University of Waterloo Live Fire Research Facility

E.J. WECKMAN, D.A. JOHNSON and A.B. STRONG
Department of Mechanical Engineering, University of Waterloo
Waterloo, Ontario, Canada N2G 3L1

ABSTRACT

Every year in North America, fire accounts for a significant number of deaths, injuries, and capital losses, as well as the related economic burdens of fire insurance, fire suppression and building fire protection systems. Indirect costs of fire due to emissions to the environment and groundwater contamination are immeasurable. These costs can be reduced through the development of fire-safe products, advancements in detection, suppression and fire fighting methodologies, and the development of innovative equipment for the fire protection and response industries. With this aim, University of Waterloo researchers from the Departments of Mechanical Engineering and Applied Health Sciences, together with the fire service in their region and other municipalities across Canada, have conducted collaborative fire training and research exercises for over a decade. A unique synergy has developed, leading to direct transfer of technology to the broader fire service community; however, it is very difficult to access facilities in which controlled, realistic, large-scale, live-fire research can be conducted. To address this need, a $5.6M, state-of-the-art Live Fire Research Facility is being constructed by the University of Waterloo with shared funding from the Region of Waterloo, the City of Kitchener, the Canadian federal and Ontario provincial governments and industry. The research facility is an integral part of a larger Region of Waterloo Emergency Services Training and Research Complex, situated on a 16 ha. site, minutes from the UW campus.

The major fire research infrastructure at the Facility includes

- a large-scale fire research area with capability for generation and control of ambient winds and ventilation conditions,
- leading edge diagnostics and instrumentation for scenario monitoring, control and data acquisition,
- a large cone calorimeter and ISO room fire test area,
- a small cone calorimeter, smoke density chamber, flame spread and flammability apparatus for testing the fire performance of materials, and
- laboratory facilities for small and medium-scale fire research/analysis and the study of physiological impacts of fire fighting.

The large-scale fire test area is 3,975 ft^2 and 4+ storeys high. It is designed to accommodate a two storey house or other large-scale burn experiment. It consists of an outer enclosure with a moveable, inner steel burn 'house' in which fires can be set. Rooms in the house can be reconfigured, lined with representative materials and furnished as appropriate for a particular test fire scenario. Ambient crosswinds from 0 to

20 mph can be generated by a bank of six, 72 inch diameter fans with a plenum/flow straightening system leading to a 20 ft × 24 ft opening into the main test area. The crosswinds flow around the 'house' (or other fire experiment) and exhaust through a large overhead sectional door at the far end of the enclosure. Also in the main test area are a 2 MW calorimeter and an ISO room fire test area situated adjacent to a 10 ft × 10 ft exhaust hood. A 3,385 ft^2 conventional building is attached to the large-scale test area. It houses the main control room, general support services, a small-scale fire test laboratory and a physiological research lab for researchers from Applied Health Sciences. Full-scale studies of fire behavior in the burn 'house' can be complemented by laboratory studies of the fire performance of materials (heat release rate, smoke generation and ignition, and flame spread characteristics) and the effects of the fire environment on fire fighting personnel.

Experiments in any part of the Facility can be instrumented for velocity, temperature, pressure and species concentration measurements with a variety of fixed and portable systems. Video and infrared visualization, laser/phase Doppler particle anemometry, particle image velocimetry, Fourier transform infrared spectroscopy and gas chromatography/mass spectrometry systems are also available.

Research efforts[1] will focus on the application of basic principles of fire science to areas such as the movement of smoke and heat in full-scale structural fires, fire initiation, heat release rate and spread, flammability and fire performance of materials and components, fire safety, equipment and methodologies for fire detection and suppression and health issues in the fire service. Combined with the existing fire and diagnostics laboratories on the main University of Waterloo campus, this new Facility will allow advancements in fundamental fire research, as well as full-scale investigations with direct application to fire service and fire safety issues, performance-based building codes and occupational health in the fire service.

KEYWORDS: fire research, large-scale fire experiments, cone calorimetry, structural fires, heat release rate, fire behavior, fire performance measurements, wind effects on fires, smoke movement, physiology of fire fighting.

[1] It is envisioned that educational initiatives will be developed in conjunction with research efforts at the Facility. In the short term, these will consist of short courses, seminars, and technology transfer workshops for fire service professionals. In addition, preliminary curricula for new professional development, undergraduate and graduate programs in Fire Safety Engineering at UW have been developed based on an international model curriculum, with additional input from the Ontario Fire Marshal's Office, practicing fire protection and investigative engineers, and various Fire Protection Engineering programs.