Building and Construction Authority

An MND Statutory Board

A GUIDE ON IMPLEMENTING LIFT MAINTENANCE CONTROL PLAN (MCP)

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INTRODUCTION

Lifts are an integral part of our daily lives. As the owner of the lift, one has the responsibility to ensure the safe operation of the equipment. Besides periodic maintenance, which is crucial in ensuring lifts can operate safely and reliably, the timely replacement of any worn out or broken components before any malfunction or accident occurs is equally important.

As the lift ages, one would also face issues relating to parts obsolescence, older technology which are of lower safety standards than the latest requirements, as well as general poor condition of aging parts. It is thus important for the lift owner to consider 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. Sets out the scope of the MCP for the lift owners, so that they are better aware of the relevant contents to be included, as they develop MCPs for their own lifts with their lift service contractors, in consultation with the original equipment manufacturers (OEMs).
b. Provides a clearer approach to the lift owners in ensuring safer old lifts (15 years and older) as they face obsolescence of parts for their equipment.
c. Provides information on modernisation of old lifts so that the equipment is rejuvenated.

Readers are also encouraged to refer to the Good Practices Guide for Lift Owners[1] on the different approaches in lift maintenance and good practices for lift owners.

[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

1.1 Regular Maintenance

1.1.1 The life cycle maintenance of a lift involves ongoing care and upkeep from first installation till its end-of-life as components are subject 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 owner to appoint a lift service contractor to carry out periodic maintenance of the lift. During such maintenance, the lift service contractor is required to ensure that the outcomes as stipulated in Part 1 of the First Schedule of the Regulations are met. The areas of maintenance include the followings:

Table 1: Areas of Maintenance Outcomes for Lifts in Part 1 of the First Schedule of LEBM Regulations.

S/N	Area of maintenance	S/N	Area of maintenance
1	Door open control	11	Direct current machine
2	Door protective devices	12	Overspeed governor
3	Lift car doors and lift landing doors	13	Main rope and compensation rope
4	Lift car emergency alarm	14	Compensation rope and compensation rope sheave tie-down and tensioning
5	Lift car intercom	15	Buffer
6	Emergency power supply for lift car lighting and ventilation	16	Controller and electrical system
7	Movement of lift car	17	Guide shoes or rollers of lift car and counterweight
8	Housekeeping	18	Safety gear
9	Lift machine and drive (including motor, gear box, drive sheave and motor generator set)	19	General level of corrosion, wear and tear of all lift parts
10	Brakes of lift machine and drive	20	Stopping or level accuracy

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

[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

1.2 Parts Replacement

1.2.1 It is inevitable that parts of moving equipment such as lifts will deteriorate over time due to wear and tear, and aging. Timely replacements of parts that have worn out or broken are critical in ensuring the safe and reliable operation of the lift. Examples include brake pads, wire ropes and insulation layer of electrical wiring.

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

1.3 Parts Obsolescence

1.3.1 Furthermore, for old lifts, the availability of original parts will decrease over time as these are phased out of production with technological advancements. Seeking part replacements will become more difficult and costlier as compared to when the lift is new. Preparation for parts obsolescence (including budgeting for lift replacement or modernisation if necessary) should begin early in the lifetime of the lift.

2 MAINTENANCE CONTROL PLAN

2.1 An MCP is a document that is owned by the lift owner, and is prepared with his lift service contractor, in consultation with the OEM of the equipment. The objective of the MCP is to document detailed information on criteria (such as frequency, usage cycles or condition) for which a safety critical component ought to be replaced, in order to ensure the safe operation of the lift.

2.2 With the MCP, both the owner and the lift service contractor will have a common ground on the criteria under which the identified safety component must be replaced. This removes any potential dispute between the owner and the lift service contractor, as well as undesired delay in part replacement. It is not uncommon for a lift owner to delay a part replacement in a basic maintenance contract under which lift owner will pay for the cost of replacement; and for a lift service contractor to delay a part replacement in a comprehensive maintenance contract under which the cost of replacement is covered by the contract price.[3]

2.3 Scope of MCP

2.3.1 There are many components in a lift. Some of these are safety critical, failing of which the lift should not be allowed in operation. The MCP, co-developed by the owner with his lift service contractor, must at least cover these safety critical components (as listed in Table2 below).

Table 2: Major Lift Components

Major Mechanical Parts	a. Brake b. Sheave c. Ropes d. Car Door e. Landing door f. Ascending Car Overspeed Protection g. Uncontrolled Car Movement Protection (UCMP) h. Buffer i. Governor & safety gear
Major Electrical/Electronic Parts	a. Safety Switches b. Uninterruptible Power Supply (UPS) c. Light Curtain d. Controller & Printed Circuit Board e. Machine Drive

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

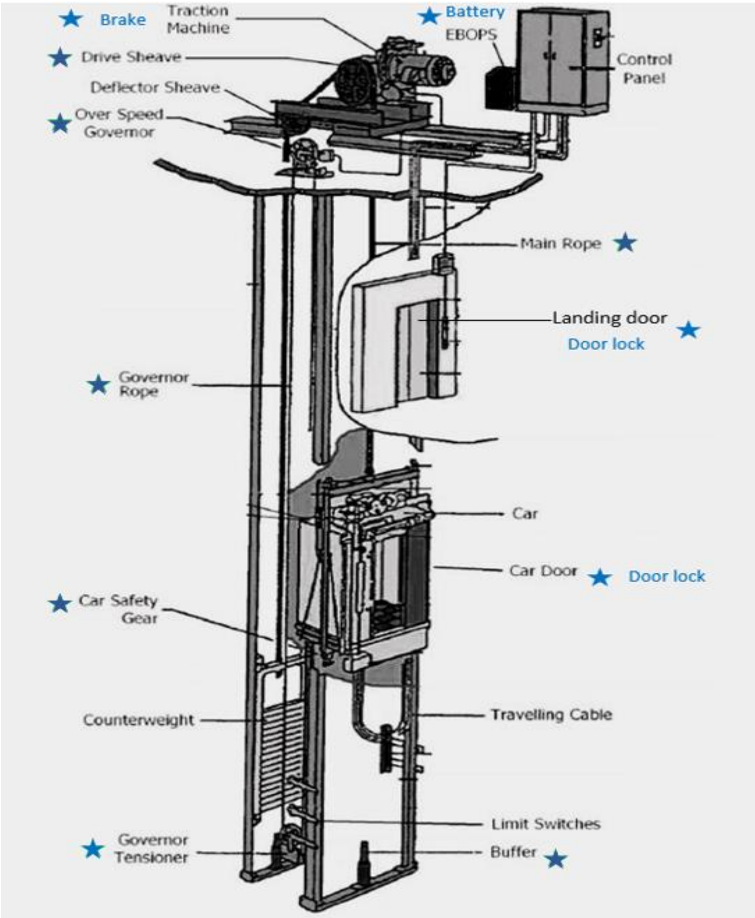


Figure 1: Major Lift Parts

2.4 Replacement Criteria for Safety Critical Components

2.4.1 The approach to determining replacement criteria could generally be classified under two main groups:

a. Measurable components – These are usually mechanical components. The conditions of these components are quantifiable through measurements or visual inspections. For example, wire rope diameter and brake pad thickness. For some of these components, the lifespan or condition could be restored with proper repair. For those that are beyond repaired, replacement will be necessary.

   To determine the replacement criteria, the lift owner and his service contractor could refer to (i) the relevant standards or codes; and (ii) recommendations of the OEM. Usually, the more stringent requirements will apply. For example, ISO 4344 on Steel Wire Ropes for Lifts requires the replacement of wire rope when the diameter of the rope is reduced by 6% or more.

b. Non-measurable components – These are typically electrical/electronic components whose conditions are difficult to ascertain based on measurement, inspection, or testing. In such scenarios, the general practice towards replacement of these components 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 determine the likelihood of obsolescence/wear and tear and consider alternative compatible parts if necessary.

Table 3: Type of Replacement

Type of replacement	Applicable for	What to do
Condition-based	For measurable parts (e.g., mechanical components)	Follow code requirement or manufacturer's replacement criteria and adopt two-stage monitoring approach (see Section 2.5)
Frequency-based	For non-measurable parts (e.g., electronic components)	Follow manufacturer's recommended replacement frequency

2.4.2 Please refer **Annexes A** and **B** for detailed information on the suggested replacement criteria for the safety critical components.

2.5 Two-Stage Approach

2.5.1 This Guide recommends a two-stage approach for replacement of condition-based parts – the first stage is to trigger the indentation and procurement of the relevant replacement part; and the second stage is when the part must be replaced immediately, or the lift must be suspended from operation to ensure safety.

2.5.2 <u>The First Stage: Triggering of Indentation and Procurement of Parts.</u> In the MCP, the lift owner and his service contractor should identify the condition or time at which the part replacement process is triggered, and the replacement part must be indented and procured. The criterion/criteria largely depend on the availability of the replacement part with the lift service contractor, as well as the shipment lead time required if the part is not readily available locally.

2.5.3 For example, for the replacement of wire ropes, typically the contractor would require ordering and shipping from overseas supplier and this process would usually takes 2 to 3 months. Based on the general wear rate of wire ropes in normal usage, this replacement process should be initiated between the contractor and the owner when the rope diameter reduction reaches 4%. This is to allow sufficient time for the replacement to take place before the rope diameter reduction reaches 6%.

2.5.4 Other factors to consider for setting criterion for the first stage may include the building operation, e.g. the lift could only be shut down for rope replacement on weekends.

2.5.5 The Second Stage: Replacement of Relevant Part Must Be Carried Out. At this stage, the relevant part must be replaced immediately as replacement criteria have been reached. Otherwise, the lift owner must suspend the operation of the lift. From the above example, if rope replacement was not carried out when the diameter reduction reaches 6%, the lift should not be in operation until the rope has been replaced.

2.5.6 Below are two examples illustrating the concept of two-stage monitoring.

Example for 2-stage monitoring – Ropes

Table 4a: Data of the ropes:

	Allowable diameters as per code or as per Manufacturer's Recommendation[1]	***Action to take***
Diameter of installed rope	12mm	-
1st stage	4% reduction in diameter 11.50 mm	*To prepare for replacement including seeking owner's approval on the replacement*
2nd stage	6% reduction in diameter 11.30 mm	*To replace or shutdown the lift*

Table 4b: Monitoring of the ropes:

Date	***Diameter measured[2]***	***Action taken***
March 2022	*11.40 mm*	*Parts quotation was sent to owner and owner approved to replace once 2nd stage is reached.*
April 2022	*11.39 mm*	*Continue to monitor*
May 2022	*11.37 mm*	*Continue to monitor*
June 2022	*11.35 mm*	*Continue to monitor*
July 2022	*11.32 mm*	*Replacement carried out.* *Logbook is updated with the Information of new ropes.*

Example for 2-stage monitoring – Brake Pads

Table 5a: Data of the brake pads:

	Allowable thickness as per Manufacturer's Recommendation[1]	***Action to take***
Thickness of installed brake pads	*Left pad: 7mm* *Right pad: 7mm*	-
1st stage	*4.0mm*	*To prepare for replacement including seeking owner's approval on the replacement*
2nd stage	*3.0mm*	*To replace or shutdown the lift*

Table 5b: Monitoring of the brake pads:

Date	***Thickness measured[2]***	***Action taken***
March 2022	*Left pad: 4.1mm* *Right pad:4.0mm*	*Parts quotation was sent to owner and owner approved to replace once 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 the Information of new brake pads.*

[1] To obtain information from installation contractor or OEM.

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

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

3 LIFT MODERNISATION

3.1 Due to technological advancements in the safety standards established worldwide, it is inevitable that over time, gaps emerge between the existing lifts technology and the latest technology and code requirements. In addition, the performance of the lift could decline, and more errors could occur as the components age, resulting in frequent breakdowns. Parts obsolescence could also limits availability and access to parts, resulting in increased cost and difficulty in maintenance of lifts as it age.

3.2 Lift modernisation is the process of carrying out upgrading works of either the entire lift or certain critical lift components. This will rejuvenate the lifts with modern safety enhancements, making them safer and more efficient and reliable. For example, in changing from the older brake design with single plunger to a new permanent magnet traction machine with multiple disc brakes, the new system will provide better safety features and typically require fewer repairs, thus lower maintenance costs.

3.3 For older lifts that have significant disparity between previous design standards and current code requirements, total replacement is recommended. Total replacement refers to the complete replacement to a brand-new lift compliant with latest code requirements.

3.4 In other settings in which the aged lift is relatively newer, owners may find that partial modernisation will be more suitable because the lift can still achieve the intended outcomes by being retrofitted with the additional items while being easier on the budget and reducing downtime of the lift. For such modernisation, the contractor will usually examine the entire lift and propose the items to modernise e.g., install Ascending Car Overspeed Protection (ACOP) device.

3.5 Challenges with Old Lifts

Old lift design does not meet the latest Code requirements

3.5.1 Singapore lifts are designed and installed in accordance with Singapore Standards SS550: Code of Practice for Installation, Operation and Maintenance of Electric Passenger and Goods Lifts. The Standard is typically reviewed once every 5 years so that new developments in technology or industry practices are periodically updated into the Standard. Over the years, lifts that were based on older standards may have features that are no longer on par with the latest industry best practices.

3.5.2 Generally, it is advisable for owners of lifts aged 15 years and older to discuss with their service contractor to identify components for modernisation so as to keep up to date with latest standards.

3.5.3 Case Study: Single-Plunger Brake Lift

3.5.3.1 Brakes system is a critical component of a lift. For older lifts in Singapore that were designed to Code of Practice CP2:1979, it was common that the entire brake system is actuated through a single plunger. While such design can continue to be used, it is critical that the single plunger brake must be properly maintained to be working at all times. As a single point of failure with no redundancy in the design, and any failure of the plunger can result in dangerous uncontrolled movement of the lift.

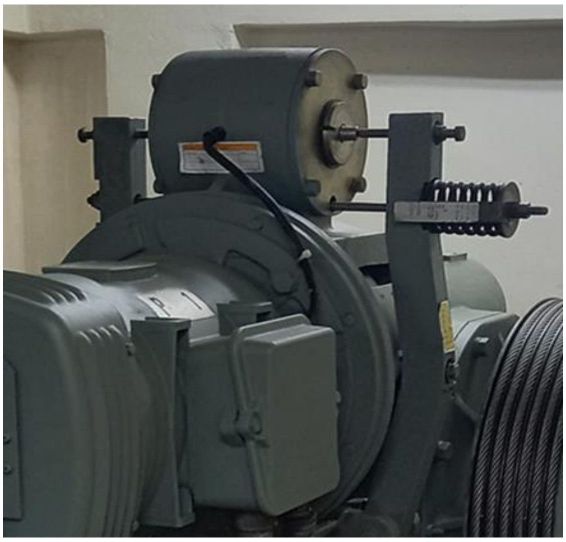


Figure 2: Single Plunger Brake

3.5.3.2 The revised Code of Practice, SS550:2009 requires a redundant set of brake system, and that each individual brake system can at least hold the lift with 125% rated loading.

3.5.3.3 In addition, ACOP and Unintended Car Movement Protection (UCMP) were first required in SS550:2009 and its subsequent amendments. These improvements further mitigate the risks of over-speeding upwards and uncontrolled car movements.

3.5.3.4 <u>Recommended solutions.</u> To address the risks posed by single-plunger brake lift installed more than 20 years ago (prior to CP2:2000), it is recommended that owners change to a newer traction machine which has redundant brakes design and self-monitoring features compliant with SS550:2020.

3.5.3.5 Although there are other possible solutions such as adding rope gripper and in conjunction with ACOP/UCMP, these old lifts also face additional challenges including parts obsolescence and retrofitting constraints (such as space constraint and controller incompatibility). Therefore, it might be more economical for owners to consider traction machine modernisation.

3.5.3.6 In addition, when modernising the brakes, the owner and contractor should also include the ACOP and UCMP if these features have not been installed.

3.6 Parts obsolescence

3.6.1 Parts obsolescence is inevitable due to technological advancements and product developments. As the lifts age, it also becomes increasingly difficult to source for new parts, especially for electrical and electronic components such as printed circuit boards which are commonly used in the controller and car door control circuits. Thus, part of the modernisation strategy would also need to consider parts obsolescence and the components which will be impacted, with the view to modernise if necessary.

3.6.2 The format below may be useful for owner to plan for electrical/electronic parts obsolescence.

Table 6: Periodic Checks for Parts Obsolescence

Component		**Periodic Checks for Parts Obsolescence**		
		Current Model	Estimated year of part obsolescence	Details of the 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 (for example PCB used for call button, indicators, lanterns etc.)				

Component	Periodic Checks for Parts Obsolescence		
	Current Model	Estimated year of part obsolescence	Details of the alternative replacement part (e.g. brand, model number)
ARD/ UPS charging circuits			
UCMP Detection Means (if applicable)			

3.6.3 Case Study of Printed Circuit Board (PCB)

3.6.3.1 PCB is widely used in lifts. The PCB can be found in many applications such as hall call panel, car door control circuit, car-top control panel, Uninterrupted Power Supply (UPS), UCMP detection circuit, traction machine drive and main controller. Unlike most of the mechanical parts which are designed to have a longer life span, PCBs which contains electronic devices have a relatively shorter life span.

3.6.3.2 As PCBs are often customized for certain circuitries and applications, it may be difficult to find an exact one-to-one replacement, unlike other mechanical or electrical components. Therefore, PCBs should be closely monitored for parts obsolescence to avoid disruption to the lift operation.

3.7 Maintenance Difficulties

3.7.1 Older lifts may be more difficult to maintain and achieving the maintenance outcomes required by BCA. For example, lifts using an aged controller can be challenging to achieve the required levelling accuracy of ±10mm, as older technology can typically only achieve approximately ±30mm levelling accuracy. This may pose a tripping risk to users.

3.7.2 Case Study: Outdated Relay-Logic Controller and Motor Starter

3.7.2.1 Some of the older lifts possess an outdated relay-logic controller, and the entire controller or certain components could have already become obsolete. Such lifts using single-speed or double-speed motor control that were installed in the 1980s are referred to as AC1 or AC2 lifts for single-speed lift and double-speed lift, respectively.

Levelling & Ride Comfort Issue

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

Figure 3: Outdated Lift Controller

3.7.2.3 Bad levelling accuracy poses tripping risks to users entering or exiting the lift. In case of a wheelchair or PMD user, the level difference can constitute more danger when reversing the PMD or wheelchair out of the lift.

3.8 Recommended Items to be modernised

3.8.1 This section provides two lists of items to be considered for lift modernisation. Table 7 contains safety critical items that should be given priority and urgency in modernisation. Table 8 includes additional components/subsystems which should also be considered to further improve the safety, reliability as well as ride comfort of the lift.

3.8.2 For those modernisation items which are considered major alteration, readers may refer to the Good Practices Guide for Lift Owners to find out more details of major alteration and its requirement.

Table 7: Recommended Safety Critical Modernisation Items

S/N	Modernisation Items	Description	For lifts	Is this a major alteration or Replacement work?
1	Ascending car over speed 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 shall 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	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 with the landing door and lift car door are open.	Commonly for lifts installed before year 2015* which do not have UCMP *:certified to SS550:2009 (before adoption of first amendment in 2014) and earlier versions	Yes
3	Inverter drive & 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	Yes

S/N	Modernisation Items	Description	For lifts	Is this a major alteration or Replacement work?
			levelling accuracy	
4	Electrical safety interlocking for multi-panel landing doors	An interlocking switch for every lift door panel that ensures that where 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 (ineffective mechanical lock, i.e., cannot meet the 7mm engagement) and cannot meet 25-mm 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
6	Continuous traction belt monitoring	A smart monitoring device installed at the end of the steel cord belt will provide continuous monitoring and send out timely warning signals upon any breakages and stop 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 brake on its own shall be capable of stopping the machine when the car is travelling downward at rated speed and with the rated load plus 25 %. When the brakes are used as stopping means of ACOP or UCMP, self-monitoring of the brakes shall be included, which could include 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 year 2001 (certified to CP2:2000 or earlier versions) which uses non-redundant brakes e.g. single plunger brakes	Yes

Table 8: 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 people at the lift landing falling into the lift shaft if the lift landing doors are opened when the lift car is stopped above the levelling position.	Commonly for lifts installed before year 2001 (certified to CP2:2000 and earlier versions) which do not have this feature	No
3	Means of Communication from 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 response.	For existing lifts which do not have 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 power failure.	For existing lifts which do not have these features	No
5	Residual Current Device (RCD) to be added for single phase power supply	A residual-current device (RCD), (also called residual-current circuit breaker (RCCB) or earth leakage circuit breaker (ELCB) is an electrical safety device that quickly breaks an electrical	For existing lifts which do not have these features	No

S/N	Modernisation Items	Description	For lifts	Is this a major alteration or Replacement work?
	to car/car top lighting/fan	circuit when leakage current (to ground) is detected		
6	LED Lights to meet new car top/pit etc lux requirement	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 handrailing	A balustrade of 1.1m height consisting of a handrail & 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 which do not have this feature;	No
8	Cartop foldable prop or safety prop on counterweight (with proper interlocking) if car top clearance not enough	The prop shall be able to support the mass of the lift car/counterweight & provided with an electric safety device in checking 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 to authorised personnel	For existing lifts with insufficient car top clearance	Yes
9	Pit foldable Prop (with proper interlocking) if car bottom clearance not enough	The prop shall be able to support the mass of the lift car/counterweight & provided with an electric safety device in checking 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	For existing lifts with insufficient car bottom clearance	Yes

S/N	Modernisation Items	Description	For lifts	Is this a major alteration or Replacement work?
		accessible only to authorised positions		
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 which do not have this feature	No
11	Distribution board/Isolator for supplying power to the lift	Upgrading old distribution boards/isolator will enhance the electrical safety of the system	For existing lifts using obsolete distribution boards/isolator	No
12	Partition for lifts with common lift shaft	Where the 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 which do not have 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 which do not have this feature	No

3.9 Condition Assessment for Old Lifts (15 years and older)

3.9.1 For lifts that are 15 years or older and have not undergone modernisation, the owner should carry out condition assessment for these lifts. The conditional assessment should cover minimally the safety critical components as given in **Annex C**. This is to ensure that the lifts are still in good condition for continuing operation. Such assessments are more thorough and in depth than inspections carried out during the yearly inspection and testing for Permit-To-Operate renewal.

3.9.2 The condition assessment should be carried out by accredited Inspection Bodies acceptable to BCA.

3.9.3 The condition assessment of these safety critical parts should continue to be carried out at least once every 5 yearly until the replacement or modernisation of the components takes place. You may refer to **Annex C** for details on the tests suggested for condition assessments of these components.

3.9.4 Additionally, the Inspection Bodies typically can also assess the level of compliance of the existing lift installation to the latest code and regulatory requirements, and highlight the gaps for owner's consideration to modernise the lift for increased safety and reliability.

3.9.5 As the performance of lift components deteriorates over time depending on frequency of lift usage, the owner should exercise discretion to conduct condition assessment ahead of the 15-year mark when necessary.

4 LOGBOOK

4.1 Logbooks are essential to the life cycle maintenance of lift as they provide detailed recording of works carried out on the lift. These include, but are not limited to, records on routine servicing, parts replacements, call-backs, incidents, annual testing, and condition assessments. Each lift should have its own logbook.

4.2 Electronic logbooks are preferred to hardcopy logbooks as they offer several advantages, including ease of access, improved accuracy, and the ability to store substantial amounts of data in a compact format. Electronic logbooks also allow for easy sharing of information between different stakeholders, such as lift maintenance contractors and building owners, which can help to improve communication and collaboration.

4.3 It is recommended that the following records for each individual lift to be digitalised and included in the logbook in order to provide greater clarity on the overall lift conditions.

Table 9: Information recommended to be captured in the logbook

A. Maintenance works			
Date	**Component**	**Checks**	**Remarks**
For example, service works in the machine room, in the hoist way, in the lift car, and at the lift landing			
1	Service work #1	XXX	XXX
2	Service work #2	XXX	XXX
3	Service work #3	XXX	XXX
B. Call back/Breakdown records			
Date	**Description of lift fault**	**Cause of the fault and Affected component/circuit**	**Part repair or replacements carried out**
XXX	Example: Mantrap call back	Example: Safety circuit trip, and landing door switch at Level 11 was found to be faulty	Safety switch was replaced. Details of the new safety switch: Make and Model etc… (for major repairs or parts replacement, fill under Section D and E respectively)

C. Incidents			
Date and time	**Root cause**	**Affected component/circuit**	**Work done/part replacements carried out**
XX Feb 2022	Faulty inductor plate	Levelling circuit	Inductor plate replaced. See details in Item xx in Section E.
D. Major Repairs			
Date	**Component**	**Description of works**	**Reason for repair or replacement**
XXX	Example: Main Ropes	Example: Replacement of ropes	Example: Reduction in rope diameter more than 6%
E. Part replacements carried out			
Date	**Component**	**Manufacturer/model**	**Reason for replacement**
XX May 2023	Example: Door shoes, hangar rollers, car guide rollers	OEM/ABC	e.g. wear and tear
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 which are normally 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 expected functional outcomes and the failure symptoms for the respective 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 Manufacturer's Recommendations on test methods, test frequency and acceptance criteria.

To be carried out at least once yearly

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

Replacement criteria:

a. Visible cracks and physical deterioration of surface;
b. Reduction in thickness below the allowable limit;
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 Manufacturer's Recommendation	***Action to take***
Thickness of installed brake pads		*-*
1st stage		*To prepare for replacement including seeking owner's approval on the replacement*
2nd stage		*To replace or shutdown 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 manufacturer's recommended criteria*

2 Ropes and Sheaves

Steel wire ropes are typically used to suspend both the lift car and counterweight on each end. Depending on the roping ratio & sheave configuration, the ropes are supported and pass through grooves of the respective rotating sheaves.

2.1 Suspension Rope

Typical replacement criteria are:

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 is beyond the limit specified in ISO4344 (refer to Table E.1 below), or given by the manufacturer.
c. Excessive rope slippage beyond the manufacturer / service provider's allowable limit.

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

Table A4: Number of visible broken wires – Single layer ropes with fibre cores operating in cast iron or steel sheaves (Table E.1 in ISO4344)

Condition	Replace ropes or examine within a specified period as stated by the competent person		Discard ropes immediately	
	Class 6 × 19 FC	Class 8 × 19 FC	Class 6 × 19 FC	Class 8 × 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]

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

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

2.2 Suspension Belt

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

2.3 Traction sheave and Diverting / guiding pulleys

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

Example of two stage monitoring criteria of the sheave groove profile

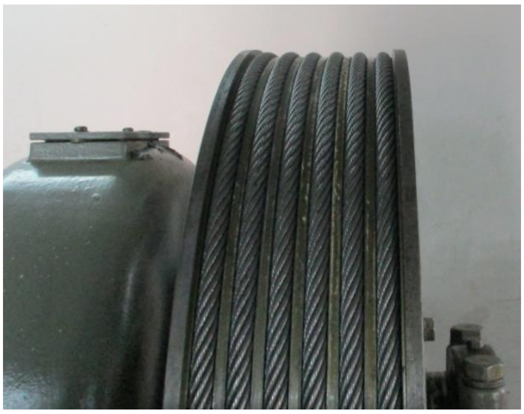
1st stage:	Plan for replacement when ropes are almost flush with the surface level of the grooves 
2nd stage:	Replace the sheave when the ropes are sitting below the surface level of the grooves  

Figure A1: Sheave groove profile

3 Safety Gear and Governor System

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

3.1 Safety Gear

a. Cracks or deformations observed on the safety gear components.
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	XX March 2023

3.2 Governor

a. Visible cracks and physical deterioration of governor components (e.g., sheave, flyweight, springs, connecting rod)
b. Excessive rope slip (i.e., more than allowable slippage recommended by the manufacturer) observed during 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	XX March 2023

Note: *Rope slippage test shall follow 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 E.1 under Section 1.2.1) or given by the manufacturer.
d. Excessive rope slippage observed which is beyond the manufacturer / service provider's allowable limit.

Note: *Monitoring of Governor rope diameters*

Replacement 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.
e. Abnormal noise and vibration observed.

4 Buffers

Buffers are resilient terminal stopping devices utilising either hydraulic fluids, springs, or polyurethane material to cushion the lift car or counterweight in the event of 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 which both can affect the shock absorbing performance.

4.2 Energy dissipation buffer

a. Cracks in the hydraulic components or unresolvable oil leakages
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 (Polyurethane 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.
c. PU buffer has reached its expiry date. If the expiry date is not available, the replacement shall follow 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/deformation on the locking device which affects the locking operation of the door and is beyond repairable.

5.2 Air Cord rope

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

5.3 Drive Belt/ Chain

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

5.4 Door Hanger

a. Deformation of hanger rollers, abnormal noise or vibration during operations.
b. Rusting of upthrust / eccentric roller.

6 Landing Doors

Landing door refers 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 affects the smooth operation of doors.
b. Elongation beyond the adjustable limit.

6.3 Spring closer

a. Severely corroded/Presence of instability at the end attachments of the spring closer.
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, worn off.
b. Shows severe signs of wear and deformation which can affect the smooth operation of doors.
c. Drive belt / chain, slacking at the un-tensioned span between the drive and driven pulleys, beyond manufacturer's criteria.

6.5 Door Hanger

a. Hanger rollers deformed, operating noisily, or are causing abnormal vibration.
b. Up thrust / eccentric roller rusted or/and 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 & 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 & self-monitoring	Refer to Annex A 1
2	Rope Gripper	Presence of cracks and deformation; Excessively corroded or rusted lining surface (friction element)

3	Sheave jammer	Cracks in frictional plate
4	Counterweight safety gear	Refer to Annex A 3

8 Ascending Car Overspeed Protection (ACOP)

8.1 ACOP Detection Means

a. Bi-directional Overspeed Governor (Refer to Annex A 3.2)

8.2 ACOP Stopping Means

Table A9: Replacement criteria for different ACOP stopping means

S/N	Stopping Means	Wear criteria for replacement
1	Brake with redundancy & self-monitoring	Refer to Annex A 1
2	Rope Gripper	Presence of cracks and deformation; Excessively corroded or rusted lining surface (friction element)
3	Sheave jammer	Cracks at frictional plate
4	Counterweight safety gear	Refer to Annex A 3

ANNEX B – REPLACEMENT CRITERIA OF SAFETY CRITICAL ELECTRICAL AND ELECTRONIC PARTS

1 Electrical Switches

It is recommended that a time-based replacement shall be adopted for the 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 includes:

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				
	Governor rope tension switch (if applicable)				
5	Hydraulic buffer switch (if applicable)				
6	Car door switch				

S/N	Component	Current Model	Installation Date	Recommended Replacement Frequency	Alternative Model that can be used
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/EBOPS / UPS / ARD / Emergency Battery releasing device

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

a. Provides lighting, ventilation, ability to raise distress calls during a power failure; and
b. For buildings with backup power, an Automatic Rescue Device (ARD) automatically brings the lift to the nearest landing and open 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 manufacturer's recommendation, or measurements of output performance, whichever met the replacement criteria.

Battery shall be replaced when any of the following output performance are 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;
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

	Battery Set 1	Batter Set 2	……
Ambient temperature			
Operating Voltage			
Voltage after charging			
Rated Capacity			
Actual Capacity			

3 Car Door Light Curtain/Sensor

The light curtain is not able to detect obstacles having a size of 50 mm diameter or greater effectively.

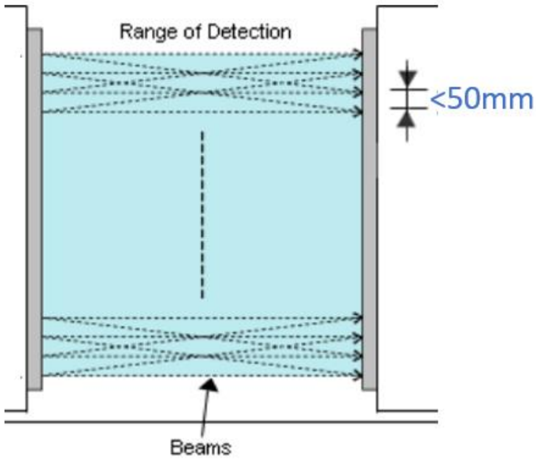


Figure B1: Light Curtain Diagram.

ANNEX C – RECOMMENDED CHECKS FOR CONDITION ASSESSMENT OF LIFT

S/N	Component	Recommended Tests
1	Brake	Dismantle the brakes and carry out the condition assessment of the following items if applicable: 1) Condition of the brake springs 2) Condition of the brake pads (thickness etc) 3) Movement of the plungers & brake arm 4) Condition of the brake drum
		Brake test according to the code requirement that includes: • Holding capacity up to 125% • Verifying the stopping distance against the manufacturer's recommendation. • Proper functioning of manual release & winding for rescue operations.
2	Traction Motor	• Motor insulation. Refer to Table 61 Minimum Values of Insulation Resistance in SS638:2018. • Check motor protection (overload, short circuit etc) those required by SS550:2020
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 installation manual (or manufacturer's recommendation); • Check the condition of the door protective device, the mounting of the sensors, and if any loosen wire for the sensor; • Check distance between the car door cam and the landing door for all landings.
4	Landing doors	• Condition assessment of ALL the landing door locks including both effectiveness of the mechanical locks and the electrical contacts (switch) • Check of the self-closing of the landing doors • Check the condition of the tensioning wires and conditions of all rollers; • Check if ALL the landing doors have sufficient mechanical strength.
S/N	**Component**	**Recommended Tests**

5	Main Controller	• Acceleration and deceleration profile of lifts • Verification of levelling accuracy of every floor against manufacturer’s recommendation • Testing of the safety circuits during full load (all contacts along the safety circuits one by one and their corresponding relay in the controller) • Examine each PCB both sides for a) signs of burns and delamination; b) unauthorised/unrecorded alteration of safety circuits/features on PCB involving safety circuits by third-party • Measurement of the insulation level (refer to Table 61 Minimum Values of Insulation Resistance in SS638:2018) and earthing impedance; • Thermal scan of main controller & separate main power supply box (if applicable)