

**THERMAL INSULATION, POLYSTYRENE,
BOARDS AND PIPE COVERING**

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For further information on ULC services, please contact:

CORPORATE HEADQUARTERS

Underwriters' Laboratories of Canada
7 Underwriters Road
Toronto, Ontario M1R 3B4
Telephone: (416) 757-3611
Fax: (416) 757-9540
Toll-free telephone: 1-866-9373-ULC

EASTERN OFFICE

6505 Trans-Canada Hwy., Suite 330
St. Laurent, Québec H4T 1S3
Telephone: (514) 363-5941
Fax: (514) 363-7014
Toll-free telephone: 1-866-9373-ULC

PACIFIC OFFICE

No. 130 – 13775 Commerce Parkway
Richmond, British Columbia V6V 2V4
Telephone: (604) 214-9555
Fax: (604) 214-9550
Toll-free telephone: 1-866-9373-ULC

For further information on ULC standards, please contact:

STANDARDS DEPARTMENT AND GOVERNMENT

RELATIONS OFFICE

200-440 Laurier Avenue West
Ottawa, Ontario
K1R 7X6
Telephone: (613) 755-2729
Fax: (613) 231-5977

E-mail: customerservice@ulc.ca

Web site: www.ulc.ca

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K1P 6N7

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**THERMAL INSULATION, POLYSTYRENE,
BOARDS AND PIPE COVERING**

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MEMBER

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P. Kelly	Thermal Insulation Association of Canada, Canada
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STANDARD FOR THERMAL INSULATION, POLYSTYRENE, BOARDS AND PIPE COVERING

PREFACE

This is the Third Edition of the Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering, CAN/ULC-S701-05.

This Edition of the Standard has been formally approved by the ULC Committee on Thermal Insulation Materials & Systems.

Only metric SI units of measurement are used in this Standard. If a value for measurement is followed by a value in other units in parentheses, the second value may be approximate. The first stated value is the requirement.

Appendix A, identified as informative, is for informational purposes only.

Attention is drawn to the possibility that some of the elements of this Canadian Standard may be the subject of patents rights. Underwriters' Laboratories of Canada shall not be held responsible for identifying any or all such patents rights.

Requests for interpretation of this Standard should be sent to the Standards Department of Underwriters' Laboratories of Canada. The requests should be worded in such a manner as to permit a "yes" or "no" answer based on the literal text of the requirement concerned.

1. SCOPE

1.1 This Standard specifies the requirements for factory made rigid expanded polystyrene insulation in the form of pipe covering and boards with or without facings or coatings made by moulding (EPS) or extrusion (XPS) of expandable polystyrene beads. This Standard does not apply to laminated products manufactured with any type of rigid board facer including fibreboard, perlite board, gypsum board, or oriented strand board.

1.2 The Standard describes product characteristics and includes procedures for testing, evaluation of conformity, marking and labelling. The Standard covers four types of rigid expanded polystyrene distinguished on the basis of their material properties. Products manufactured to this Standard are intended for use as thermal insulation in building construction and other applications for temperatures ranging from -54°C to $+75^{\circ}\text{C}$.

1.3 Products covered by this Standard are also used for sound insulation and in prefabricated thermal insulation systems and composite panels. The performance of systems incorporating these products is not covered.

NOTES:

1. For more detailed information on product properties, see Subsection 8.2.
2. For applications other than the above - e.g., cryogenic, flotation, etc. - consult manufacturers for specific recommendations and properties.

1.4 This Standard does not purport to address all possible end-use concerns. It is the responsibility of the user of this Standard to contact the manufacturer regarding design considerations including specific end-use applications.

1.5 This Standard does not purport to address all the health and safety aspects associated with its use. Anyone using this Standard has the responsibility to consult the appropriate authorities and to establish health and safety practices, in conjunction with any existing applicable regulatory requirements prior to its use.

2. REFERENCES

2.1 The documents shown below are referenced in the text of this Standard. Unless otherwise stated elsewhere in this Standard such reference shall be considered to indicate the edition and/or revisions of the document available at the date on which the Committee approved this ULC Standard.

Documents Published by the American Society for Testing and Materials (ASTM)
100 Barr Harbour Drive, PO Box C700, West Conshohocken, PA 19428-2959 U.S.A.
Telephone: (610) 832-9585
www.astm.org

- C 177-97, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
- C 203-99, Standard Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation
- C 303-02, Standard Test Method for Dimensions and Density of Preformed Block and Board-Type Thermal Insulation

- C 390-03, Standard Criteria for Sampling and Acceptance of Preformed Thermal Insulation Lots
 - C 518-02^{e1}, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
 - C 585-90 (R 1998), Recommended Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System)
 - D 618-00, Standard Test Method for Conditioning Plastics for Testing
 - D 1621-00, Standard Test Method for Compressive Properties of Rigid Cellular Plastics
 - D 2126-99, Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging
 - D 2842-01, Standard Test Method for Water Absorption of Rigid Cellular Plastics
 - D 2863-00, Standard Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
 - E 96 00^{e1}, Standard Test Methods for Water Vapor Transmission of Materials
-

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- CAN/ULC-S770-03, Standard Method of Test for Determination of Long Term Thermal Resistance of Closed-Cell Thermal Insulation Foams
 - CAN/ULC-S773-01, Standard for Thermal Insulation Terminology
-

Document Published by the Technomic Publishing Co. Inc.

Box 3535, Lancaster, PA, 17604, U.S.A.

- Bomberg M.T., Kumaran M.K. and Dillon R., 1992, Testing Flexural Strength of Expanded Polystyrene Boards for In-Plant Quality Assurance, Journal of Thermal Insulation, Volume 16, October 1992, pages 194-208.

3. TERMINOLOGY

3.1 INTRODUCTION

Definitions and symbols used in this Standard are found and defined in CAN/ULC-S773, Standard for Thermal Insulation Terminology.

4. CLASSIFICATION

4.1 INTRODUCTION

Products manufactured to this Standard are classified as Types 1 to 4 on the basis of material properties indicated in Table 1.

5. REQUIREMENTS

5.1 GENERAL REQUIREMENTS

5.1.1 The expanded polystyrene shall be free from defects affecting serviceability.

5.2 DETAILED REQUIREMENTS

5.2.1 Material Property Tables

5.2.1.1 Requirements shall be as specified below and in Table 1.

5.2.1.2 Table 1A contains additional requirements for products manufactured with the intent to retain a blowing agent, other than air, for a period longer than 180 days - i.e. extruded polystyrene insulation.

5.2.2 Raw Material

5.2.2.1 All rigid expanded polystyrene thermal insulation in the form of pipe covering and boards as detailed in Clause 1.1 shall contain sufficient flame retardant to meet the Limiting Oxygen Index (LOI) requirements of Table 1.

5.2.3 Dimensions

5.2.3.1 *Finished Boards* - When measured as specified in Clauses 6.3.2.1 and 6.3.2.2, expanded polystyrene boards shall meet the dimensions specified (Subsection 8.1) within the following tolerances:

Length: -0.2%, +0.4%

Width: -0.2%, +0.4%

Thickness: -2, + 4 mm for thickness up to 75 mm
-3, + 5 mm for thickness more than 75 mm

Squareness: 3 mm maximum on boards up to and including 1.2 m long
and 6 mm maximum on boards more than 1.2 m long

5.2.3.2 *Pipe Covering* - When measured as specified in Clause 6.3.2.3, expanded polystyrene pipe covering shall meet the dimensions specified in ASTM C 585 (Subsection 8.1).

6. TESTING

6.1 SAMPLING

6.1.1 As a minimum, a total of three boards shall be selected at random from three blocks/bundles from widely separated locations or manufactured on different days. A 0.6 m by 1.2 m sample shall be cut from each of the large boards selected, with each sample selected from a different position of the respective board.

NOTE: Alternative Sampling Criteria - Sample in accordance with criteria provided in ASTM C 390.

6.1.2 Where a test procedure calls for multiple specimens, these specimens are to be taken from different boards.

6.2 CONDITIONING

6.2.1 Unless otherwise specified in this Standard, all tests shall be made on materials conditioned in accordance with ASTM D 618, Procedure A (88 to 96 h, 23°C and 50% RH).

6.3 TEST METHODS

6.3.1 Specimen Thickness

6.3.1.1 Unless otherwise specified in this Standard, testing is to be done on 38 mm thick material as a minimum with natural skins intact. Material not produced to at least this thickness shall be tested at full thickness with natural skins intact. The actual thickness tested is to be reported with the results.

6.3.2 Dimensions

6.3.2.1 *Finished Board* - Dimensions of finished board shall be measured using a steel tape measure, graduated in 1 mm intervals, as per ASTM C 303, unless otherwise indicated.

6.3.2.2 The squareness is the difference between the lengths of diagonals of the board. The length, width and squareness shall be determined to a precision of 1 mm. The thickness shall be determined to a precision of 0.5 mm.

6.3.2.3 *Pipe Covering* - Dimensions shall be determined according to ASTM C585.

6.3.3 Thermal Resistance

6.3.3.1 Determine the thermal resistance of newly manufactured material in accordance with ASTM C 518 or C 177, but in case of dispute ASTM C 177 shall be used. Test at actual specimen thickness (with thickness reported) and a mean temperature of $24 \pm 2^\circ\text{C}$ and a temperature differential of $22 \pm 2^\circ\text{C}$. Materials produced with a blowing agent other than air or pentane shall be conditioned for 28 days at $70 \pm 2^\circ\text{C}$ in an oven and then cooled in a desiccator prior to testing.

6.3.3.2 All cellular plastic insulations manufactured with the intent to retain a blowing agent, other than air, for a period longer than 180 days, shall be tested for long term thermal resistance (LTTR) in accordance with CAN/ULC-S770, Standard Method of Test for Determination of Long Term Thermal Resistance of Closed-Cell Thermal Insulation Foams.

This thermal resistance value shall be the design thermal resistance value for purposes of energy calculations.

The LTTR value depends on material thickness. The LTTR shall be determined and reported for 25, 50 and 75 mm products, based on less than 2-year old test results. From the above data points, LTTR values can be calculated for products from 12 mm to 100 mm. Other thicknesses may be tested and reported.

6.3.3.3 Measure the thickness of the board for each type of material. Calculate the result for a 25 mm thickness using the following equation and report the average R-value of three specimens:

$$\text{RSI 25 mm} = \frac{\text{RSI (measured)}}{\text{thickness (mm)}} \times 25$$

where RSI = thermal resistance, $\text{m}^2 \cdot ^\circ\text{C}/\text{W}$

6.3.4 Water Vapour Permeance

6.3.4.1 Determine the water vapour permeance as detailed in ASTM E 96 using the desiccant method and a temperature of $23 \pm 1^\circ\text{C}$. Test a total of three 25 mm thick specimens with natural skins intact, with each specimen taken from a different board, and report the mean value.

6.3.5 Dimensional Stability

6.3.5.1 Determine the dimensional stability following ASTM D 2126. The size of specimens shall be 100 mm by 100 mm. Measure the length and width of specimens before and after exposing the material for 7 days at $70 \pm 2^\circ\text{C}$, ambient humidity. Report dimensional differences after exposure with "+" for expansion or "-" for contraction.

6.3.6 Flexural Strength

6.3.6.1 Determine the flexural strength according to ASTM C 203, Method 1, Procedure B or with the flexural strength tester specified in A2.2.3.3. For samples with a natural skin and manufactured in a thickness greater than 25 mm, a specimen 25 mm thick shall be cut with one natural skin intact. The sample shall be tested with the natural skin in tension. Test three specimens from each of three different boards (nine specimens in total), except where the insulation is anisotropic, and report the mean value. For anisotropic insulation (i.e. extruded), test two specimens (one from each direction) from each of three different boards (six specimens in total) and report the mean.

6.3.7 Water Absorption

6.3.7.1 Condition the samples in accordance with Subsection 6.2. Note that no water absorption test method gives a complete picture of the water uptake of a material. Water absorption will be determined following ASTM D 2842. For the determination of water

absorption, buoyancy forces shall be measured rather than calculated. In the case of the initial buoyancy force, the method is applicable if the force does not vary more than 0.5 grams in 5 min after submersion of the sample. Remove air bubbles before reading the initial buoyancy force. The samples tested shall have a thickness of at least 51 mm.

NOTE: In relation to Table 1, Note 1, the Water Absorption values obtained using ASTM D2842 are applicable to specific end-use design requirements only to the extent that the end-use conditions are similar to the immersion period (normally 96 h) and 51 mm head requirements stated in the test method.

6.3.8 Compressive Strength

6.3.8.1 Determine the compressive strength according to ASTM D 1621, Procedure A. Test two specimens cut from each of three different boards (i.e. a total of six specimens) and report the mean value.

6.3.9 Limiting Oxygen Index

6.3.9.1 Determine the presence of a combustion modifier in the finished insulation product using the Limiting Oxygen Index (LOI) test ASTM D 2863. If the LOI is 24 or more, modifier is present. The test is not intended to reflect the fire hazard under actual fire conditions or to attribute any flame spread rating to the product.

6.4 REPORTING REQUIREMENTS

6.4.1 The report for tests conducted under this section shall include the following information:

- A Product Name;
- B Product type as per Subsection 4.1;
- C Name & address of manufacturer and, if applicable, supplier;
- D Address of manufacturer;
- E Production lot number; and
- F Date of sampling.

6.4.2 For extruded polystyrene insulation only, the report for tests under this section shall also include reporting of long term thermal resistance tested using CAN/ULC-S770 as per detailed requirements in clause 6.3.3 of this Standard.

7. PACKAGING AND LABELLING

7.1 PACKAGING

7.1.1 Unless otherwise specified (Subsection 8.1), normal commercial packaging and packing shall be acceptable.

7.2 MARKING AND/OR LABELLING

7.2.1 The product, as delivered to the Customer, shall be suitably marked to identify its type number, the ULC Standard number, and the manufacturer's name or trademark. The product shall also be marked with a warning:

CAUTION: This product is combustible. A protective barrier or thermal barrier is required as specified in the appropriate building code.

8. NOTES

8.1 OPTIONS

8.1.1 The following options must be specified in the application of this Standard:

- A Type (Subsection 4.1);
- B Dimensions of board (Clause 5.2.3.1) or pipe covering (Clause 5.2.3.2);
and
- C Packaging and packing details, if normal commercial practice is not suitable (Clause 7.1.1).

8.2 ADDITIONAL PRODUCT PROPERTIES

8.2.1 The properties contained in this Standard are considered suitable for most insulation applications. If the intended application requires other properties, the manufacturer should be consulted.

8.2.2 *Pipe Covering* - Manufacturers may require a vapour barrier coating or jacketing for some applications. Specify vapour barrier, if required.

TABLES

TABLE 1
MATERIAL PROPERTIES

(Reference: clauses 4.1, 5.2.1.1 & 5.2.2.1)

Property	Requirements				Test Method (see Note 1 below)
	Type 1	Type 2	Type 3	Type 4	Reference Clause
Thermal Resistance, minimum $\text{m}^2 \cdot ^\circ\text{C}/\text{W}$ (for 25 mm thicknesses)	0.65	0.70	0.74	0.86	6.3.3.1
Long Term Thermal Resistance	See Table 1A				6.3.3.2
Water Vapour Permeance, maximum, $\text{ng}/\text{Pa} \cdot \text{s} \cdot \text{m}^2$ (see Note 2 below)	300	200	130	60	6.3.4
Dimensional Stability, maximum % linear change	1.5	1.5	1.5	1.5	6.3.5
Flexural Strength, minimum, kPa	170	240	300	350	6.3.6
Water Absorption, maximum % by volume	6.0	4.0	2.0	0.7	6.3.7
Compressive Strength, minimum, kPa	70	110	140	210	6.3.8
Limiting Oxygen Index, minimum %	24	24	24	24	6.3.9
<p>NOTE 1: The test methods used to determine the above material properties provide a means of comparing different cellular plastic thermal insulations. They are intended for use in specifications, product evaluations and quality control. They are not intended to predict end-use product performance.</p> <p>NOTE 2: Values quoted are maximum values for 25 mm thick samples with natural skins intact. Lower values will result for thicker materials. Where water vapour permeance is a design issue, consult the manufacturer.</p>					

TABLE 1A
MATERIAL PROPERTIES
(Additional Requirements Applicable to Extruded Polystyrene Insulation Only)

(Reference: clause 5.2.1.2)

Property	Requirements (see Note 1 below)	Test Method
		Reference Clause (see Note 2 below)
Long Term Thermal Resistance, minimum $\text{m}^2 \cdot ^\circ\text{C}/\text{W}$ (for 50 mm thickness)	1.73	6.3.3.2
<p>NOTE 1: The above LTTR value for compliance is based upon 50 mm thick product. However, as required in Clause 6.3.3.2, LTTR values shall also be reported for 25 mm and 75 mm thick product.</p> <p>NOTE 2: The LTTR test procedure is applicable to cellular plastic insulation manufactured with the intent to retain a blowing agent, other than air, for a period longer than 180 days.</p>		

APPENDIX A - (INFORMATIVE)

(Reference: n/a)

Commentary on Product Quality Assurance Requirements for Rigid Expanded Polystyrene (EPS) Insulation

A1 SCOPE

A1.1 Appendix A provides interpretation of this product Standard when applied to quality assurance in the development of a Third Party Certification Program for rigid expanded polystyrene insulation (EPS) in the form of boards made by moulding of expandable polystyrene beads only. This Appendix conforms to the requirements of this product Standard to ensure that the production of EPS insulation board by moulders sold in Canada, meets this Standard.

A2 THE MOULDER

A2.1 The moulder will identify to the Third Party Certifier, a manager in his plant(s) who is responsible for process and quality control. The manager may delegate his authority to interrupt, halt or correct the production process at any time when specifications and quality characteristics are out of control or are not being met.

A2.2 Establish a quality assurance system in his plant(s) to assure that the insulation boards produced comply with the product standard.

A2.2.1 The quality assurance system will provide traceability of the manufacturing process from raw material to the finished product. Each process control, inspection or test, agreed to by the moulder and the certifier as critical to the material properties required by this Standard, shall have a maximum or minimum value identified. Records must demonstrate that finished material not meeting the accepted maximum/minimum values is removed from this stream of certified material.

A2.2.2 Any finished material removed from the stream of certified material can be sorted based on tests of material properties. Records must clearly show that the accepted maximum/minimum values for material properties required by this Standard are met before material removed from the stream of certified material can be reclassified as certified.

A2.2.3 As a minimum, the moulder will regularly monitor two properties of the finished insulation board.

A2.2.3.1 Density shall be determined by calculation for each flexural strength specimen cut based upon accurate measurement of specimen dimensions and mass.

A2.2.3.2 The correlation between in-plant density test results and thermal resistance/density test results determined by a laboratory accredited by the Standards Council of Canada for testing of cellular foam plastics is to be confirmed by testing random samples at least three times per year. Samples selected by the Third Party Certifier can be used for this purpose.

A2.2.3.3 Flexural strength shall be determined using either ASTM C203, Method 1, Procedure B or the in-plant flexural strength tester as developed through the research program described by Bomberg M.T., Kumaran M.K. and Dillon R., in Testing Flexural Strength of Expanded Polystyrene Boards for In-Plant Quality Assurance, Journal of Thermal Insulation, Volume 16, October 1992, pages 194-208.

A2.3 The moulder will allow the Third Party Certifier full access to his plant(s), records, and product as the Third Party Certifier requires it.

A3 THE THIRD PARTY CERTIFIER

A3.1 The Third Party Certifier will validate the moulder's quality assurance program by monitoring, in-plant, a minimum of three times per year, the following minimum requirements. At the option of the Third Party Certifier, one of these inspections can be done in the field at a retail location or at a job-site.

A3.2 Assure that the purchased raw material, expandable polystyrene, is suitable for the insulation product, particularly with respect to flame retardant additives.

A3.3 Audit the quality assurance records of the moulder to verify that the critical controls agreed to by the moulder and the Certifier are controlled within the identified limits. The audit will confirm that any material produced outside the identified process control limits is removed from the stream of certified material.

A3.4 Verify that moulder has valid methods of maintaining equipment calibration and accuracy on critical process controls, inspections and tests. Absolute traceability to National Standards is not as important as consistency of values to reflect variations in the process.

A3.5 Verify product meets the property values required by this Standard from the records of in-plant testing.

A3.6 Sampling

A3.6.1 Follow the sampling procedures in this Standard except for in-plant samples selected by Third Party Certifiers to verify process control.

A3.6.2 In-Plant Sampling

A3.6.2.1 Plant records will identify blocks that have been produced to meet the Standard. Inspector is to randomly select a minimum of three blocks from block inventory which have aged sufficiently to be ready for cutting.

A3.6.2.2 Blocks selected are to be from widely separated production times - eg. three blocks manufactured on three different days unless three days' production is not available.

A3.6.2.3 Selected blocks are to be cut in the presence of the inspector.

A3.6.3 Sample Locations

A3.6.3.1 Sample sizes are to be 1.2 m by 2.4 m block by thickness of mould at door end if it is a portion of a block from a longer block mould.

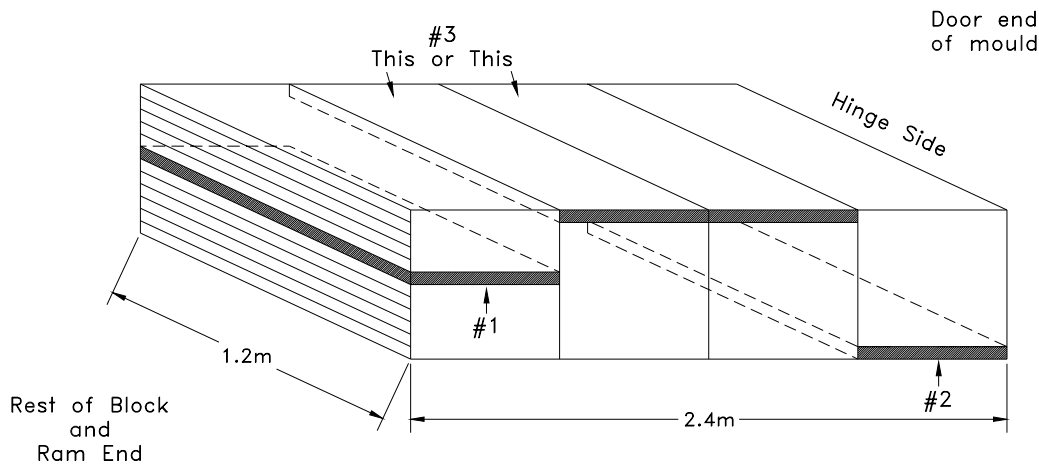
A3.6.3.2 Samples are to be selected from locations as identified in Clauses A3.6.3.2.1 to A3.6.3.2.3 and Figure A1 below:

A3.6.3.2.1 Block 1 - #1 Sample: inside end of block centre board.

A3.6.3.2.2 Block 2 - #2 Sample: door end lock side, surface board.

A3.6.3.2.3 Block 3 - #3 Sample: centre of length of block opposite side, surface board.

FIGURE A1



A3.6.3.3 In the case of surface boards from a large block, the block skin is removed and the board selected is the first suitable board. Identify each selected board with the moulding plant identification, type of product, location in the block (1,2, or 3), date sampled and inspector's identifying mark.

A3.6.4 The moulding plant shall forward samples immediately for testing.

A3.7 Verify that Third Party Certifier's logo or certificate is used by the moulder in accordance with the Certifier's requirement to properly identify insulation board that meets this Standard.

A3.8 Testing Procedures for Production Samples

A3.8.1 If samples are tested in a laboratory other than a Certifier's own testing facilities, the testing laboratory shall be accredited by the Standards Council of Canada for the tests that are to be performed.

A3.8.2 All testing performed on boards that are moulded to thickness and sold in that form are to be done on samples where at least one surface skin is intact.

A3.8.3 The selected samples will be tested for thermal resistance and flexural strength. Other properties specified in this Standard may be performed by the Third Party Certifier at his option or upon the request of the moulder.

A3.8.4 Sample conditioning may be reduced to the requirements of ASTM D 618, Procedure A in order to expedite testing.

A3.9 Interpretation of Test Results

A3.9.1 If the average test results for each material property reported meets or exceeds the product standard, the product meets this Standard.

A3.10 Decertification

A3.10.1 Any moulder who is in default of the product standard will be decertified by the Third Party Certifier, in accordance with the Standards Council of Canada Regulation CAN – P - 3 - latest edition.