Building and Construction Authority

A GUIDE ON IMPLEMENTING

MAINTENANCE CONTROL PLAN (MCP) FOR LIFTS

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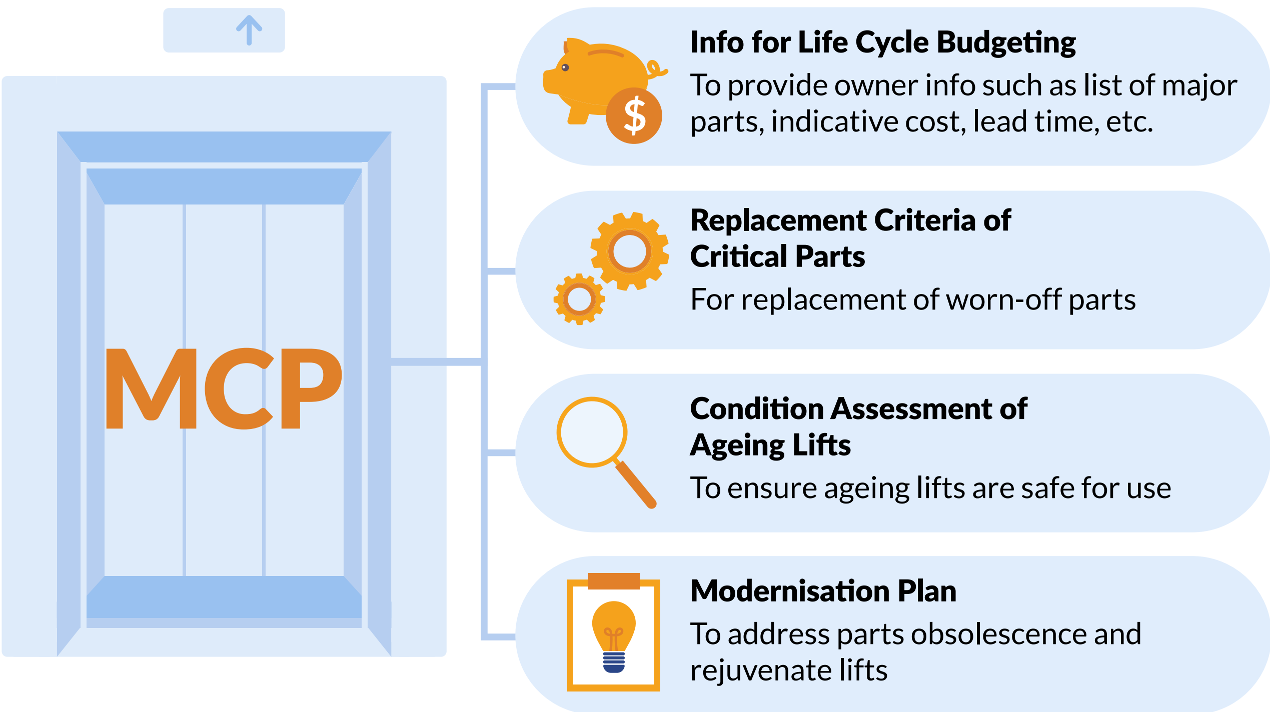
INTRODUCTION

Why is a lift Maintenance Control Plan important?

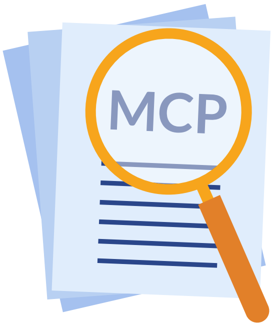
- It is used to help lift owners ensure that their lifts can operate safely and reliably.
- It guides lift owners on how to manage ageing lifts and address maintenance challenges.
- It provides information for lift owners on how to rejuvenate and modernise their equipment to meet latest compliance standards.

From housing blocks to office buildings to shopping malls, lifts have become an integral part of our daily lives. As such, lift owners carry the responsibility of ensuring their equipment is safely operated. In addition to periodic maintenance, which is critical for ensuring that the lifts can operate safely and reliably, the timely replacement of any worn-out or broken components is equally as important to prevent malfunctions or accidents.

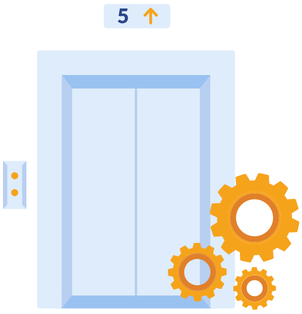
As a lift ages, various challenges may arise, including parts obsolescence, outdated technology with lower safety standards than the latest requirements, as well as the general deterioration of ageing components. Therefore, lift owners must carefully consider either replacing the old lift or modernising it to rejuvenate the equipment.



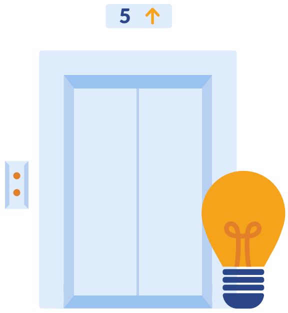
This "Guide on Implementing the Maintenance Control Plan (MCP)" has three key objectives:



a **Clearly outlines the scope of the MCP for lift owners,** enabling them to better understand the relevant contents to be included. This facilitates the development of MCPs for their own lifts, as they collaborate with lift service contractors and consult the original equipment manufacturers (OEMs).



b **Offers a comprehensive approach for lift owners managing lifts that are 15 years and older,** addressing challenges related to parts obsolescence and ensuring the safety of ageing equipment.



c **Provides information on the modernisation of ageing lifts,** guiding lift owners on how to rejuvenate their equipment and bring it up to contemporary safety and technology standards.

Readers are also encouraged to refer to the "Good Practices Guide for Lift Owners[1]", which offers insights into the different approaches of lift maintenance and provides recommendations for best practices in lift ownership.

[1] *For BCA's Good Practices Guide for Lift Owners, please refer to https://www1.bca.gov.sg/docs/default-source/docs-corp-regulatory/lift-escalators-e-guide/good-practices-guide-for-lift-owners.pdf*

1. LIFE CYCLE MAINTENANCE OF LIFTS

What does a life cycle maintenance include?

- Regular maintenance and parts replacement.
- Rejuvenation of ageing and obsolete parts.

1.1 Periodic Maintenance

The maintenance life cycle of a lift involves ongoing care and upkeep from the initial installation until its end-of-life, as components are subjected to wear and tear with continuous usage.

The Building Maintenance and Strata Management (Lift, Escalator and Building Maintenance) Regulations 2016 (henceforth referred to as "LEBM Regulations") requires lift owners to appoint a lift service contractor to carry out periodic maintenance of the lift. During such maintenance, the lift service contractor is obligated to ensure that the outcomes stipulated in Part 1 of the First Schedule of the Regulations are met. The areas of maintenance include the following:

Area of Maintenance

1. Door Open Control
2. Door Protective Devices
3. Lift Car Doors and Lift Landing Doors
4. Lift Car Emergency Alarm
5. Lift Car Intercom
6. Emergency Power Supply for Lift Car Lighting and Ventilation
7. Movement of Lift Car
8. Housekeeping
9. Lift Machine and Drive (including motor, gear box, drive sheave and motor generator set)
10. Brakes of Lift Machine and Drive
11. Direct Current Machine
12. Overspeed Governor
13. Main Rope and Compensation Rope
14. Compensation Rope and Compensation Rope Sheave Tie-down and Tensioning
15. Buffer
16. Controller and Electrical System
17. Guide Shoes or Rollers of Lift Car and Counterweight
18. Safety Gear
19. General Level of Corrosion, Wear and Tear of all Lift Parts
20. Stopping or Level Accuracy

Readers may also refer to BCA's Lift Maintenance Outcome Guidebook[2] for more details on the maintenance requirements for lifts.

1.2 Parts Replacement

It is inevitable that components of lifts will deteriorate over time due to wear and tear and ageing. Timely replacement of parts that have worn out or broken are crucial in ensuring the safe and reliable operation of the lift. Examples include brake pads, wire ropes, and insulation layer of electrical wiring.

The use of deteriorated parts will eventually lead to lift failure and breakdown, which may result in unsafe conditions, service disruption, and costly emergency rescue and repairs.

1.3 Parts Obsolescence

Additionally, for older lifts, the availability of original parts will decrease over time as they get phased out of production due to technological advancements. Seeking new parts will become more challenging and costlier as compared to when the lift is new. Preparation for parts obsolescence, including budgeting for lift replacement or modernisation if necessary, should commence early in the lift's lifetime.

[2] For BCA's Lift Maintenance Outcome Guidebook, please refer to https://www1.bca.gov.sg/docs/default-source/docs-corp-regulatory/lift-escalators-e-guide/lift-maintenance-outcome-guidebook.pdf

2. MAINTENANCE CONTROL PLAN

What are the key aspects of a Maintenance Control Plan?

- Info for life cycle budgeting.
- Replacement criteria of critical parts.
- Condition assessment of ageing lifts.
- Modernisation plan.

An MCP is a document owned by the lift owner, prepared in collaboration with their lift service contractor and in consultation with the OEM of the equipment. The MCP's objective is to document detailed information on criteria such as frequency, usage cycles or condition for which a safety-critical component should be replaced to ensure the safe operation of the lift.

With the MCP, both the owner and the lift service contractor will have established a common ground on the criteria under which the identified safety component must be replaced. This eliminates potential disputes between the owner and the contractor, and prevents undesired delays in parts replacement.

It is not uncommon for a lift owner to delay replacing a part in a standard maintenance contract where the owner covers the cost; or for a lift service contractor to delay replacing a part in a comprehensive maintenance contract where the cost is included in the contract price.[3]

[3] *For differences between "standard maintenance contract" and "comprehensive maintenance contract", please refer to the BCA's Good Practices Guide for Lift Owners.*

2.1 Scope of MCP

A lift comprises numerous components, some of which are safety-critical, failing of which the lift should not be allowed in operation. The MCP must at least encompass the following safety-critical components.

Major Mechanical Parts

a. Brake
b. Sheave
c. Ropes
d. Car Door
e. Landing Door
f. Ascending Car Overspeed Protection (ACOP)
g. Uncontrolled Car Movement Protection (UCMP)
h. Buffer
i. Governor and Safety Gear

Major Electrical/Electronic Parts

a. Safety Switches
b. Uninterruptible Power Supply (UPS)
c. Light Curtain
d. Controller and Printed Circuit Board (PCB)
e. Machine Drive

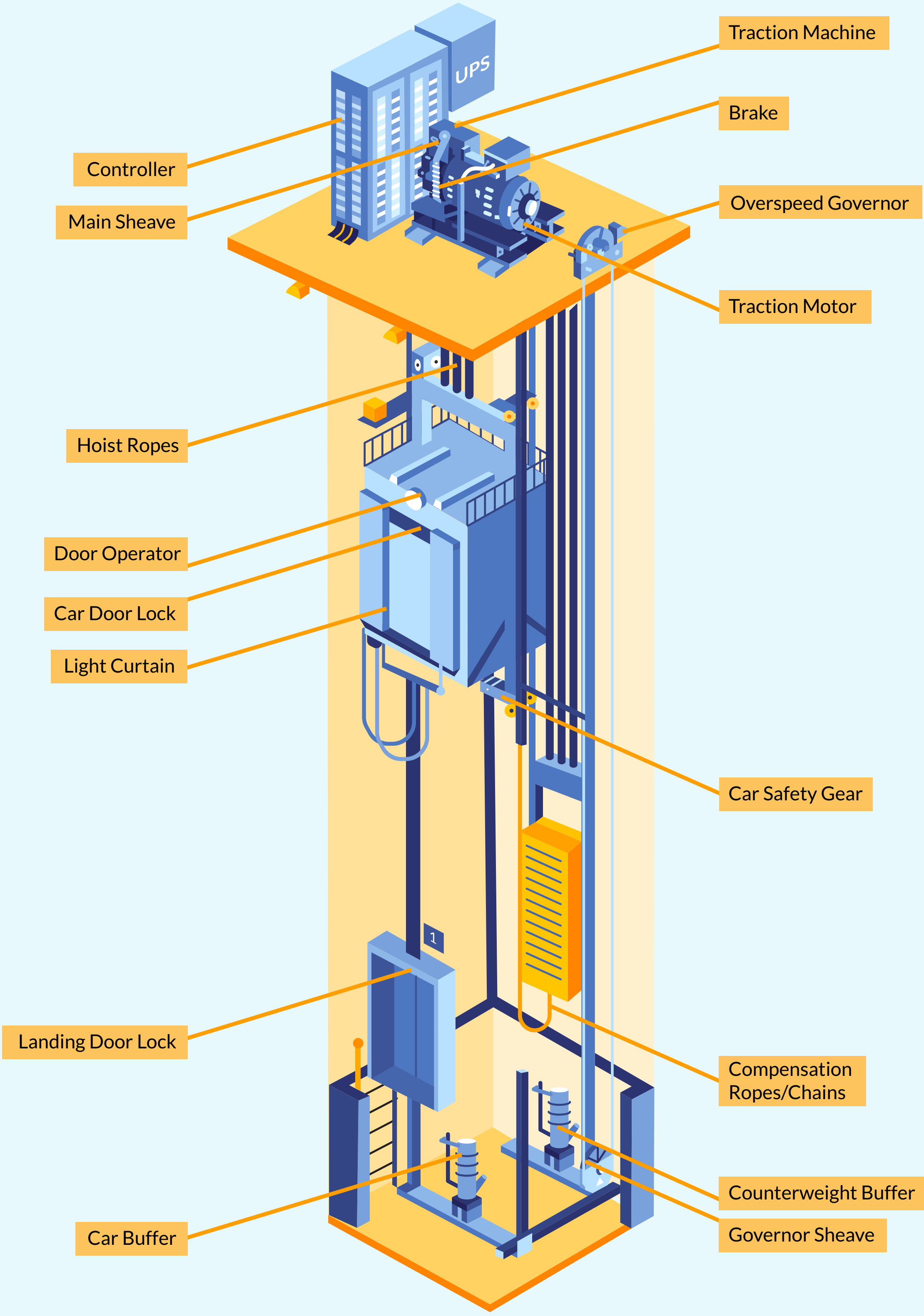


Figure 1: Major Lift Parts

**Note: As there are different configurations for UCMP/ACOP, please check with the lift contractor on the exact configuration installed.*

2.2 Replacement Criteria for Safety-Critical Components

The approach to determining replacement criteria can generally be classified into two main groups:

Measurable Components

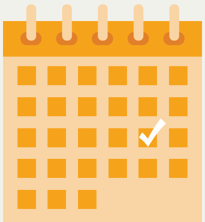
These are usually mechanical components with conditions quantifiable through measurements or visual inspections. Examples include wire rope diameter and brake pad thickness. Some of these components can have their lifespan or condition restored through proper repair, while others beyond repair necessitate replacement.

To determine the replacement criteria, the lift owner and their service contractor may refer to (i) the relevant standards or codes, and (ii) recommendations of the OEM, with the more stringent requirements typically applying. For example, ISO 4344 on Steel Wire Ropes for Lifts stipulates the replacement of a wire rope when its diameter is reduced by 6%.

Non-Measurable Components

These are typically electrical and electronic components whose conditions are challenging to ascertain through measurement, inspection, or testing. In such scenarios, the general practice for replacement is based on the manufacturer's recommended usage or time-based frequency. The owner is also advised to conduct regular reviews with the contractor to assess the likelihood of obsolescence and wear and tear, and consider alternative compatible parts if necessary.

Table 1: Type of Replacement

Type of Replacement	Applicable for	Action to Take
 Condition-Based	**Measurable parts** (e.g., mechanical components)	Follow the **code requirement or manufacturer's replacement criteria** and adopt the two-stage monitoring approach (see Section 2.3)
 Frequency-Based	**Non-measurable parts** (e.g., electrical and electronic components)	Follow the **manufacturer's recommended replacement frequency**

Please refer to Annexes A and B for detailed information on the suggested replacement criteria for these safety-critical components.

2.3 Two-Stage Approach

This Guide recommends a two-stage approach for the replacement of condition-based parts.

The First Stage:
Triggering of Indentation and Procurement of Parts

At this stage, the lift owner and their service contractor should identify the condition or time at which the part replacement process was triggered, and the replacement part must be indented and procured. This criteria is largely dependent on the availability of the replacement part and the shipment lead time if it is not locally available.

For instance, in the case of replacing wire ropes, the contractor may need to order and ship the part from an overseas supplier, a process that typically takes 2 to 3 months. Considering the general wear rate of wire ropes in normal usage, the replacement process should be initiated between the contractor and the owner when the rope diameter reduction reaches 4%. This allows sufficient time for replacement before the diameter reduction reaches 6%.

Additional factors to consider when setting the criteria for this stage may include building operations, such as limiting lift shutdowns for rope replacements to weekends.

The Second Stage: Replacement of Relevant Part Must Be Carried Out

At this stage, the replacement of the relevant part must occur immediately upon reaching the replacement criteria. Failure to do so would necessitate the owner suspending the lift's operations. Using the earlier example, if the rope replacement is not executed when the diameter reduction reaches 6%, the lift should remain out of operation until the replacement is completed.

Please refer to the following two examples illustrating the concept of two-stage monitoring for wire ropes and brake pads.

Example of a two-stage monitoring approach for wire ropes

Table 2a: Data of the Wire Ropes

	Allowable Diameters as per Code or Manufacturer's Recommendation[4]	Action to Take
Diameter of installed rope	12mm	–
1st stage	4% reduction in diameter at 11.50mm	To prepare for replacement, including seeking owner's approval
2nd stage	6% reduction in diameter at 11.30mm	To replace or shut down the lift

**Note: Values presented in the tables above are for illustration purposes only.*

Table 2b: Monitoring of the Wire Ropes

Date	Diameter Measured[5]	Action to Take
March 2022	11.40mm	Quotation for parts was sent to the owner. Owner approved to do the replacement once the 2nd stage is reached.
April 2022	11.39mm	Continue to monitor
May 2022	11.37mm	Continue to monitor
June 2022	11.35mm	Continue to monitor
July 2022	11.32mm	Replacement carried out. Logbook is updated with information of the new ropes.

**Note: Values presented in the tables above are for illustration purposes only.*

[4] *To obtain information from the installation contractor or OEM.*
[5] *To be measured by the lift service contractor and recorded in the logbook.*

Example of a two-stage monitoring approach for brake pads

Table 3a: Data of the Brake Pads

	Allowable Thickness as per Code or Manufacturer's Recommendation[4]	Action to Take
Thickness of installed brake pads	Left pad: 7.0mm Right pad: 7.0mm	–
1st stage	4.0mm	To prepare for replacement, including seeking owner's approval
2nd stage	3.0mm	To replace or shut down the lift

**Note: Values presented in the tables above are for illustration purposes only.*

Table 3b: Monitoring of the Brake Pads

Date	Thickness Measured[5]	Action to Take
March 2022	Left pad: 4.1mm Right pad: 4.0mm	Quotation for parts was sent to the owner. Owner approved to do the replacement once the 2nd stage is reached.
April 2022	Left pad: 3.8mm Right pad: 3.7mm	Continue to monitor
May 2022	Left pad: 3.6mm Right pad: 3.5mm	Continue to monitor
June 2022	Left pad: 3.3mm Right pad: 3.2mm	Continue to monitor
July 2022	Left pad: 3.1mm Right pad: 3.0mm	Replacement carried out. Logbook is updated with information of the new brake pads.

**Note: Values presented in the tables above are for illustration purposes only.*

[4] *To obtain information from the installation contractor or OEM.*

[5] *To be measured by the lift service contractor and recorded in the logbook.*

3. LIFT MODERNISATION

Why is the modernisation of lifts necessary?

- To tackle challenges related with ageing lifts.
- Lifts will be easier to maintain.
- Safety and performance of the lifts can be improved.

Due to ongoing technological advancements in safety standards worldwide, it is inevitable that gaps between the pre-existing and latest lift technologies and code requirements will emerge. Additionally, as components age, the performance of the lift may decline, leading to increased errors and more frequent breakdowns. Parts obsolescence can also further limit access to parts, resulting in increased costs and maintenance difficulties.

Lift modernisation involves upgrading either the entire lift or specific critical components to rejuvenate the lift with modern safety enhancements for increased efficiency and reliability. For example, transitioning from older brake designs with a single plunger to a new gearless traction machine with multiple disc brakes will enhance a lift's safety features and reduce the need for repairs, subsequently lowering maintenance costs.

For older lifts with significant disparities between previous design standards and current code requirements, a total replacement is recommended. This involves replacing the entire lift system with a new one that is compliant with latest code requirements.

In cases where the aged lift is relatively newer, partial modernisation may be more suitable. This approach involves retrofitting the lift with additional items to achieve the intended outcome while being more budget-friendly and reducing lift downtime. In such modernisation efforts, the contractor will typically assess the entire lift and propose specific items to upgrade, such as installing an Ascending Car Overspeed Protection (ACOP) and Unintended Car Movement Protection (UCMP) device.

3.1 Challenges with Ageing Lifts

Gaps with Latest Code Requirements

Generally, lifts in Singapore are designed and installed in accordance with the Singapore Standard. The Standard is typically reviewed once every 5 years to incorporate periodic updates of new developments in technology or industry practices. Currently, the industry follows the Singapore Standards SS550: Code of Practice for Installation, Operation and Maintenance of Electric Passenger and Goods Lifts, as well as other applicable standards that have been approved by the BCA.

Over the years, lifts designed and installed based on older standards may have features that are no longer on par with the latest industry best practices. As a general rule of thumb, it is advisable for owners of lifts aged 15 years and older to work with their service contractor to identify components for modernisation to ensure compliance with latest standards.

Case Study:
Single-Plunger Brake Lift

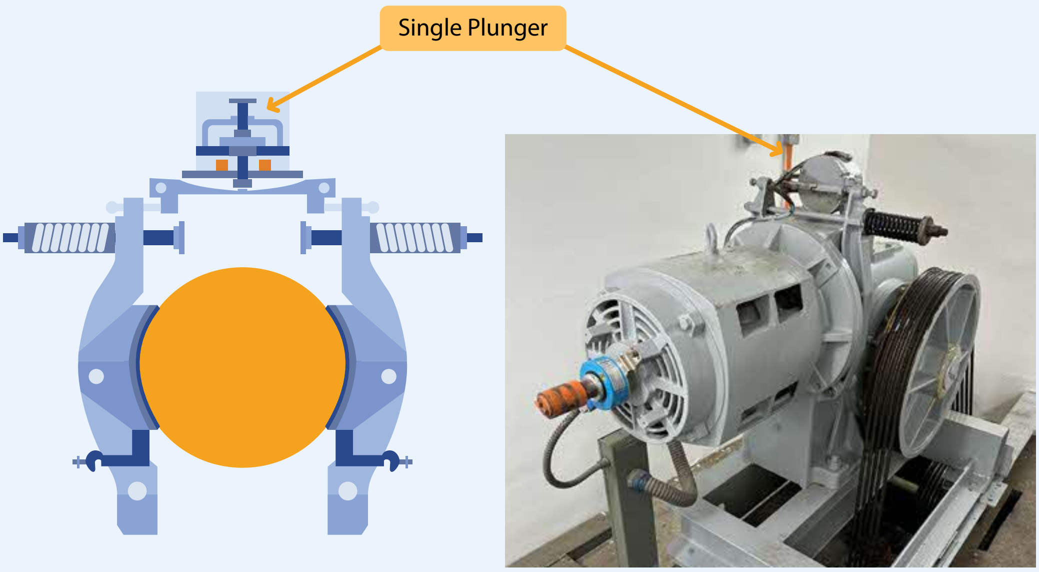


Figure 2: Single Plunger Brake

The brake system is a critical component of lifts. The subsequent revision Code of Practice, CP2:2000, stipulates that all lifts require a redundant set of brake systems, and that each individual brake system must be able to hold the lift with 125% of the rated loading. Additionally, SS550:2009 and its subsequent amendments mandate the inclusion of ACOP and UCMP to further mitigate the risks of over-speeding upwards and uncontrolled car movements.

However, for lifts that were designed to Code of Practice CP2:1979, it was common for the entire brake system to be actuated through a single plunger. While such lifts can still be used today, it is critical for the single plunger brake to be properly maintained to ensure that it operates at maximum capacity at all times. This is because this design has a single point of failure with no redundancy, and any failure of the plunger can result in dangerous uncontrolled movements of the lift.

To further address the risks posed by single plunger brake lifts, lift owners are recommended to change to a newer traction machine with redundant brake design and self-monitoring features compliant with SS550:2020. Additionally, lift owners should also install the ACOP and UCMP if these features have not yet been installed.

**Note: Although solutions such as adding a rope gripper as a stopping means for the ACOP/UCMP are possible, older lifts do face challenges like part obsolescence and retrofitting constraints (e.g. space and controller incompatibility). Therefore, traction machine modernisation might be a more economical option.*

Parts Obsolescence

In the age of technological advancements and product developments, parts obsolescence is inevitable. As lifts age, sourcing new parts becomes increasingly challenging, particularly for electrical and electronic components such as printed circuit boards commonly used in controller and car door control circuits. Thus, a modernisation strategy should also account for parts obsolescence and the affected components, with the intention to modernise if deemed necessary.

The following template may be useful for owners to plan for electrical and electronic parts obsolescence.

Component		Periodic Checks for Parts Obsolescence		
		Current Model	Estimated Year of Part Obsolescence	Details of an Alternative Replacement Part (e.g. brand, model number)
Controller	VFD (Variable Frequency Drive)			
	PCB (Printed Circuit Boards)			
Door Controller	VFD (Variable Frequency Drive, if applicable)			
	PCB (Printed Circuit Boards, if applicable)			
Other PCBs (e.g. those used for call buttons, indicators, lanterns)				
Automatic Rescue Device (ARD)/UPS Charging Circuits				
UCMP Detection Means (if applicable)				

Case Study:
Printed Circuit Board (PCB)

Widely used in lifts, PCBs can be found in various applications such as hall call panels, car door control circuits, car-top control panels, UPS, UCMP detection circuits, traction machine drives and main controllers. Unlike many other mechanical parts designed for a longer lifespan, PCBs containing electronic devices have a relatively shorter lifespan.

Given that PCBs are often customised for specific circuitries and applications, finding an exact one-to-one replacement may be difficult as compared to other mechanical or electrical components. Therefore, it is crucial to closely monitor PCBs for parts obsolescence to prevent disruptions to lift operations.

Maintenance Difficulties

Older lifts may present increased challenges in maintenance, making it difficult to achieve the maintenance outcomes mandated under the LEBM regulations. For example, lifts equipped with aged controllers may struggle to meet the required levelling accuracy of ±10mm. This is because older technologies typically only achieves approximately ±30mm levelling accuracy, effectively posing a potential tripping risk to users.

Case Study:
Outdated Relay-Logic Controller and Motor Starter

Some older lifts feature outdated relay-logic controllers, and the entire controller or specific components may have already become obsolete. These lifts, utilising single-speed or double-speed motor control installed in the 1980s, are known as AC1 or AC2 lifts for single-speed and double-speed lifts.

Levelling and Ride Comfort Issue

The control over single and double-speed lifts is limited, making it difficult for AC1/AC2 lifts to achieve the required levelling accuracy and ride comfort. In contrast, newer lifts use a modern inverter drive with advanced control over the starting acceleration, deceleration and stopping of the motor and the lift car. This results in smooth rides and accurate levelling at the landing. For double-speed lifts, a stopping accuracy of ±½ to 1 inch (about 13 to 24mm) can be achieved under all load conditions, as opposed to the one-speed accuracy of 1 to 3 inches (about 24 to 75mm), which varies with load. With a modern controller and inverter drive, a much more accurate levelling (within ±10mm) can be easily achieved.

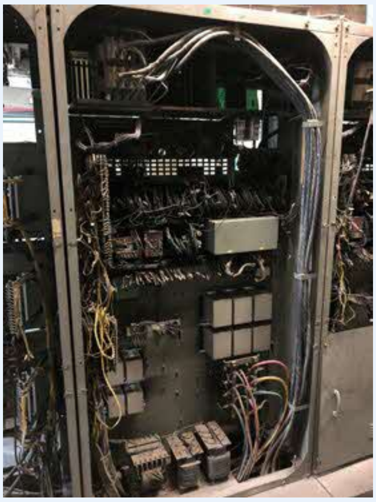


Figure 3: Outdated Lift Controller

Bad levelling accuracy poses tripping risks to users entering or exiting the lift.

3.2 Recommended Items to be Modernised

This section outlines two lists of items to be considered for lift modernisation. Table 4 comprises safety-critical items that merit priority and urgency in the modernisation process. Table 5 includes additional components and subsystems that should also be considered to further enhance the safety, reliability, and ride comfort of the lift.

Readers may refer to the "Good Practices Guide for Lift Owners" to find out more information on major alterations and their requirement.

Table 4: Recommended Safety-Critical Modernisation Items

S/N	Modernisation Items	Description	For Lifts	Is this a Major Alteration or Replacement Work?
1	Ascending Car Overspeed Protection (ACOP)	A traction drive lift shall be provided with ascending car overspeed protection, which includes speed monitoring and speed reducing elements, to detect uncontrolled movement of the ascending lift car. This will cause the lift car to stop, or at least reduce its speed, to that for which the counterweight buffer is designed.	Commonly for lifts installed before year 2010 (certified to CP2:2000 and earlier versions) which do not have ACOP installed.	Yes
2	Unintended Car Movement Protection (UCMP)	A traction drive lift shall be provided with a means to detect and stop unintended lift car movement away from the landing if the landing door and lift car door are both open.	Commonly for lifts installed before year 2015* which do not have UCMP installed. *Certified to SS550:2009 (before adoption of the first amendment in 2014) and earlier versions.	Yes

S/N	Modernisation Items	Description	For Lifts	Is this a Major Alteration or Replacement Work?
3	Inverter Drive and Modern Controller	A variable voltage variable frequency (VVVF) drive will provide smoother acceleration and deceleration curves and draw much less current as compared to AC drives.	Lifts with a relay-logic controller and non-inverter drive that are unable to meet the required levelling accuracy.	Yes
4	Electrical Safety Interlocking for Multi-Panel Landing Doors	An interlocking switch for every lift door panel that ensures when the lift door panel is open, the lift will stop moving immediately and remain in position.	For existing lifts without this feature.	No
5	Car Door Control (door operator, door locking device and door protective device)	▶ Car door locking device (i.e. ineffective mechanical lock that cannot meet the 7mm engagement and 25mm requirement ▶ Light curtain ▶ Inverter drive for car door control (closing force and speed)	For existing lifts of which the car door control does not have these features.	No

S/N	Modernisation Items	Description	For Lifts	Is this a Major Alteration or Replacement Work?
6	Continuous Traction Belt Monitoring	A smart monitoring device installed at the end of the steel cord belt that provides continuous monitoring and sends out timely warning signals upon any breakages and stops the lift.	For existing belt-driven lifts without this feature.	Yes, if modification of safety circuit is involved.
7	Redundant Brakes with Self-Monitoring	Redundant brakes with each individual brake capable of stopping the lift when the car is travelling downwards at the rated speed and with 125% of the rated load. When the brakes are used as a means of stopping ACOP or UCMP, self-monitoring of the brakes shall be included, which could entail verification of correct lifting or dropping of the mechanism; or verification of the braking force. If a failure is detected, the next normal start of the lift shall be prevented.	Commonly for lifts installed before 2001 (certified to CP2:2000 or earlier versions) which uses non-redundant brakes e.g. single plunger brakes.	Yes

Table 5: Recommended Modernisation Items to Improve Lift Safety, Performance, and Reliability

S/N	Modernisation Items	Description	For Lifts	Is this a Major Alteration or Replacement Work?
1	Governor Slack Rope Electrical Safety Device	Electrical switch that is triggered by the elongation of the governor rope and will cause the lift car to stop moving.	Commonly for lifts certified to CP2:1979 or earlier versions, which do not have this feature.	Yes
2	Car Apron	A smooth vertical part extending downwards from the sill lift car entrance. It is meant to mitigate the risk of users at the lift landing falling into the lift shaft if the lift landing doors are opened and the lift car is stopped above the levelling position.	Commonly for lifts installed before 2001 (certified to CP2:2000 and earlier versions) which do not have this feature.	No
3	Means of Communication from the Lift	The telephone, intercom system or other communication device installed in the lift shall enable notification or direct communication with personnel who can activate emergency responses.	For existing lifts without these features.	No
4	Automatic Rescue Device (ARD)	A battery-operated device which will bring the lift to the nearest landing and open both the lift landing and car doors in the event of a power failure.	For existing lifts without these features.	No

S/N	Modernisation Items	Description	For Lifts	Is this a Major Alteration or Replacement Work?
5	Residual Current Device (RCD) to be added for single phase power supply to car/car top lighting/fan	An RCD, also called residual current circuit breaker (RCCB) or earth leakage circuit breaker (ELCB), is an electrical safety device that quickly breaks an electrical circuit when leakage current to the ground is detected.	For existing lifts without these features.	No
6	LED lights to meet latest lux requirement at car top/pit	Lighting of at least 50 lux shall be provided at 1.0m above the car roof and 1.0m above the pit floor.	For existing lifts which cannot comply with the lux requirement.	No
7	Car Top Handrail	A balustrade of 1.1m height consisting of a handrail and intermediate bar at half the height shall be installed at a maximum distance of 0.15m from the edge of the car roof to provide fall protection.	For existing lifts without this feature.	No
8	Car top foldable prop or safety prop on counterweight (with proper interlocking) if car top clearance is not enough	The prop shall be able to support the mass of the lift car or counterweight and be provided with an electric safety device to check the fully retracted position. The operation to put the prop into the working position shall be possible from the pit or by means located outside of the well and accessible only by authorised personnel.	For existing lifts with insufficient car top clearance.	Yes

S/N	Modernisation Items	Description	For Lifts	Is this a Major Alteration or Replacement Work?
9	Pit foldable prop (with proper interlocking) if car bottom clearance is not enough	The prop shall be able to support the mass of the lift car or counterweight and be provided with an electric safety device to check the fully retracted position. The operation to put the prop into the working position shall be possible from the pit or by means located outside of the well and accessible only by authorised personnel.	For existing lifts with insufficient car bottom clearance.	Yes
10	Pit Ladder	The ladder shall extend to a minimum height of 1.5m above the lowest landing sill and be made of aluminium or steel with anti-corrosion protection to withstand the weight of one person counting for 1500N.	For existing lifts without this feature.	No
11	Distribution Board/Isolator for supplying power to the lift	Upgrading old distribution boards/ isolators will enhance the electrical safety of the system.	For existing lifts using obsolete distribution boards or isolator.	No

S/N	Modernisation Items	Description	For Lifts	Is this a Major Alteration or Replacement Work?
12	Partition for lifts with a common lift shaft	If a well contains several lifts, there shall be a partition between the moving parts of different lifts extending from within 0.3m from the pit floor to a height of 2.5m above the floor of the lowest landing.	For existing lifts without this feature.	No
13	Counterweight Shield in Pit	The travelling area of the counterweight shall be guarded by means of a screen, which shall extend from the lowest point of the counterweight resting on the fully compressed buffer to a minimum height of 2.0m from the pit floor.	For existing lifts without this feature.	No

Readers may also refer to BCA's advisory on modernisation for existing lifts to enhance reliability and performance published in 2016.

**Note: For BCA's advisory on modernisation of lifts, please refer to: https://www.corenet.gov.sg/media/2032991/advisory-modernization-of-lifts.pdf*

3.3 Condition Assessment for Ageing Lifts (15 Years and Older)

For lifts that are 15 years or older and have not undergone modernisation, the owner should carry out condition assessment for these lifts. This assessment should minimally cover the safety-critical components in the following table. This is to ensure that the lifts remain in good condition for ongoing operations. Such assessments are more thorough and in-depth than inspections carried out during the annual inspection and testing for Permit-To-Operate renewal.

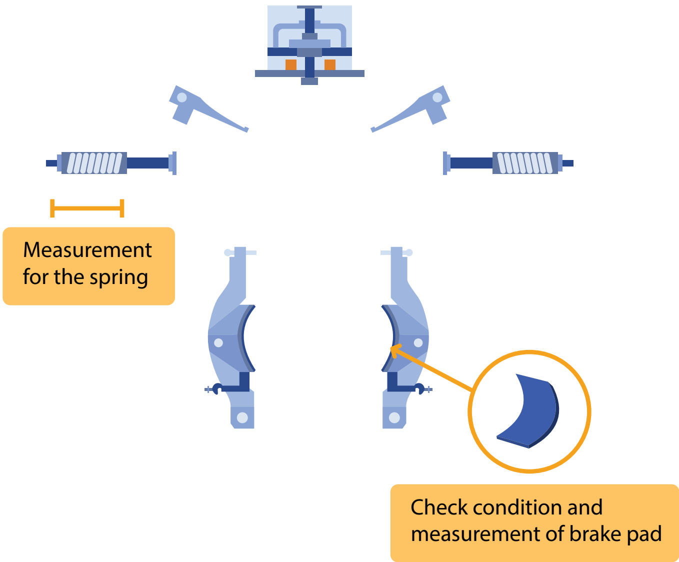


Figure 4: Example of Condition Assessment for Brake

Table 6: Recommended Condition Assessment of Safety-Critical Components

S/N	Component	Recommended Tests
1	Brake	Dismantle the brakes and carry out condition assessment of the following, if applicable: 1. Brake Springs; 2. Brake Pads (thickness etc.); 3. Movement of the Plungers and Brake Arm; and 4. Brake Drum.
		Test the brakes according to the code requirement that includes: ▶ Holding capacity of up to 125%; ▶ Verifying the stopping distance against the manufacturer's recommendation; and ▶ Proper functioning of manual release and winding for rescue operations.
2	Traction Motor	▶ Motor insulation. Refer to Table 61 'Minimum Values of Insulation Resistance' in SS638:2018. ▶ Check motor protection (e.g. overload, short circuit as required by SS550:2020).

S/N	Component	Recommended Tests
3	Car Door Control (car door assembly and protective device)	▶ Dismantle the car door control assembly and check the condition of the parts; ▶ Verify the door closing force and door closing speed as per the installation manual or the manufacturer's recommendation; ▶ Check the condition of the door protective device, the mounting of the sensors, and if any sensor wires are loose; and ▶ Check the distance between the car door cam and the landing door for all landings.
4	Landing Doors	▶ Carry out condition assessment of <u>ALL</u> landing door locks, including the effectiveness of the mechanical locks and the electrical contacts (switch); ▶ Check on the self-closing feature of the landing doors; ▶ Check on the condition of the tensioning wires and condition of all rollers; and ▶ Check if <u>ALL</u> the landing doors have sufficient mechanical strength.
5	Main Controller	▶ Check on the acceleration and deceleration profile of lifts; ▶ Verify levelling accuracy of every floor; ▶ Test the safety circuits during full load (i.e. all contacts along the safety circuits one by one and their corresponding relay in the controller); ▶ Examine each side of the PCB for a. signs of burns and delamination; b. unauthorised/unrecorded alteration of safety circuits/features by a third-party; ▶ Measure the insulation level (refer to Table 61 'Minimum Values of Insulation Resistance' in SS638:2018) and earthing impedance; and ▶ Conduct thermal scan of main controller and separate main power supply box (if applicable).

**Note: The condition assessment can include other safety-critical components depending on the actual design/ installation of the lift.*

The condition assessment should be conducted by accredited Inspection Bodies acceptable to BCA. This evaluation of safety-critical components should continue to be performed at least once every 5 years until its replacement or modernisation takes place.

Additionally, Inspection Bodies typically can assess the level of compliance of the existing lift installation with the latest code and regulatory requirements. They can also highlight any gaps for the owner's consideration, in turn encouraging modernisation for increased safety and reliability.

As the rate of deterioration of lift components vary with usage, lift owners should exercise discretion to conduct a condition assessment ahead of the 15-year mark when necessary.

4. LOGBOOK

Logbooks are integral to a lift's life cycle maintenance as they offer detailed documentation of all works carried out on the lift. These records include, but are not limited to, routine servicing, parts replacements, callbacks, incidents, annual testing, and condition assessments. Each lift should have its own dedicated logbook.

Electronic logbooks are preferred over hardcopy versions as they offer several advantages, including ease of access, improved accuracy, and the ability to store substantial data in a compact format. Electronic logbooks also facilitate seamless information sharing among different stakeholders, such as lift maintenance contractors and building owners, effectively fostering improved communication and collaboration.

To ensure comprehensive insight into a lift's overall conditions, it is recommended to digitise and include the following records in its accompanying logbook.

Table 7: Information Recommended to be Captured in the Logbook

A. Maintenance Works
(e.g. service works in the machine room, in the hoistway, in the lift car, at the lift landing)

Date and Time	Component	Checks	Remarks
XXX	Service work #1	XXX	XXX

B. Callback/Breakdown Records

Date and Time	Description of Lift Fault	Cause of the Fault and Affected Component/Circuit	Repair/Replacements Carried Out
XXX	Example: Mantrap callback	Example: The safety circuit tripped, and the landing door switch at Level 11 was found to be faulty	Example: Safety switch was replaced. *Note: details of the component/circuit (e.g. make and model) should be included too (for major repairs or parts replacement, please fill up Section D and E respectively)

C. Incidents

Date and Time	Root Cause	Affected Component/Circuit	Repair/Replacements Carried Out
XXX	Example: Faulty inductor plate	Example: Levelling circuit	Example: Inductor plate replaced. See details in item xx under Section E.

D. Major Repairs

Date and Time	Component	Description of Works	Reason for Repair/ Replacement
XXX	Example: Main ropes	Example: Replacement of ropes	Example: Reduction in rope diameter of more than 6% *Note: details of the new repair (e.g. make and model) should be included too

E. Part Replacements

Date and Time	Component	Description of Works	Reason for Repair/ Replacement
XXX	Example: Door shoes, hangar rollers, car guide rollers	OEM/ABC	Example: Wear and tear *Note: details of the new part (e.g. make and model) should be included too

F. SPE's Recommendation

Example:

Date: XXX
Recommendation: XXX
Attachment: SPE Report

ANNEX A – REPLACEMENT CRITERIA FOR SAFETY-CRITICAL MECHANICAL PARTS

1 Brakes

Lift brakes are electromechanical devices that are typically closed by compression spring force and opened when the plunger is activated by electrical energy to push the brakes apart. There are several different types of brakes available in the market such as drum, calliper, and block brakes. Though the operational concept is similar, the physical configuration of these components may differ. The anticipated functional outcomes and failure symptoms for each type of brake components are explained below:

Table A1: Brake Information

Brake Type	Model Number	Installed On	Installed By

Monitoring Brake Slip Distance

- To be based on the manufacturer's recommendations with regards to test methods, test frequency, and acceptance criteria.
- To be carried out at least once a year.

Table A2: Brake Slip Distance

Brake Functional Verification	Brake Slip Distance (mm)
Manufacturer's recommendations	
Site measurements	
Date of measurement at site	

1.1 Brake Pad

a. Visible cracks and physical deterioration of surface;
b. Reduction in thickness below the allowable limit; or
c. Severe scratches on the brake pad.

Monitoring Brake Pad Thickness

- To be carried out during periodic maintenance.

Table A3: Data of Brake Pad Thickness

	Allowable Thickness as per the Manufacturer's Recommendation	Action to Take
Thickness of installed brake pads		–
1st stage		To prepare for replacement, including seeking owner's approval
2nd stage		To replace or shut down the lift

**Note: For encapsulated disc brakes that do not allow disassembly for inspection, a brake slip test should be carried out to determine the decision for replacement based on the manufacturer's recommended criteria.*

2 Ropes and Sheaves

Steel wire ropes are commonly employed to suspend both the lift car and counterweight on each end. Depending on the roping ratio and sheave configuration, these ropes are supported and passed through the grooves of the respective rotating sheaves.

2.1 Suspension Rope

a. Visible deformation, wear, kinks, corrosion, rouging with presence of red dust due to rope wear and tear;
b. Number of broken wires, reduction in rope diameter beyond the limit specified in ISO4344 (refer to the table below) or given by the manufacturer; or
c. Excessive rope slippage beyond the manufacturer's allowable limit.

**Note: Rope slippage test shall follow the manufacturer's recommended testing method and acceptance criteria.*

Table A4: Taken from Table E.1 in ISO4344, this table details the number of visible broken wires – single layer ropes with fibre cores operating in cast iron or steel sheaves

Condition	Replace Ropes or Examine within a Specified Period as stated by the Competent Person		Discard Ropes Immediately	
	Class 6 x 19 FC	Class 8 x 19 FC	Class 6 x 19 FC	Class 8 x 19 FC
Broken wires randomly distributed among the outer strands	More than 12 per rope lay[a]	More than 15 per rope lay[a]	More than 24 per rope lay[a]	More than 30 per rope lay[a]
Broken wires predominating in one or two outer strands	More than 6 per rope lay[a]	More than 8 per rope lay[a]	More than 8 per rope lay[a]	More than 10 per rope lay[a]
Adjacent broken wires in one outer strand	4	4	More than 4	More than 4
Valley breaks	1 per rope lay[a]	1 per rope lay[a]	More than 1 per rope lay[a]	More than 1 per rope lay[a]

Even if only one rope has reached the discard or replacement criteria, the whole set has to be replaced.

[a] *The length of one rope lay is approximately equivalent to 6 x d (where d is the nominal rope diameter).*

2.2 Suspension Belt

a. Meets the wear replacement criteria (e.g. number of usage cycle) given by the suspension belt manufacturer; or
b. Shows signs of cracks, or broken wires encased within the belt coating have become exposed due to wear and tear or damage.

2.3 Traction Sheave and Diverting/Guiding Pulleys

a. Rope grooves are badly or unusually worn or damaged, and the rope is sitting below the designated groove level;
b. Rope grooves shows signs of deformation or cracks;
c. Excessive rope slippage is beyond the manufacturer's allowable limits; or
d. Abnormal noise and vibration observed.

Example of two-stage monitoring criteria of the sheave groove profile

1st stage: Plan for replacement when the ropes are almost flushed with the surface level of the grooves.

2nd stage: Replace the sheave when the ropes are sitting below the surface level of the grooves.

3 Safety Gear and Governor System

A safety gear is a mechanical device that is activated when the governor detects overspeeding or free-falling of the lift car or counterweight, and stops the descent by gripping on the guide rails.

3.1 Safety Gear

a. Cracks or deformations observed on the safety gear's components; or
b. Worn off or corroded safety gear wedges which are not able to effectively stop the car or counterweight within the distance specified in the code or manufacturer's recommendations for the downwards speed test.

Table A5: Safety Gear Stopping Distance

Safety Gear Functional Verification	Stopping Distance (mm)
Manufacturer's recommendations	
Site measurements	
Date of measurement at site	

3.2 Governor

a. Visible cracks and physical deterioration of governor components (e.g., sheave, flyweight, springs, connecting rod); or
b. Excessive rope slip (i.e., more than allowable slippage recommended by the manufacturer) observed during a mechanical trip.

Table A6: Governor Rope Slip Test

Governor Rope Slip Verification	Rope Slip Distance (mm)
Manufacturer's recommendations	
Site measurements	
Date of measurement at site	

**Note: Rope slippage test shall follow the manufacturer's recommended test method and acceptance criteria.*

3.3 Governor Rope

a. Meets the replacement requirement or criteria given by the rope manufacturer;
b. Visible deformations in rope, wear, kinks, corrosion, rouging with presence of red dust due to rope wear and tear;
c. Number of broken wires, reduction in rope diameter is beyond the limit specified in ISO4344 (refer to Table A4) or given by the manufacturer; or
d. Excessive rope slippage observed which is beyond the manufacturer's allowable limit.

**Note:* *Replacement of governor rope should be considered if the nominal diameter is reduced by 6% or beyond the manufacturer's recommended replacement criteria.*

3.4 Governor Pulley/Tension Pulley

a. Presence of deformation, cracks, or damaged bearing;
b. Severely worn sheave groove;
c. Severe deformation or corrosion of the mechanical parts of the tensioning device;
d. Inability of governor to activate the safety gear within the specified distance; or
e. Abnormal noise and vibration observed.

4 Buffers

Buffers are resilient terminal stopping devices utilising either hydraulic fluids, springs or polyurethane (PU) material to cushion the lift car or counterweight in the event of an impending collision with the lift pit.

4.1 Energy Accumulation Buffer (Spring/Polyurethane)

a. Cracks in the polyurethane layer or when springs become permanently deformed, both of which can affect the shock absorbing performance.

4.2 Energy Dissipation Buffer

a. Cracks in the hydraulic components or unresolvable oil leakages; or
b. Buffer cannot be restored appropriately or when there is permanent deformation or damage that affects its shock absorbing performance.

4.3 Non-Linear Buffer (PU Buffer)

a. Cracks and disintegration of surface e.g., peeling off due to operating environment;
b. Permanently deformed or damaged buffer layer which affects its shock absorbing performance; or
c. PU buffer has reached its expiry date. If the expiry date is not available, the replacement shall follow the manufacturer's recommendation based on regular checks.

Table A7: Monitoring of PU Buffer Expiry Date

	Car Buffer(s)	Counterweight Buffer(s)
Installation date		
Expiry date specified by manufacturer		
Buffer manufacture date		

5 Car Door

5.1 Door Locking Device

a. Damage or deformation on the locking device which affects the locking operation of the door and is beyond repair.

5.2 Air Cord Rope

a. Presence of broken wires or strands which can affect the smooth operation of doors; or
b. Rope has been stretched beyond the adjustable limit.

5.3 Drive Belt/Chain

a. Chain has elongated beyond the adjustable limit, or the belt has worn off;
b. Exhibiting severe wear and deformation which affects the smooth operation of doors; or
c. Excessive slacking of the un-tensioned portion between the motor drive and pulleys beyond the manufacturer's recommendation.

5.4 Door Hanger

a. Deformation of hanger rollers, abnormal noise, or vibration during operations; or
b. Rusting of up-thrust/eccentric roller.

6 Landing Doors

Landing doors refer to the panels at the lift shaft entrance which open to permit the passage of passengers. Each set of landing doors consist of 2 or more panels and are usually equipped with a vision panel on each side.

6.1 Door Locking Device

a. Damage/deformation affecting the locking operation.

6.2 Air Cord Rope

a. Broken wires, or presence of fraying strands which affect the smooth operation of doors; or
b. Elongation beyond the adjustable limit.

6.3 Spring Closer

a. Severely corroded or the presence of instability at the end attachments of the spring closer; or
b. Plastic deformation such that the spring has yielded, thus losing the linear relationship between force and displacement.

6.4 Chain

a. Stretched beyond the adjustable limit or worn off;
b. Shows severe signs of wear and deformation which can affect the smooth operation of doors; or
c. Drive belt/chain, slacking at the un-tensioned span between the drive and driven pulleys, beyond the manufacturer's criteria.

6.5 Door Hanger

a. Hanger rollers deformed, operating noisily, or are causing abnormal vibration; or
b. Up-thrust or eccentric roller rusted and/or jammed.

**Note: Door damages which require maintenance or repairs are not included in this Guide.*

7 Unintended Car Movement Protection (UCMP)

7.1 UCMP Detection Means

a. Door zone detection element (e.g., car proximity switch) working together with car door and landing door contacts – Wear criteria for replacement: corrosion of switches and contacts.

7.2 UCMP Stopping Means

Table A8: Criteria for Replacement of Different UCMP Stopping Means

S/N	Stopping Means	Wear Criteria for Replacement
1	Brake with redundancy and self-monitoring	▶ Refer to Annex A1
2	Rope Gripper	▶ Presence of cracks and deformation ▶ Excessively corroded or rusted lining surface (friction element) ▶ Presence of leaking or faulty hydraulic cylinder
3	Sheave Jammer	▶ Excessively corroded guide plates (friction element) ▶ Presence of damaged rollers
4	Counterweight Safety Gear	▶ Refer to Annex A3

8 Ascending Car Overspeed Protection (ACOP)

8.1 ACOP Detection Means

a. Bi-directional Overspeed Governor (Refer to Annex A3.2)

8.2 ACOP Stopping Means

Table A9: Criteria for Replacement of Different ACOP Stopping Means

S/N	Stopping Means	Wear Criteria for Replacement
1	Brake with redundancy and self-monitoring	▶ Refer to Annex A1
2	Rope Gripper	▶ Presence of cracks and deformation ▶ Excessively corroded or rusted lining surface (friction element) ▶ Presence of leaking or faulty hydraulic cylinder
3	Sheave Jammer	▶ Excessively corroded guide plates (friction element) ▶ Presence of damaged rollers
4	Counterweight Safety Gear	▶ Refer to Annex A3

ANNEX B – REPLACEMENT CRITERIA FOR SAFETY-CRITICAL ELECTRICAL AND ELECTRONIC PARTS

1 Electrical Switches

It is recommended that a time-based replacement be adopted for electrical switches to prevent sudden failure. Such replacement frequency shall be based on the manufacturer's recommendations, if available.

Electrical safety switches **associated with the major safety-critical parts** in this guide include:

a. Brake Switch
b. Safety Gear Switch
c. Governor Overspeed Switch
d. Governor Rope Tension Switch
e. Hydraulic Buffer Switch
f. Car Door Switch
g. Safety Edge Switch
h. Landing Door Switch
i. Compensation Pulley Switch

Table B1: Recommended Replacement Frequency by Manufacturer

S/N	Component	Current Model	Installation Date	Recommended Replacement Frequency	Alternative Model that can be Used
1	Brake Switch (if applicable)				
2	Safety Gear Switch				
3	Governor Overspeed Switch				
4	Governor Rope Tension Switch (if applicable)				

S/N	Component	Current Model	Installation Date	Recommended Replacement Frequency	Alternative Model that can be Used
5	Hydraulic Buffer Switch (if applicable)				
6	Car Door Switch				
7	Safety Edge Switch (if applicable)				
8	Landing Door Switch				
9	Compensation Pulley Switch (if applicable)				
10	Levelling/Door Zone Sensor				
11	Car Door Light Curtain or Sensor(s)				

2 Emergency Power Supply/Rescue Devices – ARES/EB-OPS/UPS/ARD/Emergency Battery Releasing Device

Life sustenance and rescue devices are battery-operated devices which operate in the event of a power failure to:

a. Provide lighting and ventilation, and offer the ability to raise distress calls during a power failure; or

b. For buildings with backup power, an Automatic Rescue Device (ARD) automatically brings the lift to the nearest landing and opens both the car and landing doors for passengers to evacuate.

2.1 Batteries

The replacement of batteries should follow a time-based replacement based on the manufacturer's recommendation, or measurements of output performance, whichever meets the replacement criteria. The batteries shall be replaced when any of the following output performance is met:

a. Batteries not charging appropriately;

b. After a full charge, the voltage of the battery continues to be lower than its rated working voltage; or

c. After a full charge, the battery is unable to provide a long enough backup operating time to meet its intended functional duration.

Table B2: Battery Condition Monitoring

S/N	Battery Set 1	Battery Set 2	......
Ambient Temperature			
Operating Voltage			
Voltage after Charging			
Rated Capacity			
Actual Capacity			

3 Car Door Light Curtain/Sensor

a. The light curtain is not able to effectively detect obstacles with a diameter of 50mm.

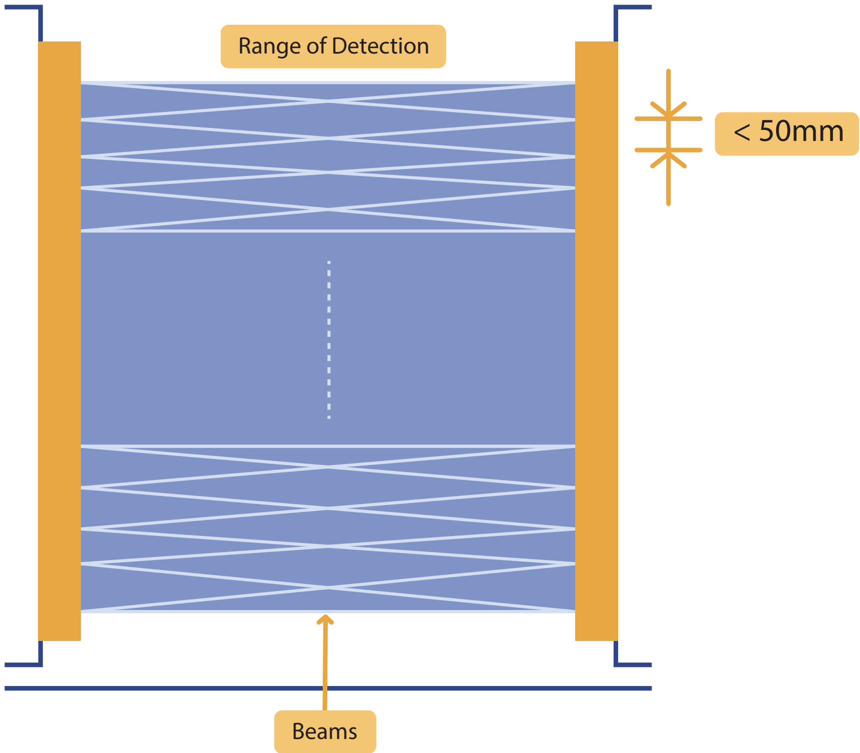


Figure B1: Light Curtain Diagram.

Building and Construction Authority