MEDIA RELEASE

RELEASE OF FINDINGS FROM FINAL INVESTIGATION REPORT OF THE TAH CHING ROAD LIFT INCIDENT

Singapore, 6 November 2015 – The Building and Construction Authority (BCA) received the final investigation report from the independent Authorised Examiner (AE) appointed by Jurong Town Council, on 2 November 2015. The investigation report probes into the very unfortunate lift incident in which 85-year old Mdm Khoo Bee Hua's left hand was severed.

Findings of the Authorised Examiner (AE)

2. The AE has reviewed and analysed the CCTV footage, the specialist medical report and other evidence gathered, as well as conducted interviews. He also performed detailed inspection and tests on the lift, and simulations of how the accident could have happened.

3. He thereby reconstructed the sequence of events which are summarised as follows:

a. Mdm Khoo entered the lift while her leashed pet dog was still outside at the first floor lift lobby. She pressed the lift button to the 16th storey and the 'Close' button. The dog was still outside the lift with the leash straddled across the lift doorway when the lift doors closed.

b. As soon as the lift doors[1] closed, the lift's ascent tightened the leash that was looped around Mdm Khoo's left wrist. Mdm Khoo would have fallen onto the floor of the lift from the pull of the taut leash. The dog was also pulled upwards against the lift lobby doors till its harness buckle was caught at the top part of the lift lobby door.

c. Based on the AE's simulations, it is likely that the pull of the taut leash could have caused a fulcrum action, opening up a small gap at the base of the lift cabin doors (i.e. the inner lift doors). As the lift continued to travel upwards, the strong force of the taut leash would have caused Mdm Khoo's hand to be pulled through this small gap at the base of the lift cabin doors.

d. Her left hand, which was partially pulled through the lift cabin doors was crushed and severed between the lift cabin doors and the internal parts

[1] The lift doors comprise outer and inner doors - the (outer) lift lobby doors and the (inner) lift cabin doors.

of the lift lobby doors (i.e. between the inner and outer lift doors) before the lift came to a gradual stop. The lift came to a gradual stop as the opening of the lift cabin doors triggered the emergency stop feature[2].

e. The severed hand, which was in between the lift cabin doors and lift lobby doors, fell to the bottom of the lift pit when the dog leash was released ***(see Annex A – BCA infographics on reconstructed sequence of events).***

4. The following are the key findings summarised from the AE's report: ***(see Annex B* – Verbatim Extract of Findings of the Authorised Examiner's Final Investigation Report*)***:

a. The door protective devices (i.e. the full height safety edge and the infra-red sensor) were designed to re-open or remain open if there is an object that will hit safety edge and trigger the control to stop the door from closing or an object that will block the infra-red sensor.

b. As the dog leash was only 2mm thick, the door protective devices were unable to detect it as an obstruction in the lift doorway as the door protective devices were not designed to detect objects that were less than 10mm thick.

c. All the door protective devices were tested and verified to be working according to their specifications. The lift doors were also observed to have responded to obstructions during the rescue operation by SCDF. The door protective devices cannot be proven reasonably to have failed to function properly on the day of the incident.

d. During the lift's ascent/descent, the lift cabin doors will remain closed as power to the lift cabin doors would be cut off as an operational norm. The lift cabin doors are designed to be hung on rails at the top. If a significant force is applied at the bottom of the lift cabin doors, it can cause the doors to be prised open. The gap will be narrowest at the top and widest at the bottom, forming a slim A-shaped gap. This is likely to be what had happened during the incident - the forces resulting from the sudden downward pull of the taut leash through the bottom of the lift cabin doors when the lift was ascending could have caused a fulcrum action, opening up a small gap at the bottom part of the lift doors. Subsequently, Mdm Khoo's hand was pulled by the leash through the lift cabin doors which then opened the cabin doors further and triggered the emergency stop.

[2] The emergency stop feature is designed to cause a gradual rather than sudden stop of the lift.

AE's Recommendations

5. In the AE's final investigation report the AE has made the following recommendations:

a. To step up efforts on educating the public on safe use of lifts.

b. To work with the industry to review the settings of various safety devices in lifts, e.g. door protective devices/door re-opening devices.

BCA's Investigation and Assessment

6. BCA had reviewed the AE's final investigation report. We also conducted an independent investigation of the lift incident.

7. BCA's investigation team went through all the evidence, including the CCTV footage, statements from relevant personnel, the dog leash, the specialist medical report and other technical information and documents relating to the incident lift. BCA engineers also inspected the lift components and machinery for possible abnormalities and evidence that could be related to the injury. Detailed simulation tests were done to determine how and where Mdm Khoo's hand could have been severed. In addition, BCA conducted tests to verify that the incident lift's safety edges and sensors were working and ascertained that the lift's door protective devices complied with both the local SS550 standard and international standards. Our findings are consistent with the AE's conclusions in his final investigation report.

BCA's Follow-up Actions

8. BCA accepts the recommendations of the AE's final investigation report and will work closely with the industry and lift owners of both public and private buildings, to enhance public awareness on the precautions to observe when using lifts, including the need to keep small and thin objects - such as a dog leash or dangling straps of backpacks - away from the lift doors.

9. Lifts are part and parcel of our everyday life in Singapore's densely built-up environment. BCA will continue its regular review of the safety and maintenance standards of lifts and work closely with the industry to ensure our standards continue to be on par with the latest international standards ***(see Annex C – Factsheet on regulatory regime for lifts in Singapore).***

10. BCA has updated Mdm Khoo's immediate family members of the findings of the investigations. The Tah Ching Road lift incident is a very unfortunate one. We are saddened by what has happened to Mdm Khoo and hope that she recovers well from this traumatic experience.

Annex A – BCA Infographics on Reconstructed Sequence of Events

Annex B – Verbatim Extract of Findings of the Authorised Examiner's Final Investigation Report

Annex C – Factsheet on Regulatory Framework of Lifts in Singapore

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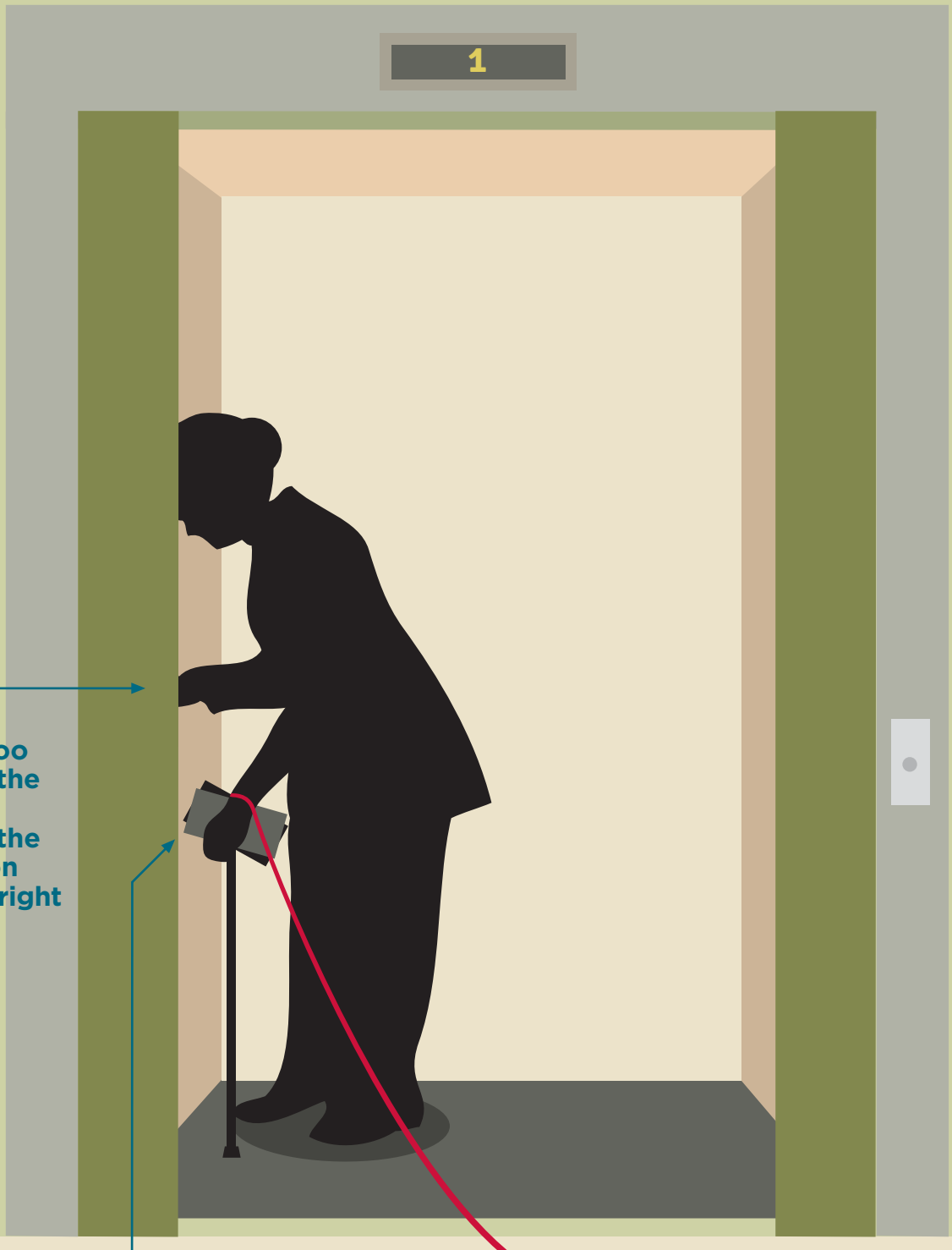
SEQUENCE 1

MDM KHOO ENTERS THE LIFT



Mdm Khoo entered the lift and pressed the lift button with her right hand

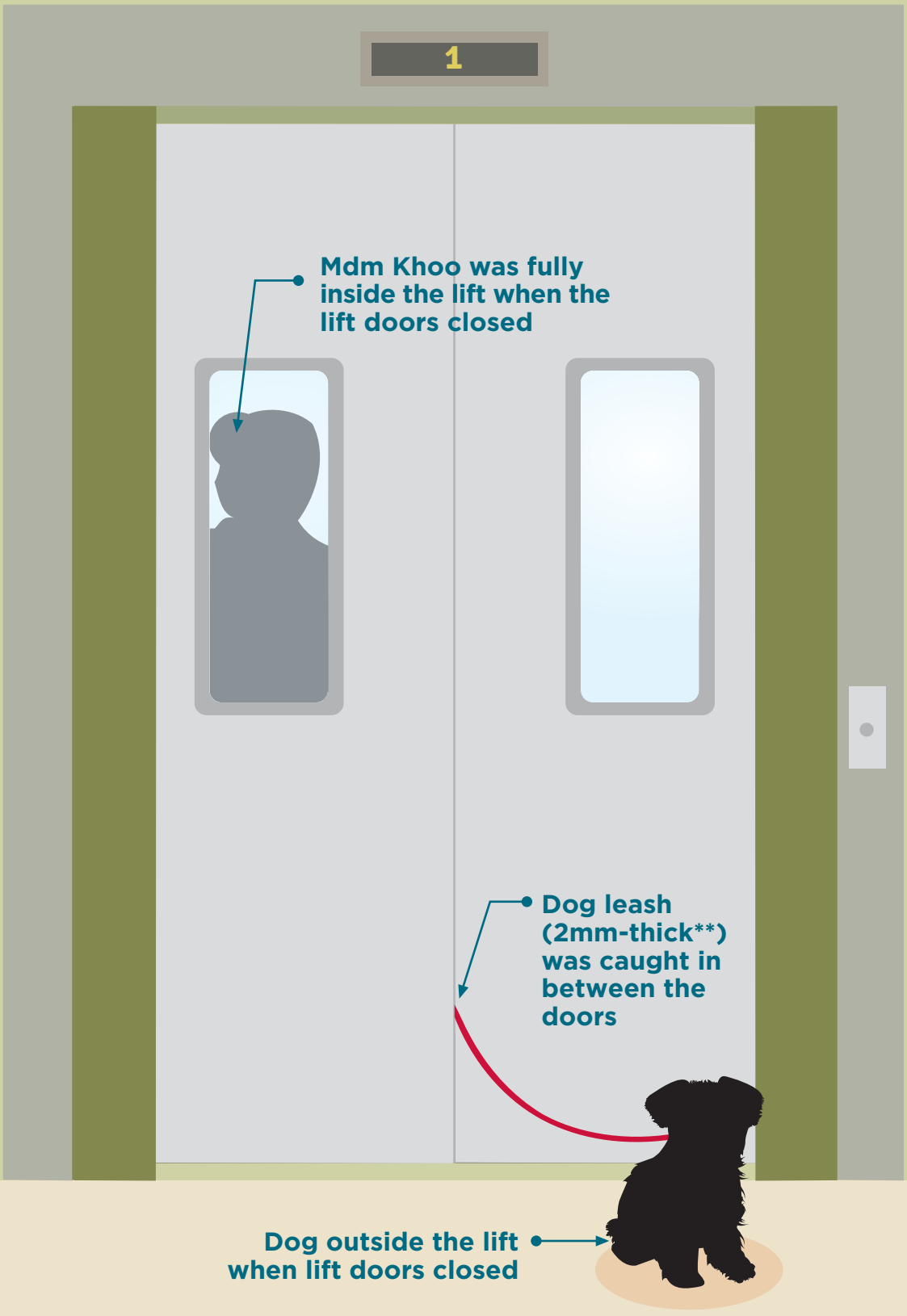
Mdm Khoo held a stack of letters and a walking stick on her left hand. The dog leash was around her left wrist

Dog was outside the lift cabin

Note: The lift doors comprise the (outer) lift lobby doors and the (inner) lift cabin doors.

SEQUENCE 2

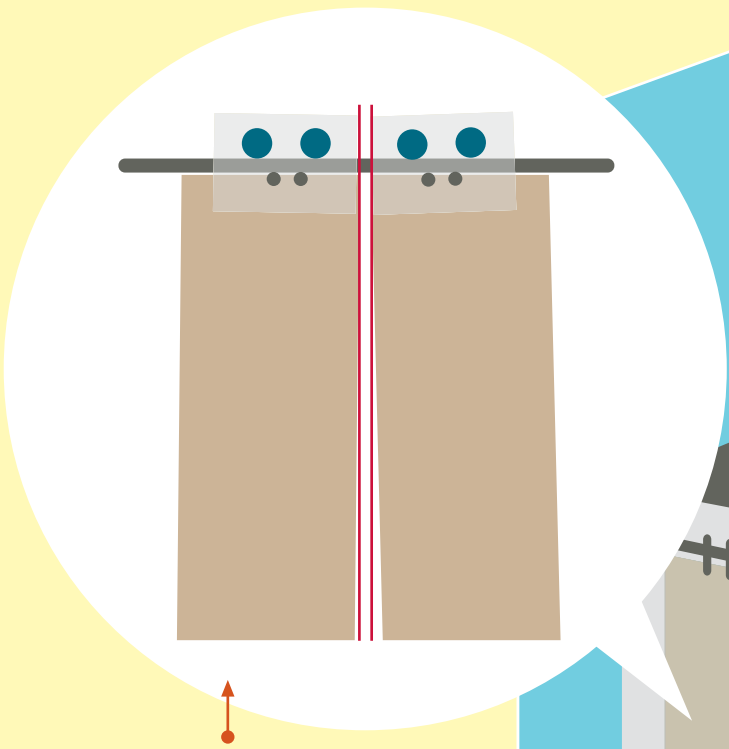
MDM KHOO IS IN THE LIFT



**Sensors on lift cabin doors are not designed to detect extremely small objects, such as a 2mm-thick dog leash

SEQUENCE 3

LIFT ASCENDS



The lift cabin doors are hung from rails at the top. The lift cabin doors will remain closed when the lift is in motion. If a significant force is applied at the bottom of the lift cabin doors, it can cause the bottom of the doors to be prised open, forming a slim A-shaped gap.

(The gap in this drawing has been exaggerated for illustrative purposes.)

Lift ascended towards second floor

Dog leash tightened as the lift moved upwards

- Mdm Khoo was pulled to the ground as the leash tightened due to the lift moving upwards
- The force of the lift moving upwards and the pull of the leash would have possibly resulted in a fulcrum action, opening a small gap at the bottom part of the lift cabin doors
- Mdm Khoo's hand slipped out of the gap and was crushed and severed between the lift cabin doors and inner parts of the lift lobby doors

The dog was pulled up to the top of the lift lobby doors

First Floor

Note: These infographics are to provide a simplified version of the Authorised Examiner's (AE) reconstruction of the possible sequence of events that would have taken place during the incident.

Annex B – VERBATIM EXTRACT OF FINDINGS OF THE AUTHORISED EXAMINER'S FINAL INVESTIGATION REPORT

The Authorised Examiner (AE) has reviewed and analysed the CCTV footage, the specialist medical report and other evidence gathered, as well as conducted interviews. He also performed detailed inspection and tests on the lift, and simulations of how the accident could have happened.

Verbatim Extract of AE's Findings

"1. When the incident occurred, the injured was already fully inside the lift with the dog leash straddling across the lift doorway. She (The injured) was seemingly unaware that her dog was still left outside of the lift as she seemed to be looking at the stack of mail in her hand, after she had pressed the lift buttons to close the lift doors. As door protective devices installed on the lift, meant to detect obstruction in the lift door way during closing, were unable to detect the presence of the dog leash, the lift door proceeded to close. Once the door was closed and as the lift did not sense any anomaly, it prepared for ascending from 1st storey. It was possible that close to or at the time that the lift door was fully closed did she realize that her dog was not inside the lift cabin as the leash around her wrist may have become slightly taut.

2. As the leash was between the lift doors - with one end on the dog harness and the other end around the injured's left wrist - when the lift started to ascend, both the dog and the injured were dragged towards the lift doors. Subsequently, the leash pried open a gap at the bottom centre of the lift cabin door as it was dragged at an angle into it. As the turn of events were sudden, the injured was unable to react in time to release the leash from her left wrist, which pulled along her left forearm into the same gap with the leash. Consequently, her hand was severed by the great forces against other lift parts as the lift was travelling.

3. The incident lift was designed, both with a pair of full height mechanical safety edges and a single beam infra-red sensor at about 250mm from the lift floor. If the lift cabin door is closing, it would re-open if an object is placed within its detectable

range, i.e. pushing back either of the safety edges by 10mm or more, or if the infra-red beam was blocked at the height of 250mm from the floor.

As the thickness of the leash is small, the door protective devices were unable to detect it as an obstruction in the lift door way as the devices were never designed to detect objects that were too thin, such as in this case when the leash was only 2mm thick.

4. The door protective devices cannot be proven reasonably to have failed to function properly on the day of incident as it was clear that during the evacuation operations conducted by SCDF, the lift doors had clearly responded to obstructions several times when SCDF officers were in the door way at 07:26 hrs, time stamped by Police CCTV footage. They were further tested by AE following the incident and confirmed that they worked according to their specifications.

5. During the lift's vertical travel, power to the cabin doors are cut off when they have closed and the cabin door remains closed by resistance achieved using the mechanical inertia of the door machine gearing and chain pulley reduction ratios, as well as mechanical linkages with a small counterweight on the door machine. In normal use, any passenger in the lift cabin will need to apply quite a considerable amount of force to overcome this resistance if he or she is to manually pry the cabin door open. To allow for proper running clearances, the design of lift doors are also such that when a door is forced opened, the door gap is narrowest at the top and widest at the bottom. During the incident, the forces resulting from the sudden dragging of the leash in the downward direction through the bottom of the lift cabin door when the lift was ascending could have likely caused a fulcrum action, opening up a gap at the bottom part of the lift door.

6. *Subsequently, the door switch (also termed the "gate switch") detected the injured's hand causing the lift cabin door to be opened, i.e. when the gap at the top of the lift door was breached. This caused the lift to perform an emergency stop and stalled close to the 3rd storey*** ." (Italicised by BCA)

** AE has clarified that the italicised paragraph above means that the door switch (also termed as the “gate switch”) detected the gap caused by the injured’s hand and this caused the lift to perform an emergency stop, stalling close to the 3rd storey.

Annex C - FACTSHEET ON REGULATORY REGIME FOR LIFTS IN SINGAPORE

1. In Singapore, the Building Control Act regulates the design and installation of lifts whereas the Building Maintenance and Strata Management (Lift and Building Maintenance) Regulations lay out the duties and responsibilities of the lift owner, lift contractor and Authorised Examiner (AE) in ensuring the safe operation of lifts. The regulations also prescribe the maintenance, inspection and tests to be carried out and the documentation to be submitted to BCA.

Inspection and Testing of New Lifts

2. To ensure the safe operation of new lifts, a full commissioning inspection and set of tests need to be carried out by an AE to ensure compliance to the Singapore Standard 550 (SS 550)[1].

Maintenance

3. All lift owners are required to engage a lift contractor who is registered with BCA to maintain their lifts. The lift contractor is required to maintain and test the lifts in accordance with the requirements in the SS 550. According to the standard, periodic maintenance should be carried out at an interval not exceeding one month. Home lifts or lifts designed to carry persons with physical disability should be maintained at periodic intervals according to the manufacturer's recommendation. In the event that there is no manufacturer's recommendation, the frequency of maintenance shall be monthly.

Annual inspection

4. The periodic examination, test and inspection on every lift must be carried out by a registered lift contractor in the presence of an AE annually. This AE is a professional engineer who is registered with the Ministry of Manpower in the competency area of lifting equipment. The AE will thoroughly inspect the lift and all

[1] SS550 is the Code of Practice for Installation, operation and maintenance of electric passenger and goods lifts and contains the general scope of works for lift maintenance and the typical items of the lift equipment to be maintained. As every lift make and model is different, those responsible for lift maintenance should adhere to the list of components and items as recommended by the lift manufacturer.

the machinery and equipment connected therein. Safety equipment are required to be tested without any load in the lift at intervals not exceeding 12 months and with the full rated load at intervals not exceeding 5 years.

Lodgement

5. After the test and inspection of the lift, the lift owner has to lodge a Certificate of Lift Maintenance and Testing to BCA. This certificate is valid for a period of 12 months and lift owner must also ensure that there is a valid lodgement with BCA during the operation of the lift at all times.

6. Lifts owned by HDB, JTC and LTA are not required to have their Certificate of Lift Maintenance and Testing lodged with BCA. Although lodgement with BCA is not needed, these lifts are subject to the same regulations and checks under the Regulations – the regular maintenance by a registered lift contractor, the annual lift test and issuance of the certificate by an AE.