RISK ASSESSMENT WORKSHEET:
A TOOL FOR COMPANY OFFICERS
AND
FIRE PREVENTION INSPECTORS

EXECUTIVE ANALYSIS OF FIRE SERVICE OPERATIONS
IN
EMERGENCY MANAGEMENT

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ABSTRACT

The problem that gave rise to this research paper was that the London Fire Department lacked a process to identify and rate risks within the municipality. The purpose of this research paper was to develop a risk assessment worksheet for use by company officers and fire prevention inspectors. This research project employed action research methodologies.

The following questions were posed for the purposes of this research:

1. What is the definition of risk?
2. What is a risk assessment?
3. What standards, federal (Canadian) and/or provincial (Ontario) legislation, and/or local requirements mandate municipalities, or entities thereof, to identify risk hazards in their community?
4. What quantitative criteria do other agencies and organizations use in their risk assessments?
5. What quantitative risk assessment models are in existence today?

The research process commenced with a review of literature germane to the topic of risk assessment, whereby criteria used by various models was reviewed to seek commonalities. Major categories of risk were identified, and then entered into a table for comparative purposes.

Several National Fire Protection Association standards identified applied either wholly or in part to the subject. Currently, only one piece of Canadian legislation, Ontario's *Fire Protection and Prevention Act* applies to risk assessments, albeit

indirectly. However, an upcoming Bill, if passed, shall mandate the risk assessments. Several risk assessment models were found to exist, a few specific to the fire service.

The recommendations included a) implementation of a risk assessment program, preferably RHAVE, and the risk assessment worksheet developed, b) involvement of inspectors and officers in the program, c) delivery of a training program, d) notifying frontline responders, e) exploring the feasibility of a self-inspection program, f) automating the data gathering process, and g) developing risk based mapping both citywide and by response zone.

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INTRODUCTION

On October 27, 1997, the Ontario government proclaimed the *Fire Protection and Prevention Act* (FPPA) ("Fire Protection and Prevention Act," 1997). Unlike the previous *Fire Departments Act*, which it replaced, this piece of legislation included proactive initiatives that focused on such things as prevention and planning. From this legal obligation flowed a mandate that all municipalities complete a simplified risk assessment (*FPPA opinions & applications - subsection 2(1), municipal responsibilities*, 1999; *Public fire safety guideline PFSG 02-02-03: Analyzing local circumstances - Risk assessment*, 1998; *Public fire safety guideline PFSG 02-02-12: Analyzing local circumstances - Risk assessment*, 1998). The provincial government has since stepped up its emergency preparedness requirements in the wake of the tragic events of September 11, 2001. That day not only profoundly changed the way emergency responders view large-scale emergencies, but caused governments and citizens to demand that the emergency services be prepared to properly mitigate emergencies when they threaten the community.

The problem that gave rise to this research paper is that the London Fire Department (LFD) lacks a process by which to identify and rate risks within the geographic boundaries of the municipality. The purpose of this research paper is to develop a risk assessment worksheet for use by company officers and fire prevention inspectors.

To investigate the issues surrounding the problem, and achieve the goals cited within the purpose, the researcher employed action research methodologies. In an attempt to develop a solution, the researcher sought to answer the following research

questions:

1. What is the definition of risk?
2. What is a risk assessment?
3. What standards, federal (Canadian) and/or provincial (Ontario) legislation, and/or local requirements mandate Ontario municipalities, or entities thereof, to identify risk hazards in their community?
4. What quantitative criteria do other agencies and organizations use in their risk assessments?
5. What quantitative risk assessment models are in existence today?

BACKGROUND AND SIGNIFICANCE

The events of September 11, 2001, forever changed the world for North Americans. A sense of security, once taken for granted, vanished that day as their vulnerability became apparent. They watched in horror as two commercial jetliners crashed into the World Trade Center towers, followed by a third one into the Pentagon. The heroic actions by passengers on a fourth hijacked airliner caused it to crash into a remote area of Pennsylvania.

> The unexpected ease with which the 9/11 attacks were carried out threw into doubt governments' capacity to ensure the security of citizens and vital infrastructure and called into question many accepted security and administrative practices. The attacks also highlighted how political, economic, social, and cultural differences between various regions of the globe can be translated into violence. (Dartnell, 2002, pg. 1)

While the impact of September 11, as well as the possible consequences from

devices such as Weapons of Mass Destruction (WMD) and Chemical, Biological, Radiological, and Nuclear (CBRN) instill fear, they are overshadowed by the more probable, but equally devastating, consequences caused by natural and human-caused emergencies. Tudor's (1997) report for Emergency Preparedness Canada found that 68% of disasters in Canada are caused by natural phenomena, whereas 32% can be attributed to human-caused incidents.

In his address to the Institute for Catastrophic Loss Reduction's (ICLR) second annual symposium that focused on building resilient communities, George Anderson, president and CEO of the Insurance Bureau of Canada, stated, "While Canada does a great job responding to natural disasters and rebuilding afterward, we have a lot of work to do when it comes to preventing disaster" ("Canada needs to invest in natural disaster reduction efforts to save lives, property and money," 2000, p. 1). Mr. Anderson added, "With foresight, planning and timely investment we can save lives, property and money" (p. 1). Rice's (2001) article *Creating Winds of Change* quotes Dr. Alan Davenport, Research Director for the ICLR as saying, "We've learnt over the past decade that the problem of natural disasters is getting measurably worse'" (pg. 1). Within that article, Dr. Davenport observed other issues escalating the challenge such as worsening weather patterns, earthquakes, and the continuing trend toward urbanization.

Using the recent events to promote emergency preparedness, governments in the United States and Canada are moving toward mandated identification of hazards, and assessments of the risks posed by those hazards, to ensure proper mitigation strategies are in place, and adequate resources are available for deployment. Two recent events are driving the LFD to take a proactive approach toward assessing risks

in the community. First, the Government of the Province of Ontario has introduced a Bill, which if passed will mandate disaster and emergency preparedness, as well as those activities necessary in such programs. Second, the recent introduction of the National Fire Protection Association's (NFPA) standard *NFPA 1710* is causing fire departments to review their deployment and staffing models. At this time, the LFD lacks information to address either issue.

Other pressures are also driving the need for a risk assessment. The City of London is currently experiencing financial challenges. Accordingly, all of the departments within the corporation are required to reduce costs. Without the proper data to substantiate the current deployment of resources, there may be pressures to cutback on frontline staff and equipment. While it is recognized that Council sets the level of service, it is critical that the administration provide the requisite information so that informed decisions are made.

In conformance with National Fire Academy (NFA) requirements, participants of the Executive Fire Officer (EFO) program must select a topic pertinent to the course. The issue must also be applicable to the researcher's organization. This research paper focuses on *Unit 4: Community Risk Assessment* contained within the *Executive Analysis of Fire Service Operations in Emergency Management* course. Specifically, the LFD needs to identify and evaluate the risks within the City of London. It is hoped that such a process will assist the department in developing a community risk profile, so that it may determine if its current resources are properly deployed, provide justification should it require additional resources, and enable it to meet legislative requirements.

LITERATURE REVIEW

The researcher undertook a review of Canadian legislation, standards, trade journals, magazines, textbooks, internet sources, and other material germane to the topic of risk, specifically those related to risk assessment. Included in this section is a summary of those findings.

Risk

Risk can be defined as, “The possibility of suffering harm or loss; danger” or “a factor, thing, element, or course involving uncertain danger; a hazard” (Rathmell, Keyman, & Zuris, 1994). Risk Assessment Information System (RAIS), a project sponsored by the U.S. Department of Energy (DOE), Office of Environmental Management, Oak Ridge Operations (ORO) Office offers a definition from *Webster's New World Dictionary of the American Language* which declares risk as being “the chance of injury, damage, or loss” (*What is risk?*, 2002a, p. 1). “Risk is the potential or likelihood of an emergency to occur” is how Environmental Systems Research Institute, Inc. (ESRI) describes the term in its 1999 *White Paper GIS for Emergency Management* (*GIS for emergency management*, 1999, p. 4). Australian Geological Survey Organization Cities Project’s Granger, Jones, Leiba, & Scott (1999) contend risk is “the outcome of the interaction between a hazard phenomenon and the vulnerable elements at risk (the people, buildings and infrastructure) within the community” (p. 25), while Gordon (2000) defines it as “the possibility that harm may occur from an identified hazard” (p. 1).

Looking at the concept from a different viewpoint, several individuals and groups feel risk is best described as a mathematical expression (*Glossary of risk analysis*

terms, 2001; *How is risk measured?*, 2002; R. A. Klein, 1997; Meston, 2001; *NFPA 1250: Recommended practice in emergency service organization risk management*, 2000). The NFPA, a proponent of a mathematical concept, states, “Risk is a characteristic of an entire probability distribution, with a separate probability for each outcome” (*NFPA 1250: Recommended practice in emergency service organization risk management*, 2000, p. 15), and then goes on to suggest “risk is evaluated by measuring its probability and severity" (p 18). Klein (2001), another proponent of the mathematical theory, suggests that consequence more appropriately replaces the variable severity. Further, he suggests that risk is the product of three variables, with hazard being that third component. Other risk focused organizations, such as RAIS, the New Zealand Society for Risk Management (NZSRM), and the Society for Risk Analysis (SRA), also ascribe to the theory of a mathematical model; however, they proffer a formula whereby risk is equal to the product of probability times consequence (*Dealing with risk*, 2001; *Glossary of risk analysis terms*, 2001). Looking to express the model in layperson’s terms, the NFPA and the NZSRM distill the probability and consequence argument into the following two questions; how likely is an event to happen, and, should it occur, how severe are its adverse consequences?

Cool (1999) contends that many confuse uncertainty with risk. With respect to unknown factors and the impact on risk, Cool offers the following definition:

> Risk can be said to deal with the case of known probabilities or when unknowns are assumed to be uniformly distributed over known categories. It is not customary to use the term 'risk' for unknown categories. (p. 3)

In his study of performance-based fire protection engineering, Meacham (2001)

discovered risk appears to mean “different things to different people” (p. 16). Further, there are two types of risk: quantifiable and qualitative. Quantifiable risk, which relies upon the availability of objective data, may be expressed by a mathematical equation (Kuepper, 1999; Meacham, 2001). Others choose to select a qualitative approach because of their doubts about the accuracy of quantifying frequencies, and the consequences (*Introduction to security risk analysis & risk assessment*, 2002; Meacham, 2001).

Concerning the known and unknown aspect to risk, RAIS refers to a report entitled *Background Risk Information to Assist in Risk Management Decision Making* written in 1992 by J. S. Hammonds et al. RAIS recommends against the use of a single faceted definition because Hammond and his associates found traditional definitions of risk could not stand on their own. Accordingly, the group recommended the following comment for consideration:

> Risks may also be defined as statistically verifiable or statistically nonverifiable [sic]. Statistically verifiable risks are risks for voluntary or involuntary activities that have been determined from direct observation. These risks can be compared to each other. Statistically nonverifiable [sic] risks are risks from involuntary activities that are based on limited data sets and mathematical equations. These risks can also be compared to each other, but no comparison should be made between verifiable and nonverifiable [sic] risks (*What is risk?*, 2002a, p. 1).

Risk Assessment

"Simply, a risk assessment asks, 'How risky is this situation?' while risk management asks, 'What shall we do about it?'" (Iolster & Flanagan, 1997, p. 7). Iolster and Flanagan observed that some individuals perceive risk assessment to be a scientific issue, whereas other groups consider it a policy and community involvement matter. "In any case, all of these issues are integral parts of the risk assessment process" (Iolster & Flanagan, 1997, p. 4).

Why are risk assessments necessary? Basically, "Scarce time and resources prevent individuals and society from doing everything that they might to reduce risks to health, safety, and the environment" (Long & Fischhoff, 2000, p. 339). Risk assessments, the first vital step toward emergency preparedness, cause jurisdictions to critically examine the potential risks within the community, so that they may ensure the appropriate resources are deployed to achieve a desired outcome (*Emergency planning: A guide for emergency planning for community officials*, 2001; S. Gary, 2001; Levitin, 1998). They are a method by which to not only to identify risks but also enable organizations to prioritize plans of action (*NFPA 1250: Recommended practice in emergency service organization risk management*, 2000).

The degree of detail captured in a risk assessment is extremely important because the identification and description of potential hazards, as well as the associated vulnerabilities, permits the development of a community risk profile, which in turn facilitates the prioritization of mitigation strategies (*Public fire safety guideline PFSG 04-40A-12: Fire prevention and public fire safety education - Simplified risk assessment*, 2001; "Understanding your risks: Identifying hazards and estimating losses

(FEMA 386-2)," 2001). Choosing to move beyond traditional definitions, Oyo RMS, a risk analysis firm formed through a partnership with OYO Corporation of Japan and Risk Management Solutions, Inc. of the United States, prefers to express risk assessment as the catalyst that promotes the development of informed organizational strategies, consequently, resulting in the effective management of risk (*What is risk?*, 2002b). Risk assessments when used appropriately can be a very important management tool for making critical decisions, and, in some cases, meeting regulatory requirements (*Risk assessment*, 2002; Short & Rosa, 1998). Nevertheless, Goossens and Cooke (1997) caution they are by nature explanatory, and not predictors of events.

The National Research Council (NRC) and the United States Environmental Protection Agency (EPA), organizations focused on environmental health hazards, define risk assessment as “the identification of potential adverse health effects on humans or ecosystems resulting from exposure to the same” (White, 2000, p. 17). Alternatively, the Federal Emergency Management Agency (FEMA) describes risk as “a process or application of a methodology for evaluating risk as defined by probability and frequency of occurrence of a hazard event, exposure of people and property to the hazard, and consequences of that exposure” (*Multi Hazard Identification and Risk Assessment*, 1997, p. 295). SRA combines these ideas but then goes on to further refine that definition by identifying persons, groups, society, and the environment as those impacted by a hazard (*Glossary of risk analysis terms*, 2001). Gordon’s (2000) studies offer yet another perspective suggesting proper risk assessments identify hazards and assess ones vulnerability, which in turn permits the management of risk based on identified exposure(s) and education of those affected through the adoption of

preventative steps.

U.S. military sources, specifically the U.S. Navy's Fleet Information Warfare Center, see risk assessment as, "Using sound concepts to detect, hazards and estimate the risk they pose" (*What is risk?*, 2002b, p. 1). In his study of operational risk management (ORM), Beckvonpeccoz (1997) cited, "Risk assessment is the process of detecting hazards and assessing associated risks. The goal of the process is to make smart risk decisions which reduce risk to acceptable levels commensurate with mission accomplishment" (p. 6).

Early in the 1980s, the U.S. congress authorized a study on the subject of risk assessment. Accordingly, the NRC commissioned the Commission of Life Sciences Committee on Institutional Means for Assessment of Risk to Public Health to take on the project. The product of that research was a 1983 report entitled *Risk Assessment in the Federal Government: Managing the Process*. Project contributors noted the lack of a standard definition for the term risk assessment. Accordingly, after much research the Committee chose to adopt the following explanation:

> We use risk assessment to mean the characterization of the potential adverse health effects of human exposures to environmental hazards. Risk assessments include several elements, description of the potential adverse health effects based on an evaluation of results of epidemiologic, clinical, toxicologic, and environmental research; extrapolation from those results to predict the type and estimate the extent of health effects in humans under given conditions of exposure; judgments as to the number and characteristics of persons exposed at various intensities and durations; and summary judgments on the existence and

> overall magnitude of the public-health problem. Risk assessment also includes characterization of the uncertainties inherent in the process of inferring risk.
>
> The term risk assessment is often given narrower and broader meanings than we have adopted here. For some observers, the term is synonymous with quantitative risk assessment and emphasizes reliance on numerical results. Our broader definition includes quantification, but also includes qualitative expressions of risk. Quantitative estimates are not always feasible, and they may be eschewed by agencies for policy reasons. Broader uses of the term than ours also embrace analysis of perceived risks, comparisons of risks associated with different regulatory strategies, and occasionally analysis of the economic and social implications of regulatory decisions - functions that we assign risk management. (Stallones et al., 1983, p. 18)

Several authors, including agencies of the U.S. Government, reference the NRC's risk assessment definition (*Glossary of risk analysis terms*, 2001; Iolster & Flanagan, 1997; Mehta, 2002; White, 2000), although the definition is most applicable in situations where environmental health hazards are the key concern (White, 2000).

Gathering information for the purposes of identifying risks is certainly not a new concept for the British fire service, as there has been a legislated requirement in place for over 50 years; however, today the focus is upon risk assessments (Davis, 1997). Davis claims the shift came when fire brigades sought a tool to protect the public and firefighters. He claims the process assists fire departments identify the appropriate level of resources for a circumstance. Fire risk assessments, somewhat more narrowly

focused, look primarily at the likelihood of the hazards related to firefighting occurring, as well as the consequences caused because of them. Farrell (2002) professes the assessment process involves five stages including indication, estimation of occurrence, estimation of consequence, risk calculation, and risk acceptability.

For the most part, the North American fire service is still in its infancy with respect to the use of risk assessments. However, the Commission on Fire Accreditation International's (CFAI) accreditation program, along with the adoption of *NFPA 1710* and *NFPA 1720*, has recently brought risk assessments to the forefront. It should be noted that the Insurance Services Office (ISO) has, for several decades, assessed community fire protection, although it was another type of assessment (*Evaluating Community Emergency Services*, 2002).

Standards, Federal (Canadian) Legislation and Local Requirements

Standards. The National Fire Protection Association (NFPA) is an international nonprofit organization whose mission is to lessen the global burden of hazards, including fire, on the quality of life (*About NFPA - A worldwide leader in providing fire, electrical, and life safety to the public since 1896*, 2002). The organization does so through the provision and promotion of research, training, and education, as well as the development of scientifically based consensus codes and standards. Several of its standards speak to risk assessments.

NFPA 1600 addresses various aspects of disaster and emergency management, including business continuity programs. The standard identifies hazard identification and risk assessment as critical elements of disaster and emergency management. In Chapter 3, the NFPA states:

3-3.1 The entity shall identify hazards, the likelihood of their occurrence, and the vulnerability of people, property, the environment, and the entity itself to those hazards. Hazards to be considered at a minimum shall include, but shall not be limited to, the following:

1) Natural events
2) Technological events
3) Human events (*NFPA 1600: Standard on disaster/emergency management and business continuity programs*, 2000, p. 7)

The same NFPA standard also requires the following the actions with respect to analyzing the impact those hazards may create:

3-3.2 The entity shall conduct an impact analysis to determine the potential for detrimental impacts of the hazards on items including but not limited to the following:

1) Health and safety of persons in the affected area at the time of the incident (injury and death)
2) Health and safety of personnel responding to the incident
3) * [*sic*] Continuity of operations
4) Property, facilities, and infrastructure
5) Delivery of services
6) The environment
7) * [*sic*] Economic and financial condition
8) Regulatory and contractual obligations
9) Reputation of the entity (*NFPA 1600: Standard on disaster/emergency*

management and business continuity programs, 2000, p. 7)

NFPA 1201: Standard for developing fire protection services for the public, specifically Chapter 20, cites the need for a fire department to have a disaster plan, and that plan shall identify and evaluate risks (*NFPA 1201: Standard for developing fire protection services for the public*, 2000). Another NFPA standard, *1670,* which deals with technical rescue incidents, requires the authority having jurisdiction (AHJ) to identify hazards, analyze them and conduct a risk assessment (*NFPA 1600: Standard on disaster/emergency management and business continuity programs*, 2000). This risk assessment must:

> include an evaluation of the environment, physical, social, and cultural factors influencing the scope, frequency, and magnitude of a potential technical rescue incident and the impact they might have on the ability of the AHJ to respond to and to operate safely at those incidents. (*NFPA 1670: Standard on operations and training for technical rescue incidents*, 1999, p. 17)

NFPA 1250, *Recommended Practice in Emergency Service Organization Risk Management, is* a standard which assists emergency services organizations "develop, implement, or evaluate an emergency services organization risk management program for effective risk identification, control, and financing" (*NFPA 1250: Recommended practice in emergency service organization risk management*, 2000, p. 3). This standard, however, relates primarily to internal risks instead of risks within the community.

Federal (Canadian) Legislation. The *Emergency Preparedness Act, R.S., 1988, c. 6 (4th Supp.)* is the applicable Canadian statute which deals with emergency

preparedness. Regarding the specifics of municipal preparedness, Section 4 of the Act states that the Minister so charged will advance emergency preparedness by developing and implementing civil emergency plans, and that such efforts will occur through facilitation and coordination with the provincial governments ("Emergency Preparedness Act," 1988, p. 2).

In addition to the broader responsibilities and powers associated with emergency plans, the Minister's responsibilities under the Act include:

> 5.(1) The responsibilities of the Minister with respect to the development of civil emergency plans are
>
> (*a*) to develop policies and programs for achieving an appropriate state of national civil preparedness for emergencies;
>
> (*b*) to encourage and support provincial civil preparedness for emergencies and, through provincial governments, local civil preparedness for emergencies;
>
> (*c*) to provide education and training related to civil preparedness for emergencies;
>
> (*d*) to enhance public awareness and understanding of matters related to civil preparedness for emergencies;
>
> (*e*) to analyse [*sic*] and evaluate civil preparedness for emergencies and conduct related research;
>
> (*f*) to establish arrangements for ensuring the continuity of constitutional government during an emergency;

(*g*) to establish arrangements with each province whereby any consultation with the lieutenant governor in council of the province with respect to a declaration of an emergency under any Act of Parliament can be effectively carried out; and

(*h*) to coordinate and support

(i) the development and testing of civil emergency plans by government institutions,

(ii) the activities of government institutions relating to civil preparedness for emergencies with like activities of the provincial governments and, through the provinces, of local authorities, and

(iii) in accordance with the external relations policies of Canada, the participation of Canada in activities relating to international civil preparedness for emergencies.

(2) The responsibilities of the Minister with respect to the implementation of civil emergency plans are

(*a*) to monitor any potential, imminent or actual civil emergency and to report, as required, to other ministers on the emergency and any measures necessary for dealing with it;

(*b*) to coordinate or support, as required,

(i) the implementation of civil emergency plans by government institutions, and

(ii) the provision of assistance, other than financial assistance, to a province during or after a provincial emergency; and

(*c*) to provide financial assistance to a province when authorized pursuant to section 9.

(3) The Minister has such other responsibilities in relation to civil preparedness for emergencies as the Governor in Council may, by order, specify.

R.S., 1985, c. 6 (4th Supp.), s. 5; 1995, c. 29, s. 25 ("Emergency Preparedness Act," 1988, p. 2).

Notwithstanding the Minister's responsibilities herein described, the Act envisages provincial governments assuming responsibilities for the management of most national emergencies associated with public welfare and public order. Section 5(2)(c) describes the federal government's role as one of support for the provinces during such events (*Public communications: Policy - national emergency planning*, 2002).

The *Emergency Plans Act, 1999, c. 12, Schedule. P, ss. 3-9,* is the Ontario statue that delineates responsibilities and requirements concerning emergencies within the province. Shown below are those parts of the Act specific to a municipality's obligations:

3. Municipal emergency plan

(1) The council of a municipality may pass a by-law formulating or providing for the formulation of an emergency plan governing the provision of necessary services during an emergency and the procedures under and the manner in which employees of the municipality and other persons will respond to the emergency. R.S.O. 1990, c. E.9, s. 3 (1). ("Emergency Plans Act," 1999, p. 2)

Emergency plan may be required

(4) The Lieutenant Governor in Council may designate municipalities that shall have an emergency plan respecting the type of emergency specified in the designation and, where so designated, a municipality shall formulate or provide for the formulation of the emergency plan. R.S.O. 1990, c. E.9, s. 3 (4). ("Emergency Plans Act," 1999, p. 2)

6. Emergency plans of provincial government bodies

Director, Emergency Measures Ontario

(2) The Lieutenant Governor in Council shall appoint a Director, Emergency Measures Ontario who, under the direction of the Solicitor General, shall be responsible for monitoring, co-ordinating [*sic*] and assisting in the formulation and implementation of emergency plans under this section and section 8 and ensuring that such plans are co-ordinated [*sic*] in so far as possible with emergency plans of municipalities and the Government of Canada and its agencies. R.S.O. 1990, c. E.9, s. 6 (2); 1999. c. 12, Sched. [*sic*] P, s. 4. ("Emergency Plans Act," 1999, p. 3)

9. What plan may provide

An emergency plan may,

(a) in the case of a municipality, authorize employees of the municipality or, in the case of a plan formulated under section 6 or 8, authorize Crown employees to take action under the emergency plan where an emergency exists but has not yet been declared to exist;

(b) specify procedures to be taken for the safety or evacuation of persons in an emergency area;

(c) in the case of a municipality, designate one or more members of council who may exercise the powers and perform the duties of the head of council under this Act or the emergency plan during the absence of the head of council or during his or her inability to act;

(d) establish committees and designate employees to be responsible for reviewing the emergency plan, training employees in their functions and implementing the emergency plan during an emergency;

(e) provide for obtaining and distributing materials, equipment and supplies during an emergency; and

(f) provide for such other matters as are considered necessary or advisable for the implementation of the emergency plan during an emergency. R.S.O. 1990, c. E.9, s. 9. ("Emergency Plans Act," 1999, pp. 4, 5)

The *Fire Protection and Prevention Act, S.O. 1997, c. 4*, applies to municipalities within Ontario, and their respective fire departments. According to an opinion rendered by the Office of the Fire Marshal (OFM), this act legislates municipalities to complete a simplified risk assessment (*FPPA opinions & applications - subsection 2(1), municipal responsibilities*, 1999). *Part II, Responsibility for Fire Protection Services, Municipal responsibilities*, Subsection 2(1) of the Act states:

Every municipality shall,

a. establish a program in the municipality which must include public education with respect to fire safety and certain components of fire prevention; and
b. provide such other fire protection services as it determines may be necessary in accordance with its needs and circumstances. (p. 6)

Although the *Emergency Plans Act* remains in effect, the Honorable Mr. Runciman, Minister of Public Safety and Security for the Province of Ontario, is currently advancing a Bill through the legislature, which if enacted, will replace the aforementioned Act. *Bill 148* contains several key amendments that will radically alter emergency planning in the province.

The current Act contains permissive language allowing a municipality to formulate an emergency plan. Conversely, *Bill 148* broadens the scope of emergency planning to include emergency management programs. Further, as noted in the following excerpts of *Bill 148*, such plans and programs are no longer voluntary but mandated. Regarding emergency plans, the proposed changes are as follows:

4. The Act is amended by adding the following section:

Municipal emergency management programs

2.1 (1) Every municipality shall develop and implement an emergency management program and the council of the municipality shall by by-law adopt the emergency management program.

Same [*sic*]

(2) The emergency management program shall consist of,

(a) an emergency plan as required by section 3;

(b) training programs and exercises for employees of the municipality and other persons with respect to the provision of necessary services and the procedures to be followed in emergency response and recovery activities;

(c) public education on risks to public safety and on public preparedness for emergencies; and

(d) any other element required by the standards for emergency management programs set under section 14. ("Emergency Management Act," 2002, pp. 1, 2)

5. (1) Subsections 3 (1) and (2) of the Act are repealed and the following substituted:

Municipal emergency plan

(1) Every municipality shall formulate an emergency plan governing the provision of necessary services during an emergency and the procedures under and the manner in which employees of the municipality and other persons will respond to the emergency and the council of the municipality shall by by-law adopt the emergency plan. ("Emergency Management Act," 2002, p. 2)

Included within the proposed Act are legislative requirements to identify hazards and critical infrastructure, and to conduct risk assessments. Regarding this subject, the Bill proposes the following amendments:

Hazard and risk assessment and infrastructure identification

(3) In developing its emergency management program, every municipality shall identify and assess the various hazards and risks to public safety that could give rise to emergencies and identify the facilities and other elements of the

infrastructure that are at risk of being affected by emergencies. ("Emergency Management Act," 2002, p. 2)

Demonstrating its ongoing commitment to protect the citizens of Ontario, the government also proposes the restructuring of Emergency Management Ontario (EMO) as follows:

9. The Act is amended by adding the following section:

Chief, Emergency Management Ontario

6.1 The Lieutenant Governor in Council shall appoint a Chief, Emergency Management Ontario who, under the direction of the Solicitor General, shall be responsible for monitoring, co-ordinating [*sic*] and assisting in the development and implementation of emergency management programs under sections 2.1 and 5.1 and for ensuring that those programs are co-ordinated [*sic*] in so far as possible with emergency management programs and emergency plans of the Government of Canada and its agencies. ("Emergency Management Act," 2002, p. 3)

In addition to appointing a Chief for EMO, the government is further reinforcing the need for municipal emergency plans by requiring that the individual appointed to this position ensure that every municipality, as well as other public entities so identified, submit such plans to their Office. The Act, if amended, would read:

10. The Act is amended by adding the following section:

Emergency plans submitted to Chief

6.2 (1) Every municipality, minister of the Crown and designated agency, board, commission and other branch of government shall submit a copy of their

> emergency plans and of any revisions to their emergency plans to the Chief, Emergency Management Ontario, and shall ensure that the Chief, Emergency Management Ontario has, at any time, the most current version of their emergency plans. ("Emergency Management Act," 2002, p. 3)

In addition to the *Emergency Plans Act*, the Province of Ontario, through the Ministry of Public Safety and Security, has published Public Fire Safety Guidelines (PFSG). Developed by the OFM, these guidelines focus primarily on fire type emergencies; however, they do speak to the subject of risk. Two guidelines, one aimed at municipal Councils and fire administrations, while the other addresses operations, focus on risk assessments. *PFSG 02-02-12* requires that municipal Councils and fire administrations analyze local circumstances. Regarding the identification of problems associated with fires, the OFM states:

- All municipalities should analyze the what, where, who, why, and when questions about its fires, casualties and losses. Some of the elements to consider are as follows:
    - the type and nature of the local municipality
    - the building stock and occupancy types
    - fire prevention and public education programs
    - public and private fire protection systems
    - political resolve/commitment
    - historical analysis and comparisons
    - comparative analysis with others

- special hazards
- major rail lines/waterways (*Public fire safety guideline PFSG 02-02-12: Analyzing local circumstances - Risk assessment*, 1998, p. 1)

PFSG 02-02-03, aimed specifically at fire department operations, is a comprehensive document that identifies the critical factors to consider when conducting fire-related risk assessments. A copy of that guideline can be found in Appendix B.

Concerning the requirements of local government, the *Peacetime Emergency Plan* defines the responsibilities and activities of the Corporation of the City of London, and the employees thereof. Duties and responsibilities of the Fire Chief include maintaining hazardous material spills plans, specifically, with regard to the prevention of explosions and the spread of poisonous vapors. Section 21 of the plan states:

> The Fire Chief will have the following responsibilities in the emergency in addition to the normal responsibilities of the Fire Department:
>
> - providing information on the emergency to the E.O.C.G.;
> - maintaining plans and procedures for dealing with spills of hazardous material from the viewpoint of prevention of explosions, or of the spread of noxious fumes;
> - evacuation, in consultation with Police authorities on the spot, of areas involved with fire, or threat of fire or explosion, or for other urgent safety reasons;
> - arranging for additional Firefighting assistance when necessary; and

- providing advice to other City Services to bring into play other equipment or skills as required in the emergency. (*Peacetime Emergency Plan*, 2002, p. 6)

The Commissioner of Environmental Services & City Engineer is also charged with similar responsibilities, albeit they refer primarily to actions to be taken to mitigate a hazardous materials spill. With respect to this type of incident, Section 22 charges the Commissioner of Environmental Services & City Engineer with the responsibility for "maintaining procedures and plans for Engineering response to spills of hazardous materials including containment, neutralizing and clean-up, upon advice from the Fire Department as to the material involved and the remedial action required" (*Peacetime Emergency Plan*, 2002, p. 6)

Risk Assessment Criteria

Risk assessments must consider the following three key factors: the frequency, or how often has the event occurred in the past, and how likely is it to occur the future; the severity, or how harsh will the undesirable consequences be should the event occur; and probability, otherwise described as how expected is the event to occur (*NFPA 1250: Recommended practice in emergency service organization risk management*, 2000). NFPA cautions that inconsistencies between the results of one organization and another are almost certain because of the absence of a universal standard by which to measure frequency and severity. Nonetheless, despite the challenge noted, the results of such a process are invaluable as they enable organizations to prioritized plans of action (*Disaster prevention for the 21st century*, 1999; Loflin et al., 1996; *NFPA 1250: Recommended practice in emergency service organization risk management*, 2000).

Properly completed risk assessments include detailed descriptions of all the hazards within the municipality, as well as an analysis of the jurisdiction's vulnerability to those hazards (*Strategic planning guide for the evacuation of a highly urbanized environment*, 2001; "Understanding your risks: Identifying hazards and estimating losses (FEMA 386-2)," 2001). "The first stages supposes that managers will divide the municipal or metropolitan area into planning sectors" (*Strategic planning guide for the evacuation of a highly urbanized environment*, 2001, p. 4). Jurisdictions then need to compile data regarding the numbers and categories of structures in the community, probable losses in monetary terms should an emergency event strike, as well as general trends regarding land use (*DMA 2000 state & local plan interim criteria: Mitigation planning workshop for local governments - Part 3*, 2002). This data, as well as information on equipment, material, existing and available resources, procedures and agreements, should be linked to the planning sectors identified earlier in the process (*Strategic planning guide for the evacuation of a highly urbanized environment*, 2001). The FEMA model encompasses the following six steps:

- Identifying Hazards
- Profiling Hazard Events
- Assessing Vulnerability: Identifying Assets
- Assessing Vulnerability: Estimating Potential Losses
- Assessing Vulnerability: Analyzing Development Trends
- Multi-jurisdictional Risk Assessment (*DMA 2000 state & local plan interim criteria: Mitigation planning workshop for local governments - Part 3*, 2002, p. 9)

Local authorities within the United States seeking funding under the Hazard Mitigation Grant Program must meet the criteria set forth under Code of Federal Regulations *(CFR) §201.6 of the Interim Final Rule*. The required criteria are as follows:

Requirement §201.6(c)(2)(i):

> [The risk assessment shall include a] description of the … location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.
>
> The plans should also describe the analysis used to determine the probability of occurrence and magnitude of future hazard events. The plans should characterize each hazard and include the following information:
>
> - The probability or likelihood that the hazard event would affect an area;
> - The magnitude or severity of the hazard events;
> - The geographical extent or areas in the community that would be affected; and
> - The conditions, such as topography, soil characteristics, meteorological conditions, etc., in the area that make it prone to hazards.
>
> The analysis should be detailed enough to allow identification of the areas of the jurisdiction that are most severely affected by each hazard. (*DMA 2000 state & local plan interim criteria: Mitigation planning workshop for local governments - Part 3*, 2002, p. 14)
>
> Requirement §201.6(c)(2) (ii)(A):

[The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community. The plan should describe vulnerability in terms of:

- The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas… (*DMA 2000 state & local plan interim criteria: Mitigation planning workshop for local governments - Part 3*, 2002, p. 18)

Requirement §201.6(c)(2) (ii)(B):

[The plan should describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) of this section and a description of the methodology used to prepare the estimate. (*DMA 2000 state & local plan interim criteria: Mitigation planning workshop for local governments - Part 3*, 2002, p. 22)

Requirement §201.6(c)(2) (ii)(C):

[The plan should describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions. (*DMA 2000 state & local plan interim criteria: Mitigation planning workshop for local governments - Part 3*, 2002, p. 24)

Requirement §201.6(c)(2) (iii):

For multi-jurisdictional plans, the risk assessment section must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.

(*DMA 2000 state & local plan interim criteria: Mitigation planning workshop for local governments - Part 3*, 2002, p. 26)

Offering the British fire service's perspective on risk assessments, Davis (1997) and Klein (1997) propose the first step of a risk assessment is to identify all the potential hazards. When conducting the assessment, the assessor needs to consider a wide variety of hazards including hazards to firefighters, the environment, to occupants and with the building (Davis, 1997). Each major classification is then further divided into subcategories, as listed in Appendix E. Davis also purports categorizing each premises as complex and non-complex. Categorization is accomplished by comparing the situation posed by each building, facility, or site. The specific items and circumstances considered include:

Complex premises

- Major hazard sites as defined by European legislation
- Premises subject to radiation risks
- Premises subject to exposure or conflagration risks
- Buildings with large undivided floor area or high life risk
- Premises and sites where a fire threatens an explosion
- Where a major release of toxic or flammable material would be harmful to people or the environment

Non-complex premises

- Industrial premises with a variety of normal premises
- Public buildings
- Large isolated private residences

- Large multi-storey buildings
- Public utilities premises
- Teaching, training and research establishments
- Premises with a water supply problem
- Premises with difficult access to and/or within
- Premises requiring special arrangements to obtain extinguishing media

(Davis, 1997, pp. 12, 13)

Concerning risk assessments specific to the fire service, Klein (1997) identifies three types of incidents, specifically, fires, explosions, and mechanical damage. Klein's approach to hazard identification varies somewhat from that of Davis as his criteria considers hazards associated with the premises, people, chemicals, biological concerns, ionizing radiation, as well as mechanical and electrical equipment. His research suggests the following other factors must also be considered: "number of people likely to be exposed, time exposed to hazard, circumstances of exposure, physical characteristics of hazard, quantitative estimate of the 'size' of the hazard, characteristics of operation or activity, and the state of premises" (R. A. Klein, 1997, p. 29). The details applicable to each category herein noted are shown in Appendix K.

In U.S. fire service, risk assessments came to the forefront in late 1996 with the signing of an agreement between the International Association of Fire Chiefs (IAFC) and the International City/County Management Association (ICMA) for the purpose of forming an independent organization, the Commission On Fire Accreditation International (CFAI), to oversee the accreditation of fire departments (*Accreditation, NFPA 1710 and standards of response*, 2002). One of the studies engaged by CFAI

was a review of fire service deployment models. Electing to deviate from traditional linear systems such as response time and company staffing, the organization instead "chose a comprehensive systems approach to analyzing deployment in order to thoroughly assess whether a department pursuing accreditation is properly deployed to meet its community's risks and expectations" (S. W. Gary, 2001, p. 66).

Looking to automate the collection and analysis of risk assessment information for its system of cover process, CFAI collaborated with the United States Fire Administration (USFA). The product of that partnerships is RHAVE, a software program which electronically captures and analyzes data based on risk, hazards and values (*Accreditation, NFPA 1710 and standards of response*, 2002). The outputs of the program assist "local public policy makers who choose to collect useful information and data regarding the identification and assessment of fire and related risks within their community" (*U.S. Fire Administration offers new risk, hazard and value evaluation program for local officials*, 2002).

> Structure fire risk assessment is performed on the community's building stock. Common fire and life safety factors, such as fire flow and code compliance for life safety, are used to determine a risk classification. The four classes range from Low to Moderate, Significant and finally Maximum risk. The majority of most communities are Moderate or typical risk, which are dwelling units. To assist in achieving standardized risk typification [*sic*], the accreditation commission had a committee, in cooperation with the USFA, develop a software program to evaluate and score building risk. (S. W. Gary, 2001, p. 67)

Details of the information inputted into RHAVE are exhibited on the program's screen shots depicted in Appendix N. The list below provides a general overview of the criteria utilized within the program:

Premises

- Planning zone
- Property use and description
- Occupancy type
- Geographic location
- Major employer and number of employees
- Assessed value

Building

- Exposure separations
- Construction type
- Structure height
- Accessibility
- Building/structure size

Life Safety

- Occupant load
- Mobility of occupants
- Type of alarm system
- Status of conformance of existing system

Risk

- Frequency/Likelihood

- Regulatory Oversight
- Accessibility of authorized personnel
- Frequency of events
- Consequence
    - Capacity of the local fire department to control an event
    - Ranking of hazards within the building
    - Fire load within the building

Water Demand

- Required fire flow
- Available fire flow
- Availability of sprinklers

Value

- The value of the property to the community as a whole (Raddigan, 2000)

Concerning fire services within the Province of Ontario, the OFM published several guidelines since 1998 relating to simplified risk assessments and fire risk assessments. *PFSG 04-40A-12* (Appendix C) denotes the type of general information that assessors must gather and analyze when conducting a simplified risk assessment, with a far more detailed process outlined in *PFSG 04-40-03*. A synopsis of those needs identified in *PFSG 04-40-03* includes:

Community Demographic Profile

- Population makeup, based on age groupings
- Vulnerable individuals or occupancies

- Cultural differences, such as language and customs
- Seasonal population shifts in tourist areas, mobile homes, trailer parks, university/college locales, etc.
- Other considerations specific to certain municipalities

Building Stock Profile

- Breakdown by Ontario Building Code occupancy classification
- Building density (core areas)
- Age of building stock
- Potential high fire risk occupancies (industrial, commercial, residential)
- Potential high life safety risk occupancies (hospitals, nursing homes, detention centres [*sic*], group homes, residential care, retirement homes)
- Potential economic/employment/environmental impact

Municipal Fire Loss Profile

- Deaths/injuries
- Dollar loss
- Breakdown by occupancy classification (*Public fire safety guideline PFSG 04-40A-12: Fire prevention and public fire safety education - Simplified risk assessment*, 2001, pp. 1, 2)

Concentrating specifically on fire risk assessments, *PFSG 02-02-03* details the critical considerations when undertaking such an assignment (*Public fire safety guideline PFSG 02-02-03: Analyzing local circumstances - Risk assessment*, 1998). Appendix B provides an outline of those requirements; however, *PFSG 02-02-12*, the guiding document on the topic, provides the following general requirements:

All municipalities should analyze the what, where, who, why, and when questions about its fires, casualties and losses. Some of the elements to consider are as follows:

- the type and nature of the local municipality
- the building stock and occupancy types
- fire prevention and public education programs
- public and private fire protection systems
- political resolve/commitment
- historical analysis and comparisons
- comparative analysis with others
- special hazards
- major rail lines/waterways (*Public fire safety guideline PFSG 02-02-12: Analyzing local circumstances - Risk assessment*, 1998, p. 1)

Risk Assessment Models

Risk can be assessed by utilizing either qualitative or quantitative methodologies. Quantitative risk analysis looks at the probability of an event occurring, and the likely loss should it occur. However, several sources note that unreliability and inaccuracy of the data are inherent with this type of risk analysis (Clemens, 2000; Farrell, 2002; *Introduction to security risk analysis & risk assessment*, 2002; *Multi Hazard Identification and Risk Assessment*, 1997). Unfortunately, probability is difficult to predict accurately. Nevertheless, despite the flaws, quantitative risk analysis is successfully used by many organizations.

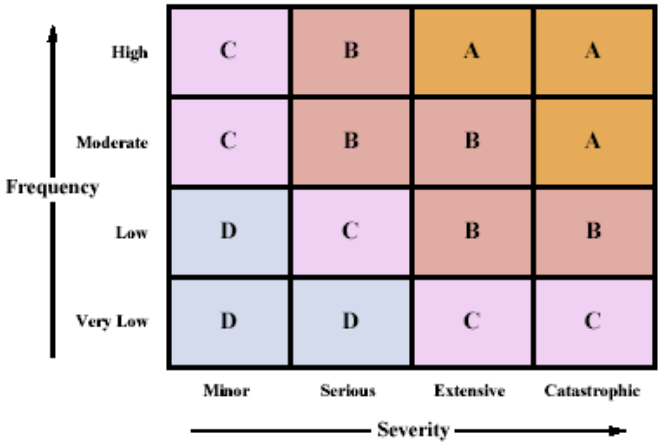

Figure 1. A risk assessment matrix using the letter method to categorize risk. (*Multi Hazard Identification and Risk Assessment*, 1997, p. 315)

One approach to quantitative risk assessment uses a risk matrix to graphically depict the degree of risk present (Clemens, 2000; Farrell, 2002; Mallet & Brnich, 1999; *Multi Hazard Identification and Risk Assessment*, 1997; Ream, 2002). Under this method, the y and x-axis of the charts, labeled as the probability of the occurrence of an event and the desired consequences, are assigned numeric values ranging between one and five (Clemens, 2000; Farrell, 2002), or in terms of high, medium, or low (R. A. Klein, 1997; Mallet & Brnich, 1999; Ream, 2002). Within the grid, the outcome may be captured through a numerical value, as shown in Appendices D, G and I, or as letters, as per the example shown in Figure 1. For those organizations electing to use the matrix method, FEMA suggests using the risk assessment process shown in Figure 2. Mallet & Brnich in their report to the U.S. Department of Health and Human Services, recommend the mining industry use a term-based fire hazard risk matrix, although they do caution that those ranking the hazards must be fully cognizant of the definitions of probability and severity. Clemens acknowledges the aforementioned method, but

advises there are problems with it because analysts often use the worst outcome to determine severity. Consequently, the ratings tend to be overly cautious.

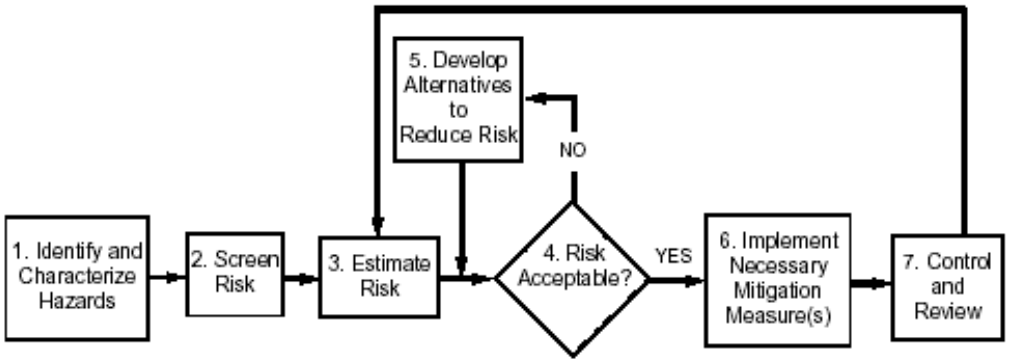

Figure 2. FEMA's multi-hazard process used to assess risks. (*Multi Hazard Identification and Risk Assessment*, 1997, p. 314)

Davis' (1997) approach, designed specifically for the British fire service, is based on the risk matrix model described earlier. The process commences by evaluating a risk based on its probability of occurrence, and the severity of the outcome. Unlike other models, this model uses eight severity and probability rating levels, as shown in Appendix F. Once the severity and probability values are determined, they are transferred to the risk-rating matrix found in Appendix G. The resultant risk rating value is then applied to the Range of Risk table, also found in the Appendix G, to determine the necessary course of action.

Davis also speaks of another method that simply categorizes risk as A, B or C. "The current method of assessing standards of fire cover is by a points value awarded on the basis of the buildings' construction and risk of spread" (Davis, 1997, p. 14). Like other systems, numerical values are assigned to specific descriptors under the

categories of density (the area of the building), separation (exposures from other structures), construction (type), number of stories, and occupancy rating. The total of these points generates a risk rating, which in turn is compared against a simple risk table to determine the risk rating for that premises. The shortened version of this model can be found in Appendix H.

The approach of the another British author, Klein (1997), differs somewhat. A comprehensive hazard rating process (Appendix J) and detailed risk assessment criteria (Appendix K) are used in conjunction with a simple risk-rating matrix (Appendix I). Once the risk rating is determined, the evaluator enters the hazards, and the corresponding risks values, into a Risk Assessment Form (Appendix L). They must then determine the actions necessary to eliminate, minimize, or control the risk, and note their recommendations on the form. In this model, severity and risk are considered cumulative in nature, and, accordingly, the sum of each is totaled at the bottom of the appropriate column. As an aside, the information gathered is then used to develop Headline Risk Cards (Appendix M) for responding companies. While responding to an incident, the officers can get a quick overview of the problems awaiting them, as well as review the potential actions to take depending upon the nature of the emergency.

"RHAVE is a 'quick and dirty' method for categorizing buildings based on the information requested in the OVAP" (Ortiz, 1999, p. 1). Considering three factors, risk, hazard, and value, the software program outputs an Occupancy Vulnerability Assessment Profile (OVAP) score. Ortiz, the Fire Chief of Santa Maria, California, claims that his department with 35 staff were able to profile more than 17,500 buildings within a two month period (Ortiz, 1999). "By plotting the risk areas on a map with one

overlay of available resources and another overlay of concentration issues, the department is able to make intelligent recommendations on resource requirements, as well as fixed fire protection and other life safety measures" (Ortiz, 1999, p. 1).

As suggested earlier, the RHAVE process considers more than just risk. Assessors start the process by simply opening a new file. They are then prompted to seek information concerning the premises, the building, life safety issues, risk, water demand, and value. Each category may contain three of four subcategories within it. Once all the requisite data is entered into the appropriate fields, a summary screen shows the OVAP score. The OVAP score, compared against a scale ranging from low, moderate, significant, and maximum, produces a risk rating. Screen shots of the prompts are shown in Appendix N.

Wright's (1999) work for the British Home Office, Fire and Emergency Planning Directorate, proposes a risk assessment for large-scale, low frequency emergencies. As a first step, fire brigades need to identify the types of incidents or hazards within their area of response; however, he notes that in some cases, key information associated with such events is often not available at the local level, and, as a result, such data must sometimes be obtained from national and international sources. As depicted in Figure 3, the next step in the process involves determining the tolerability of risk, followed by looking at worst-case scenarios along with response goals, and finally assessing the emergency response resources. The information gathered is then entered into the risk assessment matrix shown in Appendix O. Appendix P, a risk-rating guide, provides the necessary prompts so that assessors can look at their local situation, and then equate it accordingly.

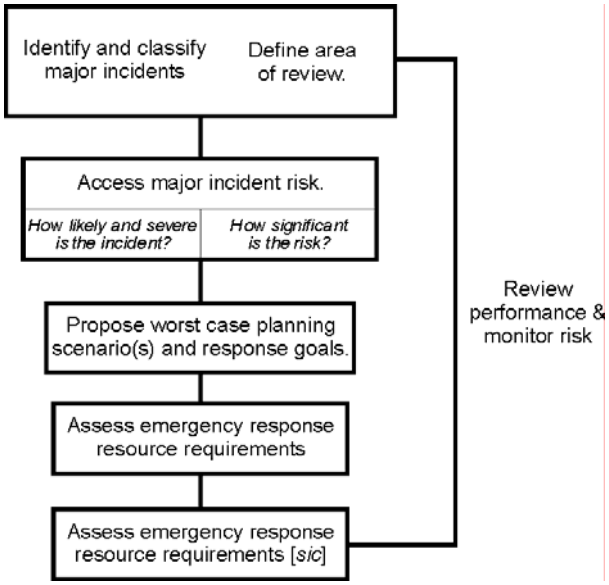

Figure 3. An overview of the major incident risk assessment process. (Wright, 1999, p. 7)

A fire risk assessment model proposed by the OFM was acknowledged earlier in the literary review. *PFSG 02-02-03* does not propose an actual process, instead it offers criteria to consider, as shown in Appendix B (*Public fire safety guideline PFSG 02-02-03: Analyzing local circumstances - Risk assessment*, 1998). *PFSG 04-40-03*, the guideline for simplified risk assessments, does provide a process, albeit it is for the purposes of developing a general community fire profile. The process involves gathering information and statistics in the following three categories: community demographics, building stock, and municipal fire loss, deaths and injuries.

The Underwriters' Laboratories of Canada released *Fire Risk Analysis – Rating System* in June of 2001. The system, which can use a paper format, a software program, or both, looks at three main areas: real property risk factors, property

management and usage risk factors, and human risk factors (*Fire risk analysis - rating system*, 2001). Evaluators assess the various features of a building by selecting the applicable text prompt (Appendix Q). Their selection generates a numerical risk value to that specific feature. The overall summation of these risk values produces a risk rating for that property. For those using the computerized version, the software program automatically summarizes the data in several ways, as shown in Appendix R ("Fire risk analysis - rating system," 2001).

Literature Review Summary

"The possibility of suffering harm or loss; danger" or "a factor, thing, element, or course involving uncertain danger; a hazard" (Rathmell et al., 1994), and "the chance of injury, damage, or loss" (*What is risk?*, 2002a, p. 1) is how two dictionaries define risk, while Granger, Jones, Leiba, & Scott (1999) describe risk as "the outcome of the interaction between a hazard phenomenon and the vulnerable elements at risk (the people, buildings and infrastructure) within the community" (p. 25). Others contend risk is best described by a mathematical expression such as risk is equal to the product of probability times severity (*Glossary of risk analysis terms*, 2001; *How is risk measured?*, 2002; R. A. Klein, 1997; Meston, 2001; *NFPA 1250: Recommended practice in emergency service organization risk management*, 2000), or risk is equal to probability multiplied by consequence (*Dealing with risk*, 2001; *Glossary of risk analysis terms*, 2001).

"Simply, a risk assessment asks, 'How risky is this situation?' while risk management asks, 'What shall we do about it?'" (Iolster & Flanagan, 1997, p. 7). Formal definitions include: the identification of potential adverse health effects on

humans or ecosystems resulting from exposure to the same (White, 2000); “a process or application of a methodology for evaluating risk as defined by probability and frequency of occurrence of a hazard event, exposure of people and property to the hazard, and consequences of that exposure” (*Multi Hazard Identification and Risk Assessment*, 1997, p. 295); “Using sound concepts to detect, hazards and estimate the risk they pose” (*What is risk?*, 2002b, p. 1); and, “the process of detecting hazards and assessing associated risks” (Beckvonpeccoz, 1997, p. 6).

Four standards refer to the subject of risk assessment, *NFPA 1201, 1250, 1600, and 1670*. Concerning applicable Canadian legislation, the *Emergency Preparedness Act, R.S., 1988* governs emergency preparedness from a federal perspective, while the *Emergency Plans Act, R.S.O. 1999,* deals with related matters at a provincial level. According to the OFM, the *Fire Protection and Prevention Act*, *S.O. 1997, c. 4* mandates municipalities complete, at the very least, a simplified risk assessment. However, more in-depth risk assessments may become regulatory requirements for Ontario municipalities should *Bill 148*, currently before the legislature, be enacted. Locally, the City’s Peacetime Emergency Plan provides general guidance concerning emergency preparedness matters.

Risk assessment criteria may include information about the numbers and types of structures, potential dollar losses, and an overall description of land use trends ("Understanding your risks: Identifying hazards and estimating losses (FEMA 386-2)," 2001), the frequency and predicted severity of events (*NFPA 1250: Recommended practice in emergency service organization risk management*, 2000), as well as detailed descriptions of potential hazards within the municipality, including a vulnerability

analysis (*Strategic planning guide for the evacuation of a highly urbanized environment*, 2001; "Understanding your risks: Identifying hazards and estimating losses (FEMA 386-2)," 2001).

Several sources suggest the first step to a risk assessment is to identify all the potential hazards (Davis, 1997; *DMA 2000 state & local plan interim criteria: Mitigation planning workshop for local governments - Part 3*, 2002; R. A. Klein, 1997). Then, assessors need to consider a wide variety of factors such as those shown in Appendices B, C, E, H, J, K, N, and Q.

Quantitative risk analysis relies primarily on two fundamental factors, probability and consequence (Farrell, 2002; *Introduction to security risk analysis & risk assessment*, 2002; *Multi Hazard Identification and Risk Assessment*, 1997). A common quantitative risk assessment technique, used internationally within a variety of fields and industries, is the risk matrix. Probability and consequence are plotted on a chart, which in turns delivers a risk rating (Clemens, 2000; Davis, 1997; Farrell, 2002; R. A. Klein, 1997; Mallet & Brnich, 1999; *Multi Hazard Identification and Risk Assessment*, 1997; Ream, 2002). RHAVE, a computerized quantitative method, does not use a matrix; however, the program outputs an Occupancy Vulnerability Assessment Profile (OVAP) score, which then can be translated into a risk rating (Ortiz, 1999).

PROCEDURES

Definition of Terms

Consequence. "The outcome of an event or situation expressed qualitatively or quantitatively, being a loss, injury, disadvantage or gain" (Blanchard, 1999, p. 5).

Emergency.

"An unexpected event which places life and/or property in danger and requires an immediate response through the use of routine community resources and procedures. Examples would be a multi-automobile wreck, especially involving injury or death, and a fire caused by lightning strike which spreads to other buildings. Emergencies can be handled with local resources" (Blanchard, 1999, p. 14).

E.O.C.G. Emergency Operations Control Group

Frequency. "The number of occurrences per unit time at which observed events occur or are predicted to occur "(*NFPA 1250: Recommended practice in emergency service organization risk management*, 2000, p. 4).

Hazard.

"Hazard means an event or physical condition that has the potential to cause fatalities, injuries, property damage, infrastructure damage, agricultural loss, damage to the environment, interruption of business, or other types of harm or loss" (Blanchard, 1999, p. 16).

Probability. "The likelihood that a given event will occur" (Rathmell et al., 1994).

Severity. "When the event does occur, how severe are its adverse consequences?" (*NFPA 1250: Recommended practice in emergency service organization risk management*, 2000, p. 18).

Vulnerability. "The potential for loss or the capacity to suffer harm from a hazard…can generally be applied to individuals, society, or the environment (Blanchard, 1999, p. 21).

Research Methodology

The focus of this research paper was to create a risk assessment worksheet (Appendix A) for company officers and fire prevention inspectors. The critical information gathered during the process will help the LFD assess risks in the municipality for the purposes of meeting regulatory requirements, assisting with operational planning, and demonstrating due diligence. Since the goal was to create a product, the researcher employed an action research methodology.

Literature Review

The procedure commenced in June 2002 with a literature review of the pertinent trade journals and magazines archived within the NFA's Learning Resource Center (LRC). Other such references were also obtained later in the year via local libraries, on-line sources, and the LFD library. Acts, standards and guidelines related to emergency planning and response were acquired from several sources, including on-line Internet resources, government offices, and standards organizations. Information germane to the topic was subsequently summarized and documented in the literature review section of this paper.

Risk Assessment Criteria and Model Evaluation

A simple matrix was utilized in the research process to establish commonalities between the various models, as well as identify the common types of risk assessment criteria. Recognizing the degree of detail employed by several of the models, the researcher decided to use the major categorizes of criteria for the initial comparison.

Construction of the matrix commenced by listing those models found in the columns along the x-axis. Unfortunately, the researcher did not have a universally

recognized list of criteria to input into the matrix. Accordingly, when new criterion was identified during the literature review, it was assigned to a row along the y-axis.

With the matrix complete, each model was then individually evaluated for the purposes of identifying the type of criteria it used to output a risk value, or a risk descriptor. As a criterion was identified during the evaluation, it was recorded in the matrix by entering a checkmark into the corresponding row. Criteria found to be common across several models served to form the basis of the risk assessment worksheet noted earlier. The summary of that evaluation can be found in Appendix S.

To understand how other industries and sectors evaluate risk, the models selected for evaluation models were not limited to those used by the fire service, particularly those used in North America. Several British fire service models were evaluated, as were models from emergency preparedness organizations, various government agencies, the U.S. military, the mining sector, as well as others.

Assumptions and Limitations

The outcomes of this research project are dependent upon the reliability and accuracy of the research methodology employed by the authors selected, differences in terminology used between the disciplines studied, and the accuracy of this researcher's interpretation of the literary material. Other potential limitations include a lack of books on the subject specific to the fire service. Further, several Canadian and British sources were cited in this paper, and while every effort was made to acknowledge the different spellings of certain words, some may have been inadvertently missed. Finally, the professional commitments of the researcher, and the six-month time limit presented challenges, which prevented a more comprehensive review of the subject matter.

RESULTS

Answers to Research Questions

Research Question 1. Strict dictionary definitions for risk include: "The possibility of suffering harm or loss; danger" or "a factor, thing, element, or course involving uncertain danger; a hazard" (Rathmell et al., 1994); and, "the chance of injury, damage, or loss" (*What is risk?*, 2002a, p. 1). ESRI, a U.S. based graphical information system (GIS) company simply describes risk as "the potential or likelihood of an emergency to occur" (*GIS for emergency management*, 1999, p. 4). Expanding upon that definition, Granger, Jones, Leiba, & Scott (1999) cite it as "the outcome of the interaction between a hazard phenomenon and the vulnerable elements at risk (the people, buildings and infrastructure) within the community" (p. 25).

Several entities describe risk as a mathematical expression. Some see it as being equal to the product of probability times severity (*Glossary of risk analysis terms*, 2001; *How is risk measured?*, 2002; R. A. Klein, 1997; Meston, 2001; *NFPA 1250: Recommended practice in emergency service organization risk management*, 2000), while others advocate the theory that risk is equal to the product of probability times consequence (*Dealing with risk*, 2001; *Glossary of risk analysis terms*, 2001) . Klein (2001) agrees to the latter formula; however, in his opinion, hazard is a third variable that needs to be included.

According to Meacham (2001), risk can be categorized as quantifiable or qualitative. Quantifiable risks, frequently expressed by a mathematical equation, rely on the availability of objective data (Kuepper, 1999; Meacham, 2001). A qualitative approach is used when there are doubts concerning the accuracy of data related to

frequencies and consequences (*Introduction to security risk analysis & risk assessment*, 2002; Meacham, 2001). In a report submitted by J. S. Hammonds et al., entitled *Background Risk Information to Assist in Risk Management Decision Making,* he and his group proposed there are two types of risk: statistically verifiable or statistically non-verifiable (*What is risk?*, 2002a). Verifiable risks are determined from direct observation, whereas non-verifiable risks are based on imperfect facts and algebraic equations.

Research Question 2. "Scarce time and resources prevent individuals and society from doing everything that they might to reduce risks to health, safety, and the environment" (Long & Fischhoff, 2000, p. 339). Accordingly, risk assessments are tools that allow managers to evaluate if sufficient resources are deployed to achieve the outcome desired (*Emergency planning: A guide for emergency planning for community officials*, 2001; S. Gary, 2001; Levitin, 1998). Sometimes characterized as a catalyst (*What is risk?*, 2002b), or the first step toward developing important critical decision making management tools (*Emergency planning: A guide for emergency planning for community officials*, 2001; S. Gary, 2001; Levitin, 1998), risk assessments also identify shortcomings with respect to meeting regulatory requirements (*Risk assessment*, 2002; Short & Rosa, 1998).

Several descriptions of risk assessment exist. Samples include: "the identification of potential adverse health effects on humans or ecosystems resulting from exposure to the same" (White, 2000, p. 17); "a process or application of a methodology for evaluating risk as defined by probability and frequency of occurrence of a hazard event, exposure of people and property to the hazard, and consequences of

that exposure" (*Multi Hazard Identification and Risk Assessment*, 1997, p. 295); "Using sound concepts to detect, hazards and estimate the risk they pose" (*What is risk?*, 2002b, p. 1); **"**the process of detecting hazards and assessing associated risks" (Beckvonpeccoz, 1997, p. 6); and "the characterization of the potential adverse health effects of human exposures to environmental hazards" (Stallones et al., 1983, p. 18). Although the latter definition applies best in situations where environmental health hazards are the key concern (White, 2000), several authors reference this definition in their writings (*Glossary of risk analysis terms*, 2001; Iolster & Flanagan, 1997; Mehta, 2002; White, 2000). Strangely, some see risk assessment as a scientific issue (Iolster & Flanagan, 1997), while others view it as a policy and social matter (*Glossary of risk analysis terms*, 2001; Iolster & Flanagan, 1997). Despite the differing views, "all of these issues are integral parts of the risk assessment process" (Iolster & Flanagan, 1997, p. 4).

Identifying hazards, and assessing the organization's vulnerability based on those hazards, facilitates the introduction of defensive steps to evade some, or all of the associated risks (Gordon, 2000), as well as the prioritization of mitigation strategies (*Public fire safety guideline PFSG 04-40A-12: Fire prevention and public fire safety education - Simplified risk assessment*, 2001; "Understanding your risks: Identifying hazards and estimating losses (FEMA 386-2)," 2001). In short, risk assessments allow jurisdictions to develop a community risk profile, which enables them to prioritize plans of action (*NFPA 1250: Recommended practice in emergency service organization risk management*, 2000).

While the British fire service has been gathering information for the purposes of

identifying risks for over 50 years (Davis, 1997), the concept has only come to the forefront in North American with the introduction of fire department accreditation, as well as the introduction of *NFPA 1710* and *NFPA 1720* (*Evaluating Community Emergency Services*, 2002). Davis explains that the British fire service made the transition toward fire risk assessments because they sought a tool to protect the public and firefighters. They consider critical elements such as the likelihood of the hazard occurring, and the consequences of the occurrence. Farrell's (2002) concept of the process involves five stages, namely, indication, estimation of occurrence, estimation of consequence, risk calculation, and risk acceptability.

Research Question 3. Four standards speak to the topic of risk assessments, specifically, *NFPA 1201, 1250, 1600* and *1670*. Although *NFPA 1250* references the subject, the document as a whole looks primarily at internal organizational risks instead of those within the community. *NFPA 1201*, a standard that describes the development of fire protection for the public, cites the need to identify and evaluate risks in several areas of the document, as well as the need to develop disaster plans. *NFPA 1670* looks specifically at emergency responses; however, the risk assessments therein noted focus directly upon those hazards and risks normally associated with technical rescue situations. The final NFPA standard reviewed, *NFPA 1600,* addresses the broader subject of community disaster and emergency management. Chapter 3 of *NFPA 1600* requires municipalities to identify hazards and conduct risk assessments, taking into consideration the probability of occurrence and vulnerability of citizens, property, the environment, and the entity itself, and at a minimum, consider natural events, technological events and human events (*NFPA 1600: Standard on*

disaster/emergency management and business continuity programs, 2000). The standard also requires that the assessment process predict the potential impact the identified hazards may have on the following: the health and safety of persons within area impacted by the incident; the health and safety of responding personnel; operational continuity; property, facilities, and infrastructure; delivery of services; the environment; economic and financial condition; regulatory and contractual obligations; and the reputation of the entity.

Canadian legislation, through the *Emergency Preparedness Act, R.S., 1988, c. 6 (4th Supp.)*, covers emergency preparedness issues. Concerning municipal requirements, Chapter 4 of the statute speaks to the Minister so charged advancing emergency preparedness by way of the development and implementation of civil emergency plans, and that emergency preparedness efforts be limited to facilitation and coordination with the provincial governments ("Emergency Preparedness Act," 1988, p. 2). Chapter 5 limits Ministerial responsibilities to encouraging and supporting local preparedness through provincial governments, or agencies thereof, through such ancillary services like emergency preparedness education and training, and public awareness.

The *Emergency Plans Act, R.S.O., 1999, c. 12, Schedule. P, ss. 3-9*, the governing legislation that deals with emergencies in the province of Ontario, empowers municipal councils to pass by-laws to create emergency plans for the purposes of authorizing employees to take certain actions before the declaration of a provincial emergency, specifying evacuation procedures, providing for the delegation of powers and duties of the Act to a designate should the head of council be absent, establishing

committees and/or designate an employee to review the emergency plan, training employees and, when required, implementing the plan during an emergency, and authorizing the purchase and distribution of necessary items during an emergency ("Emergency Plans Act," 1999, p. 2). In limited circumstances where a known threat exists, the Lieutenant Governor in Council can direct municipalities to formulate an emergency plan.

Bill 148, an initiative forwarded by the provincial government, if enacted, shall mandate the current permissive language, as well as broaden the scope of emergency planning ("Emergency Management Act," 2002). Mandates include the development and implementation of emergency management programs, the formalization of emergency management programs through municipal by-laws, implementation of emergency plans, training programs and exercises for municipal employees, public education focusing on emergency preparedness, as well as a provision to add other elements as required by the standards for emergency management programs. Not found previously in the Act, though herein proposed, is a new mandate:

> (3) In developing its emergency management program, every municipality shall identify and assess the various hazards and risks to public safety that could give rise to emergencies and identify the facilities and other elements of the infrastructure that are at risk of being affected by emergencies. ("Emergency Management Act," 2002, p. 2)

Contained within the provincial framework, and providing guidance to municipalities and fire services, are the Public Fire Safety Guidelines (PFSG) developed by OFM. The guidelines developed by the OFM tend to focus mainly on fire type

emergencies, albeit some deal directly with the topic of risk. *PFSG 02-02-12*, which requires municipal councils and fire administrations to analyze local circumstances with respect to risk, states, “municipalities should analyze the what, where, who, why, and when questions about its fires, casualties and losses” (*Public fire safety guideline PFSG 02-02-12: Analyzing local circumstances - Risk assessment*, 1998, p. 1). The requisites of the applicable provincial guidelines are listed in Appendices B and C.

The *Peacetime Emergency Plan*, the guiding document for employees and entities of the City of London during declared emergencies, cites that the Fire Chief is responsible for the maintenance of hazardous material spills plans, specifically with regard to the prevention of explosions and the spread of poisonous vapors (*Peacetime Emergency Plan*, 2002). Similarly, the Commissioner of Environmental Services & City Engineer is charged with “maintaining procedures and plans for Engineering response to spills of hazardous materials including containment, neutralizing and clean-up, upon advice from the Fire Department as to the material involved and the remedial action required” (*Peacetime Emergency Plan*, 2002, p. 7).

Research Question 4. Detailed descriptions of potential hazards within the municipality, as well as a vulnerability analysis, form the basis of a proper risk assessment (*Strategic planning guide for the evacuation of a highly urbanized environment*, 2001; "Understanding your risks: Identifying hazards and estimating losses (FEMA 386-2)," 2001). Information regarding the numbers and types of structures, potential dollar losses, and an overall description of land use trends ("Understanding your risks: Identifying hazards and estimating losses (FEMA 386-2)," 2001), combined with a prediction regarding the frequency and severity of events

(*NFPA 1250: Recommended practice in emergency service organization risk management*, 2000), form an integral part of the assessment. The Office of Critical Infrastructure Protection and Emergency Preparedness (OCIPEP) suggests that prior to commencing such an assessment the municipality should be segregated into planning sectors (*Strategic planning guide for the evacuation of a highly urbanized environment*, 2001). Data regarding equipment, material, existing and available resources, procedures and agreements is then linked to these planning sectors to facilitate the development of area specific mitigation strategies (*Strategic planning guide for the evacuation of a highly urbanized environment*, 2001).

CFR 201.69[c][ii] of the Interim Final Rule cites the U.S. Government's criteria pertaining to risk assessments. Administrated by FEMA, the CFRs call for the implementation of a six step process which identifies hazards, profiles hazard events, identifies assets, estimates potential loss, analyzes trends concerning development, and requires a multi-jurisdictional risk assessment (*DMA 2000 state & local plan interim criteria: Mitigation planning workshop for local governments - Part 3*, 2002). Ontario legislatively directs municipalities to complete, as a minimum, a simplified risk assessment ("Fire Protection and Prevention Act," 1997; *Public fire safety guideline PFSG 04-40A-12: Fire prevention and public fire safety education - Simplified risk assessment*, 2001). Information compiled and analyzed in the process should include the community's demographic profile, building stock, and municipal fire loss, which also includes deaths, injuries, as well as dollar loss. Details regarding the information required are documented in the literary review, as well as Appendix C of this research paper.

Focused on fire risk assessments, but nevertheless a recommendation by the Government of Ontario, the OFM also advocates looking at factors such as “the type and nature of the local municipality, the building stock and occupancy types, fire prevention and public education programs, public and private fire protection systems, political resolve and commitment, historical analysis and comparisons, comparative analysis with others, special hazards and major rail lines/waterways” (*Public fire safety guideline PFSG 02-02-12: Analyzing local circumstances - Risk assessment*, 1998, p. 1). Appendix B provides the comprehensive list of considerations.

Continuing with risk assessments in the fire service, in this case the British fire service, hazard identification is not only cited as part of the criteria, but noted as being the first step in the process (Davis, 1997; R. A. Klein, 1997). When searching for hazards, Davis recommends looking for hazards to firefighters, the environment, to occupants, and those inherent in the building. Klein’s (1997) hazard identification focuses specifically on fires, explosions, and mechanical damage. Deviating from Davis’ approach, Klein recommends considering hazards associated with the premises, people, chemicals, biological concerns, ionizing radiation, and mechanical and electrical equipment, as well as the “number of people likely to be exposed, time exposed to hazard, circumstances of exposure, physical characteristics of hazard, quantitative estimate of the ‘size’ of the hazard, characteristics of operation or activity, and the state of premises” (R. A. Klein, 1997, p. 29). The details of Davis’ and Klein’s criteria can be found in Appendices E and K, respectively.

RHAVE is probably the most widely known risk assessment process within the U.S. fire service. A collaborative effort between the CFAI and the USFA, the computer

software program evaluates each premises based on risk, hazards, and its value (*Accreditation, NFPA 1710 and standards of response*, 2002). The program works ideally in those circumstances where the fire department is looking to apply a system of cover approach to fire protection. System of cover strays away from traditional linear systems that solely consider response time and company staffing, and instead uses "a comprehensive systems approach to analyzing deployment in order to thoroughly assess whether a department pursuing accreditation is properly deployed to meet its community's risks and expectations" (S. W. Gary, 2001, p. 66). The process will assist "local public policy makers who choose to collect useful information and data regarding the identification and assessment of fire and related risks within their community" (*U.S. Fire Administration offers new risk, hazard and value evaluation program for local officials*, 2002). The community's building stock, life safety factors, fire flow, and code compliance are just some of the criteria utilized by RHAVE (S. W. Gary, 2001). The main categories examined include general information about the premises, building features, life safety systems, water demand requirements, the value of the property to the community, and risk factors, which are determined based on the frequency of events, and the consequences should those events occur. Details concerning each category are listed in the literary review on page 32, and Appendix N.

Research Question 5. Quantitative risk assessments rely primarily on two fundamental factors, probability and consequence (Farrell, 2002; *Introduction to security risk analysis & risk assessment*, 2002; *Multi Hazard Identification and Risk Assessment*, 1997). Since predicting probability with any degree of accuracy is nearly impossible, those using such systems must be cognizant of the potential unreliability and inaccuracy

of the data (Clemens, 2000; Farrell, 2002; *Introduction to security risk analysis & risk assessment*, 2002; *Multi Hazard Identification and Risk Assessment*, 1997). Despite the limitations, quantitative methods are still quite popular.

Risk matrices are a common method of quantitative risk assessment. Used internationally, and within many fields and industries, risk matrices graphically depict probability and consequence on a chart, which in turn produce a risk rating (Clemens, 2000; Davis, 1997; Farrell, 2002; R. A. Klein, 1997; Mallet & Brnich, 1999; *Multi Hazard Identification and Risk Assessment*, 1997; *Operational Risk Management*, 2002; Ream, 2002). Inputs for probability and consequence can be expressed using a combination of descriptive terms and numeric values. Alternatively, the terms may be categorized using a variety of descriptive phrases (R. A. Klein, 1997; Mallet & Brnich, 1999; *Multi Hazard Identification and Risk Assessment*, 1997; *Operational Risk Management*, 2002; Ream, 2002), with examples shown in Figure 1, and Appendices D, and I. Outputs, or the risk ratings, are then either expressed as numeric values (Appendices D, G, and I) (Davis, 1997; Farrell, 2002; K. Klein, 2001; *Operational Risk Management*, 2002), or as letters (see Figure 1) (*Multi Hazard Identification and Risk Assessment*, 1997).

The model that FEMA proposes goes beyond simply rating the risk. The organization recommends using a seven step process (see Figure 2) that considers hazard identification, risk screening, risk rating, determining risk acceptability, risk reduction alternatives, implementation of mitigation strategies, and control and review practices (*Multi Hazard Identification and Risk Assessment*, 1997).

Several of the risk assessment methodologies found during the research process come from the British fire service. Davis' (1997) and Klein's (1997) approaches both

use the risk matrix model. Davis' model uses the descriptive terminology found in Appendix F as a guide, while Klein proposes using the terminology shown in Appendix J. In both cases, the probability and severity values are then are plotted on a risk matrix such as Davis' in Appendix G, or Klein's in Appendix I. Davis then takes risk-rating value obtained from the matrix and applies it against a risk range table to determine the degree of risk, which consequently specifies what type of action is necessary. Klein on the other hand uses a Risk Assessment Form (Appendix L).

A third British model exists; however, this risk assessment model is structured for large scale, low frequency emergencies (Wright, 1999). Commencing with the identification of hazards, fire service personnel are encouraged to look beyond local experiences, and consider pertinent data from national and international sources. Evaluative steps include determining the tolerability of risk, predicting worst-case scenarios, establishing response goals, and assessing the emergency response resources. Using the risk-rating guide shown in Appendix O, the data is recorded in a risk assessment chart (Appendix P).

RHAVE is a risk assessment process recently introduced into the U.S. fire service (*Accreditation, NFPA 1710 and standards of response*, 2002). Offered in a computer software format, RHAVE evaluates the risk, hazards and value of a building, with the output being an OVAP score (Ortiz, 1999). The OVAP score when compared against a risk value range indicates the level of risk present (S. W. Gary, 2001). The process also accentuates areas of concern related to fixed fire protection systems and life safety measures. Ortiz claims his department was able to review resource requirements by plotting the data on maps. Screen shots of the prompts are shown in

Appendix N.

Evaluating real property risk factors, property management and usage risk factors, and human risk, the Underwriters' Laboratories of Canada *Fire Risk Analysis – Rating System* is another version of an automated risk assessment process (*Fire risk analysis - rating system*, 2001). The program, driven by the text prompts shown in Appendix Q, produces numerical risk rating values. Cumulative risk values can be viewed by category, or as an overall total for the building.

The literary review also uncovered a fire risk assessment model within the OFM's guidelines. *PFSG 02-02-03*, however, focuses primarily on criteria to consider during such a process, and not the process itself (*Public fire safety guideline PFSG 02-02-03: Analyzing local circumstances - Risk assessment*, 1998). Mandated by law ("Fire Protection and Prevention Act," 1997), a community fire profile is the product of the simplified risk assessment required by another OFM guideline, *PFSG 04-40-03* (*Public fire safety guideline PFSG 04-40-03: Fire prevention and public fire safety education - Simplified risk assessment*, 2001). Information and statistics concerning community demographics, building stock, and municipal fire loss, as well as fire related deaths and injuries, are entered into charts and tables (*Public fire safety guideline PFSG 04-40-03: Fire prevention and public fire safety education - Simplified risk assessment*, 2001).

Risk Assessment Criteria and Model Evaluation. An extensive list of criteria was discovered during the evaluation of the various risk assessments models. The process revealed that the prediction of frequency and severity of events, as well as hazard identification, were by far the most widely used criteria. A more complete listing of the risk assessment criteria may be found in Appendix S, as well as results of the

comparative analysis. Although not all inclusive, the following list identifies other frequently recurring criteria:

- prediction of the frequency and severity of events (R. A. Klein, 1997; *NFPA 1250: Recommended practice in emergency service organization risk management*, 2000; Raddigan, 2000; *Strategic planning guide for the evacuation of a highly urbanized environment*, 2001; "Understanding your risks: Identifying hazards and estimating losses (FEMA 386-2)," 2001)
- vulnerability (Gordon, 2000; *NFPA 1250: Recommended practice in emergency service organization risk management*, 2000; *NFPA 1600: Standard on disaster/emergency management and business continuity programs*, 2000; *Public fire safety guideline PFSG 02-02-12: Analyzing local circumstances - Risk assessment*, 1998; Raddigan, 2000; "Understanding your risks: Identifying hazards and estimating losses (FEMA 386-2)," 2001)
- type of structure (*Fire risk analysis - rating system*, 2001; *NFPA 1250: Recommended practice in emergency service organization risk management*, 2000; *Public fire safety guideline PFSG 02-02-12: Analyzing local circumstances - Risk assessment*, 1998; Raddigan, 2000)
- occupancy types (*Fire risk analysis - rating system*, 2001; *Public fire safety guideline PFSG 02-02-12: Analyzing local circumstances - Risk assessment*, 1998; Raddigan, 2000)
- potential dollar loss (*NFPA 1250: Recommended practice in emergency service organization risk management*, 2000; *Public fire safety guideline*

PFSG 02-02-12: Analyzing local circumstances - Risk assessment, 1998; Raddigan, 2000; "Understanding your risks: Identifying hazards and estimating losses (FEMA 386-2)," 2001)

- public and private fire protection systems (*Fire risk analysis - rating system*, 2001; *Public fire safety guideline PFSG 02-02-12: Analyzing local circumstances - Risk assessment*, 1998; Raddigan, 2000)
- identifying planning sectors (*NFPA 1201: Standard for developing fire protection services for the public*, 2000; *NFPA 1670: Standard on operations and training for technical rescue incidents*, 1999; Raddigan, 2000; *Strategic planning guide for the evacuation of a highly urbanized environment*, 2001; "Understanding your risks: Identifying hazards and estimating losses (FEMA 386-2)," 2001), and
- resource deployment (*Fire risk analysis - rating system*, 2001; *NFPA 1201: Standard for developing fire protection services for the public*, 2000; *Strategic planning guide for the evacuation of a highly urbanized environment*, 2001)

DISCUSSION

The shortness of the word suggests that a simple dictionary definition should adequately define risk; however, the research showed that was not the case. Although dictionary definitions use phrases such as injury, damage, and loss (*What is risk?*, 2002a), or harm and loss (Rathmell et al., 1994), other descriptions imply a greater complexity. ESRI (*GIS for emergency management*, 1999), for example, elects to use descriptive words like chance, possibility, potential and likelihood suggesting an

unknown, or a unpredictability to the outcome. These axioms imply the existence of a mathematical facet to the concept. The theory supported by the NFPA, NZSRM, RAIS, and SRA, whereby risk is expressed as probability multiplied by consequence, best suits the needs of the LFD. (*Dealing with risk*, 2001; *Glossary of risk analysis terms*, 2001; *How is risk measured?*, 2002; *NFPA 1250: Recommended practice in emergency service organization risk management*, 2000).

The LFD, like so many other fire departments, strives to do its best to fulfill the needs of the community; however, financial pressures may limit its ability to "reduce risks to health, safety, and the environment" (Long & Fischhoff, 2000, p. 339). Looking to maximize the delivery of service to the community, as well as comply with fire service standards and other regulatory requirements (*Risk assessment*, 2002; Short & Rosa, 1998), such as *NFPA 1710* and *Bill 148,* the department needs to consider developing and implementing a risk assessment process. The information gleaned will permit it to identify and analyze probable risks, and determine if it has sufficient resources deployed to meet those challenges (*Emergency planning: A guide for emergency planning for community officials*, 2001; S. Gary, 2001; Levitin, 1998). Once a community risk profile is created, the department could then prioritize plans of action (*NFPA 1250: Recommended practice in emergency service organization risk management*, 2000; *Public fire safety guideline PFSG 04-40A-12: Fire prevention and public fire safety education - Simplified risk assessment*, 2001; "Understanding your risks: Identifying hazards and estimating losses (FEMA 386-2)," 2001). Late in the fall of 2001, the department fulfilled its requirement to complete a simplified risk; however, the results of

that process are far too vague to assist it with any specific issues concerning deployment, staffing, and other operational matters.

Seeking a risk assessment definition for adoption by the LFD, in this researcher's opinion, the following description offered by FEMA seems the most appropriate:

> "a process or application of a methodology for evaluating risk as defined by probability and frequency of occurrence of a hazard event, exposure of people and property to the hazard, and consequences of that exposure" (*Multi Hazard Identification and Risk Assessment*, 1997, p. 295).

Definitions offered by White (2000), Beckvonpeccoz (1997), and Stallones et al. (1983), while undoubtedly sound, and no doubt applicable to their fields of study, lack the depth and breadth of the one offered by FEMA.

Interestingly, Iolster & Flanagan (1997) found a general sense of confusion regarding whether risk assessments are scientific issues, or based on policy and social matters (*Glossary of risk analysis terms*, 2001; Iolster & Flanagan, 1997). Reviewing the various risk assessment models found, including the one used by the USFA in its program *Executive Analysis of Fire Service Operations in Emergency Management* ("Unit 4: Community risk assessment," 2002), this researcher would agree with Iolster's & Flanagan's view that "all of these issues are integral parts of the risk assessment process" (Iolster & Flanagan, 1997, p. 4). Accordingly, the LFD should consider these issues when it looks at developing a risk assessment process.

NFPA 1600, one of four NFPA standards studied, contained language requiring municipalities to complete both hazard identifications and risk assessments. Further, Chapter 3 of that document goes on to state that hazard identification, predicting the

probability of occurrences, and analyzing the vulnerability to life, property, and the environment are integral components of a risk assessment (*NFPA 1600: Standard on disaster/emergency management and business continuity programs*, 2000).

Notwithstanding the requirements set forth in the aforementioned standard, at this time, none of the Canadian and Ontario legislation reviewed references any NFPA standards, nor requires municipalities, or entities thereof, to comply with them. Nonetheless, NFPA is recognized as an international standards setting body. As such, one could argue that the standards created by the organization, although not legislatively mandated, could be used as a measure in a court of law.

A search for Canadian legislation germane to the subject of risk and risk assessments uncovered the federal *Emergency Preparedness Act, R.S., 1988, c. 6 (4th Supp.),* Ontario's *Emergency Plans Act, 1999, c. 12, Schedule. P, ss. 3-9, f,* as well as another piece of Ontario legislation, the *Fire Protection and Prevention Act, 1997, S.O. 1997, c. 4.* The first two pieces of legislation do not require a municipality, or a fire department, to conduct risk assessments. Even the latter, only legislates that municipalities complete a simplified risk assessment ("Fire Protection and Prevention Act," 1997; *FPPA opinions & applications - subsection 2(1), municipal responsibilities*, 1999; *Public fire safety guideline PFSG 04-40A-12: Fire prevention and public fire safety education - Simplified risk assessment*, 2001). However, *Bill 148*, if proclaimed into law in Ontario, shall legislatively mandate municipalities within the province to undertake a risk assessment of the community's hazards ("Emergency Management Act," 2002). There are strong indications that the Bill will become law by year-end. Concerning local requirements, the City of London's *Peacetime Emergency Plan* makes

the Fire Chief responsible for identifying the hazardous materials hazards in the community, as well as assessing the associated risks (*Peacetime Emergency Plan*, 2002). The legislative requirements herein noted strongly suggest that the LFD should take proactive steps to adopt, or develop, a risk assessment process.

The research divulged the absence of a universally accepted set of risk assessment criteria, although commonalities were observed when the criterion was entered into the chart found in Appendix S. For example, several individuals and groups agree that risk assessments should commence by first identifying the hazards in the community (Beckvonpeccoz, 1997; Davis, 1997; Gordon, 2000; R. A. Klein, 1997; *NFPA 1201: Standard for developing fire protection services for the public*, 2000; *NFPA 1250: Recommended practice in emergency service organization risk management*, 2000; *NFPA 1600: Standard on disaster/emergency management and business continuity programs*, 2000; *NFPA 1670: Standard on operations and training for technical rescue incidents*, 1999; *Public fire safety guideline PFSG 02-02-12: Analyzing local circumstances - Risk assessment*, 1998; *Strategic planning guide for the evacuation of a highly urbanized environment*, 2001; "Understanding your risks: Identifying hazards and estimating losses (FEMA 386-2)," 2001; *What is risk?*, 2002a). Klein (1997) suggests that hazard identification means identifying and assessing those premises where fires, explosions, and mechanical damage may occur, albeit his description applies best to a fire department based risk assessment. Although Klein's description falls within the scope of this research project, the LFD also provides high angle rescue, confined space rescue, trench rescue, water rescue, underwater body recoveries, and hazardous materials mitigation. Given the complexity of these specialty

services, a more comprehensive risk assessment may be required in areas where such risks are prevalent. However, such risks should be noted during the initial risk assessment. The department's technicians, who are more qualified, could then carry out a more in-depth assessment later.

Summarized in the results section of the paper, an extensive list of criteria was discovered. The evaluation showed that hazard identification was the most popular. Other frequently recurring criteria includes, but is not limited to, predicting of the frequency and severity of events, conducting a vulnerability analysis, identifying the type of structure, classifying the occupancy, estimating the potential dollar loss, determining the type, and condition of public and private fire protection systems used within the building, identifying planning sectors within the municipality, and reviewing resource deployment.

As noted earlier, the variety of criteria discovered was extensive, with the specifics noted in the literary review, or the appendices therein cited. While the criteria used by the ULC's *Fire Risk Analysis - Rating System* (see Appendix Q) was of interest, the criteria utilized by the RHAVE program, as shown in Appendix N, seems to suit the LFD best.

Despite the difficultly of predicting probability with any degree of accuracy (Clemens, 2000; Farrell, 2002; *Introduction to security risk analysis & risk assessment*, 2002; *Multi Hazard Identification and Risk Assessment*, 1997), risk matrices, which use probability and consequence to rate risk, were found to be a popular quantitative risk assessment method (Clemens, 2000; Davis, 1997; Farrell, 2002; R. A. Klein, 1997; Mallet & Brnich, 1999; *Multi Hazard Identification and Risk Assessment*, 1997;

Operational Risk Management, 2002; Ream, 2002). Probability and consequence can be expressed as either a combination of descriptive terms and numeric values (see Appendix F) (Davis, 1997; Farrell, 2002), or only through descriptive terms (see Figure 1, and Appendices D, I and J) (R. A. Klein, 1997; Mallet & Brnich, 1999; *Multi Hazard Identification and Risk Assessment*, 1997; *Operational Risk Management*, 2002; Ream, 2002). The risk rating, the product of the process, is most often expressed as a numerical value (Appendices D, G, and I) (Davis, 1997; Farrell, 2002; K. Klein, 2001; *Operational Risk Management*, 2002).

Several other risk assessment models were also discovered. While some shared commonalities, they were quite different from the matrix concept. RHAVE, a software program recently introduced into the U.S. fire service (*Accreditation, NFPA 1710 and standards of response*, 2002), scrutinizes a broad range of items, including features associated with the premises, the building, life safety systems, risk, and water supply. Using the data from the aforementioned categories, the program evaluates risks, hazards, and the value of the building to the community to generate a vulnerability score (Ortiz, 1999), which then can be translated into a level of risk (S. W. Gary, 2001). Ortiz claims RHAVE also accentuates issues concerning fixed fire protection systems and life safety measures. Challenges posed by these systems and measures can often be counteracted through proactive risk reduction alternatives (*Multi Hazard Identification and Risk Assessment*, 1997), thereby reducing the overall risk. Simply, assigning a greater amount of emergency resources to a higher risk building is a reactive response, and ignores alternatives. Using the interactive features of the program, the assessor can determine if other proactive actions can be implemented to reduce the risk, thereby

possibly reducing the response, or at the very least, eliminate the necessity to increase the response.

The Canadian model offered by the ULC is another comprehensive risk assessment process. Like RHAVE, ULC's *Fire Risk Analysis – Rating System* is offered in a computerized format. Evaluating real property risk factors, property management and usage risk factors, and human risk (*Fire risk analysis - rating system*, 2001), it provides risk summaries for each of the categories noted, as well as an overall risk total. The text driven process is shown in Appendix Q. Unlike RHAVE, this model seems to lack definitive probability and consequence components. Further, the model provides no means by which to correlate the total risk value against a rating scale to determine if the risk is low, moderate, high, or severe.

The fire risk assessment model provided by the Ontario fire service through *PFSG 02-02-03*, as well as the simplified risk assessment described in *PFSG 04-40-03* provide a general community risk profile, but are too vague for the needs of the LFD.

It should be noted that while the focus of this paper was upon quantitative risk assessment methodologies, qualitative models do exist, and are preferred by some industries. In the environment of the LFD, experience has shown that a quantitative approach is a more effective one, as it provides more structure for the frontline staff.

RECOMMENDATIONS

Based on the requirements of the applicable NFPA standards, and the legislative requirements that will result should *Bill 148* become law, the LFD should immediately adopt and implement a risk assessment program. In consideration of the LFD's intent to seek CFAI accreditation in the near future, it is further recommended that the RHAVE

model be adopted as the foundation for that program. This recommendation will identify and quantify risks within the City of London, assist with emergency planning and operational issues, and prepare the LFD for the accreditation review.

Since the LFD's fire prevention and frontline response vehicles are not equipped with computers, it is recommended that the department adopt the risk assessment worksheet shown in Appendix A, the product of this research paper. In consideration of the earlier recommendation to adopt RHAVE as the LFD's risk assessment model, the assessment factors used to develop the worksheet are heavily weighed toward the RHAVE process. Although not included within this paper, the LFD will need to create quick reference cards so that evaluators can easily identify the type of construction, as well as the water flow requirements, when assessing a building or structure.

Given the budget constraints facing the LFD, it is recommended that the department's Fire Prevention Inspectors and Captains lead the risk assessment process, with individuals assigned to the modified work program assisting when they are available. Consistency is paramount, therefore, the department's Training Division should be directed to develop and deliver a training program to all evaluators. In anticipation that the staff, particularly frontline crews, might be hesitant to embrace the program, the administration should release an explanatory document emphasizing the importance of the process to the municipality, including how it may assist them as frontline responders. This action should occur prior to the release of the training material.

At the time of this writing, and on direction of senior administration to reduce the 2003-operating budget, the LFD has reduced the Fire Prevention Division's staff

complement by one inspector. However, during the 2002 budget deliberations, some Councilors asked about the operational impact of reducing the Division's complement by at least two inspectors. Accordingly, given the current situation, and in anticipation of further reductions, the Fire Prevention Division should be directed to explore the viability of developing and implementing a self-inspection program. It is recommended that all premises rated as a low risk be automatically placed into a self-inspection program. Properties rated as a moderate risk may be selected for participation if there are insufficient resources available, with those with those posing least amount of risk being placed into the program first. Priority should then be given to those premises rated as a significant risk, or a maximum risk. These premises should be inspected at least once a year.

The product of this research paper was to develop a worksheet for gathering information about the risk associated with buildings and structures within the City of London. However, to avoid the duplication of work, and expedite the compilation of such data, the LFD should seek to automate the data gathering process. Options include the use of laptop computers, or smaller, easier to handle and more economical personal data assistants (PDA).

The City of London is fortunate to have developed an excellent GIS mapping system. Further, several years ago, a group of London firefighters developed and, with the permission of the Fire Chief, implemented a zone-based response system. Given the availability of these two systems, it is recommended that the computerized data be formatted such that it can be uploaded into the GIS program for the purposes of generating graphical representations of the risk challenges experienced not only

citywide, but by response zone. This tool will assist the LFD to review its current deployment, and determine if changes to the operations are necessary.

It is hoped that this research paper will assist future readers understand the necessity for risk assessments. Although regulatory requirements, as well as the requirement to adopt NFPA standards, may differ from country to country, or between the various other levels of government, effective emergency responses and mitigation strategies depend heavily upon sound information. Fire departments constantly battle fires, acts of terrorism, all types of hazards causing the need for specialized rescues, and other types of emergencies. Risk assessments are simply a form of reconnaissance. Based on the information gathered, fire service managers can review deployment and staffing models, as well as form plans of attack to combat hazards that may harm firefighters, citizens, and the environment. Further, risk assessments may actually assist resource challenged departments find other ways to conduct business, or obtain additional resources based on the results of the assessment. In conclusion, every fire department deals with risks and hazards in its normal course of business. As such, this researcher hopes that those reading this paper will be convinced to implement a risk assessment process if their department has not already done so.

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APPENDIX A

RISK ASSESSMENT WORKSHEET

LONDON FIRE DEPARTMENT
Risk Assessment Worksheet

Note: All "Yellow" boxes are required for the RHAVE program.

GENERAL INFORMATION

Address: Number | Prefix | Street Name | Type **Occupancy Type:** Building Code **No. of Units:**

Property Use: **Code Description:**

Assessed Value: $

Employment Impact:
Major :
Employees :

Revenue Benefit:
Property Tax :
Sales Tax :
Non-Contributor

Special Hazards:
Hazmat :
Confined Space :
High Angle :
Wildland Interface :
Non-Owner Occupied:
Disable Persons:
Seniors:
Pre-school Children:

Keyholder #1:

Telephone: - **Cell:** -

Keyholder #2:

Telephone: - **Cell:** -

EMERGENCY RESPONSE INFORMATION

1st Due Engine: **Response Zone:** **Map Page:** **GPS:** North: South:

Dist. to Closest Station: km X 1.062 = **Est. Response Time:** min

- Less than or equal to 4 minutes - OK
- >4.00 minutes → Advise Project Coordinator

WATER DEMAND

Building Area: Ft²

Water Flow (gpm)

Pts.
1 500 - 1500
2 1750 - 3000
3 3250 - 4500
4 4750 - 6000
5 6000 - 8000

→ A

Sprinklers

Pts.
1 Yes → Water Flow (gpm) / 2 → Adjusted Water Flow (gpm)
2 No

→ B = C

Available Water Flow

gpm

Pts.
1 Sufficient
2 Insufficient

→ D

A × B = C × D = **Water Demand Factor (WDF)**

BUILDING INFORMATION

Exposure Separation

Pts.
1 101' +
2 61' - 100'
3 31' - 60'
4 11' - 30'
5 0' - 10'

→ A

Type of Construction

Pts.
1 Type I-F.R., II-F.R.
2 Type II 1-HR, III 1-HR
3 Type IV-H.T., V 1-HR
4 Type II-N, III-N
5 Type V-N

→ B

Building Height

Pts.
1 1 - 2 Stories
2 3 - 4 Stories
3 5 - 6 Stories
4 7 - 9 Stories
5 10+ Stories

→ C

Building Accessibility

Pts.
1 All sides
2 Any 3 sides
3 Any 2 sides
4 1 side only
5 Extra ordinary effort

→ D

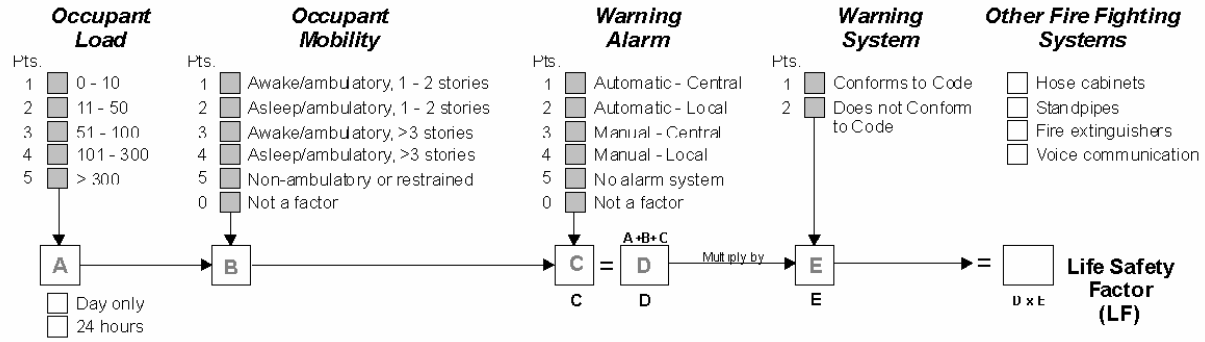
Building Size (Ft²)

Pts.
1 0 - 7,500
2 7,500 - 15,000
3 15,001 - 25,000
4 25,001 - 40,000
5 > 40,000

→ E

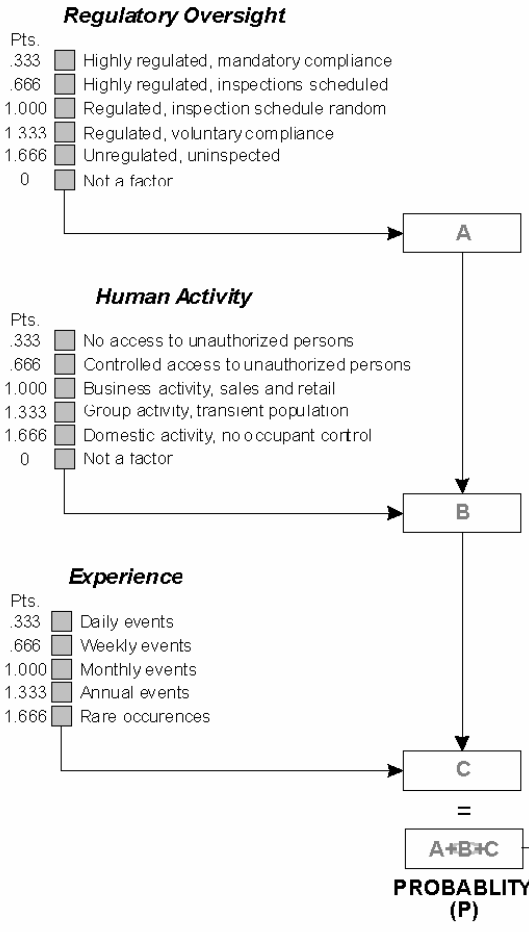
A+B+C+D+E = **Building Factor (BF)**

LIFE SAFETY INFORMATION

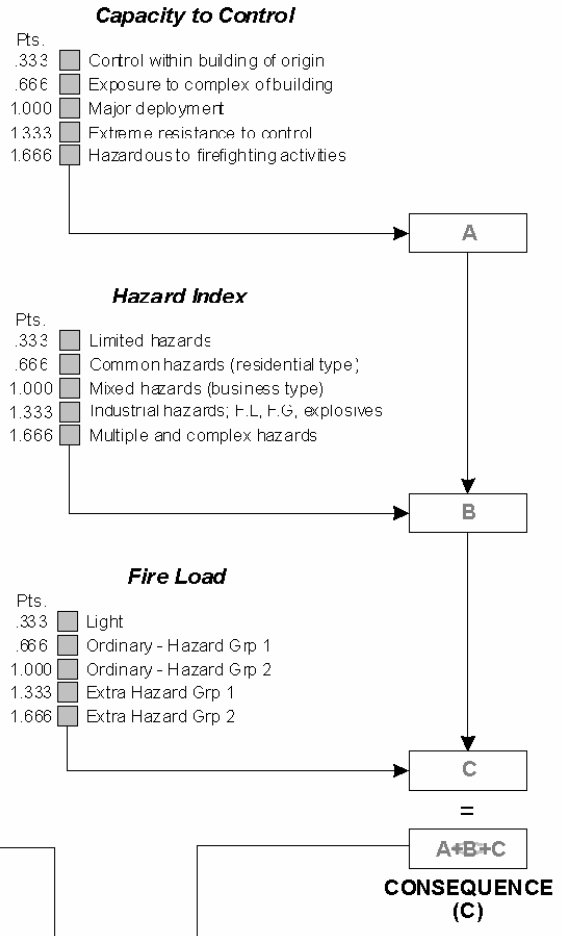


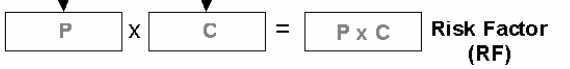
RISK

PROBABILITY

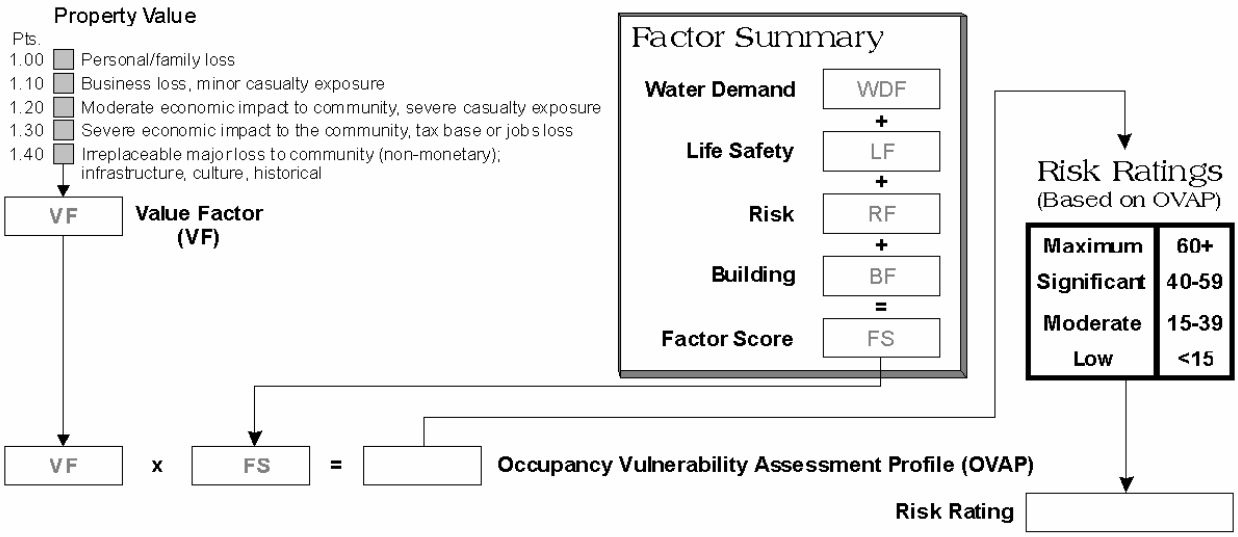


CONSEQUENCE





VALUE



OTHER HAZARDS OF CONCERN

Firefighters

Occupants

Evironment

Building

SITE SKETCH

Please provide a sketch of the site and the building noting any hazards identified in the risk assessment process.

APPENDIX B

ONTARIO FIRE MARSHAL'S PUBLIC SAFETY GUIDELINE: ANALYZING LOCAL CIRCUMSTANCES

Public Fire Safety Guidelines	Subject Coding **PFSG 02-02-03**
Section **Analyzing Local Circumstances**	Date January 1998
Subject **Fire Risk Assessment**	Page

Purpose

To identify considerations for persons conducting municipal fire risk assessments.

Ambient Factors of Risk Assessment:

The following factors should be considered in assessing the local fire risk.

- the municipality:
  - urban
  - rural
  - metropolitan
  - other, such as a bedroom community, border community
  - predominantly dependent upon a single employer, business, or institutional operation or activity
  - describe its uniqueness
  - describe its geography
  - describe its demographics
  - outline current development and development trends
  - describe street network and traffic patterns
  - describe traffic barriers
  - consider applicable by-laws
  - labour relations climate and history
- historical
  - indicate emergency call volume last year, last 5 years
  - the number of fire casualties in the past year, past 5 years
  - identify any trends respecting cause and location
  - the fire loss for the past year, past 5 years
  - indicate trends respecting call types for the past 5 years

- comparisons with other like municipalities should be considered for the following factors:
    - population (static/subject to seasonal or other fluctuations)
    - geographical area and size of municipality
    - type of municipality
    - number of residential dwellings
    - assessment
    - development trends
    - growth history and trends
    - demographics
    - equalized assessment and tax base
        - residential/farming vs [*sic*] industrial/commercial assessment
- building stock
    - identify, as accurately as possible, the number and percentage of the following:
        - single family residences
        - multi-unit residences
        - high-rise buildings
        - large complexes
        - farms/agricultural buildings
        - commercial buildings
        - industrial buildings
        - institutional
        - business buildings
        - storage facilities
        - other special buildings
        - hospitals
            - nursing homes
            - with respect to building type, identify specific problems, such as access, density and age
            - with respect to building type, identify significant and associated outside storage areas
- building occupancies
    - identify, as accurately as possible, the number and percentage of the following occupancies:
        - assembly
        - institutional

        - residential
        - commercial
        - industrial
        - business
        - storage
        - vacant
            - other
- prevention and public education
    - if, for example, the municipality does not have a fire department, but purchases fire suppression services, describe what fire prevention and public education initiatives, if any, are undertaken by the community. Describe the significance and impact, or lack of same, of such initiatives.
- public and political resolve
    - what is the perceived awareness of fire safety by the general public and the corporate sector?
    - what are the expectations for fire protection by the general public, and the corporate sector?
    - what is the general tone of press and media coverage of fire related matters?
    - how are fire prevention, fire safety, and public education programs generally received and accepted by the community at large?
    - what is the local political climate respecting:
        - cost cutting/no budget increases?
        - preserving the status quo?
        - maintaining/improving essential services such as the fire department?
- public and private protection systems
    - independent of the assessment of (Analyzing Local Circumstances - Assessing Existing Fire Protection Services), identify and describe:
        - private fire brigades
        - industrial/commercial fire brigades
            - private water supplies and

water supply systems

Related Functions: Click on the related function below to view that function:

- Economic Circumstances
- Capabilities of Existing Fire Protection Services

Codes, Standards, and Best Practices: Codes, Standards, and Best Practices resources available to assist in establishing local policy on this assessment are listed below. All are available at http://www.gov.on.ca/OFM. Please feel free to copy and distribute this document. We ask that the document not be altered in any way, that the Office of the Fire Marshal be credited and that the documents be used for non-commercial purposes only.

See also PFSG

01-02-01 Fire Protection in Your Community
02-04-01 &
02-04-23 Capabilities of Existing Fire Protection Services
04-39-12 Comprehensive Fire Prevention Model

(*Public fire safety guideline PFSG 02-02-03: Analyzing local circumstances - Risk assessment*, 1998, pp. 1-3)

APPENDIX C

ONTARIO FIRE MARSHAL'S PUBLIC SAFETY GUIDELINE: SIMPLIFIED RISK ASSESSMENT

Public Fire Safety Guidelines	Subject Coding **PFSG 04-40A-12**
Section **Fire Prevention and Public Fire Safety Education**	Date March 2001
Subject **Simplified Risk Assessment**	Page

Purpose

Municipalities have a legislated responsibility under the Fire Protection and Prevention Act (FPPA) to provide public education with respect to fire safety and certain components of fire prevention. Conducting a simplified risk assessment is the first step towards compliance with these requirements and is intended to identify information required by a municipality to make informed decisions about the programs and activities necessary to effectively manage the community fire risk based upon local needs and circumstances.

Simplified Risk Assessment:

Conducting a simplified risk assessment is a practical information-gathering and analysing [*sic*] exercise intended to create a community fire profile that will aid in identifying appropriate programs or activities that can be implemented to effectively address the community's fire safety needs.

As a minimum, a community fire safety program must include:

- a smoke alarm program,
- distribution of fire safety education materials, and
- participating in inspections upon complaint or when requested to assist with Fire Code compliance.

(Refer to PFSG 04-40-12 in respect of public education and fire prevention services.)

As each community is different, the simplified risk assessment will indicate the degree to which these activities take place in accordance with its local needs and circumstances.

Assessment Components and Risk Considerations

The following categories of information are important to consider when gathering data and developing a community fire profile through a simplified risk assessment.

Community Demographic Profile

- Population makeup, based on age groupings
- Vulnerable individuals or occupancies
- Cultural differences, such as language and customs
- Seasonal population shifts in tourist areas, mobile homes, trailer parks, university/college locales, etc.
- Other considerations specific to certain municipalities

Building Stock Profile

- Breakdown by Ontario Building Code occupancy classification
- Building density (core areas)
- Age of building stock
- Potential high fire risk occupancies (industrial, commercial, residential)
- Potential high life safety risk occupancies (hospitals, nursing homes, detention centres [*sic*], group homes, residential care, retirement homes)
- Potential economic/employment/environmental impact

Municipal Fire Loss Profile

- Deaths/injuries
- Dollar loss
- Breakdown by occupancy classification

The information gathered in each of the 3 categories must be examined, evaluated and analysed [*sic*] to identify the community fire profile and to identify potential fire concerns.

Provincial Fire Loss Profile

To assist municipalities in interpreting and understanding

the significance of their municipal fire loss data, provincial data is provided in the following areas:

- fires by property type
- fire deaths by property type
- fire deaths by age of victim
- fire loss ($) by property type
- smoke alarm status in fatal fires

Examining, Evaluating and Analysing [*sic*] **the Information**

Municipalities are encouraged to compare these provincial statistics with their municipal fire loss profile. When insufficient municipal data exists in this regard, it is recommended that the provincial profile data be used to establish program and resource priorities.

Priority Setting for Compliance

By reviewing the information gathered in the areas of demographics, building stock and fire loss experience, fire safety concerns can be identified and prioritized [*sic*]. No two communities will have the same fire profile, as local needs and circumstances vary.

Selecting and Implementing Options

Once the community risks have been identified and prioritised [*sic*], while at the same time taking into consideration resources and other factors, an implementation strategy would be developed. The strategy would involve:

- Council approval of activities
- Resource allocation
- Assignment of responsibilities
- Development of program operational guidelines
- Ongoing program assessment

Codes, Standards, and Best Practices

Codes, Standards, and Best Practices resources available to assist in establishing local policy on this assessment are listed below. All are available at http://www.gov.on.ca/OFM. Please feel free to copy and distribute these documents. We ask that these documents not be altered in any way, that the Office of the Fire Marshal be credited and that the documents be used for non-commercial purposes only.

See also the following Public Fire Safety Guidelines:

01-02-01 Comprehensive Fire Safety Effectiveness Model
02-02-12 & 03Risk Assessment
02-03-01 Economic Circumstances
04-12-13 Core Services
04-40-03 Selection of Appropriate Fire Prevention Programs
04-40A-03 Simplified Risk Assessment
04-45-12 Fire Prevention Policy
04-56-12 Use of Fire Related Statistics

(*Public fire safety guideline PFSG 04-40A-12: Fire prevention and public fire safety education - Simplified risk assessment*, 2001, pp. 1-3)

APPENDIX D

U.S. NAVY OPERATIONAL RISK MANAGEMENT

The process of detecting hazards and assessing associated risks. Step 1 and Step 2 of Operational Risk Management constituted a risk assessment (*Operational Risk Management*, 2002, p. 5).

Step 1 Identify Hazards

- Conduct an Operational Analysis
  List major steps of the operation

- Conduct a Preliminary Hazard Analysis
  List the hazards associated with each step
  List the possible causes of the hazards

The tools at the end of this handout may be used to enhance or replace step 1 as shown above for certain specialized applications.

Step 2 Assess Hazards

- Determine degree of risk for each hazard in terms of severity and probability.

  Use of a matrix is recommended but not required. A matrix provides a consistent framework for evaluation and shows the relative perceived risk between hazards and prioritizes which hazards to control first.

  Any Matrix that supports the specific application may be used.

RAC Matrix		**Mishap Probability**			
		Likely	Probably	Maybe	Unlikely
Hazard Severity	Critical	1	1	2	3
	Serious	1	2	3	4
	Moderate	2	3	4	5
	Minor	3	4	5	5

Risk Assessment Code (RAC)

1- Critical **2** – Serious **3** – Moderate **4** – Minor **5** – Negligible

Hazard Severity

Critical – May cause death, loss of facility/asset, or grave damage to national interests.
Serious – May cause sever injury, illness, property damage; or damage to national or service interests.
Moderate – May cause minor injury, illness, property damage; or damage to national, service, or command interests.
Minor – Minimal threat.

Mishap Probability

Likely – Likely to occur immediately or in a short period of time. Expected to occur several times to an individual item or person, or continuously to a group.
Probably – Probably will occur in time. Reasonably expected to occur some time to an individual item or person, or continuously to a group.
May – May occur in time. Reasonably expected to occur some time to an individual item or person, or several times to a group.
Unlikely – Unlikely to occur. (*Operational Risk Management*, 2002, pp. 7, 8)

APPENDIX E

HAZARD IDENTICATION SUBCATEGORIZES

Hazards to firefighters

- Building collapse
- Contamination
- Explosion
- Air exhaustion
- Flashover
- Slips, trips and falls
- Backdraught [*sic*]
- Rapid fire spread

Hazards to the environment

- Likelihood of escalation to adjacent premises or plant
- The toxicity and quantity of any hazardous gases
- The flammability and quantity of any hazardous gases
- The density of the population in the surrounding area
- Fire-fighting water entering watercourses

Hazards to the occupants

- Rapid fire spread
- Premises not complying with latest fire safety standards

Building hazards

- Historically important heritage building.
- Economically important, ie [*sic*] plant and equivalent having high loss potential or those having high numbers of people employed. (Davis, 1997, p. 12)

APPENDIX F

SEVERITY OF RISK AND PROBABLITY CRITERIA

Severity of Risk		
Rating	**Risk**	**Description**
8	Extreme	Causing multiple deaths and widespread destruction or the whole organization [*sic*] to cease operation.
7	Very High	Causing death or serious injury to an individual or severe financial loss which could endanger the organization.
6	High	Permanent disabling injury [or disease] to an individual.
5	Serious	Disabling injury or disease capable of keeping an individual off work for more an 28 days or considerable financial loss which could be managed by the organization [*sic*].
4	Moderate	Serious injury keeping an individual off work between 4 and 28 days or measurable financial loss to the organization.
3	Minor	Minor injury involving up to 3 days lost time.
2	Slight	Causing minor injury which would allow the individual to continue to work after first aid treatment on site or at a local surgery involving no lost time or only slight financial loss to the organization [*sic*].
1	Minimal	No injury or disease or financial loss. Of statistical interest only.

Probability		
Rating	**Risk**	**Description**
8	Always	Everyday occurrence in the Brigade. If the work continues as it is, there is almost 100% certainty that the accident or loss will happen.
7	Frequent	Weekly occurrence in the Brigade.
6	Very likely	Occurs about once every few months in the Brigade
5	Likely	Occurs about once a year in the Brigade
4	Occasional	Occurs once a year in the UK fire service.
3	Rare	Event has occurred [or is likely to occur] once every 10-30 years in the Brigade
2	Exceptional	Event has occurred [or is likely to occur] once every 10-30 years in the UK Fire Service
1	Unlikely	Event may have occurred or be likely to occur somewhere in the fire service at some time [1 in 10,000 operating years].

(Davis, 1997, p. 13)

APPENDIX G

RISK RATING AND RANGE OF RISK

Risk Rating									
		SEVERITY							
PROBABILITY		Extreme 8	Very High 7	High 6	Serious 5	Moderate 4	Minor 3	Slight 2	Minimal 1
Always	8	64	56	48	40	32	24	16	8
Frequent	7	56	49	42	35	28	21	14	7
Very likely	6	48	42	36	30	24	18	12	6
Likely	5	40	35	30	25	20	15	10	5
Occasional	4	32	28	24	20	16	12	8	4
Rare	3	24	21	18	15	12	9	6	3
Exceptional	2	16	14	12	10	8	6	4	2
Unlikely	1	8	7	6	5	4	3	2	1

(Davis, 1997, p. 13)

Range of Risk		
48 - 64	Risk is severe and unacceptable	Immediate action must be taken
25 – 42	Risk is high	Priority action to be taken to apply control measures
12 – 24	Risk is moderate	Action to be taken as a matter of routine
5 – 10	Risk is low and broadly tolerable	No further action normally required
0 - 4	Risk is minimal	Of statistical interest only but will require review

(Davis, 1997, p. 14)

APPENDIX H

BRITISH NATIONAL CATEGORISATION SYSTEM

National Categorisation [*sic*] **System**	
	Pts Value
Density	
Under 4,000 Sq Ft	Nil
[4,001 - 40,000	2
[40,001 - 100,000	5
*[	
[100,001 - 200,000	7
[Above 200,000	9
Separation	
[40' or less from other building on one side	2
[40' or less from other building on two sides	4
*[	
[40' or less from other building on three sides	6
[40' or less from other building on four sides	8
10 Take highest points from above only	
Construction	
Fire Resisting	1
Traditional	3
Timber mostly	5
Open storage	5
Town centre complex	5
Number of Stories	
Up to 3	2
4 to 6	4
7 or above	6
Occupancy Rating	
Low	1
Moderate	3
High	5
Total points result in the following gradings [*sic*]: • 16 Points and above – A Risk • 11 Points to 15 – B Risk • 10 Pints and below – C risk * *These sections to be completed exclusive – i.e. Retain only the highest score*	

(Davis, 1997, p. 14)

APPENDIX I

RISK ASSESSMENT MATRIX

HAZARD CATEGORY	POTENTIAL FOR EXPOSURE		
	Low	Medium	High
Extreme	2/3	3	4
High	2	2/3	3
Medium	1	2	2/3
Low	1	1	1

(R. A. Klein, 1997, p. 27)

APPENDIX J

RISK ASSESSMENT HAZARD RATINGS

Extreme hazard:

- a extremely high likelihood of very serious injury, disease or death
- evacuation of public mandatory
- contingency planning required by law
- the potential to cause severe environmental impact
- associated with a high societal risk
- substances of known or suspected exceptional toxicity
- long-term effects or genetic damage, e.g., carcinogenicity
- long-term persistence of hazard
- likelihood of loss of control for whatever reason
- containment difficult or impossible
- personal protective equipment inadequate or duration of use limited
- severe problems with decontamination
- highly reactive, explosive or corrosive materials
- unstable hazards - shock, sparks movement, temperature, water, etc.
- no suitable extinguishing media available
- hazard not easily detected

High hazard:

- serious injury or death possible but not likely
- some difficulties in containment
- evacuation of public may be required
- contingency planning may be required
- protection of personnel and environment mandatory
- requires self-contained respiratory protection
- requires specialised [*sic*] protective clothing, e.g. gas-tight suits
- spread probable outside locality of incident
- high toxicity, reactivity, corrosive or irritant nature
- extremely flammable or explosive atmospheres formed
- control not likely to present problems
- requires specialised [*sic*] extinguishing media

Medium hazard:

- serious injury unlikely
- no difficulties in containment
- no difficulties in control of hazard
- no evacuation of surroundings necessary
- moderate toxicity, reactivity, corrosive or irritant nature
- may form flammable or explosive atmospheres
- normal extinguishing media adequate
- limited personal protection required, i.e., respirator, goggles, gloves

Low hazard:

- negligible risk of injury from hazard
- normal firekit [*sic*] adequate
- effects remain local
- no risk to general public
- no environmental risk
- little or no risk from flammability or explosion

(R. A. Klein, 1997, pp. 27, 28)

APPENDIX K

RISK ASSESSMENT CRITERIA – KLEIN MODEL

Number of people likely to be exposed
- initially
- as incident develops
- crowd control

Time exposed to hazard
- frequency of exposure duration
- duration

Circumstances of exposure
- associated stress
- weather conditions
- time of day
- illumination
- ambient temperature
- human life endangered or persons reported

Physical characteristics of hazard
- dense solids, non-volatile liquids, no skin or mucous membrane absorption
- dusts, powders, volatile liquids, low skin or mucous membrane absorption
- gases, vapours [*sic*], volatile liquids, aerosols, easily absorbed by skin or mucous membranes
- ease of detection

Quantitative estimate of "size" of hazard
- amount of substance
- in multiples of any threshold values
- in excess of any quantities specified by regulation
- physical extent of process or situation

Characteristics of operation or activity
- predominantly an enclosed system, low chance of mishap
- partially open system, low chance of mishap
- completely open system, no physical barrier to exposure
- chance of mishap appreciable
- can hazard be controlled after mishap
- contingency planning effective
- presence of backup systems and safety procedures

State of premises
- well organized
- established procedures in case of mishap
- extinguishing media readily available
- disorganized or chaotic site
- occupancy known/unknown
- security of site
- physical containment, e.g., bunding [*sic*]

(R. A. Klein, 1997, p. 29)

APPENDIX L

RISK ASSESSMENT (PREMISES) FORM [RAP/1]

Premises: **ABB Power Tr D Ltd. Rossimore Rd Est, E'Port** [*sic*]					Existing 1(1)(d) Category	**A**
					Risk Index [total B]	**63**
File Ref. No. 9		1(1)(d) Card No.			Hazard Index [total A]	**21**
Hazards [Table 1]	Severity x Frequency = Risk Table 1	Table 2		Risk Interpretation [Table 4]	Action Required – Safe System of Work?	Date Completed
Hazards to Fire-Fighters						
Electrocution – Test Beds	**7**	**3**	**21**	**Moderate**	**Insure isolation**	
Contamination – MDI	**7**	**3**	**21**	**Moderate**	**BACPS others inputted**	
Air Exhaustion – large premises	**7**	**7**	**21**	**Moderate**	**Consider Guidelines/ TIC BA crews**	
Hazards to Occupants						
Hazards to Environment						
Building Hazards						
Totals	[A] **21**		[B] **63**			

(Davis, 1997, p. 17)

APPENDIX M

HEADLINE RISK CARD

NAME: Grosvenor Museum					**Life Risk** Day 0 - 300	**ACTION** • Period House – wooden floors, rapid fire spread • Complex internal layout – consider Thermal Imaging Camera and BA Guidelines • Salvage – Art Gallery of most value
LOCATION: Grosvenor St.	**PDA**	3WrL 09	Bronto 09		Night Nil	
Chester	**Tel Nos**	01244 321616			Duty Contact Keyholder via 0151 227 2262	
NATURE OF BUSINESS: MUSEUM/LECTURE THEATRE						

WATER SUPPLIES	Initial up to 4 x 14 mm jets – 125 mm hydrant Grosvenor Street Opp Main Entrance Unlimited River Dee – 4 x LPP from River Dee at Little Roodee to 2 x WrL at base of steps to Castle Drive. Two further WrLs outside entrance to Chester Castle. This layout will give 4500 LPM.

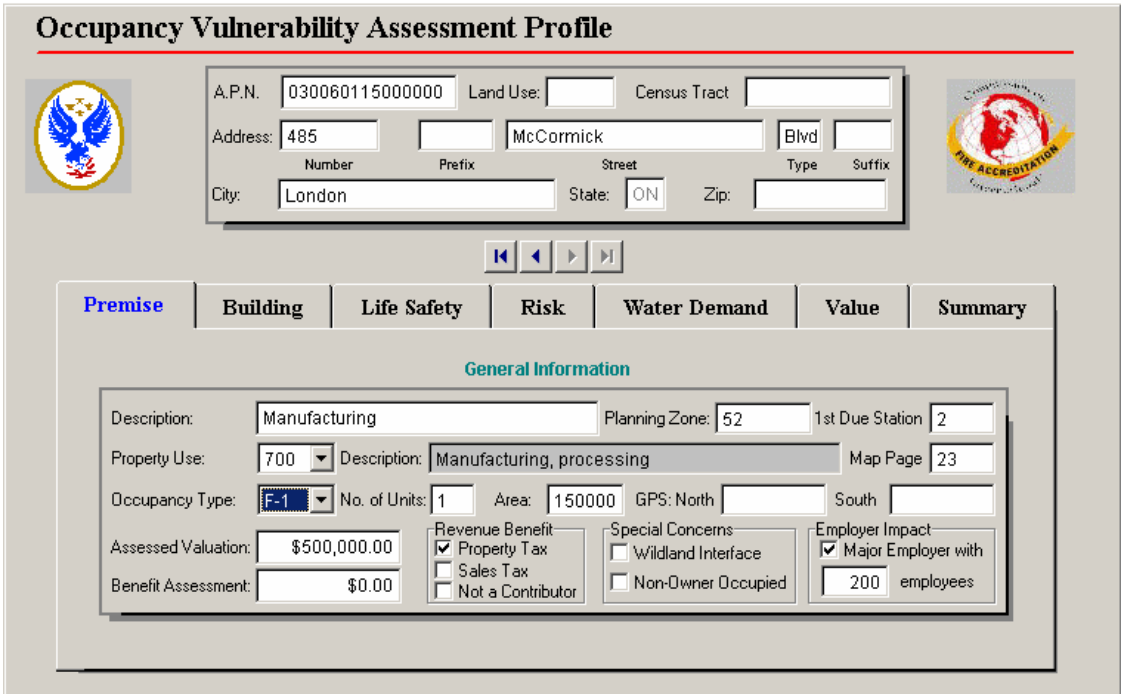
HAZARDS/ CONSIDERATIONS	**LOCATION**	**PRE-PLANNING**
1. Wooden Construction	— Period House	■ Brief crews on rapid fire spread – Period House ■ Brief crews on fall hazard atrium staircase
2. High fire loading and unprotected cast iron columns and beams	— Woodwork shop in Basement	■ Tackle fire in woodwork shop (semi-basement) from inner courtyard accessed from rear of old Trustee Savings Bank building
3. Security bars & screens	— Ground and First Floor Windows	■ Windows are well protected – Doors provide easier access
No roll call mechanism	— Throughout	■ For large fire consider water relay from Little Roodee ■ River Dee is tidal. Check tide timetable.
4. Voids, undetected fire spread	— King Arms Kitchen first floor	■ Consider Thermal Image Camera for search and rescue ■ Complex internal layout, consider BA Guidelines
5. Salvage	— Throughout	■ Salvage a priority – consider manpower implications

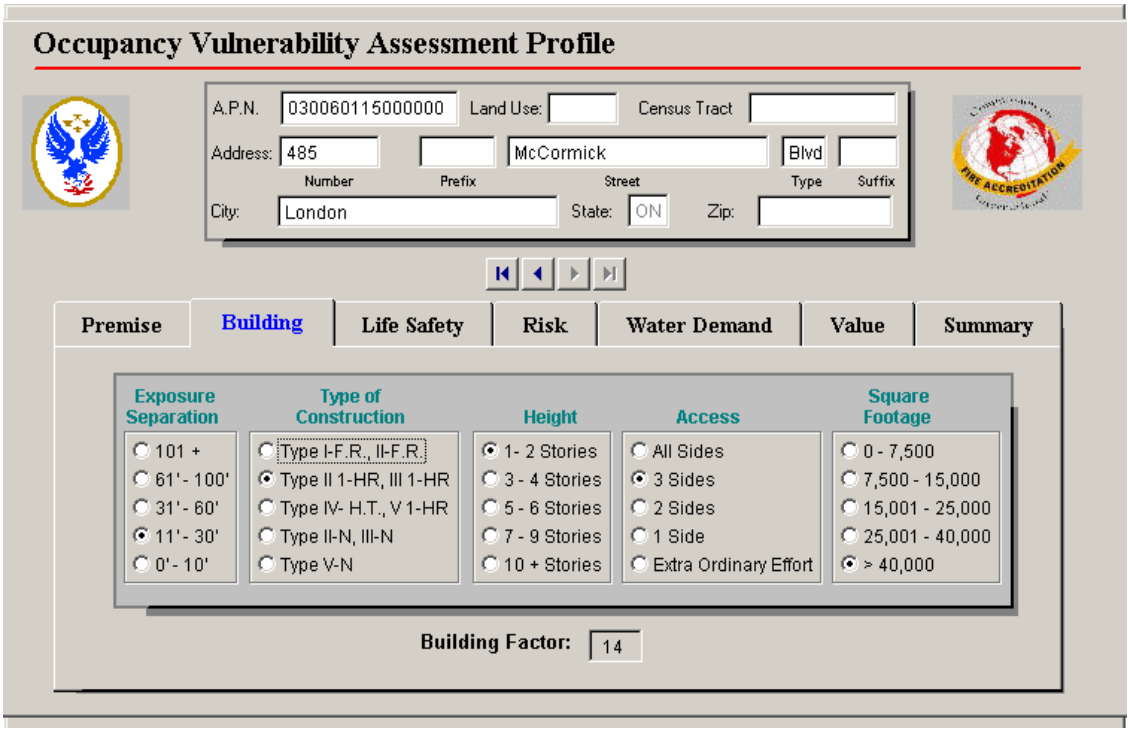
CHEMICAL HAZARDS	**LOCATION/DENSITY**	**ACTION** EAC	SIN	**PROPERTIES**	**EMERGENCY ACTION**	**REMARKS**
Insignificant						

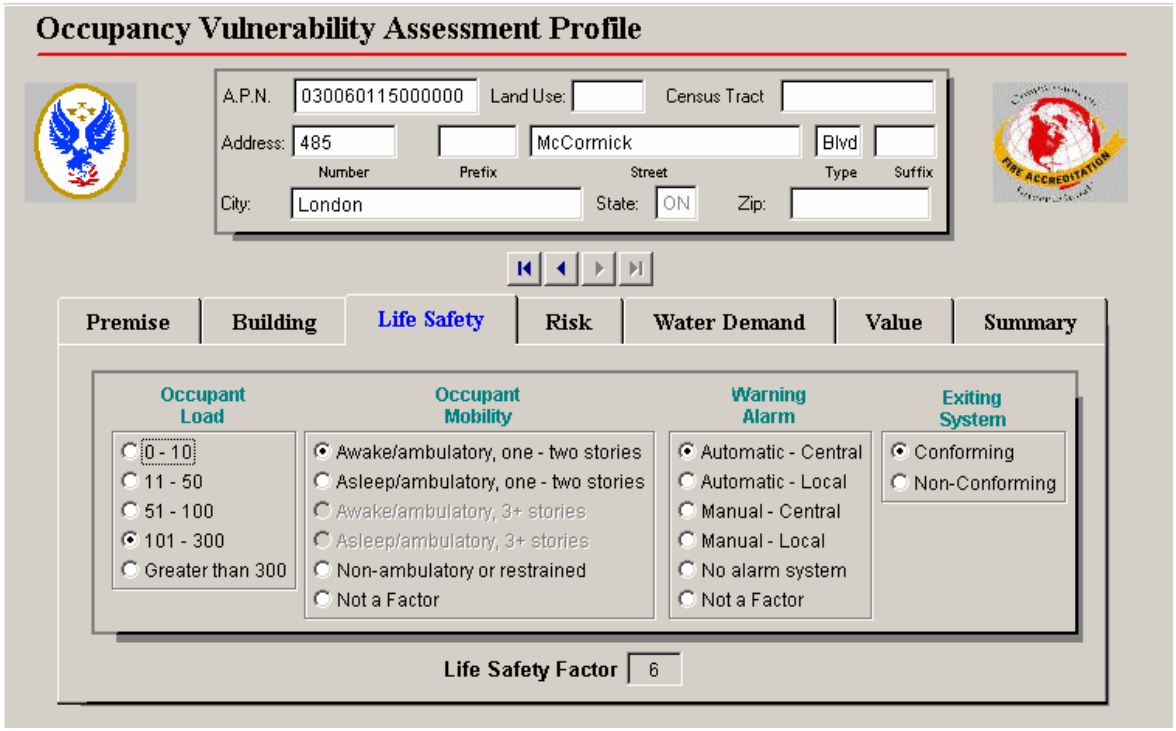
(Davis, 1997, p. 17)

APPENDIX N

RHAVE CRITERIA



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McCormick
Blvd
Number
Prefix
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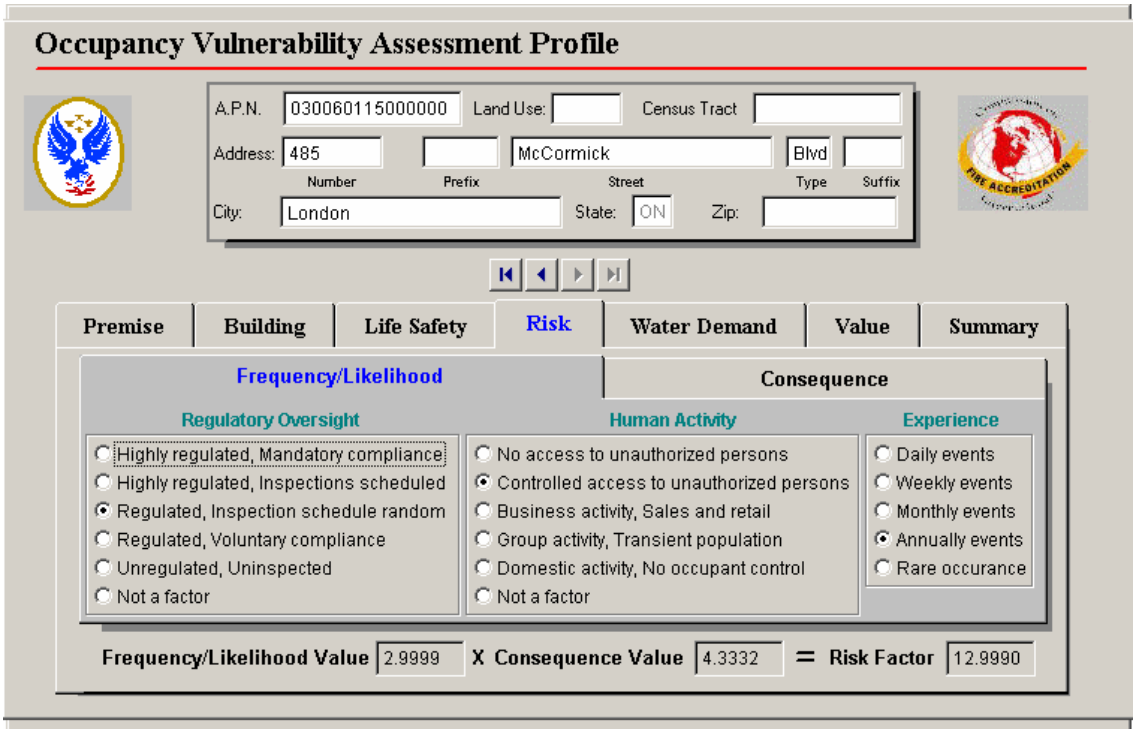
Type
Suffix
City: London
State: ON
Zip:
Premise
Building
Life Safety
Risk
Water Demand
Value
Summary
Occupant Load
0 - 10
11 - 50
51 - 100
101 - 300
Greater than 300
Occupant Mobility
Awake/ambulatory, one - two stories
Asleep/ambulatory, one - two stories
Awake/ambulatory, 3+ stories
Asleep/ambulatory, 3+ stories
Non-ambulatory or restrained
Not a Factor
Warning Alarm
Automatic - Central
Automatic - Local
Manual - Central
Manual - Local
No alarm system
Not a Factor
Exiting System
Conforming
Non-Conforming
Life Safety Factor 6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Blvd
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Prefix
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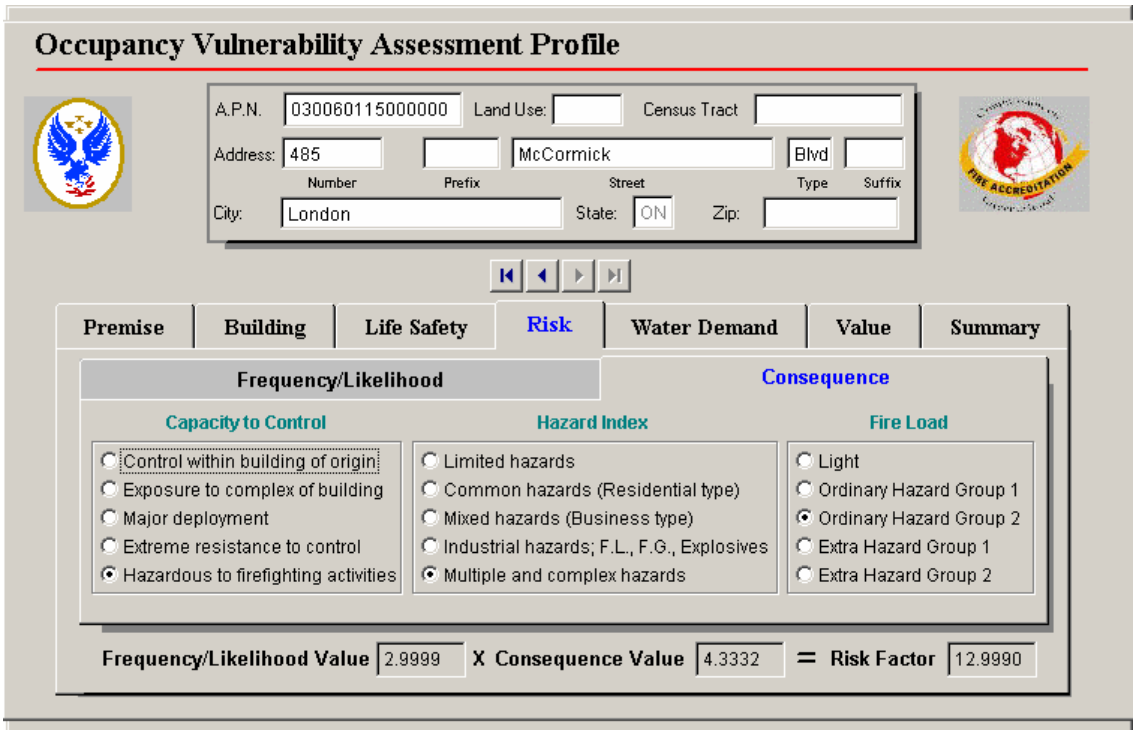
Type
Suffix
City: London
State: ON
Zip:
Premise
Building
Life Safety
Risk
Water Demand
Value
Summary
Frequency/Likelihood
Consequence
Regulatory Oversight
Highly regulated, Mandatory compliance
Highly regulated, Inspections scheduled
Regulated, Inspection schedule random
Regulated, Voluntary compliance
Unregulated, Uninspected
Not a factor
Human Activity
No access to unauthorized persons
Controlled access to unauthorized persons
Business activity, Sales and retail
Group activity, Transient population
Domestic activity, No occupant control
Not a factor
Experience
Daily events
Weekly events
Monthly events
Annually events
Rare occurance
Frequency/Likelihood Value 2.9999
X Consequence Value 4.3332
= Risk Factor 12.9990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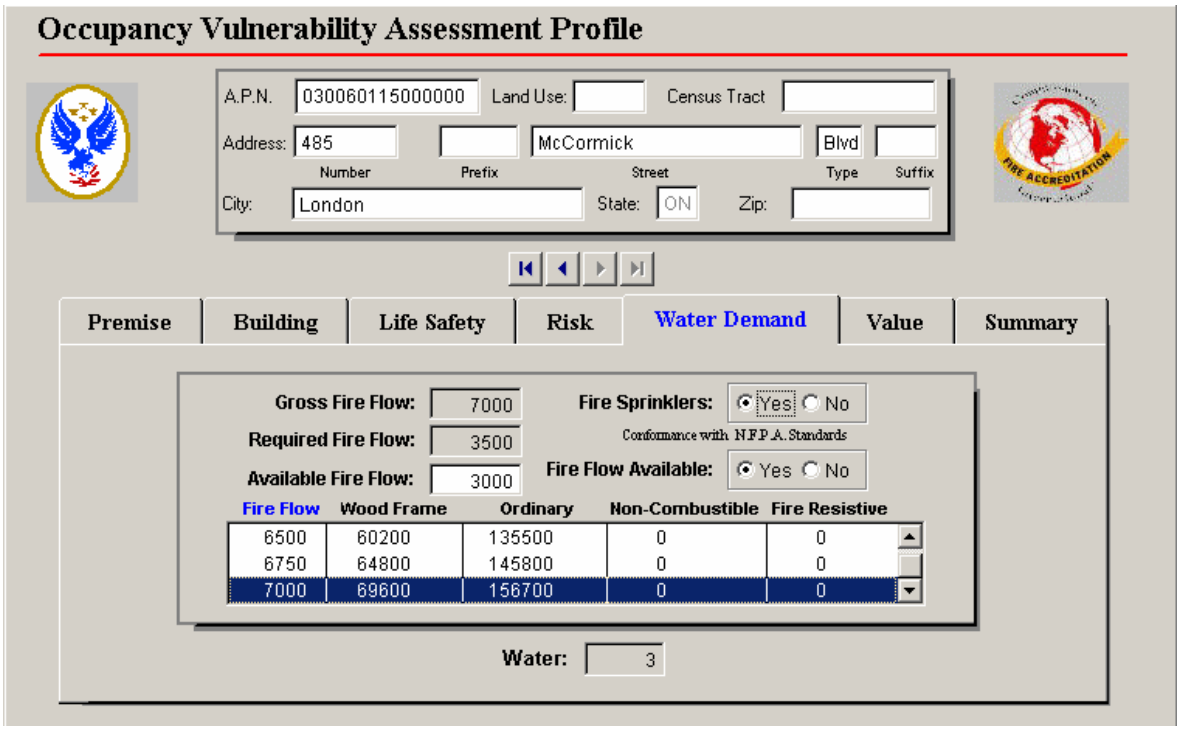
Type
Suffix
City: London
State: ON
Zip:
Premise
Building
Life Safety
Risk
Water Demand
Value
Summary
Frequency/Likelihood
Consequence
Capacity to Control
Control within building of origin
Exposure to complex of building
Major deployment
Extreme resistance to control
Hazardous to firefighting activities
Hazard Index
Limited hazards
Common hazards (Residential type)
Mixed hazards (Business type)
Industrial hazards; F.L., F.G., Explosives
Multiple and complex hazards
Fire Load
Light
Ordinary Hazard Group 1
Ordinary Hazard Group 2
Extra Hazard Group 1
Extra Hazard Group 2
Frequency/Likelihood Value 2.9999
X Consequence Value 4.3332
= Risk Factor 12.9990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Number
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Street
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Type
Suffix
City: London
State: ON
Zip:
Premise
Building
Life Safety
Risk
Water Demand
Value
Summary
Gross Fire Flow: 7000
Required Fire Flow: 3500
Available Fire Flow: 3000
Fire Sprinklers: Yes No
Conformance with N.F.P.A. Standards
Fire Flow Available: Yes No
Fire Flow
Wood Frame
Ordinary
Non-Combustible
Fire Resistive
6500 60200 135500 0 0
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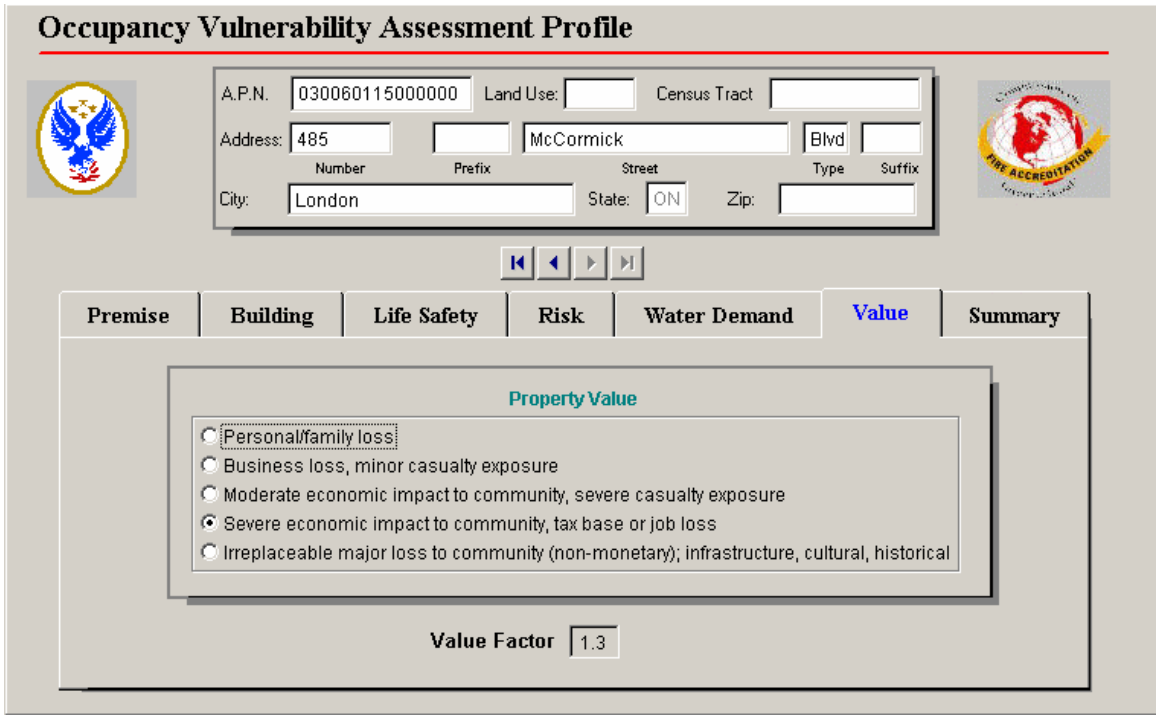
7000 69600 156700 0 0
Water: 3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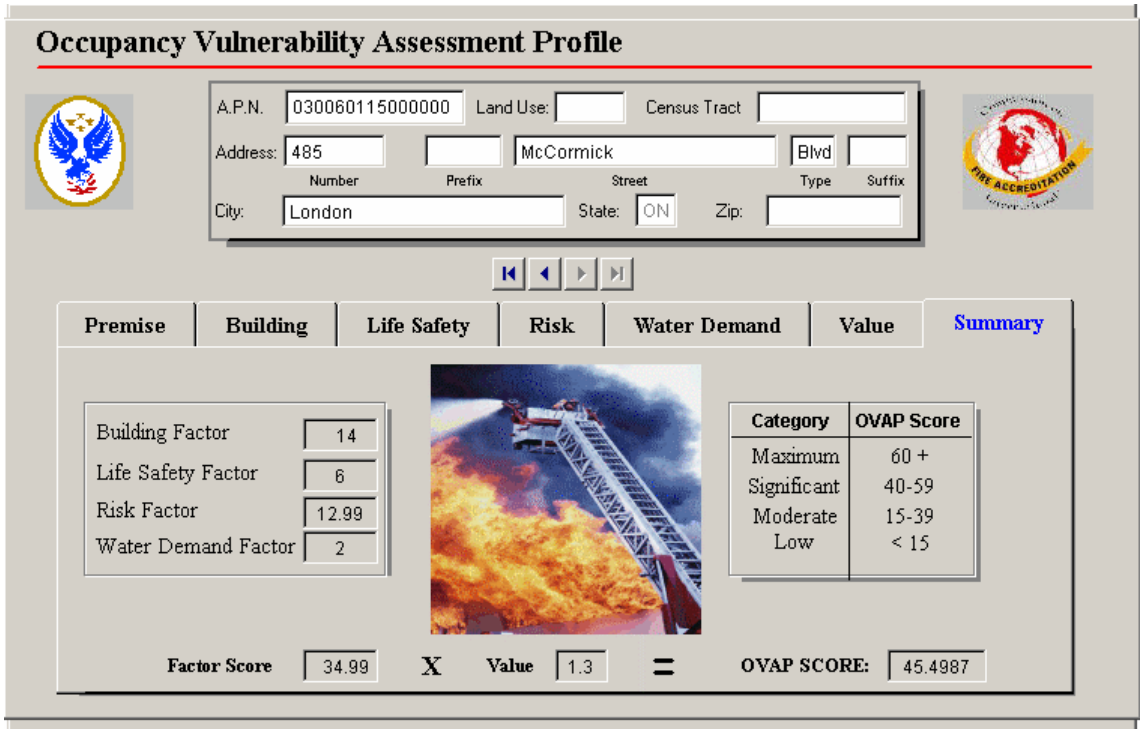
Type
Suffix
City: London
State: ON
Zip:
Premise
Building
Life Safety
Risk
Water Demand
Value
Summary
Property Value
Personal/family loss
Business loss, minor casualty exposure
Moderate economic impact to community, severe casualty exposure
Severe economic impact to community, tax base or job loss
Irreplaceable major loss to community (non-monetary); infrastructure, cultural, historical
Value Factor 1.3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City: London
State: ON
Zip:
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Building
Life Safety
Risk
Water Demand
Value
Summary
Building Factor 14
Life Safety Factor 6
Risk Factor 12.99
Water Demand Factor 2
Category
OVAP Score
Maximum 60 +
Significant 40-59
Moderate 15-39
Low < 15
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X
Value 1.3
=
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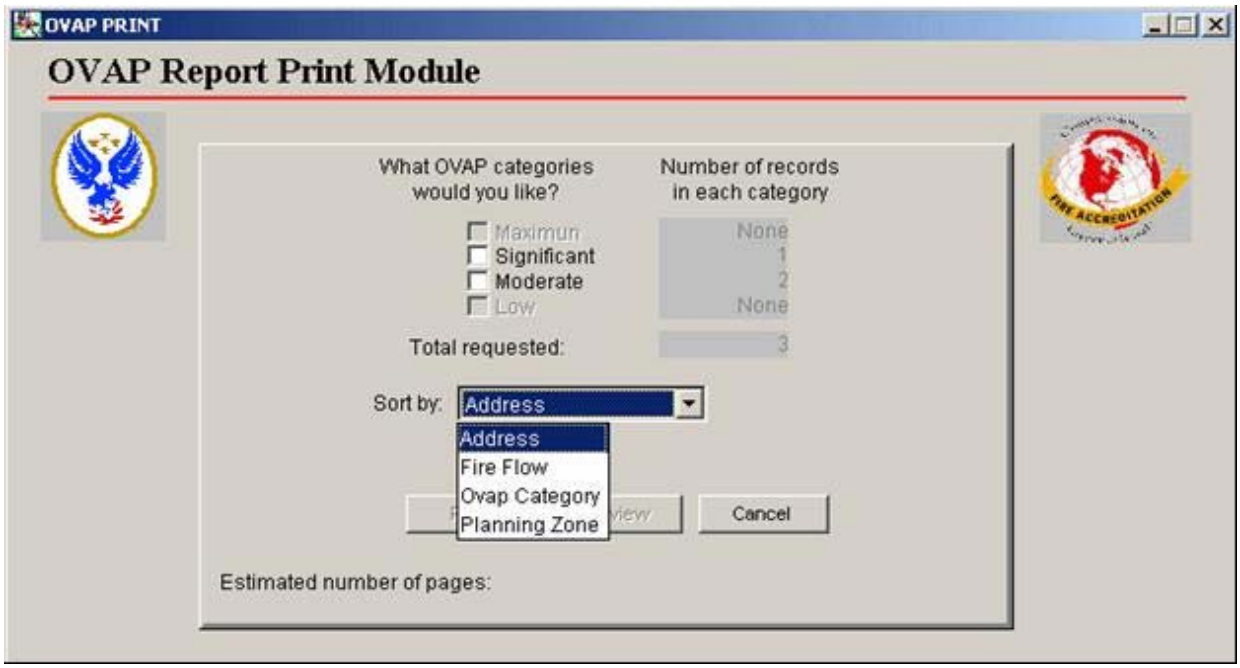
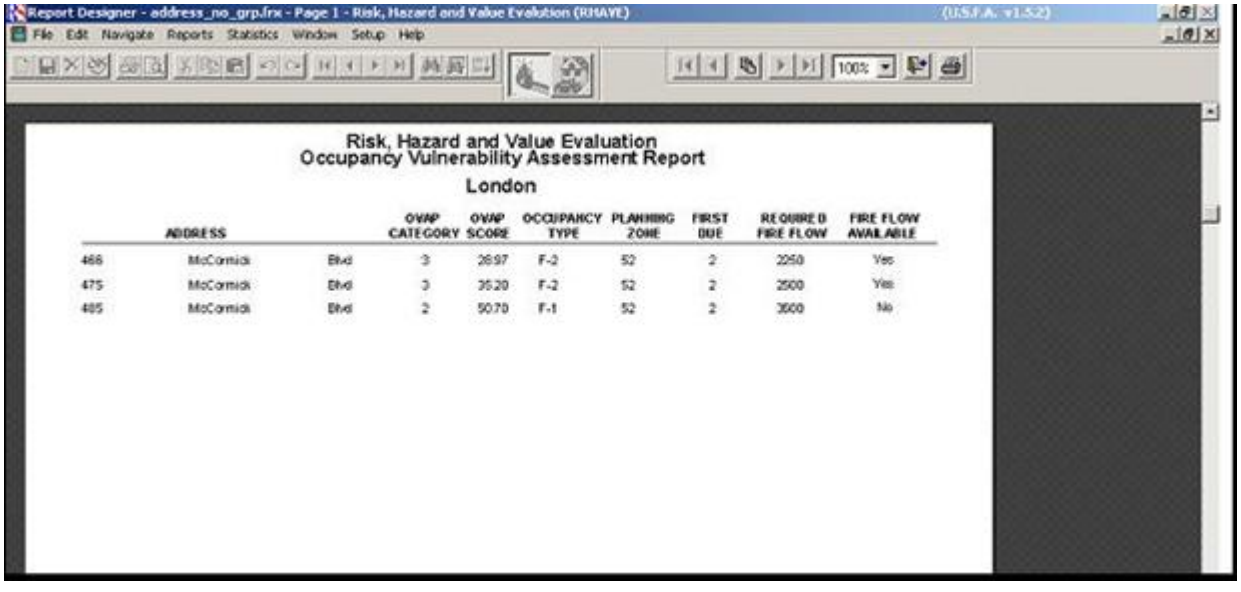




(Raddison 2000)

APPENDIX O

LAYOUT OF RESULTS OF ASSESSMENT FOR A SINGLE AREA

Incident type	Risk category	Worst case planning scenario	Potential loss of life and property	Response goal	Response time	Fire service role and tasks	Resource needs
Railways							
Vehicles							
Ships							
Aircraft							
Bombs							
Flood							
HAZCHEM							
Other							

(Wright, 1999, p. 9)

APPENDIX P

RATING GUIDANCE FOR MAJOR INCIDENTS

	Assigned major incident frequency	**Major vehicle incidents.** Rating guideline	**Railway major incidents** Rating guideline (per county or major sub-division of authority area)	**Aircraft** Rating guidelines	**Shipping** Calculate rate by multiplying number of ferries operating in area by 0.0025.
High	>1 in 10 per year	High volume of vehicle movements along over 100 miles of M-way and/or high speed regional A road.	5 or more mainline railway terminal or commuter/ intercity through routes and/or underground train lines. 7 or more significant incidents reported by HMRI each year.	Airports where likelihood of aircraft crash meets or exceeds1 in 10 p.a. (as per total crash frequency on appended table)	Ports and shipping channels in UK waters where likelihood of uncontrolled fire on ferry or other vessel with dozens of persons exceeds 1 in 10 p.a.
Medium	Between 1 in 10 and 1in 100 years	High volume of vehicle movements along between 10 and 100 miles of M-Way and/or high speed regional A road	1 to 4 mainline railway termini or commuter/ intercity through routes and/or underground train fines. 1 significant incident every 2 years to 6 years reported by HMRI.	Airports where like aircraft crash is between 1 in 11 and 1 in 100 p.a. (as per total crash frequency on appended table)	Ports and shipping channels in UK waters where likelihood of uncontrolled fire on ferry or other vessel with dozens of persons is between I in 11 and1 in 100 p.a.
Low	Below I in 100 years	High volume of movements on less than 10 miles of M-Way and/or regional A roads.	No mainline railway terminal or commuter/ intercity through routes and/or underground train lines - and less than 6 regional routes. Less than 1 significant incident	Airports where likelihood of aircraft crash is between 1 in 101 and 1 in 1000 p.a. (as per total crash frequency on appended table)	Ports and shipping channels in UK waters where likelihood of uncontrolled fire on ferry or other vessel with dozens of persons is between 1 in 101 and 1 in 1000 p.a.

			every 2 years reported by HMRI.		

(Wright, 1999, p. 15)

	Assigned major incident frequency	**Floods**	**Bombs**	**Major HAWFIBM incidents**	
				Rating guidelines	Rate of hazardous chemical incidents reported to HSE
High	>1 in 10 per year	An area with risk of flood greater than 1 in 100 years, that has either over 100 mobile homes/bungalows or many roads crossing rivers, over 400 multi storey houses and a few dozen mobile homes.	Urban areas with high rise buildings and numerous economic and political targets. (eg centre of capital cities)	Highly industrialised [*sic*] area(s) of chemical works, factories and related transport activities; or Length of route for transport of motor spirit from one or more fuel depots/manufacturing sites is 260km or more, or; Over 800 km of LPG transport route. 2 or more top tier CIM-AH sites	7 or more serious hazchem [*sic*] incidents per county or brigade area, or: 1 or more major incident noted in local brigade fire reports in past 10 years.
Medium	Between 1 in 10 and 1 in 100 years	An area with risk of flood greater than 1 in 100 years, that has either (1) a few dozen mobile homes/bungalows or (2) many roads crossing rivers and over 400 multi storey houses.	Urban areas with high rise buildings and a few economic and political targets. (eg regional cities with high value commercial areas, military or political establishments of national importance)	Area(s) of normal mix of factories, hospitals and commercial activities - occasional gas holder and factory using chemicals or 1 top tier CIMAII site. Length of route for transport of motor spirit from one or more fuel depots /manufacturing sites is 30 to 260 km, or; 100 to 800 km of LPG transport route.	2 to 6 serious hazchem [*sic*] incidents per annum per county or brigade area, or: 1 or more major incident noted in local brigade fire reports in past 50 years.

Low	Below 1 in 100 years	An area with risk of flood greater than 1 in 100 years, that has no more than 10 or 20 mobile homes/bungalows, and under 400 multi storey houses.	Rural and suburban areas lacking high rise or dense buildings.	Predominantly rural, residential or office based activities. No CIMAH sites. Under 30km of motor spirit routing and under 10Okm of LPG routing.	1 or less serious hazchem [*sic*] per annum per county or brigade area.

(Wright, 1999, p. 16)

APPENDIX Q

FIRE RISK ANALYSIS – RATING SYSTEM

Part A – Real Property Risk

Section One

ITEM #	EXTERIOR ITEMS	CURRENT CODES AND STANDARDS	RATING
1-1	Siting [*sic*], exposure to and from other property Reference(s): Applicable Building Code	Meets requirements	0
		Does not meet requirements	-100
1-2	Fire fighting services.	6 km or less from the nearest fire station	0
		For each km of distance over 6 km	-10
		For each minute in excess of 6, from time of alarm to assemblage on the fire-ground of the force required by recognized standards	-10
1-3	Siting [*sic*], fire fighting access. Reference(s): Applicable Building Code	Meets requirements	0
		Does not meet requirements	-50
1-4	Water supply. Reference(s): Applicable Building Code & NFPA 13 (Sprinklered Occupancies)	Meets requirements	0
		Does not meet requirements	-100
		Exceeds requirements	+10
1-5	Fire department connection(s)/accessibility. Reference(s): Applicable Building Code & Fire Code	Meets requirements	0
		Does not meet requirements	-30

Section Two

ITEM #	UTILITIES AND SERVICES	CURRENT CODES AND STANDARDS	RATING
2-1	Electrical services. Reference(s): Applicable Building Code	Satisfies requirements	0
		Does not satisfy requirements	-30
2-2	Natural gas/propane gas service. Reference(s): Applicable Building Code	Satisfies requirements	0
		Does not satisfy requirements - exterior	-15
		Does not satisfy requirements - interior	-30
2-3	Heating. Reference(s): Applicable Building Code	Satisfies requirements	0
		Does not satisfy requirements	-30
2-4	Ventilation and exhaust system(s). Reference(s): Applicable Building Code & Fire Code	Satisfies requirements	0
		Does not satisfy requirements	-30
2-5	Cooking equipment. Reference(s): Applicable Building Code & Fire Code	Meets requirements	0
		Does not meet requirements	-30

Section Three

ITEM #	INTERIOR ITEMS	CURRENT CODES AND STANDARDS	RATING
3-1	Sprinkler system(s) Reference(s): Applicable Building Code & Fire Code	Required and provided	0
		Required but not provided	-100
		Not required but provided	+100
3-2	Special fire suppression systems (excluding (sprinklers) Reference(s): Applicable Fire Code	Required and provided	0
		Required but not provided	-50
3-3	Standpipe and hose system(s) Reference(s): Applicable Building Code	Required and provided	0
		Required but not provided	-30
		Not required but provided	+10
3-4	Portable fire extinguishers Reference(s): Applicable Fire Code	Satisfies requirements	0
		Does not satisfy requirements	-20
3-5	Fire detection and alarm system(s) Reference(s): Applicable Building Code	Required and provided	0
		Required but not provided	-100
		Not required but provided	+20

3-6	Voice communication system(s) Reference(s): Applicable Building Code & Fire Code	Required and provided	0
		Required but not provided	-50
		Not required but provided	+10
3-7	Exits, general requirements. Reference(s): Applicable Building Code	Satisfies requirements	0
		Does not satisfy requirements	-100
3-8	Emergency lighting. Reference(s): Applicable Building Code	Satisfies requirements	0
		Does not satisfy requirements	-50
3-9	Interior finish (flame spread). Reference(s): Applicable Building Code	Satisfies requirements	0
		Does not satisfy requirements, exits	-50
		Does not satisfy requirements, general	-30
3-10	Fire stopping Reference(s): Applicable Building Code	Satisfies requirements	0
		Does not satisfy requirements	-30
3-11	Fire separations. Reference(s): Applicable Building Code & Fire Code	Satisfies requirements	0
		Does not satisfy requirements	-30
3-12	Fire walls. Reference(s): Applicable Building Code	Satisfies requirements	0
		Does not satisfy requirements	-30

Part B – Property Management and Usage Risk Factors

Section Four

ITEM #	INTERIOR ITEMS	CURRENT CODES AND STANDARDS	RATING
4-1	Fire safety plan. Reference(s): Applicable Fire Code	Satisfies requirements	0
		Does not satisfy requirements	-30
		Exceeds requirements	+10
4-2	Control of fire hazards in the building, general. Reference(s): Applicable Fire Code	Required and provided	0
		Required but not provided	-20
4-3	Combustible waste material control. Reference(s): Applicable Fire Code & NFPA 101	Satisfies requirements	0
		Does not satisfy requirements	-10
4-4	Decorations/Furnishings. Reference(s): Applicable Fire Code	Satisfies requirements	0
		Does not satisfy requirements	-10
4-5	Storage, general. Reference(s): Applicable Fire Code	Satisfies requirements	0
		Does not satisfy requirements	-10
4-6	Storage/usage of flammable/combustible liquids. Reference(s): Applicable Fire Code	Satisfies requirements	0
		Does not satisfy requirements	-30
4-7	Inspection and maintenance of special fire suppression system(s). Reference(s): Applicable Fire Code	Satisfies requirements	0
		Does not satisfy requirements	-25
4-8	Inspection and maintenance of sprinkler system(s). Reference(s): Applicable Fire Code	Satisfies requirements	0
		Does not satisfy requirements	-50
4-9	Inspection and maintenance of standpipe & hose system(s). Reference(s): Applicable Fire Code	Satisfies requirements	0
		Does not satisfy requirements	-15
4-10	Inspection and maintenance of portable fire extinguishers. Reference(s): Applicable Fire Code	Satisfies requirements	0
		Does not satisfy requirements	-10
4-11	Inspection and maintenance of fire detection & alarm system(s) & voice communication system(s) Reference(s): Applicable Fire Code	Satisfies requirements	0
		Does not satisfy requirements	-50

Part C – Human Risk Factors

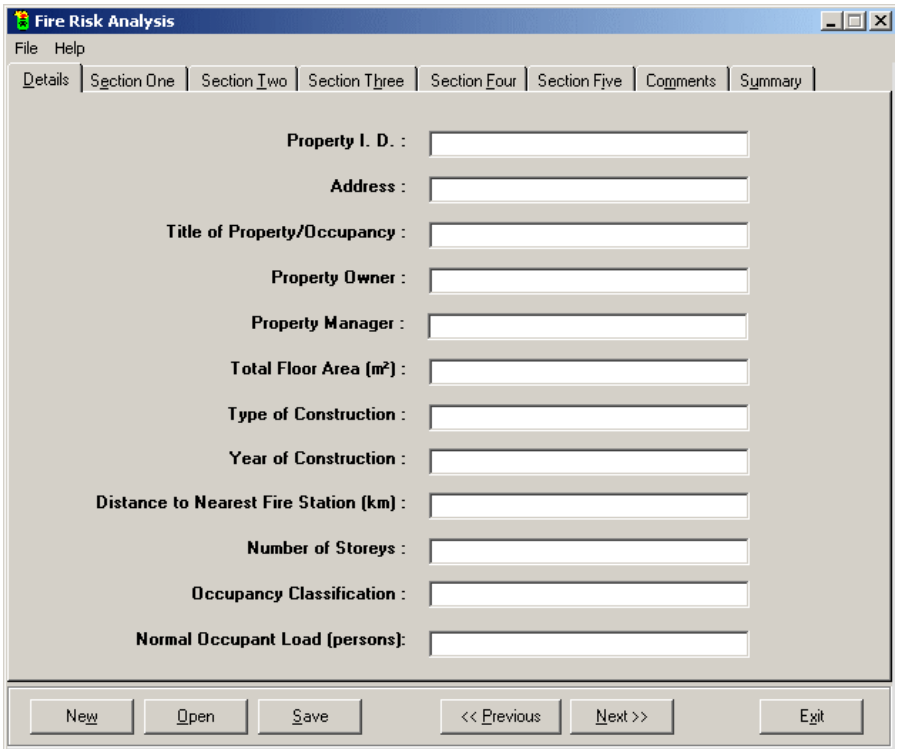
Section Five

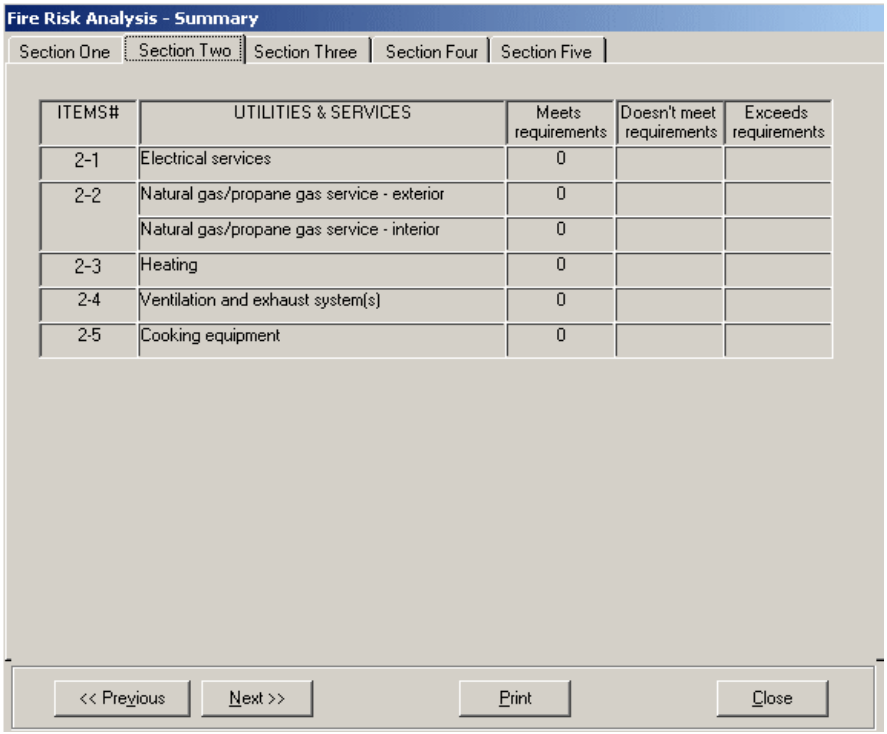
ITEM #	OCCUPANT FACTORS	EXISTING CONDITION	RATING
5-1	Assembly occupancy. Reference(s): Applicable Fire Code, Applicable Building Code& NFPA 101	Located on the ground floor/building no deficiencies	0
		Rating per floor above or below grade	-10
		Building has deficiencies that impinge on life safety	-200
		Not Applicable	0
5-2	Primarily persons with disabilities.	Located on the ground floor/building no deficiencies	0
		Rating per floor above or below grade	-10
		Building has deficiencies that impinge on life safety	-200
		Not Applicable	0
5-3	Primarily pre-school children.	Located on the ground floor/building no deficiencies	0
		Rating per floor above or below grade	-10
		Building has deficiencies that impinge on life safety	-200
		Not Applicable	0
5-4	Primarily seniors.	Located on the ground floor/building no deficiencies	0
		Rating per floor above or below grade	-10
		Building has deficiencies that impinge on life safety	-200
		Not Applicable	0
5-5	Persons under restraint.	Rating per person	-5
		Not Applicable	0

(*Fire risk analysis - rating system*, 2001, pp. 3-6)

APPENDIX R

FIRE RISK ANALYSIS – RATING SYSTEM: SUMMARY SCREENS





Fire Risk Analysis - Summary

Section One | Section Two | Section Three | Section Four | Section Five

ITEMS#	INTERIOR ITEMS	Meets requirements	Doesn't meet requirements	Exceeds requirements
3-1	Sprinkler system(s)			100
3-2	Special fire suppression system(s)	0		
3-3	Standpipe and hose system(s)	0		
3-4	Portable fire extinguishers	0		
3-5	Fire detection and alarm system(s)	0		
3-6	Voice communications system(s)	0		
3-7	Exits, general requirements	0		
3-8	Emergency lighting		-50	
3-9	Interior finish (flame spread)	0		
3-10	Fire stopping		-30	
3-11	Fire separations		-30	
3-12	Fire walls		-30	
	PART "A" RATING TOTALS		-350	110
	PART "A" RATINGS PLUS or MINUS BALANCE		-240	

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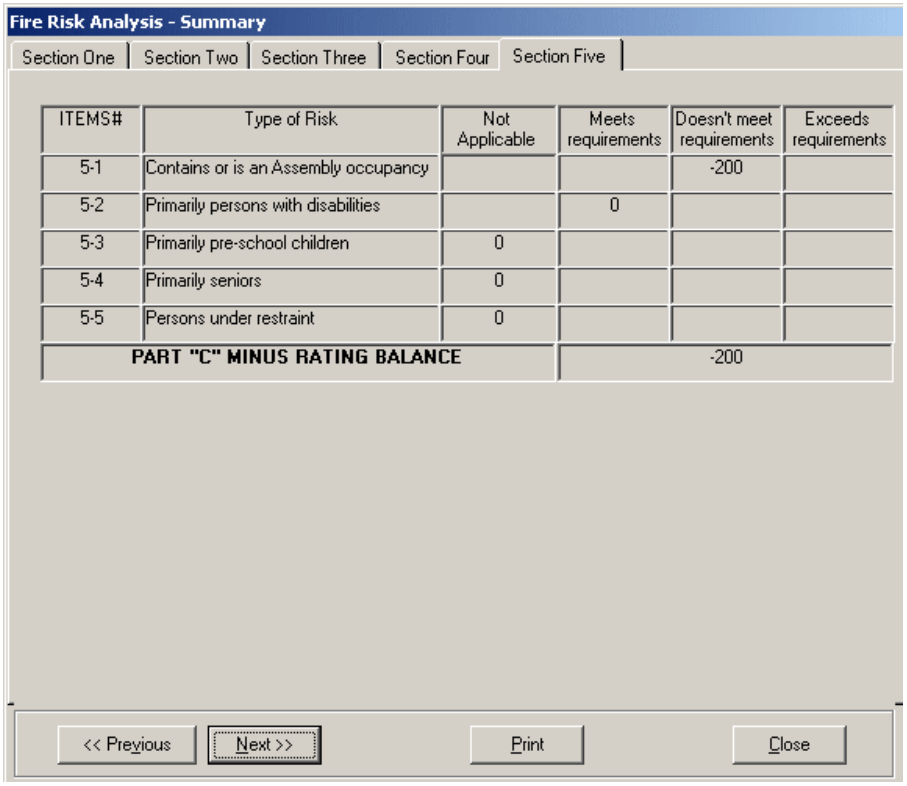
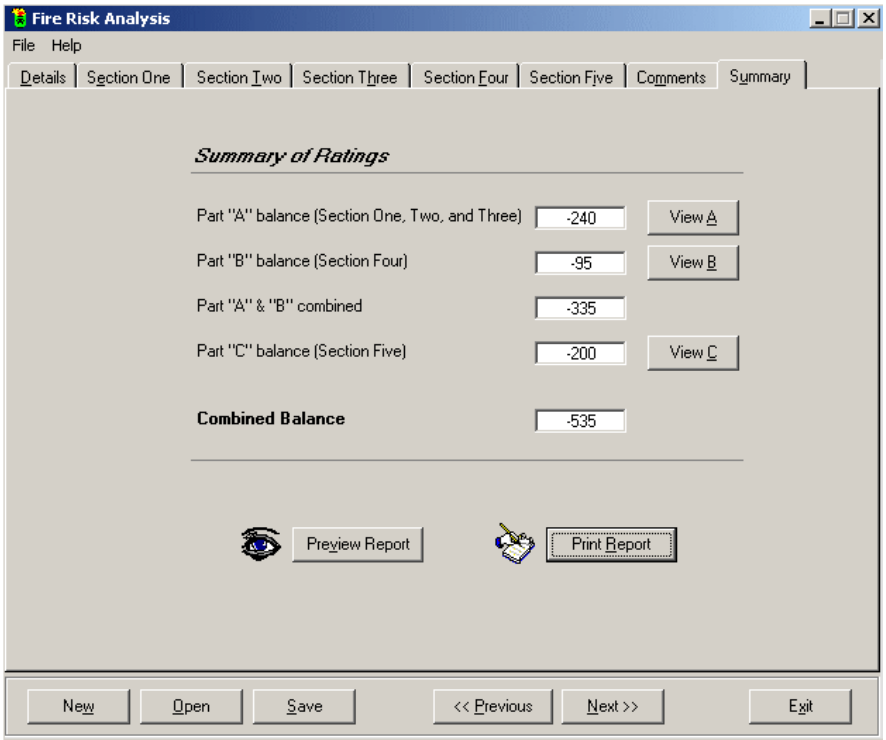
Fire Risk Analysis - Summary

Section One | Section Two | Section Three | Section Four | Section Five

ITEMS#	CONDITIONS of OCCUPANCY	Meets requirements	Doesn't meet requirements	Exceeds requirements
4-1	Fire safety plan		-30	
4-2	Control of fire hazards in the building, general	0		
4-3	Combustible waste materials control	0		
4-4	Decorations/Furnishings	0		
4-5	Storage, general		-10	
4-6	Storage/usage - flammable/combustible liquids		-30	
4-7	Inspection and maintenance - special fire suppression system(s)		-25	
4-8	Inspection and maintenance - sprinkler system(s)	0		
4-9	Inspection and maintenance - standpipe and hose system(s)	0		
4-10	Inspection and maintenance - portable fire extinguishers	0		
4-11	Inspection and maintenance - fire detection/alarm system(s) and voice communications system(s)	0		
	PART "B" RATING TOTALS		-95	0
	PART "B" RATINGS PLUS or MINUS BALANCE		-95	

<< Previous | Next >> | Print | Close





("Fire risk analysis - rating system," 2001)

APPENDIX S

COMPARISON OF RISK ASSESSMENT CRITERIA (GENERAL CATEGORIES)

General Criterion	Models								
	FEMA	NFPA	OFM	Klein	ORM	Davis	RHAVE	ULC	Wright
Hazard identification	√	√	√	√	√	√	√	√	√
Vulnerability analysis	√	√					√		
Numbers and types of structures	√	√	√			√	√	√	
Occupancy types	√	√	√	√		√	√	√	
Potential losses – human and dollar	√	√		√			√		√
Land use trends	√	√							
Prediction to the frequency and predicted severity of events	√	√	√	√	√	√	√		√
Planning sectors	√	√	√				√	√	
Public and private fire protection systems		√	√				√	√	
Fire prevention and public education programs			√				√		
Public and Political Resolve/Commitment			√						
Historical analysis and comparisons	√	√	√						
Water supply		√	√	√			√		
Value of property to community	√		√				√		
Type of construction		√				√	√	√	
Building height		√				√	√		
Number of occupants and any special needs or challenges	√	√		√		√	√		
Building size		√				√	√		
Distance from other exposures		√				√	√		
Fire and building code compliance				√		√	√		

Building accessibility		√					√		
Condition of utilities and services		√						√	
Response time								√	√