

Enhancing Building Security



Useful and Practical Measures



Building and Construction Authority



Singapore Civil Defence Force



Internal Security Department



Singapore Police Force

┌ ┌ ┌ ┌ ┌ ┌ ┌ ┌ ┌ ┌ ┌ ┌ ┌ ┌ ┌

The Fight Against Terror
Singapore's National Security Strategy

“We have committed ourselves to the global campaign against terrorism. In this, we must not waver. We may face setbacks, but terrorism cannot defeat us unless we allow it to. I am confident Singaporeans will rise to the challenge.”

Dr Tony Tan Keng Yam
Deputy Prime Minister
Coordinating Minister for Security and Defence
August 2004

BCA, SCDF, ISD and SPF are the joint authors of this publication.
No part of this publication shall be reproduced in whole or in part in any form without prior written consent.

Jan 2005

┌ ┌ ┌ ┌ ┌ ┌ ┌ ┌ ┌ ┌ ┌ ┌ ┌ ┌

Enhancing Building Security

~ Contents ~

	Page
Introduction	2
1. Provide Stand-Off Distance	4
2. Check Fire Proofing	5
3. Assess Building Resistance to Progressive Collapse	6
4. Provide Emergency Evacuation Measures	7
5. Configure Services Systems for Emergency Response	8
6. Provide Various Security Measures	9
7. Provide Reinforced Concrete Lift Shafts and Staircase Cores	10
8. Avoid Use of Scissors Staircases	11
9. Keep Air Intakes Out of Reach	12
10. Provide Smoke Stop Lift Lobbies	13
11. Provide Cell Enhancers	14
12. Provide Separation Between Higher Risk Areas and Main Building Complex	15
13. Avoid Common Lift Systems, Limit Access Points and Provide Clear Signage	16
14. Carry Out Rigorous Assessment and Analysis of Building Systems	17
15. Protect Against Flying Glass	18
Further Reading	19



Introduction

- 1 Post September 11, 2001, terrorism remains a threat for all nations including Singapore. Its shape and form have been witnessed in the tragic events reported around the world. While we cannot fully predict and prevent terrorist attacks, some measures can be taken to mitigate their effects on people and buildings should such unfortunate incidents occur.
- 2 Past events have shown that the use of vehicle bombs is a common mode of attack. In such a situation, the effect of the bomb blast would depend mainly on the quantity of explosive used, whether the vehicle is a car or a truck as well as the distance of the blast from the building.
- 3 Fire is another major threat. This could be the result of arson or the consequence of an explosion. In both cases, a large fire can result in high casualties and serious damage to the building, especially when escape or evacuation routes are blocked or damaged.
- 4 The use of chemical, biological or radiological agents could also be a mode of attack. Such agents could be brought and released into a building or introduced from outside the building through air intakes or vents.
- 5 It is difficult to determine which buildings would be at risk from an attack. In general it would likely be buildings of economic, cultural, or social importance or significance, and it could be private or public buildings.
- 6 Furthermore, even if a building is deemed to be at risk, it is not easy to specify with certainty the details of the threat as they could constantly be changing over time and it also depends on the security measures and readiness of the building.
- 7 Building owners should therefore adopt a prudent approach. A variety of possible threats should be considered and appropriate levels of security measures should be planned and provided so that in whatever form the threat takes, the effects arising from such a threat could be prevented or mitigated to as large an extent as possible.

- 8 There are currently no requirements in the building and fire codes relating to security and protection in a terrorist scenario. Building owners should decide on the extent of security provisions that they would like to have. In this connection, building owners could first seek the help of security professionals to assist them in conducting threats, vulnerabilities and risks assessment of their buildings. They could then appoint consultants to advise them on how their buildings' structural, fire protection, emergency evacuation and services system, etc, may be improved, secured and protected to address the threats and vulnerabilities.
- 9 For a new building, a combination of security measures could be employed during the design, construction or operation stages of the building as appropriate. It would involve active measures covering access control, security screening, and surveillance, as well as passive measures such as barriers and bollards.
- 10 This booklet presents several relatively simple, practical and cost effective security measures and building design considerations that could help lessen the severity of a terrorist attack on a building. The measures listed are by no means comprehensive but it hopes to serve as a useful introduction to building owners, developers, designers, contractors and other stakeholders working on enhancing the safety of our buildings.



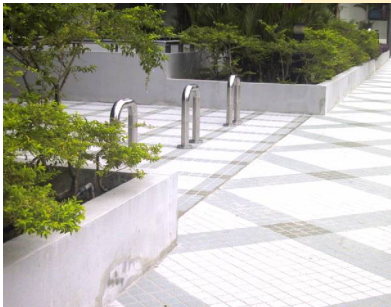
1

Provide Stand-Off Distance

Provide a stand-off distance between the building and a potential vehicle bomb as it is a most effective way of mitigating damage to the building. Stand-off distances could be achieved by passive measures such as screen walls, planter boxes, bollards, barriers, etc, or, by security measures related to access control, surveillance, detection, etc.



Low screen wall.



Planter boxes and bollards.



Bollards.

Buildings have key structural elements that help support their loads in a vital way. These key structural elements may include vertical columns, horizontal transfer beams, long span beams (of more than 20m) and cantilever structures (supported on one end only). Stand-off distances should be provided for these elements. Otherwise, if these key elements are damaged or destroyed, they could result in disproportionate collapse of the building.



Transfer beams above a car park.

2

Check Fire Proofing

Check the fire proofing insulation around structural steel members.

Steel loses its strength when exposed to the heat of a fire. The structural steel members of a building are therefore constructed with fire protection comprising an insulating layer of materials such as concrete, sprayed-on cementitious coating, dry-boarding and intumescent coating. Overtime, this protective layer may be removed, dislodged or damaged due to renovation works, ageing, water seepage and other factors. Hence periodic checks should be carried out and timely remedial action taken to make good any loss of integrity of protection of the structural steel members.



Examples of fireproofing for structural steel.

3

Assess Building Resistance to Progressive Collapse

Identify the building's key structural elements which are in close proximity to potential hazards (eg, vehicle access, fuel storage areas, etc). Assess its ability to withstand progressive collapse if one key element is destroyed and implement appropriate protective measures.

Key structural elements in potentially hazardous areas should have redundant or spare capacities. This will ensure that if one key element is destroyed, others are available to support its load. Otherwise, building damage may spread by 'domino effect' and lead to a catastrophic collapse.



Columns near vehicular traffic.



Alfred P Murrah Building, Oklahoma City, Oklahoma, Apr 19, 1995: Progressive collapse extended damage beyond that caused directly by the bomb.

4

Provide Emergency Evacuation Measures

Provide self luminescent markings where the backup power for the emergency lighting and exit signs is not of the self contained battery pack type integral with the lighting and sign fitting.



Provision of self luminescent markings along a staircase.

The fire code requires emergency lighting and exit signs to be provided with standby power supply so that in the event of a break in the normal power supply, the standby power supply will kick in to make the escape facilities visible. The standby power supply may either be in the form of a centralised source such as a generator set/central battery pack(s), or be a self-contained battery pack integral with each lighting and sign fitting.

Whilst either form of standby power supply has hitherto been reliable, the centralised source may be too easily disabled directly or indirectly in a terrorist event, leaving the escape facilities unlighted and unmarked.

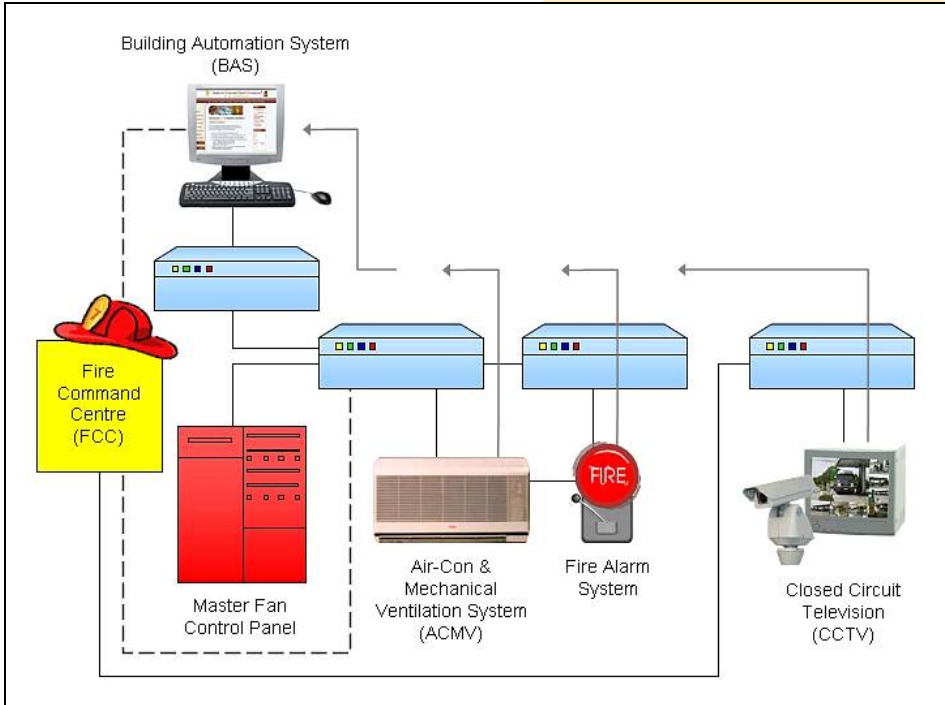
In order to have some means of directing building occupants out of the building to safety, self luminescent markings should be used in a building whose existing emergency lighting and exit signs take their standby power supply from a centralised source.

It is not intended that self luminescent markings should replace the emergency lighting and exit signs stipulated in the fire code because the emergency lightings provide general illumination and the exit signs provide better visibility from a distance. Although it is preferred that each light and sign fitting drawing its power from a central source be replaced by a fitting with its own self-contained battery pack, self luminescent markings are nevertheless a useful interim solution.

5

Configure Services Systems for Emergency Response

Configure the controls of central air-conditioning and mechanical ventilation (ACMV), and other localised systems for emergency response to stop the exchange of outdoor and indoor air quickly.



Controls for ACMV, fire and CCTV.

The central ACMV system in a building is designed to distribute air across different parts of the building, often using internal air mixed with fresh air from the outside. In the event of the release of toxic airborne substances in or outside the building, the ACMV system could spread these substances throughout the building. As part of the emergency response plan to be drawn up by the building management to such an event, the controls of the ACMV system have to be configured to prevent the spread of toxic substances throughout the building.

6

Provide Various Security Measures

Implement security measures related to access control, surveillance and detection.



Various security measures for buildings.

Access control:

Provide waiting space as far away as is practical from the building exterior for the conduct of security checks of vehicles entering the building complex.

Avoid designating visitor car park lots next to vital mechanical and electrical plants/facilities serving the building.

For premises that demand a higher level of security, a security pass system may be instituted. Public and secure areas should be clearly demarcated.

Surveillance:

CCTV cameras should be strategically positioned to focus on the building perimeter, entry/exit points and other high risk areas such as car park entrances. Signage indicating that these areas are under CCTV surveillance would serve as deterrence.

Detection:

An effective intruder alarm system supplements the physical security of the building premises. Various types of alarm systems such as magnetic contact, break-glass sensor and motion detector systems can be employed to deter and detect intrusions.

7

Provide Reinforced Concrete Lift Shafts and Staircase Cores

Design the lift shafts and staircase cores to be of reinforced concrete.



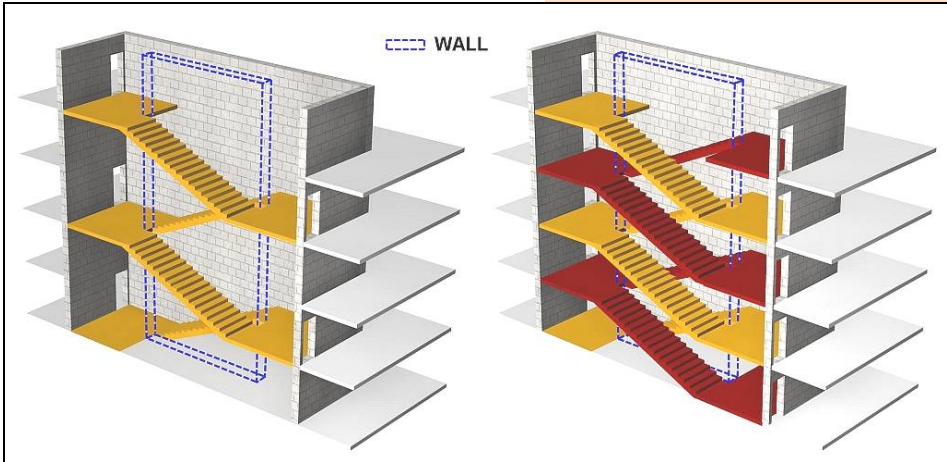
Reinforced concrete staircase cores.

Reinforced concrete lift shafts and staircase cores are better at withstanding impact and help keep evacuation and escape routes intact. They also increase the strength and robustness of the building as a whole. During an emergency, a strengthened staircase core is very important and useful as it can provide protection to occupants as the first place of refuge besides being used for subsequent evacuation by occupants.

8

Avoid Use of Scissors Staircases

Avoid the use of scissors type staircases, whatever their construction, in tall buildings or in buildings with a floor area greater than 1000m².



Regular staircase.

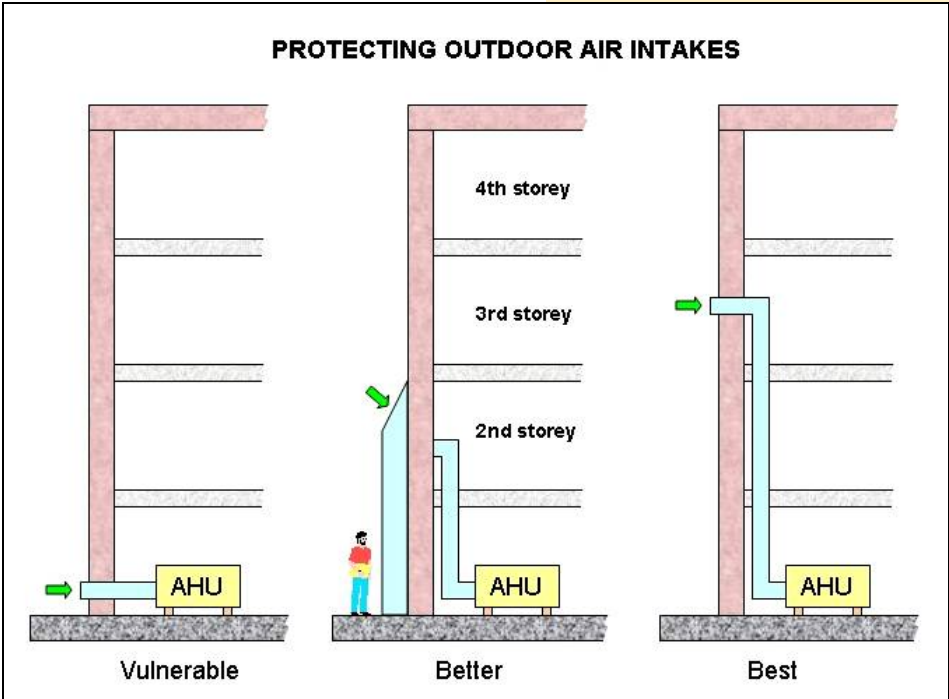
Scissors staircase.

A scissors type staircase is essentially an arrangement of putting two sets of stairs into a single staircase core. This saves space and, in the case of a small footprint building, makes layout more efficient. However, in a situation where damage occurs to the core, it is likely that both stairs in the core would be disabled. Because many tall buildings may only have two sets of stairs to satisfy their occupant load requirements, it is important that the two sets be physically separated to reduce the chance of both being disabled in a single incident.

9

Keep Air Intakes Out of Reach

Design the location and height of air intakes of air-conditioning and mechanical ventilation systems to prevent easy access by unauthorised persons.

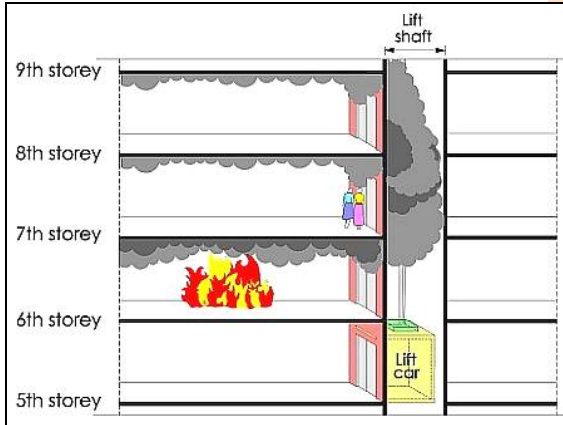


Outdoor air intakes supply fresh air to the air handling units (AHU) of a building. The AHU together with the environmental control system (ECS) of the building help circulate air into the building to keep it ventilated. These air intake openings can be vulnerable to sabotage such as chemical-biological contamination and package bombs. Hence, they should be designed out of reach to prevent easy access by unauthorised persons.

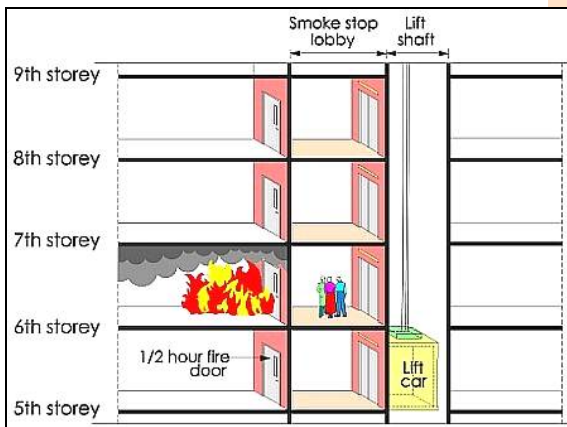
10

Provide Smoke Stop Lift Lobbies

Provide smoke stop lobbies for all lifts serving more than 4 storeys to minimise the vertical spread of smoke up lift shafts.



Without smoke stop lobby.
Smoke from fire spreads to upper storeys via lift shaft.



With smoke stop lobby.
Smoke from fire is prevented from spreading.

In many building fires, more people fall victim to smoke than to the fire itself. People become casualties due to smoke inhalation or to accidents caused by panic reaction or disorientation due to the presence of smoke. As hot smoke is buoyant, it would spread rapidly up a lift shaft and spill onto the different storeys served by the lift. A smoke stop lift lobby would reduce the possibility of smoke spreading to other floors through the lift shaft.

11

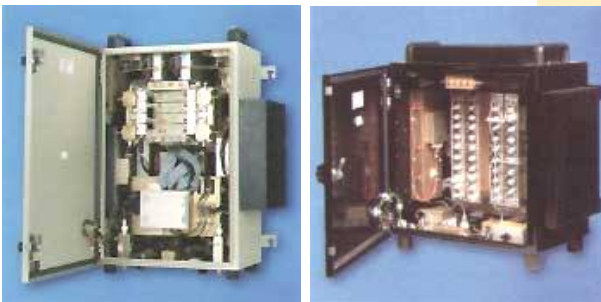
Provide Cell Enhancers

Provide cell enhancers to facilitate communication by emergency responders.



Cell enhancer system.

Deep basement floors and buildings with relatively small window openings could potentially stop radio communication with emergency responders who are inside the building. With the installation of cell enhancers, communication by radio among emergency responders becomes possible between the interior and exterior of the building and within the building between the different storeys including basement levels.

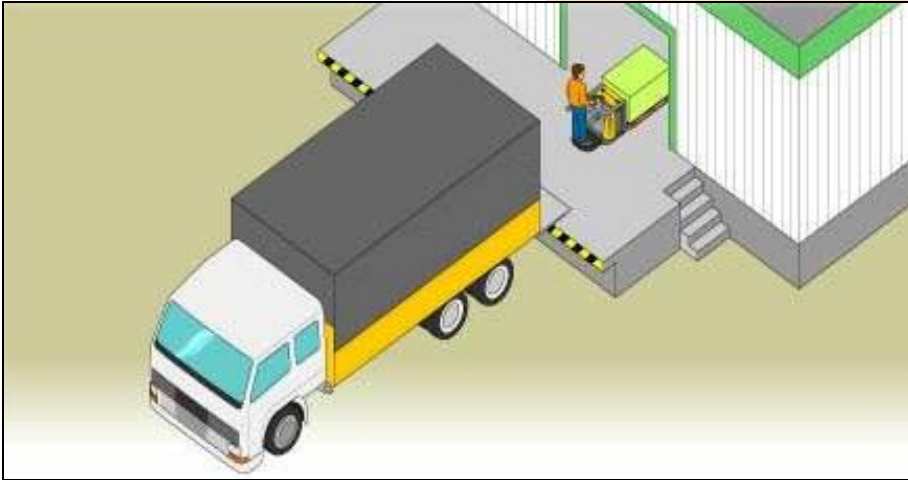


Cell enhancers.

12

Provide Separation Between Higher Risk Areas and Main Building Complex

Locate higher risk areas such as loading and unloading bays, mail rooms, car parks, etc, away from the main building complex.



Loading/unloading areas, mail rooms, etc, should be located away from the main building complex.

Higher risk areas such as the loading/unloading areas, mail rooms and car parks should be separated from the more secured areas of the building complex.

If this could not be done, loading/unloading areas should be located away from critical columns or transfer beams so that vehicles will not be driven into or parked near them.

Delivery and service vehicles serving the building complex should be scheduled, access controlled and monitored by security personnel or equipment.

13

Avoid Common Lift Systems, Limit Access Points and Provide Clear Signage

Avoid designing common lift systems, limit pedestrian path access points and provide clear directional signage.



Avoid common lift systems.

Avoid the design of common lift systems serving the car park storeys and the main building that bypass the main lobby/reception area.

Pedestrian paths should be channelled through a limited number of access points. This facilitates focused attention as well as improves the ability to see and be seen by other users.

Signage should be clear to avoid confusion and direct visitors to their destinations efficiently. If an escort service is available, signs should inform them of this service.

14

Carry Out Rigorous Assessment and Analysis of Building Systems

Carry out a more rigorous assessment and analysis of the building systems when designing a new building.



Khobar Towers, Saudi Arabia, Jun 25, 1996: The building did not suffer progressive collapse in spite of the massive bomb blast which left a large crater in the ground.



$$\begin{matrix} 510784.36 \\ 2.712372 \\ 9 = 1.73 \\ (x+y)12.5g \end{matrix} \quad x^2 + y^2 - 22x + 24y - 9 = 0$$

$$a = \pi r^2$$

For a new building, the building owner could consider carrying out a more rigorous assessment and analysis of the building's architectural and structural design, and its mechanical and electrical systems with respect to building security, robustness against impact or collapse and ease of evacuation. Additional information can be found in the references listed in the Further Reading section of this booklet.

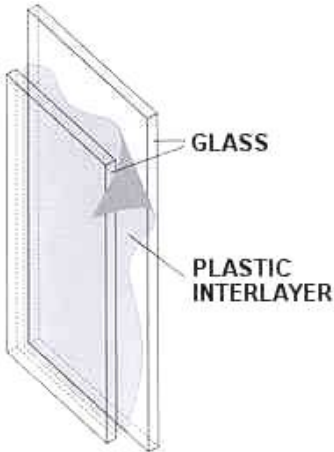
15

Protect Against Flying Glass

Design glazing systems that minimise the harmful effects of flying glass.



Glazed buildings.



Components of laminated glass.



Broken laminated glass.

Many buildings are often designed with a significant amount of glazing or glass finishes. In the event of a blast, the glass can shatter into sharp, high velocity fragments and injure occupants and passers-by. Protection against flying glass can be achieved in 3 main ways:

- Applying a transparent polyester anti-shatter film to the glass, or
- installing laminated glass which is more blast resistant, or
- installing a blast resistant secondary glazing on the inside of the existing exterior glazing.

To achieve the intended performance, care should be taken to ensure the various parts of the system, eg, glazing, frames, anchorage and supporting wall, are designed appropriately.

Further Reading

More information on the subject of building security and mitigation of terrorist attacks on buildings may be found in the following literature:

Guide to Securing Your Organisation's Security

~ Ministry of Home Affairs, Nov 2003 ~

Hotel Security, The SHA Manual

~ Singapore Hotel Association, Dec 2003 ~

Crime Prevention Through Environmental Design Guidebook

~ National Crime Prevention Council, Oct 2003 ~

The Fight Against Terror, Singapore's National Security Strategy

~ National Security Coordination Centre, 2004 ~

**Reference Manual to
Mitigate Potential Terrorist Attacks Against Buildings**

~ Federal Emergency Management Agency, Dec 2003 ~

**Primer for Design of
Commercial Buildings to Mitigate Terrorist Attacks**

~ Federal Emergency Management Agency, Dec 2003 ~



Acknowledgements

We would like to thank the following organisations for their support and contribution in the production of this booklet:

Ministry of Home Affairs

Ministry of National Development

Building and Construction Authority

Singapore Civil Defence Force

Internal Security Department

Singapore Police Force

Housing and Development Board

Urban Redevelopment Authority



┌ ┌ ┌ ┌ ┌ ┌ ┌ ┌ ┌ ┌ ┌ ┌ ┌ ┌

“...no one can guarantee that a terrorist attack will not happen here. Our approach must be to make it extremely difficult for terrorists to carry out their evil deeds while at the same time, be well prepared and ready to deal with the repercussions if such an attack does happen.”

*Minister for Home Affairs Wong Kan Seng
Addressing Parliament on 14 March 2003*

┌ ┌ ┌ ┌ ┌ ┌ ┌ ┌ ┌ ┌ ┌ ┌ ┌

Useful Contact Numbers

Building and Construction Authority
63252211

Singapore Civil Defence Force
1800-2865555

Internal Security Department
1800-2626473

Singapore Police Force
1800-2550000