RESULTS AND LESSONS LEARNED FROM THE FIRE CODE REFORM CENTRE

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ABSTRACT

The work of the Fire Code Reform Centre's (FCRC) program to introduce a scientific basis and risk assessment methodology and performance assessment into the fire safety requirements of the Building Code of Australia is reviewed. FCRC's approach to transferring research results into code recommendations is discussed and the major FCRC reports are summarized.

INTRODUCTION

In 1989, a Study Group coordinated by the Warren Centre of Advanced Engineering at the University of Sydney was established under the Centre's Fire Safety and Engineering Project[1]. The project and its associated technical papers addressed many aspects of fire safety design and regulatory practices. One of the principal recommendations was that design for fire safety should be an engineering responsibility and not governed by prescriptive regulations. Another recommendation called for the development and validationof risk assessment models for use in identifying cost effective fire safety designs.

In 1989, the Australian government established the Building Regulations Review Task Force (BRRTF) to review the Australian building regulations and standards. That Task Force, commissioned the principle participants of the Warren Centre project to develop a

conceptual alternative to building fire safety. The outcome of this work was the framework for a risk-based approach employing building fire safety performance requirements, building and occupant characterization, fire spread and growth occupant response and fire brigade responses. This Draft National Building Fire Safety Systems Code (NBFSSC) was developed by 1991[2].

The work of the Warren Centre and the NBFSSC recognized that further research was needed in order to move toward performance-based fire engineering and that research was also needed to establish the basis for prescriptive regulations.

THE FIRE CODE REFORM CENTRE

In 1993 the Australian Uniform Building Code Council (AUBRCC), the predecessor of the Australian Building Codes Board (ABCB), commissioned the development of a business plan for a Fire Code Reform Centre (FCRC). This plan outlined a research program, time schedule and funding requirements to introduce an engineering approach to the Australian building fire safety regulations. In 1994, FCRC presented a detailed research plan to the ABCB for projects in the area of Performance Regulation Framework (Project 1), Fire Performance of Materials (Project 2), Fire Resistance and Non-Combustibility (Project 3), Fire Safety Risk Engineering Models (Project 4), Fire Engineering Guidelines (project 5A) and Fire Safety Engineering Design Code (Project 5B). Later, a project was undertaken with support from the Victoria Building Code Commission to study design of shopping centers.

The first projects were commissioned in 1994. These projects were the Performance Regulation Framework: Analysis of the Building Code of Australia – 90 and the Fire Engineering Guidelines.

The work of the FCRC can be considered a joint government, industry and research/university effort. Over the years, nearly half of support for FCRC's programs has come from the ABCB. The timber and steel industries have provided major support as have a number of large building industry firms as well as the concrete industry and private individuals. Additional support was provided by the research organizations in the form of in kind services and some reduced labor rates. Later in the program, labor rates were raised to be competitive with the effect of improved delivery schedules.

The research work was largely collaborative often with several organizations working on parts of the same project. The research groups included:

Scientific Services Laboratories (SSL)
Center for Environmental Engineering and Risk Engineering (CESARE), Victoria University of Technology
Commonwealth Scientific and Industrial Research Organisation (CSIRO)
BHP Research
Building Research Association of New Zealand (BRANZ)

The FCRC completed its work at the end of June 2000 having produced 15 project reports and 19 technical reports. At the closure of the FCRC, the ABCB took over the rights to the intellectual property represented by the work and now maintains the information.

ORGANIZATION OF THE FCRC

The FCRC organization was headed by a board of directors made up of representatives of the major funding organizations with additional invited directors representing specific interests such as the fire service. Dr John Nutt, A.M. of Ove Arup & Partners, chaired the Board. A Research Supervisory Committee composed of both representatives of funding organizations and individuals with specific expertise in the fire safety and risk research areas was constituted to review the research work and approve it upon completion. In addition, an Industry Advisory Group made up of selected industry representatives was established for several years to provide a broader industry perspective.

OBJECTIVES

The principal objectives of the FCRC were, for all classes of building occupancy, to

- establish a scientific foundation for the Australian building fire safety requirements and develop additional design solutions and
- introduce a risk assessment methodology and performance assessment into the fire safety requirements, together with the progressive development of a comprehensive fire safety design code and related software.

MEETING THE OBJECTIVES

Early in the FCRC program, it was found that a technical report from a research project did not necessarily fit seamlessly into the building code change process. Thus meeting the FCRC objectives required that research results be reviewed and translated into a form where they could be used as the basis for recommended changes to the BCA. It should be noted, that the BCA was revised in 1996 to contain performance objectives that could be met either by following deemed to satisfy requirements or using engineered approaches to develop alternative solutions. This made the need for the FCRC outcomes more pressing.

In 1998 FCRC retained the lead author for the position of Technical Director charging him with formalizing the process of completing the remaining research projects, developing and coordinating reports and publications and transferring the results of the

research to the ABCB in a form suitable for ABCB's use for the development of recommendations for changes to the BCA.

To accomplish the latter, the Technical Director was made Chair of the Research Supervisory Committee (RSC) and a Technical Working Group (TWG) was established for each project including completed work and work in progress. The TWG's were chaired by the Technical Director and comprised of selected members of the RSC, a representative of the ABCB, representatives of the interested industry or industries and the leader(s) of the given project.

Shortly after the Technical Director began work at FCRC, ABCB retained a technical expert in the fire safety research field on a short-term basis to interface with the FCRC. This representative was appointed Deputy Chair of the RSC and Deputy Chair of each of the TWGs. Subsequently the co-author of this paper joined ABCB overlapping for a brief period with his predecessor.

The objective in establishing the TWGs was to have smaller groups interacting closely with the research teams both during the research. More importantly, after the research was completed the TWG would prepare separate report for the project evaluating the work as related to changes for the building code and develop, with the input of the researchers, code representatives and industry, recommendations for submission by the FCRC Board to the ABCB.

In several projects, additional tests and analyses were commissioned by the TWG and carried out by the researchers. This work was reported as part of the TWG activity and not part of the original research. Although the TWG occasionally made comments and suggestions during progress meetings for work in process, no changes were requested of the researchers in their reported results or conclusions. In some cases the final TWG recommendations differed from those of the researchers in that the TWG either did not adopt all recommendations or added/modified recommendations.

In the end, each project output was represented by a research report and a TWG report. The active participation of "end users," particularly the ABCB, in the process was a major factor in the success of the TWGs.

PROJECT OVERVIEWS AND RESULTS

The following are brief snap shots of the major FCRC reports and the results. Copies of these reports are available on the ABCB web site: www.abcb.gov.au

Project 1

Final Report on the Restructure of the BCA-90 Fire Provisions - Volume One

Volume one of this report presents a methodology for a tabular restructuring of the Building Code of Australia (BCA-90) in an approach that simplifies the

identification of fire safety requirements based on Class and Type of building being considered.

Final Report on the Restructure of the BCA-90 Fire Provisions Volume Two

Volume Two demonstrates a first approximation of the application of the methodology to parts of the BCA-90. While not based on the current edition of the BCA (BCA-96), the work represents a useful methodology and a logical approach to code analysis.

Project 2

Fire Performance of Wall and Ceiling Materials - Final Report with Supplement

This report discusses the need to control the fire performance characteristics of wall and ceiling lining materials and the factors that control fire performance. A review is provided of the various test methods presently used for classification of material performance and data from large and small-scale tests are presented and discussed. A classification of materials based on cone calorimeter and ISO room fire test results is suggested for consideration in regulatory applications.

Fire Performance of Floors and Floor Coverings

This report reviews the national and international performance tests for flooring materials and floor coverings and makes recommendations regarding test methods for regulation of flammability and smoke production properties. A classification methodology for regulating flooring and floor coverings by in the Building Code of Australia (BCA-96) is developed. Data for a range of flooring and floor covering materials using the Early Fire Hazard (AS 1530 Part 3), Cone Calorimeter and Flooring Radiant Panel tests are presented.

Fire Performance of Exterior Claddings

This report reviews the history of exterior claddings in fire development and the test methods used domestically and internationally for regulation of the fire performance of cladding materials. Test data from candidate methods are reported and compared and a method is recommended for consideration.

Fire Performance of Fire Retardant Surface Coatings

This study investigated the use of fire retardant coating systems on wood products and the effect of prior weathering/aging on the results of small scale fire tests. The weathering/aging procedures simulated exterior exposure conditions, changes in temperature and humidity, and periodic cleaning. Test results from unweathered/aged and weathered/aged are provided. Recommendations regarding testing and suggested weathering/aging procedures are also presented.

Project 3

Objectives and Performance Levels for Fire Resistance

This report examines the historical basis and the requirements for the fire resistance levels in the Building Code of Australia (BCA-90). An analysis is made of the performance of the BCA-90 provisions based on statistical evidence. A

performance framework for fire resistance levels in the BCA is developed based on objectives relating to building systems and characteristics, occupant characteristics and fire fighter access.

Fire Resistance and Non-Combustibility

This report summarizes the development and basic features of FIRE-RISK (formerly called CESARE-Risk), a model designed to assess the effects of fire safety strategies and regulatory changes on fire losses in terms of risk and cost. The report contains a detailed sensitivity analysis of residential occupancies showing the effects of varying building size, fire compartment size and fire safety elements such as detection, fire resistance level and the presence of automatic sprinklers. The report also provides a statistical analysis of residential fires using US and Australian data.

Evaluation of Non-Combustibility Requirements

This report reviews the use of requirement for non-combustibility as determined by AS 1530 Part 5 (Test for Ignitability) in the Building Code of Australia (1990) in the context of the intent of each clause in which the term is used. Recommendations are made for continuing the use of the term, deletion of the non-combustibility requirement or use of an alternative test.

Room and Furnace Tests of Fire Rated Construction

This report presents the results of a series of tests to investigate the performance of selected fire resistant construction designs exposed to furnace tests (AS 1530.4 -1990) and room fire tests. Replicates were conducted to investigate the intra-laboratory repeatability and inter-laboratory reproducibility of the results. The test program also investigated the effects of different levels of workmanship in the construction of the tested walls.

Evaluation of Fire Resistance Levels, Techniques, Data and Results

This report covers an investigation of the factors effecting burn out time and fire severity for compartment fires both for performance based analyses and as the basis for setting prescriptive requirements for building codes. The effects of compartment geometry, ventilation and fire load are considered and a methodology for developing fire severity as a function of these parameters is developed. Examples of the application of the fire severity methodology are presented. The report provides an extensive compilation of fire load density data for buildings of various occupancies. The report contains extensive references.

Project 4

Fire Risk Summary Report

This report summarizes the development and basic features of FIRE-RISK (formerly called CESARE-Risk), a model designed to assess the effects of fire safety strategies and regulatory changes on fire losses in terms of risk and cost. The report contains a detailed sensitivity analysis of residential occupancies showing the effects of varying building size, fire compartment size and fire safety

elements such as detection, fire resistance level and the presence of automatic sprinklers. The report also provides a statistical analysis of residential fires using US and Australian data.

An additional report on the FIRE-FISK model has just been issued by VUT covering a series of short-term tasks identified during an International Review in March 2001. These tasks include, calculation of fire injuries, evacuation when flames enter an egress corridor, fire brigade intervention, probability-consequence data, sensitivity to window size and fuel load, breakdown of fire element costs and structural collapse.

Project 5

Fire Engineering Guidelines - First Edition

The Fire Engineering Guidelines identify a methodology for the design and assessment of fire safety in buildings and provides guidance on the application of fire science and engineering to performance-based design for the protection of people and property. The document contains fire safety principles, methodologies, data and extensive technical references.

Fire Safety Engineering Manual of Practice

This document is a major revision and reorganization of the FCRC Fire Engineering Guidelines-1996. The Manual is organized in four parts, Principles, Process, Methodologies and Data and contains a substantial addition of methodologies, data sources and references. The Manual has been designed for publication in a loose-leaf format for ease of updating.

Project 6

Fire Safety in Shopping Centres

This report discusses fire safety design of sprinklered shopping centres up to four stories in height under the requirements of the Building Code of Australia (BCA-96. The report contains results of fire incident statistics and case studies and addresses issues such as fire resistance and compartmentation, occupant response and movement, sprinkler performance, smoke management and fire brigade involvement.

The Effect of Combustible Construction on Fire Safety in Shopping Centres

This report investigates applicability in shopping centers of types of construction that use combustible building materials, including wood-based lining materials on the walls and ceilings, and heavy structural timber and light timber frame construction for the building structure. This report does not consider the use of plastic materials.

ABCB IMPLEMENTATION

Project 1 – This project out come will be considered by the Code Review Committee to assist in the development of the Future Building Code.

Project 2 - The following recommendations were made with respect to the fire performance of materials and will be considered for amendments to the BCA.

Flooring Materials and Floor Coverings - ISO Radiant Floor Panel test [3]
Wall and Ceiling Linings - Room Corner [4] and ASTM Cone Calorimeter [5] tests
Exterior Cladding - ASTM Draft Vertical Channel [6] test

Project 3 - The project concluded that the Deemed to Satisfy FRL (fire resistance level) requirements within the BCA were reasonable for most scenarios and suggested a methodology for estimating required FRL. This methodology is expected to be included as a future revision to the Fire Safety Engineering Manual of Practice and may be considered by the Code Review Committee as a verification method in the Future Building Code. The recommendations from this project regarding non-combustibility clauses within the BCA are expected to be implemented as amendments to the BCA.

Project 4 - This project had the ambitious objective to develop a model to estimate the risk from fire to occupants of all classes of building types, be used by regulators to further develop the fire code, and applied by practitioners to aid cost-effective fire safety design. Although the outcomes have not met all these expectations, ABCB is planning to initiate a project to survey Class 2 (residential) building types throughout Australia and establish a risk baseline for deemed to satisfy buildings. This base line will be used to evaluate acceptable alternatives for designs of Class 2 buildings. In the medium to long term the ABCB recognize the need for such a model to aid the decision making process with respect to fire code reform.

Project 5. The revised and user-friendlier document is now available. It is ABCB's intent to maintain this valuable document and continue its further development.

In summary, the ABCB has supported the FCRC projects, that should lead to more cost efficient regulations and help both designers and building surveyors in their work with the performance-based BCA. Of these projects, some will have an impact on building regulations in the near future (wall, ceiling and floor coverings, non-combustibility requirements), while others may result in changes to the BCA at a later date. Projects 4 and 5 may also change the way fire safety design is being done and evaluated.

LESSONS LEARNED

- There is a continuing need for technical basis for prescriptive requirements in building codes if these requirements are to be linked to performance objectives.
- The technical aspects of a multi-project research program is difficult to manage without central technical direction independent of any given project.
- The process of transferring research into practice through code reform requires an intermediate step involving both the researchers and end users such as the TWG approach used by the FCRC.
- Research projects directed toward code reform need to have clearly defined short-term objectives although objectives can be directed to long-term goals.
- While "funding" research with in-kind services and reduced rates of researchers may reduce the cost up front, the need to give priority to other projects paying higher rates can affect delivery schedules.
- Funding support for code reform work is keyed to identifiable and achievable goals and regular outcomes.

References

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[4] ISO 9705 *Fire Tests – Full-scale Room Test for Surface Products*, International Organization for Standardization, Geneva.

[5] ASTM E 1354 *Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter*, American Society for Testing and Materials, Philadelphia, Pennsylvania.

[6] Proposed Standard Test Method for Surface Flammability of Combustible Cladding and Exterior Wall Assemblies, ASTM Task Group E5.22.07 Vertical Channel Test, December 1992.