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A Framework for Fire Risk Assessment of Buildings Based on Performance Based Engineering Analysis

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ABSTRACT

BACKGROUND AND INTRODUCTION

Fire research and Fire safety science have made so much progress over the last twenty years that engineers, designers and regulators are using or willing to use computer mathematical models to specify fire safety equipment and assess the fire hazard of an occupancy instead of using only prescriptive building or equipment(approval) codes. To make these computer codes credible and easily available to engineers and regulators, there is need to ease the application of the computer codes by proper interfaces and also at the same time provide the user with a methodology to evaluate the validity of outputs by performing for example what-if-analysis.

Because fire (unlike structural building analysis) is not a completely deterministic problem, an analysis of the overall evaluation of building fire safety includes several probabilistic aspects such as equipment (detector , sprinkler) reliability, human response (evacuation, fire department, emergency response) and uncertainties in the parameters of the deterministic models. All these considerations drive the new fashionable trend and term : Performance Based Criteria for Fire Safety. This new approach includes both deterministic and probabilistic modeling. In fact, performance based methods (i.e. engineering methods) have been used for many years now for the design of fire protection devices for a specific scenario (e. g. sprinkler design in warehouse). The need, however, to include many scenarios and account for stochastic events has been the driving force behind the new developments for fire safety evaluation.

The combination of deterministic and probabilistic models is the primary component of Quantitative Risk Analysis (QRA) developed in chemical and nuclear industry. In this work, we develop a framework to obtain a fire risk analysis methodology using fire computer codes together with probabilistic models for equipment reliability and human response. Our focus is the fire safety analysis of buildings. An automatic event tree algorithm has been developed to follow all important event paths and provide a risk evaluation in terms of probability versus consequence. Also, a new computer program is suggested for development to efficiently assess sensitivities and uncertainties in the predictions.

ACCOMPLISHMENTS AND CONCLUSIONS

We have demonstrated with a simple one compartment application how a risk analysis program for fire performance in buildings works. The proposed risk analysis framework consists of Deterministic, Probabilistic and Impact models. Deterministic and probabilistic models are run prior to the activation of event tree. An important contribution of this work has been the development of an algorithm for the automatic creation of event trees and their outputs in the form of risk curves as shown in Fig. 1.

We have also searched, discuss and recommend a methodology to calculate uncertainty and sensitivities. One should pursue this methodology which is much more intuitively physical and efficient than other classical methods.

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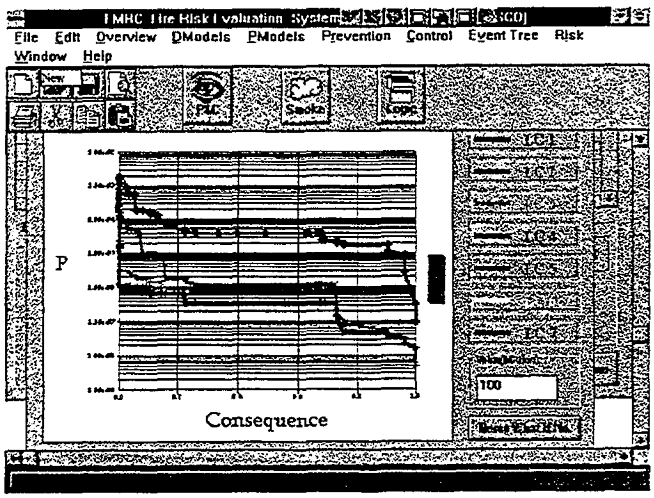

Risk Curves

Top Curve: Base Case

Middle Curve: Better Detection & Halon (FM 200)

Bottom Curve: Better Detection & Smoke Management (secondary air handling unit)

Figure 1. Risk curves plotted as complementary cumulative distributions for an undivided computer room and various protection schemes.