March 2008

Evaluation of Fog Security Devices

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HXA A081

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Keywords: Fog Security System, Smoke Security Device, Obscuration

February 29, 2008

Abstract

The purpose of this report is to investigate and advise on the safety, regulation and procedures relevant to the use of fog security systems in greater Melbourne, Victoria. The project evaluates existing literature pertaining to these devices such as building and fire codes, incident reports, and manufacturer information, as well as interviews with emergency services personnel, system installers, and users of these systems. From these sources, this report is written as a comprehensive outlook on the safety of these systems as well as recommendations in the best interests of the fire brigade, community and manufacturers.

Executive Summary

The purpose of this report is to investigate and advise on the safety, regulation and procedures relevant to the use of fog security systems in greater Melbourne, Victoria and other metropolitan areas of Australia. Fog security systems, introduced to the Australian market a decade ago, are currently sold by three firms in Australia. The purpose of these devices is to act as theft deterrents by filling a designated area with fog upon being triggered by a linked security system, thereby driving an intruder out of a premise before he or she has time to steal valuable goods. These systems sometimes include powerful strobe lights and sounders to accompany the fog in order to improve the deterrent effect (Martin Security Smoke, Ltd., 2005). There is little regulation concerning the use of these devices in Australia, and limited communication regarding these devices within the fog security device industry, emergency services, or between the two groups. The use of these systems has led to concerns regarding safety and emergency response considerations for both the community and emergency services stakeholders.

The Metropolitan Fire Brigade of Melbourne (MFB) and other parties have raised many concerns regarding the use of fog security devices, both in regards to fire fighting operations as well as community risks. The main concern stems from the possibility of false alarms of fire caused by fog security device deployments. Occupational health and safety issues, mostly relating to the fog and use of strobe lights were also raised alongside concerns regarding the absence of regulatory control over the use and installation of fog security devices.

In order to gain a comprehensive understanding of the scope of fog security system installations, seven of the eight known sites with systems in the Metropolitan Fire District (MFD) were inspected by the project team. In addition, key members of the MFB were interviewed to determine operational concerns, and outside personnel, recommended as credible sources by the MFB, were consulted to identify and interpret any applicable laws or regulations concerning these systems and their use. From these inspections and consultations, information was gathered concerning the state of the fog security device market in Australia, personal experiences of those present during fog security device deployments, operational concerns of the MFB, and the applicability of building regulations and other legislation.

Identifying the strengths of the use of fog security systems provides a better idea of the selling points which these devices have among potential users of the product, as well as with other stakeholders such as police or insurance providers. End-user testimonials provided by various manufacturers indicate that the devices have acted as successful theft deterrents in a number of installations, and do so in a cost-effective manner when considering the cost of the crimes they deter (Martin Security Smoke, Ltd). For the end-user, the systems are easy to use; the user only has to arm or disarm their burglar alarm as they would normally in order to activate the fog security device. Since the systems are not built-in to a structure and do not have any unusual requirements such as a hardwired high-voltage supply, these devices can be installed without a building permit; the units require about as much wiring and planning as the installment of a computer projector. Additionally, independent laboratory tests have found that the fog produced by these systems is nontoxic for short-term exposures under normal conditions (Ackermann, 1997;

Smith, 1993). Similar investigations have shown that the fog is harmless to electronics (Martin Security Smoke, Ltd.), as well.

The weaknesses inherent in the use of fog security devices are issues that have the potential to impact business owners, emergency services, the general public, and even intruders. Just like the burglar alarm to which they are connected, these systems carry a risk of false activation, which can include deployments of fog and accessory activation (such as security strobe lights). A false deployment at a business during trading hours would result in a loss of trading for at least as long as it would take for the fog to be removed, notwithstanding any injuries or other problems resulting from the evacuation of occupants. Employees must also be properly trained in order to deal safely with deployments of fog or accessory devices. Finally, by requiring additional planning for, and consideration of, accidental deployments and other measures, fog security devices put additional burden on employers that utilize these devices to comply with occupational health and safety regulations.

There are a number of opportunities presented by the use of fog security systems to the community, largely resulting from their apparent effectiveness to date as a theft deterrent. A reduction in theft resulting from the deterrent effect of these devices could be a benefit to overall crime prevention by in turn reducing the amount of police time spent investigating burglaries. As shown through end-user testimonials, the installation of fog security devices also allows businesses in high-crime or high-profile locations to regain insurance coverage (Eighteen, 2005) or to reduce premiums by minimizing or eliminating losses from theft (Martin Security Smoke, Ltd).

The threats that fog security systems present are focused on safety. The main threat is that of blocking egress routes in the event of a deployment. Another safety threat is that of photosensitive epileptics finding themselves in an environment with active strobe lights that could induce seizures. The loudness of sounders (which can also induce nausea (Martin Security Smoke, Ltd., 2005)) also poses a threat of hearing damage after certain lengths of exposure (Occupational Safety & Health Administration, 2006). Other threats created by fog security devices include possible charges from the fire brigade to businesses for false alarm calls and the allocation of MFB resources to false alarms, diverting personnel and equipment that could respond to an actual emergency.

Thoughtful consideration of all findings and the above analysis has led to many conclusions, mainly regarding the safety risks associated with the use of fog security devices. For example, it has been determined that the only legislation in Victoria concerning these devices is the Occupational Health and Safety Act of 2004 and the associated Occupational Health and Safety Regulations of 2007, with bearing on the devices from a personal injury and workplace safety perspective. The only direct references to fog security systems internationally are present in a French security standard and British Standard 7939:1999 (“BS7939:1999”). BS7939:1999 is voluntary, however, and is comprised of guidelines using the word “should” as opposed to “must.” Therefore, the advertisement of compliance with BS7939:1999 by fog security device manufacturers has little to no definitive meaning.

These concerns, along with poor communication within the fog security device industry, within the MFB, and between these two groups pertaining to fog security system use, are addressed by recommendations for improving the safety and regulatory environment surrounding these systems. These recommendations are separated into community, industry, and fire fighting interests, and then further categorized into immediate and long-term measures.

Recommendations for immediate action, intended to mitigate community concerns while more long-term solutions are established, primarily focus on notification and reporting on fog security systems. First, consistent and conspicuous signage at all entrances to premises with fog security systems installed, providing notification of the presence of the fog security device and its accompanying accessories is necessary for the safety of both the public and emergency response personnel. Furthermore, education provided by system installers to the management of premises with fog security systems installed on the duties of care of the management with respect to these systems is important. Information relating to the function and use of fog security devices must be passed from the distributors to the installers and then to the end user and the fire services in order to reduce risks to the MFB and community by increasing the knowledge about the systems. Finally, risks to the community may be reduced by changing strobe light settings to safer defaults, as well as reducing the sound levels emitted by sounder accessories to within acceptably safe levels.

Recommendations for long-term measures are needed, focused on transitioning successful immediate solutions for the community into sustainable and effective solutions based on system design, standards, and regulatory practices. This includes requiring permits for the installation of fog security systems, therefore ensuring that parts of the Building Code of Australia (BCA) can be used to guide the safe design of system installations. Also recommended is that WorkSafe Victoria provides clarification on the duty of care of employers in workplaces where fog security devices are installed. Last, it is recommended that time interlocks, allowing fog security devices to be functional only outside of trading hours, be installed to eliminate the risk of accidental deployments of the systems while the building is occupied.

Concerns applicable to the fire brigade and other emergency services are to be addressed through improvements in data collection, voluntary efforts on the part of fog security system installers and monitoring companies, and the development of a MFB policy on false alarms from these systems. Data collection can be improved within the MFB by utilizing a common procedure for issuing Australian Incident Reporting System (AIRS) codes and reports for attendance of false alarms. Other immediate solutions are based on the cooperation of installers in providing installation notification to the appropriate fire brigades, as well as private monitoring companies compiling statistics on the deployment of fog security devices. Such cooperation in the near term is to be facilitated by ad-hoc creation of a fog security system industry partnership for best practices and data sharing.

Over the long term, permanent solutions in the interests of the fire brigade include requiring the monitoring of security alarms with attached fog security devices. Reporting requirements on such alarms and amendments to existing operational procedures are long-term solutions, as well as the creation of an Australian Standard to govern the use of fog security devices and coordinate safety and communication efforts among installers, manufacturer representatives, and emergency response organizations. Fog security system installers need to form a working group between themselves and all suppliers of fog security systems to Australia. Private monitoring companies should be required to monitor the fog security device itself when installed as part of a burglar alarm, and to report on the deployment of such devices to the fire brigade. Last, a metric should be implemented and tracked to follow the progress and success of the proposed recommendations.

The implementation of these recommendations will help to mitigate the risks posed by the use of fog security devices. This will create a regulatory environment such that fog security devices can continue to be used as theft deterrents, while posing minimal risks to emergency service responders and the community.

Authorship

In the creation of this report, authorship was split evenly among the team members. Research into topics was conducted both in a collaborative manner and individually, with sources shared in order to increase project efficiency. All sections were edited by all members of the group in order to ensure better error detection and correction.

Jordan Prevé was primarily responsible for the formatting of the report. All members of the team were responsible for providing sources for the material used for citation purposes and Alex Andrews was responsible for using this material to create actual citations and managed the information in RefWorks.

Below is a table containing all sections of the report and their respective primary authors and editors. It should be noted that these are *primary* authors and editors, as collaboration at some level was conducted on all sections of the report.

Table of Authorship:

Section	**Primary Author(s)**	**Primary Editor(s)**
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1. Introduction

Business owners face the risk of loss of inventory or assets and the possibility of harm to their staff in the normal operations of their firm, inherent when dealing with the public. The problem of crime applies on an international basis to industries from retail banking to equipment warehousing, and has long spurred innovation in the field of security. The Australian Institute of Criminology (AIC), for example, reports that burglary is the most expensive crime to small businesses in Australia, accounting for 35% of the total cost of crime to firms in 1998-1999. In the same period, the AIC found that 27% of Australian small businesses reported being burglarized, with an average direct cost to the business of AU$2822 per incident (Taylor and Mayhew, 2002).

Increasingly, technology in the form of security systems has been applied to problems ranging from small-scale shoplifting to grand theft or armed robbery. Beginning as simple security systems functioning just as door or window alarms, more modern security installations may commonly include video surveillance and advanced motion detectors. A novel idea was introduced a few decades ago for use as a deterrent in a security system – a new class of active deterrents, fog security devices. These devices, similar to theatrical fog machines, rapidly fill a room with relatively inert fog, making theft difficult and encouraging prompt egress from the premise. Systems may also come equipped with accessories such as strobe lights and sounders, or voice notification systems (Martin Security Smoke, Ltd., 2005).

In the early 1990s, a number of manufacturers introduced fog security devices to the UK for the protection of high-valued goods and theft prevention (Martin Security Smoke, Ltd., 2007); (Gibbard, 2008). Smokecloak, a major distributor, has installed devices in warehouses of leading retail stores in the UK, and those from another producer, Concept Smoke Screen, are installed at a number of Tesco and Boots' locations in the UK as well (Concept Smoke Screen, 2007). These customers have been "impressed with the speed and efficiency of the entire design and installation of the systems" (G4S Security Systems, Ltd., 2007). Since the introduction of this product and other similar devices to UK markets, the product idea has spread to other countries (Martin Security Smoke, Ltd., 2007). In the USA, for example, the product is being featured at various trade shows (Martin Security Smoke, Ltd., 2007). Since its introduction to Australia, the product has caught the attention of Australia's fire protection services, notably the Metropolitan Fire Brigade (MFB) of Melbourne, among others. The MFB has raised concerns about the effects of the deployment of fog security systems, mainly with regard to their impact on emergency response teams.

One of the primary concerns has been the issue of false alarms of fire arising from the deployment of these systems, where a false alarm could be created from either internal fire alarm systems (by smoke detectors activating) or community calls to emergency services by passerby upon seeing the fog. These false alarms present an operational concern to the MFB in deploying unnecessary resources to such responses, and to the possibility of deploying fire resources to what is effectively a police matter. To bring this matter into perspective, for fires in the Metropolitan Fire District, the average cost per attended fire to businesses in the past seven years (2000-2007) has been AU$36,817 (Metropolitan Fire Brigade, 2008b), thirteen times the cost per incident of burglary to businesses in Australia (Taylor and Mayhew, 2002). Thus there is a certain risk, inherent in tying up MFB resources at false alarms unnecessarily as a result of efforts to mitigate theft losses that can manifest itself as a direct cost to the business community.

Additionally, there is concern regarding the impact of fog security systems on mandated emergency evacuation and building safety plans. The Building Code of Australia (BCA) provides performance requirements in Sections D and E that could be affected by the use and deployment of fog security systems. British Standard 7939:1999, one of very few international standards on these devices, and the only one relevant in Australia, also has bearing on how fog security devices are installed and used. International building and fire codes also have sections pertinent to the use of fog security systems.

Another consideration of the MFB is the health and safety of those involved in the deployment of these systems; individuals on the premises at time of deployment, general public outside the premises, and emergency responders to the scene must all be considered. There are liability and injury concerns regarding these systems in certain circumstances, such as visibility issues and the obscuration of exits, which could present safety hazards. Also, the actual fog deployed could have negative effects on people with existing health issues (Concept Engineering Limited, 2007). Psychological effects must also be taken into account for the purposes of liability and community safety, including the risk of latent problems exacerbated by conditions in a deployment.

The deployment of a fog security system can create problems for emergency responders, particularly firefighters. In all situations when a fire alarm is reported via a “000” (the number in Australia called to report emergencies) call, the fire department is obligated to respond (Metropolitan Fire and Emergency Services Board, 2007). If the firefighters are responding to a report of “smoke” issuing from a building that is actually fog, this could divert the fire service from more pressing matters. Another risk is the possibility that an armed intruder could still be on the premises when the fire crew arrives; this would pose a threat to the fire service’s personnel working to ventilate the structure or determine the cause of a false alarm. It would also be very difficult for police forces to ensure that the building is clear due to the limited visibility.

With these concerns in mind, as well as those for the community, this project examines the positive and negative aspects of fog security devices and their deployment. Recommendations for measures to mitigate health and safety risks associated with the use of these devices are presented for consideration by the governing authorities of the Building Code of Australia, the Metropolitan Fire Brigade, and other interested parties.

2. Literature Review

The goal of this report is to investigate and advise on the safety, regulation and procedures relevant to the use of fog security systems in greater Melbourne, Victoria and other metropolitan areas of Australia. All of these factors will be addressed further in the following literature review. This literature review is separated into twelve topics covering the history, purpose and development of these devices, as well as information concerning fire and smoke including relevant standards information.

2.1 History and Development of Fog Security Devices

Originally, fog making devices were developed and installed in the 1960s by the predecessor of Concept Smoke Screen (Gibbard, 2008).These oil-based systems were used initially for fire training, and later adopted into a security role as demand increased. Initial applications in security were for protecting gold reserves and by the UK Ministry of Defence, starting in 1975 (Gibbard, 2008).

Fog security systems are marketed largely in Europe by four major firms: Smokecloak Ltd. (a division of Martin Security Smoke), Concept Smoke Screen, Protect Global, and Bandit Solutions. The devices of all firms are intended as a nonlethal deterrent to burglary in retail and warehousing environments in order to combat the issue of repeat burglaries and robberies of business sites. They are triggered by burglar alarms or any professionally installed, hardwired security system, and in some cases (Smokecloak, Concept, and Protect, for instance), have status indication communication with the alarm panel (British Standards Institute, 1999), or in the case of Bandit, computer monitoring capabilities (Bandit Americom, 2006). According to the manufacturers, the presence of sudden fog plumes is intended to encourage egress from the building in the case of trespass or burglary (Martin Security Smoke, Ltd., 2007).

Fig. 2.8A – Fog Security Device (Smokecloak Brand)

Sales and service of the devices worldwide is through authorized installers and security system vendors. Three of the four major European manufacturers, Concept Smoke Screen, Smokecloak Ltd., and Protect Global, are represented in Australia by independent distributors. In the case of Smokecloak and Concept Smoke Screen installations, these systems are advertised as being governed by British Standard 7939:1999 (Gibbard, 2008), discussed later. According to Smokecloak's promotional and marketing materials, the target markets are small retail locations or warehouse locations, both of which are prone to inventory loss through break-ins (Martin Security Smoke, Ltd.)

2.2 Fire Detection and Alarm Systems

Automatic fire detectors detect heat, light, or smoke in order to detect the presence of a fire; there are many different variations. There are two kinds of smoke detectors: ionization and photoelectric. Ionization detectors detect small particles by using radioactive material (normally americium). This radioactive material ionizes air molecules as they enter a designated area within the detector, which then allows a certain amount of current flow between oppositely charged plates. When smoke particles enter the chamber, they attach to the ions, thus reducing the electrical conductivity within the chamber of the detector. When this occurs, an alarm signal is initiated. An advantage of this type of detector is that it automatically resets itself when the air clears (Hall, R. and B. Adams, 1998).

Photoelectric smoke detectors come in two varieties: beam application and refractory application types. The beam application type operates by focusing a beam of light across the area to be observed and onto a photoelectric cell. Light induces a current in the photocell to keep a switch in the open position. The switch closes when current is no longer produced due to the presence of smoke particles in the path of the light beam. The refractory beam application also uses a light beam, directed away from the light source. The light is not aimed toward the photocell, meaning that no current is produced under normal circumstances and the switch remains off. The light is refracted upon the presence of smoke particles and some reaches the photocell, opening the switch and signaling an alarm. These detectors also reset themselves when the atmosphere clears (Hall, R. and B. Adams, 1998).

The average particle size of the fog produced by a fog security system is about 0.8 micron for glycol-based fog and approximately 0.2 micron for glycerine-based fog (Smoke Security US, 2007). Ionization smoke detectors respond best to particles less than 1 micron in size and photoelectric varieties are best at detecting particles greater than 1 micron in size (National Fire Protection Association, 2006b). This means that fog deployed from these security systems would likely be detected by ionization smoke detectors and mistaken for smoke particulate. Although the fog would be less likely to trip a photoelectric detector, this possibility still exists. The potential exists, then, to create false alarm signal situations when the fog security system is deployed.

Heat detectors are another type of alarm-initiating device. There are two basic types, namely fixed-temperature devices and rate-of-rise detectors. Fixed temperature devices are fairly inexpensive and among the oldest type of fire detection. They are the least prone to false alarms as well as being the slowest to activate of all alarm-initiating devices. They must be placed at a high point in the room (because heat rises) and are set to react at some temperature higher than would be expected to occur at that location. These fixed-temperature devices operate on one or more of three principles: expansion, melting, or changes in resistance of heated material. Fixed temperature detectors are preferable because of their tendency not to initiate false alarms but are undesirable too because of their lateness in activation (Hall, R. and B. Adams, 1998).

Rate-of-rise detectors have other advantages and disadvantages. They are designed to react when the rate of rise reaches about 7°C to 8°C per minute. The functionality of these detectors depends heavily on proper installation, though. If installed properly, they are not often subject to false alarms. But if the unit is installed near an exit door, for example, a drastic change in temperature upon opening of the door could trip the sensor. An advantage of this type of detector is that they reset automatically (if still functioning properly). In addition, these detectors can detect heat from a fire before fixed-temperature detectors because they are based on a rate, not a specific temperature (Hall, R. and B. Adams, 1998).

Finally, flame detectors, also referred to as "light detectors," come in three types: UV detectors, IR detectors, and combined UV and IR detectors. These detectors detect the ultraviolet wave spectrum, the infrared wave spectrum, or both (which can be generated by a fire), respectively. An advantage to this type of detector is that they are extremely sensitive in fire detection. However, they are subject to false alarms in the presence of bright light (Hall, R. and B. Adams, 1998).

Upon detecting an emergency situation, these fire detection units signal an alarm system. This alarm system uses audible and/or visual signals to notify people of an emergency situation. Fire alarm systems can also be triggered manually by a person through the use of a pull box. Guidelines exist for visual alarm signals, (Bukowski & O'Laughlin, 1987) which can be found in AS1670.1, or in NFPA 72, as discussed in Section 2.7 (Standards Australia Committee FP-002, 2004b). In addition to signaling an emergency situation, these alarm systems can initiate fans and dampers to control the spread of smoke (Klote et al., 1992).

2.3 Operation and Function of Fog Security Devices

Fog security devices operate on a common principle of adiabatic fluid expansion caused by a high-temperature heated nozzle. The nozzle operates at around 180°C depending on the fluid composition used by a particular brand (Martin Security Smoke, Ltd.). Two delivery methods are used for these devices, either a pump-based system (used by Smokecloak, Concept, and Protect) (Martin Security Smoke, Ltd.; Concept Smoke Screen Ltd, 2003; Protect Global, 2007) or pressurized aerosol canister system (Bandit) (Bandit Americom, 2006). Pump-based systems draw fog fluid at atmospheric pressure and force it through a nozzle to generate the fog effect (Martin Security Smoke, Ltd.), whereas pressurized canister systems rely on internal pressure of the fluid canisters to force fog fluid through the heated nozzle (Bandit Americom, 2006). The fog itself is only slightly warmer than room temperature due to the adiabatic effect.

In addition to the primary fog-deployment aspect of fog security devices, other accessories are available through manufacturers to further the deterrent effects of their systems. These include voice modules, strobe lights, and sounders. The voice modules are designed to be set inside or outside of the protected premises with the purpose of informing people in the surroundings area if systems are set or activated (Martin Security Smoke, Ltd.). The strobe option from Smokecloak is a 3000-watt entertainment strobe light provided "to produce a blinding effect" (Martin Security Smoke, Ltd., 2005), strobe lights are also available from both Concept Smoke Screen and (Concept Smoke Systems, 2007); (Protect Global, 2005). The sounder units from Concept Smoke Screen and Smokecloak are intended to stop intruders from entering premises and claims to be "so loud and intolerable that it can produce nausea" (Martin Security Smoke, Ltd., 2005). It produces 125dB at a 1m range (Martin Security Smoke, Ltd., 2005), a level categorized as "painful" by the American Speech-Language-Hearing Association (ASHA) (American Speech-Language-Hearing Association).

The systems currently being installed in Australia also have the option to be equipped with a panic trigger. A panic trigger is any device for manual activation of a fog security system for reasons other than demonstration or testing. These triggers would likely be linked to a silent alarm in a bank or a holdup alarm at a convenience store. The main purpose of the panic triggers is to allow employees to deploy the fog security system when under duress. The use of this type of system has the potential to result in a fog security system deployment during business hours.

In order for fog security devices to function without fault, certain aspects must be taken into account. Integration with fire detection systems must be considered, for example. Smokecloak and Concept both recommend that heat detectors be used in conjunction with regular smoke detectors in order to discriminate between fog and fire (Martin Security Smoke, Ltd.; Protect Global, 2007). In fact, Concept Smoke Screen's installation guidelines require that a rate-of-rise thermal detector is installed on the premises' fire alarm to reduce false alarms (Concept Smoke Screen Ltd, 2003). Another recommendation from Smokecloak is that a "fire shutdown circuit" be connected in the presence of a fire panel. The purpose of this is to "eliminate the production of Smokecloak fog during a fire" (Martin Security Smoke, Ltd.). In this case, a signal will disarm the Smokecloak unit in a fire situation, and the unit will remain disarmed as long as the signal is active. In addition, the control panel will sound an audible signal as well as notify the monitoring station (Martin Security Smoke, Ltd.,).

Another aspect of Smokecloak-brand fog security devices that aims to minimize faults is the presence of multiple triggers needed for a system to deploy. These triggers include one primary and multiple confirmation sensors depending on how the system is configured. Smokecloak units use 12 VDC signals for both of its triggers, and for status indication. When the burglar alarm system is armed, the Smokecloak's arming trigger is turned on, readying the system and allowing it to respond to a deploy trigger; when the alarm is disarmed, the arming trigger is turned off. This aims to ensure that the Smokecloak does not activate accidentally during normal hours of operation when the burglar alarm is ordinarily off. The confirmation trigger is connected to an optional sensor which can deploy the system only when a dedicated motion detector is triggered, for example. Any system without such a confirmation trigger attached and without a hold-off on the alarm for the fog security device deployment is considered an "instant-on" system. Finally, a triggered output is available. This output can supply the accessories like the sounder or strobe. (Martin Security Smoke, Ltd.).

Initial deployment of fog is timer-controlled across all manufacturers' fog security device models (Concept Smoke Screen Ltd, 2006; Martin Security Smoke, Ltd.; Protect Global, 2007). However, Smokecloak-brand devices use a device linked into the fogging device as a feedback sensor to determine when the fog has dissipated. This device is similar to a smoke detector in that it uses the same principles but is calibrated to only activate when there is a high level of obscuration. Thus, after some time when the fog has either dispersed or settled, the fogging unit will be re-activated and will fog until adequate obscuration is achieved (a default setting on what is called the "feedback sensor") (Martin Security Smoke, Ltd.).

Another feature of fog security devices is their ability to report certain faults when connected to an alarm system. In the case of Smokecloak, there are six zones that each reports a different fault. For example, "Key Switch Isolation" (to isolate for servicing) and "Smoke Unit Tampers" (when covers are tampered with) are zone faults that can be reported by "on" or "off" electrical triggers. Also reported by normally closed contacts are "Smoke Unit System Trouble," "Low Fluid Warning," and "Smoke Unit AC Fail" (when power is turned off). Finally, the "Smoke Being Discharged" alarm fault is reported via another simple electrical trigger (Martin Security Smoke, Ltd.).

In the case of Concept Smoke Screen’s commercially available fog security unit, the RAPID, triggers and status are reported much the same way. Alarm connections are provided for two triggers which are needed to cause a fog release. These are an alarm panel connection and a secondary, confirmation trigger for use with an optional motion detector, and both are 12 VDC contacts. Status reporting is provided on the “ready” state of the device, as well as a “low fluid” indicator (Concept Smoke Screen Ltd, 2003).

Reporting capabilities of fog security devices from Protect Global closely follow those of Smokecloak-brand units. Device faults, fog deployment, and “low fluid” can be indicated to an alarm panel through 12 VDC signals. A facility is also provided for use of a confirmation sensor, such as a motion detector, connected directly to the fogging unit (Protect Global, 2007).

2.4 Installation and Deployment of Fog Security Devices

Fog security systems are installed by professionals trained by the manufacturer of the device. All four major manufacturers (Martin, Bandit, Protect and Concept) offer solutions for wall-mounting, ceiling mounts, or standalone systems. Concept also offers a ceiling ducting option for their high-output units which helps to route fog into smaller, separated rooms (such as offices or cubicle rows) (Gilmartin & Dards, 2006). Smokecloak’s units support this, but the company does not recommend the use of this option, instead recommending multiple units to cover appropriate volumes (Arias Tech).

Manufacturers have attempted to address the concern of false alarms both on-premises and from passersby calling “000” with regards to fire response in various ways. One manufacturer, Bandit Solutions, adds a menthol (minty) scent to their HY-3 fog fluid to distinguish it from smoke from a fire or other source (*BS7939*, 1999). They are the only one of the three main manufacturers to do this. The Smokecloak fluid, FL600, Protect's fluid, and the Concept fluid are all solutions of glycols and water (Concept Engineering Limited, 2007; Martin Security Smoke, Ltd., 2005; Protect Global, 2007). Bandit and Smokecloak offer optional voice warning systems to alert any individuals in a fog-secured building to the deployment of security fog, to both head off false alarm calls and to encourage egress from the building (Martin Security Smoke, Ltd.) and (Bandit Americom, 2006). Concept offers an optional deterrent sounder called the "S3B" to encourage egress from the premises upon a security system being tripped (Concept Smoke Screen, 2007), and Smokecloak offers a similar sounder device (Martin Security Smoke, Ltd.).

2.5 Standards for Fog Security Devices

There is no Australian Standard which governs the use of fog security devices. A British Standard is the only such document with which distributors advertise compliance in Australia. This standard is a voluntary compliance measure designed to make the processes of distributors more transparent and easily audited, as seen by the provisions within it (British Standards Institute, 1999). Since these standards are voluntary, the only obligation manufacturers or installers have to these standards is to honor their own advertising and initial compliance certification.

British Standard BS7939:1999 (the "Standard" in this section), "*Smoke security devices - code of practice for manufacture, installation, and maintenance*" is issued by the major British standards body, the British Standards Institute, and compliance is advertised by at least two fog security device manufacturers, Martin Security Smoke and Concept Smoke

Screen (Martin Security Smoke, Ltd.,); (Gibbard, 2008). Concept also was represented on the working group in developing a French security standard on fog security devices, and both firms are involved with a European Union-wide version of BS7939:1999 (Martin Security Smoke, Ltd.,); (Gibbard, 2008). There is no English version of the French standard, however, and the European Union standard is in draft form, so neither has been included in determining installer compliance in Australia.

Manufacturers in compliance with BS7939 must ensure that their devices meet certain specifications. These include features on the devices to ensure the safety of business owners and customers. To reduce tampering, the devices are to be identified with unique serial numbers for traceability and housed in a keyed cabinet with an alarm tamper trigger to the central panel to make any changes to the system known. More importantly, there is discussion in the Standard of a common design feature of fog generators, the design of the discharge nozzle, which must be heated to high temperatures to aerosolize the fog fluid. In accordance with the Standard, the nozzle should both be shielded from exterior access and temperature-monitored to ensure safe and proper operation. The Standard also prescribes a system integral to the fogging device itself which monitors fogging levels and prevents over-release of fog. All fog security devices should be integrated with a central alarm panel to ensure informed response to fog release and to allow for implementation of safety protocols detailed in the Standard (British Standards Institute, 1999).

The Standard provides two categories of installation policies and procedures - one for physical deployment matters and one for liaising with interested parties in the community (fire rescue, police, insurers, etc.). In the case of physical deployment, there are certain constraints placed on the release of fog by these devices in the interest of safety during false alarms and accidental releases. Fog security devices should only be triggered during an alarm condition (as indicated by the connected master alarm panel, mentioned earlier), and not while the premises are occupied, or if the area covered by the fog is needed for emergency egress, as described in Section 8.8:

> "The smoke generator should not be operable when the premises are occupied or if the area is required for means of escape."
> (British Standards Institute, 1999).

Additionally, some provision must be made to have a backup power source for deployment in the case of power loss (British Standards Institute, 1999).

The Standard also stipulates that the installer or manufacturer of such devices - whoever is responsible for the final installation - should initiate a dialogue with local fire rescue, police departments, and insurers to discuss effective use of the device. Notably, this dialogue includes the management or bypass of fire smoke detection or exhaust systems and how to prevent the installation from triggering such a system inadvertently. Also recommended in Section 8.14 of the Standard, is that the "installer should inform the fire brigade, police and alarm receiving centre of the installation" (British Standards Institute, 1999) in order make them aware of possible false alarms generated by the fog-based security system. Additionally, manufacturers and installers are to provide technical information, technical presentations and documents, and training courses for installers relating to fog-based security devices to interested community parties (such as fire services) (British Standards Institute, 1999).

2.6 Health and Psychological Impacts of Fog Security Devices

The health and psychological concerns about the use of fog security devices are centered on the risks associated with them. Mainly, physical health risks are those due to exposure to chemicals. Psychological concerns are those of risks brought on by accidental deployments of fog security systems.

2.6.1 Health Impacts

The health concerns surrounding the deployment of fog security devices are primarily focused on the inhalation or skin contact of the aerosolized fog fluid by any individuals on the premises. In the case of Smokecloak units, Protect Global's units, or Concept's RAPID, the fluid used is water- and glycol-based, with the resulting fog having a particle size of approximately 0.8 microns (Smoke Security US, 2007). Bandit systems use an ethanol- and glycol-based mixture with the fog particle size being closer to approximately 0.4 microns (Bandit Americom, 2006).

The Material Safety Data Sheet (MSDS) for the Smokecloak FL600 fluid indicates the fluid as nontoxic, as does the MSDS for the Bandit HY-3 fog fluid (Beirinckx, 1997). However, the FL600 data sheet indicates handling precautions for the undiluted fluid including gloves and safety glasses (Martin Security Smoke, Ltd., 2005). Protect, which uses dipropylene glycol, notes in their literature material that the fog can act as an irritant to mucus membranes if a person is in dense fog for a long period of time (Protect Global, 2006).

The chemical components of the manufacturers' fluids have hazards and risks when considered on their own. FL600 from Smokecloak is a mixture of propylene glycol, triethylene glycol, and water (Martin Security Smoke, Ltd., 2005). The RAPID unit from Concept Smoke Screen and the Protect Global units use fluids composed of dipropylene glycol and water (Concept Engineering Limited, 2007; Protect Global, 2007).

The bulk form of propylene glycol bears European hazard codes of R21 and R22, or “Harmful in contact with skin and if swallowed”, and can be “absorbed through the skin and cause systemic effects similar to those of ingestion” (ScienceLab, 2005b). Effects of ingestion can include central nervous system (CNS) issues, kidney, and liver problems. It should be noted that propylene glycol is indicated as incompatible, in terms of reactivity, with strong acids, bases, and silver nitrate among others (ScienceLab, 2005b).

Triethylene glycol is commonly used as a drying agent to absorb moisture in the air or as an airborne disinfectant commercially (ScienceLab, 2005c). Its bulk MSDS sheet indicates that the United States Occupational Health and Safety Administration considers it hazardous, and bears a European hazard code of R41, or “risk of serious damage to eyes”(ScienceLab, 2005c).

Dipropylene glycol, used as a plasticizer, alternative de-icing compound, and industrial solvent, is listed as slightly hazardous by matter of irritation in bulk form. In pure bulk form, there are indications of health risks due to chronic exposure such as kidney, liver, and possible CNS damage, and animal tests indicate a possibility of adverse reproductive effects (ScienceLab, 2005a). A notable difference between the propylene and triethylene glycol mixture, and dipropylene glycol, is that the flash point of dipropylene glycol is approximately 280 deg. F (138 deg. C) (ScienceLab, 2005a) compared to the approximate 700 deg. F (370 deg. C) flash point of propylene glycol (ScienceLab, 2005b). This means that in the presence of a paper fire such as what one could find in an office or retail shop paper fire (minimum of approximately 450 deg. F or 232 deg C, the ignition temperature of plain paper), bulk dipropylene glycol has the potential to be a fire hazard. It is not clear from the bulk MSDS whether this translates to, or what other conditions must be satisfied for, a fire risk from the aerosolized form.

Further investigation into possible toxicity of Smokecloak's FL600 fog fluid was performed by a health and environmental consultancy firm, NOHS, for Smokecloak Ltd. in 1993. The results of both background research by the firm and exposure experiments in deployment environments indicated that the fluid poses no harm to occupants when aerosolized by a Smokecloak unit. The exposure results also indicated no inadvertent byproducts of the heating of the fluid to a fog, a condition which can occur if the heating element goes above a certain temperature range, causing decomposition of the glycol solution (Smith, 1993).

Documentation provided by Concept Smoke Screen indicates similar toxicology of the dipropylene glycol fluid used in their commercially available security fog products when compared to Smokecloak's FL600 fluid. However, Concept includes a warning in their operating instructions regarding the presence of asthmatics or those with respiratory issues in a deployment (Concept Engineering Limited, 2007).

Additional issues arise when consideration is made for accessories often sold and installed alongside fog security devices, such as strobe lights or white noise sounders. Available documentation on the security strobe light from Smokecloak, the IPL3000 (identical to the Atomic 3000 from Martin Entertainment aside from badging), indicates that in the default configuration shipped from the factory, as well as the recommended configuration, the strobe will pulse at a rate between 16 and 17 flashes per second (fps) (Martin Entertainment, 2007)**.** One study suggests that at this flash rate, 96% of photosensitive epileptics would be susceptible to a seizure episode (Health and Safety Executive, 2000). The Greater London Council banned the use of theatrical strobes with flash rates greater than 8 fps to mitigate public risk in 1971(Health and Safety Executive, 2000). The security strobe accessory available from Protect Global operates at 4 fps (Protect Global, 2005), and will trigger less than 5% of the photosensitive epileptic population, thus not posing the same level of risk to the general population (Health and Safety Executive, 2000).

2.6.2 Psychological Impacts

When a fog security system is deployed, its purpose is to prevent thieves from seeing what they are aiming to take and encourage them to leave the premise. The possibility exists that the deployment of these devices could block egress by tenants or customers thus introducing a safety hazard (a man trap situation). A NFPA study found that when visibility was less than 12 feet (3.7m), 91 percent of people turned back into the building when they tried to leave (National Fire Protection Association, 1962). The fact that people may be staying in a fog-filled environment in the event of a deployment during business hours could cause additional work for the fire brigade if they need to evacuate a large number of people from a fog-filled premise. Also, since it is feasible that individuals could panic from the loss of sight in an unfamiliar environment, it is important to recognize that there is a risk of injury to occupants trying to exit the building in a state of panic.

2.7 Building Code of Australia and Permitting in Victoria

Building permits are an important part of any construction project. They are proof that, before construction has started, a building surveyor has endorsed the plans of the proposed work. In Australia, building permits are required by the "Building Act and Regulations" for construction of a building, alterations to an existing building, and the demolition or removal of a building (Governor in Council, 2007). The issuing of building permits ensures compliance with the Building Code of Australia (Building Commission Victoria, 2006b).

The Building Code of Australia (BCA) is a central, performance-based building code which is applied in all states and territories of the country with slight state-to-state variations. In the state of Victoria, the BCA is given authority by the Building Act of 1993, with additional provisions made by the Building Regulations of 2006. These variations serve to clarify the role that the BCA plays in the state as well as providing for permitting procedures and other specifications (Building Commission Victoria, 2006a).

Since 1996, the Building Code of Australia has been released as a performance-based code, intended to reduce the cost of code compliance in new construction (Australian Building Codes Boards, 2007a).This performance-based approach is split into two categories of statements: guidance and compliance. Guidance statements contain the highest-level objectives of the BCA and are the "spirit" of the code, whereas compliance statements describe the objectives in technical detail and how to meet them (Australian Building Codes Boards, 2007c).

The design of the BCA is both flexible and simple, in that a building designer has the option of following a simple "cookbook" of sorts in the form of deemed-to-satisfy (DTS) provisions, or flexibility through an "alternative solution". DTS provisions are the equivalent of an ordinary prescriptive building code in that the code provides examples and direct specifications for meeting the performance requirements of the BCA. Alternative solutions are the flexible side of the BCA, in that they allow building designers to bypass the DTS provisions and use novel approaches to meet the performance requirements of the BCA (Australian Building Codes Boards, 2007a).

Alternative solutions outside the deemed-to-satisfy provisions must be judged against the BCA's performance requirements by an appropriate professional, generally a building surveyor. In Victoria, however, the Building Regulations of 2006 stipulate that for judging the performance of fire-safety related alternative solutions, the building surveyor must be properly accredited in interpreting performance based fire codes, or must seek the certification of a party with such accreditation (Governor in Council, 2007).

Under the BCA, performance requirements and deemed-to-satisfy provisions are both provided within a building classification framework, limiting parts of the code to certain types of structures. The BCA classifies buildings by their use, as determined by the design and construction of the structure, into ten major classes (Australian Building Codes Boards, 2007c). Out of these classes, there are four which are of concern to this report due to the limited market of the fog security devices being researched: classes 5, 6, 7, and 9b. Class 5 buildings are office space that is governmental, legal, or professional in tenancy. Class 6 buildings are retail shops, service stations, or anywhere goods or services are sold to the general public. Class 7 buildings are used by wholesale or for business-to-business transactions, or warehouses used for storage of goods (Australian Building Codes Boards, 2007c). It is noted that "if the general public has access to the building, it is considered […] a Class 6 building" (Australian Building Codes Boards, 2007c) as a guideline to determining the Class 6/Class 7 assignment. Additionally, Class 9b is used for buildings of public assembly such as gaming halls. Under the BCA's class scheme, buildings with multiple classifications are regulated according to the stricter of the set of applicable classes (Australian Building Codes Boards, 2007c).

The provisions of the BCA make up a code against which to check a building before it is allowed to be occupied, and is not written as a document against which to check the use of a building. The Guide to the BCA highlights this as an issue for consideration in Section E4, "since the BCA generally relates to the construction of a build, rather than its on-going use […]" (Australian Building Codes Boards, 2007c). The Building Regulations of 2006 in Victoria vary the BCA to provide for annual inspection and reporting of life safety and other critical systems as needed (Governor in Council, 2007). This allows for equipment checks rather than comprehensive evaluation of the use of the building against the performance requirements of the BCA.

Further provisions of the BCA outline standards governing smoke detection and notification systems. These systems and their application in certain classes of buildings is discussed in Section E of the BCA, "Services and Equipment". Class 5, 6, 7, and 9b buildings must have smoke detection systems compliant with the majority of the provisions of AS1670.1, an Australian Standard on fire detection systems and their operation (Australian Building Codes Boards, 2007b).These smoke detection systems, as opposed to smoke alarm systems, are interconnected and designed to provide notification of larger groups of people unfamiliar with the premise, such as retail shoppers (Australian Building Codes Boards, 2007c; Standards Australia Committee FP-002, 2004b).

The BCA specifies that certain smoke detection systems must be tied directly into the fire brigade or emergency notification center in such a way as to generate an “alarm of fire” when the system is triggered. These alarms are described by Australian Standard AS1670.3, which describes how these alarms are to interface to the fire brigade or notification center and what they are comprised of (Standards Australia Committee FP-002, 2004a).“Brigade-linked” alarms, as they are known, are required for three classes of buildings – large Class 3a buildings, Class 9a “health care”, and Class 9c “aged care” facilities. Additionally, these systems are also required in any building having a pressurized staircase or automatic smoke extraction system, as per E2.2a-7(Australian Building Codes Boards, 2007b), such as high-rise Class 5 buildings.

Emergency lighting, exit visibility and accessibility are also discussed in Section E of the BCA. The intent of these provisions is for a building to provide enough light so as to clearly see the evacuation route (Australian Building Codes Boards, 2007c). Under E4.2(b), for all levels of a Class 5-9 building which exceed 300 m^2 in floor space, emergency lighting must be provided. Under the same provision, emergency lighting is required in any room over 300 m^2 in floor space, in any room not opening into natural light, or an emergency-lit space over 100 m^2 (Australian Building Codes Boards, 2007c). Performance requirement EP4.2 requires that markings on routes and points of egress must be sufficient to find exits, get to them, and to see any other pertinent signs on the route even in the case of failure of the emergency lighting system (Australian Building Codes Boards, 2007b).

2.8 International and Other National Building and Fire Codes

The building and fire codes of countries other than Australia are of interest for purposes of comparison. One topic of interest in these codes is the method of alerting people in the event of a fire. There is more than one way to alert people of the need to leave an area; one is audibly and the other is visually. In the United States, fire alerting systems are required to comply with NFPA 72.7.5.4.5, which describes the performance requirements for the system to comply with the "application, installation, location, performance, inspection, testing, and maintenance of fire alarm systems, fire warning equipment and emergency warning equipment, and their components" (National Fire Protection Association, 2006a). It is also necessary to make sure that once people have been informed of the need to exit the premise, they can locate the exits, they have access to the exit, and the exit is usable. NFPA 101.7.1.10.2.1 states that nothing should limit the visibility of the exit way. The standards contain a considerable amount of information regarding the location and appearance of exit signs, such as NFPA standard 101.7.10, which provides criteria for marking the means of egress. One standard of particular importance is NFPA 101.7.10.1.8 (National Fire Protection Association, 2006b),

> "Visibility. Every sign required in Section 7.10 shall be located and of such size, distinctive color, and design that it is readily visible and shall provide contrast with decorations, interior finish, or other signs. No decorations, furnishings, or equipment that impairs visibility of a sign shall be permitted. No brightly illuminated sign (for other than exit purposes), display, or object in or near the line of vision of the required

exit sign that could detract attention from the exit sign shall be permitted" (National Fire Protection Association, 2006b).

Also of interest is the NFPA code for the installation of systems designed to remove smoke from buildings. NFPA 204 provides specifications on different types of ventilation for smoke and heat. The ventilation systems that are discussed by NFPA 204 are air inlets and outlets, draft curtains, and ordinary walls. They can be deployed manually or automatically. Some of the automatic vents are activated only when they have reached a certain temperature. This is accomplished through the use of a fusible link, a device that is held in place with solder of a known melting temperature, ensuring release when the specified temperature is reached (Hall, R. and B. Adams, 1998). These types of vents would not deploy in the case of fog security system deployment because the temperature would not exceed such a release point. Other vent types are activated by smoke detectors (NFPA Section 5.3.6-7), which would likely be affected by a fog security system deployment (National Fire Protection Association, 2002b).

Draft curtains are building features which help to limit the movement of smoke through a premise. They work by keeping the rising hot gases created by a fire in a localized area, restricted in size by the distance the curtains hang from the ceiling (NFPA Section 7.2). The distance from the ceiling is specified by the NFPA to be no less than 20% of the ceiling height (NFPA Section 7.2). Air inlets are another method of smoke control, allowing fresh air to enter the building to replace the air that was removed by ventilation. These are deployed in similar ways to the vents (NFPA Section 6.5.7) (National Fire Protection Association, 2002b).

NFPA code 90A concerns air conditioning and ventilation for a building, describing the requirements for systems to prevent the spread of smoke, or conditions similar to smoke, from moving through a building. NFPA 90A.5.3.5 requires that smoke dampers be installed to stop smoke passage where smoke barriers are required. There are some situations and limitations where they do not need to be installed as discussed in the code; the specific nature of these limitations is outside the scope of this report (National Fire Protection Association, 2002a).

Heat, ventilation and air conditioning (HVAC) systems can form an important part in the process of smoke extraction. The transformation of a HVAC system from its primary role of heating and cooling to a role of smoke removal is crucial; the system needs to be able to rapidly change from HVAC to smoke ventilation. Systems capable of smoke ventilation work with the different components described in the previous paragraphs to make this transition. Once the system has made the transition from HVAC to smoke ventilation, smoke removal becomes the system's primary function. NFPA standard 92A specifies 75 seconds (National Fire Protection Association, 2006c) as the maximum time permitted between when the system "realizes" that there is a problem and how quickly different parts of the system are required to respond. This code also provides information on how the transition from HVAC system to smoke ventilation system can be initiated and the different types of air control systems (National Fire Protection Association, 2006c).

NFPA code 11, which deals with high expansion foam, has a protocol for dealing with emergency reentry into a foam-filled environment. It recommends that the person entering the area wear a self-contained breathing apparatus and use a lifeline in order to find his or her way out. This is applicable to fog security devices because similar levels of sight obscuration are achieved in both situations. (National Fire Protection Association, 2005)

The International Fire and Building Codes, although not applicable in Australia, contain some sections that are similar to the NFPA codes. The need to maintain egress paths is addressed by 1028.2, which prescribes that an exit must not be blocked in any way at any time. Additionally, 1028.2 states that any security device that has an effect on exit routes needs to be approved by a fire code official. Section 401.5 states that any security system that blocks the exits of any premise by using any substance is not allowed (International Code Council, 2007).

Section 1003.6 of the International Building Code provides for ensuring that the paths of egress are not impeded. There are to be no obstructions to exit ways other than permitted projections. The importance of having exit doors that are easily distinguished from the walls is discussed in Section 1008.1. The doors also need to be made to look like a door so that they may be found easily. Section 1015.2 states that exits must always be easily seen and not having anything blocking them at any time (International Code Council, 2006).

2.9 State Legislation in Victoria

Occupational health and safety matters in Victoria are governed by both the Occupational Health and Safety Act of 2004 (OHS Act) and the Occupational Health and Safety Regulations of 2007 (OHS Regulations), which build upon the OHS Act.

The matter of enforcing OHS legislation and regulations falls to a division of the Victorian WorkCover Authority called WorkSafe. As administrators of the OHS Act, inspectors from WorkSafe have authority to enter premises under suspicion of OHS Act breaches and also possess the power to issue notices of improvement and prohibition (WorkSafe Victoria, 2005).

WorkSafe's inspection and policing authority is to ensure that employers and employees follow their responsibilities under the OHS Act. The most basic premise of the OHS Act, as defined by WorkSafe, is for employers and others involved in the business to provide a safe workplace for employees (so far as "reasonably practicable"). Key stakeholders include officers of a firm, building or site owners, designers of a building or physical plant, employees (WorkSafe Victoria, 2005), and other persons who could be affected by the actions of the employer (Occupational Health and Safety Regulations 2007, 2007). A workplace is defined, in Section 5 Part 1, by the Act as "a place, whether or not in a building or structure, where employees or self-employed persons work." (Occupational Health and Safety Regulations 2007, 2007). For emergency responders, the site of an emergency often becomes their workplace.

When implementing provisions of the OHS Act to ensure a workplace is in compliance, a standard known as "reasonable practicability" is applied. Determination of what is "reasonably practical" to avert a risk is done on the basis of five factors found in Section 20(2): the likelihood of the risk, the danger or harm involved in the risk, any knowledge of the employer in mitigating or wholly eliminating the risk, how easy it is in terms of availability to mitigate or remove the risk, and the cost of implementing such available methods (WorkSafe Victoria, 2007a). For employers, there are seven main parts of the

OHS Act which WorkSafe identifies as key to the mission of the Act, namely Sections 21, 22, 23, 25, 26, 30 and 32.

Section 21 specifies that an employer must provide a safe and healthy working environment and that such an environment is maintained. This section also requires that an employer train, instruct and provide information to its employees so that they may carry out their work in a safe manner (Occupational Health and Safety Regulations 2007, 2007).

Section 22 of the Act outlines the responsibility of an employer to monitor the health of employees and the conditions of the workplace (as far as is "reasonably practicable"). The employer also is responsible to provide the employee with information if he or she wishes to make a complaint or enquiry about the working environment (Occupational Health and Safety Regulations 2007, 2007).

Section 23 describes the need of an employer to protect the general public from risks stemming from the normal operations of their business (Occupational Health and Safety Regulations 2007, 2007). Similarly, Section 25 of the Act dictates that an employee must do their best to make sure the health and safety of other people in their working environment are not affected by the employee's actions. This section states that employees must cooperate with their employer in efforts to comply with the OHS Act (Occupational Health and Safety Regulations 2007, 2007).

Provisions for management responsibilities are outlined in Section 26 (Occupational Health and Safety Regulations 2007, 2007).The section states that those with control over a workplace must “keep the workplace, including entrances and exits, safe and without risks to health” (WorkSafe Victoria, 2005).

Section 30 of the Act provides guidelines for suppliers of substances, specifically that the suppliers are required to provide a product that does not endanger a user’s health when used properly. Also outlined in this section is the requirement of suppliers of substances to provide information to users about health and safety concerns of the substance (Occupational Health and Safety Regulations 2007, 2007). Suppliers must test to ensure that the information supplied is accurate and be able provide OHS information in the form of the Material Safety Data Sheet (MSDS) or other acceptable means upon request (WorkSafe Victoria, 2005).

Finally, Section 32 of the Act states that one must not “recklessly endanger a person at a workplace” (WorkSafe Victoria, 2005). According to this section one must have a lawful reason as to why they have endangered another person in a workplace (Occupational Health and Safety Regulations 2007, 2007).

WorkSafe Victoria has established specific noise exposure regulations, as part of their authority under OHS Act, within the OHS Regulations. These limits for noise exposure are comprised of two criteria, a time-weighted exposure limit, and a peak exposure limit, both of which are set by the National Occupational Health and Safety Commission (NOHS) (Australian Government: National Occupational Health and Safety Commission, 2000). The time-weighted exposure limit is the sound energy equivalent to a constant sound pressure level of 85 dB over an eight-hour period. Peak exposure level is set at a sound pressure level of 140 dB for any amount of time (WorkSafe Victoria, 2007c).

Similar standards exist in the United States through the Occupational Health and Safety Administration's ("OSHA") Regulation 1910.95, providing an 8-hour weighted exposure limit of 85 dB, considered a 50% dose, and a peak exposure limit of 140 dB, similar to the NOHSC specification (Occupational Safety & Health Administration, 2006). Regulation 1910.95 also provides a guideline to safe exposure times as a reference to the regulation, scaling down in time from the eight-hour, 85-dB 50-percent "dose", as the sound levels become higher, and vice-versa (such that at 100 dB, the 50-percent dose would be much less exposure time) (Occupational Safety & Health Administration, 2006).

While no case law has arisen from the installation and use of fog security devices, it is necessary to consider readily applicable statutes pertaining to possible liability of owners or users of these devices. Within the state of Victoria, the Crimes Act of 1958 Part 1 Section 26 considers the use of set traps or devices as follows:

> "A person who sets a trap or device with the intention of causing, or being reckless as to whether or not there is caused, serious injury to another person (whether a trespasser or not) is guilty of an indictable offence." (Crime Act 1958, 2008)

The Crimes Act goes on to specify a maximum prison term of ten years for indictment under Section 26 above.

2.10 Smoke Behavior and Control

The driving force of smoke movement is buoyancy forces. The stack effect, for example, illustrates that if there are openings at the upper and lower area of a building, flow of air will occur due to the temperature difference between the air in the building and the air outside. If the air inside the building is warmer than the air outside, the warm inside air will flow up through the building and out through the top opening, replaced by cooler air coming in at the bottom. Conversely, if the air inside the building is cooler than the air outside, the cool air will sink to the bottom of the building and flow out. Warm air from the outside will flow in at the top to replace this cooler air (Wright). If one looks at smoke as warm air, then, due to buoyancy forces, smoke moves up. It travels through ducts, stairwells and shafts to travel as far up as possible and then builds up in layers back down whichever path it took to travel upwards (Butcher & Parnell, 1979). One point to note about smoke behavior is that it moves in parallel or series paths, and can be analyzed in this manner similar to that of electrical current (Klote et al., 1992).

Smoke control can be affected by various characteristics of a facility itself. For example, HVAC systems can have a negative impact on a smoke-filled building by dispersing the smoke throughout the building. In contrast, though, they can also be signaled to enter a mode of operation that controls smoke movement (more information regarding smoke control in relation to existing HVAC systems can be found in the Literature Review). HVAC systems use fans and dampers to control smoke movement. The fans are used to pressurize escape routes and/or to extract smoke from a building. Fire and smoke dampers restrict the passage of fire and smoke in ducts respectively. They are made of spring-loaded blades that are released in a fire situation, either mechanically (fire melts links holding the blades open, causing damper to close) or electronically. Finally, smoke can be controlled in buildings by venting (Klote et al., 1992). It is unknown how the fog deployed from a fog security device will act in HVAC systems.

Another factor to consider is that of smoke control in the areas of escape routes. For escape routes, a visibility of at least 10m is considered necessary for safety (*Fire Engineering Guidelines* 1996). To achieve this smoke-free escape route, pressurization is commonly used, especially in stairwells. This method employs the use of fans and compartmentation if necessary. In this case, one or more fans operate continuously and push air in from the outside, creating a high-pressure area in the stairwell. The compartmentation aspect of stairwell pressurization is simply a more advanced version of pressurization, used for tall buildings. When compartmentation is used, the stairwell is separated into sections, each having its own air supply instead of one fan supplying air to the whole area (Klote et al., 1992). Another version of compartmentation is a passive method of fire protection that refers to the use of physical barriers such as walls, doors, or smoke dampers to deter the movement of smoke from a fire area to a non-fire area (*Smoke Management*, 2006).

2.11 Fire Response and Firefighting Procedures

The Standard Operating Procedure (SOP) for the Metropolitan Fire Brigade when responding to alarms of fire varies slightly depending on the type of alarm, whether it is from a low-rise structure or a multi-story building. The common parts between both SOP's are the establishment of command on the scene, communication with a building representative, increasing the pressure of hydrants when necessary, locating, and accessing the fire. To gain access to the fire, if it has not already breached the building's structure, the firefighters need to gain access to the building. This can be done with keys (if they have been provided to the fire brigade) or by forcing entry. Once the fire brigade has gained access, they search for the fire to extinguish it or to prove that it was a false alarm (Metropolitan Fire Brigade, 2006).

The Metropolitan Fire Brigade follows the General Alarm Response System (GARS) as their SOP for responses to most alarms of fire (Metropolitan Fire Brigade, 1996). For some locations, there are different standard operating procedures, called Assignment Rules. Assignment Rules are used to increase the number of appliances responding to high-risk assignments or to reduce the number responding to specific events. Assignment Rules are also used to determine which apparatuses should respond to which assignments. The Assignment Rule is used to tailor the response of the Metropolitan Fire Brigade to the specific needs of the assignment (Standard Procedures Operations, 1996).

The purpose of fog security systems is to fill a portion of a building with fog. This fog can set off a fire alarm system in a building or someone could see the fog, and, believing that it is smoke, call an emergency number. Since there is no way of guaranteeing without attendance that there is no fire present, the fire service is obligated to respond to the "000" call reporting the emergency (Metropolitan Fire Brigade, 1958). In the case of responding to a scene where a fog security device is present, the MFB has a standing order (issued in the Safety Alert in Appendix C) that if they arrive to a scene and find that a fog security system has deployed, they are required to inform Victorian Police (VicPol) of the deployment. Also, if there are signs of break-in, the MFB crew is not to enter the premise. Finally, if it is determined that a fog security system has deployed, the MFB is not to conduct salvage operations (MFB Director-Operations, 2007).

A method used by firefighting crews in normal operations that could be applicable to responses involving deployed fog is that of ventilation, which could be accomplished in multiple ways. There are four types of ventilation: natural, positive, negative, and hydraulic. Natural ventilation could also be used, however in most cases this takes longer for a building to vent. If natural ventilation is going to be the prime form of ventilation, the fire service must take into account the weather and know the direction of the wind. This allows the fire service to know which windows or doorways are to be opened first. To properly ventilate a structure with natural ventilation, the windows and doors on the leeward side of the structure need to be opened before the windward side are opened (Hall, R. and B. Adams, 1998).

To assist in natural ventilation, negative and positive pressure ventilation can be used as these would cause the least damage to the structure. Negative pressure ventilation requires that fire fighters enter the building and place fans in openings to draw the air out of the building. Positive pressure ventilation uses a fan placed at a single entrance to the building to make the pressure higher in the building than the surrounding atmosphere. Once this is done an opening as close as possible to the size of the inlet would be opened to let the smoke escape. By opening different parts of a structure such as windows and doors, different rooms can be vented and rooms that do not have any smoke in them can be left sealed (Hall, R. and B. Adams, 1998).

2.12 Alarms and Emergency Dispatch in Victoria

In discussion of burglar alarms, emergency response, and security procedures, it is necessary to identify the types of fire alarm systems available, the way in which security and fire alarms may operate, and the response of emergency services. In Victoria, three types of fire alarms exist: brigade-linked (as per Australian Standard 1670.3 – AS1670.3), privately monitored, and standalone.

Brigade-linked fire alarms trigger an immediate response to an alarm of fire from the MFB when one or more of their smoke, heat or flame detectors are activated. They do so by sending direct notification to the Emergency Services Telecommunication Authority (ESTA, discussed later). These systems are required by the Building Code of Australia (BCA) for certain types of buildings, as discussed in Section 2.7. Their design, installation, and commissioning are governed by AS1670.3, which sets standardized guidelines for fire alarms in high-risk or high-value situations to be reliably linked to the fire brigade (Standards Australia Committee FP-002, 2004). The specifics of AS1670.3 are outside the scope of this research; however it is necessary to realize that brigade-linked alarms are legally obligated to conform to set standards. Brigade-linked alarms will trigger a response to an "alarm of fire" by the MFB when they are activated (Standards Australia Committee FP-002, 2004b).

Privately monitored alarms link together fire sensors (smoke, CO, heat, etc.) to an alarm panel, and in turn, to a private alarm monitoring company. These are generally tied into a burglar alarm or other central control unit which serves as both a fire and security alarm. A fire alarm indication is passed to the monitoring company, not directly to the fire brigade or ESTA. It is at the discretion of the monitoring company to contact ESTA by calling "000" for a triggered fire alarm, and generally will happen only after the private firm has not been able to reach the registered owner of the system via telephone or the private monitoring company has confirmed a fire. A "000" call from a monitoring company carries the same requirements to respond as a call from the general public, that is, it is treated as an alarm of fire by the MFB (Personal communication with Commander of Alarm Assessment, 21 Feb 2008).

Standalone alarms are simpler and only alert occupants and sometimes passersby to the presence of smoke or fire, depending on the type of the system installed, by using noise or other feedback to warn people. These systems do not trigger a fire brigade or monitoring response, and rely on passersby or the occupants to dial “000” if there is actually a fire (Personal communication with Commander of Alarm Assessment, 21 Feb 2008).

The Emergency Services and Telecommunications Authority (ESTA) is a unified body which provides “000” emergency call and non-emergency contact to and for the emergency services of Victoria. They receive calls from both private citizens and monitoring companies and pass the appropriate information along to the needed emergency service, whether it is fire, ambulance, or police (Emergency Services Telecommunication Authority, 2006).

When an emergency is reported to the MFB, the information is relayed to the responding crew. The firefighters at the MFB receive information about the nature of the call on a printed document called a turn-out report. Turn-out reports provide information such as the location of the emergency, a map, and any other pertinent information such as hazardous chemicals or the presence of a fog security device (Personal communication with Commander of Community Safety, Central Zone, 22 Jan. 2008).

The turn-out sheets are generated by a system that uses data from “000” callers to provide additional information. The system is only as accurate as the location that the caller is able to provide; additional information (the presence of fog security devices, for example) is linked only to the exact address. If, for example, only the names of the cross streets are given by a “000” caller, the additional data available in the system for a specific address will not be indicated on the turn-out sheet (Personal communication with Commander of Community Safety, Central Zone, 22 Jan. 2008).

Currently, when a fog security system is installed, information is provided to the MFB by only one distributor of fog security devices on a regular basis. The notification is faxed to the Central Zone Commander of Community Safety at the MFB, who then distributes the information to the relevant fire stations to inform them the new installation. The information is also added to the database that provides information for turn-out reports, given that an address is known. This informal process was established as a result of repeated attempts by the installer to make contact with the MFB (Personal communication with Commander of Community Safety, Central Zone, 22 Jan. 2008).

The calls to which the MFB responds are not always actual emergencies, and in such cases, the owner or occupant of the building may be charged for the turn-out. The guidelines that the MFB follows for the charging of calls to false alarms are provided in the MFB Act. The Act states that if the MFB responds to a call that turns out to be a false alarm, the MFB is allowed to charge the premise owner or occupier for the cost of the attendance at the false alarm. The purpose of this is to recover some of the cost of responding to the call (Metropolitan Fire Brigade, 1958). The MFB is not allowed to charge for all false alarms, though; there are criteria that must be met before the owner or occupier can be charged (Personal communication with Commander of Alarm Assessment, 21 Jan. 2008).

An owner/occupier will not be charged for a false alarm if the call originates from a "000" call and is classified as a good intent call. If the call comes from an alarm monitoring company or from a brigade-linked alarm then the owner or occupier may be charged for the false alarm. Before the MFB issues a charge, they will ask the owner/occupier for a letter explaining why the false alarm occurred. Once all reports are received, the MFB will then decide if the owner/occupier has a reasonable excuse for the alarm being given. If the MFB believe that the owner/occupier does not have a reasonable excuse then they will issue a false alarm charge (Personal communication with Commander of Alarm Assessment, 21 Jan. 2008).

As described in a legal brief by MFB counsel (Maddocks, 2005), if the issue of the false alarm being chargeable is contested by the owner/occupier, then the case is heard by the Victorian Civil and Administrative Tribunal (VCAT) to determine if the reason for the false alarm is acceptable. The VCAT uses a two-step test for determining if the owner/occupant is required to pay the false alarm charge. To meet the first step, the owner of the premise needs to provide a reasonable excuse as to why the alarm occurred. The owner must have taken all necessary steps available to them to have prevented the fire alarm activation. If so, they are not charged, otherwise, step two is considered. To meet step two of the test, the owner must prove that there is no explanation for the alarm or that the reason for the false alarm was outside the control of the owner or occupant. If this can be proven, a charge is not incurred (Maddocks, 2005).

The information gathered in this literature review has proven useful in serving as the knowledge base for the completion of this report. It contains all information necessary to explore the regulatory environment and technical nature of fog security devices and to draw conclusions regarding their use

3. Methodology

The goal of this report is to examine and advise on the risks associated with the use of fog security systems to firefighters as well as the community. With this objective, the project team has taken into consideration the health and safety of occupants of premises with installed fog security devices as well as firefighters responding to emergency calls at these sites. In order to accomplish this, fog security systems in Victoria were closely investigated through all available means. This investigation included the comprehensive research of operational experience of local fire authorities, installers, and building managers. Also included in this research are appropriate local, national, and international legislation, building and fire codes, and product standards, consulting area experts where necessary. This chapter presents the methods by which this research was conducted.

3.1 Device Function and History Analysis

In order to determine the state of fog security device installations in Victoria, it was first necessary to examine all documents pertinent to the subject already in the possession of the MFB. Appropriate records were gathered and all documents were scrutinized. From these files, the team was able to piece together the past relationship between the MFB and the fog security system industry in Melbourne. A contact list of relevant parties, mostly MFB personnel, was assembled and those on the list were questioned for direction and further contacts as well as whether any other information was available. Contact information for the device installers in the area was ascertained from these files. Also included were copies of all installation notifications faxed to the MFB from installers, which provided the site locations that the team inspected.

In determining the scope of installations of these systems, it was necessary to contact security system installers with experience in this field. The project group was able to contact the three main installers in Australia, specifically Smokeshield Australia (Smokecloak), Concept Smoke Systems (Concept Smoke Screen), and Protect Security Systems (Protect Global). Contact with Smokecloak was conducted through phone calls, email contacts, and meetings. A phone interview and ongoing e-mail discussions with a Concept Security installer provided information about their systems. Phone and email conversations with various representatives of Protect Security Systems yielded installation documentation used in the compilation of this report. Discussions via e-mail with the manufacturer of the Smokecloak product provided additional information as more data was garnered from on-site interviews and code analysis. A list of contact information for these installers and manufacturers is included in Appendix D. The material furnished by these contacts provided a better understanding of the operation, performance, and safety of these devices. Information gathered on their product and installation sites was through online resources or personal inspections.

Individuals who have been present during or following the deployment of fog security devices were also interviewed. These witnesses provided key firsthand accounts of reactions and/or events, and offered accounts of how the fog behaves in a real-world setting. The team met with a senior MFB firefighter who had attended a call where a fog security system had deployed. He explained how he would have dealt with the situation if there had been an actual fire and the difficulties that he perceived for firefighters. This individual was selected for an interview due to the team’s interest in operational experiences in simultaneous fog deployment and strobe light activation. Since the MFB has only been called to three different fog deployment alarm calls thus far, few members of the MFB have experienced fog security device deployments. Therefore, the team believes that one member was a representative sample of those with experience.

A live demonstration of a fog security system by Smokeshield Australia (Smokecloak) provided a first-hand account of the operational conditions of these devices. Other individuals that provided first-hand experiences were those interviewed at site inspections.

3.2 Identifying Issues

Fire authorities in Australia were contacted to determine any existing or potential issues, policies, or understandings regarding fog security devices. The Metropolitan Fire Brigade of Melbourne (MFB) and the Australasian Fire Authorities Council (AFAC) were used as the primary sources. Additionally, the Country Fire Authority (CFA) of Victoria and other municipalities' (New South Wales, Queensland, and ACT) fire authorities were contacted in order to form a broader picture of the issues and experiences with the installed base of these systems.

Occupational health and safety concerns were also investigated through interviews. At the MFB, the team talked with a member of the Occupational Health and Safety department about possible concerns surrounding firefighters facing fog security systems, such as becoming trapped by a deployment. The same concerns were also discussed with the Director of Capacity Development at the MFB. A list of questions asked of fire authorities can be found in Appendix B.

Two members of the Victoria Police, a Crime Prevention Officer and an Arson Investigator, were questioned as well. The team looked to learn of their experience with fog security devices, their opinions of the efficacy of them, and procedures for dealing with deployments. The lack of experience of those questioned with these systems meant that little information was gathered. The list of questions asked these Police representatives can be found in Section 4 of Appendix B.

3.3 Site Inspections

The team inspected seven of the eight known fog security system installation sites in the MFD, specifically a grocery store, two service stations, three retail stores, and the office of a fog security device installer. The intent of the inspections was to determine what accessories are being used in actual installations, how many fogging units are installed per location, and the design of the installations.

At two of the locations, building managers were also interviewed. Through these interviews, the team sought to determine the motive for installing a fog security system, any history of crime at the site, and past deployments of the device while installed. In addition, the team inquired as to the manager's knowledge of the system's interactions with existing fire detection systems, their concerns about the system, and understanding of how the device operates. The representative interviewed at Site "A" was the warehouse supervisor and the owner/manager of Site "D" was also interviewed. Contacts with those interviewed at the site were provided by the MFB and a Smokecloak representative for sites "A" and "D" respectively. Interviews were not conducted at the other sites because the appropriate parties were not available at the time of inspection. A list of questions asked at these interviews can be found in Section 5 of Appendix B.

3.4 Code, Legal, and Standards Analysis

Research was conducted into the Building Code of Australia, international fire standards such as (U.S.) NFPA standards, and International Building Code. Additionally, voluntary standards such as the British Standard Institute's BS7939:1999 manufacturer and installer's standard were used in the final analysis. Research was conducted into Australian legislative works, such as the OHS Act of 2004 and MFB Act of 1958, and how they affect the deployment, operation, and installation of these devices or otherwise regulate this class of systems.

Research into the BCA and OHS Act was supplemented by interviews to provide direction to appropriate parts of the legislation. For the BCA, one building surveyor and one building inspector for design standards (based upon the BCA itself and Victorian legislation such as the Building Act and Regulations) in Melbourne were interviewed, seen by MFB as knowledgeable authorities, to determine any possible issues that these devices would pose relative to existing building legislation. Also interviewed was a building surveyor of a private firm who provided information about the applicability of the BCA to fog security devices as well as information regarding permitting for construction and occupancy. The team had a similar conversation with a member of the Building Commission of Victoria. Such interviews yielded valuable information on the regulation provided by the BCA on these systems. The regulations that govern occupational health and safety in the workplace were explained in great detail by a Group Leader and a Technical Inspector from WorkSafe. This interview clarified how the Occupational Health and Safety Act of 2004 and the Occupational Health and Safety

Regulations of 2007 could affect owners and employees of businesses with fog security devices.

3.5 Fire Brigade Analysis

The Standard Operating Procedure (SOP) of the Metropolitan Fire Brigade of Melbourne was considered in relation to the operation and installation of these devices. Further analysis was conducted on available incident reports from the MFB to determine the extent of emergency response to fog security system deployments. Careful attention was paid to the involvement of "000" calls or other false alarm triggers, and whether police or emergency medical response teams were involved.

Additionally, data such as false alarm charges were gathered through MFB incident databases, with assistance from MFB personnel. Database results were also used in compiling some statistics, such as cost of fire for businesses in the CBD of Melbourne. Response times were gathered through government annual reports on service organizations. The majority of statistics, calls, and other fire brigade data were acquired through the use of the Australian Incident Reporting System, or AIRS, a database of fire brigade turn-outs and related details.

The MFB Central Zone’s (CBD) Community Safety Commander was interviewed by the team in order to draw on his experience in working with distributors of fog security systems, as he is the primary MFB contact for one of the major fog security device manufacturers in the area (the only installer that has currently maintains contacts with the MFB). The Commander had been receiving faxes of install notifications of fog security systems from that installer, which allowed the team to compile a list of the installations known to the MFB (this list probably does not contain every installation in the area, as is explained in Findings).

The team met with the Commander of Alarm Assessment for the MFB to discuss the issue of false alarms. He was able to clarify the monetary costs of false alarms to the MFB, building owners, and community. Some of the other risks associated with false alarms were also discussed, such as tying up resources and the possibility of trucks and other apparatus becoming involved in traffic accidents.

3.6 Timeline

The first four weeks of the project on site were spent gathering the majority of information according to the methodology above. The information-gathering process, though, was ongoing as it continued throughout the duration of the project. The first week and a half was spent scheduling interviews and reviewing previous exchanges and documents provided by the MFB regarding these systems. The execution of the bulk of interviews took place in the following three weeks. Site inspections were conducted at points throughout the first six weeks. The sixth week was spent analyzing the data gathered and preparing the final report, while the final week focused on developing the conclusions and recommendations and composing the final document.

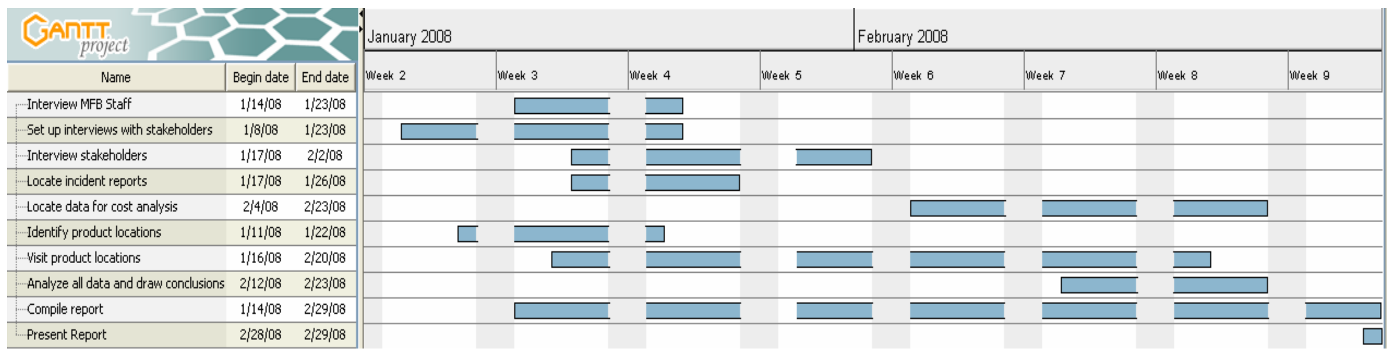

Fig. 3.6A - Timeline

4. Findings

Information on how fog security systems are installed and operated, any statutes pertaining to them, as well as the risks and concerns associated with their use, were discovered through all available means. This information formed a detailed understanding of the environment in which fog security systems operate.

4.1 Fog Security Device Market Status

There are currently three major firms in the fog security device market in Australia. These are Smokecloak (trading under the name Smokeshield Australia), Concept Smoke Screen (as Concept Smoke Systems) and Protect Global. These three distributors install systems in commercial locations, mostly service stations, supermarkets and retail stores in both urban and suburban areas.

At this time, there are eight fog security system installations in the Metropolitan Fire District of which the MFB has been made aware (Commander of Community Safety, Central Zone, 2007). This list has been compiled from faxes sent in by installers notifying the MFB of an installation. It is reasonable to assume that this list does not include every installation site, as there is no legal requirement to send notifications to the fire brigade. All of the installations involve at least one fogging unit, with some having accessory strobe lights. The MFB is not aware of any sounder units currently being used and all available information suggests that no system installed has yet incorporated a panic trigger (Personal communication with Director of Smokeshield Australia, 23 Jan 2008 and Director of Concept Smoke Systems, 1 Feb 2008). Both Smokecloak and Concept do not encourage the use of panic triggers and Concept will not endorse the use of strobes in the systems (Personal communication with Director of Smokeshield Australia, 23 Jan 2008 and Director of Concept Smoke Systems, 1 Feb 2008). The position of Protect Global on these system components in Australia is unknown. These companies also claim that their systems are not for the purpose of creating a man-trap situation. In one known case, Smokecloak actively advised against a customer's desires to create a man-trap for the purpose of catching criminals and instead installed a safer system (Personal communication with Site "D" representative, 11 Feb 2008).

In speaking with building representatives of two of the sites, information concerning their motivation to install the systems and their knowledge bases about the systems became clear. The motivation to install the fog security systems in both cases was to act as a theft deterrent (Personal communication with Site "D" representative, 11 Feb 2008; Personal communication with Site "A" representative, 16 Jan 2008). In the case of the supermarket, the installation was completely preventative, as no break-ins had been attempted prior to the installation of the fog security device (Personal communication with Site "D" representative, 11 Feb 2008). The retail shop, however, had been previously broken into (Personal communication with Site "A" representative, 16 Jan 2008). The knowledge of the systems for both interviewees was similar. Both representatives had experience with deployments and have established procedures for dealing with them. They also know where and why the units were installed and what is required to activate them (Personal communication with Site "D" representative, 11 Feb 2008 and Site "A" representative, 16 Jan 2008). One of the representatives educates each new employee about the device and what to do in the event of a deployment (Personal communication with site "D" representative, 11 Feb 2008). The representative of Site

“A” knew that the fog deployed by the installed fog security system did interact with the smoke detectors. The fire detection system at the site had not been altered to deal with this (Personal communication with Site “A” representative, 16 Jan 2008).

Fog security devices have not generated many false alarms in the MFD to date. While one user of a fog security system interviewed indicated a number of false deployments on-site, these were limited enough to only result in one false alarm call to the MFB (Personal communication with site “A” representative, 16 Jan 2008). From available records and operational knowledge of the MFB, out of the eight known installations in Melbourne, there have been three separate fog deployment device incidents that have yielded MFB turn-outs in the past three years. One of these calls was due to a cleaning crew arming a system equipped with a fog security device incorrectly and while the premise was occupied (Personal communication with Director of Smokeshield Australia, 23 Jan 2008), another was to an accidental deployment (at Site “A”) (Personal communication with Senior Firefighter, 21 Jan 2008), and another was to a service station at two separate times in one morning, the cause of which is unknown (Site “B”) (*Call costing report*).

4.2 Experiences of Fog Security Device Deployments

The experiences of those interviewed, as well as those of the project group, indicate that the fog from these devices has little to no noticeable effect on people in the short term. Visibility in both the real-world deployments and those demonstrations witnessed by the project group was generally reduced to less than half a meter within 20 seconds of activation. When any side-effects were mentioned, they were consistently an odd taste or smell, and a drying effect in the sinuses and throat. The behavior of the fog was noted to be different than ordinary smoke from a fire in that it was the same temperature as the surrounding air, and simply stayed in the air, not rolling as smoke does.

While the fog itself was dismissed by those with experience of a deployment as a nuisance more than immediately troubling or harmful, those experiencing strobe-accompanied deployments describe them as a disorienting component of these systems. A firefighter responding to a business with a strobe-linked fog security system described the effects as so intense that “you couldn’t keep your eyes open” (Personal communication with Senior Firefighter, 21 Jan 2008). It was mentioned that the only way normal operations could have been carried out with the system activated was if firefighters could cancel out the effects of the strobe (Personal communication with Senior Firefighter, 21 Jan 2008). The project group also noted the effect of a security strobe in a fog-filled room to be extremely disorienting, even with closed eyes. It was also noted by MFB personnel that the experience of facing a fog deployment coupled with a strobe was very similar to the experiences of those with extreme visual impairments, given how much sight was affected (Personal communication with Director of Capacity Development, 17 Jan 2008). It is not known at this time if the strobe would be disorienting in the absence of fog, as the project team was not able to experience this.

4.3 Operational Concerns of the MFB

In discussions with personnel involved in MFB operations and planning, certain concerns were raised with regard to the impact of fog security systems on firefighting response to both alarms of fire and false alarms. These operational concerns focus on the safety and efficacy of firefighters, as well as the resulting effects on the community they serve.

The MFB had a 90th percentile response time in 2005 - 2006 of 8.6 minutes when responding to structural fires in Melbourne (Steering Committee, 2007). Operational experience indicates that the MFB will arrive on a scene before VicPol (Personal communication with Commander of Community Safety Central Zone, 24 Feb 2008), which does not respond with the same priority to all calls. This allows the possibility that the MFB might have encounters with an intruder at a fog security device-equipped premise. This could cause serious problems for firefighting personnel, in that they are not trained or prepared to deal with such circumstances.

Fire crews called to a site with a fog security system installed face two immediate risks, as identified by an occupational health and safety representative of the MFB. In the case of burglar alarm activation, these are the limited visibility caused by the generated fog, and as a result, not knowing whether the intruder still remains in the building (Personal communication with Occupational Health & Safety Co-ord, 14 Jan 2008). While there are Safety Alerts issued by the MFB to its crews, as explained in the Literature Review, the OHS specialist for the MFB believed that a team of firefighters responding to a site with an unknown or unmarked fog security device would face this risk.

An additional issue raised by the Commander of the MFB's Central Zone was related to the fog in any circumstances of deployment and the concurrent use of strobe lights. Given the disorienting nature of these lights when used in conjunction with the translucent fog generated by these machines, the Commander suggested that the normal duties of firefighters would be greatly impeded by its effects. While limited visibility is a common condition for firefighters, the addition of strobe lights and the white noise sounder accessories were considered a hazard to the performance of firefighting crews. The concern of accidental activation of these devices in normal operations of fire fighting was also brought up (Personal communication with Commander of Community Safety Central Zone, 24 Jan 2008).

Further discussions with MFB personnel brought up other operational concerns. For example, the Director of Capacity Development pointed out the possibility of a fire crew mistaking the heat around a fog security device for a fire when using thermal imaging cameras (Personal communication with Director of Capacity Development, 17 Jan. 2008). Another issue raised by a firefighter that had responded to a deployment call was that attempting to clear the fog by ventilation could spread a smoldering fire if one was present (Personal communication with Senior Firefighter, 21 Jan 2008).

The Alarm Assessment department of the MFB has indicated that fog security devices have shown to be an issue in the past, with four turn-outs of MFB crews to three fog-related false alarms (there were two turn-outs to one incident). As illustrated by the Commander of Alarm Assessment, false alarms pose a risk to the community at large by tying up fire brigade resources for such calls. The other issue raised was that of the need of the fire brigade to remain on-scene in some capacity to clear out fog, in order to prevent additional “000” calls for smoke issuing from a building (Personal communication with Commander of Alarm Assessment, 21 Jan 2008).

4.4 Building Regulations and Other Legislation

According to two experts on the Building Code of Australia (BCA) and the Victorian Building Regulations, recognized as authorities on the subject by the Metropolitan Fire Brigade, there are no sections of the BCA or any other Victorian regulations which directly relate to fog security systems. Any provisions of the BCA that could be interpreted as related to a deployed fog security system were determined to have no particular bearing on the installation of these devices, as they are generally installed after occupancy permits have been issued, and no permit is required for installing a fog security device (Personal communication with Building Commission Representative and a Building Surveyor, 22 Jan 2008).

4.5 Site Inspections

Site inspections were performed in order to investigate the installations of fog security systems actually performed in the market. The installations investigated did not require any modifications to the building other than the mounting of fog security devices and accessories. No known changes to the fire detection systems in the buildings were made in order to reduce the risks of false smoke detector activations due to deployed fog.

4.5.1 Inspection Site "A" – Retail Shop

Site "A" is located on a street corner in the CBD of Melbourne. The building has a "split-level" ground floor housing merchandise, with each level measuring about 10m by 15m. The first floor houses a museum area as well as more merchandise and the third floor is a large warehouse used for storing the establishment's inventory. The premise is equipped with a sprinkler system, smoke detectors, and heat detectors. The fire detection system causes the doors to unlock upon activation. There is an HVAC system installed, though the management does not know if it is possible to reverse the system for the purposes of ventilation.

The ground floor holds two Smokecloak –brand fog security devices and one strobe light. One fogging unit is located approximately 3 meters from an entrance (Figure 4.5.1A), with a feedback sensor directly in front of an emergency exit sign (Figure 4.5.1C). The other is located in the middle of the room, above a display of high-valued goods (Figure 4.5.1B). Both are units wall-mounted. The strobe is ceiling-mounted in the middle of the retail floor. These units are controlled by two motion sensors; tripping one sensor initiates a call to the alarm monitoring company and tripping the second deploys the Smokecloak units.

Fig. 4.5.1A – Installation by Door

Fig. 4.5.1B – On Ground Retail Floor

Fig. 4.5.1C - Feedback Sensor by Emergency Exit Sign

The second floor also houses 2 fogging units (Figure 4.5.1D) and a security strobe (Figure 4.5.1E). They are located towards the middle of the floor, protecting the wide entrance to the museum. These units are activated by a vibration sensor that can be triggered by glass breaking. The warehouse is also equipped with two wall-mounted Smokecloak units (Figures 4.5.1F, 4.5.1G)**.** The staff areas, photo development lab, control rooms and basement are not protected by fogging units.

Fig. 4.5.1D – Two Units on Museum Floor

Fig. 4.5.1E – Museum Security Strobe (Close-Up)

Fig. 4.5.1F – Warehouse Unit #1

Fig 4.5.1G – Warehouse Unit #2

The building displays Smokecloak signage warning of the installation on all entrances (Figure 4.5.1H). These placards were installed by Smokecloak without consultation of a building representative. There is no panic trigger incorporated into the system, nor are any voice notification modules used. A service contract with the installer is maintained, providing service on an as-needed basis. The fluid in the units is refilled by the service provider.

Fig. 4.5.1H – Smokecloak Warning Signage

A tour of the site was given by the warehouse supervisor and he was able to give an account of the false deployment situations that have occurred. False alarms that have occurred at this location were triggered by breaking glass, working on the security systems, and incorrect inputs to the alarm panel. In one case, the building owner repeatedly entered the wrong alarm code when opening the store and the units deployed. This caused the smoke detectors to go off, the monitoring company to be contacted, and the MFB to respond to the scene. This did not result in a false alarm charge from the MFB.

The warehouse supervisor pointed out that in the case of accidental trigger, the system can be disarmed by entering a code on the alarm panel. He also explained that the usual routine when a false alarm occurs is to disarm the system as soon as possible and call the alarm monitoring company, informing them of the situation to avoid a turnout of the MFB (Personal communication with Site “A” warehouse supervisor, 16 January 2008).

In speaking about the Smokecloak units, the warehouse supervisor said “thirty seconds and you can’t see anything in front of your face” (Personal communication with Site “A” warehouse supervisor, 16 January 2008). He also said that the fog takes 20-30 minutes to clear, using fans and opening the stairwell doors to speed the process. He claimed that the fog leaves a fine white powder behind that is easily wiped off with a cloth. Closing procedures and the arming of the burglar alarms were also inquired about in conversation. The closing procedure for the premise involves a manager checking the building to ensure that he is that last one there, then arming the system (Personal communication with Site “A” warehouse supervisor, 16 January 2008).

Verbal authorization of photography at this site was provided by the firm’s Warehouse Supervisor.

4.5.2 Inspection Site “B”- Service Station

This site, a service station located in a suburb of Melbourne, was visited in the presence of a representative of Smokeshield Australia, distributor for Smokecloak. The retail floor of the station covers an area of approximately 6m by 8m and the site has two main entry points through the front and stock-room doors. The main stock to be protected is the cigarette cabinet, located behind the counter.

Fig. 4.5.2A – Signage on Front Door

Fig. 4.5.2B – Ceiling Nozzle and Feedback Sensor

There is signage posted on the front door indicating presence of the fog security system (Figure 4.5.2A) and it is unknown whether there is signage present on the stock-room door. One fogging unit is ceiling-mounted above the counter with a feedback sensor near it, also on the ceiling. The fogging unit is recessed into a drop ceiling, and the fog nozzle is integrated into a modified halogen light fixture to hide the device, as shown in Figure 4.5.2B. The feedback sensor is clearly visible in Figure 4.5.2B behind the nozzle, circled. It does not appear that the unit will create a man-trap situation in the event of a deployment. The unit is activated by an instant alarm trigger and is monitored by an alarm company that receives signals of “activation” and “system trouble” from the unit. Upon a notification of “activation,” the alarm company is to contact ESTA (Emergency Services Telecommunication Authority) for further assistance from the police in the case of only the burglar alarm activating.

Authorization of photography at this site was arranged through Smokecloak Australia with site management.

4.5.3 Inspection Site “C” – Service Station

Site “C” is a service station with a convenience store located on the same premise. The building is single-story with a small retail area in the front and offices and supplies in the back. The retail area is approximately 2.5 meters by 5 meters. The fog security system is located on the wall in front of the counter, at one end of the retail floor. The customer entrance is located at the opposite end from the counter and entrance to the back room is on the opposite the wall from the fog security device.

Fig. 4.5.3A – Signage on Front Door

Fig. 4.5.3B – Unit and Feedback Sensor

The installed system, manufactured by Smokecloak and installed by Smokeshield Australia, is configured as instant-on and does not have a confirmation motion detector sensor. The system is installed to protect the counter and the cigarettes located behind it (Figure 4.5.3B). The system also protects the back area of the store by blowing the fog into the back rooms. There is signage on the front door of the premise that indicates that there is a fog security system installed (Figure 4.5.3A). There are no strobes or voice modules installed with this system and it is not equipped with a panic trigger. It does not appear that a man-trap situation would be created given a deployment of the installed system.

The system was installed because the premise had been burglarized so many times that the owner could not get insurance to cover the losses. Once the system had been installed, though, the owner was able to receive insurance coverage (Eighteen, 2005).

Authorization of photography at this site was arranged through Smokecloak Australia with site management.

4.5.4 Inspection Site "D" - Supermarket

Site "D" is a small supermarket franchise facing a street in a suburb of Melbourne, containing both a small liquor store and a basic grocery. The area covered by the fog security devices is the grocery and liquor area, which is on the ground floor (Figure 4.5.4A). The fog security system is manufactured by Smokecloak and installed by Smokeshield Australia.

Fig. 4.5.4A – Front Space of Store

Fig. 4.5.4B – Counter Area

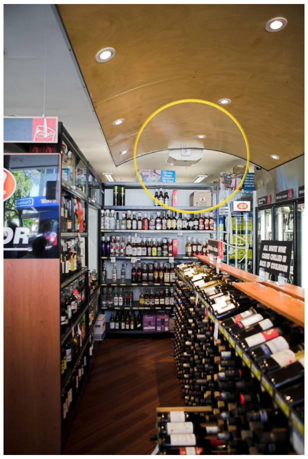

Fig. 4.5.4C – Liquor and Wine Area

Fig. 4.5.4D – Close-up of Liquor/Wine Unit

There are two units on the ground floor, with one unit placed to cover cigarettes and checkout counter space (Figure 4.5.4B) and another one covering liquor and some of the wine display space (Figures 4.5.4B, 4.5.4C). The checkout counter unit is larger in size than the liquor unit, and both units deploy simultaneously. Both units are configured with a confirmation sensor, so that when the alarm is triggered the devices wait for a single motion sensor to be tripped before deploying fog. Warning signage is on both the front and rear doors of the building (Figures 4.5.4E. 4.5.4F).

Fig. 4.5.4E – Warning Signage on Front Window

Fig. 4.5.4F – Warning Signage on Rear Door

According to the franchise owner, there had been one break-in with the fog security system installed with limited losses, and no break-ins prior to the installation. The burglar broke the laminated front door glass, entered the premise, took two bottles of liquor, and left through the same broken glass. A second attempt was made shortly thereafter by the same burglar, who then tried to remove a bicycle used in a promotional display through the same hole in the front door. The bicycle was later recovered due to a trail left by the burglar.

Authorization of photography at this site was arranged through Smokecloak Australia with site management.

4.5.5 Inspection Site “E” – Retail Shop

Site “E” is the location of a large retail store. There are two fog security devices in one 3.5m by 4.5m (approximate) section of the store separated by three walls and one half-wall that houses high-value goods. The units are located above the half-wall (about 2.5m high) on either side of the single entrance to the area, aiming at the floor. Motion sensors are also installed in three corners of the area. If the units are triggered with a delay so that any intruder has time to enter the area before deployment, there is reason to believe that a man-trap would be created. If the units are triggered instantly when one first steps into the area, however, such a man-trap situation would be most likely avoided.

No authority was available on site at the time of inspection to authorize photography.

4.5.6 Inspection Site “F” – Retail Shop

Site “F” is another large retail store. It has an area similar to Site “E” with three complete walls and one half-wall, measuring about 4 by 5m. There are motion sensors mounted in the corners of the area as well as three fog security devices mounted high (about 2.5m) on the wall opposite the single entrance in the half-wall. Each device points into the area towards the half-wall. The number of units installed means that upon deployment, the area would fill with fog quickly. However, because the units are mounted opposite the entry/exit point, they would not likely create a man-trap.

No authority was available on site at the time of inspection to authorize photography.

4.5.7 Inspection Site "G" – A&F Electrical / Smokeshield Australia

In conjunction with members of VicPol, the project group interviewed and inspected the premises of A&F Electrical, the Australian representative of Martin Security Smoke Ltd., manufacturer of the Smokecloak line of fog security devices and accessories. Demonstrations of two machines in their product line were observed, and questions were fielded regarding the firm's distribution, installation, and support of Smokecloak-brand fog security devices.

The two systems demonstrated were a SY8000 high-volume unit and an IPX25 warehouse-class unit – capable of 430 m^3 and 800 m^3 volume in 30 seconds, respectively, according to product literature (Martin Security Smoke, Ltd.). The SY8000 was paired with a security strobe unit, the IPL3000, and the IPX was demonstrated independently (however the premises were equipped with a strobe paired for the IPX unit as well).

The SY8000 demonstration was conducted on the ground floor of a two-level combined office and warehouse space. The SY8000 unit was triggered by a remote key fob control, and the strobe was triggered separately by remote as well (an example key fob is shown in Figure 4.5.7A).

Fig. 4.5.7A - Trigger Remote

Witnesses to the demonstration were placed at all corners of the room and observed the fog release and subsequent strobe activation. Timestamps from continuous photographs taken during deployment indicate the time from triggering until functional obscuration of the room to be approximately 15 seconds. The room itself is shown in different stages of deployment in Figures 4.5.7B-E.

Fig. 4.5.7B – One Second After Deployment

Fig. 4.5.7C – Two Seconds After Deployment

Fig. 4.5.7D – Five Seconds After Deployment

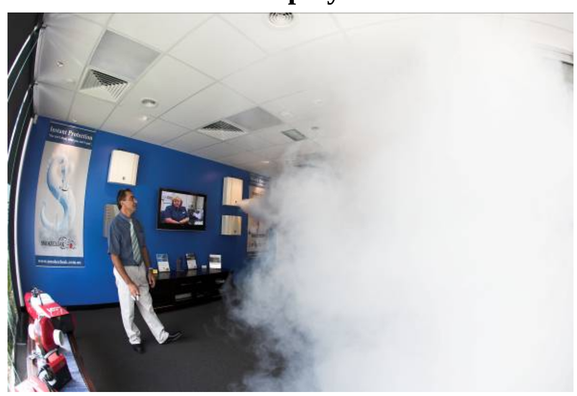

Fig 4.5.7E – Nine Seconds After Deployment

An IPL3000 strobe was activated by a representative of Smokecloak Australia a few seconds into the SY8000 demonstration. Observations from individuals in the room at the time of activation include those of “complete disorientation” and being “unable to move” while the strobe was on in conjunction with the fog. Members of the project group noted that the strobe was bright enough that closing one's eyes was not enough to stop the disorienting effect of the strobe flashing.

The second demonstration took place in the stock warehouse (2 floors measuring about 15m by 10m each) of Smokecloak Australia and was conducted using an IPX25 system triggered by remote control. While the initial demonstration of the SY8000 system was an independent demonstration unit, this IPX25 unit was part of Smokecloak Australia's security system and had a remote control trigger capability. The unit was ceiling-mounted at a height of approximately 10m, and oriented such that it would fire downwards at the warehouse floor on ground level. Most observers were located underneath the fog jet, with a photographer in a corner farthest away from the jet. Timestamps for photographs taken during the deployment indicate the time to functional obscuration of the ground level of the warehouse to be approximately 15 seconds as well. The warehouse is shown in different stages of fog deployment in Figures 4.5.7F-I.

Fig. 4.5.7F – Two Seconds After Deployment

Fig. 4.5.7G – Three Seconds After Deployment

Fig. 4.5.7H – Six Seconds After Deployment

Fig 4.5.7I – 13 Seconds After Deployment

The company representative from Smokecloak reviewed their marketing strategy and general compliance measures in accordance with their advertised standards adherence. Their fog security devices are largely directed at the commercial market, with some casual research and development efforts being made to determine suitability and direction for the residential market. Standards compliance was emphasized as a key point of Smokecloak Australia's operations. The British Standard 7939:1999 industry standard, ISO 9001 manufacturing standards, and Australian C-Tick electronics compliance standards were highlighted.

Representatives of the firm demonstrated a basic understanding of the regulatory environment surrounding their product, preferring to highlight its benefits instead of discussing the possible restrictions of the legislative or regulatory framework of Australia. Compliance with the notification provisions of BS7939:1999 was accomplished solely with the assistance of the MFB's Central Zone Community Safety Commander – Smokecloak representatives had limited familiarity with the organizational structure of the MFB. Smokecloak does not interact with the leadership of other MFB zones for notification of installation, instead routing through the Central Zone commander for that purpose.

According to the firm, there have been no Smokecloak installations in premises with AS1670.3-type brigade-linked alarms, nor have there been any installations linked to “panic buttons” or duress triggers by the installer. However, installations have been performed where the premises may be occupied and deployment may occur within normal business hours (see findings on site “A” for more information on such an installation). Additionally, there have been no residential installations commissioned – though the firm is pursuing this route as a possible market.

The firm also supplies Smokecloak accessories to the Australian market. As of the time of writing, Smokecloak Australia offers strobe lights, voice modules, and additional fluid or density sensors from the Smokecloak range of products. The IPL3000 strobe light is, according to the firm, sold at a rate of approximately “three Smokecloaks for every one strobe” (Personal communication with Director of Smokeshield Australia, 23 Jan 2008).

Authorization to use images was given by a representative of Smokeshield Australia.

The information gathered through interviews and site inspections along with all the material from the Literature Review has formed a clear picture of the current situation surrounding fog security systems. This information allows for a detailed analysis to be preformed.

5. Analysis of Findings

The various concerns surrounding the use of fog security systems, such as risks to the community and emergency services personnel, were explored to form a broad picture of the environment in which fog security systems operate. With this information in mind, the issues discovered were analyzed in order to recommend solutions to best reduce the risks to the community and emergency services personnel.

5.1 Installation Design and Standards Compliance

Through the inspection of properties with fog security devices installed and marketing materials of firms selling these systems in Australia, certain issues have been discussed in the design of installations and claims of compliance with voluntary industry standards. To examine these issues, it is necessary to distinguish between industry claims and the reality of the marketplace and the installations actually performed; the intentions of firms in the industry communicated through marketing documents stand in contrast to what is actually sold and installed in the marketplace.

The advertised intentions of the industry are reflected largely in standards documents, to which manufacturers may voluntarily comply. There exist both French and European Union standards pertaining to fog security devices, the latter of which is still in draft form, however they are not commonly discussed in advertisements and brochures. As discussed previously in the Literature Review, the primary document to which the two of the three manufacturers in Australia advertise compliance is British Standard 7939:1999, a standard for the manufacture, operation, and installation of fog security devices. Key elements of the British Standard that have been reflected in marketing materials and discussions with company representatives have been restrictions on man-trap designs, ensuring safe exit paths, and notification of emergency services (police and fire) of installations. These elements of BS7939:1999 are found in many marketing materials and presentations made by manufacturers of fog security devices (Martin Security Smoke, Ltd.).

The use of strobe lights linked into security systems raises concerns of intentional disorientation, as noted by representatives of Inspection Site “A” who had been party to a deployment on their premise (Personal communication with Site “A” warehouse supervisor, 16 January 2008), and by the project team, having witnessed a deployment with strobe use. Marketing materials indicate that the purpose of the strobes is to be blinding or disorienting in nature (Martin Security Smoke, Ltd.,). Additionally, when first asked about the flash rate and the impact on epileptics, a Smokecloak representative quoted their strobe rate at 10 flashes per second (fps), and that they had “consulted the Epilepsy Foundation” and had been told that “this was safe for [photosensitive epileptics]” (Personal communication with Director of Smokeshield Australia, 23 Jan 2008). This is in contrast with a report from the Health and Safety Executive in the United Kingdom on photosensitive epilepsy, and Smokecloak’s own technical documentation on their strobe lights. Smokecloak documentation, discussed previously in the Literature Review, indicates that the default flash rate is 16-17 fps (Martin Entertainment, 2007). The UK report, quoting research which indicated that the actual default flash rate of the strobes is within the testing range of 15-20 flashes per second, indicates that such a rate would trigger 96% of photosensitive epileptics (Health and Safety Executive, 2000).

The discomfort caused to the project team and other witnesses to the Smokecloak Australia demonstration, as well as the deployment experiences of an MFB firefighter and a representative of Site “A” indicate other, more widespread, concerns. These individuals who have witnessed deployments where strobes have been in use were not photosensitive epileptics to the best of their knowledge, and still had trouble maintaining balance or orientation within strobe-lit security fog. The level of disorientation experienced in a security fog deployment with strobe use could lead to operational concerns for emergency responders and to occupants of the building.

Those individuals interviewed who had experienced strobes in fog, as well as the project team, reported having to close their eyes to lessen the effects (Personal communication with Senior Firefighter, 21 Jan 2008), reducing visibility from about half a meter in a normal, fog-only deployment, to zero in a strobe deployment. Thus, in the event of a deployment during normal trading hours, occupants of a building may have to exit the premise given limited to no visibility and possibly disorienting conditions.

Information gathered from the site inspections also raised concerns of the planning of fog security device installations in a safe and responsible manner. BS7939:1999 suggests that “care should be given to ensure safe escape routes” (British Standards Institute, 1999), and advises against the activation of a fog security system while “the premises are occupied or if the area is required for means of escape” (British Standards Institute, 1999). In the case of the inspected Site “A”, these two criteria and compliance efforts conflict with what was actually installed. As shown in Figure 4.5.1 C, a feedback sensor was installed directly in front of an exit sign marking an emergency egress route. This sensor would cause the fog security system to continue fogging the area if the exit door were to open and vent fog to the outside. This feedback loop would keep the egress signage, as well as the exit door itself, obscured, and make locating that exit from certain points on the ground floor difficult. Additionally, according to representatives of both the system installers and the site owners, an area on the second floor was configured to go to an alarm state from glass-break sensors and activate the fog security units whether the building was occupied or not (Personal communication with Director of Smokeshield Australia, 23 Jan 2008). This second floor layout was also designed in the style of a man-trap, that is, to prevent an intruder or any occupant within the secured area from leaving the zone of security fog deployment. In this case, two fog security units were aimed at the protected area, along with a security strobe, in such a way that finding an exit through the fog would be difficult from within the museum area.

These inspections demonstrate the flexibility inherent in voluntary standards, particularly in BS7939:1999 currently used by manufacturers and installers. In marketing materials, manufacturers and installers tend to justify the concerns surrounding their product using standards compliance (Gibbard, 2008; Martin Security Smoke, Ltd.).The descriptions of compliance are given to the public in such a way as to imply that in order to meet compliance, installers “must” follow the criteria of the standard, but when asked about compliance conflicts, words such as “should” in BS:7939 are used to justify installations that bypass the standard’s criteria (Personal communication with Director of Smokeshield Australia 23 Jan 2008).

While standards such as BS7939:1999 contain criteria which address a number of operational and OHS concerns such as egress routes and man-trap scenarios, the use of “should” in the document reduces the benefits of compliance. Therefore, any level of compliance with BS7939, even if independently verified, has negligible merit when considering the criteria of the standard to be definitive, since most are written as suggestive guidelines as opposed to mandatory criteria.

5.2 BCA Provisions

In Victoria, the Building Regulations and Building Code of Australia (BCA) provide a regulatory framework for the design, inspection, and permitting of new construction, as well as the periodic maintenance and auditing of essential safety measures such as exit doors, sprinklers, signage, and detectors. They provide only limited regulation regarding how a building is used once the occupancy permit is issued aside from the previously mentioned safety measures. Building surveyors and guidance literature to the BCA both confirm that the codes apply more to the initial construction and first stages of build-out than to the ongoing use of the building (Australian Building Codes Boards, 2007c).

There are, however, provisions within the BCA which appear to have particular impact in relation to fog security devices. These are the sections on smoke and fire detection and notification as well as egress, the technical details of which are discussed in the Literature Review. It should be noted, however, that these are only indications of the intent of the BCA relative to these devices, and authorities on the subject have indicated that fog security devices do not fall under the provisions of the BCA due to their post-permitting installation (Personal Communication with Building Commission Representative, 22 Jan 2008).

The premises where the BCA requires AS1670.1-compliant smoke detection systems include the four main classes of buildings where fog security devices are marketed: retail, warehouses, offices, and gaming halls. Especially in the case of retail and gaming establishments, the possibility of false alarms and undue panic due to lack of familiarity of occupants with the facilities can be of concern in the case of an accidental deployment of a fog security system. Such a scenario could also prompt “000” calls from concerned occupants thinking that an actual fire had broken out.

Additional false alarm issues arise when considering the market for fog security systems in office buildings as a theft deterrent. The BCA requires brigade-linked fire alarms (as per AS1670.3) for any building with a pressurized staircase or automatic smoke extraction system, a common element of many Class 5 (office) buildings. Thus, any fog security system deployment in such an office space would result in an immediate call to the fire brigade of an “alarm of fire” as per AS1670.3, and an appropriate response from the MFB.

The egress concerns of the BCA are such that the performance requirements seek to provide a safe and unimpeded route for evacuation from a building in foreseeable emergencies. This is accomplished through emergency lighting and exit visibility provisions which are intended to work in the case of power loss or light smoke (Australian Building Codes Boards, 2007). The fog from fog security systems is translucent in nature. Therefore, any light that is introduced around it reflects off the particles in the fog, making it look as if the fog is glowing. Given the nature of a room after the deployment of a fog security system, such emergency lighting could possibly make the exit route more difficult to see, as ambient light would obscure any lit egress signage due to the reflection of the ambient light off the fog particles. This is the same principle behind the disorienting effect of security strobes sometimes built into these systems.

Consequently, an individual on one side of a fogged room would likely not be able to see an illuminated exit sign or path lighting if there was sufficient ambient light from sources such as daylight, or even an emergency lighting system, to mask the sign. This is contrary to the objective of the BCA relative to emergency exit and lighting, which provides for "light to see the evacuation route", and "signage to indicate the evacuation route" (Australian Building Codes Boards, 2007c).

Provisions within the Building Code of Australia and the Building Regulations of Victoria address fire and smoke detection, notification of emergency services, and emergency egress. These sections have no regulatory bearing on fog security devices, though, because the devices are usually installed after the permitting process. Given the objectives of the BCA with regard to considerations for visibility and safety of egress paths, however, it is clear that the purpose of fog security systems conflict with this intent, irrespective of the provisions made to mitigate such conditions as created by these systems for occupant safety (Australian Building Codes Boards, 2007b).

5.3 Occupational Health and Safety and Other Legislation

The use of fog security systems highlights occupational health and safety concerns for firefighters and building occupants. With consideration of some systems' disorienting accessories, it is necessary to consider the purpose and installed nature of these systems when discussing the accessories relative to occupational health and safety regulations. Consideration needs to be made for employees of a firm using these systems, contractors, members of the general public, and emergency services personnel, all of whom may be impacted by the way these systems are installed and activated. The Occupational Health and Safety Act of 2004 (OHS Act), as discussed earlier in the Literature Review, can be applied to situations involving fog security devices.

The first applicable section of the OHS Act, Section 21, is about maintaining a safe working environment. In relation to fog security devices, compliance with this section would require that all employees be trained on how to react if a fog security system deploys, how to safely exit the premise, and how to help others do so (WorkSafe Victoria, 2007b). If employees were not trained properly and a fog security system deployed, there could be injuries to occupants as a result of not knowing how to react. The employees could also be trained to help in removal of the fog once the system has deployed. Section 22 describes the need to maintain the safety of employees (WorkSafe Victoria, 2007b), an issue if a fog security system was to deploy and obstruct the egress routes, rendering egress difficult.

Section 23 outlines the duties of employers to non-staff persons (WorkSafe Victoria, 2007b). This includes patrons of the premise, who if a fog security system deployed, would be exposed to certain risks. In the event of a fog security device deployment, patrons would be unable to see and might be subjected to the effects of strobes and sounders which could lead to problems such as triggering seizures in photosensitive epileptics. Most of the population depends on using sight to navigate, and the sudden loss of visibility may induce panic. This panic could result in injury to people and property and make it difficult to evacuate the premise, if necessary. This risk also would apply to firefighters responding to an alarm of fire, resulting in potential injury. According to

Section 23, these possible conditions, and their associated risks, would need to be reduced by the employer of the premise.

In Section 25, the responsibilities of employees to themselves and others are described (WorkSafe Victoria, 2007b). It can be interpreted from the Act that if a fog security system were accidentally activated during business hours, the employees would be responsible to reduce the associated risk and thus help people to exit. The employees also would need to ensure that the workplace is as safe as possible so that others will not be injured, including making sure that egress paths are clear. Finally, the employees would need to work with the employer to reduce the risk of unnecessary system deployments.

Section 32 addresses the issue of not recklessly endangering people in a workplace (WorkSafe Victoria, 2007b). A fog security system could be seen as recklessly endangering an employee if their sight was suddenly obscured while working. The same would apply to firefighters going into a building to locate a fire and then having the premise unexpectedly filled with fog, preventing them from seeing exit routes.

Another OHS concern is that of the risks associated with fog security system accessories. For example, noise sounders supplied by Concept Smoke Screen and Smokecloak advertise sound pressure levels at one meter range of 125 dB, and a nauseating effect due to the particular sounds at that volume (Concept Smoke Screen, 2007; Martin Security Smoke, Ltd., 2005). According to United States OSHA Regulation 1910.95, the maximum safe time to experience that sound level is approximately 113 seconds (Occupational Safety & Health Administration, 2006). This figure represents the 50 percent dose acceptable for daily exposure in a workplace to the Occupational Health and

Safety Administration (Australian Government: National Occupational Health and Safety Commission, 2000). (It should be noted however, that fog security deployments should occur rarely and not daily). This determination is similar in nature to what is described in NOHSC 1007; however without access to Australian Standard 1269, the referenced methods for determining occupational noise exposure, this could not be confirmed. It is feasible that during most exposures to white-noise sounders in false alarm environments, building occupants could realistically face sound levels near the device's 125 dB output for in excess of 113 seconds in attempting egress from a fogged premise (Occupational Safety & Health Administration, 2006), based upon project group experience within a fogged area. This does not take into consideration the time required by building management to locate the alarm panel in the fog and disarm the system.

It is unknown at this time whether Section 26 of the Crimes Act of 1958 in Victoria would apply to owners or users of fog security systems. The application of Section 26 would be dependent on the qualification of a fog security system both as a "device" or the configuration as a "trap", and whether occupants stand to sustain "serious injury" from activation of the system (Crime Act 1958, 2008). Additionally, absolute determination of whether the Section is applicable to owners and users is the sole responsibility of the courts of Victoria.

5.4 Firefighting Operations

In the scope of fire fighting operations, the subject of fog security devices raises a variety of concerns. The risks incurred by crews responding to a deployment, whether due to a real emergency or false activation, are real and must be addressed.

The first risk to crews responding to alarms caused by fog security devices arises even before the crew arrives on the scene. In 2006-2007, for example, 40 MFB vehicles responding to an emergency were involved in collisions. Between 2003 and 2007, one out of every 100 MFB vehicles responding to emergency calls was involved in a collision (Metropolitan Fire Brigade, 2008a). As the number of calls per year increases, so does the likelihood of injury. Therefore, an increase in the number of unnecessary calls (such as false alarms due to accidental fog security device deployment), will be accompanied by an increase in risk of injury to responding firefighters. Also at increased risk due to these responses are pedestrians and motorists on the road that could be involved in these accidents.

Another potential risk to firefighters is the presence of an intruder still hidden in the fog deployed by a security device. This scenario is entirely possible if the deployment of the fog security device is caused by an actual break-in; the person that forced entry could be trapped in the fog if the design of the installation of the device is such that it creates a man-trap, or if the thief decides to proceed into the premises instead of exiting as ideally encouraged by the device.

Although firefighting crews will likely know that a fog deployment has occurred prior to entering a building if they see any fog issuing from it (which will not look like smoke), it is possible that a fog device could activate after the crew enters. For example, if a brigade-linked smoke alarm goes off in a building on the first floor, the fire crew will enter the premises with keys. However, if a fog security device is installed (and armed) on the ground floor with a confirmation sensor, it will deploy fog and possibly activate strobes and sounders when fire crews enter the motion detector's coverage area.

The strobe light and sounder accessories pose a risk to firefighters if these devices are activated when a crew enters a building and can greatly affect fire fighting operations. Threats posed by hindered operations include an increase in risk to firefighters due to slowed progress (and therefore prolonged exposure in an emergency situation), an increased risk of mistakes made in operations, and an increased likelihood of injury due to affected operations. Health threats in the form of adverse reactions to the strobe, due to unknown photosensitive epilepsy for example, also could create a problem. The sounder accessory is a risk due to its disorienting nature and intentions of causing pain. This could negatively impact fire fighting operations and pose a threat to the safety of a crew, as discussed above.

The fog deployed by these devices has the potential to affect fire fighting operations to a point that the safety of the crew and building are jeopardized and these risks arise when trying to ventilate a building. If a smoldering fire were present where a fog device had deployed, it could be very dangerous if windows were opened to begin ventilation; opening a window could cause a backdraft situation which would greatly endanger any fire personnel or other occupants of the building. Another operational procedure that might be affected is negative pressurization. This process would not be a feasible operation to carry out where a fog device has deployed because it involves entering a premise in order to effectively place fans to remove smoke (or fog, in this case). Crews may not always enter a premise, as dictated in the Safety Alert included in Appendix C and previously discussed in the Literature Review.

Another way that fog security devices have the potential to affect firefighting operations is their potential to tie up resources for a long period of time. Although the MFB is advised “not to undertake salvage operations to attempt evacuation of smoke from the premises” (MFB Director-Operations, 2007), they are required to respond to “000” calls. If the MFB leaves a premise before the fog deployed from a security device is cleared completely, it is possible that “000” calls from passersby will continue. In this case, it would be in the best interest of the fire services to stay on the site instead of responding to the scene repeatedly, as has occurred in the past (see Findings, Section 4.1). While the crew is occupied at a scene where this is occurring, they are not able to respond to other emergency situations. Therefore, fog security devices have the potential to tie up essential resources unnecessarily.

Finally, these units can affect fire fighting operations by creating false signs that a fire is present. If a fire crew investigates a scene of a deployment using a thermal imaging camera to look for a fire, they could be misled. The high temperature of the nozzle on the fogging device and the high temperature of the strobe could look deceiving through a thermal imaging device. The units could lead firefighters to believe that there is a fire in the walls if they are unfamiliar with the operation of fog security devices.

5.5 Community Safety

The community safety aspect of fog security device deployment broaches a wide range of concerns. Risks to the community include those to business patrons and employees as well as motorists and pedestrians. The issues of greatest concern are ones that would apply if a fog security device were to deploy during normal business hours, when the premises is occupied. Deployments at any time of day, however, also raise concerns.

Fog security devices are supposed to be disarmed during business hours, although there are a number of reasons for a device to deploy during such times. For example, accidental arming could be caused by the user at the control panel. The units could also be accidentally activated when the alarm panel is being serviced. Some systems even have instant vibration sensors, activating the fog security device instantly in the event of breaking glass or other similar impacts.

In any of the aforementioned events where a deployment could occur while the building is occupied, many issues come into play. Business patrons on the premises will be taken by surprise and engulfed in fog and strobes and sounders may be activated, depending on the system installed. Upon experiencing this, it will only be natural for those involved to panic. The lack of visibility will hinder the egression process greatly, trapping people in the building. The possibility of injury in attempting egress is increased, as people are not likely to be familiar with the surroundings. If strobes activate, photosensitive epileptics will likely be distressed. People would also be affected by the sounders, given that they sound so loudly that they cause nausea and great discomfort. Finally, given the conditions introduced by a deployment, it would be reasonable for those unfamiliar with the devices experiencing it to assume that it is smoke from a fire or a hazardous chemical. Psychological harm could certainly occur to those finding themselves in what they consider to be a life-threatening situation.

The danger of fire during business hours is a constant one. If a fire somehow causes a fog security device to activate, however, the risk is increased significantly. This situation could occur in the presence of an instantly-activated system where a smoke alarm or breaking glass over a fire pull station would trigger the instant (vibration-triggered) alarm. A fire could also cause activation by the heat triggering infrared sensors. In the event of a concurrent fire and fog security device deployment situation, egress would become essential for safety. This process would be made more difficult, though, as discussed above.

Fog security devices offer protection from losses due to theft, but simultaneously have the potential to adversely affect life safety considerations within a building. The regulatory environment surrounding fog security systems in Australia is still in an early stage, with no direct regulation of the devices in place yet. With no permit required by current state legislation for the installation of a fog security system, the Building Code of Australia has no bearing on the installation or operation of these systems. In Victoria, Occupational Health and Safety Act of 2004 and the Occupational Health and Safety Regulations of 2007 are the only legislation affecting the use of fog security systems at present. The British Standard governing fog security systems that many companies advertise compliance with is mainly a list of suggestions, limiting the value of compliance.

Limited communication between the fog security system industry and the Metropolitan Fire Brigade, in the absence of effective knowledge management processes across the organization, has resulted in information being held by individuals within the MFB as opposed to throughout the organization. This isolated knowledge has resulted in discrepancies in installation design, confusion about installation notification to emergency services, and a lack of understanding on the part of emergency services how these systems operate. There is currently no written procedure for notifying the MFB of installations, limiting the information distributed to firefighters likely to encounter these systems in the field.

Through the identification of such concerns in the course of this research, it has been possible to develop courses of action for the MFB and other stakeholders to more effectively address these matters. Through consultation with the MFB, these recommendations have been designed to achieve an outcome over both the short and long terms which will benefit the fire brigade and the community as a whole.

6. Recommendations

Since the problems associated with fog security systems to the community and the fire service have now been identified, they must be addressed. These issues can be dealt with such that fog security devices can be used as theft deterrents while posing minimal harm to the fire services, emergency responders, and the community. The recommendations that follow have been developed with the intent of mitigating these risks in a manner that benefits the community, emergency services and the fog security device market.

6.1 Community Recommendations

Changes must be made so that fog security systems can act as an effective theft deterrent while not posing a threat to the community. Of these changes, some can be made rapidly to help alleviate threats posed by fog security systems. Other, more permanent measures will take longer to implement.

6.1.1 Immediate

Since the number of fog security systems that have been installed in the Metropolitan Fire District is rather low relative to the number of security alarms installed, the number of people that are aware of these systems is also low. This means that if a fog security system were to deploy while a business is occupied, some number of people, unaware of how a fog security system works, may panic. A way to alleviate this problem is to post signs, larger than those currently in use, warning of the system installment as well as any accessories to the system. If the signage is located in a consistent, noticeable location, more people will be aware of the system's presence and may be less likely to panic in the event of a deployment.

Another way of reducing risks to the community is through the education of management of firms with fog security systems installed as to their duties to have proper procedures for arming and disarming their security systems. This should result in a written plan for all businesses that outlines the procedure for safe actions to be taken in the event of a fog security system deployment. Information on how the system works, such as how to disable the units, and what is to be done in the event of a deployment should also be passed from the distributor to the installer and from the installer to the end user in order to increase education and reduce risk.

Risks caused by the strobe light and sounder accessories have also been discovered. As mentioned earlier, the strobe lights are set to a default rate that can trigger seizures in photosensitive epileptics. It is recommended that this threat be mitigated by reducing the strobe rate to four flashes per second or less. The threat that sounders pose to hearing loss should also be addressed. If the sound levels that these emit can be reduced and still be effective, it would be advantageous to both employers and employees who may be exposed to these noise levels on a repeat basis and still want the sounders to act in deterring theft.

6.1.2 Long-Term

There are additional concerns that must be addressed and cannot be immediately changed, including changes to legislation and codes to better regulate the use of fog security systems. These will take time to implement but will ultimately make the use of fog security systems safer for the community.

As Australian legislation currently exists, permits are not required for the installation of fog security systems. If this is changed so that permits are required for the installation of these systems, then the site would have to be re-evaluated under the performance requirements of the BCA given the possibility of system deployment. These sections would initiate more strict guidelines for the location of fog security devices so that when discharging, they would not violate any provisions of the BCA, such as section EP4.2, which sets standards for the visibility of exit signs. The requirement of permitting for the installations would also provide a way to keep track of how many systems have been installed.

The duties of employers at firms where fog security systems are installed to their employees and patrons are also of concern. It is recommended that clarification of these duties of care under the OHS Act be provided by WorkSafe. If there were some way to be certain that fog security systems would not deploy during business hours, though, these responsibilities may be reduced. This can be accomplished if all fog security devices have a time interlock, similar to a bank vault, which only allows the heater block for the fog security system to warm up outside of business hours. This would need to be kept up-to-date so that if trading hours change, the time interlock would change accordingly.

6.2 Firefighting Recommendations

One issue at the forefront of discussion on fog security systems, and one that tends to be the most apparent when evaluating fire brigade concerns, is that of false alarms generated by these systems. In earlier analysis of false alarms generated by fog security systems, it was noted that such calls needlessly tie up fire brigade resources. It is therefore in the brigade's best interests, as well as those of the community given the protective role of the fire brigade, to mitigate the impact of these systems generating false alarms of fire. While some of these recommendations are long-term solutions which may require legal or legislative action, simple solutions may also be instituted in the interim with the cooperation of system installers, alarm monitoring companies, and the Metropolitan Fire Brigade.

6.2.1 Immediate

The most immediate solutions pertain to the reporting and tracking of deployments or false alarms of fire from deployments. The fire brigade's effective use of the Australian Incident Reporting System, or AIRS, for statistical and reporting purposes depends on the correct alarm code assignment by both firefighting crews in the field and staff following up on a call. The current false alarm code used for fog security device deployments is "746", or "False Alarms generated from a private security company – Commercial Premises". By evaluation of the Greater Alarm Response Handbook of the Metropolitan Fire Brigade, it is noted that without knowledge of fog security systems, the false alarm code "622", or "Steam vapour, fog, or dust thought to be smoke", is likely to be used on-scene. It is listed as a non-chargeable good intent call (Metropolitan Fire Brigade, 2007), and no description field is required. First, it is necessary to make firefighting crews aware both of the use of these devices and the need for using code "746" in dealing with calls to fog security device-equipped premises. Additionally, so as to indicate the presence of a fog security device more easily in AIRS reports, the phrase "fog security device" should be included in the beginning of all description fields provided for false alarm code "746".

It is also recommended that the MFB seek counsel to clarify previous legal opinions as to their ability to charge for attendance to false alarms from fog security system deployments. While there is a current legal brief from MFB counsel regarding charging for general false alarms arising from the deployment of fog security systems, these do not discuss the differentiation between "000" calls and brigade-linked alarms or private monitoring companies reporting a false alarm of fire (Maddocks, 2005). It should be promptly determined whether installation and arming of a fog security device constitutes a cause for a "000"- initiated false alarm and is within the control of the property manager, or whether the "000" call itself is considered the cause, and therefore outside the control of the property manager.

In order to reduce the number of false alarms in the short-term, it is also recommended that fog security system installers encourage, if not require, the use of voice modules in their systems. These units could act to reduce occupant panic or concern in the case of an accidental deployment by informing those in the vicinity of what has happened, and reduce the likelihood of a "000" call from passersby. Such modules are already available from all three manufacturers operating in Australia, according to their product literature.

Certain issues identified in the course of this research pertain more to the individual firefighter responding to a scene with a fog security system installed, as opposed to the MFB as an organization. Solutions to these operational concerns are focused largely on making it well-known to responding emergency services personnel that a premise has a fog security system installed, and whether it is armed or has deployed. Additionally, it is necessary to ensure the safety and most efficient use of personnel and resources when fog security systems are encountered.

To that end, more comprehensive response procedures for fog security systems must be developed than what presently exist, which are described in the relevant Safety Alert of December 2007 (reproduced in Appendix C). It is recommended that the MFB amend their procedures to allow that smoke extraction be performed on the premise, given appropriate permission from building management to perform salvage operations. Additionally, MFB personnel in attendance must ensure that the premises are secure and safe to enter through responsible parties on scene. This would serve to reduce the likelihood of “000” calls after the MFB’s first attendance, by both removing the cause of the alarm (“smoke” issuing or within the building), and by maintaining a visible fire brigade presence while fog is issuing from the building. Furthermore, MFB personnel attending calls relating to fog security systems should contact WorkSafe Victoria, following the same channels as would be used for controlled substance releases. This is at the suggestion and request of WorkSafe Victoria for tracking and statistical purposes. MFB personnel are recommended not to enter any premise where strobe lights or sounders are active in order to undertake smoke extraction or other salvage efforts. The fog itself may obscure any intruder still within the building, while strobe lights and sounders pose an undue operational risk to firefighting crews.

These operational guidelines should be issued in the interim as a Safety Alert to be implemented immediately, with recent research into the nature of these systems included. Such additions should address the possible presence of strobe lights or sounder devices and the possibility of a motion-sensitive trigger for certain fog security devices in the case of entry to a premise without disarming any burglar alarm system present.

It is recommended that a department at the Metropolitan Fire Brigade be given responsibility to act as a single point of contact for notification and interim policy efforts of the MFB relative to fog security systems. By providing two points of contact between the MFB and an industry alliance (discussed in Section 6.3), a clearly defined and balanced dialogue can be established to jointly guide standards and notification efforts to the benefit of both parties.

6.2.2 Long-Term

While immediate solutions such as the preceding offer an option to lessen the impact of issues facing various stakeholders, efforts must be made to effect the necessary changes. Certain considerations should be consolidated into a single Australian Standard relating to the design, installation, and use of fog security systems.

Foremost among these long-term considerations for false alarms is ensuring that private alarm monitoring companies have the ability to distinguish between a fog security system deployment and a fire, and that they have enough information available to make that judgment. Instead of building upon the provisions already made for such a reporting ability (status zones, for example), it should be mandated that such reporting ability is built-in to systems being installed in Australia. That is, systems should be able to indicate to an alarm panel that they have released fog, and the alarm panel should be able to report that status back to the monitoring company. If the monitored system is capable of fire detection, it should be required to be equipped with alternative fire detection units (other than smoke detectors) to distinguish between fire and security fog, and be able to report the status of these fire detectors separately back to the monitoring firm. This is not without precedent, as within its deemed-to-satisfy provisions, the BCA has considerations for the use of heat detectors in order to reduce false alarms in an area prone to them, as per Specification E2.2a-4(b) (Australian Building Codes Boards, 2007b). An area protected by a fog security system could be considered prone to false alarms.

It is also recommended that alarm companies monitoring security alarms with fog security devices attached be under certain reporting requirements. In line with earlier immediate recommendations, monitoring firms used to handle alarms with attached fog security devices must notify the fire brigade of deployments. Such notification would include only the MFD or CFA area in which the deployment occurred, a date, time, and that a deployment occurred. Notifications would not be used to identify premises, but instead for statistical purposes in aggregate, such as determining the ratio of total deployments to false alarms reported to the MFB.

In tracking false alarms of fire from fog security systems, it is necessary to be able to quickly distinguish between fog security device calls, and those from other private security company false alarms. This is to be accomplished through the introduction of a new AIRS code for fog security system deployment, requiring a description field of the scene.

The long-term creation and tracking of a metric derived from data provided by manufacturer representatives, private monitoring companies, and MFB records is also suggested. Such a metric would compare the number of sites with fog security devices (not necessarily the number of units), to the number of deployments (provided by monitoring companies), against the number of false alarm calls actually attended by the MFB (from MFB records, such as AIRS). This metric could be used to determine the level of success over time of the recommendations in this report which pertain to false alarms by comparing the number of actual deployments to the number of false alarm calls attended. Comparing the number of sites with installed systems to the number of false alarm calls attended over time could provide guidance as to a general false alarm rate of these devices.

Standard operating procedures from the Safety Alert of December 2007 (Appendix C) issued in light of the most recent research, combined with false alarm clarifications and other pertinent information should be integrated into the *Emergency Response Guidebook*. This would allow firefighters to more effectively manage incidents involving fog security systems, and to clearly identify risks and hazards associated with operating in such environments.

It is recommended that the Metropolitan Fire Brigade develop an “assignment rule” for use in the case of fog security system deployments, as described in the Literature Review. This would enact a policy that, when the alarm monitoring company notifies ESTA of a deployment, ESTA will limit the number of responding fire brigade apparatuses to “000” calls of smoke issuing from the building. More appliances may be dispatched if it is determined that the alarm is not false in nature. This would reduce wasted MFB resources and reduce the cost of false alarms incurred by businesses due to fog security system deployments by limiting the number of appliances and personnel responding to a false alarm call.

6.3 Industry Recommendations

In order to most effectively address concerns brought to light by the research conducted, it is necessary for the fog security device industry in Australia to seek resolution of certain matters as well. These recommendations, also separated into immediate and long-term recommendations, were developed to the benefit of the community as a whole, as well as industry, owners and users, and emergency services stakeholders specifically.

6.3.1 Immediate

An ad-hoc industry alliance should be formed in order to better align standards compliance and communication efforts between fog security system manufacturer representatives. The first use of this alliance would be to arrange a common method of installation notification between installers of fog security systems and the responsible department of the MFB. This notification system should be voluntary and performed formally via facsimile or email, with a common format, and the document would be kept within the MFB. The common format should include the address, name of the business, nature of the business, number of units installed, any accessories installed (strobe lights, sounders, voice notification, etc.), contact information for the installer, contact information for the manufacturer's representative in Australia (if different), and a description field to provide any pertinent information to emergency services in case of a deployment. Pertinent information would be any information that could be considered useful for first responders to an emergency at the premise (such as a hold-off timer or the use of a confirmation sensor on individual units).

Another use of such an alliance would be to agree on a single symbol to use on warning signage to indicate installation of such systems. This would greatly ease firefighter training and response efforts to premises with these systems installed, as a uniform style and location of warning placards would simplify identification of an equipped building.

As much as these are recommendations made for improving relations between the MFB and industry in the short-term while standards are developed and policies established, they are important first steps which should be voluntarily adopted by representatives of all manufacturers in Australia. Such an alliance would only benefit both parties and encourage regulatory and safety best-practices sharing, as well as providing a well-informed single point of contact for all three manufacturers for other fire services and other Australian stakeholders. Having the appropriate firms in place informally, as well as appropriate fire services representation, allows these processes to be transitioned into a formal working group for developing an Australian Standard.

In addition to more effective use of data collection tools to report on calls attended for false alarms resulting from fog security system deployments, it would be useful for the MFB and industry to track deployments which did not result in attendance to false alarms by the MFB. With the cooperation of private alarm monitoring companies in providing statistics (with identifying characteristics such as address, etc. removed) to the fire brigade or to fog security device manufacturers, this would be possible. Since all fog security devices on the market in Australia have some sort of method of indicating fog deployment, whether through a dedicated zone status or by the burglar alarm being triggered, alarm monitoring companies can be made aware of fog deployment at a facility. This, however, depends on the installer configuring the fog security system appropriately, and the monitoring company furnishing anonymous information about deployments to the fire brigade or fog security device manufacturers. This would allow further statistical analysis to determine the rate of false alarms when compared to deployments, as well as the acquisition of more information on the overall frequency of use within the installed base of systems. The deployment reports themselves can be as simple as a note that a deployment has occurred, the time and date, and the Metropolitan Fire District or CFA area where the deployment has occurred, without any specific information on the client or site monitored. These deployment notifications should be provided through the same channels recommended later for fog security system installation notifications.

6.3.2 Long-Term

In the long-term, it is necessary for the fog security system industry to provide a single point of contact between suppliers and installers, and the relevant community parties such as the MFB. Such an alliance must include all representatives of manufacturers distributing fog security devices and accessories in Australia. Additionally, a department of the MFB should be given official responsibility for receiving, handling, and disseminating information, notification, and other communications related to fog security systems.

It is recommended that a formal working group be established, comprised of the industry alliance, representation from the MFB’s designated department, Victoria Police, and any other interested parties in Australia. This working group should establish a strict Australian Standard pertaining to the safe design, installation, and use of fog security systems. The working group should also liaise with the appropriate legislative bodies to ensure that all fog security systems marketed or sold in Australia meet the criteria set forth by the proposed Australian Standard.

6.4 Recommendations on an Australian Standard

Following are recommendations for the development of an Australian Standard (referred to herein as the "Standard") governing fog security systems. It is recommended that the Standard be based upon the British Standard 7939:1999, with the provision that "must" replaces "should" in all relevant sections. Certain amendments to the Standard listed below and referenced to sections of BS7939:1999, should also be adopted. Compliance with this standard should be mandatory, referenced from within the Building Code of Australia ("BCA"). Local building regulations should additionally require a permit for the installation of fog security systems to ensure compliance with both the relevant sections of the BCA and the proposed Australian Standard.

6.4.1 Signage

(to replace Section 6.2.2): A standardized symbol shall be used to indicate the presence of a fog security system to emergency responders. It is to be mounted and located in a fashion similar to that of hazardous materials signage.

(to be added to Section 6, replacing Section 8.16): Conspicuous and standardized signage indicating the presence of fog security devices and any accessories installed to the general public must be displayed at each entrance of a premise.

(to amend Section 8.13): The use of visual and audible indicators of fog deployment by a fog security device is mandatory. Acceptable visual indicators include indicator lights or lit signs, and consideration must be made to the high visibility of such indicators, when activated, to responding emergency services personnel or passersby. Acceptable audible indicators consist of voice announcement systems or voice modules which publicly announce the nature of the fog both inside and outside the premise. Consideration for audible indicators must be made such that they can be heard by passersby and by occupants given any ambient noise during a deployment, such as sirens or street noise.

(to replace Section 8.5): The design of installations of fog security devices should be such that a man-trap, that is, any scenario where exit routes are obstructed such that egress in the event of an emergency is hindered, shall not be created.

6.4.2 System Configuration and Accessories

(to be added): Duress alarms, or “panic triggers”, shall not be used to activate or deploy fog security systems. Duress alarms or “panic triggers” are defined as any capability, either built-in or added during or after installation, for manual activation of the fog security device for purposes other than testing or demonstration.

(to be added): The flash rates of strobes used in conjunction with fog security systems must have a flash rate of 4 flashes per second or less.

(to be added): Sound-generating devices used in conjunction with fog security systems must be restricted to a sound pressure level that causes no hearing damage after periods of exposure lasting up to 10 minutes. This length of time must be sufficient to evacuate the immediate area and disarm the system. The sound pressure levels generated by such a device must be measured in accordance with AS1269.

(to amend Section 8.12): To mitigate false alarms of fire, alternative fire detectors must be fitted to any existing smoke detection system on the premise where a fog security device is to be installed. Where addressable sensors are not used, alternative fire detectors must be on a separate reporting zone than smoke detectors, and zone status must be available to the alarm monitoring company. The fog security system installer must verify that the installation of alternative fire detectors has taken place before proceeding with installation of the fog security system.

Premises with fog security systems installed must utilize an alarm monitoring company, which must be able to receive status of both fire and security zones. It is mandatory that fog activation and fault zones be monitored by the alarm and available as a security zone to the monitoring firm.

Alarm companies monitoring fog security systems must notify ESTA immediately in the event of a fog security device deployment to report on the status of the fire detection systems. This will initiate limited response procedures from the MFB in the event of “000” calls.

6.4.3 System Function and Safety

(to be added): The devices shall be designed to be fail-safe with respect to power supplies. That is, loss of power must not trigger a release of fog. In addition, severing any connections to the units shall not trigger them.

(to be added): Fog security devices shall not be installed on any “monitored site,” as described in AS 1670.3.

(to be added): Fire shut-down circuits, that is, the capability to disengage a fog security device upon detection of fire, shall be required with all installations.

6.3.5 Notifications and Reporting

(to replace Section 7.5) Material Safety Data Sheets ("MSDS") in compliance with Australian regulations shall be provided to the customer upon request. As a guideline, the MSDS shall conform to Regulation 4.1.6 of the Victorian Occupational Health and Safety Regulations 2007.

(to be added to Section 7): The MSDS for any fluid (or fog as applicable) used by the fog security system shall be kept at the alarm panel to be accessed by emergency responders. Location of MSDS provided for fog fluid must be marked and visible in the case of a fog deployment.

(to be added): Manufacturers must provide independent laboratory verification by an accredited testing facility, that the fluid used to produce fog, as well as fog itself, do not present a health hazard to humans or animals. This verification shall include detailed chemical analysis of both the fog and fluid to determine any contaminants present and report on all chemical compounds detected. The test must also include research on chemicals and health and safety research regarding the environment produced by the deployment of the device.

(to be added to Section 11): Complete lists of local installation sites as well as information regarding any alterations to previously installed systems must also be made available upon request to emergency services (police, fire, etc.). "Local" is defined as the entirety of the state in which the emergency service is based.

(to be added to Section 12.1 and 2): Comprehensive lists of local installation sites as well as information regarding any alterations to previously installed systems must also be maintained by both manufacturers and installers.

(to be added): All alarm monitoring companies must notify the appropriate fire authorities of all fog security system deployments for statistical purposes.

(to be added): All installers must notify the local police and fire service of new fog security system installations within one week of completion of the installation. This notification shall include the name and address of the premise, nature of the business, number of units installed, any accessories installed (strobe lights, sounders, voice notification, etc.), contact information for the installer, and contact information for the manufacturer's representative in Australia (if different).

(to be added): Distributors of fog security systems in Australia must conduct audits of installations of their devices to ensure they meet this Standard. Such audits shall be reported on annually, with results from audits of systems installed in the past year. Audits must be conducted by the distributor if a separate installer is used. An independent agent of the distributor may also be used to conduct such audits if it is infeasible for the distributor to do so.

With the implementation of these recommendations, it is believed that the environment surrounding fog security systems will be greatly improved for the community, emergency responders, and those involved in the sale of these systems.

7. Conclusion

The purpose of this project, to investigate the use of fog security devices, was achieved through a number of means. First, records of the MFB were analyzed in order to determine any past investigations into the use these devices. Next, interviews were conducted with internal MFB personnel, WorkSafe representatives, fog security device installers, building authorities, and representatives of premises where the devices were installed.

The information identified through these methods was then analyzed in order to identify all issues surrounding the use of these devices. The issues identified through this process included occupational health and safety concerns for firefighters and employees of a protected premise, applicable building regulations, and risks to the general public as well as business owners. Through the identification of these risks, it became clear what recommendations were needed in order to mitigate these issues.

Recommendations posed included the drafting of an Australian standard as well as long- and short-term solutions for the fire services, industry, and community. It was recommended that the Australian Standard be based on BS 7939:1999, with the important provision that the word "must" be used instead of "should." Specific additions and amendments were also recommended in order to lessen the risks of the use of fog security devices. Recommendations for the fire services involved changes to policies and procedures to ensure educated responses by fire crews. It was recommended that the fog security device industry come together and address issues within the industry. Finally, strict regulations addressing health risks to the community stemming from the use of these devices were posed.

With the implementation of the policies recommended, fog security devices can continue to exist in the Australian market. It is possible that the devices can serve their purpose of deterring theft in a manner that is safe for all parties involved.

8. References

Ackermann, R. (1997). *70448/97* No. 70448/97) DEKRA

American Speech-Language-Hearing Association. *Noise and hearing loss.* Retrieved January 30, 2008, from http://www.asha.org/public/hearing/disorders/noise.htm

Arias Tech. *Frequently asked questions.* Retrieved 12/20, 2007, from http://www.ariastechltd.com/arias_tech_english/el_cegador/faq.asp#24

Australian Building Codes Boards. (2007). *BCA 2007: Building code of Australia*. Fyshwick: CanPrint Communications Pty Ltd.

Australian Building Codes Boards. (2007a). *About the building code.* Retrieved 2/14, 2008, from http://www.abcb.gov.au/go/about_bca_p1

Australian Building Codes Boards. (2007c). *Guide to the BCA 2007: Building code of Australia*. Fyshwick: CanPrint Communications Pty Ltd.

Bandit Americom. (2006). *Bandit fog generation system - frequently asked questions.* Retrieved 11/12, 2007, from http://www.banditamericom.org/faqeng.html

Beirinckx, P. (1997). *HY-3 material safety data sheet (MSDS).* Bandit NV. Retrieved 13 Nov 2007

British Standards Institute. (1999). *Smoke security devices - code of practice for manufacture, installation, and maintenance* No. BS7939) British Standards Institute.

Building Commission Victoria. (2006a). *Victoria's building regulatory system.* Retrieved 2/14, 2008, from http://www.buildingcommission.com.au/www/html/1343-victorias-building-regulatory-system.asp

Building Commission Victoria. (2006b). *What you need to know about permits and paperwork before, during, and after building.* Building Commission Victoria.

Building Regulations 2006 no. 68, (2007)

Bukowski, R. W., & O'Laughlin, R. J. (1987). In Zimmerman C. E. (Ed.), Fire alarm signaling systems handbook. Quincy, MA: National Fire Protection Association.

Butcher, E. G., & Parnell, A. C. (1979). Smoke control in fire safety design. London: Spon.

Call costing report. Unpublished manuscript.

Commander of Community Safety, Central Zone. (2007). *Fire and hazard Safety/Monitoring: Smoke security devices, burglar alarms - installed in MFD* No. 07/01981A) MFB.

Concept Engineering Limited. (2007). Concept smoke systems: Health and safety data Concept Engineering Limited.

Concept Smoke Screen. (2007). Product guide. Retrieved 13 Nov, 2007, from http://www.smoke-screen.co.uk/images/productguide.pdf

Concept Smoke Screen Ltd. (2003). *RAPID security smoke system: Installation and operation manual* No. ELM100 v1) Concept Smoke Screen Ltd.

Concept Smoke Screen Ltd. (2006). *Concept smoke systems sales and installation guidelines*. Rockingham: Concept Smoke Screen Ltd.

Concept Smoke Systems. (2007). Concept smoke systems. Retrieved 12/5, 2007, from http://www.smokescreen.com.au

Crime Act 1958, (2008). Retrieved 26 February 2008 from http://www.legislation.vic.gov.au/Domino/Web_Notes/LDMS/PubLawToday.nsf/a12f6f60fbd56800ca256de500201e54/B9CFD00D1D50542BCA2573B70022E3D1/$FILE/58-6231a195.pdf

Eighteen, J. (2005). *Re Smokecloak at BP*. Retrieved 1/30, 2008, from http://www.smokecloak.com.au/index.php?option=com_content&task=view&id=40&Itemid=52#

Emergency Services Telecommunication Authority. (2006). *ESTA annual report 2005/2006* Emergency Services Telecommunication Authority.

Fire engineering guidelines (1996). (First ed.). Sydney, AU: Fire Code Reform Centre.

G4S Security Systems, Ltd. (2007). *Smokecloak.* Retrieved November 5, 2007, from http://www.accontrols.co.uk/solutions/smokecloak.html

Gibbard, C. (2008). *Concept smoke screen – overview.* Unpublished manuscript.

Gilmartin, M., & Dards, P. (2006). *Security smoke systems.* Retrieved November 13, 2007, from http://www.thesecurityinstaller.co.uk/Content/smoke.asp

Hall, R. and B. Adams (Ed.). (1998). *Essentials of fire fighting* (4th ed.). Stillwater, OK: Fire Protection Publications.

Health and Safety Executive. (2000). *Disco lights and flicker sensitive epilepsy* (Local Authority Circular No. 51/1). United Kingdom: United Kingdom Health and Safety Executive. Retrieved 25 Jan 2008 from http://www.hse.gov.uk/lau/lacs/51-1.htm

Klote, J. H., Milke, J. A., American Society of Heating, Refrigerating and Air-Conditioning Engineers, & Society of Fire Protection Engineers. (1992). *Design of smoke management systems*. Atlanta, GA; Boston, MA: American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.; Society of Fire Protection Engineers.

International Code Council. (2006). *International building code* (2006 ed.) International Code Family.

International Code Council. (2007). *International fire code* (2006 ed.) International Code Family.

Maddocks. (2005). *Legal brief from Maddocks regarding alarm charging for fog security systems.* Unpublished manuscript.

Martin Entertainment. (2007). *Atomic 3000 User Manual* (Rev. E) Martin Entertainment. Retrieved 29 Jan 2008 from http://www.martin.com

Martin Security Smoke, Ltd. (a). Product guide. Northamptonshire: Martin Security Smoke, Ltd.

Martin Security Smoke, Ltd. Smokecloak: Information - OH&S manual

Martin Security Smoke, Ltd. (2005). Smokecloak FL600 fluid - safety data sheet/8 Nov 2007

Martin Security Smoke, Ltd. (2007). *Martin security smoke products are being featured at trade shows in USA.* Retrieved 11/6, 2007, from http://www.smokecloak.com/home/?section=2&sub_section=1&lang=en

Metropolitan Fire Brigade. (2006). *Emergency response guidebook* (1.0th ed.)

Metropolitan Fire Brigade. (2007). *False alarm codes*

Metropolitan Fire Brigade. (2008). *Response presentation.* Unpublished manuscript.

Metropolitan Fire Brigade. (2008). *Commercial fire and estimated cost for incidents attended by the MFB.* Unpublished manuscript.

Metropolitan Fire Brigade Director - Operations. (2007). *Safety alert smoke security alarms.* Unpublished manuscript.

Metropolitan Fire Brigades Act 1958, Definitions (1958).

Metropolitan Fire and Emergency Services Board. (2007). *Communication standard operating procedures.* Unpublished manuscript.

Metropolitan Fire and Emergency Services Board (2007). *Knowing the MFB.* Retrieved 12/4, 2007, from http://www.mfb.org.au/default.asp?casid=798

National Fire Protection Association. (1962). In Cote A. E. (Ed.), *Fire protection handbook* (16th ed.). Boston, Mass.: National Fire Protection Association.

National Fire Protection Association. (2002a). *National fire codes: Standard for the installation of air-conditioning and ventilating systems* (No. 90A). Avon, MA: NFPA.

National Fire Protection Association. (2002b). *National fire codes: Standard for smoke and heat venting* (No. 204). Avon, MA: NFPA.

National Fire Protection Association. (2005). *National fire codes: Standard for low-, medium-, and high-expansion foam* (No. 11). Avon, MA: NFPA.

National Fire Protection Association. (2006a). *National fire codes: Fire alarm code* (No. 72). Avon, MA: NFPA.

National Fire Protection Association. (2006b). *National fire codes: Life safety code* (No. 101). Avon, MA: NFPA.

National Fire Protection Association. (2006c). *National fire codes: Standard for smoke-control systems utilizing barriers and pressure differences* (No. 92A). Avon, MA: NFPA.

National Standard for Occupational Noise, (2000). Retrieved 20 February 2008 from http://www.ascc.gov.au/NR/rdonlyres/7C3EFB91-6C19-4161-A572-D5155EB20E50/0/Noise_standard_NOHSC1007_2000.pdf

Occupational Health and Safety Act 2004, (2007b).

Occupational Health and Safety Regulations 2007, (2007).

Occupational Safety and Health Standards, 1910.95U.S.C. (2006).

Protect Global. (2005). *Protect security strobe.* Retrieved Feb/ 23, 2008, from http://www.protectglobal.com/ss1185.sspx

Protect Global. (2006). *Installation- safe guard process*. Hasselager: Protect Global.

Protect Global. (2007). *Installation manual*. Denmark: Protect Global.

ScienceLab. (2005a). *Material safety data sheet dipropylene glycol* (MSDS. Houston: ScienceLab.

ScienceLab. (2005b). *Material safety data sheet propylene glycol* (MSDS. Houston: ScienceLab.

ScienceLab. (2005c). *Material safety data sheet triethylene glycol* (MSDS. Houston: ScienceLab.

Smith, G. (1993). Report on the health and safety Aspects of smoke generator machines NOHS. 8 Nov 2007

Smoke management. (2006). Retrieved November 13, 2007, from http://www.bfrl.nist.gov/IAQanalysis/applications/smoke.htm

Smoke Security US. (2007). Smoke screen security products. Retrieved 12/1, 2007, from http://www.smokesecurityus.com/products.htm

Standard Procedures Operations: Assignment Rules, (1996).

Standards Australia Committee FP-002. (2004). *Fire detection, warning, control and intercom system- system design, installation and commissioning* No. AS 1670.3-2004) Standards Australia.

Standards Australia Committee FP-002. (2004b). *Fire detection, warning, control and intercom system- system design, installation and commissioning* No. AS 1670.1-2004) Standards Australia.

Steering Committee. (2007). *Report on government services 2007* Productivity Commission.

Taylor, Natalie and Mayhew, Pat. (2002). Financial and psychological costs of crime for small businesses. *Trends and Issues in Crime and Criminal Justice* (229) Retrieved 6 Nov 2007 from http://www.aic.gov.au/publications/tandi/ti229.pdf

Vandoninck, A. (1995). Device for generating a fog. AU, CA, JP, US, AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE: F41H 9/06, G08B 15/02.

WorkSafe Victoria. *About WorkSafe Victoria.* Retrieved 1/29, 2008, from http://www.workcover.vic.gov.au/wps/wcm/connect/WorkSafe/SiteTools/About+WorkSafe/About+Worksafe/

WorkSafe Victoria. (2005). *Guide to the OHS act 2004*. Victoria, Australia: Victorian WorkCover Authority. Retrieved 29 Jan 2008 from http://www.worksafe.vic.gov.au

WorkSafe Victoria. (2007a). *How WorkSafe applies the law in relation to reasonably practicable*. Victoria, Australia: Victorian WorkCover Authority.

WorkSafe Victoria. (2007c). Your health and safety guide to noise (1st ed.)WorkCover.

Wright, C. Convective flow due to stack effect. Retrieved November 25, 2007, from http://www.chuck-wright.com/calculators/stack_effect.html

9. Nomenclature

"000" call: a phone call to ESTA reporting an emergency

AFAC: Australasian Fire Authorities Council

AS: Australian Standard

ASHA: American Speech-Language-Hearing Association

BCA: Building Code of Australia

CFA: Country Fire Authority

CNS: Central Nervous System

GARS: Greater Alarm Response System

HVAC: Heating, Ventilation, and Air Conditioning

ESTA: Emergency Services Telecommunication Authority

Fog Security Device: a device that rapidly deploys a cloud of fog to obscure an area for the purposes of deterring theft

Man-trap: any situation where means of egress are blocked are obscured, hindering efforts to exit a premise

MFB: Metropolitan Fire Brigade

MFD: Metropolitan Fire District

MSDS: Material Safety Data Sheet

NFPA: National Fire Protection Association

NOHS Commission: National Occupational Health and Safety Commission

OHS: Occupational Health and Safety

OSHA: Occupational Safety and Health Administration

Panic trigger: A device for manual activation of a fog security system for reasons other than demonstration or testing

SOP: Standard Operating Procedure

Sounder: A device which emits a high volume noise that causes discomfort to anyone in close proximity to the device

SWOT: Strengths, Weaknesses Opportunities, and Threats

VCAT: Victorian Civil and Administrative Tribunal

VicPol: Victoria Police

Appendix A: Sponsor Description

The Metropolitan Fire Brigade (MFB) provides emergency services to the metropolitan area of the city of Melbourne. In addition to basic fire and hazardous response through its city-wide coordination of fire stations, the organization also provides community outreach programs, emergency medical response, fire safety inspection, and other strategic functions within the Melbourne emergency services community.

The scope of the Metropolitan Fire Brigade's authority is bordered by and includes the suburbs of Melbourne in an approximately 20 kilometer radius from the city center. This area, the Metropolitan Fire District (MFD), covers 47 stations in approximately 1100 square kilometers, and is divided into four major sections - the Central (including Melbourne's CBD), Northern, Southern, and Western Zones. Each of these divisions has its own governance and manager within the organization. Regions outside those governed and operated by the MFB are under the jurisdiction of the Country Fire Authority (CFA).

Within the MFD, the MFB oversees both emergency and non-emergency services for the population of Melbourne and its suburbs. Within the domain of emergency matters, the MFB governs and coordinates responses to fire, hazmat, emergency medical, and rescue situations. On the non-emergency front, the MFB is responsible for community outreach and education, fire safety inspection, and event safety consultation (Metropolitan Fire and Emergency Services Board, 2007).

Appendix B: Questions for Interviews

B.1 Building Commission Victoria & Independent Building Surveyor

Can you identify any provisions in the Victorian building framework which would prohibit fog-based obscuration security devices from being implemented by building tenants or owners?

What are the requirements for egress, according to the Building Commission?

What regulatory action or efforts would you think to be satisfactory in making these devices compliant with the BCA and Victorian legislation?

When installed after construction, i.e. in front of an exit, what prohibitions or items in the BCA would apply to these devices?

Are there any regulations/inspections conducted by the Building Commission after the building has received its occupancy certificate?

How would the devices affect the egress requirements and would it be possible to have one of these devices and follow performance-based requirements of the BCA?

B.2 Commander of Alarm Assessment (MFB)

What are the issues raised in the incident of a general false alarm?

What about a false alarm cause by the deployment of a fog-based obscuration system?

What are the standard penalties applicable to false alarms of these systems?

What is the cost outlay for general false alarms scenarios, in terms of time, personnel, and equipment?

For how much is the building owner responsible (in terms of cost)?

What is their Standard Operating Procedure, once it is known that the call is a false alarm?

How long are resources tied up in the event of a standard (smoke detector, etc.) false alarm vs. that of a fog-based obscuration system false alarm?

How many false alarms due to fog-based obscuration systems have been reported?

What files are available relating to false alarms due to these devices?

What is the cost outlay for false alarms scenarios due to the deployment of fog-based obscuration systems, in terms of time, personnel, and equipment?

May we have access to any reports of the false alarm incident occurring recently at Michael's Camera Shop?

B.3 Installers

Do you follow any national codes or guidelines for installing your devices?

Any familiarity with national/local guidelines/codes/requirements that would be applicable (BCA, etc.)?

Do you integrate current fire detection/alarm systems into your installation? If so, how?

Do you install systems only to fire/alarm panels, or with "mock panels?"

Do you notify local fire or police authorities when installing a system?

Can you provide some information regarding company-provided guidelines for installation? changes to existing fire/smoke detection systems? signage?

How common are these devices?

Are you confident that these devices provide no safety threats to fire and rescue services? Occupants? Intruders?

What is the average cost of a fog-based obscuration system?

Can you show us some example configurations of these systems?

If the alarm system is tripped, is there a way to know if it is only a false alarm or if the Smokecloak has deployed? (important for notification of responding parties)

B.4 Victoria Police

Do you consider fog-based obscuration systems effective theft deterrents?

Do you see any benefit to the installation of these devices?

Have you responded to a call involving one of these devices?

What operational concerns, if any, do you have with these devices?

What is the evidentiary impact of fire responders arriving first to the scene?

B.5 Landlords or Building Managers

What was the motivation for you to install one of these systems?
(if motivation was crime: Have you had successful break-ins since the system was installed? Any attempts?)

Has the system deployed at all since its installation?
(if system has deployed: Under what conditions?)

Was there any damage to property or cost incurred?

Who installed your system? When? With what options?

Do you use an alarm monitoring company?

Do you have a service/maintenance plan with the installer or security monitoring company?

Is your system tied into your burglar alarm? Fire panel? Why or why not?

Have you registered your system with anyone – alarm company, local authorities, etc.?

Who is responsible for arming/disarming the system?

What is your closing procedure just prior to arming (with respect to personnel in the building)?

Do you have the remote control for deployment?

Are you aware of any regulation regarding the use or install of these systems?

Could you explain why the devices are located where they are?

Why do (or don't) you have signage on the entry and exit points of your building?

What is your understanding of the operation of these devices?

B.6 Commander of Community Safety Central Zone (MFB)

Do you have any experience with fog security systems?

Do you know of any station drills that pertain to these systems?

What operational changes have been made in the Central zone's responses due to the presence of these devices? (turnout sheets, dispatch, etc.)

What are your concerns for firefighters that run into fog-based obscuration security systems in the field?

Do you see any upside to these devices?

What approach would you prefer to see in the management of these devices?

Have you instituted any policy or done any work relating to the regulation of the installation and operation of these devices?

What measures (signage, notification outside the building, etc.) would be necessary for you to feel comfortable with the installation of these devices (if any)?

Which manufacturers, distributors, or installers have contacted you? Provided information? Demonstrations?

B.7 Fire Services Personnel (MFB Operational Experience)

Are you familiar with fog security systems? Please tell us about your familiarity with these systems.

Have there been any changes to the standard operating procedure of the MFB when dealing with premises known to have these devices installed?

Please tell us about your experiences in dealing with them directly.

Do you foresee any conflicts with the installation of these devices and the BCA?

What is your opinion of these devices from a fire safety perspective?

Do you feel that they would affect fire services in the event of a concurrent fire and deployment situation? Rescue Services?

Do you foresee issues with false alarms?

Do you think that these devices will prove to be safety hazards to fire and rescue services? Occupants? Intruders?

B.8 WorkSafe Victoria (Victorian Occupational Health and Safety)

Is there a definitive workplace for a firefighter? Are sites of fires treated as a workplace for them?

What kind of special considerations, in terms of duty of care of the employer, is there in the case of emergency services organizations such as the police or fire brigade, given the nature of their work?

What concerns would you have for the safety of a fire fighter entering a site where one of these devices has deployed (actual alarm, not false)? In a concurrent deployment and fire situation?

Looking at a deployment of one of these systems, what concerns would you have regarding the responsibility of the employer/tenant in a deployment after normal business hours? With employees on-site? During normal business hours?

Do the installers of these systems have any responsibility to follow rules regarding the installation of these systems?

What concerns would WorkSafe have in regards to the MFB's operational response to a false alarm involving these devices? If it knew premises had been outfitted?

Whose responsibility would a deployment be? Would it be a fire or police matter first?

Appendix C: MFB Safety Alert of December 2007

Safety Alert

SMOKE SECURITY ALARMS

Scenario

The MFB has become aware of a new type of Security Alarm being installed that employs smoke as the deterrent for attempted burglaries.

The smoke security alarms are designed to fill the protected area with a dense cloud of smoke in order to significantly reduce visibility. This concept is designed to prevent the burglar seeing and therefore reaching intended targets, thus attempting to reduce property loss or damage. There is currently limited use of these devices across the MFD.

Operating Philosophy

The activation of the smoke security alarm requires two triggers. The triggers for operation are a break-in or when a door is opened and when movement is detected within the premises. In some buildings the smoke security alarm is only installed within a single compartment inside the building.

The smoke security alarm is monitored by a security company who will respond in accordance with their protocols.

These alarms are designed for properties where high net worth goods are stored or where there is a history of burglary.

The device can fill a 375 cubic metre compartment with smoke within approximately 20 seconds. The product used is non hazardous and similar in nature to that used in generating theatrical smoke.

Standard practice by the companies installing the smoke security alarms is to provide warning signage on entry/exit doors to alert Police and Fire Authorities.

Operational Response - Risk

1. These devices may be installed in buildings where a Fire Indicator Panel (FIP) is also installed. Operation of the Smoke security device may precipitate operation of the FIP.
2. An MFB crew may enter a building to investigate an Alarm of Fire and precipitate operation of the Smoke Security Device.
3. The MFB may receive "000" calls from the public following activation of the smoke security alarm.
4. The MFB may be requested to attend by VicPol following their notification and attendance after activation of a smoke security alarm.
5. In some cases the MFB may receive a "000" call from a Private Security Monitoring Company for a fire alarm activation.

Health

There are no health issues related to the smoke/fog product generated via the smoke security alarm.

Safety Actions

1. Should MFB crews find themselves in a building and a smoke security device activates they are to exit the building immediately via the entry route and await the arrival of the security company.
2. MFB crews attending "000" calls for smoke issuing from a commercial/industrial premises should consider the possibility of a smoke security device having being activated (prior to entering the building to investigate or prior to commencement of forced entry). **Please see photo 1 and photo 2 on page 2 of this Safety Alert.**
3. Where responded by VicPol to investigate smoke issuing from a premises and a smoke security alarm is identified as the cause, MFB personnel are not to enter the building.

MFB attendance at Smoke Security Alarms

1. Once identified as a smoke security device MFB crews are to notify VicPol to attend immediately.
2. Where MFB crews are in attendance prior to the security company or VicPol attendance and there are signs of a break-in MFB crews are not to enter the building.
3. MFB crews are not to undertake salvage operations to attempt evacuation of smoke from the premises.
4. For all calls to activation of smoke security alarms False Alarm Code 746 is to be used, this will ensure a report is generated. Calls to these types of devices can then be investigated and if appropriate false alarm charges can be issued.

SAFETY ALERT 12 /2007
ISSUED BY OPERATIONS: 05/06/2007
AUTHORISED BY: DIRECTOR – OPERATIONS

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Photo 1 = Actual Signage

Photo 2 = Smoke generating unit

Appendix D: Fog Security Device Market Contact Information

D.1 Smokeshield Australia (Smokecloak / Martin Security Smoke)

Phone: 1800 554 995

D.2 Concept Smoke Screen (Concept Smoke Systems)

E-mail: frank@smokescreen.com.au

Phone: 08 9368 0931

D.3 Protect Security Systems Pty Ltd (Protect Global)

E-mail: Info.Australia@ProtectGlobal.com

Phone: 1800 200 996

Note that all phone contact information provided is for Australia unless otherwise noted.

Appendix E: SWOT Analysis Quick Reference

Objective: The use of fog security devices

Strengths	**Weaknesses**
• Successful theft deterrent • Cost effective • Simple to use • Does not require building permits • Deployed fog is safe for people and electronics	• Suspension of trading due to accidental deployments • Employees must be trained to deal with accidental deployments • Safety is dependent on proper installation • Additional OHS compliance burden
Opportunities	**Threats**
• Reduction in break-ins may benefit other crime prevention efforts • Can provide opportunity to businesses to be insured or save money on existing policies	• Fog can block egress routes • Strobe flash rates can trigger seizures in photosensitive epileptics • Hearing damage can occur with long-term exposure • False alarm charges can apply to owners/occupants • Diversion of MFB resources can be dangerous to other sites in need of them