ForIntek Canada Corp.

Simple Progress Report No. 43

Fire Safety Design for Non-residential Buildings

Project Leader:	Jim Mehaffey, Fire Research Group, Ottawa Laboratory		
Program Area:	Building Systems	**Start Date:**	April 1, 1999
Program Goal:	BF	**Completion Date:**	March 31, 2001
Project No.:	2400	**Date of Last Update:**	March 22, 2001
Project Liaison(s):	Rod McPhee, Canadian Wood Council		

Long Term Goal / Strategy

Optimise the use of wood to meet end-user expectations by developing tools to aid in the design and assessment of fire-safe non-residential wood-frame buildings.

Key Objective

- Develop fire-safety design tools that will allow the wood products industry to expand its market share of non-residential buildings.

Key Actions and Deliverables

Deliverable	Expected Delivery Date
NSERC Industrial Research Chair in wood and fire at Carleton University	Completed
Multidisciplinary research program addressing issues limiting construction of non-residential buildings and identification of the first fire-research projects for that program	Completed

Background

Building codes set fire-protection requirements in order to ensure an adequate level of safety in buildings. The current Canadian requirements are prescriptive, so there is no clear statement of what performance is acceptable and no guarantee that all buildings are constructed to the same level of safety. In fact, for non-residential occupancies, current regulations often demand a higher level of fire safety be built into wood-frame buildings than into their concrete or steel counterparts. The extra costs associated with providing this higher level of safety often make wood-frame buildings less economical to build. Even when the building code and economics are not impediments, concerns about fire safety often cause designers, owners or insurers to avoid the use of wood in non-residential applications.

Building codes around the world are being revised to include performance-based fire-safety requirements. Rather than simply complying with prescriptive requirements intended to address fire safety in generic buildings, the designer will have the option of tailoring fire-safety systems to address the actual fire hazards in a building. By judging the acceptance of building design solely on the basis of performance, performance-based fire-safety requirements are expected to eliminate the inequitable treatment of wood products present in prescriptive building codes and thereby improve market access for wood products. The adoption of performance-based codes will also encourage more flexible and cost-effective design.

In order to be prepared for the introduction of performance-based codes, architects, engineers and building code officials around the world have pointed out the need for engineering tools to assess the fire performance of buildings. If the wood industry has the tools in place, the move to performance-based design could result in increased market share for wood building products. It would be particularly advantageous to develop fire-safety design tools for the non-residential wood-frame buildings governed by Part 3 of the National Building Code of Canada (NBCC) as these buildings must be structurally engineered.

In countries where building codes have parallel prescriptive and performance-based requirements, it has been found that the lack of educational programs addressing fire-safety-engineering principles has been a serious impediment to the use and acceptance of performance-based fire-safety design. In other words, the potential benefits to the wood industry may not be realised as few practitioners and building code officials are conversant with the principles of performance-based design. It is, therefore, important that the wood industry encourage engineers to learn more about this subject.

This project was initiated in 1999/2000 to develop fire-safety design tools for non-residential wood-frame buildings and to foster development and delivery of educational modules to train students and practitioners in performance-based fire-safety design. The proposed mechanism for achieving these goals was to establish an Industrial Research Chair at Carleton University.

Partners

- Carleton University
- Canadian Wood Council
- Canadian Forest Service

Rationale and Potential Impact

As mentioned in the Background section, concerns about fire safety often cause designers, owners or insurers to avoid the use of wood in non-residential applications even when building codes permit wood. The adoption of performance-based codes is expected to eliminate the biases against wood that are inherent in prescriptive codes. However, in order to take full advantage of the introduction of performance-based codes, it is necessary to develop design tools to aid in the design and assessment of fire-safe non-residential wood-frame buildings.

In order to provide a solution to fill this need, Forintek has led an effort to establish an NSERC Industrial Research Chair in *Wood and Fire Safety* at Carleton University. The proposed candidate for the Chair has been undertaking research directed at developing tools to aid in the design and assessment of fire-safe non-residential buildings of non-combustible construction.

In addition to establishment of the Industrial Research Chair, Forintek has taken steps to develop a comprehensive multidisciplinary research program addressing structural, acoustical, economic, fire and durability issues limiting construction of non-residential buildings.

Progress During 1999-2000

NSERC Industrial Research Chair

Even before the initiation of this project in April 1999, Forintek had begun to take steps to establish a Natural Sciences and Engineering Research Council (NSERC) Industrial Research Chair in *Wood and Fire Safety* at Carleton University. The Department of Civil and Environmental Engineering at Carleton University had been approached with the idea in late 1998. The Department expressed interest and informed the Dean of Engineering and the President of the University who also expressed interest.

A candidate with a good international reputation was approached and quickly agreed to pursue the Chair in co-operation with Forintek. The candidate, a research scientist at the National Research Council Canada (NRC), had been leading a research team developing tools to aid in the design and assessment of fire-safe non-residential buildings of non-combustible construction.

As writing the research proposal to NSERC was proving to be very time-consuming, a consultant familiar with wood industry issues, was retained to draft the proposal in consultation with Forintek, the candidate and the University. A first draft was nearing completion in the spring of 1999.

During the summer of 1999, an informal meeting was held with NSERC to discuss the draft proposal. A number of revisions were recommended by NSERC in order to strengthen it. The research component of the proposal was completely reworked by Forintek scientists and the candidate during the fall in order to respond to the NSERC comments. The financial component of the proposal, ensuring significant leveraging of Forintek's investment, was finalised during the winter of 1999-2000.

The Research Proposal

The focus of the proposed research was the development of engineering tools that could be used by fire protection engineers to design fire-safe wood-frame buildings in a performance-based code environment. This would entail conducting research into fire growth, fire behaviour of building materials, smoke movement, occupant response and evacuation, fire detection and suppression system effectiveness, and fire risk analysis. Emphasis was to be given to research that would benefit the wood industry by providing design tools which ensure fair assessment of the impact of wood products in building fires. To this end, it was agreed that a fire risk assessment framework and computer model to evaluate the overall fire safety performance of wood-frame buildings would be developed. The framework would be ideally suited to assess the fire performance of three- or four-storey commercial buildings.

Progress During 2000-2001

NSERC Industrial Research Chair

Carleton University and Forintek finalised the proposal to create an NSERC Industrial Research Chair in Fire Safety Engineering at Carleton University and submitted it to NSERC on June 2. Forintek proposed to provide the wood industry portion of the funding with NSERC covering the balance. Strong letters of support from the Canadian Wood Council and the Canadian Forest Service were attached to the proposal.

On August 15, an NSERC Site-Visit Committee visited Carleton University to learn more about the proposed research program as well as about the university's and the industry's commitments to the Chair. Although the Committee looked favourably on the proposal, it recommended some revisions including increased financial and administrative support from the University. Revisions were made and the revised proposal was submitted to NSERC on August 23.

On September 27, NSERC approved the proposal, subject to the following conditions:

- The candidate is granted tenure from the outset.
- NRC acknowledges that its facilities can be employed as stated in the program of work.
- An agreement on intellectual property is secured among NRC, Forintek and Carleton University.
- Carleton University agrees to offer a Masters degree in Civil Engineering with specialisation in fire safety engineering within 2 years.
- NRC is invited to participate on the Chair's Steering Committee.
- Users (an architect and an engineer) are invited to participate on the Chair's Steering Committee.

By late 2000, Carleton University, NRC and Forintek had agreed to meet all six conditions. On January 15, the Chair was activated and Dr. George Hadjisophocleous, formerly of NRC, was appointed Professor of Fire Safety Engineering at Carleton University. NSERC made an official announcement of the creation of the Chair on March 1. The announcement received favourable coverage by Ottawa radio and television stations. Funding for the Chair will commence April 1, 2001.

The Research Proposal

The proposed research entails development of computer models for evaluating and quantifying the overall risk from fires in buildings with initial emphasis on four-storey wood-frame commercial buildings. A system model will be developed whereby the building will be treated as a system, complete with its fire protection options,

building characteristics, occupants and functions. This approach will enable comparison of the costs and benefits of different design options available to designers and assist them in selecting safe and cost effective designs. With risk analysis the impacts of various possible fire scenarios on both life safety and property protection may be evaluated.

A comprehensive system model to represent the interactions of fire growth and spread, fire detection and warning, fire suppression and human behaviour will be developed together with subsidiary computer models dealing with the various aspects of the fire problem. The proposed model will be able to handle different types of building characteristics and functions, occupant characteristics, active and passive fire protection systems, construction materials, as well as the variety of fire scenarios that may be encountered in buildings. The subsidiary models will calculate the consequence of fire incidents both in terms of human losses and property damages and the frequency of these incidents.

Conclusion

With the approval of the Chair and the completion of the research program proposal, the objectives of this project have been met. It will not be part of the 2001/02 CFS program of work.