs project engineering on behalf of the Owner.
 - d. The Intermediary ("Intermediary") is either a Contractor ("Contractor") or Original Equipment Manufacturer ("OEM"), where the Contractor performs facility construction and the OEM assembles and sells a complete process system incorporating the Manufacturer's equipment.
 - e. The Manufacturer ("Manufacturer") is the company that manufactures the laminates and fabricates the equipment either directly for the Owner or an Engineer or Intermediary appointed by the Owner.
 - f. The Fiberglass Reinforced Plastics Institute ("FRPI") is the Non-profit membership organization certifying compliance to this Standard Practice.
2. Laminate lay-up composition:
- a. The Inner Surface ("Inner Surface") is the portion of a laminate made up of surface veil, which is regarded as being on the mold surface side of the Structural Layer.
 - b. The Interior Layer ("Interior Layer") is the portion of a laminate made up of random strand mat and/or chopped strand roving, which is regarded as being on the mold surface side of the Structural Layer and follows the inner surface in lay-up sequence.
 - c. The Inner Corrosion Barrier ("Inner Corrosion Barrier") is the Inner Surface and Interior Layer combined.
 - d. The Structural Layer ("Structural Layer") is the portion of a laminate that is made up of any one or combination of reinforcements other than surface veils. The thickness of this portion of the laminate, when added to the Inner and Outer Corrosion Barrier thickness, makes up the total laminate thickness for the determination of strength values used in engineering calculations to design equipment structure.
 - e. The Exterior Layer ("Exterior Layer") is the portion of a laminate made up of random strand mat and/or chopped strand roving, which is regarded as being on the opposite side of the Structural Layer from the Interior Layer and follows the Structural Layer in lay-up sequence.
 - f. The Outer Surface ("Outer Surface") is the portion of a laminate made up of surface veil and/or pure resin finish coat, which is regarded as being on the opposite side of the Structural Layer from the Inner Surface and follows the Exterior Layer in lay-up sequence. This surface is typically not in contact with the mold and includes a resin finish coat with paraffin wax when not a mold surface.
 - g. The Outer Corrosion Barrier ("Outer Corrosion Barrier") is the Exterior Layer and Outer Surface combined.
 - h. The Corrosion Allowance ("Corrosion Allowance") is the portion of a laminate thickness made up of the Inner and/or Outer Corrosion Barrier that shall not be included in the total laminate thickness determination

for the purpose of engineering calculations used for the design of equipment structure. This portion is regarded as sacrificial, with designation made in a laminate specification.

1.3 REFERENCE STANDARDS:

- A. The most recently published standards at the time a contract requiring Laminate Certification is entered into shall govern requirements imposed on the Manufacturer as they apply to the administration of this Standard Practice.
- B. In the event of conflict, inconsistency or ambiguity between these Reference Standards, the specific project requirements and/or FRPI requirements, the following order of precedence shall govern where laminate quality and conformance to FRPI requirements are questioned –
 - 1. FRPI requirements, as published in FRPI Standard Practices, Laminate Specifications and Specification Bulletins.
 - 2. Specific project requirements, as documented in FRP equipment procurement contracts plus related drawings and specifications.
 - 3. Reference Standards.
- C. American Society for Testing and Materials (“ASTM”) –
 - 1. ASTM C581 - Standard Practice for Determining Chemical Resistance of Thermosetting Resins used in Glass Fiber Reinforced Structures Intended for Liquid Service
 - 2. ASTM C582 - Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion Resistant Equipment
 - 3. ASTM D638 - Standard Test Method For Tensile Properties of Plastics
 - 4. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
 - 5. ASTM D2471 - Test Method for Gel Time and Peak Exothermic Temperature of Reacting Thermosetting Resin
 - 6. ASTM D 2563 - Standard Recommended Practice for Classifying Visual Defects In Glass Reinforced Plastic Laminates
 - 7. ASTM D2583 - Standard Test Method for Indentation Hardness of Rigid Plastics By Means of a Barcol Impressor
 - 8. ASTM D2584 - Standard Test Method for Ignition Loss of Cured Reinforced Resins
 - 9. ASTM D2996 - Filament-Wound Reinforced Thermosetting Resin Pipe
 - 10. ASTM D3299 - Standard Specification for Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Chemical Resistant Tanks
 - 11. ASTM D3982 - Standard Specification for Contact Molded “Fiberglass” Duct and Hoods
 - 12. ASTM D4097 - Standard Specification for Contact-Molded Glass-Fiber Reinforced Thermoset Resin Chemical-Resistant Tanks
 - 13. ASTM D5421 - Standard Specification for Contact Molded “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) Flanges
- D. American Society of Mechanical Engineers (“ASME”) –
 - 1. ASME RTP-1 - Reinforced Thermoset Plastic Corrosion Resistant Equipment
- E. Fiberglass Reinforced Plastics Institute (“FRPI”) –
 - 1. FRPI SP9000 - Standard Practice for Laminating Process Certification
 - 2. FRPI SB01 - Level I Engineered Post-cure
 - 3. FRPI SB02 - Level II Engineered Post-cure

4. FRPI SB03 - Preparation for Food Grade and High Purity Product Contact
- F. Food and Drug Administration (“FDA”) –
 1. Title 21 CFR 177.2420

1.4 SUBMITTALS:

- A. The Manufacturer shall, unless otherwise stated herein, submit simultaneously for approval or release a minimum of two (2) copies (except for cutouts or runouts) all items listed in this section to –
 1. The Owner, Owners Agent, Engineer and/or Intermediary as required by their contract for the supply of FRP equipment.
 2. The Fiberglass Reinforced Plastics Institute.
- B. Approval or acceptance of the submittals by each party shall not release the Manufacturer of their responsibility for compliance with any contract requirements and/or obligations for which they entered into in order to furnish FRP equipment.
- C. Schedule of submittals shall be as follows, unless otherwise agreed in writing between the parties involved in the FRPI acceptance process –
 1. Within three (3) weeks after Manufacturer’s receipt of order for equipment or as otherwise agreed to with Manufacturer’s customer:
 - a. Project Summary.
 - b. Engineering calculations.
 - c. Fabrication drawings.
 - d. Manufacturer’s equipment nameplate(s).
 - e. If tanks or vessels are to be manufactured per ASME RTP-1 and bear the applicable ASME stamp as a symbol of compliance –
 - 1) User’s Basic Requirements Specification (“UBRS”).
 - 2) Design Report per Part 1-300.
 - f. Inquiry and contract laminate specifications, with required written statements per FRPI SP9100 Part 1.4 M and O.
 - g. Post-cure procedures.
 - h. Other test procedures (i.e. hydro, acoustic emissions).
 - i. Written statement confirming suitability of corrosion barrier design.
 - j. Written statement regarding laminate specification compliance.
 - k. Copy of Manufacturer’s Laminating Process Certification.
 - l. Quality Control document with manufacturing Hold Point Checklist showing required FRPI acceptances.
 - m. Other submittals that may be required by project specification that may have bearing on laminates certified.
 2. As soon as available without jeopardizing equipment shipment:
 - a. But at least four (4) weeks prior to equipment shipment –
 - 1) Laminate cutouts and run outs.
 - b. But at least two (2) weeks prior to equipment shipment –
 - 1) In process inspection records.
 - 2) Notice of delivery.
 3. Within one (1) week after equipment shipment:
 - a. Final inspection records.
 - b. Data Report(s) per ASME RTP-1 Part 1-520, where tanks or vessels are to be manufactured per RTP-1 and bear applicable ASME stamp as a symbol of compliance.
 4. Within two (2) weeks after equipment installation is complete:

- a. Certificate of installation, inspection and conformance.
 - b. Operation and Maintenance manual(s).
 - c. FRPI Laminate Certification.
- D. Project summary, with the following details –
 - 1. Project name and contract reference number(s).
 - 2. Manufacturer's scope of work.
 - 3. Company and primary contacts name, mail and ship to address, office and fax phone number plus e-mail address for the following organizations that are involved in the project:
 - a. Owner.
 - b. Owner's Agent (FRP Consultant).
 - c. Engineer.
 - d. Intermediary (Contractor and OEM where engaged).
- E. Engineering calculations, with the following details included –
 - 1. Equations used to derive laminate thickness of components, per Reference Standards included herein.
 - 2. Equipment design basis, including:
 - a. Description of chemistry equipment is exposed to.
 - b. Operating and upset pressure, with pressure source identified.
 - c. Operating and upset temperature, with temperature source identified.
 - d. Other pertinent loads.
 - 3. Values used for strengths of materials in cylinder (axial and hoop direction) and other major component designs:
 - a. Tensile strength, per ASTM D638.
 - b. Tensile modulus of elasticity, per ASTM D638.
 - c. Flexural modulus, per ASTM D790.
 - d. All tensile properties (strength and modulus in hoop and axial direction) representative of laminate to be tested per FRPI SP9100 Part 2.1 shall be included and clearly identified for test laminate verification purposes, regardless of whether such properties are used in design.
 - 4. Values used for composition of materials:
 - a. Reinforcement ply and laminate layer thicknesses, per ASTM C582 and ASME RTP-1.
 - b. Reinforcement type and sequence, per ASTM C582 and ASME RTP-1.
 - c. Resin to glass ratio, per ASTM D2584. Include statement for minimum amount of resin to be provided in each laminate design.
 - 5. Other design variables and/or assumptions, such as:
 - a. Safety factors.
 - b. Stress intensification factors.
 - 6. Laminate design results:
 - a. Thicknesses for all major and nonstandard components (i.e. cylinders, heads, baffles, elbows, reducers, transitions, support rings, brackets), whereas nonstandard shall be those components not covered within referenced industry standards.
 - b. Laminate sequence.
 - c. Resulting laminate thicknesses shall be clearly identified, correlated with laminate sequence and correspond with such details shown on drawings.
 - 7. Calculation revisions shall be clearly identified, noted within engineering report submitted and dated. Copies of all revisions shall be submitted.
 - 8. Licensed professional engineers stamp when required by Owner or Engineer:

- a. Professional engineer shall include date stamp was applied to documents alongside their signature that is adjacent to such stamp.
 - b. In lieu of stamping all calculation pages, calculations may include a cover page to be stamped, where such page clearly identifies all pages included under the professional engineer's stamp.
 9. The Manufacturer's engineer of record shall be identified by name within all related submittals and meet requirements of Manufacturer's certification under FRPI SP9000.
- F. Fabrication drawings corresponding to engineering calculations submitted, with the following laminate details included –
 1. All dimensions related to:
 - a. Equipment sizes and configuration.
 - b. Radii of integrally (monolithically) laminated corners, knuckle radii and dished or otherwise curved components.
 - c. Laminate thicknesses, with reinforcement type and sequence described.
 - d. Location of features, components and joint lines.
 - e. Width and thickness of joint interior and exterior overlays (welds).
 2. Resin, cure system, additive and reinforcement supplier brand names.
 3. Flange and nozzle construction type and installation method.
 4. Laminate composition for each component and joint overlay shall be clearly described plus correspond with the Manufacturer's engineering calculations and laminate specifications submitted. Laminate sequences shown shall add up to and equal theoretical thicknesses accompanying sequences on drawings when utilizing ply thickness values per ASTM C582 and ASME RTP-1, where such thicknesses shall equal or exceed engineering calculations.
 5. Identification and location of all cutout and run out specimens taken, with nozzle mark or piece numbers to identify specimens for inspection, testing and analysis.
 6. A Key shall be provided showing meaning of nomenclature and abbreviations used on drawings.
 7. Location of where FRPI labels will be affixed by the Manufacturer.
 8. Drawing revisions shall be clearly identified, noted within drawing title block and dated, where a delta symbol with revision number inside triangle shall be placed alongside all drawing changes made under the revision so noted. As each drawing revision is released for review, such notations shall be shown in red. Copies of all revisions shall be submitted.
 9. Licensed professional engineer's stamp when required by Owner or Engineer:
 - a. Professional engineer shall include date stamp was applied to documents alongside their signature that is adjacent to such stamp.
 - b. In lieu of stamping all drawing sheets, drawings may include a cover sheet to be stamped, where such sheet clearly identifies all sheets included under the professional engineer's stamp.
 - c. Any disclaimer associated with professional engineer's stamp shall not disclaim engineer's responsible charge over drawing details, where review includes assurance that outcome of calculations was accurately reflected on drawings and Manufacturer's design or other engineering work related to FRP reflects best industry practices.
- G. Manufacturer's equipment nameplate(s) shall include the following minimum information –
 1. Manufacturer's name and job number.

2. Date of manufacture.
 3. Design pressure and temperature.
 4. Chemistry stored in or processed through the equipment.
 5. Corrosion barrier/allowance composition (i.e. veil type and quantity, resin and cure system, nominal thickness).
 6. Structural layer composition (i.e. resin and cure system).
 7. Capacity (tanks only).
 8. FRPI registration number issued for SP9100 certification.
- H. ASME RTP-1 User's Basic Requirements Specification ("UBRS"), if tanks or vessels are to be manufactured per ASME RTP-1 and bare the applicable ASME stamp as a symbol of compliance.
- I. Laminate specifications for the project as provided by the Owner, Owner's Agent, Engineer or Intermediary at the time of inquiry and agreed upon when the Manufacturer entered into an agreement to supply the equipment for the project. The laminate specifications shall provide the following details –
1. Laminate type(s) utilized for each major component of the equipment, as reference standards define.
 2. Laminate composition, with specific materials utilized plus quantity of and where (i.e. inner surface, interior layer, structural layer, exterior layer and outer surface) they are utilized within the laminates:
 - a. Resin(s), where vetted or equals shall be from the same resin family as defined within FRPI Generic Resin Types reference posted on FRPI website at time laminate specification was published for project and take into consideration caution statement made in such reference.
 - b. Additives (i.e. antimony trioxide or pentoxide, ultraviolet light inhibitor, thixotropics, graphite, aluminum or silicon carbide, pigment, paraffin wax).
 - c. Cure system(s).
 - d. Surface veil(s).
 - e. Other reinforcements.
 - f. Any type of reinforcements excluded.
 - g. Laminating method (i.e. hand lay-up, spray-up and/or filament winding with wind angle stated) for each of the following laminate layers –
 - 1) Inner surface and interior layers (interior corrosion barrier).
 - 2) Structural layers.
 - 3) Exterior layers and outer surface (exterior corrosion barrier).
 - h. Resin to glass ratio for each individual layer and corrosion barrier defined in FRPI SP9100 Part 1.2 above and total laminate composition.
 - i. Minimum physical property values per referenced standards or Manufacturer's design basis for Type X laminates.
 - j. Minimum Barcol hardness values, including allowed knockdown value for synthetic polyester surface veils.
 - k. Visual defects allowed –
 - 1) Name of defect and acceptance criteria per ASTM D2563, ASME RTP-1 or other governing documentation.
 - 2) Quantity limitation for gaseous bubbles, entrapped air, voids, blisters and dry spots.
 - 3) Maximum surface area percent allowable repairs for Inner Corrosion Barrier, Structural Layer and Outer Corrosion Barrier.
 3. Language clearly indicating whether or not:

- a. Multiple resin and cure systems can be used for laminates.
 - b. The corrosion barrier (inner surface and interior layers) contributes to the laminate strength or is regarded as sacrificial (corrosion allowance, nonstructural) and consequently does not contribute to laminate strength.
 - c. The structural layer thickness of the cylinder section shall be the same or tapered from the bottom to the top, for projects involving vertically oriented tanks and vessels.
4. Laminate treatments to be performed, if required by laminate specifications:
 - a. Level I Engineered Post-cure per SB01.
 - b. Level II Engineered Post-cure per SB02.
 - c. Preparation for Food Grade or High Purity Product Contact per SB03.
 - d. Any other treatments or cleaning.
5. In the event Owner, Owner's Agent, Engineer or Intermediary does not furnish laminates specifications, the Manufacture shall develop and submit them in conformance with FRPI SP9100 requirements.
- J. The Manufacturer shall not make any undisclosed substitutions to a specification provided to them. Substitutions when made shall be fully disclosed to an authorized representative of the issuing organization. A written variance acknowledging an authorized representative's acceptance of such substitutions shall be obtained by Manufacturer and submitted to FRPI substantiating deviations from specifications provided.
- K. Engineered Post-cure procedure Manufacturer intends to use for project, per FRPI SB01 and/or SB02 as may be required by the laminate specification for equipment.
- L. Other test procedures Manufacturer intends to use for project, where such shop or field testing may be required including –
 1. Hydro testing.
 2. Acoustic emission testing.
- M. Written statement confirming suitability of corrosion barrier (inner surface and interior layers) and balance of laminate (structural layers and outer surface) design given temperature and chemistry exposure for the application, with source of information identified. Suitability shall be based upon and include details associated with any one (1) or more of the following –
 1. Case history provided by Raw Material Supplier corrosion guide data.
 2. Case history from other experience.
 3. In service testing.
 4. Laboratory testing, per ASTM C581.
 5. Combination of above.
- N. Technical data sheets for resin, cure system and additives utilized in corrosion barrier documenting compliance with FDA Title 21 CFR 177.2420, where specification requires such compliance and Manufacturer claims to meet this standard.
- O. Written statement clearly indicating that all laminates represented within the engineering calculations and fabrication drawings submitted are intended to comply with the laminate specifications submitted for the project.
- P. Copy of Manufacturer's valid Laminating Process Certification, per FRPI SP9000.
- Q. Quality Control document with Hold Point Checklist or other such document acknowledging FRPI acceptance requirements for –
 1. Release of laminating for all components, including submittals SP9100 Part 1.4 D thru Q.
 2. Release of shipment, including submittals SP9100 Part 1.4 R through T.

- R. Copy to FRPI of Owner's, Owners Agent's and Engineer's approval of any and all submittals, with full manufacturing release clearly communicated to Manufacturer. Where Intermediaries are involved in project, such approval shall include Owner's and Engineer's acknowledgement of same in addition to Intermediary's approval.
- S. All cutouts and run outs ("specimens") of laminates used in the fabrication of the equipment, with the exception of run outs that may be used to establish conformance to laminate specifications and flashing –
1. Specimens provided shall exemplify the specified laminate composition, with no other material included (i.e. "turnaround" areas in filament wound laminates, cutout reinforcement, buildups).
 2. At least half of each specimen shall be provided as removed from components. Other than cutting specimen to size, specimens shall have no other alterations, machining and/or specimen conditioning of any sort performed by the Manufacturer. Specimens may be Post-cured. The remaining half shall be retained by the Manufacturer for at least five (5) years. The Manufacturer shall provide a sufficient amount of material for FRPI to perform its work, whereby FRPI reserves the right to have both halves of a specimen.
 3. Specimens greater than 30" diameter or 120" perimeter shall be cut to reasonable shipping dimensions as agreed in writing between Manufacturer and FRPI during submittal acceptance phase of project.
 4. Sufficient run outs (i.e. cylinders, flat bottoms, panels) shall be planned for and provided for meeting FRPI SP9100 Part 2.2 and 2.3 if no suitable cutouts are available for FRPI inspection and testing purposes. The amount of such material shall be as agreed in writing between Manufacturer and FRPI during submittal acceptance phase of project.
 5. Specimens used for tensile strength and modulus physical properties testing shall:
 - a. Be taken from large openings, nozzles and/or manway locations. If insufficient material is available to meet the testing requirements per SP9100, then the Manufacturer shall produce enough extra cylinder lengths (run outs) required in order to provide sufficient material for testing. Run out material shall be shown or otherwise noted on drawings as to where it will be included and cut from.
 - b. When a corrosion allowance has been called out in the laminate specification, a mylar or other non-bonding thin piece of material shall be placed between the cutouts greater than or equal to 18" diameter or run outs of all diameters inner corrosion barrier (the combined inner surface and interior layers) and structural layer during consolidation of the laminate to clearly differentiate the layers for testing purposes. This material shall be selected and included in the laminate in such a way as to not interfere with the properties of the completed laminate.
 6. All specimens shall be labeled with removable tag tied or wired to specimen through a 1/4" diameter hole drilled in corner. Label format shall be as supplied by FRPI and include the following information:
 - a. FRPI certification registration number.
 - b. Manufacturer's name and job number.
 - c. Date laminate specimen was manufactured.
 - d. Specimen nozzle mark or piece number.
 - e. Drawing number, with revision number and date, from which the specimen was removed.

- f. Axial and hoop direction for cylinder specimens.
 - g. Branch and run diameters for ductwork and pipe specimens.
- 7. All specimens shall be properly packaged and shipped to FRPI for inspection, analysis and verification of composition, such that they arrive at FRPI in like new condition. A packing slip shall be included with each specimen shipment that clearly identifies by specimen nozzle mark or piece number what has been shipped or is to be shipped at a later date. The packing slip shall correlate with tags on specimens shipped and drawings accepted.
- 8. The latest version of engineering calculations and fabrication drawings shall be submitted per SP9100 Part 1.4 E and F with related cutouts and run outs if any changes were approved that relate to the specimens sent.
- T. Notice of delivery for each completed piece of equipment shipped that is intended to have FRPI Certified laminate components.
- U. Inspection records with results of in process component and final equipment inspection performed, to also include –
 - 1. Gel Time or snap test results for each batch of resin used, showing compliance with resin manufacturer's guidelines per ASTM D2471 or ASME RTP-1.
 - 2. Mold setup inspection.
 - 3. Laminate visual defects, per governing Laminate Specification and referenced standard.
 - 4. Actual laminate thicknesses compared to the engineering calculations and fabrication drawings.
 - 5. Barcol hardness, per ASTM D2583.
 - 6. Acetone sensitivity testing, per ASTM C582 or ASME RTP-1.
 - 7. Ultrasonic and/or Magnetic Thickness readings on major components.
 - 8. Mechanical and/or laminate property proof testing required by the contract.
 - 9. Hydro, pressure, vacuum and/or acoustic emissions testing.
 - 10. Corrective action reports for any and all defects and/or nonconformities identified through inspection.
- V. Certificate of proper installation and final field inspection in conformance to FRPI Laminate Certification requirements herein, as demonstrated on FRPI form supplied with acceptance of release for shipment and by photographs of FRPI Certified labels applied in field. Forms shall be cosigned by Manufacturer and Owner or Owner's designated Contractor that has contractual responsibility for installation of FRPI Certified equipment at time of inspection. Forms shall not be signed by independent sales representatives or other such party that may be buying and reselling FRPI Certified equipment and/or acting as an Intermediary, unless such individual has been certified by FRPI and authorized by Manufacturer in accordance with FRPI inspector practices to perform such work.
- W. Operation and Maintenance manual for equipment supplied, including record drawings and calculations (including professional engineer stamp applied when required by Manufacturer's client contract), other accepted engineering submittals (i.e. resin recommendation letters), Manufacturer's FRPI SP9000 certificate, FRPI Release Letters 1 and 2, final shop and field inspection records plus FRPI Laminate Certification certificate.
- X. Laminate Certification upon satisfactory completion of project and FRPI acceptance of submittals 1.4 D thru W, as issued to Manufacture by FRPI.

PART 2 FRPI ANALYSIS, TESTING AND INSPECTION OF SUBMITTALS

2.1 ANALYSIS:

- A. The following analysis will be performed –
 - 1. Manufacturer's submittal will be reviewed for laminate conformance to the specifications and FRPI SP9100 requirements.
 - 2. Laminate specifications submitted will be reviewed for general suitability for the application described within the submittal.
 - 3. Manufacturer's engineering calculations, fabrication drawings and post-cure procedures will be audited against the laminate specifications submitted.
 - 4. Findings from testing, inspection and analysis performed on cutouts will be compared to the Manufacturer's engineering calculations and fabrication drawings. This comparison is intended to assure the material manufactured meets or exceeds the Manufacturer's laminate design basis, which has been previously determined to be in compliance with the laminate specifications.
 - 5. All Manufacturer's equipment nameplate(s), Post-cure procedures, inspection records and other information submitted will be reviewed for conformance to the specifications and FRPI SP9100 requirements.

2.2 NONDESTRUCTIVE TESTING AND INSPECTION:

- A. The following nondestructive tests and inspections will be performed on all cutouts and/or remains of materials tested –
 - 1. Barcol hardness, per ASTM D2583.
 - 2. Acetone sensitivity, when applicable.
 - 3. Cutout thickness measurements.
 - 4. Visual Defects assessed, per ASTM C582, ASTM D2563 and/or ASME RTP-1 as specified.
 - 5. Laminate composition:
 - a. Visual identification.
 - b. Laminate sequence verification per ASME RTP-1 2A-400(d) and 6-930(c) and/or by specimen cross sectional ply identification.

2.3 TESTING:

- A. Resin to glass ratio testing, per ASTM D2584, will be performed on one (1) cutout or run out per laminate manufactured that is greater than or equal to thirty (30) square feet. No more than fifteen (15) tests will be conducted per project.
- B. Resin Identification, utilizing Infra-Red Spectral Analysis, will be performed on one (1) cutout per laminate manufactured for all tank and vessel shells that are greater than or equal to thirty (30) square feet for which laminate specifications require this test. No more than five (5) tests will be conducted per project.
- C. Axial tensile strength and modulus of elasticity will be tested per ASTM D638 using cutouts and run outs provided –
 - 1. For all Tanks and Vessels other than those that are less than eight (8) foot in diameter, vertically oriented, flat bottom and atmospheric pressure rated, one (1) of each test will be performed per cylinder size provided on a project, with no more than three (3) sizes tested per project. Axial physical properties

- testing is not required for Tanks and Vessels that are less than eight (8) foot in diameter, vertically oriented, flat bottom and atmospheric pressure rated.
2. For Ductwork, Custom Pipe and any other cylindrical equipment, one (1) of each test will be conducted per cylinder and/or laminate size provided on a project that is greater than or equal to three (3) foot in diameter, with no more than three (3) sizes tested per project.
- D. Hoop tensile strength and modulus of elasticity will be tested per ASTM D638 on filament wound (Type X laminate) cylinder sections greater than or equal to eight (8) foot in diameter using cutouts and run outs provided. One (1) of each test will be conducted per cylinder size provided on a project, with no more than three (3) cylinder sizes tested per project.
 - E. Tensile strength and modulus of elasticity will be tested per ASTM D638 using cutouts and run outs provided –
 1. For all non-cylindrical custom equipment that is not classified as a tank, vessel, scrubber, ductwork or pipe, one (1) of each test will be performed per repetitive major component configuration, with no more than three (3) configuration sizes tested per project. Where only one (1) major component is identified, only a single test shall be required.
 - F. Test reports shall be in writing and include –
 1. Testing laboratory name and project reference numbers.
 2. Specimen reference numbers, laminate sequence and resin type tested.
 3. Specimen dimensional data (thicknesses, widths, area) and weights.
 4. Results: glass content, ultimate loads, tensile strength and modulus, specimen types used and test speed, stress-strain curves with calculations, resin family type determinations and any other requirements per ASME RTP-1 7-1000.
 - G. FRPI reserves the right to reduce number of test specimens for a given ASTM test in the event insufficient specimens are provided by Manufacturer for such tests, where Manufacturer shall be required to prove design through this modified test procedure. Should this modified procedure result in a claim by FRPI that Manufacturer's design does not meet requirements of FRPI SP9100, Manufacturer shall through written agreement with FRPI provide sufficient specimen(s) and/or test data to prove Manufacturer's design.

PART 3 LAMINATE CERTIFICATION

3.1 FRPI AUDIT LOGISTICS:

- A. Upon receipt of request for Laminate Certification, FRPI will issue a firm proposal to Manufacturer for costs associated with the process of seeking Certification and an estimated schedule date. The fee will be payable to FRPI by Manufacturer per standard terms and conditions published on FRPI website, within proposal, SP9100 and referenced documents. Pricing proposed shall be for one (1) review of submittals provided under SP9100 Part 1.4. Proposal assumes Manufacturer provides all submittals timely and meets requirements on first review, with some reasonable clarification and discussion in a subsequent review. Any inordinate review shall be over and above scope of work proposed.
- B. FRPI will perform an objective audit of a Manufacturer's submittal per SP9100 at the request of an authorized Manufacturer's employee, with the intent of issuing a Laminate Certification. The Manufacturer shall initiate this audit by issuing FRPI a

- purchase order accompanied by a signed FRPI Laminate Certification proposal for such work.
- C. The audit will be conducted by an FRPI representative or an FRPI authorized Consultant experienced in the manufacturer, testing, inspection and analysis of all FRP custom equipment per FRPI SP9000 and SP9100, including ASME RTP-1 stamped vessels with Level I allowable visual defects.
 - D. An audit of a Manufacturer's submittal will be performed within approximately four (4) weeks after receipt of complete submittal and fee payment per terms of proposal. The actual scheduled audit date and delivery of acceptances is contingent upon availability at time of order entry.
 - E. Manufacturer shall not begin laminating activities until the Manufacturer's customer and FRPI approve and accept all submittals in accordance with SP9100 Part 1.4 SUBMITTALS D through Q. Manufacturer being in possession of FRPI Release Letter 1 of 2 shall be evidence of such release by FRPI.
 - F. Manufacturer shall not ship equipment requiring Laminate Certification until –
 - 1. All FRPI Testing, Inspection and Analysis of Submittals has been completed per SP9100:
 - a. Part 1.4 SUBMITTALS R and S.
 - b. Part 2 FRPI ANALYSIS, TESTING AND INSPECTION OF SUBMITTALS.
 - 2. Manufacturer's customer and FRPI have sent the Manufacturer written approval and acceptance of the laminates for shipment.
 - 3. Manufacturer being in possession of FRPI Release Letter 2 of 2 shall be evidence of such release by FRPI.
 - G. Manufacturer shall provide all submittals in accordance with SP9100 Part 1.4 SUBMITTALS T through W within a timeframe consistent with project schedule.
 - H. FRPI reserves the right to –
 - 1. Revise analysis, inspection and testing requirements plus scheduling for any project, as project scopes may warrant a more practical approach to assuring laminate quality than this Standard Practice provides for. The Manufacturer is encouraged to secure a written inspection plan from FRPI for each project, with related costs identified, prior to their quoting the project to their customers.
 - 2. Charge additional fees where inordinate submittal review discloses excessive errors, omissions, delays, noncompliance and/or other such circumstances associated with submittals made in accordance with SP9100 Part 1.4 resulting in undue FRPI certification effort and release delays. This includes additional review time associated with project scope changes.
 - 3. Reject incomplete submittals.
 - I. If the conduct and/or decisions made by FRPI auditor are unsatisfactory to the Manufacturer, then Manufacturer may object. All objections shall be submitted in writing to FRPI Board of Advisors in the form of numbered questions, backed with any supporting information Manufacturer would like FRPI to take into consideration when answering each question. FRPI will answer all questions to the best of its ability in as timely a manor as possible and in the presence of Manufacturer if Manufacturer desires to attend the hearing.

3.2 LAMINATE CERTIFICATION AND FRPI CERTIFIED LABELS AWARD:

- A. A Manufacturer that successfully demonstrates that their laminates meet the requirements of SP9100 will be issued a Laminate Certification, with one (1) FRPI Certified label for each tank, vessel and scrubber or several labels for major components of ductwork, piping and non-cylindrical custom equipment from which specimens were evaluated and accepted. Each label issued shall bear an FRPI registration number for traceability from equipment to certification auditing, analysis, inspection and testing records.
- B. The certification and labels are at all times the property of FRPI, shall be used in accordance with any and all FRPI requirements and shall be returned immediately to FRPI upon FRPI's request or when the Manufacturer ceases work on the project prior to fulfilling the requirements of FRPI SP9000 and SP9100.
- C. Written notification of acceptance for release of shipment per FRPI SP9100 will be sent by FRPI to the Manufacturer at the address provided on the initial request for a Laminate Analysis upon acceptable completion of equipment per SP9100.
- D. The Manufacturer or their FRPI certified independent inspector shall affix a FRPI Certified label to each piece of equipment evaluated and accepted after they perform a field inspection of the completed equipment installation per FRPI SP9100. If any handling, installation, other damage or potential operational problems threatening the equipments laminate integrity are identified, then the Manufacturer shall satisfactorily repair or negotiate elimination of threats, complete a nonconformity corrective action field inspection report and then apply the FRPI Certified labels following corrective action.
- E. After FRPI Certification labels are applied, the Manufacturer will send written notification to FRPI indicating that the equipment has been successfully installed with Manufacturer's equipment nameplate(s), all laminates are in like new condition and FRPI Certified labels are in place as per SP9100 requirements. An authorized representative of the Manufacturer's customer as defined within SP9100 shall duly sign this notification.
- F. Upon receipt of Manufacturer's completed nonconformity corrective action field inspection report, FRPI will send the official Laminate Certification to the Manufacturer. The Manufacturer will in turn send a copy of this certification to their client per SP9100, a copy of which shall be included in Operation and Maintenance manual passed on to Owner.

3.3 DENIAL OF LAMINATE CERTIFICATION:

- A. Manufacturers who are deemed to have not met all of the requirements covered within this Standard Practice SP9100 will be denied certification.
- B. Manufacturers denied certification will receive a written report with detailed explanation and corrective actions required in order to bring their laminates in line with requirements of the FRPI SP9100 published at the time of their audit. This notification will be sent by register mail to the address provided on the initial request for a Laminate Analysis.
- C. Additional audit work by FRPI needed in order to provide the Manufacturer with Laminate Certification that results from a Manufacturer having been denied certification will be handled as a new request for a Laminate Analysis per SP9100. With costs and schedule adjusted accordingly.

3.4 ADDITIONAL TERMS AND CONDITIONS:

- A. FRPI reserves the right to reverse, with cause, any and all decisions pertaining to Certification of a Manufacturer's Laminates.
- B. All Manufacturers who enter into this voluntary certification process are deemed, as evidence of their involvement with FRPI, to be in complete agreement with all of the written terms and conditions associated with the FRPI process of Certification. If a Manufacturer contests a decision, the Manufacturer agrees to pay to FRPI in advance any and all costs associated with FRPI's defense of such decision. In the unlikely event that a decision is overturned, the Manufacturer shall be awarded their Certification and continue to observe their written agreement with FRPI.

END OF STANDARD PRACTICE

Section 2 – LAMINATE SPECIFICATIONS

FRPI offers forty (40) standard Laminate Specifications that cover approximately eighty (80) percent of the basic general chemical applications in Industry. Currently there are eleven (11) Resin Type categories, where structural or nonstructural Corrosion Barriers, surface veils, cure systems and fire retardancy features are used in the laminate design further categorize each Resin Type. More laminate design features are listed in each unique specification.

Each unique laminate design is given a Laminate Specification or “LS” number. LS numbers are in a logical sequence below to reflect a particular category or subcategory that they fall under. All Laminate Specifications cover laminates manufactured by the hand lay-up, spray-up and/or filament winding processes.

Laminate Specifications contain the requirements for Manufacturers to follow in order to obtain FRPI SP9000 and SP9100 certification for specific designs. All of these Laminate Specifications are intended to be procedural specifications for managing material quality verification methods and are not intended to replace or be substitutes for industry equipment, inspection and testing standards.

See the Generic Resin Types sheet for a six (6) step process on how to choose many Laminate Specification options. Please contact FRPI if you need assistance with choosing Laminate Specifications or would like FRPI to consider adding a new standard laminate design.

LAMINATE SPECIFICATION SERIES BY CORROSION BARRIER RESIN TYPE

Isophthalic Polyester with CB SL:

- LS100 (1) C-Glass veil and MEKP/CoNap cure system
- LS110 (2) C-Glass veils and MEKP/CoNap cure system
- LS120 (1) Synthetic Polyester veil and MEKP/CoNap cure system
- LS130 (2) Synthetic Polyester veils and MEKP/CoNap cure system

Fire Retardant Halogenated Isophthalic Polyester with CB SL:

- LS200 (1) C-Glass veil and MEKP/CoNap cure system
- LS220 (1) Synthetic Polyester veil and MEKP/CoNap cure system

Chlorendic Acid Polyester with CB SL:

- LS300 (1) C-Glass veil and MEKP/CoNap cure system
- LS310 (2) C-Glass veils and MEKP/CoNap cure system
- LS320 (1) Synthetic Polyester veil and MEKP/CoNap cure system
- LS330 (2) Synthetic Polyester veils and MEKP/CoNap cure system

Bisphenol-A Polyester with CB SL:

- LS400 (1) C-Glass veil and MEKP/CoNap cure system
- LS410 (2) C-Glass veils and MEKP/CoNap cure system
- LS420 (1) Synthetic Polyester veil and MEKP/CoNap cure system
- LS430 (2) Synthetic Polyester veils and MEKP/CoNap cure system

Bisphenol-A Epoxy Vinyl Ester with CB SL:

- LS500 (1) C-Glass veil and MEKP/CoNap cure system
- LS501 (1) C-Glass veil and MEKP/CoNap cure system with Brom Bis-A EVE SL
- LS510 (2) C-Glass veils and MEKP/CoNap cure system
- LS520 (1) Synthetic Polyester veil and MEKP/CoNap cure system
- LS530 (2) Synthetic Polyester veils and MEKP/CoNap cure system

Bisphenol-A Epoxy Vinyl Ester with CB Non-SL:

- LS502 (1) C-Glass veil and MEKP/CoNap cure system
- LS503 (1) C-Glass veil and MEKP/CoNap cure system with FR SL
- LS514 (2) C-Glass veil and MEKP/CoNap cure system with 192 mil CB
- LS515 (2) C-Glass veil and MEKP/CoNap cure system with 192 mil CB and FR SL
- LS532 (2) Synthetic Polyester veils and MEKP/CoNap cure system
- LS533 (2) Synthetic Polyester veils and MEKP/CoNap cure system with FR SL
- LS572 (2) Synthetic Polyester veils and DMA-DEA/BPO cure system
- LS573 (2) Synthetic Polyester veils and DMA-DEA/BPO cure system with FR SL

Fire Retardant Brominated Bisphenol-A Epoxy Vinyl Ester with CB SL:

- LS600 (1) C-Glass veil and MEKP/CoNap cure system
- LS620 (1) Synthetic Polyester veil and MEKP/CoNap cure system

Fire Retardant Brominated Bisphenol-A Epoxy Vinyl Ester with CB Non-SL:

- LS602 (1) C-Glass veil and MEKP/CoNap cure system, Dual Class Fire Rating
- LS672 (2) Synthetic Polyester veils and DMA-DEA/BPO cure system with Bis-A EVE SL
- LS673 (2) Synthetic Polyester veils and DMA-DEA/BPO cure system with FR SL

Epoxy Novolac Vinyl Ester with CB SL:

- LS700 (1) C-Glass veil and MEKP/CoNap cure system
- LS710 (2) C-Glass veils and MEKP/CoNap cure system
- LS720 (1) Synthetic Polyester veil and MEKP/CoNap cure system
- LS730 (2) Synthetic Polyester veils and MEKP/CoNap cure system

Fire Retardant Brominated Epoxy Novolac Vinyl Ester with CB SL:

- LS800 (1) C-Glass veil and MEKP/CoNap cure system
- LS820 (1) Synthetic Polyester veil and MEKP/CoNap cure system

Furan (“Furfuryl Alcohol”) with CB SL:

- LS900 (1) C-Glass veil and Acidic Catalyst cure system
- LS910 (2) C-Glass veils and Acidic Catalyst cure system



GENERIC RESIN TYPES

July 17, 2017

This reference is intended to provide a means to identify suitable FRPI Laminate Specifications for simple applications based upon resin, surface veil and cure recommendations made by Resin Suppliers, FRP Equipment Manufacturers, Industry Consultants and FRPI. These generic resin types that make up the basis for FRPI Laminate Specifications were publicly developed by the Engineering Division of the Technical Association of the Pulp and Paper Industry ("TAPPI") Corrosion and Materials Engineering Committee, committee assignment CA-4684. The committee that developed this reference was comprised of Resin Suppliers and FRP Equipment Manufacturers. These generic resin types agreed upon were first published in a paper titled, "A Guide to the Use of Epoxy, Furan, Polyester and Vinyl Ester Equipment" in TAPPI Engineering Conference Book 1 in September 1989. Each Resin Supplier has been contacted by FRPI, input was included and resin types updated to reflect industry mergers and acquisitions as well as currently available resins.

CAUTION: This reference **IS NOT** intended to suggest Supplier's resins are chemical or functional equivalents to competing brands nor is the listing all inclusive. Extensive testing and documented case histories have proven some resin brands of the same type perform better than others in certain applications. Please contact resin manufacturers for detailed resin performance experience for your specific application prior to final selection.

To use this resin brand to FRPI Laminate Specification reference simply:

1. Obtain a resin and surface veil recommendation.
2. Look up the resin recommended in the table below.
3. Look across to the FRPI Generic Resin Type and note the category name.
4. Turn to FRPI Laminate Certification Manual table of contents.
5. Locate the FRPI Generic Resin Type.
6. Choose Laminate Spec number corresponding with type and number of surface veils recommended.

FRPI GENERIC RESIN TYPE	RESIN MANUFACTURER BRANDS AND PRODUCT NUMBERS					REICHHOLD Dion®
	AOC Vipel®	ASHLAND Aropol®	Derakane®	Hetron®	INTERPLASTIC CoREZYN®	
Isophthalic Polyester (rigid)	F701	7241 7242			75-AQ-001, S & W 75-AQ-010, S & W 75-AA-011	6631
Isophthalic Polyester (resilient)	F737 F738	7334			75-AQ-610	6334
Fire Retardant Halogenated Isophthalic Polyester	K733			99P 92FR		FR7767
Chlorendic Acid Polyester	K190			197-3	16-DA-097	797
Bisphenol-A Polyester	F282			700		382 (was Atlac) 6694
Bisphenol-A Epoxy Vinyl Ester	F010		411	922	8300	9100 9102
Bis-A Epoxy VE (lower MW)			411C	922L	8100-45	
Bis-A Epoxy VE (higher HDT)	F007		441	942	8360	9160
Bis-A Epoxy VE (higher cross linked)	F080		441	980	8710 8770	9160
Bis-A Epoxy VE (higher cross linked, low VOC)	F083		441	980/35	8360	9160
Bis-A Epoxy VE (urethane modified)						9800 (was Atlac 580)
Fire Retardant Brominated Bisphenol-A Epoxy Vinyl Ester	K022-C K022-CN		510C	FR992 992SB	VE8450 VE8440M-AT	FR9300
Fire Retardant Brominated Bis-A Epoxy VE (ASTM E84 Class I no AT)	K022-A		510A		VE8440	
Fire Retardant Brominated Bis-A Epoxy VE (higher cross linked)	K023			998		
Epoxy Novolac Vinyl Ester	F085		470	970	8730	9400
Epoxy Novolac VE (higher HDT)	F086		470HT			
Fire Retardant Brominated Epoxy Novolac Vinyl Ester (No AT for K095)	K095		510N			
Furan ("Furfuryl Alcohol")				800		



Documents

Document Sharing Hub



April 28, 2004

**ISOPHTHALIC POLYESTER LAMINATES
WITH ONE (1) C-GLASS VEIL
AND MEKP/CONAP CURE SYSTEM**

Laminate
Specification
LS100

PART 1 GENERAL

1.1 PURPOSE AND SCOPE:

- A. This specification is intended to provide laminates with good physical properties and chemical resistance for various applications. Consult FRPI for suitable applications for this specification. Proper use is the responsibility of parties other than FRPI.
- B. Furnish all labor, materials, equipment and incidentals required to provide laminates for all equipment and related components as specified herein.

1.2 DEFINITIONS:

- A. Parties involved with FRPI Certification shall be defined as per FRPI SP9100
- B. Laminate lay-up composition:
 - 1. The Inner Surface ("Inner Surface") is the portion of a laminate made up of surface veil, which is regarded as being on the mold surface side of the Structural Layer.
 - 2. The Interior Layer ("Interior Layer") is the portion of a laminate made up of random strand mat and/or chopped strand roving, which is regarded as being on the mold surface side of the Structural Layer and follows the inner surface in lay-up sequence.
 - 3. The Inner Corrosion Barrier ("Inner Corrosion Barrier") is the Inner Surface and Interior Layer combined.
 - 4. The Structural Layer ("Structural Layer") is the portion of a laminate that is made up of any one or combination of reinforcements other than surface veils. The thickness of this portion of the laminate, when added to the Inner and Outer Corrosion Barrier thickness, makes up the total laminate thickness for the determination of strength values used in engineering calculations to design equipment structure.
 - 5. The Exterior Layer ("Exterior Layer") is the portion of a laminate made up of random strand mat and/or chopped strand roving, which is regarded as being on the opposite side of the Structural Layer from the Interior Layer and follows the Structural Layer in lay-up sequence.
 - 6. The Outer Surface ("Outer Surface") is the portion of a laminate made up of surface veil and/or pure resin finish coat, which is regarded as being on the opposite side of the Structural Layer from the Inner Surface and follows the Exterior Layer in lay-up sequence. This surface is typically not in contact with the mold and includes a resin finish coat with paraffin wax when not a mold surface.
 - 7. The Outer Corrosion Barrier ("Outer Corrosion Barrier") is the Exterior Layer and Outer Surface combined.

8. The Corrosion Allowance (“Corrosion Allowance”) is the portion of a laminate thickness made up of the Inner and/or Outer Corrosion Barrier that must not be included in the total laminate thickness determination for the purpose of engineering calculations used for the design of equipment structure. This portion is regarded as sacrificial, with designation made in a laminate specification.

1.3 REFERENCE STANDARDS:

- A. American Society for Testing and Materials (“ASTM”) –
 1. ASTM C582 - Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion Resistant Equipment
 2. ASTM D638 - Standard Test Method For Tensile Properties of Plastics
 3. ASTM D2471 - Test Method for Gel Time and Peak Exothermic Temperature of Reacting Thermosetting Resin
 4. ASTM D2583 - Standard Test Method for Indentation Hardness of Rigid Plastics By Means of a Barcol Impressor
 5. ASTM D2584 - Standard Test Method for Ignition Loss of Cured Reinforced Resins
- B. American Society of Mechanical Engineers (“ASME”) –
 1. ASME RTP-1 - Reinforced Thermoset Plastic Corrosion Resistant Equipment
- C. Fiberglass Reinforced Plastics Institute (“FRPI”) –
 1. FRPI SP9100 - Standard Practice for Laminate Certification

1.4 SUBMITTALS

- A. The Manufacture shall furnish all submittals as required per FRPI SP9100.

PART 2 LAMINATE CONSTRUCTION

2.1 GENERAL:

- A. All laminates will be constructed in accordance with and possess the physical properties as required by the Reference Standards, unless otherwise specified herein.
- B. The Laminate construction for all equipment components shall consist of the Inner Surface, Interior Layer, Structural Layer, Exterior Layer and Outer Surface.
- C. All laminate surfaces that come in contact with the Owner’s process stream shall –
 1. Be regarded from a laminate design and composition standpoint as the Inner Corrosion Barrier, although they may not actually be the mold surface side of the Structural Layer
 2. Have their edges laminated with both the Inner and Outer Surface materials specified, less the ultraviolet light inhibitor for UV protection

2.2 INNER SURFACE:

- A. The Inner Surface shall be reinforced with one (1) C-Glass Surfacing Veil, with a minimum thickness of 0.010" (10 mils) and 10% reinforcement content.

2.3 INTERIOR LAYER:

- A. The Interior Layer shall be reinforced with two (2) layers of 1-1/2 ounce per square foot random strand mat, with a minimum thickness of 0.086" (86 mils) and 25 to 30% reinforcement content.

2.4 INNER CORROSION BARRIER:

- A. This portion of the laminate shall be a Type I laminate.
- B. This portion of the laminate shall be laminated with an Isophthalic Polyester resin that is cured with a cobalt naphthenate (Co/Nap) promoter and a methyl ethyl ketone peroxide (MEKP) catalyst per the resin supplier's recommendations.
- C. The Inner Corrosion Barrier shall be laminated utilizing the Hand Lay-up process. To minimize thickness variation plus the introduction of gaseous bubbles and air inclusions, no automated chopping of reinforcement or spraying of reinforcement or resin is permitted within the Inner Corrosion Barrier.
- D. The Inner Corrosion Barrier shall have a minimum thickness of 0.096" (96 mils) and 25 to 30% reinforcement content.
- E. The Inner Corrosion Barrier thickness shall be regarded as contributing to the components strength when calculating the thickness of the Structural Layer.
- F. The Inner Corrosion Barrier shall be laid up all at one time and cured prior to the addition of the following layers.

2.5 STRUCTURAL LAYER:

- A. The Structural Layer shall be a Type I, II or X laminate, as determined by the Manufacturer. All Contact Molded Type II laminates shall contain 24 ounce per square yard woven roving. All Filament Wound Type X laminates shall contain one (1) 43 mil layer of 1-1/2 ounce per square foot chopped strand glass bedding applied as a bonding layer between the cured Inner Corrosion Barrier and Structural Layer.
- B. The Structural Layer shall be laid up on the Inner Corrosion Barrier within twenty-four (24) hours after the Inner Corrosion Barrier has cured. Otherwise the Inner Corrosion Barrier non-mold surface must be completely ground to assure adequate bonding with the Structural Layer applied.
- C. The Structural Layer shall be laminated with an Isophthalic Polyester resin that is cured with a cobalt naphthenate (Co/Nap) promoter and a methyl ethyl ketone peroxide (MEKP) catalyst per the resin supplier's recommendations.
- D. The Structural Layer shall have a minimum thickness as calculated by the Manufacturer given the application and 25 to 30% reinforcement content for Type I, 35 to 40% for Type II or 50 to 80% for Type X laminates.
- E. The Structural Layer design thickness shall take into consideration the entire component laminate cross section, including the Inner Corrosion Barrier and Outer Surface. The Structural Layer for vertically oriented tanks may be tapered from bottom to top, as hydrostatic head pressure and laminating process methods dictate.

2.6 OUTER SURFACE:

- A. The Outer Surface shall be coated with a 5 mil unreinforced resin rich layer containing paraffin wax.

- B. The Outer Surface shall contain an ultraviolet light inhibitor for UV protection.
- C. The Outer Surface shall be laminated with an Isophthalic Polyester resin that is cured with a cobalt naphthenate (Co/Nap) promoter and a methyl ethyl ketone peroxide (MEKP) catalyst per the resin supplier's recommendations.
- D. The Outer Surface shall have a minimum thickness of 0.005" (5 mils).

2.7 INSPECTION AND TESTING

- A. The Inner Corrosion Barrier, Structural Layer and Outer Surface shall have no more visual defects allowed other than what is permitted under ASTM D2563 Table 1 Allowable Defects, Visual Acceptance Level II column. The Maximum Percent Repairs allowed shall be limited to 3% for the Inner Corrosion Barrier and 10% for the Structural Layer and Outer Surface of the components total surface area.
- B. Extent of testing and standard test methods for Tensile Properties, Gel Time, Barcol Hardness, Reinforcement Content and Laminate Sequence shall be as per the Referenced Standards.

END OF LAMINATE SPECIFICATION

	Fiberglass Reinforced Plastics Institute, Inc. www.frpi.org	
April 28, 2004	ISOPHTHALIC POLYESTER LAMINATES WITH TWO (2) C-GLASS VEILS AND MEKP/CONAP CURE SYSTEM	Laminate Specification LS110

PART 1 GENERAL

1.1 PURPOSE AND SCOPE:

- A. This specification is intended to provide laminates with good physical properties and chemical resistance for various applications. Consult FRPI for suitable applications for this specification. Proper use is the responsibility of parties other than FRPI.
- B. Furnish all labor, materials, equipment and incidentals required to provide laminates for all equipment and related components as specified herein.

1.2 DEFINITIONS:

- A. Parties involved with FRPI Certification shall be defined as per FRPI SP9100
- B. Laminate lay-up composition:
 1. The Inner Surface (“Inner Surface”) is the portion of a laminate made up of surface veil, which is regarded as being on the mold surface side of the Structural Layer.
 2. The Interior Layer (“Interior Layer”) is the portion of a laminate made up of random strand mat and/or chopped strand roving, which is regarded as being on the mold surface side of the Structural Layer and follows the inner surface in lay-up sequence.
 3. The Inner Corrosion Barrier (“Inner Corrosion Barrier”) is the Inner Surface and Interior Layer combined.
 4. The Structural Layer (“Structural Layer”) is the portion of a laminate that is made up of any one or combination of reinforcements other than surface veils. The thickness of this portion of the laminate, when added to the Inner and Outer Corrosion Barrier thickness, makes up the total laminate thickness for the determination of strength values used in engineering calculations to design equipment structure.
 5. The Exterior Layer (“Exterior Layer”) is the portion of a laminate made up of random strand mat and/or chopped strand roving, which is regarded as being on the opposite side of the Structural Layer from the Interior Layer and follows the Structural Layer in lay-up sequence.
 6. The Outer Surface (“Outer Surface”) is the portion of a laminate made up of surface veil and/or pure resin finish coat, which is regarded as being on the opposite side of the Structural Layer from the Inner Surface and follows the Exterior Layer in lay-up sequence. This surface is typically not in contact with the mold and includes a resin finish coat with paraffin wax when not a mold surface.
 7. The Outer Corrosion Barrier (“Outer Corrosion Barrier”) is the Exterior Layer and Outer Surface combined.