SUPPLEMENTAL EVACUATION FOR HIGH RISE BUILDING

This article explores the difficulties in evacuating occupants from high rise fires. This subject has received careful attention, with many international conferences to determine optimum systems and codes that help developers and stake holders to comply with their responsibility towards the tenants occupying high rise buildings. When balancing Economy with Responsibility, greater weight must be given to RESPONSIBILITY. It is imperative that Building Management accept responsibility for the safety of all occupants, and fulfil their duty by providing redundant Supplemental Evacuation that will be put to use when normal evacuation has failed or compromised. This article addresses the same issues with solutions and suggestions in adopting the concept of Supplemental Evacuation in enhancing fire safety and in getting more people out of danger more quickly.

Building Design And Construction

In the event of high rise fires, building occupants are commonly faced with danger from the rapid spread of flames and heat, smoke and toxic fumes, confusions and disorientations. In the absence of adequate care in either design or construction or maintenance of a tall building, a fire emergency may occur on a single floor and then spread to upper floors, and sometimes to neighbouring lower floors. Hence, Building designers and Building Managements must explore ways of minimizing such hazards and risks.

Modern high rise building must be designed and constructed such that any fire is either contained within one apartment or at the worst within one floor. This is a prime requirement that is assumed when designing for evacuating a building during a local or general emergency. Secondly, the premises must comply with safety standards by providing adequate smoke and heat detectors, alarms, sprinklers, water storage tanks with adequate pumping capacity at the required pressure, connected to adequate stand pipes and hoses distributed throughout the premises. Thirdly, adequate ventilation system with automatic baffles need to be put in place that will isolate the areas where a fire may have started and smoke and toxic fumes are being generated. If these systems are in place and kept in good operating condition, it is possible to control the spread of fire and heat sufficiently to allow occupiers to safely pass through to designated exit points.

Emergency Escape Routes are typically limited to the stairs. Most codes for high rise buildings requires multiple hardened stairwells that are to be fitted with fire doors and fire walls with a rating of two hours, and provided with adequate emergency lighting as well as

pressurised clean air for ventilation. The assumption for evacuation by stairs is that persons can be evacuated from each stairwell, provided there are no blockages or hindrances, and the occupants have the physical stamina to walk down from the upper floors to ground. However, evacuating people from above 50 storey building through the stairwells will exceed the physical capacity of most persons, and will also take too much time to get down and out, thus enhance risks to those who need assistance.

The long-held belief that **Lifts/Elevators** in skyscrapers should not be used in evacuations during emergencies, particularly fire. Smoky conditions, power failure, malfunctioning heat sensitive door buttons and electric eyes were all things safety experts feared could make lifts/elevators death traps. Don't use lifts/elevators in fires is one of the most successful public education [safety] campaigns in history. But in the wake of catastrophic loss of life on 9/11 and a growing trend toward taller buildings around the world, the role of lifts/elevators in mass evacuations, especially fires, is getting serious consideration.

Refuge Areas or Refuge Floors that are similarly hardened to stairwells, and placed at intervals of 5 to 8 floors, are also specified in most Code. The assumption is that residents will access the hardened stairwells, walk down without panic to the nearest Refuge Area, and await further orders for evacuation or rescue. With a travel distance limited to about 5 floors, using a hardened stairwell, it would be reasonable to assume that the physically fit will assist those with disabilities, and that the others will be patient and courteous despite their own anxieties. The occupants will stay put in that safe area and wait for further instructions by the Fire department.

Fire Lifts/Elevators are designated Lifts/Elevators that are totally enclosed and pressurized to prevent smoke entering, and also provided with special fire retardant sheathed cabling, fire suppressors, communication systems, independent power for lighting and motor operation, (also with standby power source), and operated by specially trained operators. The recent changes to the NFPA Life Safety Code for high rise buildings encourage developers to provide a bank of hardened Fire Lifts with similarly hardened Lift Lobbies & Shafts, which are connected to the hardened Stairwells. In theory, these lifts are allocated for the used by the Fire Department for evacuating the handicapped, but there is no practical way to control crowds to separate the physically fit from those needing special attention. Most individual lifts descend only 100m, with all passengers switching to the next bank of lifts descending a further 100m. It would be convenient to provide a fire lift at each Refuge Floor.

Building Management Responsibility

Common sense says an evacuation plan takes more than a red arrow indicating an exit, yet for some organizations and businesses that's all they have. If there is a fire in your building you want to get everyone out quickly. It is the Management's responsibility to evacuate ALL people from the building in an emergency before the fire engines arrives. It is NOT the Fire Department responsibility to evacuate building users. The fire-fighters will assist in the evacuation if people are still in the building when they arrive.

It is the responsibility of the Building Management to come up with a Building Evacuation Plan with a unifying theme for any eventuality where the building has to be emptied and then practice the plan with mock drills in ensuring smooth evacuation of everyone inside the building in every emergency prior to the arrival of the Fire Department. A building evacuation plan is of limited use if half of the people it is designed for do not understand their respective roles and responsibilities. Planning for building evacuation and conducting periodic fire drill/evacuation drill is important because, when confronted with a dire situation, many people simply do not know what to do or where to start. However, having contingency plans with self help that account for multiple 'what if' scenarios including alternative escape routes and modes of evacuation would minimize evacuation hazards and allowing more people to be evacuated in difficult conditions. Once the emergency is announced, it likely is too late to start a back-up plan. If the Building Management has in place a building evacuation plan and shares it with occupiers through dedicated cable TV, meetings and mock drills, it enables occupiers to become familiar with evacuation risks, evacuation routes, equipment, a list of Do's and Don'ts, and allows delegation of share responsibilities and duties.

Building Occupants And Tenants Responsibility

With self help the key, plans are successful only if all affected parties, building occupants, tenants and residents take equal responsibility to become familiar with the logistics of evacuation, and possibly, also control of fires, smoke and fumes. With this knowledge, the potential for panic is lowered and evacuation can be efficiently executed. Appropriate selection and placement of smoke and heat detectors, along with automatic and manual alarms, and adequate exit markings visible in all lighting conditions, will provide the critical early warning necessary to safely evacuate the building. While Management must be proactive in maintaining safety systems to prevent malfunction, however, occupiers must not do anything that would hinder prompt fire detection, fire fighting and rapid mass evacuation.

When occupiers are aware of the building evacuation plan that are essential for self help, have experience from mock drills, training in the use of evacuation systems and equipment that the building management provided, sharing responsibilities and duties, and information on the numbers and location of persons that may require assistance in evacuation, it is possible to estimate the time for occupants would take to reach safe zones. Typical evacuation strategy for high rise building is evacuating occupiers of the affected floors and those immediately below and those above first, and follow by the other floors if is required. The evacuees are to be evacuated via the stairwell to the nearest Refuge Area and where necessary are to be evacuated to a level about 5 floor below the fire or even to the ground. Adequate systems can then be specified to ensure that the time taken to reach safe zones is within reasonable practical limits. With self help, the risk of evacuees confusion, disorientation, panic, delay reaching safe zones, and some people may succumb to either smoke or become trapped in the fire zone would be minimized.

Worst Case Scenarios That Could Happened In A High Rise Evacuation

Fires are unpredictable, in location, intensity and rate of growth. Fire in an occupied high-rise could mean having to evacuate hundreds, or perhaps thousands, of people in difficult and dangerous conditions. For examples, having to evacuate a building in darkness due to power outage; having to evacuate people on wheelchair if the lifts is not working or if the stairway is not accessible because of smoke and fire.

If the building design conforms to modern codes for containing fires, it is possible to fight the fire before it spreads and gets out of control. Under ideal conditions, a building of good design and following good construction practices, total evacuation of a tall building can often be avoided. However, occupier psychology will rule, and total evacuation may become necessary, either because conditions become uncontrollable, or because occupiers feel safer when they actually leave the building rather than wait in a refuge zone.

There are essentially two types of risk level situations; those that don't happen very often but have huge exposure for risk, and those that happen all the time, but have lower or manageable risks. The [World Trade Center] incident was a wake-up call on the difficulty of undertaking full building evacuations for high-rise and super-high-rise buildings. Most ground conditions observed over the years suggest that a fire will spread faster than the time taken for the response team to deal with the emergency. More often than not, the response team has to come from the Fire Station, and the elapsed time is dependent on when they received the calls, traffic conditions and the number of simultaneous emergency calls to the same Station that also requires

attention. At the same time, the fire is expanding unless internal systems are able to control growth of the fire. It is for these ground realities that most Fire Department insists that tall buildings provide for internal response teams to deal with the fire prior to their arrival. One must also aware that the response team is helpless unless fire protection systems are put in place and kept in good operating condition. Often ground conditions have revealed that emergency lifts can also become unreliable at any given time, due to mechanical and electrical failure, or being engulfed in smoke and fumes.

The stairs may also be unreliable or unserviceable because occupiers use the stairwells for dumping packing or even scrap furniture, (and even inflammables), for moving furniture or other oversize or heavy goods. Scrap is often abandoned in the stairwell, and when overlooked by management, this creates congestion, obstructions, and fire hazards. Quite often careless handling of heavy goods will damage the stair treads creating conditions for a person to stumble. People in a rush is a common sight in public places, at airports, train stations, cinemas, and shopping malls, frequently pushing and bumping against those that are slower. When the stairs are partially obstructed, or are congested due to simultaneous mass evacuation, it takes only one person to push and shove leading to another person stumbling. It takes only one stumble in a crowded stairwell, to create a complete blockage on that stairwell, making further use impossible.

Even assuming that the movement of occupiers is orderly, the time allowed for evacuation is dependent on fire conditions, and the actual condition of the hardened stairwells. A disaster can happen if the stairwell is poorly lighted and poorly ventilated. The situation will quickly get out of control if there is a power outage and people have to evacuate in darkness, people tend to push and shove to get priority, causing others to stumble, creating blockages, or failing to give the space for the response team to gain access in the same stairwell to get to the fire floor.

The successful of evacuating a sky scraper is very much dependent on a combination of systems and factors, most of which are mechanical or electrical dependent such as lifts, ventilation, emergency lightings and backup power supply, etc. For example, smoke and toxic fumes will infiltrate into the remotest corners through the smallest opening. The opening and closing of the entrance to hardened areas is an easy route for smoke and fumes to enter protected areas. If that occurs, the occupiers will need to depend on pressurized air supply to keep the air breathable which is relying on mechanical equipment. It is also possible that the rate of smoke and fume ingress exceeds the actual capacity of the air blower, at that particular moment, to maintain air quality. Moreover, all mechanical or electrical equipment is subject to breakdown, and it usually happens when the equipment is most needed. Careful and regular maintenance may improve reliability but cannot guarantee 100% up time. The many system failures in the very high tech space satellite launches that we learnt, where despite the most stringent quality control, components failed in service, sometimes during the launch sequence. The recent case of the tsunami in

Japan crippled Fukushima nuclear power plant, where despite the most stringent quality and safety control, the cooling systems to the reactor were damaged by the killer wave and failed in service when they are most needed.

All of these circumstances and more that could happen in the worst case scenarios have to be planned for if the high rise building evacuation is to be successful.

The Case For Supplemental Evacuation

In anticipation of the worst case scenarios that could happened to a high rise and to minimize risk of people getting trapped, a sensible plan would be to provide redundant systems that can be put to use when all else fails. Supplemental Evacuation provides innovative solutions which will help in resolving many of the high-rise building evacuation issues not dictated by local regulations:-

1) How do you empty the total building population of a high-rise in the shortest possible time?

2) How do you get those people with physical disabilities down quickly and with minimum assistance in the absence of lift for egress?

3) How do you increase the egress capacity of a tall building that is designed for phased evacuation to facilitate simultaneous evacuations?

4) How do you escape from the upper floor when staircases are damaged and not accessible?

5) How do you provide additional emergency exit(s) or increase the size of existing stairways for mass rapid evacuation where it is not possible due to building structure?

6) How do you evacuate building population in darkness when the electricity goes out?

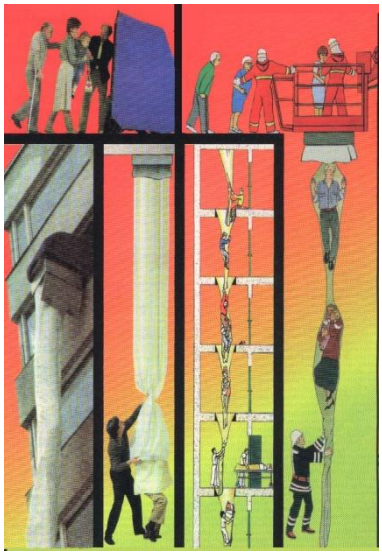
The answers are in preparedness and pre-planning for Supplemental Evacuation! The provision for Supplemental Evacuation in buildings is not a luxury but risks reduction strategy in tackling the perceived difficulties and problems of building evacuation.

In January 2009, the National Fire Protection Agency (NFPA) in the United States approved the use of “Supplemental Evacuation Technology” in high rise buildings to assist in rapid escape in an emergency. NFPA also approved the use of Supplemental Evacuation Technology in official and/or mandatory Evacuation Plans.

There are many approaches to high rise evacuation in an emergency. This article explores the typical solutions of Supplemental Evacuation that include the Ingstrom Escape Chute

systems; MARK Save A Life rescue systems; Evac+Chair; Glow In The Dark Photo Luminescent markings, evacuation signs and step nosings. The provision of supplemental evacuation products must be pre-planned and put in place in advance and be recognised as important assets in buildings of all heights.

The **Ingstrom Escape Chute** serves as both alternative and supplemental means of egress for buildings and structures when other means of escape may be damaged or inaccessible during catastrophic events. Today, Ingstrom Escape Chute is recognised by many fire authorities as a hardware solution to correct egress deficiencies and to increase egress capacity in old buildings where it is not possible to provide fire escapes or increase the size of existing stairways in its structure due to inherent limitations in design, construction, mobility or availability.



Single-Entry Escape Chute is an External Escape Chute from window, balcony and rooftop that offer a solution for blocked stairwells, and Fire Lifts. Because of the building height, and prevailing winds, the chute is now limited to 75m in height for deploying externally.

Multi-Entry Escape Chute is a Multiple Escape Chutes that are deployed inside a dedicated shaft has no height limitation. If the Fire Stairwell is designed with an inner void space between the flights, these chutes can be fitted in this void, and a separate duct will not be necessary. It would need a space of about 1.5m x 1.5m for this system to safely operate in the central void of the stairwell. Ideally, each skyscraper will have multiple stairwells with Multiple Escape Chutes provided at the core of the stairwell, with entrances at every refuge level.

Some of the important characteristics features of the Ingstrom Escape Chute are:

* No power source is required;
* Protect evacuees from fire effects;
* Can be strategically placed at evacuation sites to enhance the remoteness of egress components;
* Always available for immediate use, quick and easy to deploy;
* Can transport a continuous flow of evacuees;
* Require little or no instruction for use;
* Require little physical exertion in using the device to descend;
* Users have the ability to self-control the speed of own descends;
* Allow external means to control the speed of one's descend from ground level;
* Suitable for all ages and physical conditions of evacuees, including physically impaired people.

The **MARK Save A Life Rescue Systems** is a relatively safe, simple, low cost self-rescue 'Controlled Descent Device' that functions as an alternative means of emergency escape when needed. The systems are being used in high rise offices and hotels; individual home ownership for families in high rise apartment; small businesses in buildings with windows or glass panels that can be modified for easy removal. The systems are also used in industrial facilities such as in tower cranes, overhead crane, and cable car. The systems are also used by Fire & Rescue Department, Military for high rise recue.

The portability and flexibility of SAL's Rescue System provides an efficient and cost effective strategy to create multiple 'Escape Stations' at strategic locations in the building. This pre-plan approach of providing multiple 'Escape Stations' throughout the structure in key locations would enable everyone inside the building ready access to an evacuation system in the event of life threatening emergency. It also enables the system to be relocated to another pre-plan safer location away from fire. The system can also be moved to another office when the company moves to a new premise.

The **Evac+Chair** is an evacuation chair that has a universal evacuation solution for smooth stairway descent during an emergency. Single user operation ensures no heavy lifting or manual handling is required during emergency evacuation procedures. In the event of an emergency such an earthquake or a fire, lifts should not be used in multi-storey buildings, therefore people with a disability or who are injured maybe become trapped. The Evac+Chair is the perfect solution; it is a light weight and easy to use device which glides effortlessly down stairways to assist with the quick and safe removal of people who are mobility impaired in the event of an emergency evacuation.

The **Photo luminescent Building Evacuation Products** are egress lightings in signage, markings and step nosing. The egress lighting typically glows in the dark to define a space or path to help guide occupants in emergencies when there is little or no light so that occupants can orient themselves and identify a safe route that avoids all obstacles. Photoluminescent signs and markers are fully automatic in operation and require little maintenance. They require no electricity, other than to power the ambient light sources used to recharge them. They do not deteriorate from use and are nontoxic and non-radioactive.

Photoluminescent emergency markings and step nosing are used in office building in aiding build evacuations and they are placed on:

* All exit doors
* All doors that lead to corridors that serve as exit passageways
* The entire horizontal leading edge or side markings of all steps
* The entire leading edge of all landings
* The entire length of all handrails (in new buildings)
* The entire length of all building egress paths
* Edge markings for any obstacle that projects more than four inches into an egress path
* Step nosings inside the stairwell
* Direction signs that point towards the means of egress.
* In addition, 'not an exit' signs must be posted over dead ends in a building.

Conclusion

When balancing Economy with Responsibility, greater weight must be given to RESPONSIBILITY. It is imperative that Building Managements accept responsibility for the safety of all occupants. The governing principle is that in every emergency, saving lives must receive priority. Time is of the essence. **Self Help is the key.** Thus, every high-rise above the reach of the local Fire Department's aerial ladder truck or sky lift must be self reliant both for prevention and control of fires, and for safe evacuation of all occupiers. Building designers and Building Managements must recognize this principle. By providing adequate Supplemental Evacuation and systems for **evacuation with self help**, either to the ground or to safe zones, more people will be able to get out of the danger zone more quickly and relatively safely prior to the arrival of the response team; the Fire Department when arrive at ground zero can devote their time in concentrating on controlling and extinguishing the fire. The fire-fighters will also assist in the evacuation if people are still in the building.

Standby redundant systems that do not require power, and little skill to operate and use, offer solutions, even if it requires additional capital expenditure. The absolute cost of providing SUPPLEMENTAL EVACUATION solutions in tall buildings is quite modest when shared over the floor area or the population of the premises. Safety should never be compromised with cost when the governing principle is in saving lives in all emergencies.

For more information on Supplemental Evacuation, please visit our website: www.escapeconsult.biz