

***First Annual Interlaboratory Comparison of  
Participating  
NFRC Thermophysical Property Testing  
Laboratories  
2010***

***Prepared For:***  
**NFRC Thermophysical Property Subcommittee**

***Prepared By:***

**Ray McGowan**  
National Fenestration Rating Council, Inc.  
6305 Ivy Lane, Suite 140  
Greenbelt, MD 20770-6323

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## Executive Summary

The National Fenestration Rating Council conducted its first thermophysical properties interlaboratory comparison by requiring interested labs to test four arrangements of a composite sample. Nine thermophysical property testing labs participated in the ILC. ASTM C518 was used by all testing labs to determine the conductivity. The four samples were arrangements are as show here:

- 1) 3/4" composite material
- 2) Stack of three 3/4" composite materials
- 3) Stack of three 1/2" composite materials
- 4) Stack of three 3/4" composite materials with conductive paste in between

*Note, two labs were limited by their testing apparatus testing capability and tested only up to 2" in thickness.*

Summarized testing results are shown below:

sample	Description	Results (W/m-K)										10% of mean	Standard Deviation
		lab 1	lab 2	lab 3	lab 4	lab 5	lab 6	lab 7	lab 8	lab 9	Mean		
1	3/4"	0.110	0.117	0.117	0.115	0.120	0.128	0.116	0.128	0.121	0.119	0.1191	0.0059
2	three 3/4"	0.114	0.119	0.124	0.124	0.126	0.123	0.125	0.126	0.118	0.122	0.0122	0.0040
3	three 1/2"	0.098	0.103	0.106	0.103	0.108	0.110	0.103	0.109	0.102	0.105	0.0105	0.0041
4	three 3/4" w/paste	0.117	0.121	0.123	0.122	0.126	0.128	0.125	0.129	0.124	0.124	0.0124	0.0039

The above results indicate agreement among the nine labs. All results are within the required 10% of the mean. All labs are within two standard deviations of the mean indicating good testing results among the participants.

The results of the ILC were required to be within 10% of the mean as indicated by NFRC 103-*Verification of Thermophysical Properties, Section 2.2*. All labs demonstrated the ability to achieve results within this parameter and are therefore qualified to test thermophysical properties for use in NFRC 101-*Procedure for Determining Thermophysical Properties of Materials for use in NFRC Approved Software Programs*<sup>1</sup>. NFRC will post a list of participating labs for use by all interested window material manufacturers. All labs are within two standard deviations of the mean. This fact indicates good testing.

## Background

NFRC 103-*Verification of Thermophysical Properties* requires all labs testing materials for thermophysical properties listed in NFRC 101-*Procedure for Determining Thermophysical Properties of Materials for use in NFRC Approved Software* participate in an interlaboratory comparison (ILC). Specifically, NFRC 103, section 2.2 states:

All submitters of thermophysical property data (or their representatives) shall have

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<sup>1</sup> Oak Ridge National Labs is not available for commercial test services

successfully participated in an NFRC Interlaboratory Comparison (ILC) of the appropriate material property. NFRC shall sponsor an ILC a minimum of once every two (2) years, but preferably once each year. New submitters have the right to measure the most recent ILC sample and to qualify if the measured data is within 10% of the mean of the ILC results, or  $0.003 \text{ W}/(\text{m}\cdot\text{K})$  [ $0.02 \text{ Btu}\cdot\text{in}/(\text{hr}\cdot\text{ft}^2\cdot^\circ\text{F})$ ][ $0.002 \text{ Btu}/(\text{hr}\cdot\text{ft}\cdot^\circ\text{F})$ ] whichever is greater. NFRC shall keep ILC data private and shall publish only the standard deviation and number of outliers, without disclosing the mean of the ILC measurements for at least one (1) year or until the next scheduled ILC completion.

## **Objective**

The primary purpose of the 2010 thermophysical property testing ILC is to evaluate the technical competence of participating NFRC thermophysical testing laboratories and confirm NFRC testing procedures by having each laboratory conduct the identical tests on the same test specimen and comparing the resultant data. This helps the NFRC evaluate the current level of consistency and reproducibility among the thermophysical property testing laboratories.

## **Test Specimen**

Several test samples were provided and required to be arranged in configurations shown below:

- 1) 3/4" composite material
- 2) Stack of three 3/4" composite materials
- 3) Stack of three 1/2" composite materials
- 4) Stack of three 3/4" composite materials with conductive paste in between

## **Participating Laboratories**

Six participating thermophysical property testing laboratories participated in the Interlaboratory comparison.

- 3M-Corporate Research Analytical Lab (CRAL) Materials Science Lab-St. Paul, MN
- Air-Ins, Inc. – Varennes, Quebec, Canada
- Architectural Testing, Inc. – York, Pennsylvania
- Carli, Inc.-Amherst, MA
- Netzsch-Burlington, MA
- Oak Ridge National Laboratory
- University of Massachusetts-Amherst, MA
- Exova –Mississauga, ON, Canada

*The laboratories above are in alphabetical order and do not correspond to the listed order of data ID numbers within this report.*

Each NFRC-accredited Testing laboratory was notified by letter explaining the details of the NFRC thermophysical property testing ILC. The letter instructed the labs to test and return to NFRC specific data. The package is included as appendix A.

All participating testing laboratories were directed to keep all testing files, questions, correspondences and any other issue relating to the test ILC confidential. Any and all correspondences were to be only directed to NFRC staff.

### Conductivity, *k*

Below are the summarized results of the testing interlaboratory comparison of the six labs. The 10% of the mean value and standard deviations are reported also.

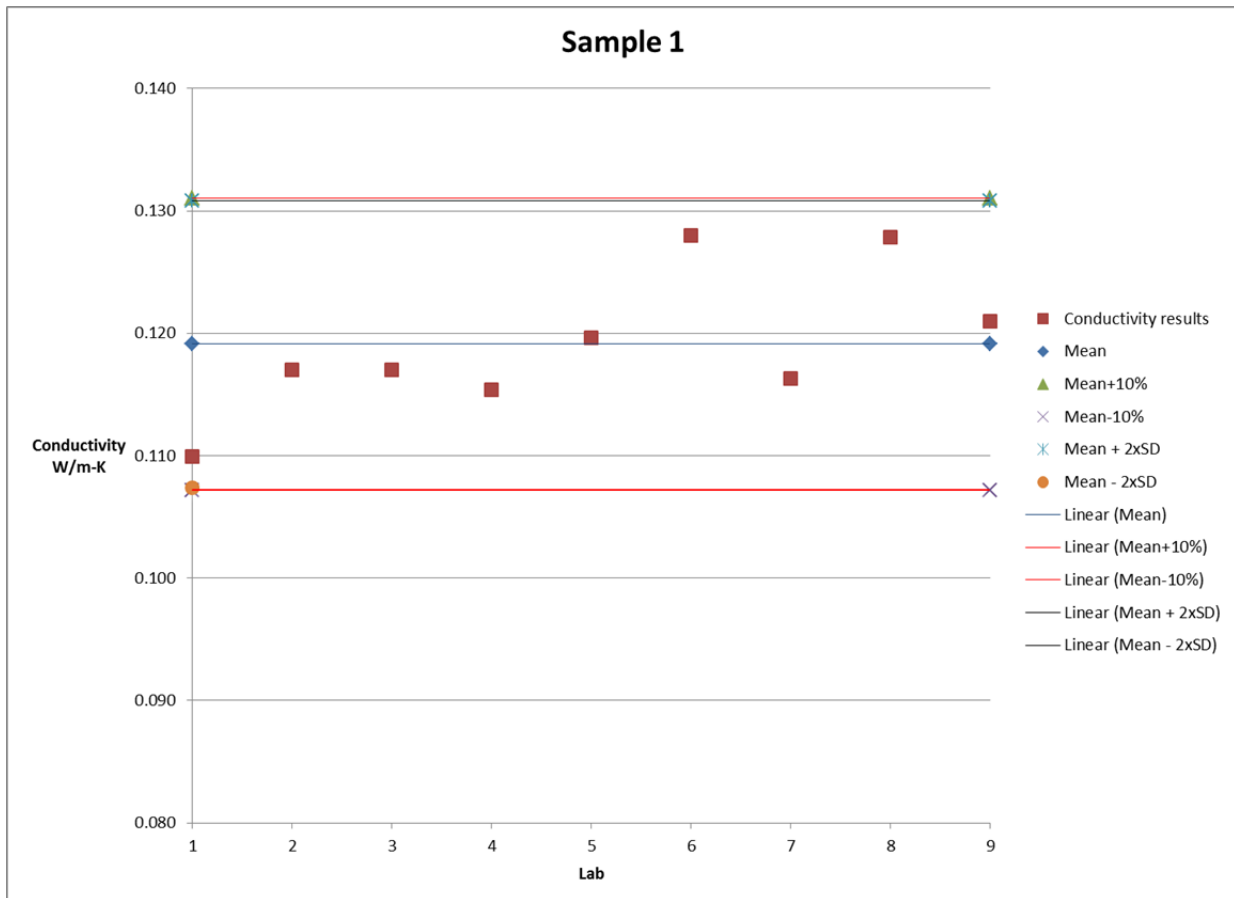
### Result Summary

sample	Description	Results (W/m-K)										10% of mean	Standard Deviation
		lab 1	lab 2	lab 3	lab 4	lab 5	lab 6	lab 7	lab 8	lab 9	Mean		
1	3/4"	0.110	0.117	0.117	0.115	0.120	0.128	0.116	0.128	0.121	0.119	0.1191	0.0059
2	three 3/4"	0.114	0.119	0.124	0.124	0.126	0.123	0.125	0.126	0.118	0.122	0.0122	0.0040
3	three 1/2"	0.098	0.103	0.106	0.103	0.108	0.110	0.103	0.109	0.102	0.105	0.0105	0.0041
4	three 3/4" w/paste	0.117	0.121	0.123	0.122	0.126	0.128	0.125	0.129	0.124	0.124	0.0124	0.0039

The results, summarized above, show that each lab successfully tested within the 10% of the mean requirement and within two times the standard deviation. Below are data and graphs from each test sample arrangement.

**Table 1-One 3/4" Sample Only**

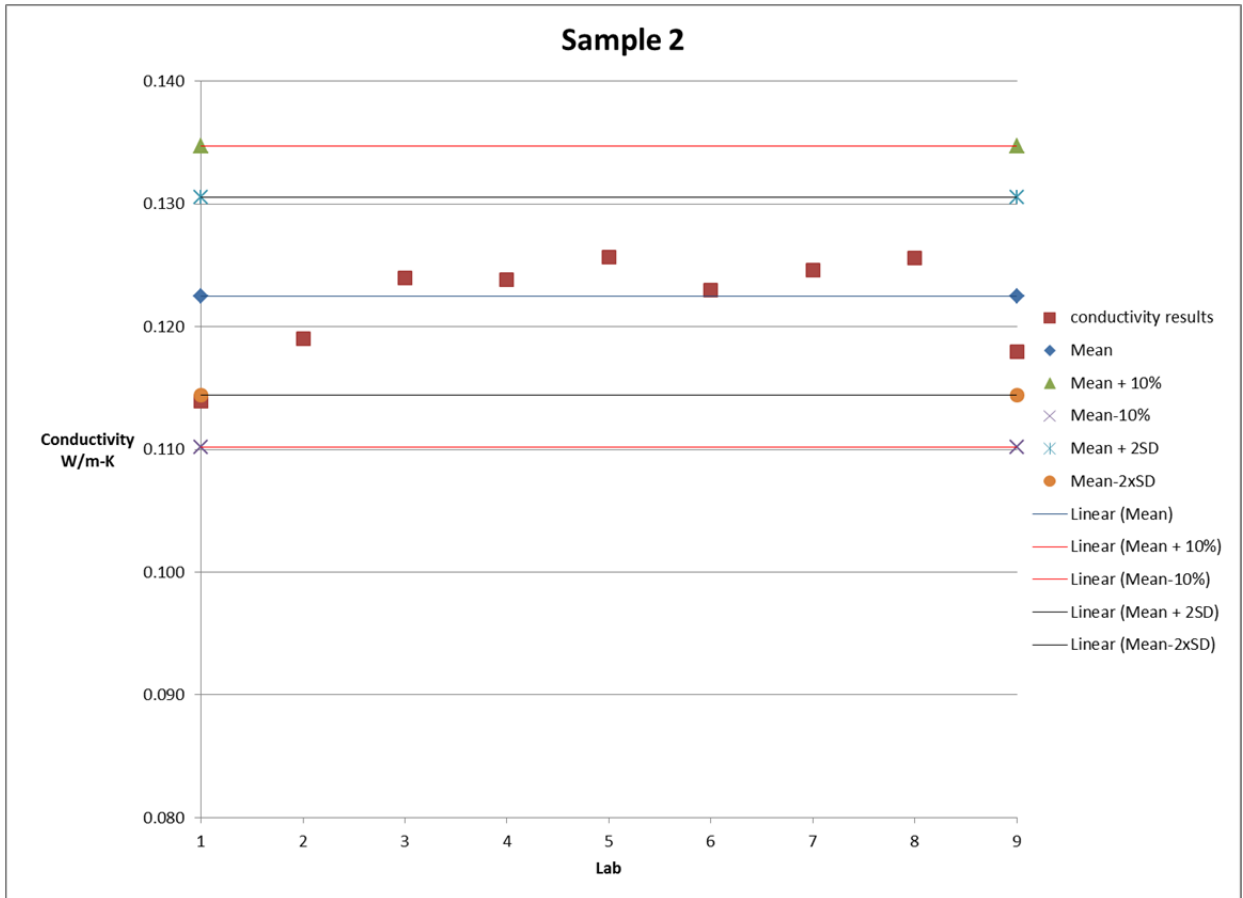
no.	w/m-k	btu-in/hr-ft <sup>2</sup> -f
1	0.110	0.7620
2	0.117	0.8112
3	0.117	0.8112
4	0.115	0.8001
5	0.120	0.8292
6	0.128	0.8875
7	0.116	0.8064
8	0.128	0.8865
9	0.121	0.8387
average	0.1191	0.8243
std dev	0.0059	0.0431



All sample 1 test results were within the 10% of the mean requirement and two times the standard deviation.

**Table 2-Three 3/4" Samples Stacked, No Thermal Paste**

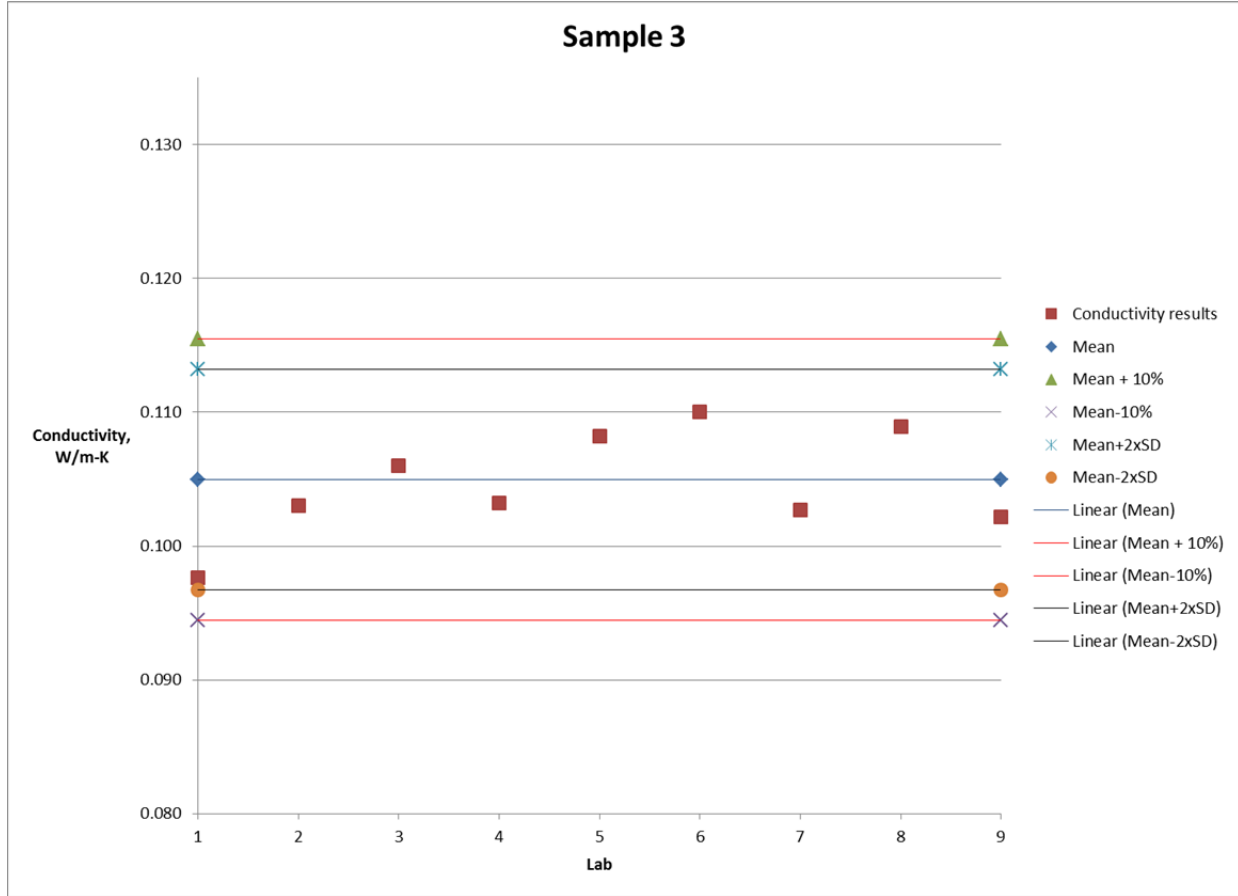
no.	w/m-k	btu-in/hr-ft <sup>2</sup> -f
1	0.114	0.7900
2	0.119	0.8251
3	0.124	0.8598
4	0.124	0.8584
5	0.126	0.8715
6	0.123	0.8528
7	0.125	0.8639
8	0.126	0.8707
9	0.118	0.8181
Mean	0.1225	0.8456
std dev	0.0040	0.0281



All test sample 2 results were within 10% of the mean and within two times the standard deviation

**Table 3-Three 1/2" Samples, No Paste**

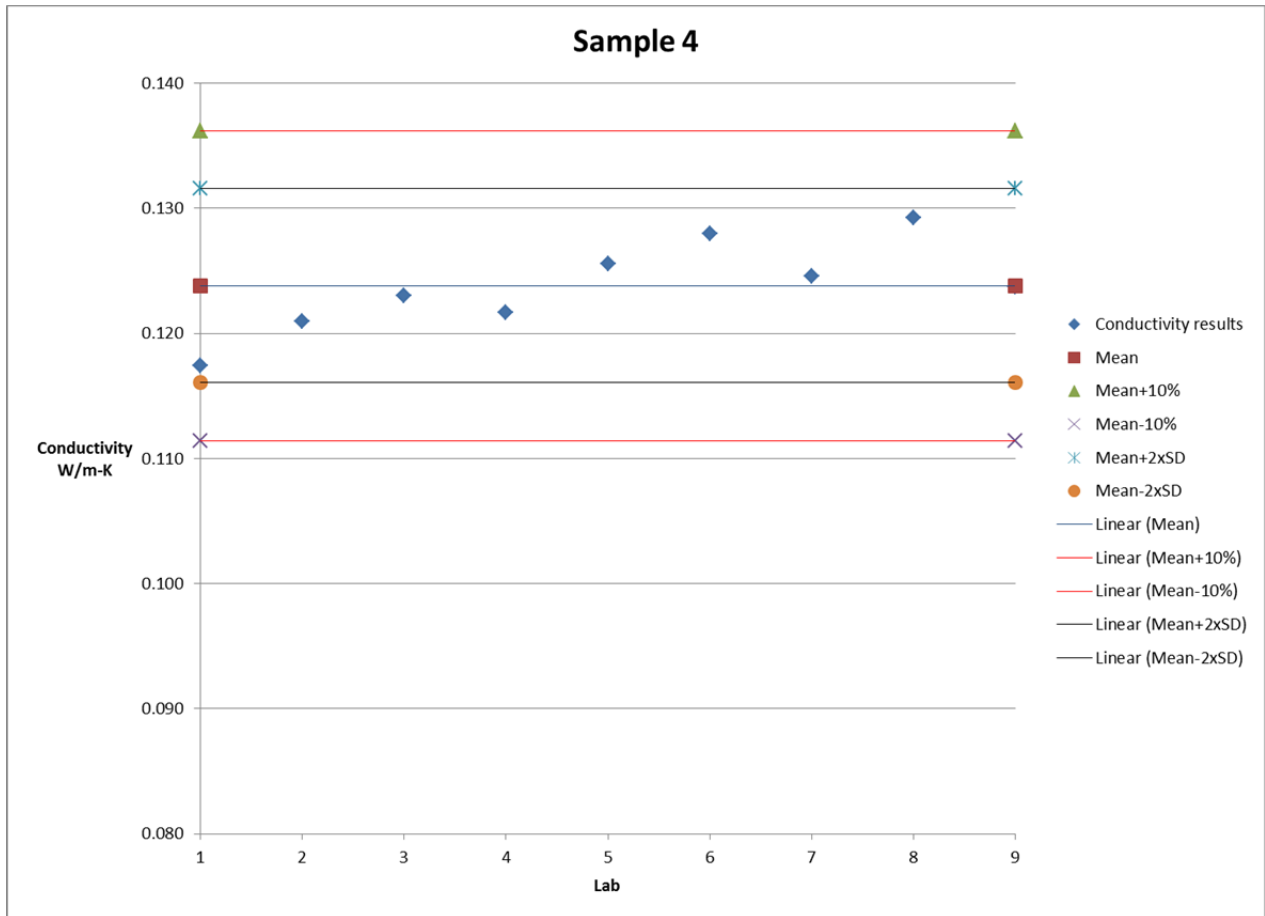
no.	w/m-k	btu-in/hr-ft <sup>2</sup> -f
1	0.098	0.6770
2	0.103	0.7141
3	0.106	0.7349
4	0.103	0.7155
5	0.108	0.7502
6	0.110	0.7627
7	0.103	0.7121
8	0.109	0.7552
9	0.102	0.7086
Mean	0.1050	0.7256
Std. Dev.	0.0041	0.0274



Test sample 3 test results were within 10% of the mean. All test results were within two standard deviations.

**Table 4-Three 3/4" Samples with Thermal Paste**

no.	w/m-k	btu-in/hr-ft <sup>2</sup> -f
1	0.117	0.8140
2	0.121	0.8390
3	0.123	0.8528
4	0.122	0.8438
5	0.126	0.8708
6	0.128	0.8875
7	0.125	0.8639
8	0.129	0.8964
9	0.124	0.8578
Mean	0.1238	0.8584
Std. Dev.	0.0039	0.0252



Test sample 4 test results were within 10% of the mean. All test results were within two standard deviations.

## Conclusions

All participating test labs were successfully able to test within the required 10% of the mean result for each test sample using the ASTM C518 test method. This first thermophysical property interlaboratory comparison will enable these participating labs to test materials in the future for use in the NFRC fenestration energy ratings system. All seven participating labs were able to test within two standard deviations of the mean, a standard statistical measurement of agreement.

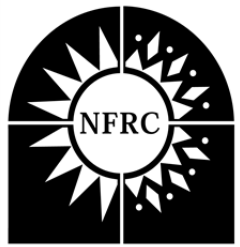
NFRC will pursue future interlaboratory comparisons to ensure accurate data are available for NFRC ratings. New labs interested in thermophysical property testing will be required to participate in any future interlaboratory comparison as well as testing labs interested in continuing to test material properties. NFRC will post a list of participating labs on its Submit Thermophysical Properties web page.

(<http://www.nfrc.org/thermophysical.aspx> )

## References

- 1) *NFRC 101-Procedure for Determining Thermophysical Properties of Materials for use in NFRC Approved Software-2010*
- 2) *NFRC 103-Verification of Thermophysical Properties-2010*
- 3) *ASTM C518-Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus*
- 4) *ASTM E 691-99: Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method; Annual Book of ASTM Standards, Vol 14.02, American Society of Testing and Materials; West Conshohocken, Pennsylvania*
- 5) *ASTM E 177-04: Standard Practice for Use of the Terms Precision and Bias in ASTM Test Methods; Annual Book of ASTM Standards, Vol 14.02, American Society of Testing and Materials; West Conshohocken, Pennsylvania*

## Appendix A-Testing Instructions



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### National Fenestration Rating Council, Incorporated

6305 Ivy Lane, Suite 140, Greenbelt, Maryland 20770-6323

Telephone: 301-589-1776 Facsimile: 301-589-3884 www.nfrc.org

To: Material-Testing Laboratories  
From: NFRC, Ray McGowan-Technical Services Manager  
Date: September 2, 2008  
Subject: 2008 Thermophysical Property Interlaboratory Comparison  
Invitation (modified schedule)

Dear Material Testing Laboratory,

*NFRC 103-Verification of Thermophysical Properties* requires all labs testing materials for thermophysical properties listed in *NFRC 101-Procedure for Determining Thermophysical Properties of Materials for use in NFRC Approved Software* participate in an interlaboratory comparison (ILC). Specifically, NFRC 103, section 2.2 states:

*All submitters of thermophysical property data (or their representatives) shall have successfully participated in an NFRC Interlaboratory Comparison (ILC) of the appropriate material property. NFRC shall sponsor an ILC a minimum of once every two (2) years, but preferably once each year. New submitters have the right to measure the most recent ILC sample and to qualify if the measured data is within 10% of the mean of the ILC results, or 0.003 W/(m·K) [0.02 Btu·in/(hr·ft<sup>2</sup>·°F)] [0.002 Btu/(hr·ft·°F)] whichever is greater. NFRC shall keep ILC data private and shall publish only the standard deviation and number of outliers, without disclosing the mean of the ILC measurements for at least one (1) year or until the next scheduled ILC completion.*

If your laboratory has in the past or has plans to submit manufacturer specific thermophysical properties to NFRC for inclusion in NFRC 101, your lab must participate in this ILC. Please respond to this letter confirming your lab's participation by April 18, 2008. Once all labs have been contacted and confirmed, a schedule for testing will be issued. NFRC expects participants to bear the testing cost, but NFRC will provide all sample-shipping costs and final report development and distribution. All results will be reported anonymously within the report. NFRC ensures full confidentiality for each lab.

### Material Sample Description

Each Material Testing Laboratory shall perform one thermal performance test on the following list of samples:

- 1) 3/4" composite material
- 2) Stack of three 3/4" composite materials
- 3) Stack of three 1/2" composite materials
- 4) Stack of three 3/4" composite materials with conductive paste in between

### Shipping/Package Details

The test sample shall be shipped as freight using Fedex transportation. The test specimen should be repacked for shipping to the next lab in a similar fashion to how it is received to ensure the specimen remains in good shape. If any changes occur to the test sequence, NFRC will send a memorandum indicating these changes. Please note, by taking a photograph, the general condition of the packing and specimen upon arrival and any defects present. Also note the specimen's condition prior to re-packing and shipment and take another photograph before final shipment. Include these photos with your test result data submission. Please use NFRC's Fedex Account number, **1480-8901-9** and note **research** as the reference. Notify NFRC staff immediately (Ray McGowan, 240-821-9510, [rmcgowan@nfrc.org](mailto:rmcgowan@nfrc.org)) of any defect or damage to the crate or specimen.

Please also photograph the sample after it is mounted in the test apparatus before and after testing. Please submit these photographs with the raw data.

Please contact Ray McGowan for the address and contact info for each laboratory.

### Test Information

A final report shall be issued according the ASTM testing document requirements. Electronic reports are acceptable preferably in Adobe format. Testing labs shall submit the results directly to NFRC staff (Ray McGowan, 240-821-9510, [rmcgowan@nfrc.org](mailto:rmcgowan@nfrc.org)).

### Testing Schedule

Below is a table listing material testing labs identified for material testing ILC. If this schedule is not convenient, please contact Ray McGowan immediately to make changes.

LAB	ARRIVAL	COMPLETION	LOCATION
University of Massachusetts	Source	6/27/08 (completed)	MA
Architectural Testing, Inc.	7/6/08	7/21/8 (completed)	PA
NETZSCH Instruments, Inc.	9/8/08	1/9/08 (completed)	MA
Vtec Laboratories Inc.	1/14/09	1/23/09	NY
Anter	1/28/09	2/2/09	PA
US DOE-Oak Ridge National Laboratory	2/6/09	2/16/09	TN
Aspen	2/20/09	2/27/09	MA
Bodycote	3/2/09	3/12/09	ON

Regards,

Ray McGowan  
Technical Services Manager

Cc: University of MA-Dr. Charlie Curcija (NFRC Thermophysical Properties Subcommittee Chair

Truseal Technologies-Werner Lichtenberger (NFRC Research and Technology Chair)

Figure 1-composite material photograph:

