NRC·CNRC
Institute for Research in Construction

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construction innovation

NRC-IRC and CMHC lead project to evaluate the effectiveness of the window/wall interface in managing rainwater

One of the most vulnerable points in the building assembly with respect to water tightness is the window opening (see photos below). Given the many different types of windows and related components, there are a number of different approaches to their installation. But which methods ensure water tightness at this critical location? And which installation measures are most likely to ensure their optimal long-term performance?

Results from a collaborative research project (see sidebar for partners) to evaluate the effectiveness of various window/wall construction details in managing rainwater over the life of the wall assembly are discussed below.

Researchers assessed the ability of such details to mitigate rainwater penetration into the wall assembly by subjecting pairs of similar-sized windows with varied interface details to simulated wind-driven rain (see figures p. 7). Each pair was tested under a range of climate loads likely to occur over a 30-year period, and under the loads used in standard water penetration tests.

Premature deterioration of sheathing board and wood studs adjacent to a flanged window.

Deterioration is most pronounced around the lower portion of the window where water has infiltrated behind the sheathing membrane at the window opening, leading to both staining from mould growth and wood rot of the sheathing board.

The effects of water leakage around windows

Project partners

Canada Mortgage and Housing Corporation (CMHC)
Public Works and Government Services Canada
Building Diagnostic Technologies Inc.
DuPont Weatherisation Systems
NRC Institute for Research in Construction

Highlights

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Based on expert advice on window installation practice in Canada, four different pairs of wall/window interface details were selected for examination. These included combinations of both boxed and flanged vinyl windows installed with hardboard siding in either a rainscreen or non-rainscreen design. Variations in the installation details included:

- drip-cap flashing
- self-adhered membrane flashing to seal joints between components
- redundant sealant joints to retard water entry
- shims on which to install windows.

Summary of selected results

The vulnerability of windows to water entry is in part related to the complexity of the installation details and process, and to the competing needs of ensuring proper lapping of the different components and of providing speedy installation. The choice of components and the sequence in which they are installed both play an important role in

Continued on page 7

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CD-ROM Versions of 2005 National Construction Codes

The CD-ROM versions of the 2005 National Building Code, the 2005 National Fire Code and the 2005 National Plumbing Code will be released on **August 31, 2006**. They will include supplementary information to facilitate the use of the "objective-based" format, namely **intent statements**, which explain the specific intent of the Code provisions, and **application statements**, which describe what the provisions apply to.

The intent and application statements will also be published separately on the following CD-ROMs as a complement to the printed versions of the Codes:

- User's Guide – NBC 2005, Intent and Application Statements
- User's Guide – NFC 2005, Intent and Application Statements
- User's Guide – NPC 2005, Intent and Application Statements

To purchase the CD-ROM versions of the 2005 National Construction Codes and related User's Guides, please visit NRC's Virtual Store at www.nrc.gc.ca/virtualstore.

Introducing the User's Guide – NBC 2005 Structural Commentaries *(Part 4 of Division B)*

ORDER NOW!

This new User's Guide is intended to help Code users understand and apply the design requirements provided in Part 4 of Division B of the National Building Code of Canada 2005. The Structural Commentaries contain valuable background information and, in some cases, suggested approaches to certain design questions. The Guide deals with the following issues: **limit states design, structural integrity, structural integrity of firewalls, deflections and vibration criteria for serviceability and fatigue limit states, effects of deformations in building components, tributary area, snow loads, rain loads, wind load and effects, design for seismic effects, foundations, and structural evaluation and upgrading of existing buildings.**

The User's Guide – NBC 2005, Structural Commentaries (Part 4 of Division B) is available in a practical soft-cover book for $94.

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New CCMC Evaluation Reports

Company	Product Name	CCMC #	Description
Prolink North America Inc.	Photoluminescent Exit Signs '"SN'" Series	13220R	The exit signs consist of red opaque letters that are silk-screened on a PVC photoluminescent background, which emits light through the absorption of ambient illumination.
BBA Fiberweb A Division of the BBA Group	Surround HouseWrap	13230R	A 100% polypropylene, spun-bonded olefin fabric coated with a microporous copolymer film designed as a sheathing membrane to resist the passage of water but at the same time permit the passage of water vapour. The roll material is applied over the exterior sheathing material so that it forms a continuous envelope around the entire building.
BBA Fiberweb A Division of the BBA Group	Surround HouseWrap – Air Barrier Material	13231R	This product is the same as 13230R (above); it has the additional function of being the principal plane of airtightness in an air barrier system.

For further information on the performance, usage and limitations of these products, as well as other reports and listings by CCMC, see the Web Registry of Product Evaluations located at **http://irc.nrc-cnrc.gc.ca/ccmc/regprodeval_e.shtml**.

Indoor environment

2nd CIE Symposium on Lighting and Health

The second CIE Symposium on Lighting and Health will be held in Ottawa, September 7–8, 2006. It follows on the heels of the recent identification of a new receptor in the human eye that plays a role in regulating circadian rhythms and associated hormone production.

This discovery has stimulated research that explores the effects of light exposure on human health, and has alerted the lighting community to the implications and new directions for lighting design.

The first CIE symposium on Lighting and Health, held in Vienna in 2004, provided a forum for both scientists and lighting practitioners to become acquainted with the scientific findings and issues. This second symposium will provide updates on the scientific progress made in the field, with a stronger emphasis on how this new information might be applied in lighting recommendations and design.

The symposium will feature invited papers and commentaries from leading scientists and practitioners, contributed posters, and round-table discussions.

NRC-IRC and the Commission Internationale de l'Éclairage (CIE) are co-hosting this important international event, with support from major lighting companies. For more information on the program, registration, and location, visit the Web site at http://irc.nrc-cnrc.gc.ca/ie/lighting/health/cie_e.html.

Confirmed topics include:

Light at night—cancer risks of shift work
Dynamic lighting—both in level and colour
Implications for lighting—what do we know?
Non-visual photoreception of light
New implications of luminaires
Effects of dim and bright work environments on retinal/circadian functions
Alzheimer patient care
Measurement implications
Circadian rhythms and other brain functions
Implications for lighting at night
Lighting in nursing homes
Applied lighting for the elderly
Implications for different light sources
The potential for treating sleep disorders
Implications of lighting for health vs well-being
Ultraviolet benefits and risks—the evolving debate

A REMINDER:

THE NRC VIRTUAL STORE IS OPEN FOR BUSINESS

You can now order all NRC-IRC publications online, including the National Building Code of Canada and other construction Codes and Guides. The new NRC Virtual Store offers you a fast, convenient and secure way of purchasing your publications. Please visit **www.nrc.gc.ca/virtualstore** for more information on how to use the Virtual Store and how to order your publications.

CORRECTION

The City of Ottawa was inadvertently omitted from the list of consortium partners in the article "Crack sealant research: developing effective construction and material specifications," which appeared in *Construction Innovation*, March 2006.

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Fire researchers begin international project on fire-detection technologies in tunnels

With more people pouring in and out of cities around the world each day, traffic tunnels are increasingly used. This has resulted in an increase in the incidence of fatal fires in road tunnels. Thus finding ways to improve fire protection in this type of environment is becoming a new imperative.

NRC-IRC's Fire Research program is involved in a two-year international research project with the Fire Protection Research Foundation to investigate currently available fire-detection technologies suitable for protecting tunnels. The project will provide information for use in the development of performance criteria, guidelines and specifications for tunnel fire-detection systems.

For their contribution, NRC-IRC researchers will conduct fire tests in their new tunnel facility (see *Construction Innovation*, March 2005) to evaluate the performance of five different types of existing fire-detection technologies. These technologies include both traditional and newer options, such as long-distance fibre-optic temperature sensing and closed circuit television imaging (CCTV). They will also use computational fluid dynamics models to investigate the impact of various tunnel fire scenarios on the performance of fire-detection systems. These scenarios include typical tunnel fire incidents, changes in tunnel ventilation conditions, and different tunnel geometries.

Full-scale fire test conducted by NRC-IRC researchers in a Montreal road tunnel

On a larger scale, the NRC-IRC researchers will also work with project partners to conduct full-scale fire tests in an operating road tunnel in Montreal and assist in a one-year investigation into the performance of fire-detection systems in the Lincoln and Holland tunnels in New York City.

The researchers expect that this project will provide a better understanding of fire-detection systems, improve the application of these systems, and enhance fire protection for tunnels. Although this research is being conducted on road tunnels, the findings should apply to other tunnels as well, such as those used in subway systems.

If you are interested in joining this project or have questions about it, contact Dr. Zhigang Liu at (613) 990-5075, fax (613) 954-0483, or e-mail zhigang.liu@nrc-cnrc.gc.ca.

Currently there are 26 partners involved in the project, including research organizations and universities from Canada, the U.S. and Switzerland; the Quebec, Ontario and B.C. ministries of transportation; the Port Authority of New York and New Jersey; manufacturers of fire-detection systems, as well as several international consulting firms, standards writing agencies and fire departments.

EU to study safety and security of traffic tunnels

As part of the European Union's (EU) efforts to improve safety and security in traffic tunnels, the L-surf (Large Scale Underground Research Facility) design study was launched. Recent events, such as tunnel fires and terror attacks in subways, have highlighted the need for a European-wide initiative to create a facility where the critical issues can be addressed.

The design study will determine the layout of the facility and the measuring techniques; define the research needs; find ways of integrating existing expertise and facilities; and identify means of raising funds for the construction and operation of such a facility.

For more details on the L-surf study, go to www.L-surf.org.

Multi-year project simulates fires in a residential basement

NRC-IRC researchers are conducting a multi-year project on the fire performance of houses (see *Construction Innovation*, September 2003). One of the primary objectives of this research is to determine the impact of new, innovative construction products and systems on the fire safety of single-family dwellings. Two key stages of the project have now been completed.

The result of the first stage is a fuel package that simulates a basement fire with realistic rates of heat-energy release, smoke production and fire growth in the room. The fuel load was derived from a survey conducted by NRC-IRC, which was used to identify the combustible contents of living areas in single-family dwellings. The NRC-IRC researchers designed the fuel package to be easy to assemble, allowing them to use the same fire "challenge" in each test so that the findings can be accurately compared.

One of the primary objectives of this research is to determine the impact on fire safety of new, innovative residential construction products and systems in single-family dwellings.

This fuel package consists of a full-size mock-up of a typical sofa, supplemented with a carefully calculated and specially arranged quantity of lumber (wood cribs), simulating the surrounding combustible items typically found in residential living rooms.

The second key stage of the project involved five full-scale fire experiments with various basement scenarios, which were conducted in the facility built for the project. The experiments investigated the effect of fuel quantity, ventilation and other parameters on fire growth in the basement room where the fire originated and tenability conditions in the upper floors of the house test facility. These baseline experiments were then used to select specific fire scenarios for ongoing experiments with unprotected floor assemblies.

Questions about the fire performance of houses project can be directed to Dr. Joseph Su at (613) 993-9616, fax (613) 954-0483, or e-mail joseph.su@nrc-cnrc.gc.ca.

For more information about this project, go to http://irc.nrc-cnrc.gc.ca/fr/fph/index_e.html.

Mock-up sofa undergoing fire test to determine its burning characteristics

Special Interest Group

Canada Mortgage and Housing Corporation
Canadian Automatic Sprinkler Association
Canadian Wood Council
Cement Association of Canada
Forintek Canada Corp.
North American Insulation Manufacturers Association
Ontario Ministry of Community Safety and Correctional Services/Office of the Fire Marshal
Ontario Ministry of Municipal Affairs and Housing
Wood I-Joist Manufacturers Association

construction *innovation* **Reader Survey**

It's not too late to comment on our newsletter, *Construction Innovation*! To complete our reader survey online, go to http://irc.nrc-cnrc.gc.ca/pubs/survey_e.html.

New apparatus developed for insulation research

Researchers in NRC-IRC's Building Envelope and Structure program have developed new innovative apparatus to evaluate the short- and long-term insulation capacity of vacuum insulation panels (VIPs) for building envelopes. Called a vacuum guarded hot plate, this apparatus meets a growing requirement in the insulation field to characterize vacuum insulation core materials. It is the first of its kind in Canada, and one of only a handful in the world.

Vacuum insulation panels are made with open porous core materials enclosed in an impermeable gas barrier (Figure 1). They are the up and comers in the insulation field, with several successful applications reported in a recently concluded International Energy Agency study of building envelope constructions in Germany and Switzerland. Vacuum insulation panels are up to ten times more thermally efficient than other insulation products with the same thickness due to the absence or reduction of gaseous pressure inside a porous material. They are particularly useful in places where space is at a premium or where energy demand is high, such as the Canadian North.

The long-term serviceability of these panels, however, depends greatly on the thermal conductivity of the core material as a function of internal pore pressure. Usually, researchers measure thermal conductivity using apparatus called the guarded hot plate at ambient pore pressure, but this apparatus requires major adjustments to measure thermal conductivity in a vacuum and at different pressure levels.

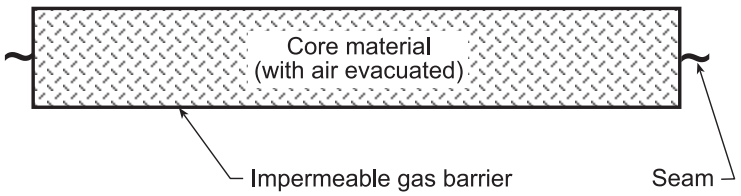


Figure 1
Schematic of key elements of a vacuum insulation panel

To make these adjustments, the NRC-IRC researchers worked with the UK's National Physical Laboratory to find a way to construct the apparatus inside a vacuum chamber. The resulting vacuum guarded hot plate can measure thermal conductivity at prescribed pressure levels close to zero and can establish the functional relationship between the thermal conductivity and internal pore pressure (Figure 2).

This breakthrough provides NRC-IRC with a product development tool that will aid Canadian and other insulation manufacturers in their search for low-cost, local resources to be used as the core materials for vacuum insulation. On the end-use side, it will provide consumers with more information on the performance of these new insulation products, and perhaps ultimately help reduce operating costs in buildings in which vacuum insulation panels have been installed.

Specific questions on VIPs and this new apparatus can be directed to Dr. Phalguni Mukhopadhyaya at (613) 993-9600, fax (613) 998-6802, or e-mail phalguni.mukhopadhyaya@nrc-cnrc.gc.ca.

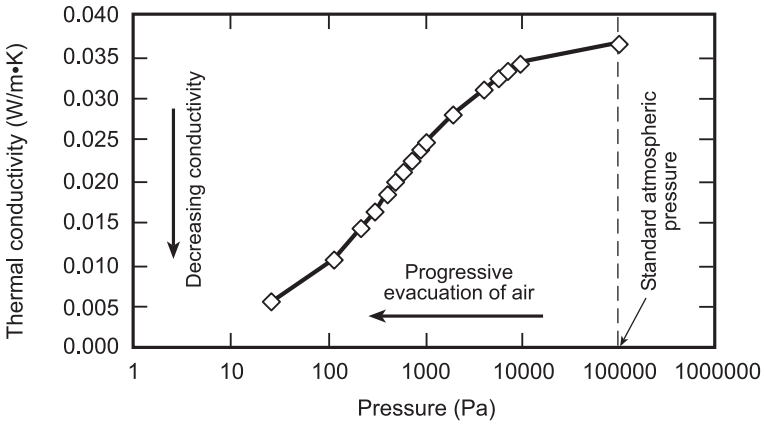


Figure 2
Thermal conductivity as a function of internal pore pressure

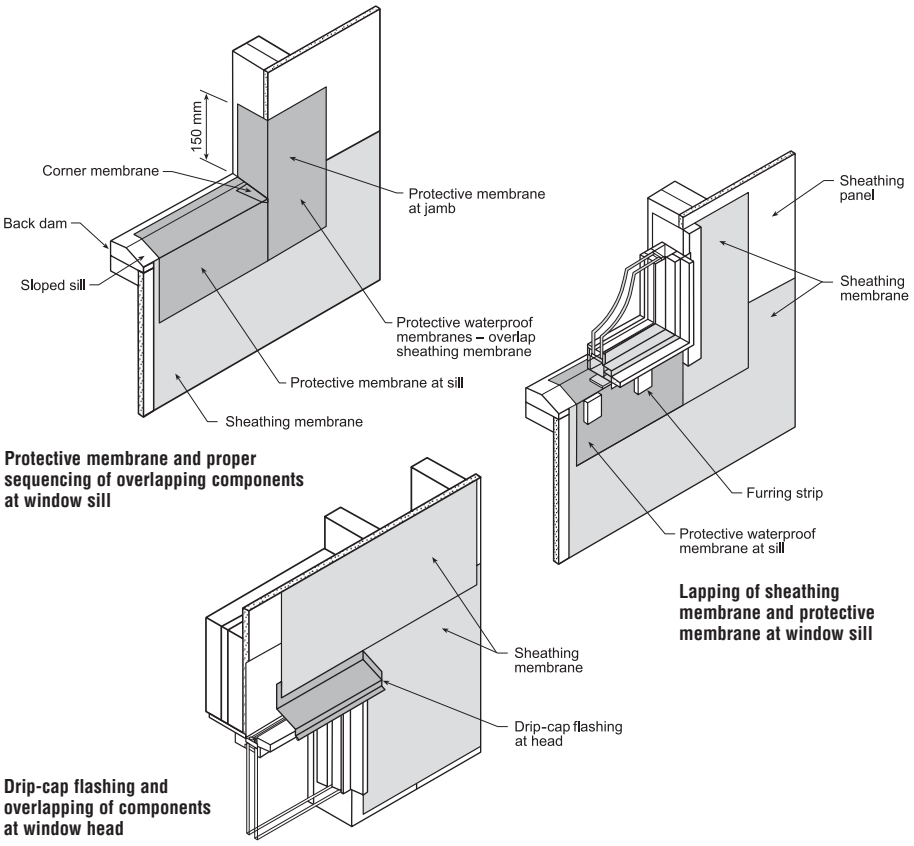
NRC-IRC and CMHC lead project to evaluate the effectiveness of the window/wall interface in managing rainwater

Continued from cover

determining the vulnerability of different wall/window interfaces in managing rainwater.

Some key observations from the project to date are as follows:

- The rough opening is most likely to get wet over its service life. Therefore it should be designed to promote drainage and be properly flashed to ensure water tightness at the sill. Specifically, the rough opening should:
  - incorporate a sloped sill, a back dam, the use of a waterproof component (e.g., a metal or plastic pan or a self-adhered waterproofing membrane) on the sill and at least 150 mm up the side of the jambs (see figures).
  - be carefully integrated with other elements at the wall/window interface (i.e., there should be proper sequencing and shingle lapping with the sheathing membrane, and protective components along the height of the jambs and at the window head).
- Drainage at the window sill should be facilitated by avoiding measures that retard or prevent drainage of incidental water at the sill; e.g., when using a flanged window, place the flange on shims or furring strips thus providing a gap between the flange and the window opening through which water may drain (see photos below).



Window opening showing components and key features that promote drainage and protect sill

Mounting flanged window on furring strips (above), or using shims behind the flange (left), provides the openings necessary for proper drainage.

Photos and figures for this story courtesy of CMHC

Results from this ongoing collaborative study will be incorporated into a best practice guide for window installation for both low-rise wood-frame construction and high-rise residential buildings to be published by CMHC.

To participate as a sponsor or partner, or to obtain more information about this work, please visit the Web site at http://irc.nrc-cnrc.gc.ca/bes/hmpe/rainwater_e.html.

Specific questions can be directed to Dr. Michael Lacasse at (613) 993-9715, fax (613) 954-5984, or e-mail michael.lacasse@nrc-cnrc.gc.ca.

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Sustainable Infrastructure:
Techniques, Tools & Guidelines

Each year, NRC-IRC presents a national seminar to provide construction professionals with practical information. Each seminar focuses on a single topic and reports the results of NRC-IRC research, as well as information from other organizations in North America and abroad.

Establishing Canada's system of roads, bridges, water mains, wastewater systems and public buildings took many years and a lot of money to complete. But maintaining these infrastructure systems is also a big job. Just meeting the demands of this aging infrastructure system takes so much time that there's little left to keep up with latest developments in the field of infrastructure management.

To make things a little easier, NRC-IRC is bringing information on the latest research on sustainable infrastructure to practitioners this fall and winter. As part of the Institute's annual Building Science Insight (BSI) seminar series, leading NRC-IRC infrastructure researchers will visit select locations across Canada (see sidebar) to present and discuss current techniques, tools and guidelines for maintaining and sustaining Canada's infrastructure systems.

Speakers at this year's seminar series will cover recent technological advances and innovations in condition assessment, deterioration modelling, service-life prediction, risk analysis, asset management and decision-support tools related to infrastructure. In addition, they will outline the relationship between this research and the InfraGuide (National Guide to Sustainable Municipal Infrastructure) Best Practices publications.

The list of speakers includes researchers Dr. Dana Vanier, Dr. Zoubir Lounis, Dr. Yehuda Kleiner, Dr. Balvant Rajani and Dr. Rehan Sadiq; and from the InfraGuide, Mr. Sylvain Boudreau. These speakers represent a wide range of disciplines, including water distribution and transmission systems, pavement, highway bridges, and integrated infrastructure management.

The speakers will also hold roundtable discussions on topical issues related to delivering, operating and maintaining sustainable infrastructure systems, such as limited financial resources, climate change, increasing environmental responsibility and competing community needs.

Registration is $329, plus applicable taxes. For more information, visit www.bsi.gc.ca.

Sustainable Infrastructure
Techniques, Tools & Guidelines

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- *Yellowknife, November 10*
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- *Toronto, November 28*
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Benefits to Canadian organizations to be gained from membership in CIB

As a national and international gateway for construction technology, NRC-IRC must maintain its reputation as a Canadian leader in construction research and development, while also remaining current on innovation and innovative thinking in other countries. One of the organizations that has proven to be a particularly good conduit for this global information is the International Council for Research and Innovation in Building and Construction (CIB).

"Membership in CIB allows NRC-IRC researchers to network with international research organizations and others in the construction industry across a very wide spectrum," says NRC vice president (and former NRC-IRC director general) Dr. Sherif Barakat. "It has sparked research collaborations and cooperation in many working commissions and task groups, and resulted in benefits through participation in CIB conferences, symposia and seminars."

Established in 1953, CIB encourages international cooperation and information exchange between research institutes in the building and construction sector. It is involved in all aspects of building and construction—scientific, technical, economic and social—and supports improvements in the building process and the performance of the built environment.

CIB membership currently includes more than 5,000 construction experts from approximately 500 member organizations worldwide. These member organizations represent some 70 countries and include most of the major national laboratories and leading universities involved in research in building and construction around the world. NRC-IRC has been a member since the organization began and has produced two past presidents, George Seaden (1989-1992) and Dr. Sherif Barakat (2001-2004).

CIB is currently in the midst of an active campaign to renew its membership, hoping to attract fresh ideas and perspectives from new individual and institutional members. As a longstanding member of CIB, the NRC-IRC understands the merits of joining CIB. Large construction firms, R&D organizations and universities in particular stand to gain an opportunity to influence and benefit from construction-related research and development on an international scale.

For more information, contact CIB General Secretariat at secretariat@cibworld.nl or visit www.cibworld.nl.

Simlog's excavator simulator receives 2005 CCA Innovation Award

Each year, the Canadian Construction Association (CCA) recognizes the outstanding contributions of individuals, companies and organizations to the Canadian construction industry with a series of national awards. The Excellence in Innovation Award acknowledges an ingenious solution to a problem in the construction industry. In 2005, the Innovation Award jury committee was particularly impressed by Simlog's efforts to deliver a product that improves safety, productivity and profitability—while reducing environmental impact—throughout a wide spectrum of the construction industry.

Simlog, a Montreal company, has developed the world's first PC-based personal simulator for heavy equipment training to feature realistic "virtual digging." The simulator provides a solution to the problem of how people operating heavy equipment on construction sites learn to do their jobs. It used to be that they needed expensive "seat time" on real equipment, which meant removing the equipment from production, and which also increased the potential for accidents due to operator inexperience.

Personal simulator for heavy equipment training features realistic "virtual digging."

The company spent more than two years developing the "dynamic terrain modelling" technology behind the simulator, which replicates realistic interaction between bucket and soil. This innovation harnesses the convenience, computing power and graphics capability of modern PC-based technology to put an operator at the controls of a virtual hydraulic excavator on a typical construction site. The operator then uses the training tool in hundreds of training exercises under realistic, safe and cost-effective conditions.

As an organization that encourages and promotes innovation in the construction industry, NRC-IRC joins the CCA in honouring Simlog for their achievement with the personal simulator: congratulations Simlog!

Upcoming events

AUGUST

27-30
8th Annual Water Distribution Systems Analysis Symposium. Cincinnati, OH. http://www.eng.uc.edu/wdsa2006/

SEPTEMBER

7-8
2nd CIE Symposium on Lighting and Health. Ottawa. http://irc.nrc-cnrc.gc.ca/ie/lighting/health/cie_e.html

10-12
Water Security Congress. Washington, DC. http://www.awwa.org/conferences/congress/

24-27
Western Canada Section American Water Works Association Annual Conference. Winnipeg. http://www.wcsawwa.net/

OCTOBER

2-5
Plastics Pipes XIII. Washington, DC. http://www.plasticspipes.com/html_email/callmail.html

19-20
Contamination Monitoring Technologies. Calgary. http://www.awwa.org/education/seminars/index.cfm?SemID=47

19-21
ASCE Civil Engineering Conference 2006. Chicago, IL. http://content.asce.org/conferences/asce2006/

22-23
Standing Committee on Structural Design. Vancouver. Contact: Cathy Taraschuk at (613) 993-0049

NOVEMBER

5-9
Water Quality Technology Conference & Exposition. Denver, CO. http://www.awwa.org/conferences/wqtc/?CFID=2878735&CFTOKEN=46404025

6-7
Standing Committee on Building and Plumbing Services. Montreal. Contact: Raman Chauhan at (613) 993-9633

14-15
Construct Alberta Show. Also: Homebuilder and Renovator Show. Calgary. www.constructalberta.com

14-15
Standing Committee on Hazardous Materials and Activities. Victoria. Contact: Philip Rizcallah at (613) 993-4064

16-17
Standing Committee on Use and Egress. Victoria. Contact: Philip Rizcallah at (613) 993-4064

22
Expo-Contech. Montreal. http://www.contech.qc.ca/eng/index_batiment.php

29-Dec. 1
Construct Canada. Also: Homebuilder & Renovator Expo, Kitchen & Bath, PM Expo. Toronto. www.constructcanada.com

DECEMBER

3-6
Society for Risk Analysis: SRA 2006 Annual Meeting. Baltimore, MD. http://www.sra.org/events_2006_meeting.php

2007 JANUARY

29-31
Fire and Materials 2007. San Francisco, CA. http://dspace.dial.pipex.com/intercomm/html/events/fm07a.htm

This calendar does not include all events scheduled to take place during this time frame. For a more complete listing, see the Web version of "Upcoming events" at http://irc.nrc-cnrc.gc.ca/events_e.html

construction innovation

http://irc.nrc-cnrc.gc.ca

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