Education for the Use of Emergency Egress Lifts (DP7)

Interactive Qualifying Project

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DP7

On May 1, 2013, the Building Code of Australia was updated to include a new performance requirement called DP7 which addresses the use of evacuation lifts. The clause is listed below:

DP7

"Where a lift is intended to be used in addition to the *required exits* to assist occupants to evacuate a building safely, the type, number, location, and fire-isolation of the passenger lift must be appropriate to-

(a) the travel distance to the passenger lift; and

(b) the number, mobility and other characteristics of occupants; and

(c) the function or use of the building; and

(d) the number of *storeys* connected by the passenger lift; and

(e) the *fire safety system* installed in the building; and

(f) the waiting time, travel time and capacity of the passenger lift; and

(g) the reliability and availability of the passenger lift; and

(h) the emergency procedures for the building" (ABCB, 2013c, p. 176).

Abstract

The scope of this project was to develop an educational seminar series that effectively conveys information on issues surrounding the use of evacuation lifts in building designs and evacuation plans. Australia has released an unprecedented building code, DP7, which permits the use of lifts for evacuation. Evacuation lifts will not only improve evacuation times for high-rise buildings, but also provide equitable egress for persons with disabilities. Few building designers in Australia have experience with evacuation lifts and it is important to inform them of some of the considerations that need to be made for their integration into building designs. Key informants from Australia and other countries that use evacuation lifts as well as Australian stakeholders involved in the design and management of high-rise buildings were interviewed and surveyed to determine the concerns and misconceptions that they had regarding the use of evacuation lifts. The seminar series focused on considerations that address evacuation planning, building design and management, and maintenance issues. The goal of our project is to educate members of the design team on the incorporation of evacuation lifts into building designs and evacuation plans so that they can be safely and effectively utilised by building occupants in the future.

Acknowledgments

We wish to acknowledge those who guided and helped us through our research project. It is with their assistance that we are able to present our seminar series to Olsson Fire & Risk, Australasian Fire and Emergency Services Authorities Council (AFAC), the Society of Fire Safety, Engineers Australia (SFS), and Fire Protection Association Australia (FPAA) with the goal of informing stakeholders concerned with the use of evacuation lifts in buildings.

We thank our co-sponsors for their help. On behalf of Olsson Fire & Risk, we thank Jonathan Barnett for his guidance on our project and for his contacts. His criticisms ensured that we made the most of our limited time and that our finished product would leave little unaccounted for. We thank Robert Llewellyn on behalf of AFAC. Robert introduced us to many contacts throughout our project and offered feedback for the seminar series and our progress. It is with his assistance that we were able to surmount many of the obstacles we encountered. On behalf of FPAA, we extend our thanks to Matthew Wright. Matthew highlighted the importance of maintenance and performance-based codes.

With help from our co-sponsors, we were put in touch with a large number of key informants and stakeholders from various organisations. We wish to extend our thanks to each and every individual that offered us a moment of their time. Whether they were a fire safety engineer, a building owner or manager, a member of the lift industry, a disability advocate, a member of the fire personnel, an architect, or a building surveyor, the information we received ensured that we fully understood the issues surrounding evacuation lifts from all relevant perspectives. We wish to thank all of our key informants and stakeholders for lending us their time. Without their services, we would have made little progress on this project.

Finally, we extend our thanks to our advisors on this project, Professors Holly Ault and Michael Aghajanian. Through the entirety of our project, our advisors were always present to give us a helping hand and to guide us through the difficulties we encountered. Our advisors aided us in perfecting this report and in accounting for each stakeholder group in our seminar series.

The guidance and assistance that we received from all parties has been invaluable and we are sincerely grateful to them.

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Acronym Reference Table

Acronym	Definition
ABCB	Australian Building Codes Board
AFAC	Australasian Fire and Emergency Services Authorities Council
BCA	Building Code of Australia
BRE	Building Research Establishment
BS	British Standards
BSI	British Standards Institution
CALD	Culturally and Linguistically Diverse
DDA	Disabilities Discrimination Act
FEB	Fire Engineering Brief
FIP	Fire Indicator Panel
FPAA	Fire Protection Association of Australia
FPRF	Fire Protection Research Foundation
FSC	Fire Strategy Company
FSEG	Fire Safety Engineering Group
HAZOP	Hazard and Operability
ICC	International Code Council
MFB	Melbourne Fire and Emergency Services Board
NCC	National Construction Code
NFPA	National Fire Protection Agency
OEE	Occupant Evacuation Elevator
OSHA	Occupational Safety and Health Administration
PDA	Physical Disability Australia
PEEP	Personal Emergency Evacuation Plan
PWDWA	People with Disabilities Western Australia
SFS	Society of Fire Safety Engineering Australia
UK	United Kingdom
US	United States of America
WTC	New York World Trade Centre

Executive Summary

Ensuring the safety of building occupants during an emergency is the concern of all members of the building design process. Organisations like the Australia Building Codes Board (ABCB) exist in order to develop the performance requirements to be used for the design of buildings. Every year, the ABCB releases a new version of the Building Code of Australia (BCA) with modifications to the existing building requirements and new building provisions. In 2013, the ABCB added a new performance requirement, DP7, to the BCA that permits the use of lifts during evacuation. As a performance requirement, DP7 can be addressed by a variety of Alternative Solutions and is very open to interpretation. As a result, there is a need to educate stakeholders involved in the building design process and the development of evacuation plans on the effective incorporation of evacuation lifts into building designs.

Evacuation lifts are permitted by building codes in some countries and have recently been inconsistently incorporated into a limited number of buildings in Australia through the use of Alternative Solutions. DP7 is the first performance requirement to address the use of evacuation lifts in Australia and is a stepping stone for the development of a robust guideline for the use of evacuation lifts. As a supplement to the release of DP7, the ABCB developed a handbook to provide more information on the implementation of DP7, *Lifts Used during Evacuation*. This handbook expands on considerations that need to be made when integrating evacuation lifts into building designs and evacuation plans.

In order to ensure proper implementation of evacuation lifts, it will be important to inform design teams about considerations that should be made for the implementation of DP7. The goal of our project was to create a seminar series to convey information from the handbook and additional information from the research project in an educational programme. This seminar series was developed based on the concerns, educational needs, and misconceptions of the stakeholder groups. The goal of our seminar series is to inform members of the design team of considerations that should be made to effectively incorporate evacuation lifts in building designs and evacuation strategies.

To gain an understanding of how lifts can be safely used for evacuation, we conducted interviews with key informants from countries where evacuation lifts are used. We also read and analysed international building codes and research papers related to the use of evacuation lifts. We then interviewed individuals from our stakeholder groups in Australia.

Our stakeholders included architects, building surveyors, building managers and owners, fire safety engineers, fire services personnel, and members of the lift industry. We developed questions for each stakeholder group to determine what considerations they believed needed to be made for evacuation lifts so that we could identify knowledge gaps and any misconceptions that they had with their use. Based on the concerns we collected from both our key informants and stakeholders, we developed a 3 question survey to identify the top concerns of each stakeholder group. This survey was used to determine the educational needs of each stakeholder group as well as identify the most vital content that needed to be addressed in each stakeholder group's seminar. Through our research, we found that the most common concerns included education of building occupants on emergency plans, fire and smoke isolation of the lift lobby and shaft, collaboration among members of the design team, and emergency back-up power generators for the lift. The concerns that were identified were organised into four categories and used to structure the seminar series. These categories included building design, lift systems, evacuation planning, and building maintenance.

Based on all the data collected, as well as research on the building codes of Australia and other countries that use evacuation lifts, we developed an informed seminar series for our stakeholders for the use of evacuation lifts. In this seminar, we focused on the relevant information for each stakeholder group regarding the building's design, the lift systems, evacuation planning, and building maintenance. Many stakeholders are primarily involved in building design and construction, but they need to keep in mind the function of evacuation lifts over the entire life of the building if they are going to utilise them, so information on maintenance is provided for all stakeholders. A main focus of the seminar series was the need to take a holistic approach to the building design when evacuation lifts are included. Evacuation lifts will affect all of the emergency systems in a building, so the emergency systems as a whole need to be considered during the design phase. The seminar also focused on the parallel development of evacuation plans and building designs by a multi-disciplinary team, as recommended by the handbook.

Misconceptions we encountered through our interviews were also addressed so that all stakeholders are aware of how evacuation lifts should be properly integrated into building designs. Many stakeholders believed that lifts could be used as a replacement for fire stairwells and that lifts are never safe for evacuation. The seminar series developed by our project group will be used by Jonathan Barnett at Olsson Fire & Risk and members of the Australasian Fire and Emergency Services Authorities Council (AFAC) and The Society of

Fire Safety, Engineers Australia (SFS) to inform our stakeholders about the utilisation of evacuation lifts.

Standardisation of evacuation lifts will be an issue in Australia in the future because there are no prescriptive requirements for the incorporation of evacuation lifts into building designs. Through educational methods such as the handbook *Lifts Used during Evacuation* and the seminar series developed by our group, the ABCB will be able to better inform stakeholders of the use of evacuation lifts.

1.0 Introduction

One of the greatest challenges for a building designer is to ensure the safety of the occupants during an emergency situation. In order to advise and standardise the design of safe buildings, organisations such as the ABCB and National Fire Protection Association (NFPA) were created in Australia and the United States, respectively. The purpose of these organisations is to inform building designers and engineers of the structural requirements that must be incorporated into a building's design in order to ensure the safety of the occupants (ABCB, 2013a; NFPA, 2013).

In many countries, there is currently a push to include lifts in building evacuation strategies. It is believed by many experts, and has been demonstrated in many evacuation simulations, that egress time could be significantly decreased in high-rise buildings if lifts were incorporated into evacuation strategies (Bukowski, 2005). Lifts could not only improve emergency evacuation for all high-rise buildings, but also provide benefits to individuals who are physically unable to descend multiple flights of stairs safely or independently. Building occupants with disabilities are currently hindered in their abilities to safely evacuate a multi-storey building during an emergency and must rely on others for assistance during egress (ABCB, 2013b). Including lifts in egress strategies would provide equity to persons with disabilities to ensure that buildings comply with the Disability Discrimination Act (DDA). The ABCB has "has progressively enhanced its access provisions with equity being the principle," but it has been difficult to mandate egress provisions because egress is highly dependent on management and the given situation (ABCB, 2013b, pp. 2-3). In order to ensure the safety of all building occupants, Australia has moved to incorporate lifts into their evacuation strategies to address this issue.

In May 2013, the ABCB is releasing a new performance requirement called DP7 that will permit the inclusion of evacuation lifts into all buildings that utilise lifts (ABCB, 2013b). If evacuation lifts are to be used as part of an egress strategy, DP7 specifies considerations to be made for their use. This is an unprecedented move in building designs for Australia because no measures have previously existed for the regulation of evacuation lifts. In the US and the UK, building codes that address egress of persons with disabilities during emergencies have already been implemented in building designs. In the US, the use of lifts and evacuation chairs are permitted to facilitate emergency egress for persons with disabilities (NFPA, 2002). Several other countries permit the use of lifts for evacuation,

including Australia, but there are no prescriptive guidelines that govern the use of these evacuation lifts. As a result, the ABCB developed a handbook, *Lifts Used during Evacuation*, to provide stakeholders with more information on how to appropriately incorporate lifts into egress strategies. Disability advocacy groups and building occupants will also be affected by DP7 but are not involved in the design process. The education of these stakeholder groups will be important in order to address issues and misconceptions surrounding the use of evacuation lifts once DP7 has been implemented.

Olsson Fire & Risk, a fire engineering consulting firm based in Melbourne, Australia, collaborated with the ABCB, AFAC, SFS, and Worcester Polytechnic Institute (WPI) to address the educational needs, concerns, and misconceptions that stakeholders may have regarding the use of evacuation lifts in new building designs. Some concerns included technical limitations of lifts and integration of lifts into building evacuation plans. To ensure that stakeholders comply with the new building codes, we developed an educational seminar series that effectively conveyed information on the new emergency egress building code provision for passenger lifts (DP7) and that addressed stakeholders' needs and misconceptions regarding the use of evacuation lifts.

2.0 Literature Review

In order to optimise evacuation time in buildings during emergencies, different strategies of egress have been considered in addition to the use of stairs. As lift technology has developed and buildings have increased in height, support for the inclusion of evacuation lifts has grown in order to supplement stair use. Lifts are not to be used as a replacement for stairs; rather, they can serve as an additional option to allow occupants to evacuate buildings more quickly. Furthermore, the use of lifts is meant to provide a means of independent evacuation for persons with limited mobility.

The new performance requirement that was released in May 2013, DP7, permits the inclusion of evacuation lifts for occupant evacuation in all buildings that have passenger lifts. Prior performance requirements are elaborated upon later in this chapter to provide a context for the changes and ways in which DP7 will affect building design and evacuation strategies. An educational seminar series was created to inform our stakeholders of the new code and to address any educational needs, concerns, and misconceptions that stakeholders had about evacuation lifts. Our stakeholders included engineers, architects, building managers and owners, fire services personnel, and building surveyors. Through the use of an educational seminar series, proper implementation of DP7 can be facilitated.

2.1 Egress

To clarify the terms used in this paper, evacuation and egress, it was important to look at their definitions. ‘Evacuation’ is “the temporary movement of people and their possessions from locations threatened by... fire” (NFPA, 2008, p. 206). ‘Egress’ is defined in code 3.3.136 of the Life Safety Code Handbook as “a continuous and unobstructed way of travel from any point in a building or structure to a public way consisting of three separate and distinct parts: (1) the exit access, (2) the exit, and (3) the exit discharge” (Coté, 2003, p. 25). Egress is a more specific term that refers to an exit strategy that enables occupants to leave the building and allows for regulation of the building structure related to occupant departure. The legislation put forth to protect persons with disabilities in the DDA, as well as established methods of egress, were investigated to provide insight into the reasons for the implementation of DP7.

2.1.1 Egress in High-Rise Buildings

In an emergency situation, it is common practise to evacuate the building or to move occupants to an area of refuge. Refuges are locations where occupants, specifically the mobility-impaired, have a safe place to wait before they are removed from the building by emergency services personnel (ABCB, 2013b). Building occupants often resort to using stairs and are discouraged from using lifts during emergencies. However, the Fire Safety Engineering Group (FSEG), an organisation at the University of Greenwich, stated that the construction of increasingly tall high-rise buildings and the World Trade Centre attacks have "cast doubt over the capability of such buildings to provide adequate simultaneous full building evacuation using stairs alone" (M. Kinsey, Galea, & Lawrence, 2012). Their modelling analyses have suggested that stairs are not designed for full simultaneous evacuation. In addition, depending on the exact building configuration, "there is a maximum number of floors above which it is not practical to evacuate a high-rise building by stairs alone" (M. Kinsey et al., 2012). While many are considering the use of lifts as a secondary egress measure to evacuate the general population, the use of lifts for emergency evacuation is not a new concept for fire personnel and persons with disabilities (Bukowski, 2005). Currently, fire personnel utilise lifts to evacuate persons with disabilities from areas of refuge during fires. This strategy, however, has its own risks because refuges can only be protected from fire and smoke contamination for a limited time. The use of evacuation lifts has been explored because it can provide an independent means of evacuation for persons with mobility impairments.

2.1.2 Egress and the Disabilities Discrimination Act

The first edition of the Disabilities Discrimination Act (DDA), enacted in 1992, was meant to "eliminate, as far as possible, discrimination against persons on the grounds of disability in the areas of: work, accommodation, education, [and] access to premises" (DDA, 1992, p. 28). The 1992 version of the DDA prevented persons with disabilities from being treated unequally in the workplace and required that "reasonable accommodations" be made. The legislation was too vague and did not specifically require that service providers make their facilities accessible to all potential users of their building. To resolve some issues encountered, amendments were made to Section 23 of the DDA in 2009 to prevent discrimination against persons with disabilities in relation to means of access to building premises (DDA, 2009, p. 22). In order to meet the requirements of this modification to the

DDA, ramps and lifts were integrated into design plans of buildings that did not provide reasonable access for persons with disabilities. This modification to the DDA legislation ensures that persons with disabilities have access to buildings, but did not specify a need to provide equitable means to evacuate a building. Persons with mobility impairments must currently rely on other building occupants or emergency services personnel to ensure that they are able to evacuate during an emergency.

The lack of independent egress methods is a large concern for persons with disabilities. Current evacuation measures, such as the use of refuges or evacuation chairs cause persons with disabilities to rely on others for aid during their evacuation, causing a disparity in treatment. Disability advocacy groups have been fighting since 1981 to ensure that persons with disabilities are treated equally (PWdWA, 2012). In order to provide equitable treatment to persons with disabilities, an effective and independent method for egress must be established. In the past, egress in Australia has been focused on the utilisation of stairs as the primary means of evacuation, particularly in the case of fire. Many of the ABCB's past provisions, DP4, DP5, and DP6 included specifications for egress during emergencies with considerations for the number of exits, their fire isolation, and their dimensions (ABCB, 2013b). The exits specified by these provisions are typically fire-isolated stairwells, which are not accessible by all people. To address this problem, the ABCB has moved to include the use of lifts in evacuation strategies. Evacuation lifts have the potential to not only improve evacuation time for all building occupants, but also allow safe, independent means of evacuation for physically impaired individuals.

2.2 DP7

The ABCB's most recent handbook, *Lifts Used during Evacuation,* to be released in May 2013, addresses issues that will result upon the addition of DP7 to the BCA. DP7 is a new performance requirement which will permit the use of evacuation lifts in emergency strategies and discusses a number of considerations that must be made in their design. Similar to DP4 through DP6, DP7 specifies that the evacuation lift designs should be appropriate to the travel distance to the exits/lifts, the mobility of occupants, the number of storeys connected by the exits/lifts, and the function of the building (ABCB, 2013c, pp. 175-176). This is an unprecedented step for Australia. The International Code Council (ICC), based in the US, has previously permitted the use of lifts for general evacuation, provided that they were incorporated into evacuation protocols for a building, but this is the first time that

Australia has incorporated a building regulation to address the use of evacuation lifts (ABCB, 2013b).

DP7 states that "where a lift is intended to be used in addition to the *required exits* to assist occupants to evacuate a building safely, the type, number, location, and fire-isolation of the passenger lift must be appropriate" (ABCB, 2013c, p. 176). This means that DP7 is only relevant for buildings where lifts are meant to be included in a building's evacuation strategy. DP7 also states that lifts are to be used in addition to other egress methods; they are not a replacement for a traditional exit method, such as stairs. The goal of this addition to the BCA is for persons with mobility-impairments to be able to evacuate safely and independently while also improving evacuation efficiency for all building occupants.

Among the considerations for the lift's design, as stated in DP7, are the fire safety systems of the building, the function of the building, and the travel distance of the occupants to the lift (ABCB, 2013b). DP7 also states that all buildings with lifts can have three different types of lifts, including passenger lifts, emergency lifts, and evacuation lifts, and that lifts can serve multiple purposes (ABCB, 2013b). This means that an evacuation lift could be used on a regular basis as a passenger lift. Emergency lifts are designed for emergency services personnel to utilise during emergencies, and evacuation lifts are designed for occupant use (ABCB, 2013b). If buildings employ multiple evacuation measures, the inclusion of a lift capable of egress does not necessitate its use. In this way, DP7 does not require that lifts be used by every individual. It simply permits the use of lifts when it is practical. Occupants may abstain from using lifts and choose an alternate egress method, should they be apprehensive.

2.3 Performance-Based Approach

Previously, prescriptive codes have been used to address issues concerning the design of buildings and facilities. Prescriptive codes consist of quantitative requirements and do not allow for flexibility in terms of materials or designs for building construction. In contrast, the performance-based approach to building codes is the "practice of thinking and working in terms of ends rather than means" (Foliente, 2000, p. 14). Performance-based codes are more flexible and cost-effective than prescriptive codes as they consist of broad performance requirements that must be met in order to achieve specific goals. With these codes, designers can be more innovative and synthesise Alternative Solutions to solve problems that arise

during unique circumstances such as emergency egress of occupants, particularly of persons with disabilities. The performance-based approach is utilised in many of the countries whose building codes are presented below. These countries include Australia, the UK, and the US. DP7 is the newest addition to Australia's performance-based building codes included in the BCA.

2.3.1 Deemed to Satisfy Provisions and Alternative Solutions

The ABCB annually releases an updated version of the Building Code of Australia (BCA). The BCA contains a list of performance requirements related to general provisions, structure, fire resistance, access and egress, services, equipment, health and amenity, ancillary provisions, special use buildings, maintenance, and energy efficiency. In order for a building solution to comply with the BCA, it must meet the performance requirements listed within it. Compliance is determined when the building design meets Deemed to Satisfy provisions (DTS) or by formulation of an Alternative Solution which complies with the performance requirements (ABCB, 2005, p. 1). DTS provisions are building codes that have prescriptive requirements that must be met for the building to gain certification. Alternative Solutions are designs that satisfy relevant performance requirements in the BCA and are used as an alternative to DTS provisions (ABCB, 2005, p. 1). Multiple Alternative Solutions can satisfy the performance requirements for a building and therefore offer more flexibility.

An Alternative Solution must also meet compliance with assessment methods in Section A of the BCA that are used to determine if performance requirements are being satisfied. Of particular interest is A0.10 which states that for a design to satisfy the performance requirements using an Alternative Solution, the relevant DTS provisions, and performance requirements from the same section that are relevant to the DTS provisions as well as from other sections that are relevant to any aspect of the Alternative Solution must be identified (ABCB, 2011, p. 15). Although this section is not specifically related to evacuation lifts, it should be considered relevant to the creation of Alternative Solutions that will comply with performance requirements. The BCA currently does not contain any DTS building code provisions for the use of evacuation lifts during emergencies, so Alternative Solutions will need to be utilised for evaluation and incorporation of evacuation lifts into building designs. Max Murray, a disability advocate at Physical Disability Australia and part of the ABCB committee for DP7, does not believe "that we will see Australian DTS provisions for emergency egress in the short term. Performance requirements will first need to be fine-tuned

and developed." As a result, it was important to stress the relevance of performance requirements in our seminar series.

Alternative Solutions can be used as long as they are found to satisfy the relevant performance requirements. These requirements include DP4 through DP6 as well as Provisions for Escape as noted in Section D1 of the NCC (ABCB, 2011). Due to the flexibility and open interpretation of Alternative Solutions, they may not address all of the issues and misconceptions surrounding the use of evacuation lifts during emergencies. The lack of consistent guidelines for the use of evacuation lifts is one of the reasons that the ABCB has moved towards including evacuation lifts in the BCA. DP7, the new performance requirement which addresses the use of evacuation lifts, is a small stepping stone to developing DTS requirements that can regulate the use of evacuation lifts. Very few buildings in Australia have attempted to utilise evacuation lifts. Consequently, many misconceptions exist surrounding the development of lift evacuation strategies and building design that have not been considered by design teams. DP7 is a performance requirement that comments on the need to construct a lift whose "type, number, location, and fire-isolation... [are] appropriate" to various characteristics of the building and its occupants (ABCB, 2013c, p. 176). Some of the performance requirements that may be relevant to the construction of these lifts could include AS 1735, C2.10 Separation of lift shafts, C3.10 Openings in fire-isolated lift shafts, and Section E3 Lift Installations (ABCB, 2011).

Currently, the assessment of Alternative Solutions is subject to broad interpretation (Personal Communication, Soylemez, Mar. 20, 2013). When Alternative Solutions are used, building surveyors and fire safety engineers are responsible for evaluating whether the building design satisfies the relevant performance requirements. Once the building design has been produced, building surveyors along with the remainder of the design team consult a fire safety engineer. The fire safety engineer then compiles a report which assesses whether or not the design meets the performance requirements listed in the BCA (Personal Communication, Soylemez, Mar. 20, 2013). Provided that the design satisfies the performance requirements, the building surveyor will approve the design. In the absence of consistent guidelines such as DTS provisions, building surveyors have only been able to certify the incorporation of evacuation lifts by utilising Alternative Solutions, which are less regulated and more open to interpretation than the strict DTS provisions (Personal Communication, Soylemez, Mar. 20, 2013).

In Australia, over 30 buildings have incorporated the use of evacuation lifts into their building designs and evacuation strategies (Personal Communication, Soylemez, Mar. 20, 2013). It is possible that the Alternative Solutions that were used to meet compliance with the BCA could be interpreted in multiple ways. Consistent guidelines that address the use of lifts will be necessary to ensure that incorporation of these lifts in building designs is done properly. Lifts need to be safe for occupant use and effective in evacuation.

2.3.2 Performance-Based Approach and DP7

DP7 is a performance requirement that will need to be considered in building designs and evacuation procedures of buildings that utilise evacuation lifts. DP7 outlines the need to make consideration for the fire safety systems of the building, the function of the building, and the travel distance of the occupants to the lift (ABCB, 2013b, p. 18). There are no DTS requirements for evacuation lifts, but some of the design considerations are outlined in DP7. The handbook, *Lifts Used during Evacuation*, states that the evacuation and emergency lift functions may be incorporated into the passenger lift so that one lift may perform all three functions (ABCB, 2013b, p. 19).

Strategically, adding lifts to evacuation strategies can be very difficult. During an emergency situation, such as a fire, people may behave irrationally. People are affected by their familiarity with building layouts and will try to exit by the same means they entered (Kobes, Helsloot, de Vries, & Post, 2010). This can be particularly dangerous in high-rise buildings where people typically enter the building by lift. Using online surveys, M.J. Kinsey and his colleagues at the FSEG in London found that 10% of occupants on any floor would be willing to wait for a lift and up to 80% of occupants would wait for a lift on the highest floors of a high-rise building (M. J. Kinsey, 2010, p. 6). When occupants are on increasingly higher storeys, they have been found to be willing to wait longer for lifts (M. J. Kinsey, 2010). This presents a strategic issue during evacuation because more people are willing to wait for a lift rather than use their valuable time to exit via the stairs.

Another strategic issue to lift use was determining who should use the lift during an emergency. Many people have silent or invisible disabilities, such as heart conditions or asthma, and may not be healthy enough to safely descend multiple storeys using the stairs. If up to 80% of the occupants are waiting for the lift on that floor, it would be impossible to ensure that these individuals, as well as the mobility-impaired, get priority for lift evacuation.

In an emergency, it is also a concern that different conditions that affect mobility, such as obesity, pregnancy, and even carrying small children, can increase one's evacuation time. To address these concerns, the ABCB has added provisions to their handbook, *Lifts Used during Evacuation*, in Sections 5 and 6 that include suggestions on the incorporation of lifts into evacuation plans. Without addressing key issues and misconceptions with the use of evacuation lifts during emergencies, evacuation lifts may not be a safe alternative for emergency evacuation. Additional considerations will be necessary to ensure that lift designs are safe to use during emergency evacuations. A holistic view of the building, including the lift, fire safety systems, and communication systems, is necessary to ensure that lifts are properly integrated into the evacuation plans of a building.

2.4 Building Codes

To understand the changes to building codes for the inclusion of lifts in egress, it is important to understand existing building codes. The building codes of Australia, the UK, and the US are overviewed below to provide a background of lift use in evacuation.

2.4.1 Australian Codes

By comparing existing Australian codes, DP7 and current international codes, one can understand the changes that DP7 will cause. Of note to this project is guideline GL-31, produced by the MFB, which concerns the use of lifts for evacuation. It is a guideline, not a requirement, that was created to inform operational crews of the issues related to evacuation lifts. The guideline "considers the design, construction, commissioning, maintenance and management of lift systems for the full life cycle of a building" (MFB, 2010a, p. 1). While this guideline is not binding, it contains recommendations that the MFB has written for design teams and fire engineers for the incorporation of evacuation lifts into building designs and evacuation procedures. While the MFB supports equitable evacuation opportunities for all occupants, it believes that "lifts for evacuation should only be considered within fully sprinkler protected buildings...to complement an evacuation strategy that concurrently considers the use of fire isolated stairwells as a means of egress" (MFB, 2010a, p. 1). Concurrent use of stairs and lifts during an evacuation is necessary as lifts are limited or cannot operate during certain situations, such as mechanical damage, overloading, repair, or insufficient power. This means that a building cannot solely rely on lifts to be used for evacuation. The guideline continues, listing 23 general concerns regarding the construction of

lifts and their implementation as a secondary egress measure. These concerns state that lifts should be implemented where proper safety measures and redundancies are in place, such as sprinklers and fire systems, including alarms and communication systems. Concern 22 stated that "regular scheduled training and familiarisation exercises for those who are expected to use the lifts in a fire situation (including occupants, fire fighters, etc.) must be provided for the life of the building" (MFB, 2010a, p. 3).

While GL-31 is only a guideline, it set the stage for DP7 by providing suggestions for lift use during evacuation. These considerations and concerns particularly impact lift engineers, building managers, and fire personnel. Lift engineers will need to conform to stricter standards in order to prevent smoke and water infiltration, prolonging the functionality of the lift in the event of a fire. Building managers have to implement educational programmes for building occupants, implement a maintenance programme, and make sure fire alarms, sprinklers, and lifts are serviced and functional at all times. Wardens need to be placed by the lifts to ensure proper use and flow of persons during evacuation. Unlike GL-31, DP7 is a performance requirement that will need to be implemented if a lift is to be used for evacuation, and there may be opposition due to the increase in responsibilities and design requirements (MFB, 2010a, pp. 3-5).

2.4.2 International Building Codes

In considering the implementation of DP7 in Australia, it was beneficial to consider building codes from other countries. From this analysis, it was possible to understand the approaches that other countries have made in regards to the issue of lifts and the challenges that may be encountered regarding the lift performance requirement specified in DP7.

In the UK, there is a series of "Approved Documents" that relate to approved building solutions. Approved Document B requires that high-rise buildings employ phased evacuation and can operate without one exit stairway to prevent congestion once emergency services arrive. In addition, the document requires the inclusion of a protected lift dedicated to emergency response services. The design teams incorporate the recommendations of the British Standards (BS) 9999 series. This code includes a section on designs which incorporate evacuation lifts, including lift power supply, lift maintenance, control functions, and the construction of the surrounding area (ABCB, 2013b, p. 61). It states that "where any part of the control mechanism is powered by electricity, a secondary supply should be provided"

(BSI, 2008, p. 125). Maintenance also needs to ensure that all components are operating at the recommended level. Access to the lift should be protected by a lobby which is provided with facilities for smoke control and emergency lighting. The lobby should also be of sufficient size to allow fire personnel to use it as a control centre and to lay out their equipment.

The BS9999 has expanded on the evacuation of persons with disabilities and "advocates the use of evacuation lifts to allow all occupants, regardless of their level of mobility, to self-evacuate without reliance on others for their safe evacuation" (FSC, 2008, p. 3). UK legislation also requires that persons with disabilities complete a Personal Emergency Evacuation Plan (PEEP). In addition to recording an individual's plan, such as escape routes and safe areas, it identifies persons who will aid them in escaping. This plan also "proposes the use of emergency lifts and safe refuges that are protected from fire" (ABCB, 2013b, p. 61). The goal of the UK's PEEP is to allow persons with disabilities to determine a personal plan of escape with other colleagues and have control over their own egress.

In the US, measures have been made to include the use of passenger lifts in the evacuation systems. As early as 2002, the National Fire Protection Agency (NFPA) supported lift use during emergencies. As part of measure 5.2.13.1 within *Code for Means of Egress for Buildings and Structures*, lifts could be used as a means of egress from high-rise buildings if an evacuation plan was created to include the lift's use, with personnel trained in the operation of its use during emergencies (NFPA, 2002, pp. 101 B-129). The same handbook also included a provision for the use of an Elevator Evacuation System in code 3.3.25, which specifies that the system must provide protection from fire effects for passengers, lift equipment, and people waiting for lifts (NFPA, 2002, pp. 101 B-108). Another governing body, the ICC, is widely followed in the US. The ICC's International Building Code 2012 contains many provisions for egress. Of note is section 3008, which allows the public service lifts to be used to evacuate high rise buildings (ABCB, 2013b). This is not a requirement, as there are safety concerns associated with using lifts for evacuation, but the option presents an additional means of egress.

Additional codes from the NFPA5000 2012 and the NFPA 101 Life Safety Code 2012 provide information on this organisation's stance on the use of lifts. Prior to smoke detection, lifts could still be used for evacuation. Once smoke is detected in the lift shaft, lobby, or

machine room, the lifts are recalled. Kristin Bigda, Senior Fire Protection Engineer at the NFPA argued that until smoke is detected, occupants may still use lifts to safely evacuate (Personal Communication, Feb. 1, 2013). Currently, lifts are not advocated as a safe method of evacuation once smoke has been detected due to safety concerns for the lift occupants. One concern involves the stack effect. If the lift is not properly sealed from smoke, then the thermal differences and height of the building will drive smoke and heat into the shaft, converting it into a veritable oven (Personal Communication, Fraser, Feb. 1, 2013).

Presently, the US and UK advocate for the use of passenger lifts during evacuation and already employ them. In terms of evacuation development, the inclusion of lifts will be a step forward for Australia. As Robert Solomon, Head of the NFPA explained, it is safe and permissible to use lifts until smoke is detected, but buildings should always have redundancies and alternate evacuation measures in the case of lift failure (Personal Communication, Feb. 1, 2013). This is why evacuation lifts are to be used in addition to building exits and not as a replacement for fire stairs.

2.5 Disadvantages of Evacuation Lifts

One similarity among these countries' current policies is that none of them require the use or inclusion of lifts. There are two primary reasons for the opposition toward using lifts: technical problems associated with lifts and issues with human behaviour during emergency evacuations.

On the technical side, there are many safety concerns associated with lifts. Lifts are not normally smoke-tight, proper lobbies need to be created for the lift, and designers need to implement structural support, failsafe options, and redundancies (ABCB, 2013b, pp. 24, 37). Allan Fraser, Senior Building Code Specialist at the NFPA noted that there is no scientific or mathematical data currently available from a realistic situation that proves that lifts will improve emergency egress. Computer models of evacuation using lifts, such as those published by Ed Galea at the University of Greenwich, show that lifts do improve egress, but models often do not appropriately account for the behaviour of occupants. Traffic studies of occupants in real situations will be needed to determine if Galea's and other computer models are accurate. In addition, lifts take up valuable space, need to be maintained, and are not as smoke-tight as stairs. As a result, lifts are not at a level where they can be as reliable as stairs, so lifts are not a suitable replacement (Personal Communication, Fraser, Feb. 1, 2013).

Human behaviour is a key factor that must be considered when designing an evacuation lift. The number of people that are willing to wait, the length of time they will wait, and the number of people who are unable to use stairs, such as asthmatics and the mobility-impaired, are all important factors to consider for effective lift use. A survey conducted by the Fire Protection Research Foundation (FPRF) found that fatigue may cause an additional delay and that it slows the evacuation of occupants with disabilities (Ronchi, 2013, pp. 17-18). In order to combat fatigue, lifts may provide a suitable addition to stairs as a method of egress.

The FSEG also conducted studies on the use of lifts for egress. They found that increasing numbers of lifts greatly reduced evacuation time when coupled with stairs or sky lobbies. A sky lobby is an intermediate interchange floor where lifts stop. In high-rise buildings that do not contain sky lobbies, those who want to reach higher levels may have to stop at every floor and face increased travel time. Sky lobbies can access local lifts that stop at every floor as needed but also express lifts that shuttle occupants between the ground floor and sky lobby. This allows access to higher floors with little wait time. However, this study found that some occupants would opt out of using a lift, despite the increased evacuation efficiency that it offers. This is due to general apprehension about the use of lifts, congestion in the wait area, or the wait time (M. Kinsey et al., 2012). The issue then becomes a matter of how long a person is willing to wait and whether, relative to the building configuration, that wait is ultimately worthwhile.

Evacuation lifts require different programming than passenger lifts and are difficult to isolate from all of the products of combustion that may be experienced during fires. This would require lift engineers to operate under tighter regulations. Building owners would have to spend more money to install and maintain these lifts, lose valuable space that could be used for other purposes, and make sure the lifts remain serviced and are properly used (Personal Communication, Solomon, Feb. 1, 2013). While lifts would be able to aid in emergency egress, there is understandable opposition coming from building owners and lift engineers. This opposition must be overcome in order to effectively implement lifts for egress.

2.6 Implementation of DP7

The purpose of DP7 is to provide an additional egress method during an emergency through the use of lifts, particularly for use in high-rise buildings and for the disabled community. Incorporation of evacuation lifts into building designs, as specified by DP7, will include the considerations of those "with varying types of disabilities and health conditions," as well as the function of the building and emergency procedures for the building (ABCB, 2013b, pp. 18-19). Since DP7 does not provide prescriptive requirements for the use of evacuation lifts, the proper implementation of this building code will be a challenge.

The establishment of DP7 will be an important measure towards ensuring the safety of occupants during evacuation and aiding the independent egress of persons with disabilities. In order to implement this code, it will be necessary to properly educate stakeholders on its standards and address any concerns and misconceptions that they may have.

2.6.1 DP7 and the ABCB Handbook

The handbook, *Lifts Used during Evacuation*, will be the primary resource available for stakeholders to use in order to educate themselves on the implementation of DP7. Section 5 outlines the need for management systems in order to guarantee the effectiveness of the program. Challenges to implementation have been found to not only come from the design and construction of lifts, but also the development of effective evacuation strategies.

The handbook considers the use of lifts for all building occupants and use of lifts for only persons with disabilities. It acts as a resource to enable building managers, engineers, and designers to develop a building with egress strategies using lifts before construction begins. The handbook advises that the evacuation strategy, Fire Engineering Brief (FEB), and building design be developed by a multi-discipline "team including a fire safety engineer, a mechanical services engineer, a lift engineer, a BCA expert, an emergency planning expert, and an access consultant" (ABCB, 2013b, p. 29). Early in the design phase, the strategy document should be developed as part of the Alternative Solution document and be used to inform the emergency plan. The strategy document is a preliminary document that outlines the paths that should be used for evacuation. The design report developed by the team should demonstrate in qualitative terms how the proposed design and systems meet the performance-based requirements of the BCA. Design considerations for the building should include safety systems, the number of occupants, building configuration, integrity of passive provisions, lift

operation systems, smoke management systems, and power systems (ABCB, 2013b). Once the building has been constructed, a traffic study should be conducted to ensure that management practises for the building are effective. The design report for the building should include studies to document the safety of the lift and ensure that system failures have been investigated. These studies include cause-and-effect matrices, decision analysis, risk analysis, a Hazard and Operability (HAZOP) analysis, and reliability or availability analysis.

Section 6 of the handbook goes on to include additional specifications for lifts if they are to be used for egress. Among its measures, Section 6 specifies considerations that must be made for the construction of lift landings, including sufficient manoeuvring space and door clearance, methods to protect the lobby and lift from smoke, signs indicating the lifts that may be used, and separate fire and smoke alarms to ensure that lifts can be controlled as long as it is safe for them to be used (ABCB, 2013b, pp. 40-41). Additional specifications that must be taken into consideration include measures to ensure the safety and integrity of the lift shafts. These measures include protection of the lift from fire, isolation from water contamination by sprinklers, and management of operating temperature. Considerations also need to be made for smoke management, as well as power and air supply to ensure lift safety.

In theory, utilising lifts in evacuation strategies is incredibly useful, but using lifts in practise presents a great challenge. To ensure that persons with disabilities get lift priority, the handbook advises that wardens be utilised to manually control the lifts until the emergency services personnel arrive (ABCB, 2013b, p. 27). Wardens would also be necessary during evacuation to determine if a storey is clear of occupants. During certain emergencies, wardens and emergency services personnel may want to utilise a staged evacuation in a high-rise building and would need to direct occupants. Fire personnel would need to take control of at least one lift, limiting those available to occupants. It is specified that in order to ensure that fire personnel know how to access lifts if the lift suddenly stopped due to a power outage and occupants were trapped, that there should be instructions for the emergency services personnel on how to access lifts through landings. With the implementation of evacuation lifts, it will be necessary for both wardens and emergency services personnel to be educated on how to properly utilise lifts and help occupants evacuate from buildings.

2.6.2 Education on DP7

Educating stakeholders on the use of evacuation lifts in building design is necessary for proper implementation of DP7. In particular, building owners and managers, fire personnel, lift engineers, fire engineers, building surveyors, and architects should be properly educated on methods to identify safety issues regarding implementation of DP7.

Building owners and managers must be committed to enforcing the regulations of DP7. Assumptions made about the usage and performance of the building by the architect must also be incorporated into evacuation strategies. The programme should also include regular self-inspections of the workplace to ensure that the regulations of the code are being enforced. Most importantly, all staff in the building should be trained to identify and react to the hazards of using the evacuation lifts. Fire personnel will need to be educated on how to take control of emergency situations where lifts are used by building occupants for evacuation. Anticipating differences in building traffic and in evacuation strategies will be important for fire personnel. Fire safety engineers will need to make safety considerations for the use of evacuation lifts which include pressurisation and smoke control in lift lobbies and shafts, water isolation, and fire isolation. Architects will need to be educated on how building plans should be created from a holistic viewpoint to integrate communication systems, lift control systems, monitoring systems, and the fire interface panel. This will be essential to ensure that evacuation lift based egress can be executed smoothly. Through the proper enactment of safety education programmes that address the use of evacuation lifts in emergencies, evacuation efficiency will be improved and the disabled community will be granted an independent method of egress.

3.0 Methodology

The goal of this project was to develop an educational programme that effectively conveyed information on the effects of evacuation lift usage on building designs and emergency strategies, as outlined in DP7, and issues that could arise during the utilisation of evacuation lifts. We used interviews to inform the development of an educational programme by following these objectives:

1. Identified key informants' and disability advocates' concerns related to DP7 and content that needed to be addressed in the educational seminar series.
2. Identified stakeholders' needs, concerns, and misconceptions regarding the use of lifts in evacuation.
3. Developed an informed seminar series to instruct stakeholders on methods to properly implement DP7, while addressing the changes that will affect the building design and planning of emergency strategies as well as concerns regarding the limitations of the new code.

3.1 Viewpoints of Key Informants, Stakeholders, and Disability Advocates

In order to understand the concerns of various groups of key informants and disability advocates, it was important to uncover their opinions related to lift use during emergency evacuations. This was accomplished using two strategies: single and group interviews. The differences in interview styles were dependent upon the availability of the interviewees. A group style was utilised when we interviewed a group of stakeholders at a single company or agency. The information obtained was used to determine the educational needs of stakeholders and to determine relevant information that needed to be included in our educational seminar about the use of evacuation lifts. Key informants, stakeholders, and disability advocates were identified based on a respondent-driven technique due to our lack of familiarity with many of our informants' fields.

Responses were recorded with a LiveScribe pen and by a note-taker. Responses to interview questions were also recorded using emails depending on the key informants' availability. A list of concerns was generated based on a content analysis of the notes and interview transcripts. The concerns of multiple key informants obtained were then compiled, analysed to determine gaps in knowledge of the building design process and development of

evacuation strategies, and used to create a survey for stakeholders. Implied consent was utilised for the interview process and the key informants were debriefed at the end of the interview. If any information presented was controversial, the interviewee's identity remained confidential, or data were deleted if necessary.

3.1.1 Key Informant Interviews

Interviews were conducted with key informants, both in the US and in Australia, with the purpose of determining issues related to the use of lifts during evacuation. One-on-one interviews as well as group interviews were conducted with these key informants to identify their overall concerns regarding specifics in the building code and effectiveness of the strategy to safely evacuate all building occupants. Semi-structured, open-ended interviews were utilised to obtain this information.

The key informants that were interviewed are listed, with a description of their areas of expertise, in Appendix 1. The interview questions for each key informant are listed in Appendix 2; however, we modified the content of interviews and the order of questions depending on the stakeholders based on their area of expertise and research, consistent with the semi-structured interview approach. Additional informants were identified using Jonathan Barnett's contacts and a respondent-driven technique, asking the interviewees for additional contacts that we could engage with (Heckathorn, 2011). We chose this method due to the small number of key informants that are available for us to interview. Few professionals have experience with the use of evacuation lifts since their use during fires is not common. As a result, the sampling frame was not represented properly since references that we obtained from key informants were based on other stakeholders that our referrer knew. This directed us in a particular way and may have excluded other key informants from being interviewed. We interviewed 20 key informants involved with fire protection and evacuation of high-rise buildings.

3.1.2 Interviews with Disability Advocates

To investigate concerns that persons with disabilities had with the use of evacuation lifts, we conducted interviews with representatives of the disabled community. Again, we employed a respondent-driven sampling strategy in order to obtain contact information of disability advocacy groups. Contact information for different advocacy groups was collected from the Physical Disability Australia (PDA) website (Heckathorn, 2011). This strategy was

appropriate for multiple reasons. First, we were unfamiliar with the disabled community in Melbourne and unsure if we would be able to connect with disabled individuals during organised community and social gatherings. Second, while the implementation of DP7 directly impacts the disabled community, we did not feel that it would be ethical to single out individuals because of their disability status. The respondent-driven sample strategy allowed us to reach out to disability advocacy groups who were already aware of our efforts (through WPI contacts). While this strategy may have excluded certain individuals and their opinions, our concern was to acquire the range of opinions rather than to quantify how frequently those opinions were represented in the disabled community. The interview questions are listed in Appendix 3. We interviewed 4 disability advocates, and interviews were conducted until a point of diminished returns was reached.

3.1.3 Stakeholder Interviews

In order to understand the educational needs of various groups of stakeholders, it was important to talk to them and evaluate their knowledge of evacuation lift use. Interviews were conducted with stakeholders that would be directly impacted by the changes in building design process and planning of evacuation strategies resulting from the implementation of DP7. The interviews were conducted in Australia to obtain an understanding of the knowledge that stakeholders such as architects, building designers, building surveyors, and building managers, needed to know in order to implement DP7 properly. Interviews were conducted primarily to assess the current knowledge of lift use in evacuation and building design. It was important to know if stakeholders understood the current performance-based codes for lifts or if there were gaps in their comprehension of the building codes as they relate to evacuation procedures. It was also important to determine the relevant information for each stakeholder in order to develop the seminar series. The assessment procedures for groups of stakeholders are shown in Appendix 4.

Initial contacts were obtained through a respondent-driven technique, asking key informants for contacts that may not currently know about DP7. All stakeholders were asked if they knew someone else in the field that we could talk to because we did not know many individuals in these fields. Initial contacts were also found using contacts from the appropriate union or website database for each stakeholder group. Modified grounded theory was utilised to identify driving causes of conflict with the implementation of DP7 (Strauss, 1998). Multiple interviews, at least 3 for each stakeholder category, were conducted.

3.2 Determination of Top Stakeholder Concerns

Once we collected the concerns of both stakeholders and key informants, we conducted a survey to determine which were most important for each stakeholder group. A 3-question Google survey was designed, shown in Appendix 5, and was emailed to all stakeholders that were interviewed as well as many that we were unable to contact through other means. The stakeholders selected their top 5 concerns and had the opportunity to fill out any additional concerns they had that were not listed. The survey was sent out over email to over 130 stakeholders overall, and the email had a message asking them to forward the survey on to anyone else that the participants believed would be interested, so the survey likely reached more than the original 130 stakeholders. The frequency of the top concerns of each stakeholder group was analysed and quantified. The most frequent concerns were considered key to the development of our educational programme and highlighted in the seminar.

3.3 Development of an Educational Programme

After we had gathered information related to the educational needs of stakeholders and their misconceptions regarding the implementation of evacuation lifts, we used it to create a seminar series that communicates the changes in building design and evacuation planning caused by the adoption of DP7. Our information allowed us to understand what needs, concerns, and misunderstandings needed to be addressed in the programme to provide the necessary knowledge to the stakeholders so that the implementation of DP7 would be effective. In order to achieve this, the information acquired from research and interview methods needed to be analysed. Once we understood the concerns related to the adoption of DP7, we determined a structure for the seminar to address all concerns, attend to any educational needs, and to resolve any misconceptions related to the use of evacuation lifts. The seminar series was developed in a PowerPoint format for ease of access.

4.0 Results

In the first phase of our research project, we informed ourselves of the issues that each stakeholder group should be aware of and what issues each particular group needs to be knowledgeable about. This phase was conducted by reading primary literature and interviewing key informants. Top concerns of key informants were identified and used to develop interview questions for stakeholders that would allow us to evaluate their knowledge and any misconceptions that they had about evacuation lifts. The concerns identified were also used to create a survey for our stakeholder and identify their top concerns quantitatively. In order to compare the current knowledge that each stakeholder has and what each group needs to know and be aware of, we constructed Venn diagrams using the results from our survey and interviews. The Venn diagrams were then used to guide the curriculum of the seminar series for each stakeholder group in order to address the issues stakeholders have related to DP7.

4.1 Concerns of Key Informants

In this section, the concerns raised by key informants are discussed. These concerns were grouped into four different categories: building design, design and protection of lift systems, evacuation planning, and building maintenance. These concerns are listed and described in depth below.

Building Design:

- Removal of the second fire-isolated stairwell in buildings over 25 metres in height
- Holistic approach to development of building designs and evacuation plans
- Sprinkler protection throughout building
- Pressurisation of lift lobbies, lift shafts, and exit stairwells
- Lift lobby needs to be appropriately sized for building type, function, number of occupants, and traffic flow
- Considerations for persons with disabilities

Design and Protection of Lift Systems:

- Lift car should be appropriately sized for the number of occupants and accommodate equipment for persons with disabilities
- Smoke, heat, and fire isolation of the lift lobby and shaft
- Water isolation of the lift lobby and shaft

- Back-up power supply for evacuation lift
- Communication between the lift controls and the fire indicator panel
- Lift programming for evacuation protocols

Evacuation Planning:

- Education of occupants on evacuation strategies and the use of evacuation lifts
- Consistent signage indicating whether a lift can or cannot be used in an emergency
- Communication and monitoring systems
- Measures to locate building occupants, including persons with disabilities
- Considerations for human behaviour during emergencies
- Wardens to aid in evacuation of building occupants

Building Maintenance:

- Standards for consistent evaluation of evacuation lifts
- Regular maintenance of lifts, emergency systems, and lift software

4.1.1 The Building Design Process

The Deemed-to-Satisfy provision D1.2 states that buildings with an effective height greater than 25 metres **need to have two fire isolated exits**. In the past, alternative solutions that replace one fire isolated exit stairwell with an evacuation lift have been used. The MFB strongly advocates against this as removal of the second fire isolated exit stairwell will interfere with fire brigade intervention. If the second fire isolated exit stairwell is removed, building occupants will only have one fire isolated exit stairwell as an egress route and the brigade will only have one fire isolated stairwell as an access route for fire fighting. The use of one fire isolated stairwell by both building occupants and the fire brigade will generate counter flow which will increase building evacuation time.

With the integration of evacuation lifts into building designs, the evacuation plan will be impacted by multiple systems throughout the building. Evacuation lifts cannot be considered in isolation because their proper use is impacted by the communication, monitoring, fire and lift control, and interface systems. **A holistic approach to the development of evacuation plans and building design** is necessary to ensure that the building will function as an entire integrated system during evacuation. A multi-disciplinary team will be necessary in order to effectively approach building design and evacuation planning holistically. As recommended by the ABCB in the handbook *Lifts Used During*

Evacuation, the multi-disciplinary design team should consist of "a fire safety engineer, a mechanical services engineer, a lift engineer, a BCA expert, an emergency planning expert and an access consultant" (ABCB, 2013b, p. 31). The design team should also take advice from the relevant fire services.

Sprinkler protection was noted as a top concern of several key informants including fire services personnel and fire safety engineers. GL-31 recommends that evacuation lifts "should only be considered within fully sprinkler protected buildings" (MFB, 2010a, p. 1). It is important for sprinklers to be used in buildings in general to provide a means to quickly manage fires before the arrival of fire services. It is particularly important in buildings that utilise evacuation lifts because lift shafts can become a veritable chimney during fires due to the stack effect, heating up and suffering from smoke infiltration. The full sprinkler protection of buildings will mitigate the effects of the fire on the lift system.

Lift lobbies and exit stairwells should be pressurised in order to prevent smoke from spreading into the lift shaft. Pressure differentials will need to be considered between the lift lobbies, lift shafts, and exit stairwells in order to effectively manage smoke and to prevent jamming of the lift door. Jonathan Barnett, a fire engineer at Olsson Fire & Risk, explained that the lift door can become jammed when the lift shaft is pressurised but the accompanying lift lobby is not. Pressurisation of the lift lobbies and fire isolated exit stairwells will also provide occupants a safe egress route whether they choose to use the lift or the stairwell for evacuation.

Lift lobbies will need to be appropriately sized to the function of the building, number of occupants, flow of traffic, and to accommodate equipment for persons with disabilities. Lift lobbies in hospitals with a high proportion of their occupants having disabilities will need to accommodate the use of equipment such as wheelchairs that take up a lot of space. According to one fire safety engineer, the lift lobby should be able to fit all of the occupants on the storey and equipment for persons with disabilities. Lift lobby sizes should also be adjusted based on how traffic flows into and out of the lobby. The appropriate sizing of lift lobbies will ensure that occupants have a safe place within the building during an emergency evacuation.

Building designs will need to make **considerations for persons with disabilities** including those that have permanent and temporary mobility impairments, hearing impairments, visual impairments, obesity, heart problems, asthma, women in a late stage of

pregnancy, and infants. Egress strategies, like evacuation lifts, should be available for persons with mobility impairments in order to allow them an effective and independent means of emergency egress. Persons with hearing and visual impairments will need to be considered when designing alarm systems and signage for lifts. Signage that depicts the availability of an evacuation lift should be associated with audio or tactile displays to inform persons with visual impairments of the lift status. This was a recommendation by Holly Ault, a mechanical engineering professor at WPI with extensive experience on projects with persons with disabilities.

4.1.2 Design and Protection of Lift Systems

In order to ensure that the **lift is appropriately sized** to be used by occupants during emergencies, it is important to make considerations for the building's design before construction. This concern was emphasised by members of fire services and fire safety engineers because they are responsible for ensuring safe and effective evacuation of building occupants. Considerations for the size of the lift car should include equipment for persons with disabilities, the number of occupants, and the mobility of building occupants.

One of the primary concerns of all key informants was **smoke and fire isolation of the lift shaft and lobbies**. Concern for smoke and fire isolation largely stems from the stack effect, i.e. the upward movement of products of combustion through the lift shaft, which is driven by the buoyancy of the gases. The hot gases collect in the lift shaft and heat up the lift car to dangerous temperatures. Without smoke and fire isolation, lifts will not be safe for occupant evacuation. To ensure the lift's safety, several fire safety engineers suggested that the lift shaft and lobby be pressurised and that the lift shaft must remain at a temperature equal to or below 40°C. Pressurisation aids in keeping smoke out of the lift shaft and removing smoke that permeates the shaft. To aid in fire isolation, it was recommended by Johannes de Jong that lift lobbies and lifts have fire-isolated doors that remain viable for at least two hours. Occupant Evacuation Elevators (OEEs) in Europe currently require that their doors be fire isolated for at least two hours. This will protect occupants in the lift lobby and the lift car from the hazards of smoke and fire for a greater amount of time according to fire safety engineers. An increase in the dwell time of occupants in the lift lobbies will be crucial to ensuring that every last person in a building have sufficient time to safely evacuate.

Water isolation is also important, however, because during a fire, the sprinkler system is activated and the water could flow down the lift shaft. Below the lift doors, the door locks are often exposed, and if water infiltrates the shaft, the lift controls will short-circuit and the lift will be compromised. If this happened when occupants were in the lift, they could become trapped and fire services would have to perform a rescue as well as extinguish a fire. In order to provide water isolation, the floors outside the lifts can be sloped, drains can be added outside of the lift, and sprinklers can be added outside of the lift lobbies. The circuitry of the lift can also be coated with water-resistant material to prevent lift failure.

In order to ensure that lifts are functional for use during emergencies, such as when power failure occurs in a building, it is beneficial to **provide back-up power to the lifts**. Fire safety engineers from the NFPA suggested that there be back-up generators that will power the lift for at least two hours during an emergency should the building lose power (Coté, 2003). The use of backup power will be essential in ensuring that occupants do not become trapped within lifts during evacuation.

Lift programming was a top concern of our key informants. Many of them, particularly members of the fire services and lift industry, were aware that evacuation lifts need to operate differently than passenger lifts and that, as a result, they need additional programming. Instead of having the lift travel using a typical top-down strategy, evacuation lifts would be modified to prioritise the floors at risk first, and travel directly to the ground floor. If a lift continued to use a top-down strategy, it would stop at multiple floors on the way down the building and would be less efficient. When lift software is updated, the updates override previous programming, and any modifications to the software are lost. Building management is often uninformed of updates, so without regular maintenance reviews of the operating system, building management will not know that the lifts are not functioning properly. In each state in Australia, software patches must be added to the programming to comply with the state's regulations, but if building management is unaware of upgrades, they will not know when they need to re-install the patch. There is also fear that if the lift programming is not correct, the lift may also open its doors to a fire floor with a compromised lobby. If this happened, building occupants inside of the lift car would be exposed to the fire and smoke from the fire floor and be at risk. As a result, it will also be important to perform maintenance to the programming as well as to have appropriate programming for evacuation lifts.

According to Ian McWaters, a lift consultant in Victoria, most lift control systems are not connected to the fire indicator panel in buildings (Personal Communication, Apr. 10, 2013). During evacuation, emergency lifts are recalled manually by fire services for their use; they do not automatically return to the ground floor once an alarm sounds and are still available for occupant use. For fire safety engineers, fire services personnel, and building managers, this is a concern. For fire services, it increases the amount of time it takes for them to respond to an emergency if they have to manually recall a lift once they arrive. Without integration of the lift control systems and the fire indicator panel, passenger lifts continue to operate during an emergency presenting a safety risk to occupants. If the lift is not intended to be used in an emergency and it is not safe to do so, the building manager has to manually turn off the lift. In order to have an emergency lift operate safely during an emergency, it is important to have the lift control systems integrated with the fire indicator panel so that passenger lifts can be disabled and the emergency lifts can be automatically recalled when a fire is detected for use by fire services. In the future, it will be important for evacuation lifts to be integrated with the FIP so that the evacuation lift programming can be activated and the lift will prioritise the fire-affected floors.

4.1.3 Evacuation Planning

A need stressed by nearly every key informant that we interviewed was the need to **provide information to building occupants on the use of evacuation lifts and evacuation strategies** of the building. If a building occupant were to become trapped within an evacuation lift, many members in the design team and lift industry could be held accountable. Without proper education, it will be difficult to ensure that building occupants know how to use these lifts properly and evacuate safely. Our interviews with building managers revealed that education of evacuation strategies only occurred when occupants were long-term residents of buildings and were reinforced through infrequent evacuation exercises. It was also found through interviews with lift consultants that in commercial buildings, workers are typically briefed on emergency procedures during their induction at a new job, but full building evacuation exercises are rarely performed. In order to ensure that occupants know how to use evacuation equipment, such as lifts, it will be important to properly educate building occupants on the evacuation plans and have them practice travelling them during evacuation exercises. During these education sessions, building occupants should also be made aware of alternative evacuation routes that they can take should one be blocked during

an emergency. If the emergency involves a power outage or a fire and the lifts are compromised, the occupants will need a different way to evacuate. For this reason, many stakeholders were aware of the need for alternative evacuation strategies to be in place to be used in addition to lifts. Currently, evacuation chairs are used as an alternative method of egress, so it would be recommended that they still be available for persons with disabilities.

Lift signage was an important concern that we came across through our interviews. Previously, the use of lifts during emergencies has not been allowed, and people are accustomed to seeing signs in front of the lift that state "Do not use lifts if there is a fire" as stated in NCC code E3.3 (ABCB, 2013c, p. 290). Some buildings that currently have lifts available for use during evacuation provide two LED displays, one that notifies occupants that lifts are not available for use during evacuation and a second that notifies occupants that lifts are available. It is absolutely necessary for signage around the lift to be changed in order to notify occupants if lifts can be used for evacuation. It will also be important to ensure that the signage is understandable to all building occupants. Signage should accommodate Culturally and Linguistically Diverse (CALD) communities, and be designed so that they can be easily understood by all occupants, including persons with visual impairments.

Monitoring and communication systems in lift lobbies and inside lift cars will enable wardens and the fire brigade to locate occupants during an emergency evacuation. CCTVs have been suggested by Johannes de Jong, a lift manufacturer from KONE Industry, to monitor occupants. CCTVs will send important up-to-date information to the wardens and the fire brigade that may be essential during rescue and fire fighting. In order to monitor fire floors, CCTVs can be installed and linked to emergency lifts utilised by fire services personnel. The fire services personnel can then **monitor the location of occupied lift cars** in the building. Communication systems will be essential to deliver information from the fire indicator panel to the lift control system and vice versa. The use of multiple alarm systems will be important as redundancies will ensure that occupants are notified of an emergency. Sometimes when a tonal alarm is used, occupants will not respond, thinking that the alarm may be part of a drill. When verbal alarms are used, as well as intercom systems, occupants can be clearly informed that the emergency is real and that they must evacuate. Karen Boyce, a researcher at the University of Ulster, said that alarm systems with recorded voice messages are very effective at improving the response phase of evacuation (Personal Communication, Mar. 26, 2013). It was suggested by both disability advocates and fire safety engineers that

multiple alarm systems, as well as flashing lights for persons with hearing impairments, be incorporated into a building's design. Without monitoring and communication systems, occupants may become trapped in lifts and not rescued until it is too late.

One of the goals of using lifts for evacuation is to help people that cannot self-evacuate and need assistance, such as persons with disabilities. During emergencies, it is the responsibility of fire services to **locate and assist persons with disabilities** to evacuate the building. A current problem is locating occupants that are in need of assistance. When lifts are utilised for evacuation, this will continue to be a concern because persons with disabilities may be on any floor, or even stuck within a lift shaft. PEEPs are currently used in some buildings to aid in the identification of individuals in need of assistance, but not everyone self-reports, so fire services have to evacuate all floors at risk systematically to ensure that occupants are not in danger. Visitors are a concern as well because they may not know the emergency procedures of the building and they will need to be located and aided as well.

Human behaviour of building occupants during emergencies was a concern for many key informants. Rita Fahy, an expert on human behaviour at the NFPA, informed us that under most circumstances, people will behave rationally and remain calm during emergencies, but problems could result when they see the fire or have to wait for lifts (Personal Communication, Feb. 1, 2013). If occupants have to wait long periods of time for the lift to arrive at their floor, they may become anxious and attempt to push their way into the lift once it does arrive. They could also try to overload the lift, in which case the lift would be unable to leave the floor because of its capacity. During stressful situations, it will be particularly difficult to ensure that occupants who need to use the lift, such as persons with disabilities, will have access to lifts.

One way to regulate the prioritisation of evacuation lifts would be to **have wardens in place to facilitate evacuation**, as recommended by the MFB in GL-31 (MFB, 2010b). In high-rise buildings that have evacuation lifts, wardens should be responsible for controlling the lifts, aiding occupants in evacuation, and ensuring that all floors are free of occupants. Their presence would allow building management to have direct control over occupant evacuation. Most commercial buildings have warden systems, but many residential high-rise buildings do not currently have them. The concern for the residential buildings is that if there is a fire at night when most occupants are in a building, there will not be anyone present to assist them and direct evacuation prior to the arrival of fire services. Without a warden to

operate the lift, it could be difficult to ensure that the people with mobility impairments are able to access the lift and evacuate. If there are no wardens present, persons with mobility impairments have to rely on other occupants or fire services personnel to evacuate if the lifts were not available for evacuation.

4.1.4 Building Maintenance

In order to ensure that maintenance has been performed correctly, it will be important to create consistent standards to evaluate evacuation lifts. Robert Llewellyn from AFAC suggests that a baseline test be performed on every lift during its initial certification that will be used as a comparison every time that the lift is tested to ensure that it is working as it did at the time of installation (Personal Communication, Apr. 4, 2013).

In order to ensure that lifts are functioning as intended, it is important for **regular maintenance to be performed on the lift's operating system**. Maintenance testing of lifts should be rigorous, extensive, and frequent. AS 1851 requires annual interface testing of emergency systems, but does not currently cover lifts. Rob Llewellyn at AFAC recommended that this test should include all lift interfaces to ensure that the emergency systems of the building are fully integrated. In order to ensure that the evacuation lifts are functioning as intended, it is important to test all aspects of the emergency as well as lift systems. These systems include communication systems, monitoring systems, the fire indicator panel, and lift control system. Each aspect of the systems should be tested individually as well as an integrated system.

4.2 Concerns of Stakeholders

In the second phase of our research, we interviewed stakeholders to determine their concerns and misconceptions related to the use of lifts for evacuation. Based on the concerns collected from the key informant interviews, we compiled a list of 17 common concerns and created a 3-question survey. We contacted stakeholders and asked them to rate their top 5 concerns. In the following sections, the concerns of each stakeholder group are organised into categories and discussed based on the survey results. The categories grouped issues that were related to building design, lift systems, evacuation planning, and building maintenance. Explanations of the survey results are explained with information from the findings of our interviews. Architects, building managers, and members of the lift industry are excluded from the analysis because a very small sample completed the survey; only 1 or 2 individuals for

each of these stakeholder categories responded. Such a small sample would not be an accurate representation of the respective stakeholder groups. Thus, the following analysis will discuss the survey results for fire safety engineers, fire services personnel and building surveyors only.

4.2.1 The Building Design Process

Figure 1 shows that all stakeholder groups shown were concerned with **collaboration in the building design process**. A higher percentage of fire safety engineers and members of fire services were concerned about collaboration, possibly because building surveyors may not be aware of the need to change the existing building design process. Building surveyors may be satisfied with the way that building designs are developed now, and not list it as a concern as a result.

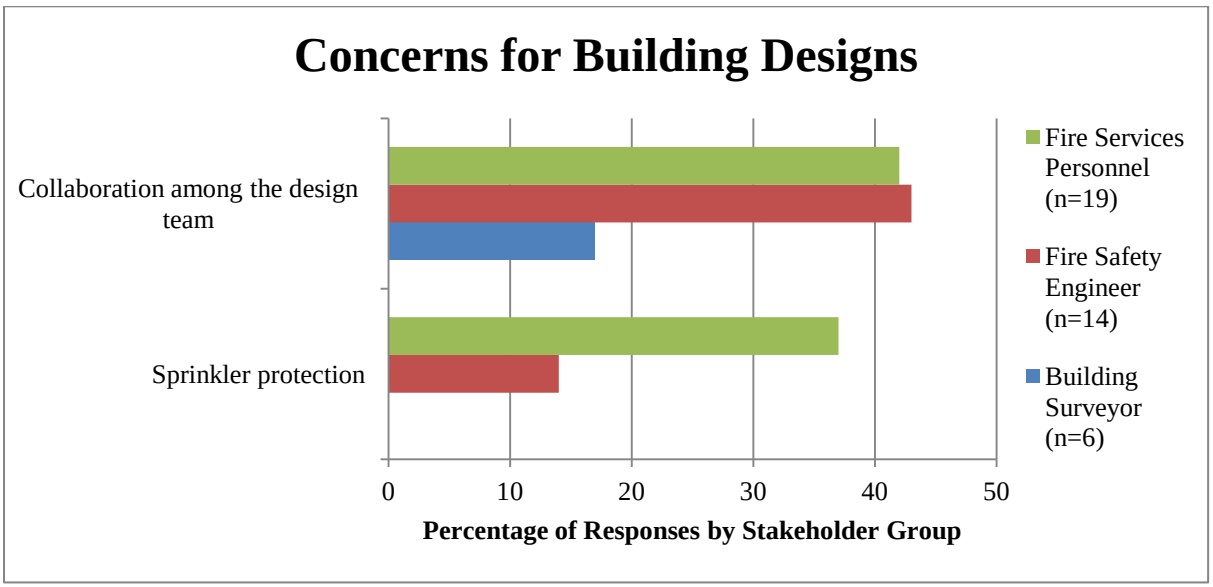

Figure 1: Concerns for Building Designs

Sprinkler protection was a concern primarily of members of fire services, likely because of their role extinguishing fires, and to a lesser extent fire safety engineers. Building surveyors did not select sprinkler protection as a concern. This could be due to the small sample size of building surveyors, only 6 individuals, or because of a lack of knowledge regarding specific aspects of fire protection systems. They may not know why sprinklers are needed in conjunction with evacuation lifts because it has only existed as a suggestion by the MFB in documents like GL-31. During some interviews, a few building surveyors did suggest that sprinkler protection would be a good idea, but it is not a current requirement of the BCA, so it would not be enforced by them during evaluations of building designs.

4.2.2 Design and Protection of Lift Systems

Figure 2 shows the percentage of stakeholders that selected each lift system design concern. All concerns related to the design and protection of lift systems were mentioned by at least one member of each stakeholder group, including fire services personnel, fire safety engineers, and building surveyors. The high response rate for each aspect of lift systems indicates that all stakeholders recognise the importance of lift systems and the need to be better educated about them.

When lifts are used for evacuation, particularly during fires, it is vital that the lift be completely protected from any of the effects of fire, including heat, smoke, and water. All stakeholders selected fire **and smoke-isolation of the lift lobby and shaft** as a high priority concern, with the highest percentage of selection for all stakeholder groups. These three stakeholder groups also expressed concerns about the **water isolation of the lift shaft**. It should be noted that water isolation was selected less frequently, indicating that although stakeholders are aware of it as an issue, it may not be a top concern for them.

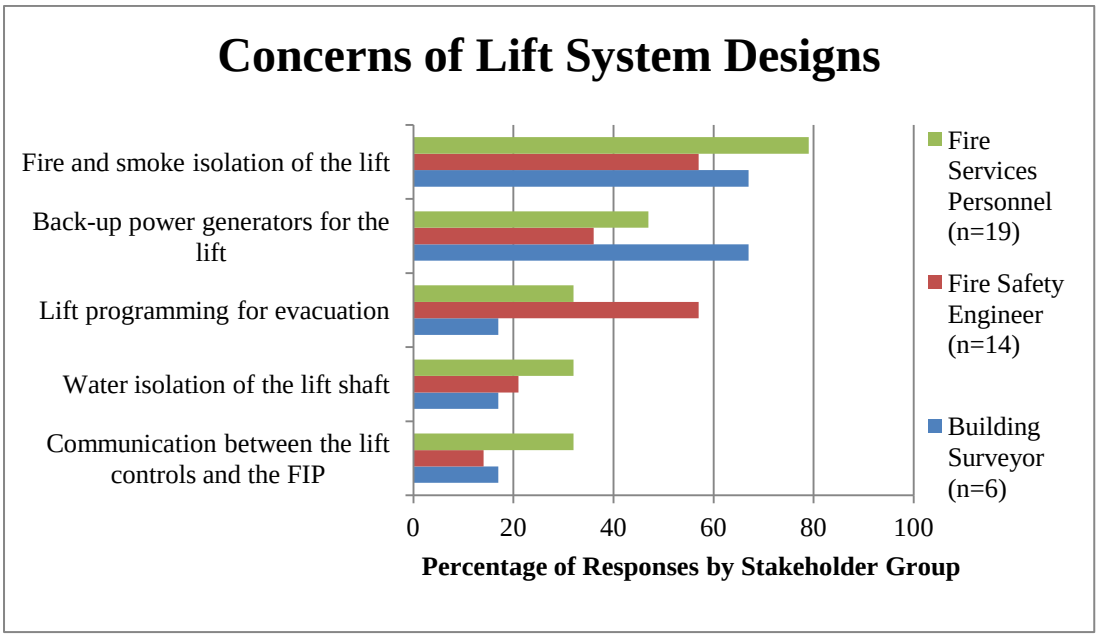

Figure 2: Concerns for Lift System Designs

Emergency back-up power was a top concern of building surveyors who are knowledgeable about the need to ensure that all components of the emergency systems are functional to guarantee the safety of occupants. If a building is found to not be safe for occupants, they could be held liable if they have approved the design of the building, so they are very aware of the need to provide for back-up emergency systems. This was a top concern

of fire services personnel, who want the lifts to function during emergencies. Back-up power was not a top concern of fire safety engineers, likely because they know that lifts will not likely be used for long periods of time. Even with smoke and fire isolation, lifts can only be protected for a certain period of time. Most buildings are also designed so that evacuation of all occupants can be performed in less than two hours, and most high-rise buildings use phased evacuations, so it is unlikely that a back-up power supply would need to last for long periods of time. Fire safety engineers are also aware that back-up power supplies are often large, expensive, and impractical, so it is not a top concern for these groups (McWaters, Apr. 10, 2013).

Lift programming for evacuation lifts was reported frequently, but was not a top concern of the three stakeholders groups. Lift programming was primarily listed by fire safety engineers, professionals that are knowledgeable about lift systems and the risk that having passenger lifts operate as evacuation lifts could pose. Fire services personnel and building surveyors listed this concern less frequently. This indicates that they are not aware of the need to change the programming of evacuation lifts, they are not as concerned about lift programming in general, or that they have higher priorities because they could only rank 5 items.

Communication between the lift systems and the fire indicator panel (FIP) was the least frequently reported concern among the three stakeholder groups. The lack of concern for this communication could be due to a lack of knowledge among the stakeholders regarding the way the lift systems operate in general. As a result, it is important to stress the need for integration of the lift control systems with the FIP in our seminar series.

4.2.3 Evacuation Planning

Figure 3 below shows the evacuation planning concerns and the percentage of each stakeholder group that selected each concern. Building surveyors were not as concerned about aspects of evacuation planning as fire services personnel and fire safety engineers. This lack of concern may indicate that building surveyors are less aware of the necessary changes in evacuation plans than other stakeholder groups. The small sample of building surveyors may also have influenced this outcome.

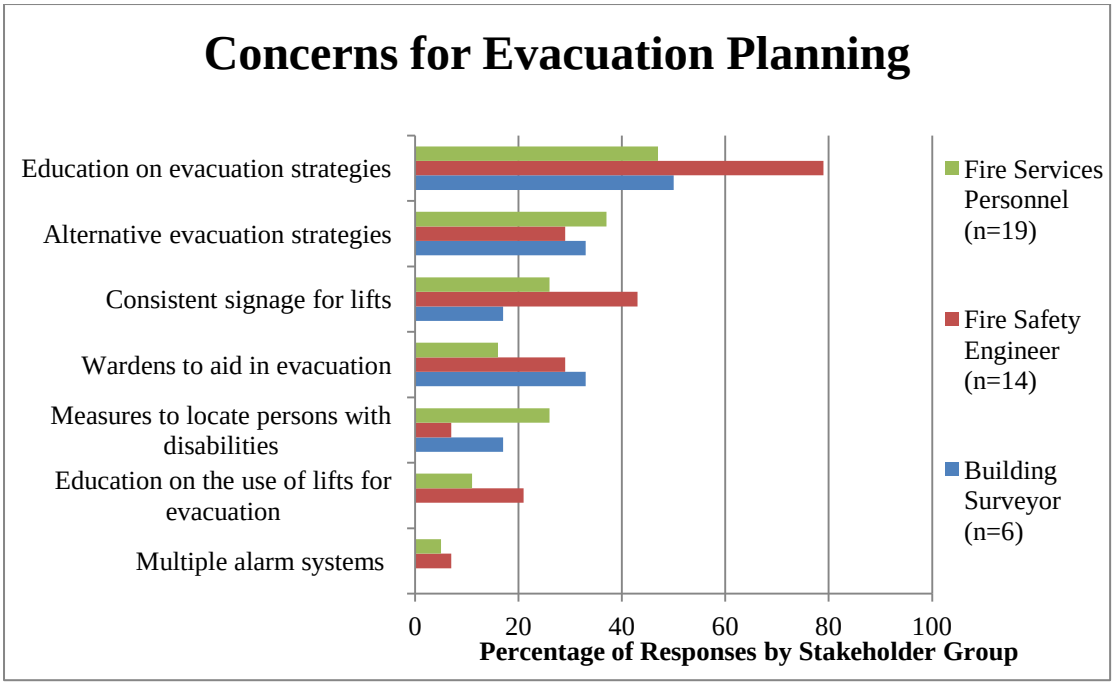

Figure 3: Evacuation Planning Concerns

One of the most important concerns of stakeholders was the need to **educate building occupants on the evacuation strategies of buildings**, as seen in Figure 3. This was the top concern in this category of all three stakeholder groups, indicating that it is of high importance. A minor concern for the stakeholders, one that was not even selected by building surveyors, was **the need to educate occupants on the use of lifts for evacuation**. This could have been due to wording of the survey; stakeholders may have thought that education on evacuation lifts would be performed when they were educated on the evacuation strategies of the building. It will be important to ensure that building occupants know that lifts will only be available for evacuation in certain buildings in the immediate future; they will not be available in all buildings.

During an emergency, it is important to have **multiple options for evacuation**. This was a concern listed by over 30% of each of the three stakeholder groups, indicating that they are very aware that alternative evacuation strategies need to be available, as seen in Figure 3. Although having alternative evacuation routes is important, it may have been under-reported because it is currently accounted for in building codes. One of the reasons that buildings of over 25 metres in height are prescribed to have a second fire-isolated stairwell currently is to provide a means of egress should one stairwell be blocked. Just because lifts will be available for occupants to evacuate does not mean that they will always be available to evacuate.

Another concern mentioned by all three stakeholder groups was the need to create consistent **signage for evacuation lifts**, see Figure 3. Currently all lifts are required to have a sign that states "Do not use lifts if there is a fire" as part of NCC code E3.3 (ABCB, 2013c, p. 290). As part of educating occupants, the signs outside of the lifts will need to be changed.

Over 30% of fire safety engineers and building surveyors selected the **use of wardens** as a concern, see Figure 3. This indicates that they are knowledgeable about the need to provide measures to regulate the evacuation of occupants prior to the arrival of fire services. Fire services personnel selected wardens less frequently, possibly because they are aware that most buildings do not currently have warden systems in place, and they are aware that evacuation can be effectively facilitated once they arrive even without wardens.

Providing **measures to locate persons with disabilities** was a concern listed by more than 15% of fire services personnel and building surveyors as seen in Figure 3. Interestingly, this was not a concern for fire safety engineers. One fire safety engineer that we interviewed did not believe that special accommodations for persons with disabilities would need to be made because of the use of the buddy system, however, the presence of an able-bodied person to assist a person with a disability cannot always be assumed.

As part of the emergency system, it is also important to have **multiple alarm systems** including intercom systems and visual displays to inform occupants when an emergency is occurring. This was a concern that was selected very infrequently, and only by members of fire services and fire safety engineers. This could indicate that having multiple alarm systems is not a concern for them currently as seen in Figure 3. Many buildings already have multiple alarm and emergency communication systems, so it may be assumed that they will be present in the buildings regardless of lift use. Bruce Thomas, a fire engineer involved in the design of many of Melbourne's high rise buildings, is not concerned with addressing the needs of persons with visual and hearing impairments given the inherent buddy system that applies for visiting persons or the familiarity that logically exists for persons residing in class 2 buildings (apartments) (Personal Communication, Apr. 19, 2013). In the case of class 3 residential buildings (hotels), Bruce believes that the circumstances are obviously very different. Provisions for specific design technologies to address such occupant characteristics should be made.

4.2.4 Building Maintenance

Figure 4 below shows the building maintenance concerns and the frequency of response by each stakeholder group. All three stakeholder groups were aware of the need to address concerns related to building maintenance because the concerns were both selected by at least one member of each stakeholder group.

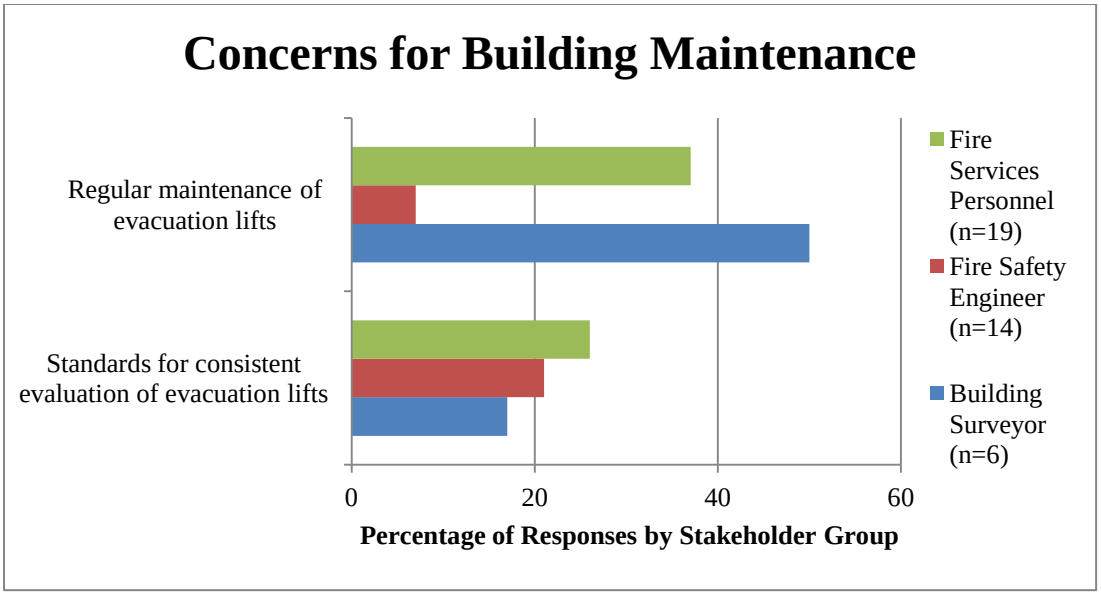

Figure 4: Building Maintenance Concerns

The need for **lift maintenance requirements** was selected by over 30% of fire services personnel and fire safety engineers as seen in Figure 4. This shows that members of each industry recognised the need to perform more regular maintenance on evacuation lifts and treat them as specialised equipment.

Currently, there are no **standards** in place **for the evaluation of evacuation lifts**, and minimal requirements for the evaluation of passenger lifts. Annual testing is mandatory in all states of Australia except Victoria, but standards for testing passenger lifts vary from state to state. Lift evaluation was a concern of about 20% of each stakeholder group, as shown in Figure 4. This indicates that members of fire services, fire safety engineers, and building surveyors are generally aware that standards are necessary for the evaluation of lifts. It is a relatively infrequent concern, but this could be due to the wide variety of concerns listed in general by fire services personnel and by fire safety engineers, who were restricted to selecting only their top 5 concerns for the survey.

4.3 Concerns of Each Stakeholder Group

Analysing our survey results showed that certain concerns were more prevalent among some stakeholder groups over others. Each stakeholder group has a different background and therefore has a different perspective on the use of evacuation lifts. The concerns that were chosen by each stakeholder group indicate that an issue which may be important from one perspective may also be important for another stakeholder with a different perspective. In this way, it is possible to fully understand the importance of each issue to various stakeholders.

4.3.1 Concerns of Fire Personnel

Through the survey, it was found that fire services personnel had a wide variety of concerns. Overall, 19 members of the fire services completed our survey. The top four concerns of fire services personnel included concerns regarding the building design, lift systems, and evacuation planning. The top concern were collaboration among members of the design team during the building design process and development of evacuation strategies (8), smoke and fire-isolation of the lift shaft and lobby (15), back-up power supplies for the lifts (9), and education of building occupants on building strategies (9). Following up at 7 votes each, popular concerns included sprinkler protection of the building, maintenance of the lifts, and alternative evacuation plans. These concerns are shown below in Figure 6.

Because members of fire services were concerned with various aspects of the evacuation systems and lift designs, it was important to address all of the selected concerns in the seminar series. The reasons for these concerns may be due to the influence that evacuation systems and lift designs would have during an emergency scenario, during which fire personnel intervene. Collaboration among the design team allows for a well-developed evacuation strategy and proper implementation of the lift and lift systems. The desire for isolation of the lift shaft and lobby as well as for back-up power provides safety to occupants who wish to use these lifts. Education of the occupants on the evacuation plan and usage of lifts would then reduce the likelihood of the building occupants placing themselves at unnecessary risk. Sprinklers, maintenance, and alternative evacuation strategies make sure the lifts function properly and that building occupants will always have an option available for their egress. These concerns all promote the safety of the building occupants, which is in concert with the duties of fire personnel.

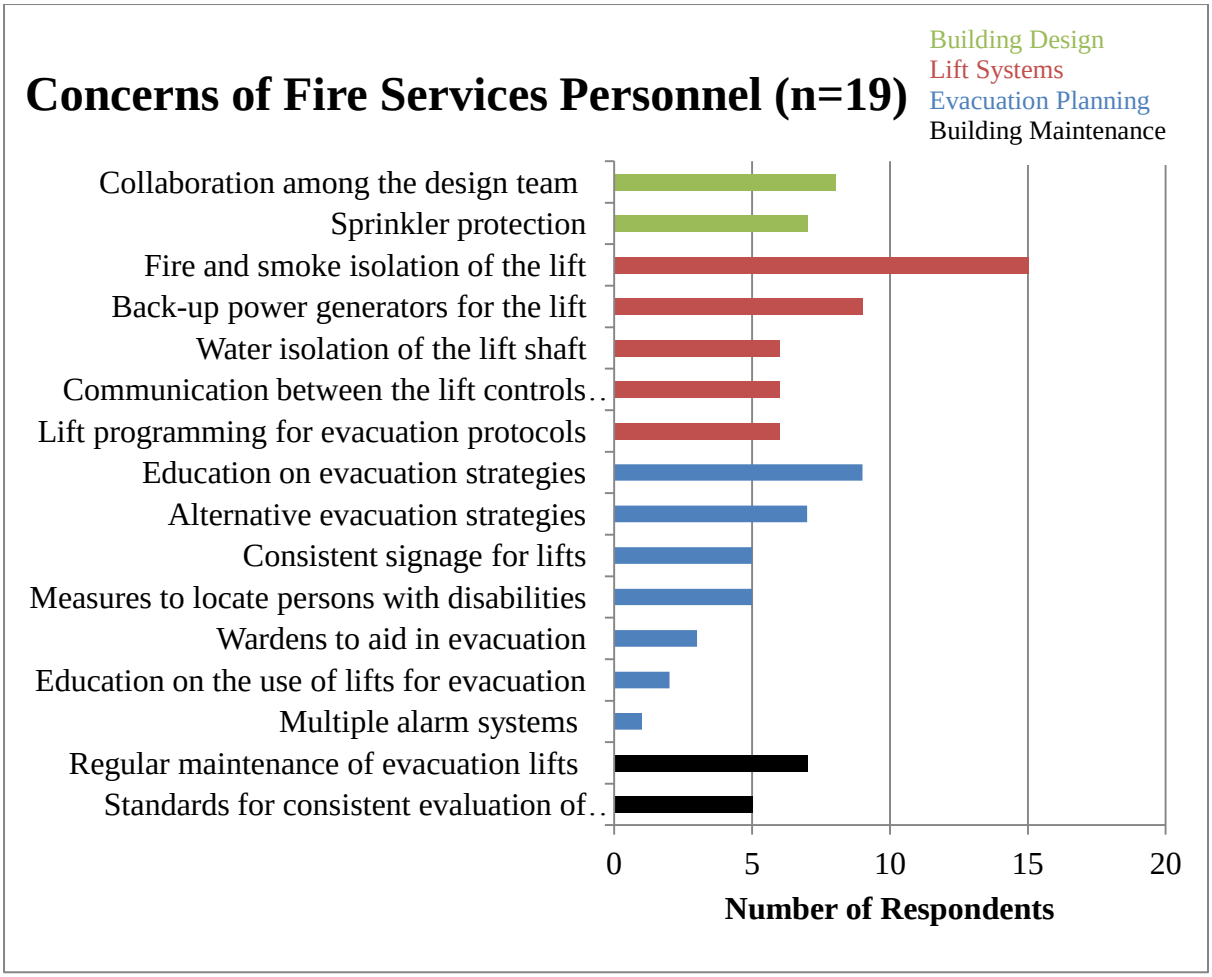

Figure 5: Concerns of Fire Services Personnel (n=19)

4.3.2 Concerns of Fire Safety Engineers

A total of fourteen fire safety engineers completed the survey and selected every concern available to them, see Figure 6. The top 3 concerns of fire safety engineers were related to lift systems and evacuation planning. These concerns were fire and smoke isolation of the lift lobby and shaft (8), lift programming for evacuation lifts (8), and education for building occupants on evacuation strategies (11). The reasons underlying fire safety engineers' choices of their top three concerns are be related to the job of a fire safety engineer. A fire safety engineer is concerned with guaranteeing that the proper safety measures are in place for the building occupants and that the occupants are properly informed. Many of the concerns related to the design of the lift and its associated systems. This may reflect the fact that these lifts are relatively new. Though a few buildings, such as the Eureka Tower, have used evacuation lifts previously, there is not much practical data regarding the use of these lifts in an actual emergency. The fire safety engineers may want to

make sure that these lifts do not endanger the passengers due to improper construction or function.

Other popular concerns that were listed by 6 fire safety engineers each were collaboration among members of the design team and consistent signage for evacuation lifts. Overall, the wide variety of concerns indicates that fire safety engineers need to be presented with the complete seminar series in order to address all of their concerns. Interestingly, fire safety engineers were generally not concerned about building maintenance, with only two individuals concerned about regular maintenance and three individuals concerned about standards for the evaluation of evacuation lifts. It would be expected that they would be very concerned about building maintenance because they are key participants in the approval of building designs and can be liable for any mistakes that are made. However, the lack of concern for building maintenance could have been due to the limitations of the survey because participants were only allowed to select their top 5 concerns. Building maintenance may have been a secondary concern of many fire safety engineers.

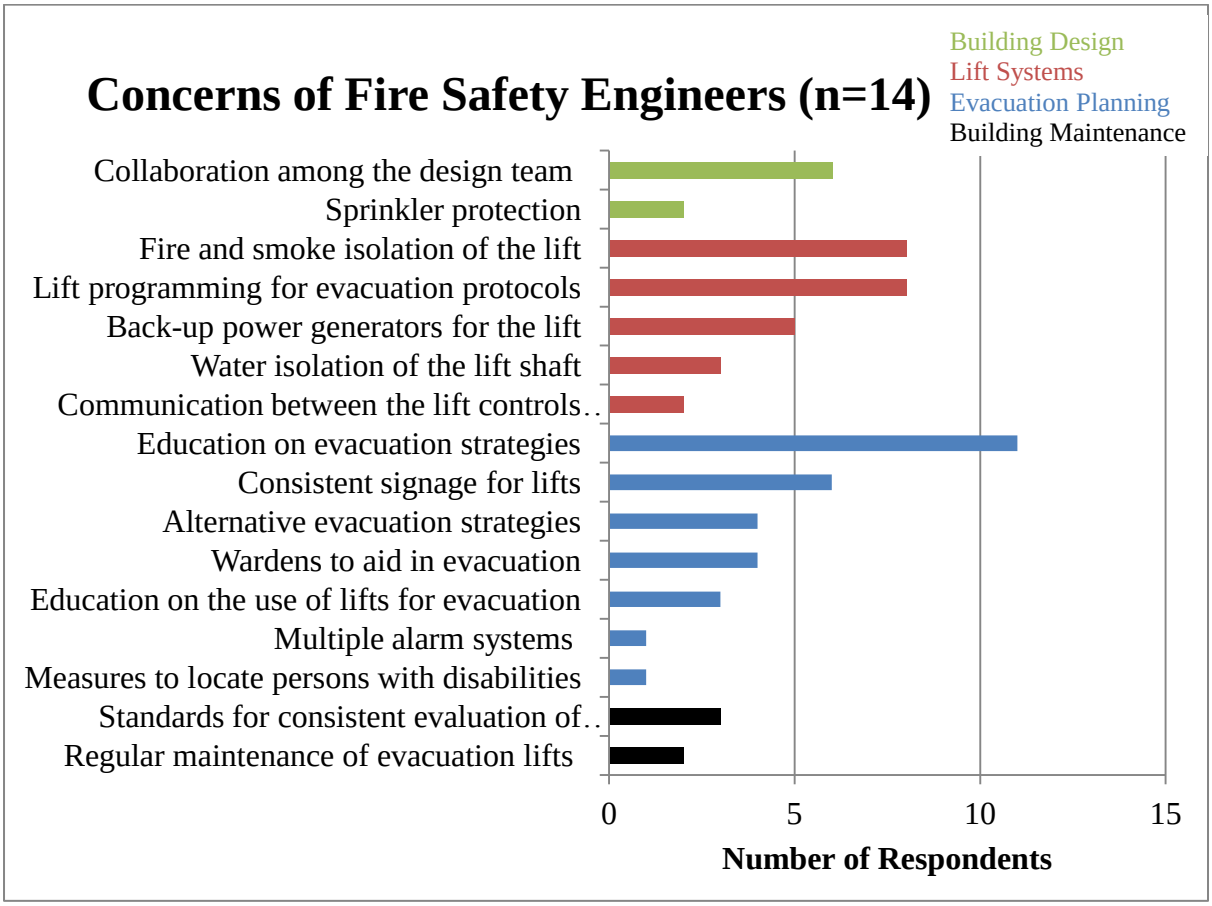

Figure 6: Concerns of Fire Safety Engineers (n=14)

4.3.3 Concerns of Building Surveyors

A total of six building surveyors responded to the survey, as seen in Figure 7. The top 4 of building surveyors related to lift systems, evacuation planning, and building maintenance. Their top concerns were fire and smoke isolation of the lift lobby and shaft (4), back-up power generators for the lift (4), education for building occupants on evacuation strategies (3), and regular maintenance of lifts (3). Their concerns largely related to the construction of lifts and measures to ensure that building occupants know when they can or cannot use the lifts during emergencies.

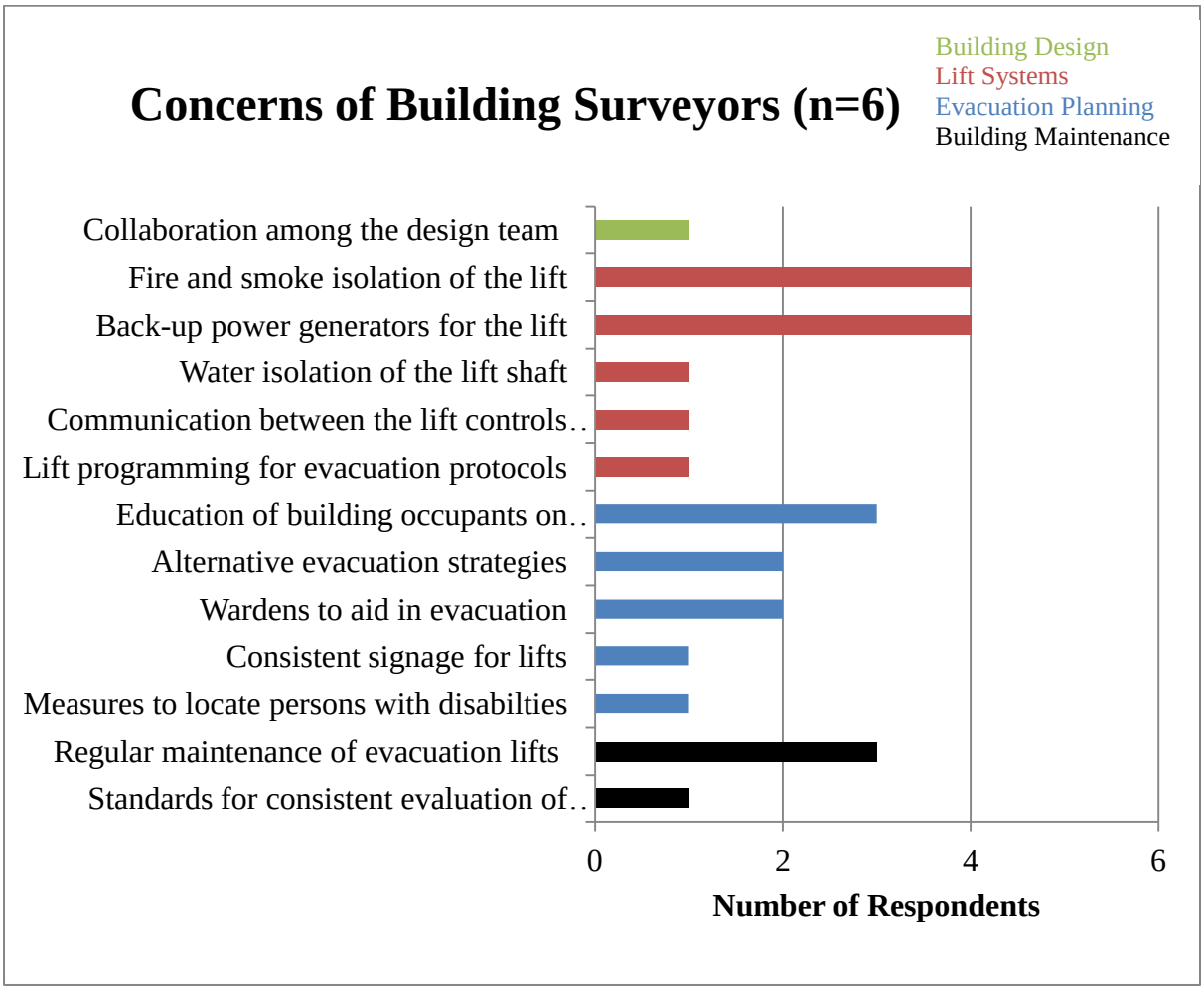

Figure 7: Concerns of Building Surveyors (n=6)

Concern for the lift systems is understandable. The building surveyor is responsible for issuing both the building permit and occupancy permit. If any part of the building or lift proves to be faulty at the moment the building is commissioned, then the repercussions may fall upon the building surveyor for wrongly certifying the building. In this way, they are concerned with fire and smoke isolation and back-up power, to make sure that occupants are

properly protected if they choose to use these lifts. Concern over education may be related to a desire to prepare for all circumstances. Although injuries may result from more than a lack of education, the victim may attribute some fault to the lift and to the surveyor for an incorrect certification. Concerns over wardens and alternative evacuation strategies are to ensure that as many safety measures and back-ups are in place as necessary to guarantee the safety of the occupants.

Although the majority of concerns were related to the design of the lift and to evacuation planning, at least one surveyor had chosen a concern in each category. Because the response sample comprised only six individuals, we could not classify this as a representative sample. As a result, we deemed it important to touch upon building design, lift design, evacuation planning, and building maintenance in some detail.

4.3.4 Concerns of Architects

Even during the interview process, it was difficult to schedule interviews with architects, and the survey generated few responses as well. The survey was sent to over twenty architects and architecture firms, and only two responses were collected. The lack of response may indicate a lack of concern and interest regarding the use of lifts for evacuation. Our two respondents identified concerns related to lift systems and evacuation planning. Both were concerned about smoke and fire-isolation of the lift lobby and shaft, back-up power supplies for the lifts, and education of building occupants on the use of lifts for evacuation, as seen in Figure 8 below.

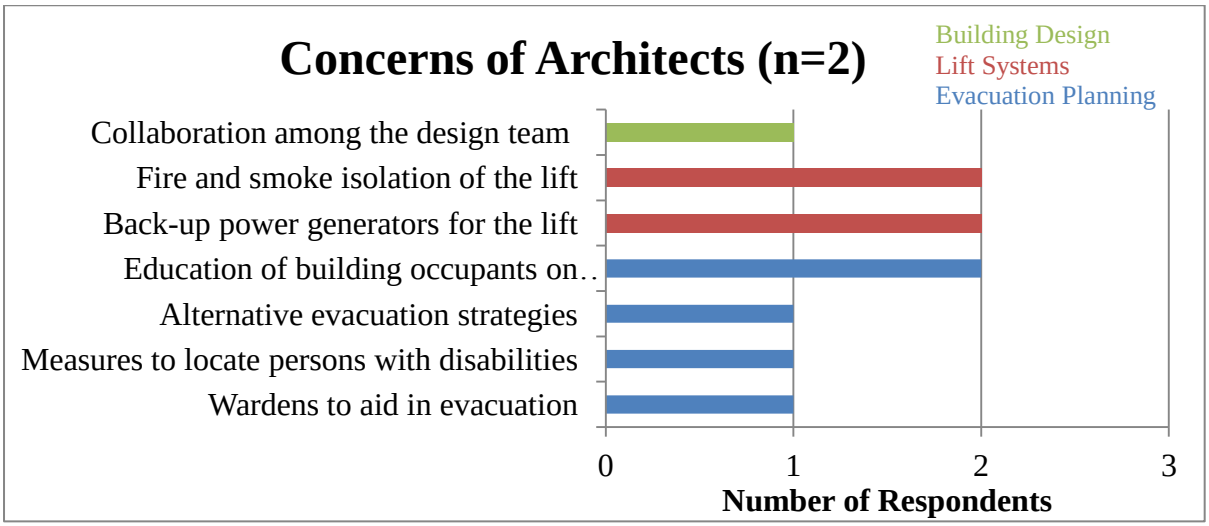

Figure 8: Concerns of Architects (n=2)

Based on the interviews that were conducted with architects, it was clear that they were not aware of many of the design considerations that would need to be made for evacuation lifts, such as water isolation. Therefore, in the seminar series, it was important to address the educational gaps along with the range of concerns. In this way, we can better inform architects and ensure that they understand the considerations that need to be made when evacuation lifts are incorporated into a building design.

4.3.5 Concerns of Lift Engineers

A very small number of responses were collected in the survey for lift engineers. This was likely due to the fact that certain companies, such as ThyssenKrupp, would only allow one lift engineer to respond in order to provide a formal response on behalf of their lift company. The close regulation of responses by members of that company indicates that the lift manufacturers consider evacuation lifts an important issue. The top two concerns of the lift industry related to evacuation planning and building maintenance. Of the two lift engineers that completed the survey, both agreed that regular maintenance of the lifts as well as measures to locate persons with disabilities were very important, as seen in Figure 9.

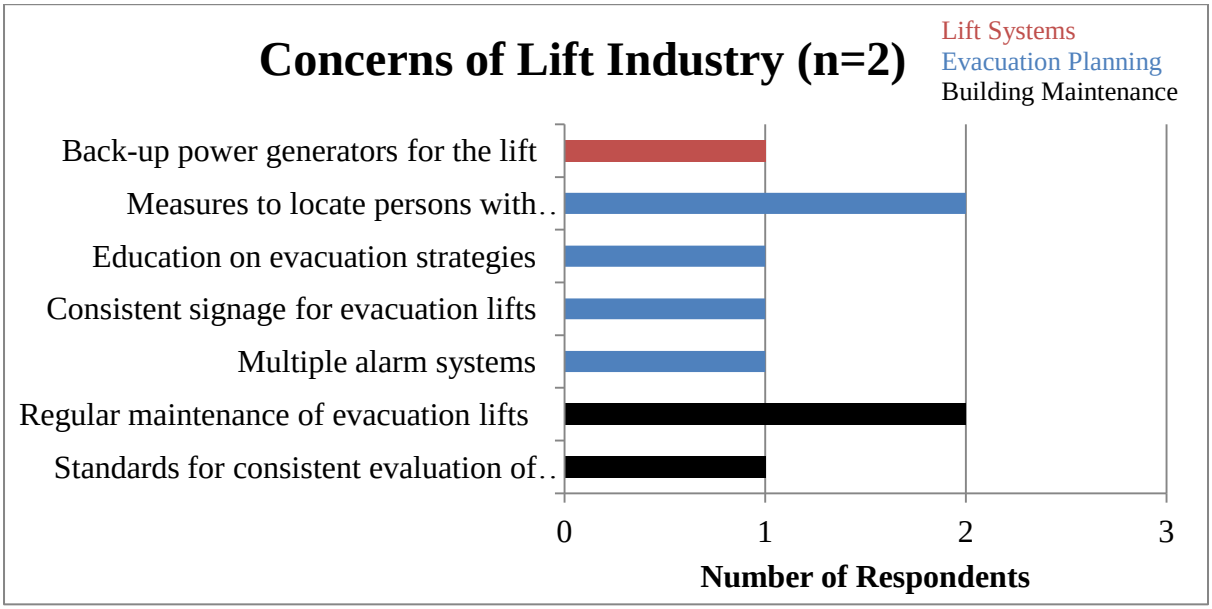

Figure 9: Concerns of Lift Engineers (n=2)

While, the small sample size is not representative, it is interesting to note that no concerns were stated for building design and that only one was stated for lift design. The lack of concerns for lift design may reflect confidence that the lift engineers are able to handle issues relating to the design of the lift. Rather, the majority of their concerns are with evacuation planning and the usage of the evacuation lifts. The measures for locating persons

with disabilities will make sure that the lifts will be used by those who have no other means by which to evacuate. The alarm systems will inform occupants of the emergency and the floors involved while the signage for the lifts will indicate whether the lift is available for evacuation. A concern for maintenance reflects that while lift engineers may be able to construct the lift and its associated systems with little issue, the lift will need to be maintained in order to operate at the same level of performance.

The survey results show that lift engineers are concerned with their lifts being implemented correctly and used effectively. Evacuation lifts are also a new addition in many buildings, so it is important to offer information in their area of expertise. As a result, the seminar series for the lift industry addresses both the concerns returned by the lift engineers as well as the information that focuses on lifts.

4.3.6 Concerns of Building Managers

During the interview process, it was difficult to find contact information for managers of building that use evacuation lifts. Managers had to be contacted by visiting buildings and getting contact information at the front desk. Due to the small pool of building managers that were found to be interviewed, the survey was sent to only 3 building managers, and returned by only 1. This building manager was largely concerned with aspects of the lift system, including back-up power supplies for the lift, fire and smoke-isolation of the lift lobby and shaft, water isolation of the lift shaft, and communication between the lift controls and the FIP. This lift will be the responsibility of the building manager, so it is understandable to want the lift to be constructed properly and to be protected against failure. She/he was also concerned with aspects of the building design, specifically collaboration among members of the design team at all stages of the building design process and development of evacuation plans.

Interestingly, the building manager was not concerned with education of occupants on evacuation strategies or the use of evacuation lifts, likely because it is part of their current role in buildings. The building manager was more concerned with aspects of the building and lifts' designs that they are not involved with, possibly indicating scepticism for the safety of evacuation lifts. One building manager that was interviewed believed that lifts would never be safe for evacuation, supporting this hypothesis. Overall, the concerns selected by the building manager highlight the need to address aspects of the lift systems and building design process in the seminar series.

4.4 Misconceptions of Stakeholders

One common misconception that we encountered relating to lift use is the idea that the second fire-isolated stairwell can be removed when an evacuation lift is integrated into building designs. Class 2 to 8 buildings that have storeys over 25 metres in height are required to have two exits, typically fire-isolated stairwells (ABCB, 2013c, p. 181). From our interviews, we discovered that some fire safety engineers believe that lifts could be used to replace one of the stairwells. This is not the case at all. DP7 explicitly states that "Where a lift is intended to be used in addition to the *required exits* to assist occupants to evacuate a building safely" certain considerations must be addressed. The keyword is that the lift is to be in addition to the required exits. DP7 does not state that an exit can be replaced by a lift.

Another misconception that we encountered from a building manager was that lifts are never safe for evacuation. With proper fire-isolation, trained staff, and evacuation plans, it is possible to use lifts safely during building evacuation. In the US, people are allowed to use lifts for evacuation until fire services arrive. In Europe, some buildings use Occupant Evacuation Elevators (OEE). Additions to the design of OEEs include fire-isolation for 2 hours and water-proof equipment as specified in EN 81-72 (Vanney, 2010, p. 6). The manner in which these lifts are operated and managed effectively prevents harm to passengers when they use the lifts even without pressurisation of the lift shaft. Once the lifts are considered unsafe due to smoke, water, or fire contamination, occupants are not allowed to use them and the lifts are recalled by fire services. Past lift use in these countries demonstrates the safe use of lifts and provide evidence that lifts can be effectively used for emergency evacuation.

While evaluating building designs, building surveyors typically consult fire safety engineers to assess whether a design solution meets performance requirements in the BCA. One of the lift engineers that we interviewed believed that building surveyors did not need to know anything about lifts in order to evaluate them. Currently the fire safety engineer creates Alternative Solutions and a fire engineering brief, which is evaluated by the MFB. The brief outlines the issues and how the design will meet the performance specifications. The fire engineer then performs analysis that goes into the fire engineering report for evaluation by the building surveyor. If the fire safety engineers have demonstrated that the systems work and are reasonably safe, they are approved by the building surveyor. Because evacuation lift use is a new concept in Australia, it is important to educate the fire safety engineers and building surveyors on the evaluation of lifts. It is possible that they may believe that a lift

would be a safe alternative to the second fire stair. It is important to stress in educational programmes that lifts cannot be used this way and that alternative evacuation options need to be available, such as the protected stairwells and evacuation chairs for persons with disabilities.

A key misconception that was found during interviews with disability advocates was the lack of understanding about evacuation lifts. When it was mentioned to some of them that there was going to a new building provision that would permit the use of evacuation lifts, they got really excited. They believed, despite several minutes of explanation, that evacuation lifts would be required and used in every building. One disability advocate got overly excited and stated that it should be announced to everyone, "through the radio and television" that lifts could be used during evacuation. The 2013 BCA and DP7 are only mandatory for new buildings and for buildings that undergo over 50% renovations, so the use of lifts for evacuation is only optional (Soylemez, Mar. 20, 2013). If evacuation lifts are used in a building's design, DP7 must be used, but it is completely optional to use lifts for evacuation. Due to the lack of understanding that people at large will have with evacuation lifts, it will be important in the future to create an educational programme for building occupants about the use of lifts for evacuation.

4.5 Gaps in Building Requirements

During our interviews, we found that there are currently gaps in building requirements for water isolation of emergency lifts. Ian McWaters at WSP Group informed us that most buildings do not have waterproof seals on the electrical equipment in the lift shaft (Personal Communication, Apr. 10, 2013). This could be an issue for any lift because the door locks are located directly below the opening of the lift, and "door locks could short-circuit as a result of water entering the lift shaft" (McWaters, Apr. 10, 2013). Building managers, some members of fire services, and fire safety engineers believed that emergency lifts would be safe to use during an emergency despite the lack of water isolation. According to fire services personnel, water isolation has not been addressed, but they believe that it could be an issue in the future.

4.6 Recommendations for Seminar Series

Using the information that we obtained from our literature review, key informant and stakeholder interviews, and survey, we created Venn diagrams. These Venn diagrams explore

the differences between the concerns that key informants have voiced and the concerns that stakeholders have voiced. Concerns that are bolded represent issues that the stakeholder group will need to be very knowledgeable about, while un-bolded concerns represent issues that stakeholder just need to be aware of. The goal of this approach was to identify the knowledge gap between what the stakeholders do know and what they should know. The comparisons made by the Venn diagrams will be used to direct the focus of the seminar series for each stakeholder group. Based on this educational needs analysis, we have developed learning objectives for stakeholders in the design team, management, and fire services. These learning objectives can be found in Appendix 7.

4.6.1 Education for Fire Safety Engineers and Fire Services Personnel

Fourteen fire safety engineers and nineteen fire services personnel completed our survey. Fire safety engineers and fire services personnel were concerned about all of the issues that we had identified through our literature review and key informant interviews. We did not create a Venn diagram to explore the differences between concerns voiced by key informants and stakeholders since there were no differences based on our survey. Both stakeholder groups recognised issues that needed to be resolved and were generally very knowledgeable about what needed to be addressed. It will be important for fire safety engineers to understand issues permeating all of the categories in our educational programme.

Through our stakeholder interviewing, we identified a view voiced by two fire safety engineers that opposes the view of the fire safety engineer community at large. These two fire safety engineers believed that the second fire isolated exit stairwell could be removed from the building design as an Alternative Solution to D1.2. The MFB, AFAC, FPAA, and SFS all believe that removing the second fire isolated exit stairwell is very dangerous as it will slow fire brigade intervention. We have included an emphasis on D1.2 in our seminar series and have suggested that designs not utilise alternative solutions that remove the second fire isolated stairwell.

Fire services personnel will only need to understand the operational aspects of evacuation using lifts. These issues include all of the concerns categorised within evacuation planning. Additionally, fire services personnel will need to be aware of how the building design will affect evacuation strategies and be aware of the need for maintenance to lift systems and emergency equipment. We have placed emphasis on fire services personnel to

understand lift operation and monitoring and communication systems and to anticipate human behaviour and changes in fire brigade intervention in our seminar series.

4.6.2 Education for Building Surveyors

Six building surveyors responded to our survey. They were concerned about the need for a multi-disciplinary team, fire and smoke isolation, back-up power supply, education for building occupants, and wardens. These concerns are shown in Figure 10. It is interesting to note that through our survey, we did not find that building surveyors were concerned about sprinkler and alarm systems. Concerns that are bolded represent concerns that building surveyors should be very knowledgeable about. With only six responses, it is difficult to say whether or not building surveyors actually care about these issues or if the sample size is not accurately representing the population.

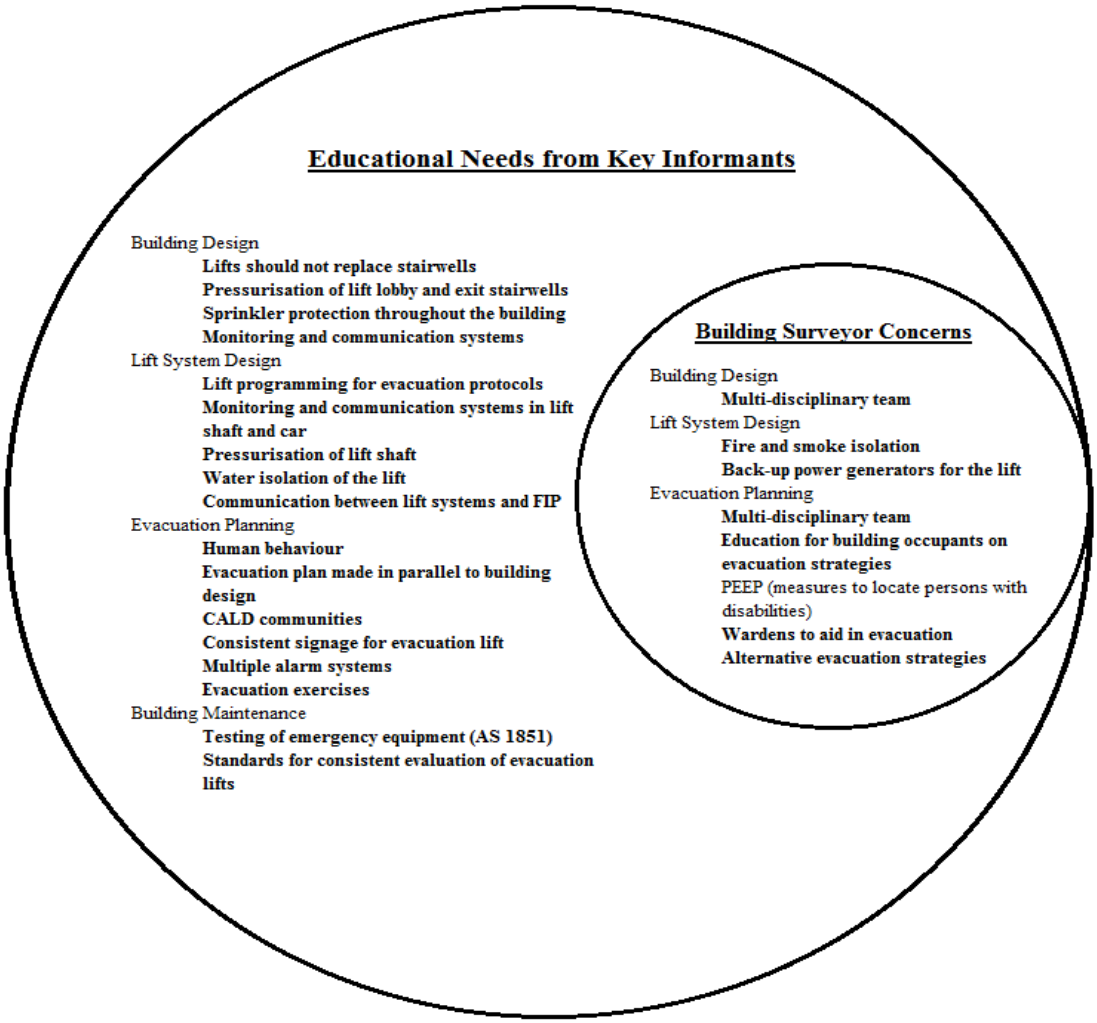

Figure 10: Building Surveyor Venn Diagram

Through our interviews we found that building surveyors often rely on fire safety engineers to assess whether or not designs meet relevant performance requirements before certifying a design. It is therefore necessary for building surveyors to be knowledgeable about issues within every category of the educational seminar series. It is also relevant to note that building surveyors recognised the importance of a holistic approach to building design and development of evacuation plans. Building surveyors understand that fleshing out all of the issues with evacuation lift systems is necessary. As a result, we have placed a focus on the holistic approach to building design and evacuation planning in our seminar series. There is an emphasis on considering the function of the building as one integrated system.

4.6.3 Education for Architects

Architects were very difficult to contact and generally dismissive of the importance of our project. Only two architects completed our survey. Architects were concerned about education of occupants, backup power supplies, fire and smoke isolation, collaboration among stakeholder groups, the need for wardens, and identification of non-ambulatory occupants. This is shown in Figure 11. Issues that architects should be knowledgeable about are bolded, while un-bolded concerns architects just need to be aware of.

The small sample size of our respondents makes it unclear what is actually known by the architects. The lack of response to our enquiries might suggest that architects do not believe that issues surrounding the use of evacuation lifts are important. They may also not be interested because they can rely on lift engineers and fire safety engineers when designing buildings with evacuation lifts. During our stakeholder interviews with architects, they admitted to not knowing much about the use of evacuation lifts and when prompted about issues from our list, agreed that the concerns we had discovered such as fire and smoke isolation and back-up power supplies for lifts were important. In our seminar series, we have emphasised a holistic approach to building design and development of evacuation planning. Issues throughout every category of building design will be presented in order to fill in any knowledge gaps that architects have. While we cannot identify all of these knowledge gaps, it is evident that architects are not knowledgeable about many of the issues surrounding evacuation lifts.

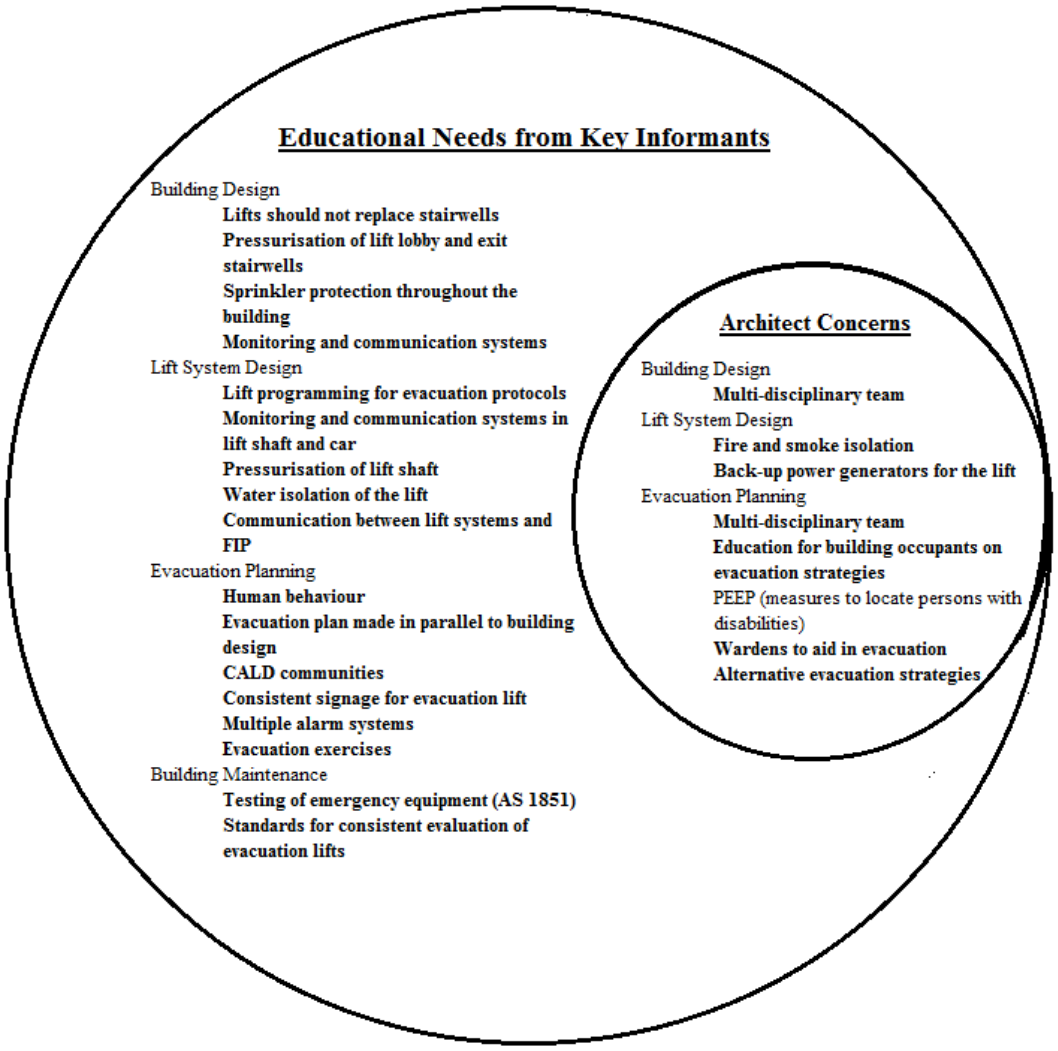

Figure 11: Architect Venn Diagram

4.6.4 Education for Lift Engineers

Due to the small numbers of contacts that we obtained though our respondent driven interviewing and due to the formal approach that the lift engineering companies took to our enquiry, the sample size of our lift engineer respondents to the survey was two. Therefore, it is not evident if lift engineers are actually concerned about other issues that they did not voice in our survey. However, lift engineers recognised the importance of our project and gathered their input from within the company and delivered a formal response to us. The two responses voiced concerns about signage, alarms systems, testing of emergency equipment, education for building occupants, standards for consistent evaluation of lifts and the need for backup power supplies. These concerns are shown in Figure 12. Concerns bolded are concerns that the lift industry needs to be knowledgeable about, while un-bolded concerns the lift industry will only need to be aware of.

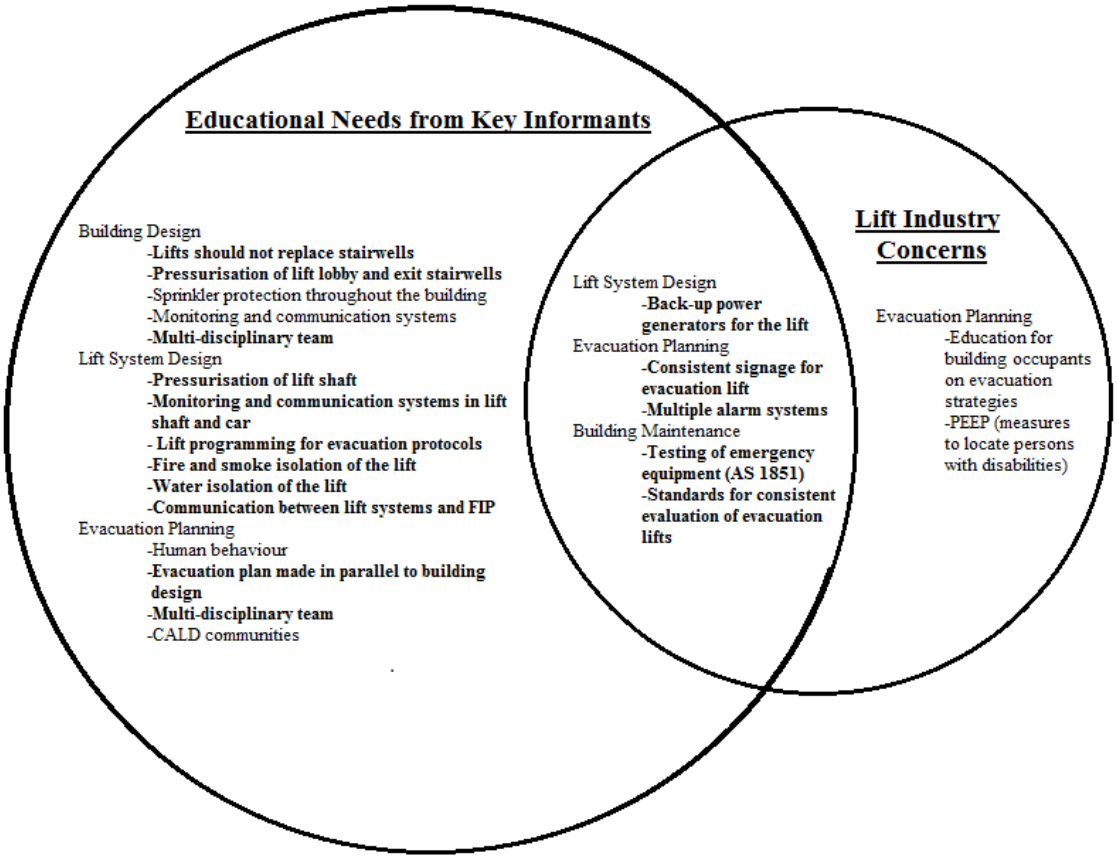

Figure 12: Lift Industry Venn Diagram

It is logical to conclude that lift engineers are mostly concerned about these unresolved issues which include back-up power supply, consistent signage, alarm systems, and maintenance because of liability. If the evacuation plan doesn't run smoothly or if the lift system does not function properly, the lift engineers may be held responsible in the eyes of the building owners. Interestingly, representatives from the lift industry did not select smoke and fire isolation as a top concern. Protection of the lift lobby is an important consideration to be made for the use of evacuation lifts and can easily be done by pressurising the lift lobby and the lift shaft. When pressurising the lift shaft, it will be crucial to account for the pressure differential generated between the lift lobby and the lift shaft. The pressure differential needs to be considered to ensure that the doors of the lift will open properly. In our seminar series, we place an emphasis on pressurisation of lift lobbies, lift shafts, and exit stairwells and suggest that pressure differentials be considered. Water isolation of the lift shaft was another concern that was not selected by the lift industry as a top concern. This is an important concern because emergency lifts currently used by the fire brigade are not required to be water isolated. This issue is emphasised in our seminar series and we have suggested that a follow up study be conducted to explore the water isolation of emergency lifts.

4.6.5 Education for Building Managers

One building manager responded to our survey. His/her concerns are related to back up power, fire and smoke isolation, water isolation, collaboration between stakeholders in the design process, and communication between fire and lift control systems. These concerns are shown in Figure 13 with bolded concerns being issues that building managers should be knowledgeable about. It is interesting to note that the building manager did not select any concerns that were identified by our key informants as topics that building managers should be knowledgeable about as a top concern. These include considerations for identifying persons with disabilities and accommodation for CALD communities. Through our interviews with all stakeholder groups, we have found that there is an overall weakness in the address of egress for persons with disabilities. Some of the high-rise buildings that we visited did not accommodate CALD communities or persons with visual and hearing impairments for emergency egress. Additionally, our interviews with building managers suggest that there is a lack of trust in the safety of evacuation lifts. Building managers believe that lifts cannot be used safely for evacuation and are very uneasy about incorporating lifts in the evacuation strategies for their buildings.

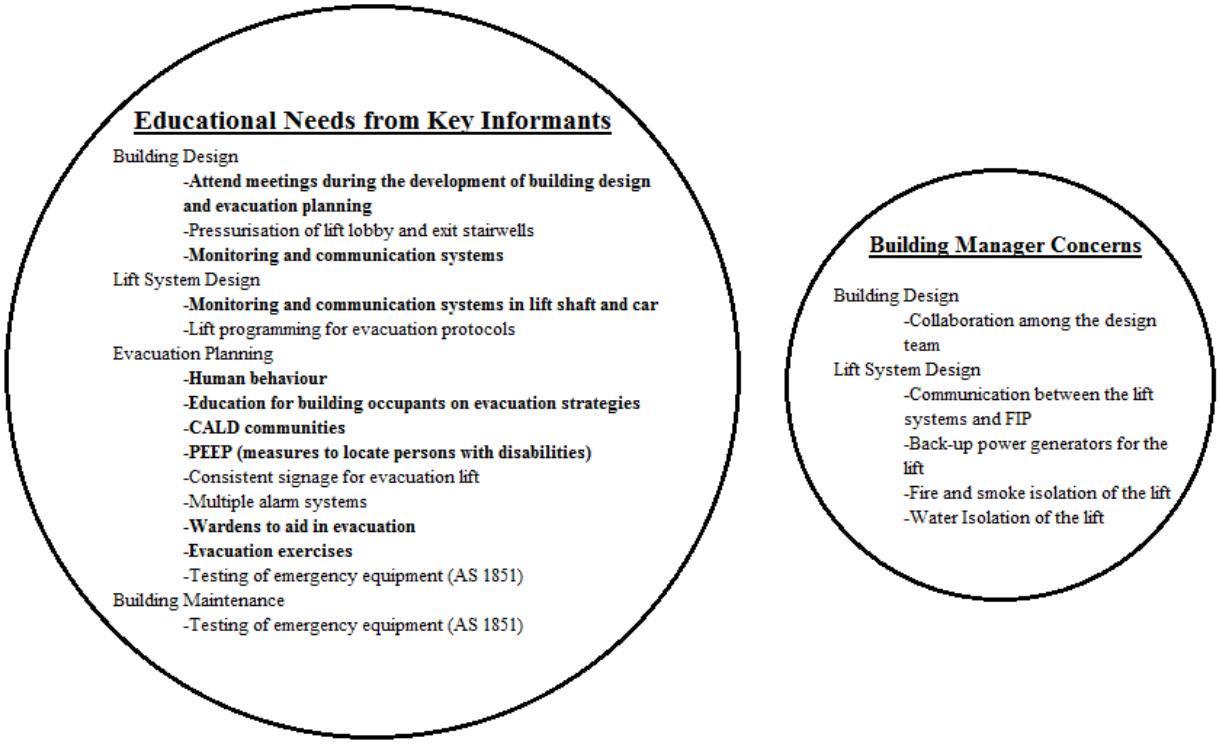

Figure 13: Building Managers Venn Diagram

Building managers and owners need to be aware of consistent signage, multiple alarm systems, testing and maintenance of emergency equipment, and pressurisation of lobbies and stairwells. While they are not involved in the design process, understanding that these building design features will impact the execution of the evacuation plan is important. It will be important for building owners and managers to understand that design features can be implemented to ensure that evacuation lifts are safe to use. In order for these design features to ensure the safe use of lifts for evacuation, building managers will need to execute evacuation plans smoothly, understand how to operate monitoring and communication systems, and consider how human behaviour will affect execution of evacuation plans. Building owners will need to understand how the building design fits the evacuation plan and how to maintain evacuation systems, lift systems, communication and monitoring systems, and interfaces. AS 1851 and AS 3745 are standards that relate to maintenance of fire protection systems and development of evacuation plans for facilities, respectively. These standards are mentioned in our seminar series as well as a focus on the holistic approach to evacuation planning.

4.6.6 Educational Seminar Series

Based on our analysis, we have organised the seminar series to include sections that address issues within four categories: building design, lift systems design, evacuation planning, and maintenance. Within these categories, a holistic approach to solving issues surrounding the use of evacuation lifts is consistently emphasised. In order to solve these problems, each system of the building cannot be considered in isolation so it will be important for all stakeholders to be involved in understanding considerations relating to design and maintenance.

A general seminar was created with syllabi for each stakeholder group, listing slides specific to them, along with a learning assessment for each stakeholder to ensure that the learning objectives had been achieved during the seminar, see Appendix 8. We have developed learning objectives for building owners and managers, the design team and building surveyors, and fire services personnel which our seminar series will use to educate stakeholders on the design and maintenance of buildings using evacuation lifts. Using these learning objectives, our seminar series will effectively educate stakeholders on design and maintenance considerations such that evacuation lifts can be properly implemented per DP7. The effective use of evacuation lifts will ensure that persons with disabilities are granted an

equitable means of egress. Furthermore, evacuation lifts will improve evacuation times, particularly in high-rise buildings, affording occupants a peace of mind knowing that they will be able to evacuate during a life threatening emergency.

5.0 Conclusion

This project was conducted with the purpose of determining the concerns, educational needs, and misconceptions that stakeholders had regarding the use of lifts for evacuation. Through our interviews and survey, we were able to identify the relevant information necessary to address the concerns and educational needs of our stakeholders. This information was incorporated into a seminar series to instruct architects, building owners and managers, building surveyors, fire services personnel, fire safety engineers, and members of the lift industry on the considerations that need to be made when evacuation lifts are incorporated into a building's design. Overall, the seminar series should address many of the concerns of the stakeholders interviewed and provide relevant information to them so that proper implementation of DP7 can be achieved. These seminars will be used by AFAC, SFS, and Olsson Fire & Risk to educate stakeholders on the use of lifts for evacuation so that they can be incorporated safely and effectively into building designs and evacuation plans.

5.1 Recommendations

The following section provides recommendations to address considerations that were beyond the scope of our project.

5.1.1 Education for Building Occupants

We recommend that educational programmes be developed to reach out to building occupants and inform them of appropriate ways to utilise lifts during evacuation. It is the role of building owners and managers to provide this information to all building users. While advice is given for these stakeholders in our seminar series, many occupants may develop misconceptions about the use of lifts. For example, occupants might assume that if they can evacuate using lifts in one building, that they can use lifts for evacuation in all buildings, which will not be the case. In the immediate future, only new buildings will have evacuation lifts available. Older buildings may include evacuation lifts following renovations and pressure from the disability community, but it is unlikely that this will be done in the near future. Some disability advocates that we interviewed did not understand, even after long explanation, that just because it will be permitted to use lifts for evacuation, that not all buildings will have them. On the other side, many disability advocates were very concerned about the use of lifts for evacuation because they did not believe that lifts would be safe for use during an emergency. It will be important to reach out to the general public and provide

information regarding the use of evacuation lifts to ensure that occupants, particularly visitors to buildings that are unfamiliar with evacuation plans, are aware that not all lifts will be available for evacuation and that when lifts are used, they are safe for evacuation.

5.1.2 Research on Water Isolation of Lifts

We recommend that research be conducted on the importance of water isolation of the lift systems. Through our research, we found that very few lifts, including emergency lifts used by fire services personnel, have waterproof seals on the electrical systems in the shafts. According to one lift consultant, Ian McWaters, "waterproof or splash-proof landing door locks have rarely been used in Australia. Their introduction would be of concern due to additional costs and the high level of uncertainty associated with maintaining them in a waterproof condition throughout their life" (Personal Communication, Apr. 10, 2013).

It will be beneficial to find out why water isolation is not currently considered to be important and to find out if it should be considered for both emergency and evacuation lifts. Many of the interviewed stakeholders listed water isolation of the lift as a concern. However, it may not be an issue moving forward if fire personnel have not encountered any problems in using lifts without water isolation. Stephen Kip from Skip Consulting Pty Ltd had voiced that hard research should be conducted into water ingress and all of the dangers it presents.

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Appendix 1 – Key Informants

- **Robert Solomon, P.E. - NFPA**
  Robert is a Division Manager for Building and Life Safety Codes. He had led Fire Safety conferences and had worked on many publications, such as the NFPA 5000 Building Construction and Safety Code Handbook. He put us into contact with other key informants at the NFPA and provided information on the safety of lift use during fires.
- **Kristin Bigda, P.E. – NFPA**
  Kristin is a Senior Fire Protection Engineer at the NFPA. She has assisted in the development of safety codes and provided information on fire safety and current evacuation measures.
- **Rita Fahy, PhD – NFPA**
  Rita is a Manager of Fire Data Bases & Systems at the NFPA. She was a key informant in human behaviour and provided information on behaviour during fires.
- **Allan Fraser, CBI, CPCA – NFPA**
  Allan is a Senior Building Code Specialist at the NFPA who specialised in safety and accessibility for persons with disabilities. He provided information on these groups, including how they felt about current evacuation methods and whether lifts were a viable evacuation option.
- **Tracy Vecchiarelli – NFPA**
  Tracy is an Associate Fire Protection Engineer at the NFPA and provided information on the NFPA's current building codes.
- **Erica Kuligowski, PhD – NIST**
  Erica works at the Engineering Laboratory at the NIST (National Institute for Standards and Technology) in Maryland. She is a Fire Protection Engineer in the Engineered Fire Safety Group of the Fire Research Division. She studied the evacuation of the 2001 New York World Trade Centre (WTC) disaster and the 2003 Rhode Island Night Club Fire. She provided information on modelling fire evacuations based on people movement and human behaviour in fires, particularly in high-rise buildings.
- **Johannes de Jong – KONE**
  Johannes is the head of technology of KONE Major Projects, a division of KONE Industrial Ltd., with international headquarters situated in Finland. KONE is one of the largest elevator manufacturers in the world, so he was able to provide information regarding the manufacture and implementation of these lifts.
- **Robert Llewellyn – AFAC**
  Robert is a Fire Protection Specialist and Community Safety Manager at the Australasian Fire Authorities Council (AFAC). He has been involved in research related to fire suppression, smoke alarms, and smoke spread through penetration.
- **Matthew Wright – FPA**
  Matthew has been the Chief Technical Officer and Deputy CEO at the Fire Protection Association Australia (FPAA) since October 2010. He has earned degrees in building

surveying, Performance-Based Building and Fire Codes, and Building Fire Safety and Risk Engineering. He has engaged with advisory committees and special interest groups to harness their contributions. In addition to attending the NFPA conference in 2011 to gain insight on how to strengthen FPAA policies, Matthew has presented on the importance of maintenance and sustainability of building design.

- **Jason Averill – NIST**
  Jason is a Supervisory Fire Protection Engineer at the NIST whose area of research focused on assessment of fire hazards to building occupants. Mr. Averill has researched occupant movement and behaviour during egress.
- **Deputy Chief John Sullivan – Worcester Fire Department**
  John has been involved in the Worcester Fire Department for 24 years and has a lot of experience with fire services. He provided insight into the current methods used by fire-fighters in the US to extinguish fires, evacuate civilians safely, and transport persons with disabilities to safety.
- **Bruce Bromley – Equal Access PTY LTD**
  Bruce is a disability advocate who inspects buildings to make sure that they comply with legislation and building codes accommodating persons with disabilities. He provided information on concerns that persons with disabilities would have with these lifts.
- **Richard Bukowski, P.E. – Rolf Jensen & Associates (RJA)**
  Richard served the US federal government as a research fire protection engineer for 35 years before becoming a senior consultant at RJA. His work at RJA includes worldwide projects in regards to code compliance on issues such a mass notification systems and performance-based design. He informed us of current international building policies that relate to the use of lifts.
- **Holly Ault – WPI**
  Holly is an Associate Professor at WPI in the Mechanical Engineering department. Her research interests include the development of tools to aid persons with disabilities, including work on wheelchairs. She provided information regarding the needs of persons with disabilities and understanding of how their considerations are used in the development of tools to aid their mobility.
- **Mike Aghajanian – UCI**
  Mike was the Managing Director of PRTM, a firm globally recognised in the areas of operational strategy, customer experience excellence, supply chain management, and product innovation. From his years of experience, he informed us on best practises for the development and presentation of seminars.
- **John Kennedy – ABCB**
  John is the Director of Projects and Research at the ABCB and the author of the handbook *Lifts Used during Evacuation*. He was a vital resource in understanding how the handbook and DP7 were developed and approved by the ABCB.
- **Karen Boyce, PhD – University of Ulster**

Karen is a Senior Lecturer at the University of Ulster. She is an expert in the movement of people with disabilities and a vital resource to understanding how lift use could affect their egress.

- **Cihan Soylemez – MFB**
  Cihan is a Senior Fire Safety Engineer at the MFB. He provided insight into maintenance issues for lifts and the need to sprinkler-protect buildings. He is an advocate for a holistic view of building design.
- **John Whitfield – LESA**
  John is the President of Lift Engineering Society of Australia. He provided insight into the issues with lift design that would need to be addressed with the inclusion of evacuation lifts into building designs and problems that might be encountered.
- **Paul Waterhouse – Property Council of Australia**
  Paul is the Executive Director of National Policy at the Property Council of Australia. He is an expert, as Executive Director, in policy issues related to property including building regulations and emergency management.
- **Christine Iliaskos – MFB**
  Christine is a Senior Fire Safety Engineer at the MFB. She had attended several of the review sessions for DP7 and had previously sent in recommendations for the MFB regarding the ABCB handbook. She provided vital information on DP7's development and acceptance into the BCA.
- **Stephen Doran - CFA**
  Stephan is a Fire safety engineer at the Country Fire Authority and with the Society of Fire Safety (SFS). He also worked with STEPS modelling for evacuation in hospitals and airports. He provided information of the role that fire engineers play in building design.

Appendix 2 – Key informant Interview Questions

NFPA

Do the evacuation elevators make a difference during emergencies?

Do you think that engineers, fire-fighters, and building managers would be open to the use of elevators during egress?

Would you recommend a requirement for egress elevators in the US? Would it be a beneficial addition to egress protocols?

What concerns would the NFPA have if evacuation elevators were required for building designs?

For a fire protection engineer, what are your main concerns regarding the use of protected elevators during fire emergencies? How would this affect your work?

For a fire fighter, would a requirement for evacuation elevators be beneficial?

What concerns would a designer have if protected elevators were a requirement in building design?

Would you predict that persons with disabilities would use elevators during fires? Why or why not?

> Would they feel safe in an elevator? Or would they feel safer in an egress chair?
>
> In an emergency situation, do you think that persons with disabilities would be given priority over able-bodied persons to use the lifts?

Who else should we interview to obtain opinions on the use of elevators in evacuation?

Erica Kuligowski, PhD – NIST

In your paper "Evacuation of People with Disabilities on Stairs" self-evacuation without assistance, assistance using a cane, assistance from another occupant or a fire fighter, and assistance using an evacuation chair were considered. Was there any particular reason why elevators were not included as an exit strategy?

Would evacuation lifts be beneficial for evacuation of persons with disabilities?

How would elevator use affect the evacuation time of persons with disabilities?

From the human behaviour side, what is the likelihood that able-bodied people would give priority to persons with disabilities to use the elevator during a fire emergency?

What could one do, in order to create a social norm applicable to fire emergencies, to ensure that persons with disabilities would get priority for elevator use?

What concerns would you have if emergency elevators were required for building designs?

What policies do you think could be put in place in order to ensure the effectiveness of lift use during egress?

Who else would you recommend that we talk to about elevator use in evacuation?

Johannes de Jong – KONE

In our project, we are exploring the use of lifts for occupants and emergency services personnel during evacuation.

> What are the advantages and disadvantages of utilising lifts during an emergency?
>
> What design changes, if any, would be needed to the lifts in order to make them suitable for use by building occupants during evacuation?
>
> How would the operation and programming of lifts have to change to enable lift use by building occupants during evacuation of high-rise buildings?
>
> How would the utilisation of double-deck lifts affect evacuation?
>
> Would using double-deck lifts as evacuation lifts be useful for evacuation of high-rise buildings?

What do you think about the incorporation of lifts into evacuation strategies for persons with disabilities?

Who else would you recommend that we consult to gain more information regarding the use of lifts during evacuation?

Robert Llewellyn – AFAC

What is AFAC's position on the use of evacuation lifts by building occupants during emergencies? What are the concerns you have for DP7, other than those listed in the handbook regarding sprinkler systems and having the lift pass fire-affected floors?

In what ways will the FBIM be affected by the implementation of DP7 if evacuation lifts are to be integrated into building designs?

How will the traffic flow of building occupants utilising evacuation lifts affect the fire brigade?

What do you think the most effective approach to informing building occupants that they can utilise evacuation lifts during emergencies per DP7 would be?

What method is used, if any, to inform persons with disabilities of building evacuation strategies when they are visiting an unfamiliar building? Would this change with DP7, and if so, how?

After reviewing evacuation models created by Ed Galea, we have learned that evacuation lifts can reduce building evacuation times by up to half. Despite the inherent risks for building occupants, do you think that the reduction in evacuation time will make utilising lifts for building evacuation worthwhile?

What adjustments do you think could be made to building evacuation plans to counter the risks of lift utilisation during emergencies?

Who else would you recommend we talk to about lift use during evacuation?

Matthew Wright – FPA

With the inclusion of emergency evacuation lifts, as per DP7, do you believe that maintenance and recording the performance of these lifts should happen more frequently?

What lift maintenance issues are most likely to occur for evacuation lifts? Will building owners have the knowledge to fix these issues?

Do you believe that National Harmonisation (i.e. all buildings' regulations would be the same) will be possible among all buildings that choose to employ these lifts? What are the potential challenges?

In your opinion, do you believe that maintenance personnel will be able to collaborate effectively with other groups in the design process to ensure that lifts operate effectively in high-rise buildings? You had included a chart that showed how each group feeds into each other.

Are there any other issues or concerns that you have related to lift use during evacuation that we have not touched upon yet?

Could you give us contact information for any other experts with whom we could consult to gain more information?

Jason Averill – NIST

In "Building Occupant Safety Research" (2012), you addressed the lack of consideration of occupant movement and behaviour, needs of emergency responders, and evolving technologies during emergency egress.

Which stakeholder groups lack consideration regarding the movement of people, needs of emergency responders, and evolving technologies?

Why do you think that these factors are not taken into consideration?

How will persons with disabilities be located during an emergency if they move to an area of refuge? How will fire personnel be able to locate them to assist their evacuation?

Do you think that integrating the use of evacuation elevators into all building designs will enhance/reduce the quality of egress performance?

How will egress elevators prioritise mobile versus immobile building occupants during emergency egress? What measures will prevent mobile occupants from using the elevators and subsequently preventing immobile building occupants from gaining access to the elevators?

Which egress method provides the safest form of evacuation for persons with disabilities? Does this method allow for the independent egress of persons with disabilities or must they rely on other building occupants/fire personnel to evacuate?

Who else would you recommend for us to contact to gain more information regarding the behaviour of building occupants during emergency egress?

John Sullivan – Worcester Fire Department

During an emergency in a multi-story building, under what circumstances would elevators be used?

> If you use the elevator, what steps are taken before the elevator is employed?

What effect do elevators have in the spread of smoke and fire throughout the building? How does this compare to stairwells?

When fires are being extinguished, is there any effort made to limit smoke and water infiltration to the elevator shafts?

What methods are used to remove persons with disabilities from a multi-story building?

When persons with disabilities wait in areas of refuge, how do you know how to find them?

Hypothetically if elevators were incorporated into evacuation strategies, would elevator use by occupants for evacuation impede fire-fighters from reaching the fire?

What concerns would you have if elevators were incorporated into evacuation strategies for persons with disabilities?

> Is there anyone that you would suggest we talk to about elevator use to gain more insight into any strategic issues elevator use could present?

Bruce Bromley

Describe how persons with disabilities and mobility impairments currently evacuate during building emergencies.

What is your opinion on current evacuation procedures for persons with mobility impairments? Are they sufficient? How do you believe they should be improved?

What do you think of the new building regulation, DP7, which will permit the use of lifts during evacuation?

How do you envision the use of lifts during emergencies by persons with disabilities?

Under what circumstances do you think that persons with disabilities would choose to shelter in place as opposed to using the lifts or evacuation chairs?

Lifts have inherent risks associated with their use including entrapment or asphyxiation due to smoke accumulation in the lift. Would persons with disabilities use a lift if they knew of the dangers involved with them?

What is the procedure used to evacuate persons with disabilities from a floor beneath the fire floor? Are different evacuation chairs currently used?

Are there any other concerns you have with DP7 that we have not yet addressed?

Who else should be contact for more information on lift use for evacuation?

Mike Aghajanian – UCI

Of all the presentations you've done, did you find that there was a common format, such as with lengths and breaks that seemed most effective?

How did you determine what would work best for your audiences format-wise?

> Do you believe that we could do the same, or that it would be best to accomplish this through other means?

You've commented on this before, but do you believe that there are better alternatives to PowerPoint presentations?

> Can you see any merit in doing a PowerPoint, monetary savings aside?

In communicating with your audience, was your speaking manner (word choice) affected by who this audience was, or was it consistent among your presentations?

What usually worked best when planning your presentations? Was it best to follow a rigid schedule or to have some flexibility in regards to when topics were covered?

Is there anything else that we should have asked about that we didn't?

Professor Holly Ault – WPI

Throughout your career you have developed lift devices with MQP students to assist the movement of persons with disabilities (wheelchair lift, athletic standing assistance, powered devices for wheelchairs).

What devices do you think would be helpful in assisting building evacuation of persons with disabilities?

> How quickly could these devices be readied, or would the persons already be in them? Would such persons still be able to escape in time?

How can you account for the wide range of disabilities and conditions, such as blindness, paralysis, or mental conditions? Is it possible to aid all of them to the same extent or in the same way?

What technical limitations exist for persons with disabilities when evacuating from a building with mandatory assistance by a wheelchair?

What technical strategies do you think could be implemented to facilitate the evacuation of persons with disabilities using evacuation lifts?

Do you believe these lifts are at a point where persons with disabilities would be able to evacuate independently, or would they still require assistance to use them effectively?

Is there anything else that we should have asked about that we didn't?

Cihan Soylemez – MFB

How will the traffic flow of building occupants utilising evacuation lifts affect the fire brigade?

What ways do you think evacuation lifts will affect building evacuation strategies?

How do you think that wardens or emergency services personnel will be able to identify the location of building occupants utilising evacuation lifts?

How do emergency services personnel currently identify the location of persons with disabilities who may be within a building?

How would the use of evacuation lifts impact the evacuation of persons with disabilities?

What measures, if any, are utilised by fire personnel to guard against lift failure?

What concerns do you have with the use of evacuation lifts during emergencies?

> Do you think that evacuation lifts will decrease evacuation time or just pose an unnecessary risk as of now?

What questions do you wish we asked or believe we would benefit from?

John Whitfield – LESA

What design changes would need to be made to the lifts in order to make them suitable for use by building occupants during evacuation?

How, if at all, would the operation and programming of lifts have to change to enable building occupants to use lifts in evacuation of high-rise buildings?

What mechanism(s), if any, are currently available to detect fire/smoke floors and signal the lift to pass these floors?

What communication systems do you know about that allow building occupants to communicate with emergency services personnel while inside of a lift? Would these systems need to be changed or improved in order to use lifts for emergency evacuation?

What measures, if any, are utilised to guard against lift failure? What safety features are incorporated into the lift design to mitigate the effects of potential failures?

> When lifts fail during an emergency evacuation, what can be done to re-activate the lift?
>
> Is there usually a back-up power supply or does the lift stop as is?

Do you believe these lifts will be suitable for use by persons with disabilities? Why or why not?

How do you recommend that evacuation lifts be protected against fire and smoke?

AFAC recommends that buildings using evacuation lifts also be protected by sprinklers. How will lift designs change in order to protect the lifts and lift shafts from accumulation of sprinkler water?

Are you familiar with DP7? How do you think this new regulation will affect lift designs, control systems, and maintenance?

Is there anything else about the design of lifts for use during emergency evacuation that you think we should know?

Can you direct us to more life engineers/ lift manufacturers? Building surveyors?

Karen Boyce – University of Ulster

In our project, we are exploring the use of lifts for occupants and emergency services personnel during evacuation.

What are the advantages and disadvantages of utilising lifts during an emergency?

How do you think occupant traffic would affect emergency services during an emergency?

Would it be best to restrict lift use to only immobile occupants? Would it be better strategically to increase the size of the lift or have mobile occupants use the stairs in multi-storey buildings?

What do you think is the best way to train people for evacuation in high-rise buildings since full-building emergency drills are difficult to conduct?

HEED analysed factors like fatigue, group formation, and perception of risk for the World Trade Centre disaster, how will the information be used to improve evacuation modelling?

> Which factor was found to influence response time and travel speed the most in the World Trade Centre? What factors reduced travel speed most, behavioural or environmental factors?
> Where do people tend to go when the familiar exit routes are blocked during evacuation, such as in the World Trade Centre?

How could we improve the response phase of evacuation in high-rise buildings during emergencies?

Who else do you recommend that we contact to gain more information regarding human behaviour during emergency evacuation and the use of evacuation lifts?

Steve Doran – CFA/SFS

How effective do you think DP7 will be? What do you think DP7 will actually accomplish?

When are evacuation strategies created relative to the creation of the building design?

What role do fire engineers play in the creation of evacuation strategies?

What design features can be incorporated into lifts to mitigate issues and will they be practical?

How often do you suggest maintenance should be performed on evacuation lifts? What are possible maintenance issues that will arise?

In a hospital setting, do you think it is best to keep persons with disabilities in areas of refuge or to use lifts to facilitate their evacuation? In your opinion, is it worth the risk to allow persons with disabilities to use lifts for self-evacuation?

In your opinion, do you think that wardens will actually be available during emergencies? What do you think is the ideal method for persons with disabilities to use to evacuate a building? Should every person with disabilities utilise a PEEP?

Do you know any other fire brigades that we can talk to in metropolitan areas?

Appendix 3 –Disability Advocate Interviews

Describe how persons with disabilities and mobility impairments currently evacuate during building emergencies.

What is your opinion on current evacuation procedures for persons with mobility impairments? Are they sufficient? How do you believe they should be improved?

What do you think of the new building regulation, DP7, which will permit the use of lifts during evacuation?

How do you envision the use of lifts during emergencies by persons with disabilities?

Under what circumstances do you think that persons with disabilities would choose to shelter in place as opposed to using the lifts or evacuation chairs?

Lifts have inherent risks associated with their use including entrapment or asphyxiation due to smoke accumulation in the lift. Would persons with disabilities use a lift if they knew of the dangers involved with them?

What is the procedure used to evacuate persons with disabilities from a floor beneath the fire floor? Are different evacuation chairs currently used?

Are there any other concerns you have with DP7 that we have not yet addressed?

Who else should be contact for more information on lift use for evacuation?

Appendix 4 – Stakeholder Interviews

Building Owners/Managers

How involved in the building design process of your building were you?

When did you begin to develop the evacuation plans and with whom did you develop them?

What kinds of compromises did you have to make in the building design process? Did you have to alter your plans once the fire safety engineers or lift engineers got involved in the design?

Do you think that it would be beneficial to permit the use of evacuation lifts in the design of multi-storey buildings?

How do you think that the incorporation of evacuation lifts would impact the design of a new multi-storey building?

What concerns would you have if evacuation lifts were incorporated into emergency evacuation strategies?

In your opinion, what measures do you think are necessary to educate building occupants and staff in lift use for emergency evacuation?

Currently, what is the evacuation strategy of your building? What is your current plan to help persons with disabilities to evacuate a building?

What measures would ensure that persons with disabilities gain access to an evacuation lift during an emergency?

How often do you perform fire drills in your buildings?

Do you think that wardens would be necessary to facilitate evacuation, or do you think that the occupants would be informed enough to make safe decisions?

Can you think of any other concerns/comments related to the use of evacuation lifts that may be helpful for our project?

Do you know any other building owners or managers that we could talk to about their involvement in the building design process and development of evacuation strategies?

Lift Engineers

In your opinion, could passenger lifts safely be used during emergency evacuation?

What extra provisions and specifications would need to be in place for a lift to be used in emergency egress?

Do you believe that there can be effective regulation of evacuation lift design and implementation with Alternative Solutions alone?

Are you familiar with DP7? How do you think this new regulation will affect lift designs, control systems, and maintenance?

> How practical is it to smoke-isolate the lift shaft and lobby?
>
> How practical is it to drain all water away from the lift shaft? Is it worth the cost?
>
> What kinds of communication systems would be necessary in the lifts to make them safe?

What mechanisms are currently available to detect fire/smoke floors and signal the lift to pass these floors?

Do you think any changes would need to be made to maintenance reviews for these lifts?

What communication systems do you know about that allow building occupants to communicate with fire services personnel while inside of a lift? Would these systems need to be changed or improved in order to use lifts for emergency evacuation?

What measures are utilised to guard against lift failure? What safety features are incorporated into the lift design to mitigate the effects of potential failures?

Do you believe these lifts will be suitable for use by occupants in high-rise buildings? What about persons with disabilities?

How do you recommend that evacuation lifts be protected against fire and smoke?

How will lift designs need to change in order to protect the lifts and lift shafts from accumulation of sprinkler water?

Can you direct us to more lift engineers/ lift manufacturers?

Fire Services Personnel

What are the risks associated with the use of lifts during a fire?

During an emergency, what is the difference between evacuation protocols utilising lifts from high-rise buildings as opposed to low-rise buildings?

What is the difference between evacuation utilising lifts from commercial and residential high-rise buildings?

During an emergency, how do you currently evacuate persons with mobility impairments?

How does distribution of building occupants, such as more persons with mobility impairments, as would be expected in a hospital, affect how the fire brigade facilitates evacuation?

When persons with disabilities wait in areas of refuge, how do you know how to find them?

What reservations or concerns, if any, do you have about occupants being able to use lifts to evacuate?

Are you familiar with DP7? How do you think this new regulation will affect the way that the fire brigade conducts fire rescue?

Any other comments/ concerns not discussed?

Architects and Building Designers

During what part of the design process did you begin to develop the evacuation plans and with whom did you consult?

What kinds of compromises did you have to make in the building design process? Did you have to alter your plans once the fire safety engineers or lift engineers got involved in the design?

How early did fire engineers get involved?

How do you think that the incorporation of evacuation lifts would impact the design of a new multi-storey building?

What extra provisions and specifications need to be in place for a lift to be used in emergency egress?

Are you familiar with DP7? How do you think this new regulation will affect lift designs?

Have you come across any buildings that use Alternative Solutions to satisfy performance requirements so that evacuation lifts could be incorporated into building designs?

Can you think of any issues that weren't properly addressed by the Alternative Solutions?

If a prescriptive guideline was available for the use of lifts during evacuation, what considerations do you believe should be made?

Can you think of any other issues that may be encountered during the implementation of lifts for evacuation, such as during the development of evacuation strategies?

Can you direct us to more architects or building designers?

Fire Safety Engineers

Currently at what point in the building design process do you typically get involved and how much input do you have into the building's overall design?

What kinds of compromises do you typically have to make in the building design process?

Do you have input in the formation of evacuation strategies? If so, please describe your involvement.

Do different design considerations need to be made for passenger and evacuation lifts?

The inclusion of such a lift in a building would impact the resulting evacuation strategies. How easily do you believe these lifts could be implemented into evacuation strategies?

Do you believe that Alternative Solutions that permit the use of evacuation lifts provide enough guidance and address associated issues?

What extra provisions and specifications need to be in place for a lift to be used in emergency egress?

In what types of buildings would you recommend the incorporation of evacuation lifts into a building design?

How do you feel about the use of evacuation lifts during a fire emergency?

Under what circumstances would you feel safe using a lift during a fire emergency?

Can you direct us to more fire safety engineers?

Building Surveyors

Can you elaborate on your role in the design process and your interactions with fire safety engineers in evaluating a building's design?

What qualities do you look for when determining if a lift's design satisfies the performance-based codes and Deemed to Satisfy provisions?

Do you look for provisions in the emergency evacuation plan for persons with disabilities, and if so, what criteria do you consider in determining whether the plan addresses their needs?

Would you have any concerns if evacuation lifts for occupant evacuation were incorporated into emergency procedures for multi-storey or high-rise buildings?

Can you elaborate on the kinds of issues that need to be addressed in order to ensure the safety of building occupants utilising lifts for emergency evacuation?

Do you think that it will be possible to properly implement lift use for emergency egress and regulate its incorporation into evacuation strategies?

What kinds of considerations would you use to evaluate the safety of evacuation lifts and its associated evacuation plan? Do you think that new standards would be necessary to do so?

With the absence of a DTS, can evacuation lifts be appropriately addressed with Alternative Solutions? Would these solutions consider all the relevant issues surrounding evacuation lifts?

Do you know any other building surveyors that we could contact, ones that may not be aware of DP7? We are trying to develop base-line knowledge of how they believe evacuation lifts should be evaluated.

Paul Waterhouse – Property Council of Australia –Building Surveyor

What criteria are currently used to evaluate the quality of egress methods and emergency plans?

What is your opinion on current evacuation procedures from high-rise buildings? What about those in place for persons with disabilities?

Are you aware of the new building code, DP7, that will permit the use of lifts for occupant evacuation?

Would you have any concerns if evacuation lifts were incorporated into evacuation strategies for building occupants?

Do you think that it will be possible to properly implement lift use for egress and regulate its incorporation into evacuation strategies?

Currently, DP7 is just a provision in the BCA, there are no Deemed-to-Satisfy provisions for it at this time. What kind of information would be useful for you to have in order to evaluate the safety of an evacuation lift and its associated evacuation plan?

What kind of policies would you suggest for the regulation of these lifts? Would you suggest any changes to their certification, or would you treat them as a passenger or emergency lift for the purposes of lift inspection?

Do you know any building surveyors that you would recommend we talk to? We would like to be able to determine their perspective on additional information necessary for evaluating the safety and use of evacuation lifts.

Anonymous Building Surveyor

What qualities do you look for when determining if a lift's design satisfies the performance-based codes and Deemed to Satisfy provisions?

Do you look for provisions in the emergency evacuation plan for persons with disabilities, and if so, what criteria do you consider in determining whether the plan addresses their needs?

Are you aware of any buildings that currently utilise lifts during evacuation as an Alternative Solution?

Would you have any concerns if evacuation lifts for occupant evacuation were incorporated into emergency procedures for multi-storey or high-rise buildings?

Can you elaborate on the kinds of issues that need to be addressed in order to ensure the safety of building occupants utilising lifts for emergency evacuation?

Do you think that it will be possible to properly implement lift use for emergency egress and regulate its incorporation into evacuation strategies?

What kinds of considerations would you use to evaluate the safety of evacuation lifts and its associated evacuation plan? Do you think that new standards would be necessary to do so?

With the absence of a DTS, can evacuation lifts be appropriately addressed with Alternative Solutions? Would these solutions consider all the relevant issues surrounding evacuation lifts?

Do you know any other building surveyors that we could contact, ones that may not be aware of DP7? We are trying to develop base-line knowledge of how they believe evacuation lifts should be evaluated.

Arnell – Building Manager

How often do you perform fire drills in your buildings and how do you conduct them?

Do you think that it would be beneficial to permit the use of evacuation lifts in the design of multi-storey buildings?

How do you think that the incorporation of evacuation lifts would impact the design of a new multi-storey building?

What concerns would you have if evacuation lifts were incorporated into emergency evacuation strategies?

In your opinion, what measures do you think are necessary to educate building occupants and staff in lift use for emergency evacuation?

Currently, what is the evacuation strategy of your building? What is your current plan to help persons with disabilities to evacuate a building?

Do you think that lift use should be used for just persons with disabilities or for all building occupants? How would you ensure lift prioritisation for persons with disabilities during an emergency?

Do you think that wardens would be necessary to facilitate evacuation, or do you think that the occupants would be informed enough to make safe decisions?

Can you think of any other concerns/comments related to the use of evacuation lifts that may be helpful for our project?

Do you know any other building owners or managers that we could talk to about their involvement in the building design process and development of evacuation strategies? Do you have any contacts in an aged-care facility or hospital?

Karl Degering – Architect

During what part of the design process did you begin to develop the evacuation plans and with whom did you consult

What kinds of compromises did you have to make in the building design process? Did you have to alter your plans once the fire safety engineers or lift engineers got involved in the design?

Currently, what evacuation strategies are utilised by persons with mobility impairments during emergency evacuation?

Can any passenger lift, as is, safely be used during emergency evacuation?

Do you think that it would be beneficial to permit the use of evacuation lifts in the design of multi-storey buildings? Do you prefer the use of stairs for evacuation?

How do you think that the incorporation of evacuation lifts would impact the design of a new multi-storey building?

What extra provisions and specifications need to be in place for a lift to be used in emergency egress?

Are you familiar with DP7? How do you think this new regulation will affect lift designs?

Do you believe these lifts will be suitable for use by persons with disabilities? Why or why not?

Do you believe you will encounter any issues when integrating evacuation lifts into building designs?

> What information do you think you would need to incorporate such a lift into a building design if there is only a performance-based code relating to its considerations?

Do you believe that Alternative Solutions or performance-based codes that permit the use of evacuation lifts provide enough guidance and address associated issues?

Can you direct us to more architects or building designers?

Appendix 5 – Stakeholder Survey

Evacuation Lift Concerns

This year the ABCB will be releasing a new performance requirement, DP7, that will permit the use of lifts for evacuation. We would like to know the main concerns that you have, as a professional, for their use. We would also like to know any additional considerations that you believe would need to be made regarding the building design process or the creation of evacuation strategies.

* Required

What is your job category? *

Lift Designer/Engineer
Architect
Fire Services
Fire Safety Engineer
Building Owner
Building Manager
Building Surveyor
Disability Advocate
Other:_____

Do you have any additional concerns or considerations?

Please list below.

Concerns or Considerations *

Please select FIVE (5) of your primary concerns from the list below regarding the use of lifts for evacuation.

- The need to educate building occupants on the use of lifts for evacuation. In the past, they have been told not to use lifts during emergencies.
- The need for emergency back-up power generators for the lift.
- The need for fire and smoke isolation of the lift lobby and shaft.
- The need for water isolation of the lift shaft.
- The need for collaboration among fire engineers, building owners/managers, and the design team for all stages of the building design process and development of emergency plans.
- The need for alternative evacuation strategies.

- The need for wardens to aid in evacuation, direct occupants, and facilitate lift use for persons with mobility impairments.
- The need for regular maintenance of evacuation lifts after their commissioning.
- The need for consistent signage indicating whether a lift can or cannot be used in an emergency.
- The need to have measures to locate persons with mobility impairments who cannot self-evacuate.
- The need to have the lift programmed for evacuation protocols.
- The need to have communication between the lift controls and the fire indicator panel.
- The need to have sprinkler protection.
- The need to establish standards for consistent evaluation of evacuation lift.
- The need to use multiple alarm systems (intercom system, sound, visual displays).
- The need to educate occupants on the use of lifts for evacuation (posters, handouts).
- Other:_____

Appendix 7 – Learning Objectives

Building Owners & Managers:

- Understand the differences between emergency lifts and evacuation lifts
- Understand relevant changes to building design due to the incorporation of evacuation lifts
- Understand what considerations need to be made in the development of evacuation strategies for persons with disabilities
- Understand the educational needs of building occupants and wardens for evacuation
- Understand how to maintain the lift and evacuation systems

Design Team (lift engineers, fire safety engineers, architects) and Building Surveyors:

- Understand lift and building design considerations
- Understand the need to concurrently devise both the building design and evacuation plans with a multidisciplinary team
- Understand that considerations for persons with disabilities should be made in building design and evacuation plans
- Understand the need for regular maintenance of lift systems

Fire services personnel:

- Understand lift operations, maintenance and use of lift systems and monitoring systems
- Understand the roles of the fire brigade and wardens
- Understand the differences between emergency lifts and evacuation lifts
- Understand the need for education on the use of evacuation lifts

Appendix 8 – Learning Assessments for Stakeholders

Learning Assessment for Evacuation Lifts
----------Lift Industry & Fire Safety Engineers----------

The following questions are intended to gauge your understanding of the material presented. Please answer every question as you are able to and turn in the survey when you are done.

Questions

1) It is permitted by DP7 to remove an exit stairwell if an evacuation lift is to be used:

   True False

2) What kind of lift is to be used by building occupants during an emergency?

   _____

   _____

3) Passenger lifts can also function as an emergency lift or evacuation lifts:

   True False

4) What considerations should be in place for evacuation lifts and emergency lifts?
   a) Water Isolation
   b) Fire Isolation
   c) Smoke Isolation
   d) All of the Above

5) Evacuation lifts should have a lift lobby that is smoke and fire isolated for at least 1 hour:

   True False

6) List some of the relevant performance requirements that should be considered for the development of an alternative solution where evacuation lifts are used:

   _____

   _____

   _____

   _____

7) Lift lobbies and shafts should be pressurised:

   True False

8) How long should lift lobbies be protected?
   a) They don’t need to be protected
   b) 30 minutes
   c) 1 hour

d) 2 hours

9) Evacuation lifts should be controlled by:
   a) Building occupants
   b) Wardens
   c) Fire Services (upon arrival)
   d) All of the Above

10) What design considerations should be made for evacuation lifts compared to those for passenger lifts? Please list as many as come to mind.

_____

_____

_____

_____

11) When designing a building, when should fire engineers and lift engineers get involved?
   a) At the beginning as part of a multi-disciplinary team
   b) After the preliminary building design has been created
   c) Once the design has been finalised

12) When should the evacuation plan be developed?
   a) Before the building design
   b) In parallel with the building design
   c) Once the building design has been finalised
   d) During construction of a building

13) It is not important to consider the life of the building when creating a building design or evacuation plan

True False

14) Circle all that apply. During evacuation planning it is important to make considerations for:
   a) Language barriers
   b) Panic or unpredictable behaviour of occupants
   c) Long lift wait times
   d) Visitors to buildings
   e) Other: _____

15) Who should be involved in the development of evacuation plans?
   a) Fire Safety Engineers
   b) Mechanical Services Engineers
   c) Lift Engineers
   d) Emergency Planning Experts
   e) Access Consultants
   f) Lift Controls Experts
   g) All of the Above
   h) None of the Above – Building Owners can do it alone

16) Circle all that apply. During an emergency, wardens are responsible for:
    a) Direct and facilitating evacuation
    b) Control the lifts
    c) Ensuring that those with PEEPs evacuate
    d) Control occupant behaviour
    e) Operate communication and monitoring systems

17) Sprinklers throughout the building are necessary if lifts are to be used for evacuation

True False

18) How should you determine the size of the lift lobby?

19) It is sufficient to have only one evacuation strategy for any building:

True False

20) What kinds of design considerations should be made for persons with disabilities? List all that come to mind:

21) What kind of signage is appropriate for an evacuation lift?
    a) Plaque that reads “In Case of Emergency, Do Not Use Lift”
    b) Plaque that reads “Lifts Available for Use During Evacuation”
    c) Display that can be changed depending on the situation
    d) Signs are not necessary

22) Evacuation plans do not need to be displayed in the building

True False

23) How long should a back-up power supply last
    a) You don’t need one
    b) As long as it takes to evacuate a building
    c) 1 hour
    d) 2 hours

24) How can water isolation of lifts be achieved?

a) Sloped floors in lift lobby
b) Drains at entrance of lift lobby
c) Water-resistant coating on electrical circuitry
d) All of the Above

25) What kinds of communication systems should be included?
a) Monitoring systems such as CC-TVs
b) Emergency phones
c) Intercom systems
d) Other backup communication. Radios, etc.
e) All of the Above

26) At minimum, how many methods of emergency communication should be in a lift car?
a) None
b) One, just the mandatory emergency phone
c) Two
d) Three
e) As many as possible

27) How often should testing of the lift occur:
a) Only during installation
b) On an as-needed basis
c) Monthly
d) Yearly, as per AS 1851
e) Once every 3 years

28) What kind of maintenance should be performed when updates to the lift programming occur? Circle all that apply.
a) Replacement of Australian software patches
b) Testing of lift programming in evacuation mode
c) Testing of all emergency systems
d) No maintenance is necessary

29) What aspects of the lift system should be tested?
a) Lift control system
b) Communication systems
c) Monitoring systems
d) Fire interface panels
e) All of the Above

30) What is the best way to test emergency systems? Circle all that apply.
a) Analysis of the individual components
b) Testing the entire emergency system as a whole
c) Routine Evacuation Exercise
d) Unannounced Evacuation Exercise

Learning Assessment Answers for Evacuation Lifts
----------Lift Industry & Fire Safety Engineers----------

1) False
2) Evacuation Lift
3) True
4) D
5) False
6) DP4, DP5, DP6, D1.2, EP1.4, E1.5, EP2.1, EP2.2, EF3.3, E3.3
7) True
8) D
9) D
10) Fire and smoke isolation, water isolation, back-up power supply, different signage, monitoring systems in the lift and lift lobby, and at least 2 communication systems
11) A
12) B
13) True
14) A, B, C, D
15) G
16) A, B, C, D, E
17) True
18) Number of occupants, Traffic flow, Equipment for persons with disabilities
19) False
20) Mobility impairments, Hearing impairments, Visual impairments. Space for wheelchairs and stretchers, Signage for the visually impaired to read, Intercom systems for the visually impaired, flashing lights and displays for the hearing impaired.
21) C
22) False
23) D
24) D
25) D
26) C
27) D
28) A, B, C
29) E
30) A, B, C, D

Learning Assessment for Evacuation Lifts

----------Fire Personnel----------

The following questions are intended to gauge your understanding of the material presented. Please answer every question as you are able to and turn in the survey when you are done.

Questions

1) What role will be expected of you (Circle all that apply)?
   a) Direct, facilitate, and aid in evacuation
   b) Extinguish the Fire
   c) Assist in the creation of evacuation plans
   d) Ensure the safety of all building occupants and visitors

2) What kind of lift is to be used by building occupants during an emergency?

   _____

   _____

3) List FOUR (4) egress strategies that are available for persons with disabilities.

4) What considerations should be in place for evacuation lifts and emergency lifts?
   e) Water Isolation
   f) Fire Isolation
   g) Smoke Isolation
   h) All of the Above

5) Who needs to be educated with the inclusion of evacuation lifts?
   a) Building occupants
   b) Building Managers and staff
   c) Fire Personnel
   d) All of the above

6) Evacuation lifts should be controlled by:
   e) Building occupants
   f) Wardens
   g) Fire Services (upon arrival)
   h) All of the Above

7) Name ONE (1) monitoring system that should be available.

   _____

8) In an emergency, it will now be possible for occupants to evacuate using lifts during the emergency.
   a) True

b) False

9) Is maintenance of evacuation lifts an important consideration?
   a) Yes, it should be done on a regular basis
   b) No, it is sufficient to test it once after installation

10) How often should testing of the lift occur:
   f) Only during installation
   g) On an as-needed basis
   h) Monthly
   i) Yearly, as per AS 1851
   j) Once every 3 years

11) What kind of maintenance should be performed when updates to the lift programming occur? Circle all that apply.
   e) Replacement of Australian software patches
   f) Testing of lift programming in evacuation mode
   g) Testing of all emergency systems
   h) No maintenance is necessary

12) What aspects of the lift system should be tested?
   f) Lift control system
   g) Communication systems
   h) Monitoring systems
   i) Fire interface panels
   j) All of the Above

13) What is the best way to test emergency systems? Circle all that apply.
   e) Analysis of the individual components
   f) Testing the entire emergency system as a whole
   g) Routine Evacuation Exercise
   h) Unannounced Evacuation Exercise

14) It is advised for fire personnel and wardens to undergo training and education for the implementation of these lifts.
   a) True
   b) False

15) Wardens are expected to be on hand at which of the following?
   a) Daylight Hours
   b) Nightly Hours
   c) All Hours
   d) Wardens are not required

16) Circle all that apply. During an emergency, wardens are responsible for:
   f) Direct and facilitating evacuation
   g) Control the lifts
   h) Ensuring that those with PEEPs evacuate
   i) Control occupant behaviour
   j) Operate communication and monitoring systems

17) What kind of signage is appropriate for an evacuation lift?
    e) Plaque that reads “In Case of Emergency, Do Not Use Lift”
    f) Plaque that reads “Lifts Available for Use During Evacuation”
    g) Display that can be changed depending on the availability of the lift
    h) Signs are not necessary

18) What do fire personnel need to understand (Circle all that apply)?
    a) How to take control of evacuation lifts and anticipate changes in traffic flow
    b) Construction and design of lifts
    c) How to find the emergency plan for a building
    d) How to operate monitoring systems
    e) The difference in cost between a passenger lift and emergency lift

Learning Assessment Answers for Evacuation Lifts

----------Fire Personnel----------

1) A, B, C, D
2) Evacuation Lift
3) Evacuation chairs, evacuation lifts, stairwells, ramps
4) D
5) A
6) A
7) Emergency phones, Intercom systems, Other backup communication. Radios, etc.
8) True
9) A
10) D
11) A, B, C
12) E
13) A, B, C, D
14) A
15) D
16) A, B, C, D, E
17) C
18) A, C, D

Learning Assessment for Evacuation Lifts

----------Building Owners & Managers----------

The following questions are intended to gauge your understanding of the material presented. Please answer every question as you are able to and turn in the assessment when you are done.

Questions

1) What kind of lift is to be used by building occupants during an emergency?

_____

_____

2) What considerations should be in place for evacuation lifts and emergency lifts?
   a) Water Isolation
   b) Fire Isolation
   c) Smoke Isolation
   d) All of the Above

3) Name TWO (2) communication systems mentioned that should be available to assist in evacuation.

_____

_____

4) What practices will be expected of you (Circle all that apply)?
   a) Attend meetings during building design process and development of evacuation strategies.
   b) Construction of the lift and its related systems.
   c) Understand how building design affects the evacuation strategies
   d) Regular training of your staff

5) It is sufficient to have one evacuation strategy in place for occupants to use.
   a) True
   b) False

6) What is the best way to test emergency systems? Circle all that apply.
   i) Analysis of the individual components
   j) Testing the entire emergency system as a whole
   k) Routine Evacuation Exercise
   l) Unannounced Evacuation Exercise

7) It is advised for fire personnel and wardens to undergo training and education for the implementation of these lifts.
   c) True
   d) False

8) Wardens are expected to be on hand at which of the following?
   e) Daylight Hours
   f) Nightly Hours
   g) All Hours
   h) Wardens are not required

9) Circle all that apply. During an emergency, wardens are responsible for:
   k) Directing and facilitating evacuation
   l) Controlling the lifts
   m) Ensuring that those with PEEPs evacuate
   n) Controlling occupant behaviour
   o) Operating communication and monitoring systems

10) Evacuation lifts are intended solely for use by and may only be used by persons with disabilities.
   a) True
   b) False

11) Software patches should be regularly installed.
   a) True
   b) False

12) What do building occupants need to know about evacuation lifts (Circle all that apply)?
   a) That they are allowed to use them
   b) That they should undergo proper training for how to use these lifts
   c) What the evacuation plan is for the building and how lifts fit in
   d) That the lifts need to be maintained to ensure consistent performance

13) You do not need to be aware of what happens during the building design process or during evacuation planning.
   a) True
   b) False

14) Who is expected to be aware of emergency procedures for your building (Circle all that apply)?
   a) Wardens/ Building Staff
   b) Building Occupants
   c) Visitors
   d) Building Owners and Managers

15) DP7 states that lifts may be used as one of the required exits.
   a) True
   b) False

16) An auditory alarm system is suitable to all building occupants and visitors.
   a) True
   b) False

17) The doors to pressurised lift lobbies and exit stairwells must be closed at all times.

a) True
b) False

18) Explain how you can prepare for an emergency.

Learning Assessment Answers for Evacuation Lifts

----------Building Owners & Managers----------

1. Evacuation Lift
2. D
3. Emergency Phone, Intercom System, Other backup communication (radios, etc)
4. A, B, C, D
5. B
6. A, B, C, D
7. A
8. D
9. A, B, C, D, E
10. B
11. A
12. A, B, C
13. B
14. A, B, D
15. B
16. A
17. A
18. Conduct evacuation exercises, keep pressurised areas closed, Inform all visitors and occupants of evacuation plans in some way (such as by displaying posters), Know locations of those that can’t self-evacuate