FPInnovations
FORINTEK

Simple Progress Report
General Revenue
March 2008

Characterization of Fires in Residential Buildings

Project Leader:	Jim Mehaffey, Building Systems Department, Fire Research Group, Ottawa Laboratory		
Program Area:	Building Systems	**Start Date:**	April 2005
Program Goal:	BF	**Completion Date:**	March 2010
Project No.:	4918	**Date of Last Update:**	March 27, 2008
Project Liaison(s):	Rodney McPhee, Canadian Wood Council; Claude Lamothe, AbitibiBowater; Bill Love, Tembec		

Long Term Goals / Strategies

- Focus on members' customers and product end-use performance by conducting empirical fire tests and numerical simulations which quantify fires originating within the living spaces of Canadian residential structures, in order to characterize typical fires in those structures and thereby identify appropriate design-fire scenarios and design fires for Canadian building code purposes.
- Increase value of research through alliances with the National Research Council of Canada (NRC) and the other government and industry partners in this collaborative project.

Key Objectives

- Participate in a collaborative NRC-led research project involving fire experiments that quantify fires originating in living spaces within multi-family dwellings and numerical simulations of various fire scenarios that determine the characteristics of fires in the living spaces of residential buildings.

Key Actions and Deliverables

Deliverables	Expected Delivery Date Completed Item ✓
A collaborative research agreement with NRC and CWC for the first phase of a research program to be carried out primarily by researchers at NRC to characterize fires in the living spaces of residential buildings in Canada	April 2005 ✓
Reports and electronic data files describing the results of fire experiments and numerical simulations that quantify fires originating in the living spaces within multi-family dwellings	March 2009
Characterization of design-fire scenarios and design fires in living spaces of multi-family dwellings	September 2010

Status

This Forintek project was initiated in April 2005 in order facilitate Forintek's participation in a collaborative research project which NRC proposed to carry out in order to respond to explicit directions from the Canadian Commission on Building and Fire Codes (CCBFC). In part, the research is intended to provide information to assist with implementation of objective-based building codes in Canada. It will also assist the CCBFC to establish appropriate fire safety objectives for future editions of the National Building Code of Canada (NBCC). Finally, this research project complements research already being carried out by researchers at NRC investigating fire safety in Canadian housing. This is a collaborative research project where, as a member of the steering committee, Forintek will have ample opportunity to provide input into the research being undertaken, to vote on all decisions made regarding the direction of the research and on all reports describing the results of the research and the conclusions reached.

In mid-June 2005, officials of NRC disclosed that that they were having great difficulty in attracting other partners for this project, and particularly partners representing manufacturers of home furnishings and governmental agencies responsible for regulating the performance of home furnishings. If the research was to achieve the objectives set for it by the Canadian Commission on Building and Fire Codes when they directed NRC to undertake the study, the participation of those agencies and industries would be essential. Therefore, the officials at NRC concluded that the research could not commence until 2006/2007.

The first meeting of the consortium for the NRC Collaborative Project on Characterization of Fires in Multi-Suite Residential Dwellings (CFRD) was held on October 27, 2006. Current members of the consortium include: Canadian Concrete Masonry Producers Association, Masonry Worx, La Régie du Bâtiment du Québec, Forintek Canada Corp., Canadian Automatic Sprinkler Association, Canadian Wood Council, NRC Fire Research Program, and NRC Canadian Codes Centre. NRC is attempting to get the Gypsum Association and an association representing the home furnishing industry to join the consortium.

The current funding for the project is $555,000, of which $105,000 is from NRC. The study was originally going to focus on fires in kitchens, living rooms and bedrooms. However, CCBFC requested that "secondary residential suites" and "residential care facilities" be included. NRC will begin a literature review of fire models, fire loads and fire test data; a survey of floor plans; and a survey of fire loads for all five room-types.

Partners

Canadian Wood Council
National Research Council Canada

Rationale and Potential Impact

As described in a number of published papers and presentations by fire researchers at Forintek, Canadian fire statistics demonstrate that about 40% of the total number of fires and 74% of the total number of fire fatalities in Canada in 2000 occurred in residential buildings. Statistics such as these clearly demonstrate the need for engineered fire-safety-design solutions for residential buildings in Canada, and since these structures are primarily of wood-frame construction, the importance of Forintek being involved in this collaborative project, on behalf of the wood industry, is obvious. While the initial phase of the research will focus primarily on fires originating within the living spaces of multi-family wood-frame structures, the results will also be applicable to single-family dwellings.

An analysis of fire loss statistics by Forintek indicates that more than 70% of all fires in residential buildings commence with the ignition of one or more items of furnishing and/or contents within the living spaces of the buildings, and that less than 10% commence with the ignition of the building's structural members. However, the severity of the fires within the living spaces has a significant impact on the performance of those structural members and on the amount of protection that must be provided to them. Therefore, it is of critical importance that the threats to the major structural components of residential structures be quantified in order for the CCBFC to establish appropriate fire safety objectives for the structural elements in those assemblies

Proposed Approach

Late in 2006-2007 NRC established a collaborative research agreement with Forintek (and other partners) to commence the first phase of a research program to be carried out primarily by researchers at NRC to characterize fires in the living spaces of residential buildings in Canada. During 2007-2008, with guidance from its partners, NRC was to commence with empirical fire tests and numerical simulations to quantify fires originating in residential structures and to thereby identify appropriate design fires and design-fire scenarios for Canadian building code purposes.

Work Completed this Fiscal Year

A Consortium of twelve interested parties has been assembled by NRC to participate in planning (and funding) of this NRC Collaborative Project on Characterization of Fires in Multi-suite Residential Dwellings (CFMRD). The Consortium members now include: FPInnovations – Forintek Division, Canadian Wood Council, Canadian Concrete Masonry Producers Association, Masonry Worx, La Régie du Bâtiment du Québec, Gypsum Association, Canadian Automatic Sprinkler Association, Ontario Ministry of Municipal Affairs and Housing, City of Calgary, Canadian Council of Furniture Manufacturers, NRC Fire Research Program, and NRC Canadian Codes Centre. Two other organisations have been invited to attend meetings as observers: Carleton University and Health Canada (Flammability Section).

The first meeting of the Consortium was held on October 30, 2006 with L.R. Richardson, J.R. Mehaffey and S. Craft in attendance. Although the study was originally going to focus on fires in kitchens, living rooms and bedrooms, the CCBFC requested that "secondary residential suites" and "residential care facilities" also be included. During the meeting it was decided that NRC would begin a literature review of fire models, fire loads and fire test data; a survey of floor plans; and a survey of fire loads for all five room-types.

The second meeting of the Consortium was held on June 19, 2007 with L.R. Richardson, J.R. Mehaffey and S. Craft in attendance. The following summarises the discussion during the meeting:

- NRC scientists reported that they had examined floor plans for 60 multi-family dwelling units and photographs of 410 furnished rooms in those dwelling units that had been posted on the internet by realtors. This internet search was to continue in order to build up a database of information about the sizes, layouts and fuel loads in dwellings units. A summary of the findings to date was provided. NRC also provided a brief summary of a survey of four "residential care facilities" in Montreal.
- It was agreed that, before commencing full-scale fire tests for this project, a series of "medium-scale" fire tests would be conducted on fuel packages in 16 m^2 room. The room would be lined with gypsum board, and have a door and a window in one wall. The ventilation conditions would be varied from test to test by opening or closing the door and/or window. NRC agreed to purchase enough new, identical (manufacturer, model and size) mattresses and bed-clothing to carry out the tests. The rate of heat release, calorific values and gas yields would be measured as a function of ventilation conditions.
- Computer models would be used to predict the burning behaviour for other compartment and ventilation scenarios.

The third meeting of the Consortium was held on March 25, 2008 with J.R. Mehaffey in attendance. The following summarises the discussion during the meeting:

- NRC has completed the survey of suites in multi-family residential buildings. In addition to fire load data, the survey provided information on typical layouts of suites as well as typical window and door sizes. NRC is preparing an interim report summarizing its findings. When completed, the report will be posted on the members' website.
- A medium-scale test facility has been constructed and instrumented at the National Fire Laboratory in Almonte, Ontario. The facility is a room 3.8 m wide, 4.2 m deep and 2.4 m in height with a window 1.5 m by 1.5 m in an end wall. This room represents the mean area (16 m^2) of living rooms and master bedrooms as determined in NRC's survey. The window is also of typical size.
- A hood outside the room collects the products of combustion and measures the rate of heat release of a fire in the room. Preliminary propane burner fires in the room with a variety of window sizes have shown the hood apparatus can accurately measure the rate of heat release up to 4.5 MW.
- As a demonstration, a mock-up of a sofa was burned in the room during the meeting. Data on the rates of heat release and toxic gas generation will be forwarded to members in a few weeks.
- Several computer simulations of sofa fires in the room have been conducted using the computer model Fire Dynamics Simulator (FDS) to evaluate the effects of varying the location of the sofa, and the locations and sizes of ventilation openings. These simulations have provided guidance in placing

instrumentation in the room. A report describing these simulations will be posted on the members' website in the late spring.

- The next step is for NRC to purchase 4 types of upholstered furniture and 4 types of mattress to burn in the room. Based on the performance of these items in the medium-scale facility a candidate piece of upholstered furniture and a candidate mattress will be chosen for subsequent full-scale tests.
- Small-scale (cone calorimeter) tests of the components of the upholstered furniture and mattresses will also be run to assess the burning characteristics of these materials as they burn. These data will be used as input to FDS computer simulations of the upholstered furniture and mattress fires in the medium-scale facility.
- Small-scale (cone calorimeter) tests of all other items typically found in the multi-family residential suites will also be undertaken to develop a material property database for use in subsequent FDS simulations of the planned full-scale tests.

The next meeting of the consortium will be held in November 2008. At that time, decisions will be made about the details of up to 16 full-scale tests that will be run. These tests will involve multi-room scenarios in which a fire is started in a living room or a master bedroom that is completely decked out in typical fashion (as determined by the survey). FDS simulations will then be run of each full-scale test. If the FDS simulations prove to give accurate predictions, numerous simulations can be run to assess the influences of minor or major variations in the fire scenario. The ultimate goal is to devise design fires for use in engineering analyses of fires in multi-family residential suites.

Changes in the original work plan, in particular the decision to run medium-scale tests before full-scale tests, have put this project significantly behind schedule.

Publications

Several reports will be posted on the members' website in the coming months.