Technical guide for glass-fibre reinforced thermoset-plastic roofing systems

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Canadian Construction Materials Centre

Technical Guide for

Glass-Fibre Reinforced Thermoset-Plastic Roofing Systems

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N.B. This Technical Guide was prepared under contract by CCMC for the evaluation of a specific product. The technical requirements and performance criteria it contains are not valid for the evaluation of other products unless verified by CCMC under separate contract.

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1.0 Scope

This Technical Guide describes the technical requirements and performance criteria for the assessment of Glass Fibre Reinforced Plastic Roofing System for the purpose of obtaining a CCMC Evaluation Report.

Glass Fibre Reinforced Plastic Roofing System falling under the scope of this Guide is made of thermosetting plastic resin that is reinforced with glass fibre strands or mats, along with various constituents such as fillers, pigments and additives that is heat and pressure molded in a panel or a tile form.

Glass Fibre Reinforced Plastic Roofing System are intended for use only on roofs having a minimum slope of 1 in 4, with limited access for maintenance purposes and in conjunction with a roof underlay. Depending on the system, the Glass Fibre Reinforced Plastic Roofing may be either continuously supported on solid roof sheathing or carried on a batten system, which in turn is continuously supported by the solid sheathing.

The criteria and requirements referenced herein were developed to evaluate the performance of Glass Fibre Reinforced Plastic Roofing systems with respect to their equivalency to the intent of the National Building Code of Canada (NBC) 1995 as allowed for in Section 2.5., Equivalents. Equivalency is established with respect to Part 9, Housing and Small Buildings, Article 9.26.2.1., Roofing Materials, of the NBC.

The performance of these types of product in their intended use cannot be assessed solely on the basis of any existing Canadian standard. Only the base material falls under the scope of an existing Canadian Standard.

A successful evaluation conforming to this Technical Guide will result in a published CCMC evaluation report that is applicable only to products bearing the proper identification of CCMC's evaluation number (see 7.3).

2.0 Definitions

Installation manual - a document governing all aspects of transportation and installation.

Licensed installer - the on-site contractor qualified to perform the work through the proponent's licensing program.

Performance requirements - the actual requirements that a product must meet, which closely simulate the pattern of behaviour in the course of its intended use.

Prescriptive requirements - criteria for specific components, as well as for the individual material types.

Proponent - the party applying for a CCMC evaluation (normally the manufacturer of a product, a major component supplier or a Canadian distributor of the product).

Recognized laboratory - a laboratory complying with CCMC's Laboratory Recognition Guideline (appended to covering letter).

Skew – an out-of-square variation from a rectangular shape

3.0 Applicable Codes and Standards

3.1 American Plywood Association (APA)

APA Test Method S-11	Siding Performance under Hard-Body Impact Loads

3.2 American Society for Testing and Materials International (ASTM)

ASTM D 570-98	Standard Test Method for Water Absorption of Plastics.
ASTM D 618-00	Methods of Conditioning Plastics and Electrical Insulating Materials for Testing.
ASTM D 635-03	Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting in a Horizontal Position.
ASTM D 638-03	Standard Test Method for Tensile Properties of Plastics.
ASTM D 696-03	Standard Test Method for Coefficient of Linear Expansion of Plastics Between 30C and 30C with a Vitreous Silica Dilatometer.
ASTM D 790-03	Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials ASTM D 792
ASTM D 792-00	Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
ASTM D 1201-99	Standard Specification for Thermosetting Polyester Moulding Compounds.
ASTM D1494-97 (2001)	Standard Test Method for Diffuse Light Transmission Factor of Reinforced Plastic Panels.
ASTM D1729-96 (2003)	Standard Practice for Visual Appraisal of Color Differences and of Diffusely-Illuminated Opaque Materials.
ASTM D 2583-95 (2001)	Standard Test Method for Indentation Hardness of Rigid Plastics by Means of Barcol Impressor.
ASTM D 3841-97 (2001)	Standard Specification for Glass-Fiber Reinforced Polyester Plastic Panels
ASTM D 5319-97 (2001)	Standard Specification for Glass-Fiber Reinforced Polyester Wall and Ceiling Panels

ASTM E661-03	Standard Test Method for Performance of Wood and Wood-Based Floor and Roof Sheathing Under Concentrated Static and Impact Loads
ASTM G 155-04	Standard Practice for Operating Xenon-Arc Light Apparatus for Exposure of Non-Metallic Materials.

3.3 Canadian General Standards Board (CGSB)

CGSB 41-GP-6M	Sheets, Thermosetting Polyester Plastics, Glass Fibre Reinforced

3.4 International Organization for Standardization (ISO)

ISO R 1172	Textile-glass-reinforced plastics – Prepregs, moulding compounds and laminates – Determination of the textile–glass and mineral–filler content – Calcination methods.
ISO R1183	Plastics – Methods for determining the density of non-cellular plastics.
ISO 7895, 1987	Facades made of components - Tests for resistance to positive and negative static pressure generated by wind.

3.5 Metropolitan Dade County Building Code Compliance Office

Protocol PA 100-95	Test Procedure for Wind and Wind Driven Rain Resistance of Discontinuous Roof Systems

3.6 National Building Code of Canada (NBC) 1995

Section 2.5.	Equivalents
Article 3.1.15.1.	Roof Covering Classification
Article 5.6.1.2.	Protective Material and Component Properties
Subsection 9.10.3.	Ratings
Article 9.26.2.1.	Material Standards

3.7 Underwriters' Laboratories of Canada (ULC)

CAN/ULC-S101-M89	Standard Methods of Fire Endurance Tests of Building Construction and Materials
CAN/ULC-S107-M87 (R2001)	Standard Methods of Fire Tests of Roof Coverings

3.8 Standards and Codes Referenced Herein May Be Purchased from:

NBC
Client Services
Institute for Research in Construction
National Research Council Canada
Building M-20, Montreal Road
Ottawa, Ontario
K1A 0R6
Tel.: (613) 993-2463
Fax: (613) 952-7673

SCC
Standards Council of Canada
Standards Information Services
270 Albert Street, Suite 200
Ottawa, Ontario
K1P 6N7
Tel.: (613) 238-3222
Fax: (613) 569-7808

ASTM
American Society for Testing and Materials International
100 Barr Harbor Drive
West Conshohocken, Pennsylvania
U.S.A. 19428-2959
Tel.: (610) 832-9585
Fax: (610) 832-9555

APA
American Plywood Association
P.O. Box 11700
Tacoma, Washington
U.S.A. 98411
Tel.: (206) 565-6600
Fax: (206) 565-7265

CGSB
Canadian General Standards Board
Sales Unit
Place du Portage III, 6B1
11, rue Laurier
Gatineau, Québec
K1A 1G6
Tel.: (819) 956-0425
(800) 665-2472
Fax: (819) 956-5644

ISO International Organization for Standardization
Standards Information Services
Standards Council of Canada
270 Albert Street, Suite 200
Ottawa, Ontario
K1P 6N7
Tel.: (613) 238-3222
Fax: (613) 569-7808

ULC Underwriters' Laboratories of Canada
7 Underwriters Road
Toronto, Ontario
M1R 3B4
Tel.: (416) 757-3611
(866) 937-3852
Fax: (416) 757-9540

4.0 General Requirements

4.1 Development of Technical Requirements and Performance Criteria

The requirements and criteria specified in this Technical Guide have been prepared by CCMC evaluation officers in consultation with researchers and experts in construction. For this purpose, CCMC maintains an ongoing relationship with experts from NRC/IRC, other research or testing organizations, and industry.

4.2 Evaluation Process

In evaluating the submitted product, CCMC personnel assess the product, test results, engineering analysis and installation instructions in relation to the technical requirements and performance criteria specified herein. Where this assessment reveals performance levels below those anticipated in this Guide, limitations on the use of the product may result. In-plant quality control procedures are reviewed to ensure that consistent product quality can be achieved.

5.0 Technical Requirements

5.1 General

Glass-fibre reinforced plastic roofing systems in combination with a roofing underlay are expected to provide the rain and snow penetration control of the roof assembly. The technical requirements described in Section 5.0 pertain to the assessment of performance in the following areas:

- appearance
- physical and mechanical characteristics
- rain penetration control
- durability and stability under the action of:
  - Traffic loads
  - Wind loads
- fire *(Optional)*

5.2 Surface characteristics

The glass fibre reinforced plastic panels when subjected to a visual examination shall not reveal the following faults:

- any hole, pinhole, dent or projections,
- any cracking or splitting,
- any defects such s resin ribs, glass folds, or glass knots exceeding 5 mm in size.

5.3 Materials

5.3.1 Matrix Binder

The matrix binder used in the composite shall be cured thermosetting polyester resin with cross-linking monomers composed of polymeric esters in which the recurring ester groups are an integral part of the main polymer chain. The finished product may contain nominal amounts of catalyst residuals and stabilizers.

The proponent shall submit information and data on the polyester resin compound used in the production of the roofing panels. The data, with respect to the polyester resin compound must include the following:

- type of polyester molding compound,
- type of surface finish gel coat, if any,
- type of surface finish film, if any,
- specific gravity,
- flexural, and tensile strength,
- modulus of elasticity in flexure, and
- infrared Spectrospcopy of the polyester resin.

5.3.2 Reinforcement

The reinforcement shall be glass fibre that will be typically drawn from E glass. The glass reinforcement must be chemically sized as to be compatible with the polyester resin system. The proponent shall submit information and data to validate the requirements indicated herein.

5.4 Composition

5.4.1 Resin : Glass / Resin : Filler Ratio

When tested in accordance with ISO R 1172 the Resin : Glass ratio and the Resin : Filler ratio shall be reported.

5.4.2 Protective coating (Surface treatment)

5.4.2.1 Presence of Protective Coating

The finished glass fibre reinforced plastic panel shall have a surface protection on the exposed weather surface. The manufacturer shall state the method of protection used and the side that is protected.

The presence of the protective coating shall be confirmed in accordance with the Acid Immersion Test described in section 6.4.1.1 of this Guide.

5.4.2.2 Durability of Protective Coating

When subjected to the Water Boil Test for 2 hours as indicated in Section 6.4.1.2 of this Guide, the gel coat shall show no evidence of crazing, cracking or loss of adhesion.

5.4.2.3 Thickness of Protective Coating

When tested in accordance with Section 6.4.1.3, the thickness of the protective coating shall be not less than 0.07 mm for surface treatment consisting of gel coat, and 0.015 mm for surface treatment consisting of a film-type coating. The minimum thickness value measured shall not be less than 20% of the indicated minimums.

5.4.2.4 Adhesion of Protective Coating

When tested in accordance with Section 6.4.1.4, the surface treatment (Gel coat / film) shall not detach form the sample.

5.4.3 Resin Curing

5.4.3.1 Water Absorption

When tested in accordance with ASTM D 570, and Section 6.4.2.1 of this Technical Guide, the water absorption of the glass fibre reinforced plastic panels shall not be greater than 1% or 0.6 mg/cm^2 whichever is smaller.

5.4.3.2 Dimensional Changes on Heating

When tested in accordance with Section 6.4.2.3, the effect of heat aging on the dimensional stability of the glass reinforced fibre panel shall not be greater than 0.1%.

5.5 Physical Requirements

Glass-fibre reinforced plastic roofing system shall meet the prescriptive requirements of the base material outlined in table 1.

Property	Requirements	Test Method
Size (mm) Length Width Thickness	 As manufactured 1350 0.50 to 4.00	 ASTM D 3841 Section 8.2 ASTM D 3841 Section 8.2 ASTM D 3841 Section 8.4.1
Dimensionnel Tolerances (%) Length Width Thickness	 ± 10 ± 5 ± 10	 ASTM D 3841 Section 8.2 ASTM D 3841 Section 8.2 ASTM D 3841 Section 8.4.1
Squareness (mm/m)	≤ 3.0	ASTM D 3841 Section 8.3
Edge Straightness (mm/m)	≤1.3	ASTM D 5319 Section 8.5
Skew[1] (mm/m)	≤ 1.3	See Note 1 at the end of table
Camber (mm/m)	≤ 3.2	ASTM D 5319 Section 8.5
Warpage[2]	≤ the greatest of 25 mm/m or 5 mm	See Note 2 at the end of table
Glass Content (%)	≥ 25	CGSB 41-GP 6M Section 7.7
Density (g/m^2) Density Tolerance from specified (%)	500 ≤ 5000 10	ASTM D 792 or ISO R 1183
Hardness (Barcol)	50 for Type 1[4] 45 for Type 2	ASTM D 2583
Nail Pull Resistance (N)	Report Value	ASTM D 1037 Part A[5]
Lateral Nail Resistance (N)	≥ 311	ASTM D 1037 Part A[5]
Colour[3]	Uniform	Visual inspection
Flammability Type 1 (mm/min.) Type 2	 ≤ 50 Report Value	 ASTM D 635 CAN/ULC S 102
Light transmission from specified value (%) (Applicable to translucent products)	≤ 5	ASTM D 1494

1 Skew refers to the out-of-square variation from a rectangular shape. The criteria identify the maximum allowable difference between the diagonals of a panel. Measurements to be made to the nearest 0.8 mm. Tolerances on skew shall be carried out using classical measurements of dimensions.

2 Warpage refers to the out-of-plane of one corner with respect to the other three corners. Measurements to be made to the nearest 0.8 mm. The warpage shall be measured when the panel is placed horizontally on two parallel supports. Tolerances on warpage shall be carried out using classical measurements of dimensions.

3 The uniformity of the colour shall be determined visually by an experienced person using daylight source in accordance with ASTM D 1729.

4 Type 1 refers to non –flame rated products, and Type 2 refers to flame rated products.

5 The fasteners used shall be as specified by the manufacturer's installation manual.

5.6 Mechanical Properties

5.6.1 Flexural Strength

When tested in accordance with ASTM D 790, Procedure A, the minimum flexural strength of the panels shall not be less than 150 MPa.

5.6.2 Loss of Flexural Strength

When tested in accordance with ASTM D 790, Procedure A, the loss of flexural strength after 2 hours immersion in boiling water and after 30 days soaking in water at 25°C shall not exceed 25%.

There shall be no significant change in appearance of the surface of the panel.

5.6.3 Tensile Strength

When tested in accordance with ASTM D D638, the minimum tensile strength of the panel shall be not less than 50 MPa.

5.6.4 Change in Barcol Hardness

When subjected to the following exposures and tested in accordance with 6.4.2.1:

- 2 hours Water Boil Test in accordance with section 6.4.1.2, and
- 7 days Heat Aging Test, in accordance with Section 6.4.2.2

The change in the Barcol Hardness shall not increase by more than 10% of its initial value.

5.6.5 Coefficient of Linear Expansion

When tested in accordance with ASTM D 696, the coefficient of linear expansion of the glass fibre reinforced plastic shall not be greater than 4.5×10^{-5}.

5.7 Impact Resistance

When tested in accordance with the test methodology of APA Test Method S-11, the glass fibre reinforced panel shall be capable of resisting the impact of a hard body, providing an impact energy of 6 N.m. The hard body shall consist of a steel ball having a diameter of 50 mm, with a mass of 0.5 kg ± 14 g. Failure is said to have occurred if any crack, split, perforation or tear extending from one surface of the panel to the other is observed.

5.8 Accelerated Weathering (UV exposure)

When tested in accordance with ASTM G 155, and section 6.4, using one of the two options in relation to cycles, and number of exposure hours, the glass fibre reinforced plastic panels shall be free from any visual surface or physical changes such as fibre pop-out, crazing, flaking, surface microcracking. The panels shall maintain a uniform colour with not more than slight colour change.

Option 1: 600 hours, 2 hours Xenon Arc radiation followed by 0.67 hours cold water spray;

Option 2: 2000 hours, 4 hours Xenon Arc radiation, followed by 4 hours cold water spray.

5.9 Performance Requirements

5.9.1 Rain Penetration Resistance

When subjected to a dynamic water rain penetration resistance test according to Section 6.4.5 of this Guide, the Glass-fibre reinforced plastic roofing system shall shed water efficiently and prevent its entry into the roof assembly. Any incidental water penetrating through the roofing must be intercepted by the sheathing membrane/flashing and dissipated by drainage to the outside. Any water passing through the sheathing membrane/flashing layer during the testing will be considered a failure of the roofing system.

5.9.2 Wind Load Resistance

The Glass-fibre reinforced plastic roofing system, when installed as recommended by the manufacturer and subjected to a wind uplift resistance test according to Section 6.4.6 of this Guide, shall be capable of resisting the applied wind load pressures without any evidence of deformation or permanent damage that could jeopardize the rain penetration resistance of the roofing system.

5.9.3 Traffic Load

Glass-fibre reinforced plastic roofing systems to be applied over solid sheathing, or battens shall be designed to support a traffic load equivalent to 900 N, concentrated on an area of 125 x 125 mm^2 when tested in accordance with ASTM E 661 at the maximum support spacing specified by the manufacturer or at other points that would produce the worst loading conditions.. Failure of the roofing system shall be deemed to have occurred when breakage and/or plastic deformation occurs.

5.10 Fire Protection (Optional)

In cases where the product is used in a rated system, it must be rated according to CAN/ULC-S101 (see Articles 3.1.7.1. and 9.10.8.1. of NBC 1995). Where roofing products are to be used on buildings governed by Part 3 of the NBC, they must also be tested according to CAN/ULC-S107 criteria to determine the roof covering classification.

6.0 Testing

6.1 General

Testing must be performed at a recognized laboratory as indicated in the covering letter. The proponent must provide copies of this Technical Guide to each laboratory performing tests. The proponent must cover the costs of testing and authorize the testing organization to forward the original test report for each sample directly to CCMC. The submitted test reports are retained by CCMC and their contents remain confidential.

6.2 Sampling

The proponent must arrange with CCMC to obtain a random selection of samples from the production line or main storage facility for their identification before they are sent to the testing laboratory.

The proponent should contact the testing laboratory to obtain information regarding fees and the number of samples required for testing in accordance with this Technical Guide. The proponent must then forward the identified samples directly to the testing laboratory. If several plants manufacture this product, samples from each facility are required.

6.3 Reports from Testing Laboratories

The following information shall be provided by testing laboratories in reports intended for CCMC evaluation purposes:

- detailed information on material sampling (sampling date, method of sampling, sites where sampling was performed and sample reference number);
- the start and end date(s) of test(s);
- detailed specimen preparation methods (if other than specified in the test method, standard or Technical Guide);
- test procedure identification, including:
  - any deviations from the referenced test procedure,
  - reasons for the deviations,
  - additional instrumentation requirements;
- all information mentioned in the reporting section of the referenced standards or standard test methods;
- test results (table format, if appropriate), including:

- written explanations to account for any discrepancies; and

- a concluding statement on the product's performance with respect to the testing performed and the results obtained. *(The test report should contain detailed observations, including photographs if applicable, describing the performance of the product and any comments the testing laboratory wish to include. In case of revised test report, the document should contain a clear description of why the report was revised and what the revisions entailed.)*

The report should include the statement: "Tested for CCMC Evaluation Purposes."

6.4 Testing Procedures

6.4.1 Protective Coating (Surface Treatment) Tests

6.4.1.1 Acid Immersion Test

Three test specimen 100 mm long and 25 mm wide shall be cut from across the panel width with a fine tooth saw. The specimens shall be conditioned in accordance with ASTM D 618, Procedure A. The specimens shall be immersed to a depth of 50 mm into a solution of 98 % concentrated sulfuric acid. The acid temperature shall be 20 ± 2°C. The acid shall not be exposed to the air for more than 20 minutes and fresh acid shall be used for each specimen. The immersion time will depend on the type of the surface coating. The immersion time and descriptive effects of immersions shall be as follows:

Surface Coatings	Immersion Time (minutes) of Immersion	Effect on Immersed Area
Polyvinyl Fluoride films (PVF)	30	No Effect
Gel Coats	7.5	Slight matt finish, no exposed glass fibres
Polyethylene terephthalate films	1	White residue coating

6.4.1.2 Water Boil Test

The test shall be conducted on specimens approximately 300 mm x 200 mm that would have been taken on the basis of 2 specimens per square metre of surface area with a minimum of 5 specimens per sample panel.

The specimens shall be placed in a container having distilled water at a temperature of 15 to 20°C. The water container shall be heated in such a way as to bring the water temperature to 100°C in 15 minutes. The water shall be maintained at that temperature for 2 hours. The specimens shall be removed from the container and allowed to cool for fifteen minutes in distilled water maintained at 20 ± 5°C. Remove the test specimen and dry them using a dry cloth. Measure the flexural strength in accordance with

Section 5.6.1 of the Guide, and measure the Barcol Hardness in accordance with ASTM D 2583 respectively.

6.4.1.3 Thickness of Protective Coating

The test shall be conducted on flat rectangular specimens 10 mm wide, 50 mm long, and of the same thickness as the evaluated panel. The specimen shall be selected on the bases of 2 per square meter of surface area of the panel, with a minimum of 5 specimens per sample panel.. The specimens shall be taken 20 mm away from the panel extremities as well from its centre. The samples shall be polished using sanding paper varying from No. 250 to 1000. The samples shall be placed under a calibrated microscope equipped with an optical system to provide sharp resolution of the cross section to be examined, with a magnification of approximately 1 x 100. Report the average coating or film thickness and the minimum thickness measured to the nearest 2.5 µm.

6.4.1.4 Protective coating (Surface treatment) Adhesion Peel Test

The test shall be conducted on three flat rectangular test specimens 25 mm wide, 100 mm long, and of the same thickness as the evaluated panel. The specimen shall be selected on the bases of 2 per square meter of surface area of the panel. Make 2 parallel cuts in the surface coating 2 mm apart and 15 mm long with a surgical scalpel. With the point of the scalpel, try to pry up the surface coating. If the strip can be lifted, insert the point of the scalpel below the strip and twist attempting to pry the film from the sheet using the blunt edge of the scalpel. If the film breaks but will not peel by more than 3 mm, the adhesion is considered adequate.

6.4.2 Resin Curing

6.4.2.1 Water Absorption Test

The test shall be conducted on specimens approximately 100 mm x 100 mm that would have been taken on the basis of 2 specimens per square metre of surface area with a minimum of 5 specimens per sample panel. The test shall be conducted in accordance with ASTM D 570.

6.4.2.2 Heat aging Test

The specimens are placed in a forced air circulation oven that can be controlled to a temperature of 190 ± 2°C and that is fitted with a sliding door to minimize heat loss when test pieces are introduced or removed. Place the test specimens in the oven at 80 ± 2°C for 16 ± 1h before removing them and conditioning them for 24 hours at 23 ± 2°C and 50 ± 5% R.H.

6.4.2.3 Dimensional Changes after Heat Aging

The test shall be conducted on specimens approximately 400 mm x 100 mm that would have been taken on the basis of 2 specimens per m^2 of

surface area with a minimum of 4 specimens per sample panel. The test specimens shall preferably be cut with their longest dimension parallel to the extrusion direction or the longer axis of the mould. Two 2 mm holes shall be drilled along the longitudinal axis of the specimen. The holes shall be distant 300 mm apart, 50 mm from each adjacent edge. The specimens shall be conditioned at 23 ± 2°C and 50 ± 5% relative humidity for not less than 24 hours prior to test in accordance with Procedure A of Methods ASTM D 618. Repeat the measurements between the two holes on each specimen and calculate the percentage change in length (Shrinkage). Report the mean percentage of length change.

6.4.3 Changes in Barcol Hardness Test

The apparatus, calibration, conditioning of test specimens and test procedures shall be in accordance with ASTM D 2583. Test two specimens, each 150 mm x 150 mm. 6 hardness readings shall be taken on each specimen and the mean value shall be established on the 12 readings. Calculate the changes in Barcol Hardness as a percentage of the initial reading.

6.4.3.1 Barcol Hardness Changes after 2 hours Water Boil Test

The test specimens shall be subjected to 2-hour Water Boil Test in accordance with Section 6.4.1.2.

6.4.3.2 Barcol Hardness Changes after Heat Aging

The test specimens shall be subjected to a heat aging in accordance with Section 6.4.2.2 of the Guide.

6.4.4 Accelerated Weathering:

The cyclic variation of radiation, temperature and moisture for the xenon arc (Weather-Ometer, using a 6000-W water cooled xenon arc burner with borosilicate inner and outer filters.) are provided in two options. The manufacturer may choose one of the following two options:

Option 1:

- 2h xenon arc radiation, intensity 0.46 (W/m^2)/nm at 340 nm, 55°C panel Temperature, 50% RH, waterspray off 0.67 hours cold water (9°C) spray, 12ºC panel temp, 100% RH, radiation off 9 cycles/day.

Option 2:

- 4 h xenon arc radiation, average intensity 50% of that of 2 - 0.67 cycles, 55°C panel temp, 50% RH, waterspray off, 4 h cold water (9°C) spray, 12°C panel temp 100% RH, radiation off, 3 cycles /day.

The samples shall be mounted along the horizontal, central axes of the rack where the radiation intensity corresponds to the intensity reading on the monitoring device. This is intended to minimize the difference in radiation intensity from the middle to the ends of a panel because the horizontal central axes of the burner,

where the radiation intensity is greatest, coincide with the middle of each panel. The water spray shall be supplied at (9°C) at a flow rate of 4 l/h.

6.4.5 Rain Penetration Resistance Test

The dynamic pressure rain penetration resistance test shall be conducted using a modification of the Dade County Protocol PA 100-95, "Test Procedure for Wind and Wind Driven Rain Resistance of Discontinuous Roof Systems."

Test Frame
The test frame shall consist of a 3.05 m x 2.44 m base structure, constructed from wood or steel framing, and a wood deck, constructed from plywood or OSB sheathing.

Observation windows shall be made in the sheathing at the following locations:

1) one at the front edge of test deck,
2) one at the edge of the flashing that is adjacent to the valley, and
3) two openings in the test field.

Deck support joists shall be placed at 600 mm on centre. The deck slope shall be adjustable or multiple interchangeable decks shall be available to test specimens at slopes of 1:6, 1:4, 1:3, 1:2. The deck support shall be capable of supporting not less than 2.6 kPa of dead load.

Wind Generator
A wind generator capable of generating a constant 170 km/h wind profile over the entire width of the test specimens shall be provided. The flow of wind over the roof shall not be obstructed at either side. Water shall be supplied to the wind stream using a sprinkle-pipe system mounted on a movable frame capable of simulating a uniform 220 mm/h rainfall over the test specimen. Wind stream calibration and water distribution check shall be conducted according to PA 100-95, Section 7, and shall be included in the report.

Test Specimen
The wood test deck shall consist of APA 50 mm span rated sheathing of 12 mm thickness or NBC prescribed wood sheathing with thickness conforming to Table 9.23.15.6.A, installed over 50 x 150 mm perimeter support and 50 x 150 mm intermediate supports spaced 600 mm apart. The sheathing shall be attached with 8d common nails at 150 mm at intermediate supports. One valley shall be constructed into the test deck, located at the deck's front edge. (Figure 1 provides an illustration of a test deck). The wood test deck shall be positioned at the minimum slope against which the roofing system is being tested.

Underlayment and prepared roof covering shall be installed in strict compliance with the manufacturer's installation instructions.

The roofing system under test shall be installed in accordance with the manufacturer's installation instructions, using the recommended placement and fastening system. The manufacturer's recommended auxiliaries should also be

used if appropriate. Any deviation must be recorded in the test report.

The areas subject to the test criteria shall consist of the field area of the test deck, the eave, the valley and one rake section. Conditioning of the test specimen shall be conducted according to the manufacturer's instructions.

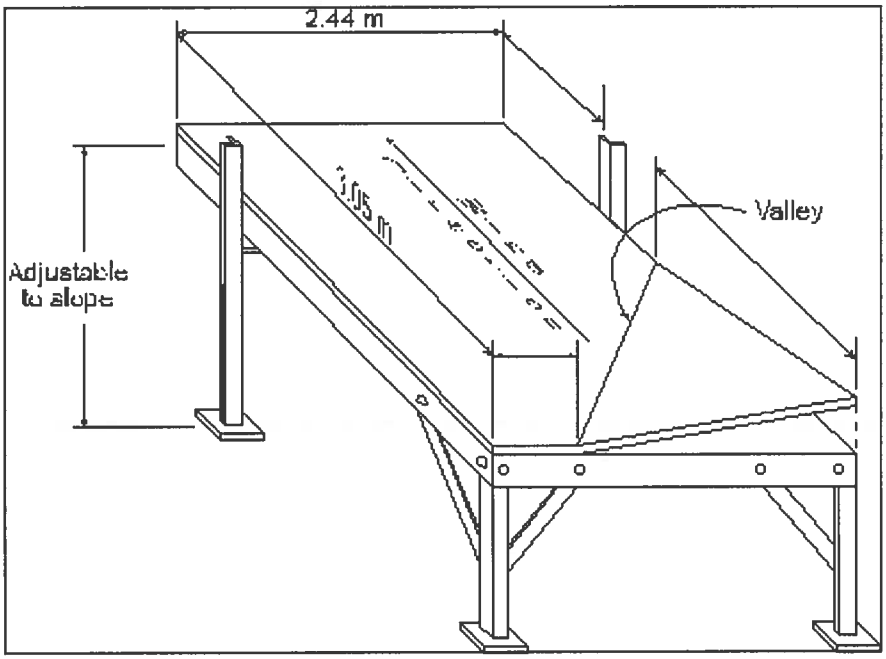

Figure 1. Rain Penetration and Wind Uplift Resistance Tests

Test Procedure

The test specimen shall be positioned on the test frame at the minimum slope proposed for installation.

The test specimen shall be positioned so that the exposed edge of the 2.44 m eave is facing the wind generator. The set-up should facilitate observer access.

The topside and underside conditions of the test specimen shall be recorded prior to starting the test.

The wind speed shall be conducted as noted below:

Interval #	Wind Speed (km/h)	Time (minutes)
1	55	15
2	0	10
3	110	15
4	0	10
5	145	5
6	0	10
7	175	5
8	0	10

Water shall be added to the wind stream upon commencement of the initial wind speed, upwind from the test deck, in an even spray, at a rate that simulates 220 mm/h of rainfall over the test specimen. The flow of water shall be measured with a calibrated flow meter during the test procedure to confirm water flow. Water flow shall be stopped and started in conjunction with the air flow noted above. The test set-up should be inspected 10 minutes after the wind speed has been reduced to 0 km/h. Photographs shall be taken of the top-side and underside of the test specimen 30 seconds prior to the completion of each interval and at the inspection time (i.e. 10 minutes after the wind has been reduced to 0 km/h). The specimen shall be inspected for any water infiltration from the underside of the deck, recording approximate quantities penetrating the deck structure during the test period. Should the volume of water increase to a steady dripping in three or more places during the test period, the test shall be terminated prior to the maximum wind speed. Water penetrating the test specimen shall be contained and measured. Loss of integrity above and below the test deck must be noted, and photographs of any observed defects shall be taken.

The test report shall contain the following information:

1- a description of the roof system, including the manufacturer's name, the type of underlayment, slope, etc.;
2- sketches of the test specimen, photographs of the top side and underside of the test specimen immediately prior and subsequent to commencement and at termination of testing;
3- wind stream and flow meter calibration data;
4- detailed observation of water infiltration through the sheathing and the times and locations of water infiltration;
5- the volume of water (if any) which infiltrated the sheathing in the area of the ridge vent of the second test specimen and which was contained.

Any test specimen that exhibits water infiltration through the sheathing shall be considered as having failed the rain penetration resistance test.

Any test specimen that has the prepared roof covering, or any portion thereof, that blows off, tears or blows upward without re-seating during the test shall be considered as having failed the rain penetration resistance test.

6.4.6 Wind Uplift Resistance Test

The frame, wind generator and test specimen preparation for the wind uplift resistance test shall be in accordance with the requirements of Section 6.4.5 of this Guide.

Test Procedure
The test specimen shall be positioned on the test frame at the minimum slope proposed for installation.

The test specimen shall be positioned so that the exposed edge of the 2.44 m eave is facing the wind generator and to accommodate an observer under the deck for the duration of the test period.

The topside and underside conditions of the test specimen shall be recorded prior to starting the test.

The wind speed shall be conducted as noted below:

Interval #	Wind Speed (km/h)	Time (minutes)
1	80	15
2	0	15
3	100	15
4	0	15
5	120	15
6	0	15
7	140	15
8	0	15
9	170	15
10	0	15

The test set-up should be inspected 15 minutes after the wind speed has been reduced to 0 km/h. Photographs shall be taken of the top-side and underside of the test specimen 30 seconds prior to the completion of each interval as well as at the inspection time, approximately 15 minutes after the wind has been reduced to 0 km/h). The specimen shall be inspected for any damage to the shingles. Loss of integrity above the test deck must be noted, and photographs of any observed defects shall be taken.

The test report shall contain the following information:

1- a description of the roof system, including the manufacturer's name, the underlayment, slope, etc.;
2- sketches of the test specimen, photographs of the top side and underside of the test specimen immediately prior and subsequent to commencement and termination of testing;
3- wind stream calibration data;
4- detailed observation of any damage to the shingles.

Any test specimen that has the prepared roof covering or any portion thereof, that blows off, tears or blows upward without re-seating during the test shall be considered as failing the wind uplift test.

7.0 Quality Assurance Program

The proponent must demonstrate that the production process is governed by a quality assurance program, which ensures consistent quality at least to the level represented by the sample being tested and evaluated. CCMC requests that quality control procedures be applied to incoming materials, processes, and finished products.

7.1 Purpose

The purpose of the quality assurance program is to provide guidelines for the control of quality. CCMC must be confident that the submitted samples are representative of the products manufactured at the plant. It remains the proponent's responsibility to ensure that the manufactured products meet or exceed the quality of the samples submitted for testing and evaluation. (See Section 6.0 for information on product testing.)

7.2 Documentation

The proponent shall provide documentation on its quality assurance program, which will be reviewed by an evaluation officer prior to the issuance of an evaluation number. Other documents deemed necessary to demonstrate compliance at the time of application for an evaluation shall be submitted by the proponent upon request.

The documentation must be prepared by the proponent or by a third party, and signed by an authorized officer of the company to confer legitimacy to the document.

The documentation must have provisions that allow for representatives of CCMC or its authorized agents to enter the specified premises for the purpose of inspecting the manufacturing facilities or designating samples for testing.

7.3 Identification

Quality control procedures for finished products must include details on how the product will be identified with the CCMC evaluation number, in the form of "CCMC # XXXXX-R," which shall be both visible and legible. Where permanently identifying a product is not possible, other forms and methods of identification may be allowed pending review and approval by a CCMC evaluation officer.

7.4 Requirements

Quality assurance may be demonstrated by the proponent either through registration by an accredited quality assurance agency that its production process conforms to ISO 9001:2000, "Quality management systems—Requirements" (see Sections 7.5 and 7.6), or by providing a copy of its quality control manual directly to CCMC.

The Quality Control Manual (QCM) shall contain the following information:

- the company's quality control policies;
- provisions for keeping the manual current, e.g., updates and revisions;
- a production flow chart indicating points of quality control, with an explanation of the control at each point, the frequency of controls, and a summary of the production methods;
- production specifications and process tolerances;
- a clear delineation of what constitutes major and minor defects;
- corrective measures for major and minor defects;
- a list of main production equipment;
- a list of manufacturer's specifications and quality control arrangements for raw materials and equipment;
- measuring equipment: type, model, range, accuracy, frequency of calibration, and calibration agency; and,
- a statement by the proponent that CCMC will be notified, in writing, when major deviations have been discovered.

7.5 ISO 9001:2000 Quality Assurance Requirements

Evidence of quality assurance in accordance with ISO 9001:2000, "Quality management systems—Requirements," is demonstrated by the proponent through registration by an accredited quality assurance agency that the facility is under its control. (See Section 7.6 for a list of accredited agencies.)

ISO 9001:2000 specifies the requirements for a quality management system that can be used for internal application by organizations, or for certification, or for contractual purposes. It focuses on the effectiveness of the quality management system in meeting customer requirements.

This edition of ISO 9001 replaces the second edition, ISO 9001:1994, as well as ISO 9002:1994 and ISO 9003:1994. It constitutes a technical revision of these documents. Organizations that have used ISO 9002:1994 and ISO 9003:1994 in the past may use this international standard and exclude certain requirements in accordance with Section 1.2 of ISO 9001.

ISO 9004, "Quality management systems—Guidelines for performance improvements," dated 2000-12-15, and ISO 9001:2000 were developed as a complementary pair of quality management standards. ISO 9004 gives guidance on a wider range of objectives for a quality management system than does ISO 9001, particularly with regards to the continual improvement of an organization's overall performance and efficiency, as well as its effectiveness. ISO 9004 is recommended as a guide for organizations that wish to move beyond the requirements of ISO 9001. However, it is not intended to be used for certification or contractual purposes.

7.6 Accredited Quality Assurance Agencies

The proponent may demonstrate quality assurance by submitting documentation attesting that the production process has been registered as conforming to ISO 9001:2000 by one of the following accredited quality assurance agencies. (The proponent may contact the Standards Council of Canada at (613) 238-3222 to inquire about other accredited agencies.)

Quality Management Institute
90 Burnhamthorpe Road West
Suite 300
Mississauga, Ontario
L5B 3C3
Tel.: (905) 272-3920
(800) 465-3717
Fax: (905) 272-4538

Intertek Testing Services NA Ltd.
Quality Systems Division
1829, 32e avenue
Lachine, Québec
H8T 3J1
Tel.: (514) 631-3100
Fax: (514) 631-1133

Underwriters' Laboratories of Canada
7 Underwriters Road
Toronto, Ontario
M1R 3B4
Tel.: (416) 757-3611
(866) 837-3852
Fax: (416) 757-9540

BNQ Enregistrements de systèmes
CRIQ
333, rue Franquet
Sainte-Foy, Québec
G1P 4C7
Tel.: (418) 652-2296
(888) 267-1476
Fax: (418) 652-2221

SGS International Certification Services Canada Inc.
6275 Northam Drive, Unit 2
Mississauga, Ontario
L4V 1Y8
Tel.: (905) 676-9595
Fax: (905) 676-9362

Canadian General Standards Board
Sales Unit
Place du Portage III, 6B1
11, rue Laurier
Gatineau, Québec
K1A 1G6
Tel.: (819) 956-0425
(800) 665-2472
Fax: (819) 956-5644

8.0 Installation Manual

8.1 Purpose

The proponent or manufacturer shall prepare a well defined and detailed installation manual that can be used as educational material for installers and users of the product.

8.2 Content

The installation manual shall include the following information:

- a description of the product, including its properties;
- temperature installation as specified by the manufacturer;
- fastening type and mechanism;
- clear installation instructions for stepped and valley flashings, ridge and hip sections, closure strips, side lap and end lap distances, and fastener spacing;
- clear installation instructions for replacing damaged panels;
- sealant type and application;
- field-applied adhesive type;
- directions for applications of field-applied adhesives;
- detailed drawings of typical installations of the system, such as ridge, hip, eaves, venting, valley and flashing details;
- storage and handling procedures, and

Other points the manufacturer deems pertinent to the installation shall also be included.

9.0 Required Documentation

Upon successful completion of testing, applicants shall submit to CCMC full-width samples of the product, together with samples of any fastening and flashing accessories, and the following documentation:

- a completed form entitled, "Application for Construction Materials Evaluation;"
- detailed description of the glass fibre reinforced plastic panels;
- confirmation that the applicant is an authorized representative of a legally constituted company;
- a copy of the installation manual provided to installers;
- a copy of the information to be provided on the packaging of the panels;
- a copy of the guarantee/warranty issued to the ultimate user of the product;
- a copy of either the QCM, prepared as outlined in Section 7.0, or the certificate stating that the manufacturing facility is under the control of a registered quality assurance agency; and
- information demonstrating how reference is to be made to CCMC's evaluation number on the product (see Section 7.3).

Note: *Lack of information or sample will delay the evaluation.*

All submitted samples and documentation should be carefully packaged to avoid damage in transit and shipped prepaid, including clearance through Canada Customs, if applicable, to:

Canadian Construction Materials Centre
Institute for Research in Construction
National Research Council Canada
Montreal Road, Building M-24
Ottawa, Ontario
CANADA
K1A 0R6

Telephone: (613) 993-6189
Facsimile: (613) 952-0268