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## **FINAL SUMMARY REPORT**

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***Date: September 1, 2005***

This is the summary page for the technical and other reports on the DOE Cooperative Agreement DE-FC36-94CH10604 for the period of January 1, 2000 to December 31, 2004.

The progress, technical and other reports and publications are consolidated by the contracting year and also by the cooperative agreement tasks. The listing sorted by tasks is also sub-sorted by fiscal year for easier navigation. These listings are given in appendix A and Appendix B of this summary report. Individual report files are located in each fiscal year directory (i.e., FY00, FY01, etc. up to FY04).

The complete listing and report files are also posted on the web site and is fully navigable by these two criteria. The web site is at:

[http://www.ceere.org/beep/beep\\_pubsanddownloads.html](http://www.ceere.org/beep/beep_pubsanddownloads.html)

More significant and less obvious part of deliverables are applications of this research, which are used in everyday operations of NFRC, software tools and manufacturers design practice, which has significantly changed as a result of this and related research efforts.

## **APPENDIX A: LISTINGS OF REPORTS SORTED BY FISCAL YEAR**

### **Publications for FY 2000:**

Technical report: Computer Modeling of CI According to NFRC500 of a Wood Fixed Window with Varying Spacers and Glazing Options

Power Point Presentation: Condensation Index

Condensation Index Spreadsheet

Technical Progress Report: 2-D Numerical Analysis of IGU Cavities at Inclined Orientation

Technical Progress Report: Modeling of Local Convective Heat Transfer in Projecting Products

Power Point Presentation: Applicability of Detailed Radiation Modeling

Technical Progress Report: 3-D Heat Transfer in Fenestration Systems And this completes

Technical Report: A Pilot Project to Establish the Technical Basis and Institutional Framework for Assuring the Energy Efficiency of Fenestration Building Products in Certain Transitional Economy Countries - Phase 0 Results

Power Point Presentation: Development of a Hot Box

Standard: NFRC 100: Draft Test Procedure for Measuring the Steady-State Thermal Performance of Fenestration Systems

Power Point Presentation: New NFRC 100 Testing Procedure

Standard: NFRC 500: Procedure For Determining Fenestration Product Condensation Index Values

Standard: THTF Drfat 0f: Procedure for Determining Fenestration Product Thermal Indices

Power Point Presentation: Expected Changes to NFRC U-Factor and SHGC Calculations

NFRC Fenestration Glossary

Standard: ISO DIS 15099: Thermal Performance of Windows, Doors, and Shading Devices - Detailed Calculations

Archive of draft ISO 15099 documents

Standard: ISO FDIS 12567: Thermal Performance of Doors and Windows - Determination of Thermal Transmittance By Hot Box Method (not available here)

Standard: ISO DIS 12567-2: Thermal Performance of Roof Windows and Other Projecting Windows - Determination of Thermal Transmittance By Hot Box Method

Standard: ISO FDIS 10077: Thermal Performance Windows, Doors and Shutters - Calculation of Thermal Transmittance - Part 2: Numerical Method for Frames

Standard: NFRC 101: Procedure for Determining Thermo-Physical Properties of Materials For Use in NFRC-Approved Software Programs - Material Library Spreadsheet

Power Point Presentation: Overview of NFRC International Efforts

Trip Report: Technical Assistance in Fenestration Technology to Bosnia and Herzegovina

Trip Report: IEA Task 27 Meeting in Grenoble, France

Trip Report: ISO 15099 and ISO 12567 Meetings in Vienna, Austria

Trip Report: "Train the Trainers" Workshop at Amherst, Mass and THERM and Window Training Workshops in Samara, Russia and Kaunas, Lithuania; and Baltic Windows Workshop in Vilnius, Lithuania.

Technical Report: Analysis of Thermal Performance of Wood Marvin Window With Clear Glazing (PFM01)

Technical Report: Analysis of Thermal Performance of Wood Marvin Window With Low-E Glazing (PFM02)

Technical Report: Computer Modeling Results for NFRC Simulation Round Robin 1999 (SRR99) Window Using THERM and WINDOW Software

Technical Report: Computer Simulation of Selected Windows and Doors According to CEN Method (Generic Report generated from the confidential report to Andersen Windows in their effort to market windows in Poland)

Conference Paper: D. Curcija. 2000. "Role of Computer Modeling Tools in Window Certification and Design" Baltic Window Conference. Vilnius, Lithuania. April, 2000

Power Point Presentation: "Role of Computer Modeling Tools in Window Certification and Design"

Conference Paper: D. Curcija. 2000. "Trends and Developments in Window Testing Methods" Baltic Window Conference. Vilnius, Lithuania. April, 2000

Power Point Presentation: "Trends and Developments in Window Testing Methods"

Conference Paper: D. Curcija. 2000. "Role of Computer Computer Simulation in Window Certification" International Workshop and Round Table Discussion: Energy Future of Bosnia and Herzegovina. Sarajevo, BiH. June 2000.

Power Point Presentation: "Role of Computer Computer Simulation in Window Certification"

ASHRAE HANDBOOK OF FUNDAMENTALS: Chapter 29: Fenestration. Modifications and new layout (D. Curcija)

ASHRAE STANDARDS: SPC142P continuing work and development and communication between ISO TC163/WG2.

**Publications for FY 2001:**

Update on Umass Research Work and Priorities - Memo to Sam

Conference Paper - Improving Information Technology to Maximize Fenestration Energy Efficiency

Presentation for paper "Improving Information Technology to Maximize Fenestration Energy Efficiency" (Thermal 8 meeting, Clearwater, FL)

CTS Panel Construction Manual

Software Demonstration\_presentation (Mexico)

Software Demonstration\_presentation (Brazil)

Trip Report to Brazil (08-01)

Trip Report to Mexico (10-01)

Condensation Resistance Analysis for NFRC (Various Options)

Condensation Index Presentation

NFRC Glossary Draft

Role and importance of fenestration computer modeling tools in the future DOE efforts

ISO 15099 implementation in NFRC

Treatment of Non-Continuous Thermal Bridges in NFRC system

ISO Standards, WINDOW 5, and THERM 5: Expected Changes to NFRC U-Factor & SHGC Calculations

OUTLINE OF TECHNICAL CHANGES IN COMPUTER ALGORITHMS FOR NFRC SIMULATION PROGRAM

NFRC 500 Draft (10-23)

Computer Modeling Results for NFRC Simulation Round Robin 2000 (SRR00) Window using THERM and WINDOW Computer Programs

Test Round Robin 2001 Using Computer Modeling According to NFRC 500

Computer Modeling of CI According to NFRC 500 Of A Wood Fixed Window With Varying Spacers and Glazing Options

Computer Modeling of CI According to NFRC 500 Of A Wood Fixed Window With Varying Spacers and Glazing Options (Final Draft)

Condensation Resistance of Commercial Fenestration Systems (ASHRAE Forum)

Environmental Boxes for the IR Laboratory - Wish-List

NFRC/CSA-A100: PROCEDURE FOR DETERMINING FENESTRATION PRODUCT THERMAL INDICES - Preliminary Draft 0.h

Evaluation of the Condensation Index Rating as Determined using the Proposed Simulation Method in the NFRC 500 Draft Procedure (ASTM Paper)

Progress Report (Linda Li) - 2/17/01

Progress Report (Hua Yang) - 2/17/01

Computer Modeling Results for NFRC Simulation Round Robin 1999 (SRR99) Window Using THERM and WINDOW Software (Final Draft)

Progress Report (Alan Leung) - 4/26/01

"Technical Basis and Institutional Framework For Assuring The Energy Efficiency of Fenestration Systems in Transitional Economy Countries". Belgrade Conference - 6/16/01

"Labeling and Certification Procedures for Energy Rating in North America and The Impact on Market for Energy Efficient Products". Mexico Conference - 10/3/01

Procedure for Determining Thermo-Physical Properties of Materials For Use in NFRC-Approved Software Programs

International Activities - Presentation to NFRC

Investigation on optimum quantity of necessary simulations of thermal performance of windows in a typical commercial building

Investigation on optimum quantity of necessary simulations of thermal performance of windows in a typical commercial building - presentation

Computer Modeling of Commercial Aluminum Framing Systems – U-Factor and Temperature Distribution

Progress Report (Hua Yang) - 8/7/01

Progress Report (Linda Li) - 8/9/01

Progress Report Presentation (Linda Li) - 08-01

Proposed Methodology For Modeling Tubular Skylights For NFRC Rating Purposes  
Software Demonstration in Sao Paulo, Brazil

ISO 15099 Draft (07-01)

Research Work at the University of Massachusetts - Presentation for NFRC

Applicability of Detailed Radiation Modeling - Presentation (Vienna, 05/08/01)

"Analyzing Thermal Performance of Building Envelope Components Using 2-D Heat Transfer Tool with Detailed Radiation Modeling". Building Simulation Conference, Rio de Janeiro, Brazil. August 2001.

"Rating and Labeling of Energy Performance of Windows as a Tool for Promoting Energy Efficiency Practices in Buildings". Building Simulation Conference, Rio de Janeiro, Brazil. August 2001.

ASHRAE HANDBOOK OF FUNDAMENTALS: Chapter 30: Fenestration. Published version IP and SI (D. Curcija)

## **Publications for FY 2002:**

Computer Modeling of Heat Transfer and Comparison for PVC Casement Window – U-Factor and CR Simulations Using WINDOW 5 and THERM 5

Computer Modeling of Heat Transfer and Comparison for PVC Casement Window – U-Factor and CR Simulations Using THERM 2.1a and WINDOW 4.1

"Role of Computer Simulations in Window Ratings and Design". Energy Efficiency Windows and Building Design Conference, New Delhi and Bangalore, India.

Role of Computer Simulations in Window Ratings and Design - Presentation

Progress Report (Shaoping Quan) - 1/14/02

Condensation Resistance Advancements - Presentation at NFRC

Technical Report - The study of convection heat transfer in triple glazing systems

Technical Report: Comparison of the results of numerical modeling of convection heat transfer in glazing cavities with ISO 15099 and WINDOW 4.1 correlations.

Non Continuous Thermal Bridge Elements - NFRC Simulation Manual Addition

Progress Report (Hua Yang) - 2/3/02 "Transition to Turbulence of Buoyant Flows In Vertical Confined Enclosures"

THERM HEAT TRANSFER ANALYSIS OF SIMULATION ROUND ROBIN 1998-99

Computer Modeling Results for NFRC Simulation Round Robin 2000 (SRR00) Window using THERM and WINDOW Computer Programs

Computer Modeling Results for NFRC Simulation Round Robin 1999 (SRR99) Window Using THERM and WINDOW Software

Progress Report (Hua Yang) - 2/21/02 "Turbulent Natural Convective Heat Transfer in Vertical Rectangular Cavity"

Progress Report (Hua Yang) - 2/21/02 "Laminar Natural Convective Flow in Inclined Rectangular Glazing Cavities"

Computer Modeling of Heat Transfer and Comparison for NFRC No4 Window with Different Emissivity around Frame – U-Factor and CI Simulations

Thermal Comparison of the Tr01 Window with Some Change of the Geometry

Technical Report: The Estimation of the Natural Convection Heat Transfer and Flow in Enclosure Modeling Steady-State Conditions in Laboratory Thermal Chambers

Modeling Tubular Daylighting Devices - Final Proposal for an NFRC Method

Trip Report: ISO Meeting

Technical Report: A Comparison of Turbulence Natural Convection Modeling Prediction to Experimental Data for an Air Filled Square Cavity

ISSUES AND CHALLENGES OF ENERGY RATING OF FENESTRATION PRODUCTS  
- Presentation at IEA Meeting

COMPONENT PERFORMANCE ASSESMENT METHODOLOGY (CPAM)

PART I: ISSUES AND RESEARCH NEEDS - Presentation at IEA Meeting

IEA Report: COMPONENT PERFORMANCE ASSESMENT METHODOLOGY (CPAM)

PART I: ISSUES AND RESEARCH NEEDS

SELECTION OF REPRESENTATIVE PRODUCTS FOR RATING FENESTRATION SYSTEMS IN COMMERCIAL (SITE-BUILT) PROJECT - Presentation at NFRC meeting

INTERNATIONAL ACTIVITIES - Presentation at NFRC Meeting

Computer Modeling of Heat Transfer For NFRC 1999-2000 Testing Round Robin Window – U-Factor and CI Simulations Using WINDOW 4.1 and THERM 2.1a

Computer Modeling of Heat Transfer For NFRC 1999-2000 Testing Round Robin Window – U-Factor and CR Simulations Using WINDOW 5 and THERM 5

Technical Report: Numerical Study of Turbulent Natural Convection Over A Backward Facing Step

Summary Report: International Activities for the year 2002

Technical Report: Numerical Study of Mixed Convection Heat Transfer and Flow in Enclosure Modeling Steady-State Conditions in Laboratory Test Chamber

Progress Report (Shaoping Quan) - 5/31/02

Progress Report (Jia Ou) - 6/10/02

Position paper: Rating Site-Built Products Under the NFRC System

Computer Modeling of Heat Transfer For NFRC 1997 Testing Round Robin Window – U-Factor and CR Simulations using WINDOW 5 and THERM5

Computer Modeling of Thermal Performance of 2001 NFRC Testing Round Robin Window – U-Factor and CR Simulations Using WINDOW 5 and THERM 5

Computer Modeling of Heat Transfer For NFRC 2002 Simulation Round Robin (SRR02) Representing Curtain Wall with Bolt – U-Factor and CR Simulations Using WINDOW 4.1 and THERM 2.1a

Computer Simulations of Heat Transfer For 2002 NFRC Simulation Round Robin Window (SRR02) – U-Factor and CR Simulations Using WINDOW 5 and THERM 5

The Application of ISO 15099 to NFRC 100 and 200

Change in Modeling Assumptions for NFRC 100 and 200

Frame Temperatures and Corresponding Convective Surface Heat Transfer Coefficients for NFRC 100 and 200

INVESTIGATION OF THE EFFECTS OF FENESTRATION SYSTEMS ON THE ENERGY PERFORMANCE OF A TYPICAL COMMERCIAL BUILDING - Presentation at NFRC

COMPONENT MODEL APPROACH IN MODELING SITE BUILT PRODUCTS - Presentation at NFRC

Technical Report: ANALYSIS OF CTS CALIBRATION DATA SUBMITTED BY ATI AS A PART OF NFRC RESEARCH PROJECT "CALIBRATION OF THERMAL TESTING METERING CHAMBERS USING CTS PANELS.

Technical Report: Using software Gambit 2.0 and Fluent 6.0 for simulation of heat mass transfer problems

Progress Report (Hua Yang) - 7/29/02 (Natural Convective Flow in Inclined Rectangular Glazing Cavities—3D study)

Technical Report: Sensitivity Study of Material Conductivity Change.

Trip Report: China - 8/14/02

USA-Russia Energy Efficient Window Tests and Simulation Round-Robin

The Application of ISO 15099 to Russian Standard GOST 26602.1: "Windows and Doors: Determination of Thermal Resistance" and SNiP II.3.79

Technical Report: Turbulent Heat Transfer in Buoyancy-Driven Natural Convection in Vertical Enclosures

Energy Efficient Windows and Building Design Software Workshop - Presentation at Bangalore and New Delhi, India

Energy Efficient Windows and Building Design Software Workshop Building Simulation Tools - Presentation at Bangalore and New Delhi, India

Lab Report: Using of Gambit 2.0 and Fluent 6.0 software for 3-Dim heat transfer window modeling

Technical Report: COMPARISON OF RESULTS FOR 11 FENESTRATION SYSTEMS USING NFRC 100-2002 (WINDOW5/THERM5) vs. NFRC 100-97 (W4.1/THERM2.1a)

COMPARISON OF RESULTS FOR 11 FENESTRATION SYSTEMS USING NFRC 100-2002 (WINDOW5/THERM5) vs. NFRC 100-97 (W4.1/THERM2.1a) - Summary Table Only

Summary Report: Projected Validation of the New NFRC Simulation and Testing Procedure

INVESTIGATION OF THE EFFECT OF CONSIDERING NFRC STANDARD SIZE U FACTOR FOR THE FENESTRATION SYSTEMS ON THE ENERGY PERFORMANCE OF A TYPICAL COMMERCIAL BUILDING - Addendum Report

Technical Report: COMPONENT MODEL APPROACH IN MODELING SITE BUILT PRODUCTS

Position Paper: Current Simplifications in Fenestration Computer Models

Technical Report: INVESTIGATION OF THE EFFECTS OF FENESTRATION SYSTEMS ON THE ENERGY PERFORMANCE OF A TYPICAL COMMERCIAL BUILDING

Technical Report: COMPARISON OF RESULTS FOR 104 GLAZING UNITS AT TWO DIFFERENT ORIENTATIONS NFRC 100-2002 (WINDOW5) vs. NFRC 100-97 (W4.1)



ISO 15099: Thermal Performance of Windows, Doors and Shading Devices — Detailed Calculations. Final Draft

"SOLAR ABSORPTION IN THICK AND MULTILAYERED GLAZINGS". WREC Conference

### **Publications for FY 2003:**

Progress Report (Bhaskar Adusumali) - 9/4/03 (Simulation of Natural convective Heat Transfer of 3D Glazing Cavity)

Progress Report (Sneh Kumar) - 9/4/03 (3-D HEAT TRANSFER MODELLING OF WOOD WINDOW USING GAMBIT 2.0 AND FLUENT6.0 SOFTWARE)

Progress Report (Bhaskar Adusumali) - 10/8/03 (Performing a mesh study to optimize the simulation time and predict accurate heat transfer results for an inclined 3D Glazing Cavity from simulations on FLUENT)

Analysis of energy performance of selected fenestration systems in commercial buildings - Presentation at ASHRAE 90.1

Technical Report: Analysis of energy performance of selected fenestration systems in commercial buildings

Listing of Assumptions for Energy Analysis of Typical Commercial Buildings for ASHRAE 90.1

"Two-Dimensional Computational Fluid Dynamics and Conduction Simulations of Heat Transfer in Window Frames with Internal Cavities - Part 1: Cavities Only". Submitted to ASHRAE

Technical Report: COMPONENT MODEL APPROACH IN MODELING NON-RESIDENTIAL FENESTRATION PRODUCTS - Version 3

STANDARD TEST PROCEDURE AND COMPUTER MODELING METHOD TO DETERMINE THE CONDENSATION RESISTANCE OF FENESTRATION PRODUCTS

Effect of varying emissivities on the thermal performance of Aluminum window

Measured Emissivities of selected Metallic samples

Trip Report: Energy Efficient Windows Conference and Workshops 3

"Numerical Study of Natural Convection in inclined Rectangular Glazing Cavities". Draft Paper

"Turbulent Natural Convective Heat Transfer in Vertical Glazing Cavities" Draft Paper

Trip Report: Report on November 2002 Trip "Seminars, Workshops, and Strategic Planning Meetings in India for Energy Efficient Windows and Building Design"

Position Paper: Statement of the problem of numerical modeling of steady-state conditions in laboratory test chamber (LBL IR box)

Technical Report: Modeling Natural Convection in a Glazing Cavity and Predicting Transition Limits for Multicellular Flow from Simulations on FLUENT

Masters Thesis (Hua Yang): NATURAL CONVECTIVE FLOW AND HEAT TRANSFER IN VERTICAL AND INCLINED GLAZING CAVITIES

NFRC 100-Part II (Non-Residential Products)

Flow Chart for NFRC 100

NFRC Glossary

Progress Report (Bhaskar Adusumali) - 10/31/03: Predicting local heat transfer rates for 3D cavities in vertical and inclined orientations for  $A=20$  simulating 3D natural convection for  $A=80$ ,  $Ra=9690$  with full and half models

PROBLEMS AND ISSUES IN SIMULATING COMMERCIAL FENESTRATION SYSTEMS FOR PRODUCT RATINGS - Presentation at NFRC Meeting

Technical Report: Use numerical modeling for estimation and improvement test method of measuring the steady thermal transmittance of fenestration systems

Position Paper: OUTLINE OF RESEARCH WORK FOR THE DEVELOPMENT AND ASSESMENT OF INNOVATIVE IGU DESIGNS (WITH IMPROVED THERMAL INDICES)

Progress Report (Sneh Kumar) - 5/5/03 (Heat transfer Comparison Between Fluent and Window5 Results For A Glazing Unit)

Summary Tables: Simulation THERM/WINDOW vs. Component Modeling Approach

IEA TASK 27: Fenestration Terminology

Thermal Properties for CO<sub>2</sub> and N<sub>2</sub>

Masters Thesis (Alan Leung): A STUDY OF LOCAL CONVECTIVE HEAT TRANSFER IN FOAM GARDEN WINDOW

Technical Report: Study of Turbulent Natural Convection Flow in Rectangular Enclosure

White Paper: Outline of the research plan for the development of new generation of testing standards and improving modeling techniques using "Virtual Thermal Testing Facility - ViTTeF" Concep

#### **Publications for FY 2004:**

TECHNICAL REPORT: Performing a mesh study to optimize the simulation time and predict accurate heat transfer results for an inclined 3D Glazing Cavity from simulations on FLUENT (Bhaskar Adusumali)

PROGRESS REPORT: Predicting local heat transfer rates for 3D cavities in vertical and inclined orientations for  $A=20$  simulating 3D natural convection for  $A=80$ ,  $Ra=9690$  with full and half models ((Bhaskar Adusumali)

TECHNICAL REPORT: Analysis of energy performance of selected fenestration systems in commercial buildings (D. Curcija, M. Bhandari)

DRAFT PAPER: A Comparison of Turbulence Natural Convection Prediction to Experimental Data for an Air Filled Square Cavity (A. Fomichev, D. Curcija, M. Bhandari)

REPORT: Fenestration Glossary and Terminology (D. Curcija)

NFRC STANDARD BALLOT: NFRC 101:2004 Procedure for Determining Thermo-Physical Properties of Materials For Use in NFRC-Approved Software Programs

THESIS PROPOSAL: Local Heat Transfer Rates In Fenestration Glazing Cavities (B. Adusumali)

THESIS PROPOSAL PRESENTATION: Local Heat Transfer Rates In Fenestration Glazing Cavities (B. Adusumali)

THESIS PROPOSAL: Investigation of 3-D Heat Transfer Effects In Fenestration Products (S. Kumar)

ASHRAE HANDBOOK OF FUNDAMENTALS: Chapter 31: Fenestration. IP and SI. (D. Curcija)

GLASS MAGAZINE ARTICLE: NFRC Releases New Standards For Energy Performance of Non-Residential Fenestration Products (M. Manteghi, D. Curcija, B. Shah)

DRAFT PAPER: A Numerical Simulation of Turbulence Natural Convection Along a Vertical Flat Plate with Backward-Facing Step (A. Fomichev, D. Curcija, M. Bhandari)

ENVELOPE IX PAPER: Component Modeling Methodology for Predicting Thermal Performance of Non-Residential Fenestration Systems (D. Curcija, M. Bhandari, M. Manteghi, B. Shah)

ENVELOPE IX PRESENTATION: Component Modeling Methodology for Predicting Thermal Performance of Non-Residential Fenestration Systems (D. Curcija)

MEMO TO ASHRAE 90.1 ENVELOPE SUBCOMMITTEE: Fenestration Criteria for Commercial buildings (D. Curcija, M. Stocki, M. Bhandari)

PRESENTATION TO ASHRAE 90.1 ENVELOPE SUBCOMMITTEE: Fenestration Criteria for Commercial buildings (M. Bhandari)

TECHNICAL NOTE: Analysis of Applicability of Trade-off Equations in Building Energy Codes and EnergyStar™ Criteria (D. Curcija)

EXCEL SPREADSHEET: THERM5/WINDOW5 Analysis vs. Component Modeling Approach: Trends. (D. Curcija)

TECHNICAL REPORT: eQUEST Building Energy Simulation Model Energy Comparison Comparison of Office Energy Density Values Carmody et al., 2004 Versus eQUEST V. 3.44. (M. Stocki, D. Curcija)

ASHRAE ONE PAGER RFP: Develop Convective Heat Transfer Coefficients for Indoor and Outdoor Surfaces of Fenestration Systems (D. Curcija)

PRESENTATION: New Rating System for Non-Residential Fenestration Products (D. Curcija)

NFRC STANDARD DEVELOPMENT: Outline for the Certification Section (D. Curcija)

ASTM STANDRAD DEVELOPMENT: Standard Test Procedure and Computer Modeling Method To Determine The Condensation Resistance of Fenestration Products (D. Curcija)

NFRC STANDARD DEVELOPMENT: NFRC Approved Form For The Submittal of a Request For Thermo-Physical Property Determination and Publication In NFRC Database (D. Curcija)

NFRC Approved Form For The Submittal of Challenge Request (D. Curcija)

NFRC PRESENTATION: Non-Residential Products Certification (D. Curcija)

FENESTRATION DAYS 2004 CONFERENCE PAPER: Role of Low-e Coatings in Energy Savings From Windows (D. Curcija)

FENESTRATION DAYS 2004 CONFERENCE PRESENTATION: Role of Low-e Coatings in Energy Savings From Windows (D. Curcija)

TECHNICAL REPORT: Listing of Assumptions for Energy Analysis of a Typical Office Building for ASHRAE 90.1 (D. Curcija, M. Stocki)

TECHNICAL NOTE: Outline of The Implementation of CEN Procedure Using THERM 5 Program (D. Curcija)

EXCEL SPREADSHEET: CEN Center of Glass and Whole Product Calculation Program

EXCEL SPREADSHEET: Validation of 10 CEN cases

TECHNICAL NOTE: How To Model THERM 5 Boundary Conditions (convection heat transfer coefficient + radiation enclosure) in Fluent Software For Conductive Models (A. Fomichev)

NFRC STANDARD BALLOT: NFRC 101V: Verification Program for Thermo-physical Property Data (D. Curcija)

NFRC MEETING PRESNETATION: Component Modeling Approach Based Non-Residential Products Procedure: Outstanding Issues (D. Curcija)

IEA Task 27 REPORT: Computer Tools For Building Energy Performance (D. Curcija)

NFRC REPORT: Technical Issues with the Non-Residential Component Modeling Procedure (CMP) (D. Curcija)

NFRC PRESENTATION: Technical Issues with the Non-Residential Component Modeling Procedure (CMP) (D. Curcija)

TECHNICAL REPORT: Investigation of the Effects of Glass Thickness and Spacer Configuration on Thermal Performance of Windows (D. Curcija)

IEA Task 27 REPORT: Fenestration Terminology And Glossary (D. Curcija)

NFRC STANDARD BALLOT: NFRC 200: Non-Residential Section. (D. Curcija)

NFRC STANDARD BALLOT: NFRC 100: Non-Residential Section. (D. Curcija)

TECHNICAL NOTE: Definition of Generic Best/Worst IGU And Spacers – Proposed Values (D. Curcija)

NFRC PROCEDURE DEVELOPMENT: NFRC Component Based Non-Residential Fenestration PCP

NFRC PROCEDURE DEVELOPMENT: Flow Chart of NFRC Non-Residential Process (B. Shah, D. Curcija)

NFRC PRESENTATION: NFRC Non-Residential Label Certificate Proposal (D. Curcija)

NFRC REPORT: Important Issues with the Non-Residential Component Modeling Approach (CMA) Procedure (D. Curcija)

NFRC PROCEDURE DEVELOPMENT: Label Certificate Proposals (D. Curcija)

- NFRC Non-Res Label Certificate Project Information
- NFRC Non-Res Label Certificate for Project
- NFRC Non-Res Label Certificate for Product
- NFRC Non-Res Label Certificate for Framing
- NFRC Non-Res Label Certificate for Glazing

TECHNICAL REPORT: Listing of Assumptions for Energy Analysis of Typical Commercial Buildings for ASHRAE 90.1 (M. Stocki, D. Curcija)

CONFERENCE PAPER: Role of Building Simulation Models in Developing Non-Residential Fenestration Rating System - Investigation of the Effects of Fenestration Systems on the Energy Performance of a Typical Commercial Building (M. Bhandari, D. Curcija, B. Shah, J. Benney)

ASHRAE PAPER: Two-Dimensional Conduction and CFD Simulations of Heat Transfer in Horizontal Window Frame Cavities (A. Gustavsen, C. Kohler, D. Arasteh, D. Curcija)

TECHNICAL REPORT: Comparison Between Simulation Results from THERM/WINDOW vs. new Non-Residential Component Modeling Approach (D. Curcija)

## **APPENDIX B: LISTINGS OF REPORTS SORTED BY THE TASK AND FISCAL YEAR**

### **CONDENSATION RESISTANCE (CR) TASK PUBLICATIONS:**

#### **FY 2000:**

Technical Progress Report: 2-D Numerical Analysis of IGU Cavities at Inclined Orientation

Technical report: Computer Modeling of CI According to NFRC500 of a Wood Fixed Window with Varying Spacers and Glazing Options

Power Point Presentation: Condensation Index

Condensation Index Spreadsheet

Technical Report: Analysis of Thermal Performance of Wood Marvin Window With Clear Glazing (PFM01)

Technical Report: Analysis of Thermal Performance of Wood Marvin Window With Low-E Glazing (PFM02)

Technical Report: Computer Modeling Results for NFRC Simulation Round Robin 1999 (SRR99) Window Using THERM and WINDOW Software

#### **FY 2001:**

Progress Report (Hua Yang) - 2/17/01

Progress Report (Hua Yang) - 8/7/01

Condensation Resistance Analysis for NFRC (Various Options)

Condensation Index Presentation

Computer Modeling Results for NFRC Simulation Round Robin 2000 (SRR00) Window using THERM and WINDOW Computer Programs

Test Round Robin 2001 Using Computer Modeling According to NFRC 500

Computer Modeling of CI According to NFRC 500 of A Wood Fixed Window With Varying Spacers and Glazing Options

Computer Modeling Results for NFRC Simulation Round Robin 1999 (SRR99) Window Using THERM and WINDOW Software (Final Draft)

Evaluation of the Condensation Index Rating as Determined using the Proposed Simulation Method in the NFRC 500 Draft Procedure (ASTM Paper)

Test Round Robin 2001 Using Computer Modeling According to NFRC 500

#### **FY 2002:**

Technical Report - The study of convection heat transfer in triple glazing systems

Progress Report (Hua Yang) - 2/3/02 "Transition to Turbulence of Buoyant Flows In Vertical Confined Enclosures"

Progress Report (Hua Yang) - 2/21/02 "Turbulent Natural Convective Heat Transfer in Vertical Rectangular Cavities"

Progress Report (Hua Yang) - 2/21/02 "Laminar Natural Convective Flow in Inclined Rectangular Glazing Cavities"

Technical Report: A Comparison of Turbulence Natural Convection Modeling Prediction to Experimental Data for an Air Filled Square Cavity

Progress Report (Hua Yang) - 7/29/02 (Natural Convective Flow in Inclined Rectangular Glazing Cavities—3D study)

Technical Report: Turbulent Heat Transfer in Buoyancy-Driven Natural Convection in Vertical Enclosures

Computer Modeling of Heat Transfer and Comparison for PVC Casement Window – U-Factor and CR Simulations Using WINDOW 5 and THERM 5

Computer Modeling of Heat Transfer and Comparison for PVC Casement Window – U-Factor and CR Simulations Using THERM 2.1a and WINDOW 4.1

Condensation Resistance Advancements - Presentation at NFRC

Computer Modeling of Heat Transfer and Comparison for NFRC No4 Window with Different Emissivity around Frame – U-Factor and CI Simulations

Computer Modeling of Heat Transfer For NFRC 1999-2000 Testing Round Robin Window – U-Factor and CI Simulations Using WINDOW 4.1 and THERM 2.1a

Computer Modeling of Heat Transfer For NFRC 1999-2000 Testing Round Robin Window – U-Factor and CR Simulations Using WINDOW 5 and THERM 5

Computer Modeling of Heat Transfer For NFRC 1997 Testing Round Robin Window – U-Factor and CR Simulations using WINDOW 5 and THERM5

Computer Modeling of Thermal Performance of 2001 NFRC Testing Round Robin Window – U-Factor and CR Simulations Using WINDOW 5 and THERM 5

Computer Simulations of Heat Transfer For 2002 NFRC Simulation Round Robin Window (SRR02) – U-Factor and CR Simulations Using WINDOW 5 and THERM 5

### **FY 2003:**

Progress Report (Bhaskar Adusumali) - 9/4/03 (Simulation of Natural convective Heat Transfer of 3D Glazing Cavity)

Technical Report: Modeling Natural Convection in a Glazing Cavity and Predicting Transition Limits for Multicellular Flow from Simulations on FLUENT

Masters Thesis (Hua Yang): NATURAL CONVECTIVE FLOW AND HEAT TRANSFER IN VERTICAL AND INCLINED GLAZING CAVITIES

Progress Report (Bhaskar Adusumali) - 10/31/03: Predicting local heat transfer rates for 3D cavities in vertical and inclined orientations for  $A=20$  simulating 3D natural convection for  $A=80$ ,  $Ra=9690$  with full and half models

Technical Report: Study of Turbulent Natural Convection Flow in Rectangular Enclosure

Technical Report: Effect of varying emissivities on the thermal performance of Aluminum window

"Numerical Study of Natural Convection in inclined Rectangular Glazing Cavities". Draft Paper

"Turbulent Natural Convective Heat Transfer in Vertical Glazing Cavities" Draft Paper

Progress Report (Bhaskar Adusumali) - 10/8/03 (Performing a mesh study to optimize the simulation time and predict accurate heat transfer results for an inclined 3D Glazing Cavity from simulations on FLUENT)

"Two-Dimensional Computational Fluid Dynamics and Conduction Simulations of Heat Transfer in Window Frames with Internal Cavities - Part 1: Cavities Only". Submitted to ASHRAE

#### **FY 2004:**

TECHNICAL REPORT: Performing a mesh study to optimize the simulation time and predict accurate heat transfer results for an inclined 3D Glazing Cavity from simulations on FLUENT (Bhaskar Adusumali)

PROGRESS REPORT: Predicting local heat transfer rates for 3D cavities in vertical and inclined orientations for  $A=20$  simulating 3D natural convection for  $A=80$ ,  $Ra=9690$  with full and half models ((Bhaskar Adusumali)

DRAFT PAPER: A Comparison of Turbulence Natural Convection Prediction to Experimental Data for an Air Filled Square Cavity (A. Fomichev, D. Curcija, M. Bhandari)

THESIS PROPOSAL: Local Heat Transfer Rates In Fenestration Glazing Cavities (B. Adusumali)

THESIS PROPOSAL PRESENTATION: Local Heat Transfer Rates In Fenestration Glazing Cavities (B. Adusumali)

#### **PROJECTING PRODUCT PUBLICATIONS:**

#### **FY 2000:**

Technical Progress Report: Modeling of Local Convective Heat Transfer in Projecting Products

Power Point Presentation: Applicability of Detailed Radiation Modeling



**FY 2001:**

Progress Report (Alan Leung) - 4/26/01

"Analyzing Thermal Performance of Building Envelope Components Using 2-D Heat Transfer Tool with Detailed Radiation Modeling". Building Simulation Conference, Rio de Janeiro, Brazil. August 2001.

**FY 2002:**

THERM HEAT TRANSFER ANALYSIS OF SIMULATION ROUND ROBIN 1998-99

Computer Modeling Results for NFRC Simulation Round Robin 1999 (SRR99) Window Using THERM and WINDOW Software

Computer Modeling Results for NFRC Simulation Round Robin 2000 (SRR00) Window using THERM and WINDOW Computer Programs

Technical Report: The Estimation of the Natural Convection Heat Transfer and Flow in Enclosure Modeling Steady-State Conditions in Laboratory Thermal Chambers

Technical Report: Numerical Study of Turbulent Natural Convection Over A Backward Facing Step

Technical Report: Numerical Study of Mixed Convection Heat Transfer and Flow in Enclosure Modeling Steady-State Conditions in Laboratory Test Chamber

Progress Report (Jia Ou) - 6/10/02

Technical Report: ANALYSIS OF CTS CALIBRATION DATA SUBMITTED BY ATI AS A PART OF NFRC RESEARCH PROJECT "CALIBRATION OF THERMAL TESTING METERING CHAMBERS USING CTS PANELS.

"SOLAR ABSORPTION IN THICK AND MULTILAYERED GLAZINGS". WREC Conference

**FY 2003:**

Technical Report: Use numerical modeling for estimation and improvement test method of measuring the steady thermal transmittance of fenestration systems

Masters Thesis (Alan Leung): A STUDY OF LOCAL CONVECTIVE HEAT TRANSFER IN FOAM GARDEN WINDOW

White Paper: Outline of the research plan for the development of new generation of testing standards and improving modeling techniques using "Virtual Thermal Testing Facility - ViTTeF" Concep

**FY 2004:**

DRAFT PAPER: A Numerical Simulation of Turbulence Natural Convection Along a Vertical Flat Plate with Backward-Facing Step (A. Fomichev, D. Curcija, M. Bhandari)

TECHNICAL NOTE: How To Model THERM 5 Boundary Conditions (convection heat transfer coefficient + radiation enclosure) in Fluent Software For Conductive Models (A. Fomichev)

### **3-D HEAT TRANSFER PUBLICATIONS:**

#### **FY 2000:**

Power Point Presentation: Applicability of Detailed Radiation Modeling

Technical Progress Report: 3-D Heat Transfer in Fenestration Systems And this completes

#### **FY 2001:**

Progress Report (Linda Li) - 2/17/01

Progress Report (Linda Li) - 8/9/01

Progress Report Presentation (Linda Li) - 08-01

Applicability of Detailed Radiation Modeling - Presentation (Vienna, 05/08/01)

#### **FY 2002:**

Progress Report (Shaoping Quan) - 1/14/02

Thermal Comparison of the Trr01 Window with Some Change of the Geometry

Progress Report (Shaoping Quan) - 5/31/02

Technical Report: Using software Gambit 2.0 and Fluent 6.0 for simulation of heat mass transfer problems

Lab Report: Using of Gambit 2.0 and Fluent 6.0 software for 3-Dim heat transfer window modeling

#### **FY 2003:**

Progress Report (Sneh Kumar) - 9/4/03 (3-D HEAT TRANSFER MODELLING OF WOOD WINDOW USING GAMBIT 2.0 AND FLUENT6.0 SOFTWARE)

Progress Report (Sneh Kumar) - 5/5/03 (Heat transfer Comparison Between Fluent and Window5 Results For A Glazing Unit)

**FY 2004:**

THESIS PROPOSAL: Investigation of 3-D Heat Transfer Effects In Fenestration Products (S. Kumar)

**INTERNATIONAL SUPPORT PUBLICATIONS:****INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO):****FY 2000:**

Technical Report: A Pilot Project to Establish the Technical Basis and Institutional Framework for Assuring the Energy Efficiency of Fenestration Building Products in Certain Transitional Economy Countries - Phase 0 Results

Standard: THTF Drfat 0f: Procedure for Determining Fenestration Product Thermal Indices

Standard: ISO DIS 15099: Thermal Performance of Windows, Doors, and Shading Devices - Detailed Calculations

Archive of draft ISO 15099 documents

Standard: ISO FDIS 12567: Thermal Performance of Doors and Windows - Determination of Thermal Transmittance By Hot Box Method

Standard: ISO DIS 12567-2: Thermal Performance of Roof Windows and Other Projecting Windows - Determination of Thermal Transmittance By Hot Box Method

Standard: ISO FDIS 10077: Thermal Performance Windows, Doors and Shutters - Calculation of Thermal Transmittance - Part 2: Numerical Method for Frames

Power Point Presentation: Overview of NFRC International Efforts

Trip Report: Technical Assistance in Fenestration Technology to Bosnia and Herzegovina

Trip Report: ISO 15099 and ISO 12567 Meetings in Vienna, Austria

Trip Report: ISO 15099 and ISO 12567 Meetings in Vienna, Austria

Trip Report: "Train the Trainers" Workshop at Amherst, Mass and THERM and Window Training Workshops in Samara, Russia and Kaunas, Lithuania; and Baltic Windows Workshop in Vilnius, Lithuania.

Technical Report: Computer Simulation of Selected Windows and Doors According to CEN Method (Generic Report generated from the confidential report to Andersen Windows in thier effort to market windows in Poland)

Conference Paper: D. Curcija. 2000. "Role of Computer Modeling Tools in Window Certification and Design" Baltic Window Conference. Vilnius, Lithuania. April, 2000

Power Point Presentation: "Role of Computer Modeling Tools in Window Certification and Design"

Conference Paper: D. Curcija. 2000. "Trends and Developments in Window Testing Methods" Baltic Window Conference. Vilnius, Lithuania. April, 2000

Power Point Presentation: "Trends and Developments in Window Testing Methods"

Conference Paper: D. Curcija. 2000. "Role of Computer Computer Simulation in Window Certification" International Workshop and Round Table Discussion: Energy Future of Bosnia and Herzegovina. Sarajevo, BiH. June 2000.

Power Point Presentation: "Role of Computer Computer Simulation in Window Certification"

### **FY 2001:**

Software Demonstration\_presentation (Mexico)

Software Demonstration\_presentation (Brazil)

Trip Report to Brazil (08-01)

Trip Report to Mexico (10-01)

"Technical Basis and Institutional Framework For Assuring The Energy Efficiency of Fenestration Systems in Transitional Economy Countries". Belgrade Conference - 6/16/01

"Labeling and Certification Procedures for Energy Rating in North America and The Impact on Market for Energy Efficient Products". Mexico Conference - 10/3/01

International Activities - Presentation to NFRC

Software Demostration in Sao Paolo, Brazil

ISO 15099 Draft (07-01)

Applicability of Detailed Radiation Modeling - Presentation (Vienna, 05/08/01)

"Rating and Labeling of Energy Performance of Windows as a Tool for Promoting Energy Efficient Practices in Buildings". Building Simulation Conference, Rio de Janeiro, Brazil. August 2001.

### **FY 2002:**

"Role of Computer Simulations in Window Ratings and Design". Energy Efficient Windows and Building Design Conference, New Delhi and Bangalore, India.

Role of Computer Simulations in Window Ratings and Design - Presentation

Trip Report: ISO Meeting

ISSUES AND CHALLENGES OF ENERGY RATING OF FENESTRATION PRODUCTS  
- Presentation at IEA Meeting

COMPONENT PERFORMANCE ASSESMENT METHODOLOGY (CPAM)

PART I: ISSUES AND RESEARCH NEEDS - Presentation at IEA Meeting

IEA Report: COMPONENT PERFORMANCE ASSESMENT METHODOLOGY (CPAM)  
PART I: ISSUES AND RESEARCH NEEDS

ISO 15099: Thermal Performance of Windows, Doors and Shading Devices — Detailed Calculations. Final Draft

INTERNATIONAL ACTIVITIES - Presentation at NFRC Meeting

Summary Report: International Activities for the year 2002

Trip Report: China - 8/14/02

USA-Russia Energy Efficient Window Tests and Simulation Round-Robin

The Application of ISO 15099 to Russian Standard GOST 26602.1: "Windows and Doors: Determination of Thermal Resistance" and SNiP II.3.79

Energy Efficient Windows and Building Design Software Workshop - Presentation at Bangalore and New Delhi, India

Energy Efficient Windows and Building Design Software Workshop Building Simulation Tools - Presentation at Bangalore and New Delhi, India

ISO 15099: Thermal Performance of Windows, Doors and Shading Devices — Detailed Calculations. Final Draft

### **FY 2003:**

Trip Report: Energy Efficient Windows Conference and Workshops 3

Trip Report: Report on November 2002 Trip "Seminars, Workshops, and Strategic Planning Meetings in India for Energy Efficient Windows and Building Design"

IEA TASK 27: Fenestration Terminology

### **FY 2004:**

FENESTRATION DAYS 2004 CONFERENCE PAPER: Role of Low-e Coatings in Energy Savings From Windows (D. Curcija)

FENESTRATION DAYS 2004 CONFERENCE PRESENTATION: Role of Low-e Coatings in Energy Savings From Windows (D. Curcija)

TECHNICAL NOTE: Outline of The Implementation of CEN Procedure Using THERM 5 Program (D. Curcija)

EXCEL SPREADSHEET: CEN Center of Glass and Whole Product Calculation Program

EXCEL SPREADSHEET: Validation of 10 CEN cases

IEA Task 27 REPORT: Computer Tools For Building Energy Performance (D. Curcija)

IEA Task 27 REPORT: Fenestration Terminology And Glossary (D. Curcija)

**INTERNATIONAL ENERGY AGENCY (IEA):****FY 2000:**

Trip Report: IEA Task 27 Meeting in Grenoble, France

**FY 2001:**

None

**FY 2002:**

ISSUES AND CHALLENGES OF ENERGY RATING OF FENESTRATION PRODUCTS  
- Presentation at IEA Meeting

COMPONENT PERFORMANCE ASSESMENT METHODOLOGY (CPAM)  
PART I: ISSUES AND RESEARCH NEEDS - Presentation at IEA Meeting

IEA Report: COMPONENT PERFORMANCE ASSESMENT METHODOLOGY (CPAM)  
PART I: ISSUES AND RESEARCH NEEDS

**FY 2003:**

IEA TASK 27: Fenestration Terminology

**OTHER INTERNATIONAL PUBLICATIONS:****FY 2000:**

Standard: THTF Drfat 0f: Procedure for Determining Fenestration Product Thermal Indices

Power Point Presentation: Overview of NFRC International Efforts

Trip Report: Technical Assistance in Fenestration Technology to Bosnia and Herzegovina

Trip Report: "Train the Trainers" Workshop at Amherst, Mass and THERM and Window Training Workshops in Samara, Russia and Kaunas, Lithuania; and Baltic Windows Workshop in Vilnius, Lithuania.

Technical Report: Computer Simulation of Selected Windows and Doors According to CEN Method (Generic Report generated from the confidential report to Andersen Windows in thier effort to market windows in Poland)

**FY 2001:**

Software Demonstration\_presentation (Mexico)

Software Demonstration\_presentation (Brazil)

Trip Report to Brazil (08-01)

Trip Report to Mexico (10-01)

NFRC/CSA-A100: PROCEDURE FOR DETERMINING FENESTRATION PRODUCT THERMAL INDICES - Preliminary Draft 0.h

Procedure for Determining Thermo-Physical Properties of Materials For Use in NFRC-Approved Software Programs

International Activities - Presentation to NFRC

Software Demostration in Sao Paolo, Brazil

### **FY 2002:**

INTERNATIONAL ACTIVITIES - Presentation at NFRC Meeting

Summary Report: International Activities for the year 2002

Trip Report: China - 8/14/02

USA-Russia Energy Efficient Window Tests and Simulation Round-Robin

The Application of ISO 15099 to Russian Standard GOST 26602.1: "Windows and Doors: Determination of Thermal Resistance" and SNiP II.3.79

Energy Efficient Windows and Building Design

\* Software Workshop \* - Presentation at Bangalore and New Delhi, India

Energy Efficient Windows and Building Design

\* Software Workshop \*

Building Simulation Tools - Presentation at Bangalore and New Delhi, India

### **FY 2003:**

Trip Report: Energy Efficient Windows Conference and Workshops 3

Trip Report: Report on November 2002 Trip "Seminars, Workshops, and Strategic Planning Meetings in India for Energy Efficient Windows and Building Design"

## **COMMERCIAL FENESTRATION SYSTEMS**

### **FY 2001:**

Investigation on optimum quantity of necessary simulations of thermal performance of windows in a typical commercial building

Investigation on optimum quantity of necessary simulations of thermal performance of windows in a typical commercial building - presentation

Computer Modeling of Commercial Aluminum Framing Systems – U-Factor and Temperature Distribution

Condensation Resistance of Commercial Fenestration Systems (ASHRAE Forum)

**FY 2002:**

SELECTION OF REPRESENTATIVE PRODUCTS FOR RATING FENESTRATION SYSTEMS IN COMMERCIAL (SITE-BUILT) PROJECT - Presentation at NFRC meeting

Position paper: Rating Site-Built Products Under the NFRC System

Computer Modeling of Heat Transfer For NFRC 2002 Simulation Round Robin (SRR02) Representing Curtain Wall with Bolt – U-Factor and CR Simulations Using WINDOW 4.1 and THERM 2.1a

INVESTIGATION OF THE EFFECTS OF FENESTRATION SYSTEMS ON THE ENERGY PERFORMANCE OF A TYPICAL COMMERCIAL BUILDING - Presentation at NFRC

COMPONENT MODEL APPROACH IN MODELING SITE BUILT PRODUCTS - Presentation at NFRC

INVESTIGATION OF THE EFFECT OF CONSIDERING NFRC STANDARD SIZE U FACTOR FOR THE FENESTRATION SYSTEMS ON THE ENERGY PERFORMANCE OF A TYPICAL COMMERCIAL BUILDING - Addendum Report

Technical Report: COMPONENT MODEL APPROACH IN MODELING SITE BUILT PRODUCTS

Technical Report: INVESTIGATION OF THE EFFECTS OF FENESTRATION SYSTEMS ON THE ENERGY PERFORMANCE OF A TYPICAL COMMERCIAL BUILDING

**FY 2003:**

Technical Report: COMPONENT MODEL APPROACH IN MODELING NON-RESIDENTIAL FENESTRATION PRODUCTS - Version 3

PROBLEMS AND ISSUES IN SIMULATING COMMERCIAL FENESTRATION SYSTEMS FOR PRODUCT RATINGS - Presentation at NFRC Meeting

Summary Tables: Simulation THERM/WINDOW vs. Component Modeling Approach

Analysis of energy performance of selected fenestration systems in commercial buildings - Presentation at ASHRAE 90.1

Technical Report: Analysis of energy performance of selected fenestration systems in commercial buildings

Listing of Assumptions for Energy Analysis of Typical Commercial Buildings for ASHRAE 90.1



**FY 2004:**

TECHNICAL REPORT: Analysis of energy performance of selected fenestration systems in commercial buildings (D. Curcija, M. Bhandari)

GLASS MAGAZINE ARTICLE: NFRC Releases New Standards For Energy Performance of Non-Residential Fenestration Products (M. Manteghi, D. Curcija, B. Shah)

ENVELOPE IX PAPER: Component Modeling Methodology for Predicting Thermal Performance of Non-Residential Fenestration Systems (D. Curcija, M. Bhandari, M. Manteghi, B. Shah)

ENVELOPE IX PRESENTATION: Component Modeling Methodology for Predicting Thermal Performance of Non-Residential Fenestration Systems (D. Curcija)

MEMO TO ASHRAE 90.1 ENVELOPE SUBCOMMITTEE: Fenestration Criteria for Commercial buildings (D. Curcija, M. Stocki, M. Bhandari)

EXCEL SPREADSHEET: THERM5/WINDOW5 Analysis vs. Component Modeling Approach: Trends. (D. Curcija)

TECHNICAL REPORT: eQUEST Building Energy Simulation Model Energy Comparison Comparison of Office Energy Density Values Carmody et al., 2004 Versus eQUEST V. 3.44. (M. Stocki, D. Curcija)

PRESENTATION: New Rating System for Non-Residential Fenestration Products (D. Curcija)

NFRC PRESENTATION: Non-Residential Products Certification (D. Curcija)

TECHNICAL REPORT: Listing of Assumptions for Energy Analysis of a Typical Office Building for ASHRAE 90.1 (D. Curcija, M. Stocki)

NFRC MEETING PRESENTATION: Component Modeling Approach Based Non-Residential Products Procedure: Outstanding Issues (D. Curcija)

NFRC REPORT: Technical Issues with the Non-Residential Component Modeling Procedure (CMP) (D. Curcija)

NFRC PRESENTATION: Technical Issues with the Non-Residential Component Modeling Procedure (CMP) (D. Curcija)

TECHNICAL REPORT: Investigation of the Effects of Glass Thickness and Spacer Configuration on Thermal Performance of Windows (D. Curcija)

TECHNICAL NOTE: Definition of Generic Best/Worst IGU And Spacers – Proposed Values (D. Curcija)

TECHNICAL REPORT: Listing of Assumptions for Energy Analysis of Typical Commercial Buildings for ASHRAE 90.1 (M. Stocki, D. Curcija)

CONFERENCE PAPER: Role of Building Simulation Models in Developing Non-Residential Fenestration Rating System - Investigation of the Effects of Fenestration

Systems on the Energy Performance of a Typical Commercial Building (M. Bhandari, D. Curcija, B. Shah, J. Benney)

TECHNICAL REPORT: Comparison Between Simulation Results from THERM/WINDOW vs. new Non-Residential Component Modeling Approach (D. Curcija)

TECHNICAL NOTE: Definition of Generic Best/Worst IGU And Spacers – Proposed Values (D. Curcija)

## **TECHNICAL SUPPORT FOR NFRC, ASHRAE, and ASTM:**

### **NFRC / ASTM:**

#### **FY 2000:**

Standard: NFRC 100: Draft Test Procedure for Measuring the Steady-State Thermal Performance of Fenestration Systems

Power Point Presentation: New NFRC 100 Testing Procedure

Power Point Presentation: Development of a Hot Box

Standard: NFRC 500: Procedure For Determining Fenestration Product Condensation Index Values

Power Point Presentation: Expected Changes to NFRC U-Factor and SHGC Calculations

NFRC Fenestration Glossary

Standard: NFRC 101: Procedure for Determining Thermo-Physical Properties of Materials For Use in NFRC-Approved Software Programs - Material Library Spreadsheet

#### **FY 2001:**

CTS Panel Construction Manual

NFRC Glossary Draft

ISO 15099 implementation in NFRC

Treatment of Non-Continuous Thermal Bridges in NFRC system

ISO Standards, WINDOW 5, and THERM 5: Expected Changes to NFRC U-Factor & SHGC Calculations

OUTLINE OF TECHNICAL CHANGES IN COMPUTER ALGORITHMS FOR NFRC SIMULATION PROGRAM

NFRC 500 Draft (10-23)

NFRC/CSA-A100: PROCEDURE FOR DETERMINING FENESTRATION PRODUCT THERMAL INDICES - Preliminary Draft 0.h

Procedure for Determining Thermo-Physical Properties of Materials For Use in NFRC-Approved Software Programs

Proposed Methodology For Modeling Tubular Skylights For NFRC Rating Purposes

**FY 2002:**

Technical Report: Comparison of the results of numerical modeling of convection heat transfer in glazing cavities with ISO 15099 and WINDOW 4.1 correlations.

Non Continuous Thermal Bridge Elements - NFRC Simulation Manual Addition

Modeling Tubular Daylighting Devices - Final Proposal for an NFRC Method

The Application of ISO 15099 to NFRC 100 and 200

Change in Modeling Assumptions for NFRC 100 and 200

Frame Temperatures and Corresponding Convective Surface Heat Transfer Coefficients for NFRC 100 and 200

Technical Report: Sensitivity Study of Material Conductivity Change.

Technical Report: COMPARISON OF RESULTS FOR 11 FENESTRATION SYSTEMS USING NFRC 100-2002 (WINDOW5/THERM5) vs. NFRC 100-97 (W4.1/THERM2.1a)

COMPARISON OF RESULTS FOR 11 FENESTRATION SYSTEMS USING NFRC 100-2002 (WINDOW5/THERM5) vs. NFRC 100-97 (W4.1/THERM2.1a) - Summary Table Only

Summary Report: Projected Validation of the New NFRC Simulation and Testing Procedure

Technical Report: COMPARISON OF RESULTS FOR 104 GLAZING UNITS AT TWO DIFFERENT ORIENTATIONS NFRC 100-2002 (WINDOW5) vs. NFRC 100-97 (W4.1)

**FY 2003:**

Standard Test Procedure and Computer Modeling Method To Determine The Condensation Resistance of Fenestration Products (ASTM STANDARD)

Measured Emissivities of selected Metallic samples

NFRC 100-Part II (Non-Residential Products)

Flow Chart for NFRC 100

NFRC Glossary

Thermal Properties for CO<sub>2</sub> and N<sub>2</sub>

**FY 2004:**

Standard Test Procedure and Computer Modeling Method To Determine The Condensation Resistance of Fenestration Products (ASTM STANDARD)

NFRC STANDARD BALLOT: NFRC 101:2004 Procedure for Determining Thermo-Physical Properties of Materials For Use in NFRC-Approved Software Programs

NFRC STANDARD DEVELOPMENT: Outline for the Certification Section (D. Curcija)

ASTM STANDRAD DEVELOPMENT: Standard Test Procedure and Computer Modeling Method To Determine The Condensation Resistance of Fenestration Products (D. Curcija)

NFRC STANDARD DEVELOPMENT: NFRC Approved Form For The Submittal of a Request For Thermo-Physical Property Determination and Publication In NFRC Database (D. Curcija)

NFRC Approved Form For The Submittal of Challenge Request (D. Curcija)

NFRC STANDARD BALLOT: NFRC 101V: Verification Program for Thermo-physical Property Data (D. Curcija)

NFRC STANDARD BALLOT: NFRC 200: Non-Residential Section. (D. Curcija)

NFRC STANDARD BALLOT: NFRC 100: Non-Residential Section. (D. Curcija)

NFRC PROCEDURE DEVELOPMENT: NFRC Component Based Non-Residential Fenestration PCP

NFRC PROCEDURE DEVELOPMENT: Flow Chart of NFRC Non-Residential Process (B. Shah, D. Curcija)

NFRC PRESENTATION: NFRC Non-Residential Label Certificate Proposal (D. Curcija)

NFRC REPORT: Important Issues with the Non-Residential Component Modeling Approach (CMA) Procedure (D. Curcija)

NFRC PROCEDURE DEVELOPMENT: Label Certificate Proposals (D. Curcija)

- NFRC Non-Res Label Certificate Project Information
- NFRC Non-Res Label Certificate for Project
- NFRC Non-Res Label Certificate for Product
- NFRC Non-Res Label Certificate for Framing
- NFRC Non-Res Label Certificate for Glazing

## **ASHRAE:**

### **FY 2000:**

ASHRAE HANDBOOK OF FUNDAMENTALS: Chapter 29: Fenestration. Modifications and new layout (D. Curcija)

ASHRAE STANDARDS: SPC142P continuing work and development and communication between ISO TC163/WG2.

### **FY 2001:**

ASHRAE HANDBOOK OF FUNDAMENTALS: Chapter 30: Fenestration. Published version IP and SI (D. Curcija)

**FY 2004:**

ASHRAE HANDBOOK OF FUNDAMENTALS: Chapter 31: Fenestration. IP and SI. (D. Curcija)

ASHRAE ONE PAGER RFP: Develop Convective Heat Transfer Coefficients for Indoor and Outdoor Surfaces of Fenestration Systems (D. Curcija)

**COMMON / DOE:**

**FY 2001:**

Update on Umass Research Work and Priorities - Memo to Sam

Role and importance of fenestration computer modeling tools in the future DOE efforts

Environmental Boxes for the IR Laboratory - Wish-List

Research Work at the University of Massachusetts - Presentation for NFRC

Conference Paper - Improving Information Technology to Maximize Fenestration Energy Efficiency

Presentation for paper "Improving Information Technology to Maximize Fenestration Energy Efficiency" (Thermal 8 meeting, Clearwater, FL)

**FY 2002:**

Position Paper: Current Simplifications in Fenestration Computer Models

"SOLAR ABSORPTION IN THICK AND MULTILAYERED GLAZINGS". WREC Conference

**FY 2003:**

Position Paper: Statement of the problem of numerical modeling of steady-state conditions in laboratory test chamber (LBL IR box)

Technical Report: Use numerical modeling for estimation and improvement test method of measuring the steady thermal transmittance of fenestration systems

Position Paper: OUTLINE OF RESEARCH WORK FOR THE DEVELOPMENT AND ASSESMENT OF INNOVATIVE IGU DESIGNS (WITH IMPROVED THERMAL INDICES)

White Paper: Outline of the research plan for the development of new generation of testing standards and improving modeling techniques using "Virtual Thermal Testing Facility - ViTTeF" Concep

**FY 2004:**

REPORT: Fenestration Glossary and Terminology (D. Curcija)

TECHNICAL NOTE: Analysis of Applicability of Trade-off Equations in Building Energy Codes and EnergyStar™ Criteria (D. Curcija)

ASHRAE PAPER: Two-Dimensional Conduction and CFD Simulations of Heat Transfer in Horizontal Window Frame Cavities (A. Gustavsen, C. Kohler, D. Arasteh, D. Curcija)