IMPROVEMENT OF PREVENTIVE MAINTENANCE PLAN OF NEW ELEVATOR PRODUCT

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การย้ายแหล่งการผลิตและการใช้ผู้จัดหาสิ่งของให้ในการผลิตอุปกรณ์ลิฟต์เป็นกลยุทธ์ที่บริษัทลิฟต์ข้ามชาติเลือกใช้เพื่อช่วยลดต้นทุนการผลิตและเพื่อเพ่งความสนใจในสมรรถนะหลักขององค์กร อย่างไรก็ตาม หลังจากที่ลิฟต์รุ่นใหม่ที่ได้ใช้กลยุทธ์นี้ถูกนำไปใช้งานพบว่าลิฟต์มีสถิติบกพร่องเป็นจำนวนหลายครั้ง ซึ่งสาเหตุของปัญหาส่วนมาก เกิดจากการขาดการบำรุงรักษาระบบประตูอย่างถูกต้อง การที่ลิฟต์มีสถิติบกพร่องเป็นจำนวนมาก งานวิจัยนี้มีวัตถุประสงค์เพื่อพัฒนาแผนงานบำรุงรักษาเชิงป้องกัน แทนที่งานบำรุงรักษาเชิงแก้ไขหลังจากลิฟต์รุ่นใหม่บกพร่อง

การวิเคราะห์ข้อบกพร่องและผลกระทบ เป็นเครื่องมือที่นำใช้ในการหาข้อบกพร่องของระบบประตูลิฟต์ที่อาจจะเกิดขึ้นได้ และใช้เพื่อคำนวณค่าดัชนีความเสี่ยงชี้นำเพื่อที่จะพัฒนาแผนงานบำรุงรักษาเชิงป้องกันที่ใช้อยู่ในปัจจุบัน ค่าดัชนีความเสี่ยงชี้นำนี้ถูกนำมาใช้ในการปรับตารางงานซ่อมบำรุง, การปรับรายการตรวจสอบงานซ่อมบำรุง, การสร้างคู่มืองานซ่อมบำรุง, การเตรียมแผนการอบรมและ ระบบการประเมินผล

ผลลัพธ์แสดงให้เห็นว่าจำนวนครั้งที่ลิฟต์บกพร่องจากระบบประตูลดลงจาก 62.5% เป็น 20% สำหรับลิฟต์เครื่องเก่า และจำนวนครั้งที่ลิฟต์บกพร่องจากระบบประตูเป็น 0 สำหรับลิฟต์เครื่องใหม่ เมื่อจำนวนครั้งที่ลิฟต์เสียลดลงแล้ว ค่าดัชนีความเสี่ยงชี้นำใหม่จึงลดลงตามไปด้วย ซึ่งเป็นสิ่งที่พิสูจน์แล้วว่าผลลัพธ์เป็นไปตามวัตถุประสงค์ของงานวิจัยนี้

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Using of offshore manufacturing and offshore suppliers for new elevator product is a strategy of multinational elevator's company to focus on both cost reduction and company's core competency. However after this strategy has been used in new elevator product, there were a number of elevator's failures which mainly caused from poor preventive maintenance on elevator's door system. The objective of the research was to develop an improved preventive maintenance plan of door system of new elevator product instead of corrective maintenance.

The methodology of the research was performed based on Failure Mode and Effect Analysis (FMEA). FMEA was used for identifying potential failure modes of door system and assigning Risk Priority Number (RPN) in order to create an improvement of preventive maintenance plan. RPN setting was used for revising preventive maintenance schedule, revising preventive maintenance checklist, creating troubleshooting manual and developing training course & evaluation system.

The result shows that a number of elevator's failures from door system was reduced from 62.5% of total failures to 20% of total failures for old unit and number of elevator's failure from door system is equal to 0 for new unit. As occurrence is reduced, new PRN is reduced. It is proved that the result is in accordance with objectives.

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Student's Signature .....
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CHAPTER I

INTRODUCTION

1.1 Introduction

In modern transportation system, safety of passenger is one of the most critical issues to concern. Elevator is an important vehicle which is used for transporting people between floors in the building however presently there are a number of accidents from using elevator around the world. In year 2014, there was a fatal accident happened in Huaqiao University in China (ChinaDaily, 2014). CCTV inside malfunctioned elevator showed that the elevator started moving up while elevator's door kept opening. It caused a young man who was getting in elevator's car to death by being trapped between elevator's door and elevator's car.

For modern elevator products of international brands, elevators have been designed, manufactured and installed to comply with regulations and standards such as EN code for Europe, ANSI code for North America and JIS code for Japan. However during normal operation period, in Thailand, there is no legal requirement to enforce elevator's owner to regularly inspect condition of elevators.

Elevator's door is one of very important parts of elevator as it is used as a gate for a passenger who takes a ride with an elevator. Malfunction from elevator's doors can make a negative impact in wide area. In terms of elevator itself, elevator will have shorter life cycle. In terms of passengers, they may get a minor injury up to fatality. In

terms of elevator brand and building's owner, they may get a complaint or suing from passengers which will damage reputation. Therefore it is necessary for elevator's company to properly maintain elevator's door.

1.2 Company background

The selected organisation is one of the world largest multinational manufacturer of elevators, escalators and moving walks founded in one of European countries. The organisation provides close loop solutions including manufactures, installs, services and modernises escalators, elevators and moving walks for various type of building requirements through subsidiaries in more than 100 countries. In Thailand, the organisation was established more than 30 years under control of Joint Venture Company.

In terms of competitive advantage, the organisation leads in innovative product such as destination control system for transit management (Figure 1), traction media for replacing conventional rope and regenerative drives for returning electricity back to buildings.

Figure 1: The PORT Technology

In Thailand market, Japanese, US and European brands are playing as main competitors in terms of market share however CEO of Joint Venture Company believes that a robust business strategy can drive the organisation become number one brand in the region in terms of sales volumes, customer satisfaction, innovation, safety, reliability, availability and quality.

Price war between competitors, expansion of urbanisation in Asia Pacific countries which currently accounts for 75% of world-wide sales volume and the need of good-looking, environmental-friendly and user-friendly products nowadays (Anon, 2014) are key drivers of organisation's business strategy to move from differentiation strategy to best-cost (hybrid) strategy in order to focus on both cost leadership and differentiation as shown in Figure 2 (Thompson et al., 2008).

Figure 2: Business strategy of the organisation

(Adopted from (Porter, 1985, Thompson et al., 2008))

Value conscious buyers who look for better product in terms of quality, feature, appeal, performance and service with lower cost than competitors are a targeted customer of best-cost strategy (Thompson et al., 2008, Bambang Baroto et al., 2012). The example organisations which succeed in best-cost strategy such as IKEA and Toyota.

Best-cost strategy in the organisation can be seen in terms of product segmentation. The organisation provides products which cover all demands of elevator, escalator and moving walk in the market. For elevator market, the organisation has 5 elevator products contain AAAA series, BBBB series, CCCC series, DDDD series and EEEE series. The target's market of each products can be seen from Table 1 below.

Table 1: Product segmentation for elevators

No.	Products	Target's Market
1	AAAA	Focus in low-rise buildings and economic market such as home office, apartment, low-rise condominium
2	BBBB	Focus in medium-rise buildings such as condominium, shopping mall, hospital
3	CCCC	Focus in high-rise buildings such as office buildings, hotel, luxury buildings
4	DDDD	Focus in heavy duty use such as warehouse, cargo lift
5	EEEE	Focus in modernisation buildings

1.3 Background of research

To harmonise with business strategy, the manufacturing strategy of new products especially for low-rise and medium-rise buildings in Asia Pacific region has been changed from onshore manufacturing site in European country to offshore manufacturing site and offshore suppliers in China (Figure 3) such as WELM, Wittur and Sematic in order to minimise manufacturing cost and to focus on company's core competency (Anon, 2015).

Figure 3: Offshore suppliers

Thailand was the few first countries to launch a substituted product of BBBB elevator called BCBB elevator in year 2012 in order to raise opportunity from rapid condominium expansion nearby extension line of Bangkok Mass Transit System (BTS)

and Metropolitan Rapid Transit (MRT) train stations in Bangkok. The target's customer is big name condominium developers in Thailand.

The unique selling points of BCBB elevators are described as Table 2 below.

Table 2: Unique selling point of BCBB elevator

No.	Unique selling point	How
1	Lower noise during travel	- New roping system (traction media) - New machine and brake design 
2	Customised to customer requirement	- More mix and match interior and exterior designs - Machine-room-less elevator for medium-rise building
3	Lower electricity consumption	- Power factor 1 for regenerative drive - Integrated Light-emitting diode (LED) product into elevator's indicators and lightings 
4	Cheaper selling price than predecessor product (BBBB elevator) by 15%	- Use of offshore manufacturing site and offshore suppliers in manufacturing processes

BCBB elevator was successfully introduced to Bangkok's market as sales volume reached the sales target (50 units) which was set by Joint Venture Company however there have been a high number of elevators' failures and complaints from users after elevators have been put into operation. Consequently, these problems delivered a big negative impact to the organisation in terms of reputation, customer's satisfaction and retaining old customers. Figure 4 shows that when we type in Thai "ลิฟต์ห่วย" which means bad elevator into Google search, the first result of the search is bad experience from customers who uses BCBB elevator in big name condominium in Bangkok.

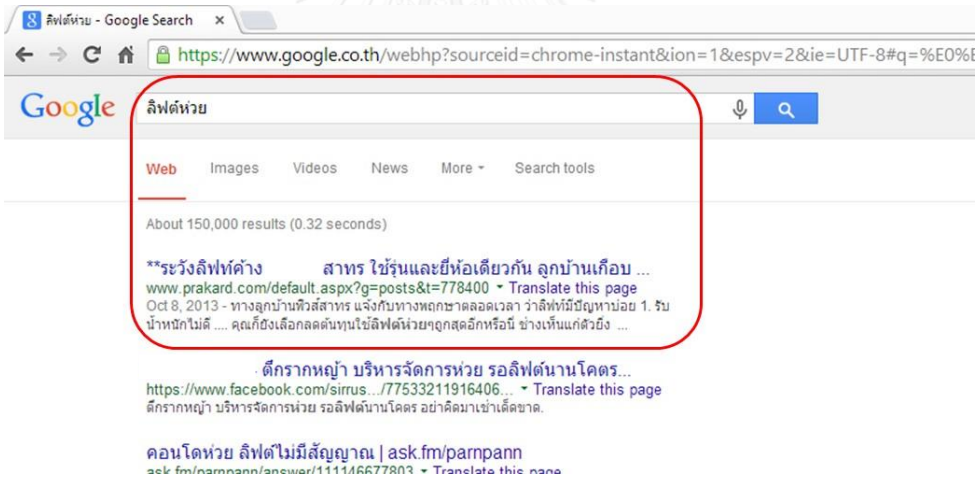


Figure 4: Customer's dissatisfaction in Social media

For internal process, there are key performance indicators (KPIs) to measure performance in each department in different period of time as shown in Table 3.

Table 3: Key performance indicators of the organisation

KPIs	Measure	Objective
CBR6	- Failure ratios of new handed-over units to maintenance department in the first 6-month period.	Reliability, availability
FPY	- Percentage of new units which can pass quality and safety at first inspection in new installation department	Safety, quality
MTBF	- Failure ratios of units in maintenance department	Reliability, availability, quality
CPSI	- Periodical inspection of safety and quality of units in maintenance department	Safety, quality
CSS	- Customer satisfaction survey in different period	Overall

Referring to Table 3, top management team from Joint Venture Company set a short-term target to focus on Mean Time Between Failure (MTBF) score of new elevator products in order to make confidence to stakeholder and customers which are the key drivers to recover organisation's reputation and revenues back soonest.

Mean Time Between Failure

MTBF is a reliability term which is used widely in many industries and calculation of MTBF is depended on failure definition (Torell and Avelar, 2010).

Failure definition

Figure 5 shows that not every telephone call from a customer will count as a failure in MTBF.

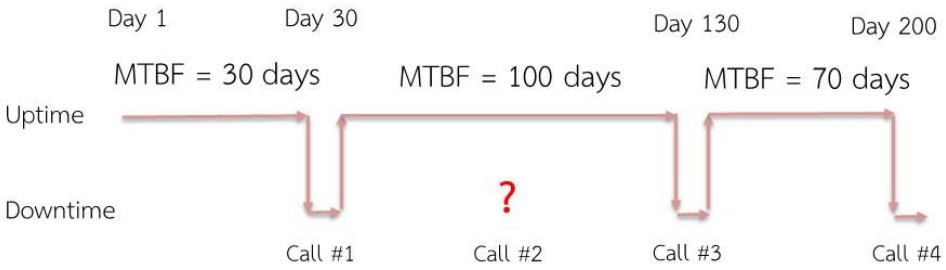


Figure 5: Mean Time Between Failure

For example, a customer asks for collecting key chain which dropped down into elevator's shaft. Therefore company has classified failure type into 2 categories.

First failure type is FD1 comprises availability, reliability and quality which caused from product and maintenance issues itself.

Second failure type is FD2 contains others reasons which are not defined in FD1 such as customer assistance, vandalism, building power failure.

Availability

Availability refers to the degree to which elevator system is operational and accessible when a passenger requires for use (IEEE, 1990). For example, car door contact is broken which leads elevator to be unable to serve passenger.

Reliability

Reliability refers to the ability of elevator system or elevator component to perform its required functions under stated conditions for a specified period of time (IEEE, 1990). For example, elevator is unable to set for running at rated speed because of ride comfort issue.

Quality

The degree to which elevator system, elevator component, or maintenance process meets specified requirements and/or user/customer needs and expectations (IEEE, 1990).

In summary, Figure 6 shows that MTBF score of BCBB product will be high or low is directly varied from 3 factors are availability, reliability and quality.

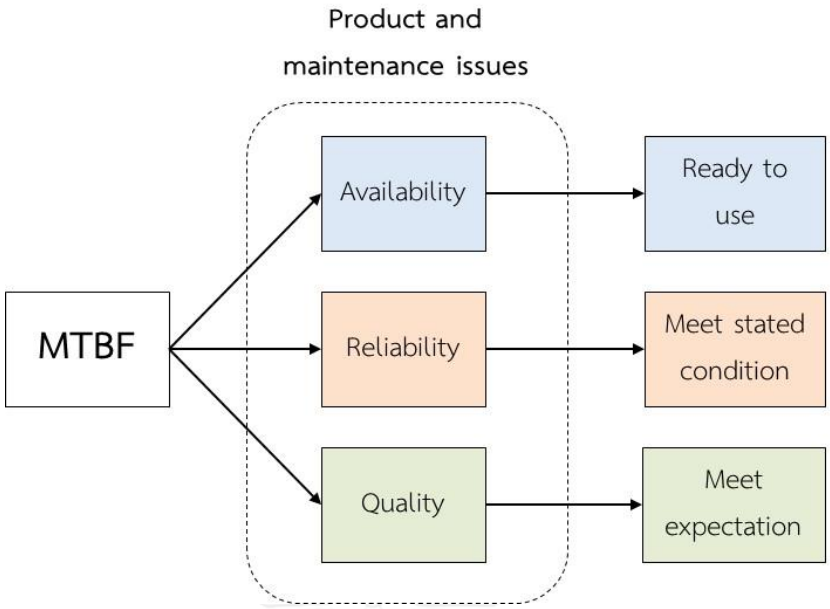


Figure 6: Relationship between MTBF and failure definition

1.4 Statement of the problem

Referring to suitability requirements of industry elevator standards, (Buede, 1995) stated that the elevator should have MTBF at least more than 1 year (365 days) and the design target is 1.5 years (547.5 days).

Figure 7 illustrates performance of Existing Installation department to maintain BCBB elevator in terms of number of failure (FD1), monthly MTBF and Year-To-Date (YTD) MTBF. It can be seen that YTD MTBF of BCBB products in whole year 2014 is only 67 days which is worse than target in industry elevator standard.

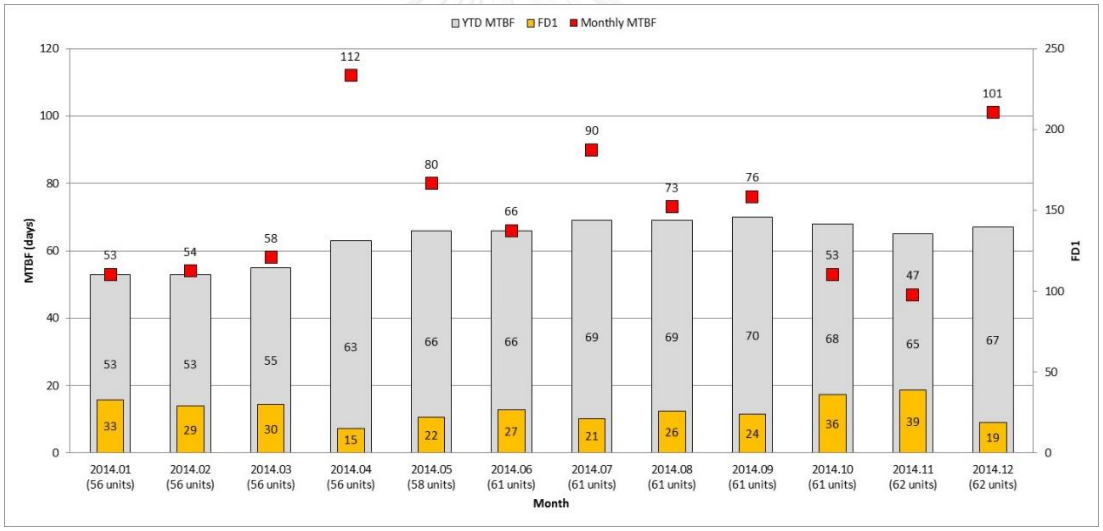


Figure 7: MTBF of whole BCBB elevators in year 2014

Monthly MTBF

According to Figure 7, monthly MTBF can be calculated by following formula.

$$= \frac{(Calendar\ days\ of\ each\ month)\ x\ (Number\ of\ elevators\ in\ each\ month)}{Number\ of\ elevator'sfailure\ caused\ from\ product\ and\ maintenance\ \ in\ each\ month}$$

For example, the calendar days in January is 31 days and the number of BCBB elevators in January 2014 was 56 units. 33 telephone calls in January 2014 are FD1 failure. The calculation of monthly MTBF in January 2014 is shown below.

$$\text{MTBF} = \frac{\mathbf{31\ x\ 56}}{\mathbf{33}} \cong 53 \text{ Days}$$

Yearly MTBF

Yearly MTBF can be calculated by following formula.

=

$$\frac{\Sigma\ (\mathbf{(}\mathit{Calendar\ days\ of\ each\ month}\mathbf{)}\ x\ \mathbf{(}\mathit{Number\ of\ elevators\ in\ each\ month}\mathbf{))}}{\Sigma\ (\mathit{Number\ of\ elevator's failure\ caused\ from\ product\ and\ maintenance\ in\ each\ month})}$$

Summation of calendar days of each month multiply by number of elevators in each month was equal to 21525 days. There were 321 telephone calls in whole year 2014 are FD1 failure. The calculation of MTBF in year 2014 is shown below.

=

$$\frac{(31\ x\ 56)+(28\ x\ 56)+(31\ x\ 56)+(30\ x\ 56)+(31\ x\ 58)+(30\ x\ 61)+(31\ x\ 61)+(31\ x\ 61)+(30\ x\ 61)+(31\ x\ 61)+(30\ x\ 61)+(31\ x\ 61)}{33+29+30+15+22+27+21+26+24+36+39+19}$$

$$\text{MTBF of year 2014} = \frac{\mathbf{21525}}{\mathbf{321}} \cong 67 \text{ days}$$

Failure reports

Failure reports of BCBB elevators (Figure 8) in whole year 2014 can be obtained from SAP database (Appendix A). However information in the failure reports is not ready to use for further analysis yet because elevator comprises complex combination of electrical components and mechanical components.

Country	Equipme	City	Wee	Mont	Notification da	Notification ti	Evaluation/Event description
Thailand (JST)	JSG6000407(	BANGKOK	2014.29	2014.07	15.07.2014	7:54:15	Jul 22: AESD had anything to do with this call back?
Thailand (JST)	JSG6000407(	BANGKOK	2014.33	2014.08	17.08.2014	13:30:35	Aug 20: check again with JST to confirm, then update
Thailand (JST)	JSG6000407(	BANGKOK	2014.39	2014.09	24.09.2014	8:17:40	08.10: Raise GCM and return the PCBs for analysis. -> Can we raise a claim for free of charge? because now the
Thailand (JST)	JSG6000408(	BANGKOK	2014.13	2014.03	26.03.2014	14:30:21	ปด.เปิด/ปิดซ้ำ
Thailand (JST)	JSG6000408(	BANGKOK	2014.15	2014.04	13.04.2014	21:32:25	based on field feedback it was general landing door mechanical fault, to be confirmed with field.
Thailand (JST)	JSG6000408(	BANGKOK	2014.39	2014.09	23.09.2014	6:20:35	05.11: Change CB_E to CB2.
Thailand (JST)	JSG6000408(	BANGKOK	2014.41	2014.10	12.10.2014	13:30:45	15.10: Maybe the door be hit and caused the KOKB, auto set-up the car door and landing door.
Thailand (JST)	JSG6000408(	BANGKOK	2014.44	2014.10	28.10.2014	8:13:21	04.11.2014: suggest field to check door mech. works smoothly, any damage to increase friction, or parameter of d
Thailand (JST)	JSG6000408(	BANGKOK	2014.44	2014.10	29.10.2014	11:54:43	ค้างชั้น 15 ปด.ปิด
Thailand (JST)	JSG6000408(	BANGKOK	2014.49	2014.12	03.12.2014	10:40:59	b. UET bridged?
Thailand (JST)	JSG6000408(	BANGKOK	2015.01	2014.12	29.12.2014	15:50:25	07.01: The lift was stopped on the 2nd floor due to KTC issue, field will replace KTC contact.
Thailand (JST)	JSG6000408(	BANGKOK	2014.07	2014.02	10.02.2014	14:34:35	ค้างชั้น 22 มีคนเดินช่วยออกแล้ว
Thailand (JST)	JSG6000408(	BANGKOK	2014.15	2014.04	09.04.2014	13:03:29	to check position contact KUET in F9, '1505 Invalid Floor Position during Trip' was found to lead to 476 and 477
Thailand (JST)	JSG6000408(	BANGKOK	2014.22	2014.05	29.05.2014	11:08:28	ค้างไม่วิ่ง
Thailand (JST)	JSG6000408(	BANGKOK	2014.28	2014.07	08.07.2014	10:59:29	ปุ่มกดชั้น 18,9 กดไม่ติด
Thailand (JST)	JSG6000408(	BANGKOK	2014.31	2014.07	29.07.2014	9:56:16	05.08: CANCP pcb fault.
Thailand (JST)	JSG6000408(	BANGKOK	2014.41	2014.10	07.10.2014	14:03:16	15.10: If can replace the ASIXB pcb, please replace, otherwise repair it to avoid the IMOF switch change position

Figure 8: Failure reports in whole year 2014 deriving from SAP database

Table 4 shows that there were 53 uncategorised causes of FD1 failure were preliminary analysed and reported by technicians after performing corrective maintenance in whole year 2014. These 53 uncategorised causes of FD1 failure can be merged into a group of component in order to highlight a key driver of FD1 failure.

Table 4: Causes of FD1 of BCBB products in year 2014

No.	Cause of failure	Number of failure	Percentage	Percentage cumulative	A group of component
1	Car Operating Panel	27	9.06%	9.06%	Fixtures
2	KTS (Hoistway door contact) - Mech. Adj.	24	8.05%	17.11%	Door system
3	Landing Door	19	6.38%	23.49%	Door system
4	Shaft information	17	5.70%	29.19%	Shaft Information
5	Landing door locking	15	5.03%	34.23%	Door system
6	LOP defective	14	4.70%	38.93%	Fixtures
7	GCIO (Global Controller I/O MX)	13	4.36%	43.29%	GCIOCF
8	Power Supply	12	4.03%	47.32%	Controller
9	BCM PCBA	12	4.03%	51.34%	Brake
10	ASIXx	11	3.69%	55.03%	ASIXB
11	Speed governor	11	3.69%	58.72%	Governor
12	ACVF	10	3.36%	62.08%	Drive
13	Door Drive Parameter	9	3.02%	65.10%	Door system
14	Software Bug	9	3.02%	68.12%	Controller
15	Door Drive	8	2.68%	70.81%	Door system
16	Blocked with unknown reason	6	2.01%	72.82%	Lack of information
17	Maintenance & safety devices/contacts	6	2.01%	74.83%	Shaft information
18	Car Door	6	2.01%	76.85%	Door system
19	Hoistway mechanical	6	2.01%	78.86%	Car Damping Device
20	Main boards/controller	5	1.68%	80.54%	Controller
21	Door steel rope	5	1.68%	82.21%	Door system
22	CAN Bus	4	1.34%	83.56%	Communication
23	KTC (Car door contact)	4	1.34%	84.90%	Door system
24	KTC (Car door contact) - Mech. Adj.	3	1.01%	85.91%	Door system
25	Light Curtain	3	1.01%	86.91%	Door system
26	Transmission cable	3	1.01%	87.92%	Door system
27	Customer assistance	2	0.67%	88.59%	Function
28	Car Connectors/Wiring	2	0.67%	89.26%	Fixtures
29	KTS (Hoistway door contact)	2	0.67%	89.93%	Door system
30	Carrier rollers	2	0.67%	90.60%	Door system
31	KSSBV (Slack Rope Speed Governor)	2	0.67%	91.28%	Governor

Table 4: Causes of FD1 of BCBB products in year 2014 (Cont.)

No.	Cause of failure	Number of failure	Percentage	Percentage cumulative	A group of component
32	Landing operating/indication panel	2	0.67%	91.95%	Fixtures
33	Shaft Encoder (IG)	2	0.67%	92.62%	Shaft Information
34	Door mechanic	2	0.67%	93.29%	Door system
35	Door Clutch	2	0.67%	93.96%	Door system
36	Battery defective/uncharged	1	0.34%	94.30%	Battery
37	Landing door panel	1	0.34%	94.63%	Door system
38	KB/KB1 adjustment	1	0.34%	94.97%	Brake
39	LMD Calibration	1	0.34%	95.30%	Load system
40	BIO Bus	1	0.34%	95.64%	Communication
41	Machine & drive	1	0.34%	95.97%	Machine
42	Safety gear	1	0.34%	96.31%	Car safety gear
43	Door bottom shoes	1	0.34%	96.64%	Door system
44	Door electric	1	0.34%	96.98%	Door system
45	KNE (final limit)	1	0.34%	97.32%	Shaft Information
46	Operator toothed belt	1	0.34%	97.65%	Door system
47	External influence	1	0.34%	97.99%	External influence
48	Misuse	1	0.34%	98.32%	Lack of information
49	LOP Connectors/Wiring	1	0.34%	98.66%	Fixtures
50	SCPU (Microprocessor PCB)	1	0.34%	98.99%	CPUCF
51	Car lighting	1	0.34%	99.33%	Car lighting
52	Load measuring device	1	0.34%	99.66%	Load system
53	Car door lock	1	0.34%	100.00%	Door system

According to Table 4, Figure 9 summarises that door system accounts for the largest proportion (37%) of a group of component of FD1 failure in year 2014.

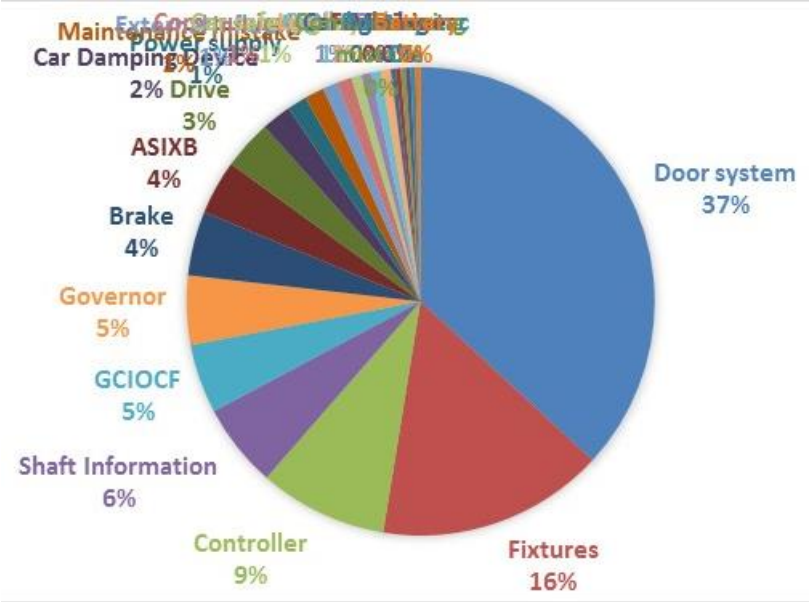


Figure 9: A group of component of FD1 failure of BCBB products in year 2014

In a big picture, door system comprise 2 primary parts are car door (Figure 10) and landing door (Figure 11).

Figure 10: Car door

Figure 11: Landing door

Why-why analysis

Why-why analysis is used as a tool to identify potential root cause of failure from door system.

Since door system of BCBB product are also supplied by offshore manufacturer for car door and by supplier for landing door , Figure 12 demonstrates that the root cause of failure comes from poor preventive maintenance plan.

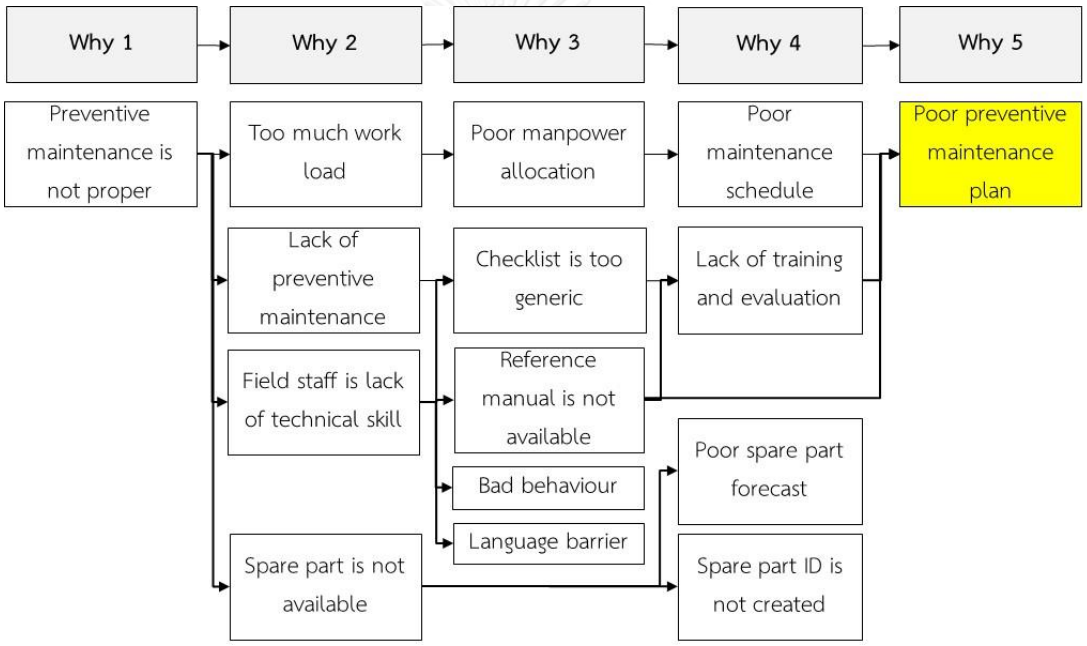


Figure 12: Why-why analysis of door system

Figure 13 shows that there are 5 Area Managers, 14 Supervisors and 148 service technicians work for Existing Installation departments. Total numbers of elevators, escalators and moving walks in Thailand's portfolio are 4952 units. It implies that one service technician has to maintain elevators, escalators and moving walks = $\frac{4952}{148}$ = 34 units.

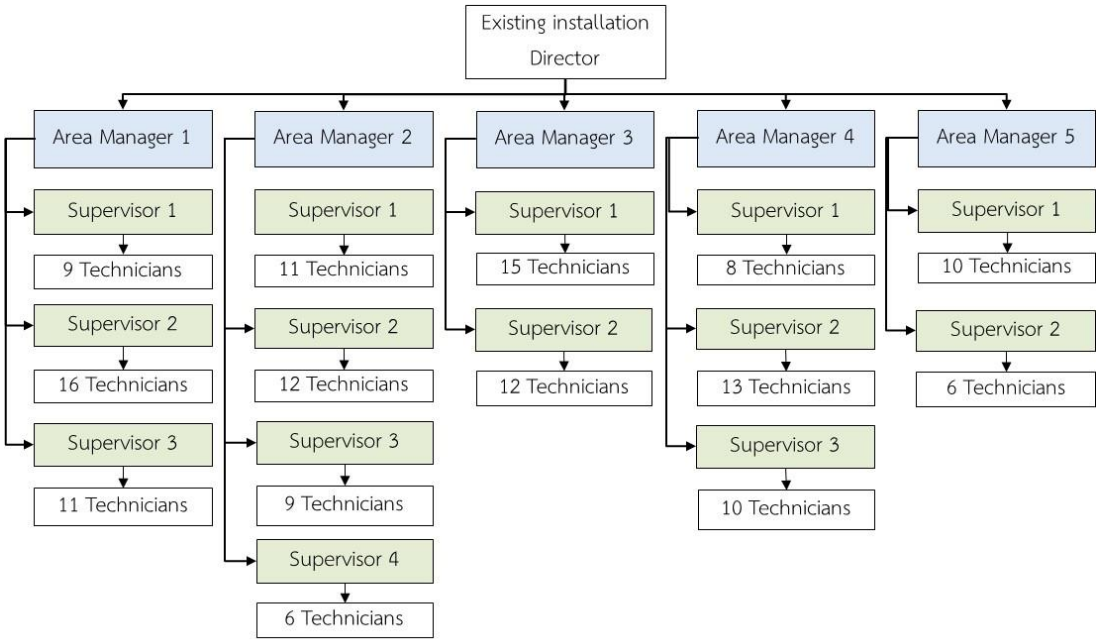


Figure 13: Organisation chart for preventive and corrective maintenance in Existing Installation department

According to current manpower capacity, preventive maintenance schedule for individual elevator, escalator and moving walk are planned to perform by monthly visit by one technician. Since technicians work 6 days/week = 24 days/month, it implies that in day technicians have to perform preventive maintenance = $\frac{34}{24}$ = 1.5 units/day.

For a normal process, Table 5 demonstrates that a technician takes approximately 2 hours to perform preventive maintenance on low-rise elevator, 3 hours on medium-rise elevator and 4 hours on high-rise elevator.

Table 5: Approximate time to perform preventive maintenance

Elevator product	Travel height	Approximate time to perform preventive maintenance
CCCC	< 30 metres	2 hours
BBBB, BCBB	30 – 100 metres	3 hours
AAAA	> 100 metres	4 hours

From Table 5, it implies that max capacity of technicians to perform preventive maintenance is 2 units/day. Therefore there are only 12 number of failures/month or 3 number of failures/week left for technicians to performing corrective maintenance to elevator's failure. If total number of failures are over 12, it will definitely interrupt preventive maintenance schedule of the other unit in that month as preventive maintenance and corrective maintenance of the same elevator are performed by the same technician.

To elaborate on one of worse old units in year 2014, Figure 14 shows that equipment number 60004539 had 12 total number of failures in year 2014 or equal to 1 number of failure/month. It implies that as one technician has to maintain 34 units/month, he has to perform another 34 times/month for corrective maintenance which it is already over maximum capacity.

Figure 14 also shows that door system which comprises door mechanic and door electric accounts for the largest causes = $\frac{(7+1)}{12}\ x\ 100$ = 66.67 % of total failures.

In terms MTBF which excluded non technical callback, MTBF score of this unit is equal to $\frac{365}{10}$ = 36.5 days.

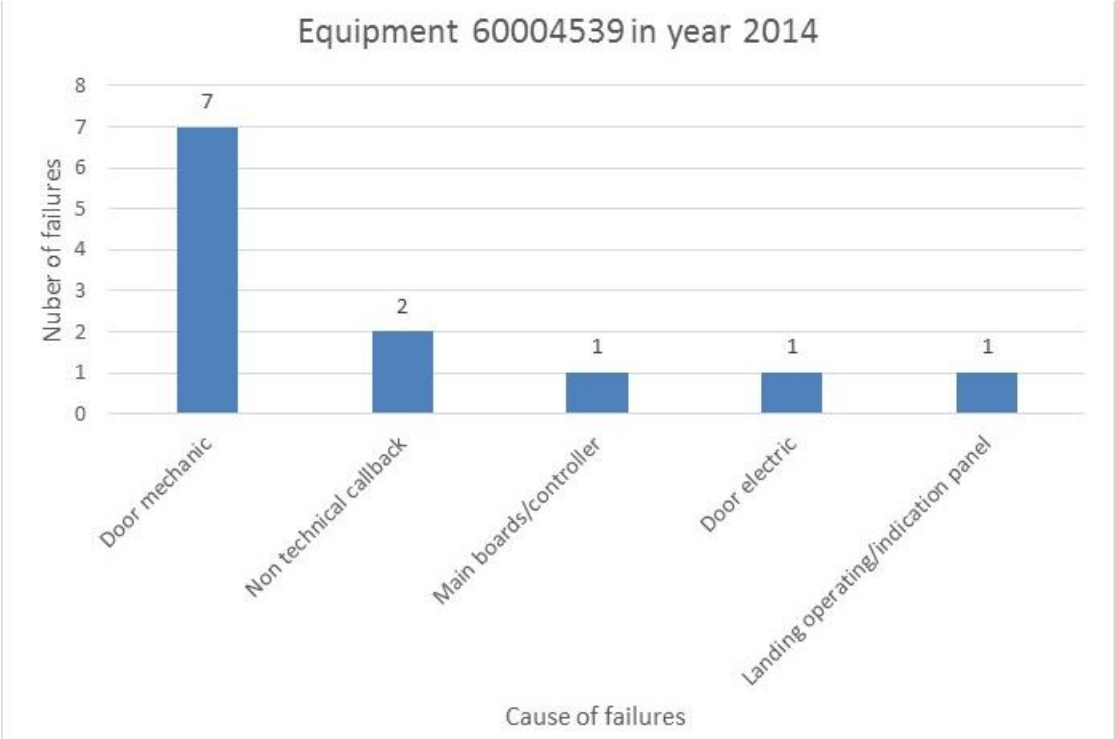


Figure 14: Causes of failure of equipment number 60004539 in year 2014

It can be seen from current situation in Existing Installation department that preventive maintenance activities of each product are referred from existing preventive maintenance checklist document. However Figure 15 shows that details of preventive maintenance checklist are not specific enough for performing preventive maintenance to any elevator product.

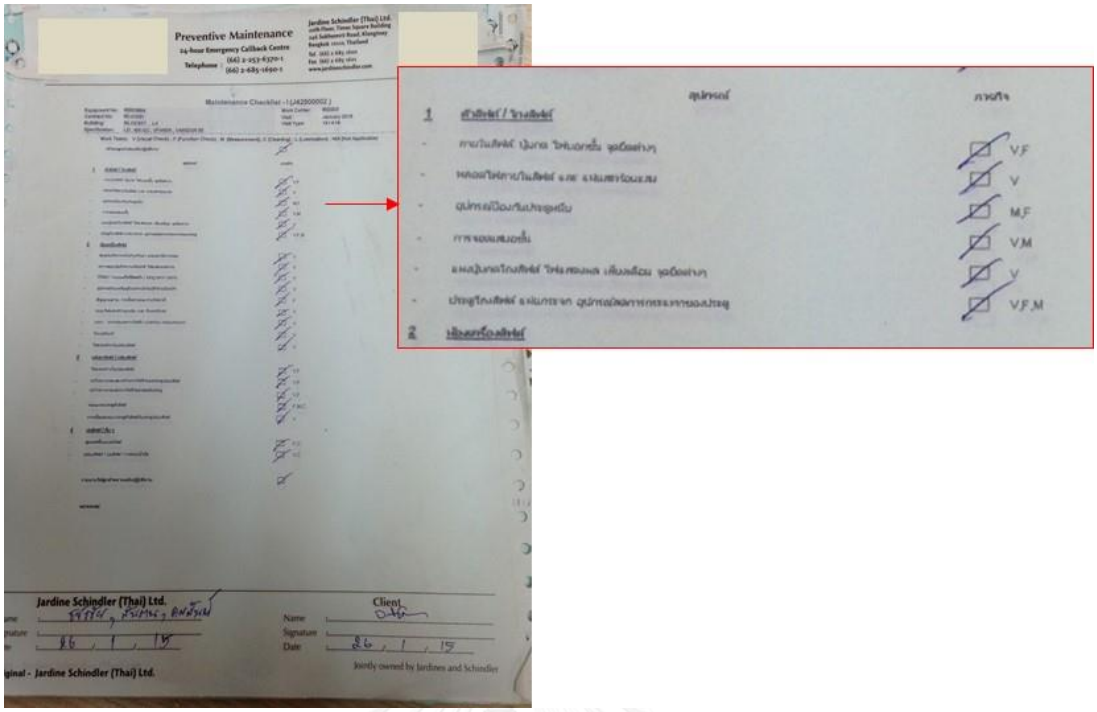


Figure 15: Existing checklist document for traction elevator

Moreover there is no regular training course and reference manual providing to technicians. Therefore it is unable to measure and control skill of technicians which directly affect to preventive maintenance and corrective maintenance quality of BCBB product. It also takes time for technicians to learn how to correctly perform preventive maintenance and corrective maintenance of new product by trial and error which it is already too late for customers.

Wrong understanding to perform preventive maintenance or corrective maintenance can lead elevators to have another failure before performing preventive maintenance in the next month

1.5 Objectives

To develop a preventive maintenance plan of door system of BCBB product to replace existing preventive maintenance plan.

1.6 Scope of the research

1. To focus on preventive maintenance plan of door system of BCBB product due to limitation of resources in terms of urgency, skill of technicians and budget

2. To reduce number of failures from door system of BCBB product

3. To implement on old and new BCBB elevators which have been used in normal operation more than 6 months. These two elevators have similar configuration in terms of door size, rated speed, rated load, numbers of floor, numbers of car group (Appendix A)

1.7 Expected benefit

1. Increase effectiveness and efficiency of preventive maintenance plan

2. Increase availability, reliability and quality of BCBB product

3. Improve overall MTBF of BCBB product

4. Increase customer satisfaction and maintain existing customers

5. Sustain revenue of Existing Installation department

6. Develop technical skill of field staffs

7. Be an example model for other units of BCBB product

1.8 Methodology

Research methodology contains following steps.

Step 1: Build task force team

This research cannot be implemented without having collaboration with others. The main members of taskforce team must come from technical people work for technical & field support department, Existing Installation department and purchasing department. The objective of constructing taskforce team is to align goal, get necessary data and information, brainstorm idea and get permission to implement (Ben-Daya, 2009, Spring, 1995).

Step 2: Perform FMEA

Failure Mode and Effect Analysis (FMEA) will be used as a systematic tool in order to find out possible failure modes, possible causes of failure mode and possible effects of failure mode of door system. Severity, Occurrence and Detection will be assigned to each failure mode in order to calculate Risk Priority Number (RPN) and create corrective actions for step 3 to step 6.

Step 3: Create troubleshooting manual

Troubleshooting manual will be created in Thai and English language contained instruction of how to troubleshoot problem based on corrective actions from FMEA.

Step 4: Revise preventive maintenance schedule

New preventive maintenance schedule will be revised based on RPN setting from FMEA.

Step 5: Revise checklist document for door system

Since current checklist document doesn't help service technicians to perform preventive maintenance correctly. New checklist document will be revised based on corrective actions from FMEA as well.

Step 6: Develop technical training course and evaluation system

Technical training course and evaluation system will be developed and trained to service technicians who responsible for selected BCBB product. A service technician must pass the assessment criteria before performing an improvement of preventive maintenance plan to selected units.

Step 7: Implement to selected units

An improvement of preventive maintenance plan will be implemented into 2 selected units. The result will be measured by 6-month period by comparing number of failures from door system between May 2014 - October 2014 (before) and May 2015 - October 2015 (after). The number of failures must be reduced by 50%.

CHAPTER II

LITERATURE REVIEW AND THEORIES CONSIDERATION

1.9 Maintenance Principle

According to British Standards Institution (Dekker, 1996), maintenance can refer to the integration of technical and administrative actions in order to retain system in a state of required function.

(Kothamasu et al., 2009) stated that performing assessment on machine health can help the organisation to minimise maintenance and repair costs and also unscheduled downtime. In doing so, Kinclaid (1987 cited in (Ben-Daya, 2009)) mentioned that maintenance philosophies consist of 2 primary approaches are reactive maintenance and proactive maintenance as demonstrated in Figure 16. Corrective maintenance is classified as reactive maintenance. It is suitable to implement when failure rate of machine is low and consequence of failure is not critical. The maintenance activity of corrective maintenance will be started after the failure was occurred (Williams et al., 1994; Sheu and Krajewski, 1994; Blanchard et al., 1995 cited in (Ben-Daya, 2009)). Whereas preventive maintenance and predictive maintenance are classified as proactive maintenance because maintenance activity will be performed before the machine has a failure (Mobley, 1990 cited in (Ben-Daya, 2009)).

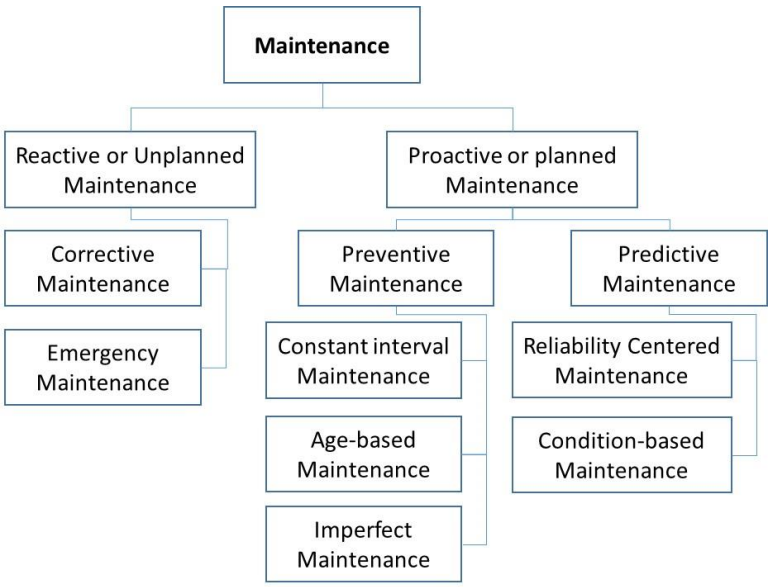


Figure 16: Taxonomy of maintenance philosophies

(Adopted from Kinclaid, 1987 cited in (Ben-Daya, 2009))

Swanson (1997 cited in (Crespo Márquez, 2007)) stated that there are 3 primary activities in modern maintenance management are maintenance planning (work load forecast, scheduling), maintenance organisation (work design, standard) and maintenance control (inventory, cost, quality). Swanson (1997 cited in (Crespo Márquez, 2007)) believed that in order to manage maintenance effectively and efficiently, the organisation must have a clear understanding in maintenance management process and maintenance management framework.

1.10 Maintenance Management Process and Planning

In terms of maintenance management process, (Crespo Márquez, 2007) stated that the elements of maintenance management process comprise course of action, maintenance planning, maintenance scheduling, managing maintenance actions

execution, maintenance assessment, ensuring continuous improvement and considering equipment re-design. To focus on maintenance planning, (Crespo Márquez, 2007) proposed the model of maintenance planning as illustrated in Figure 17.

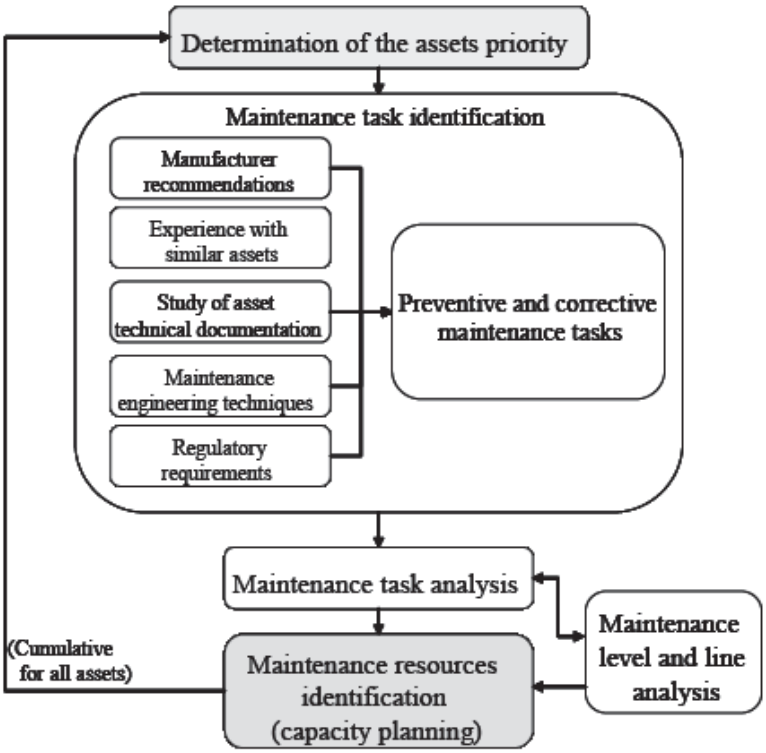


Figure 17: Maintenance Task and capacity planning Model

(Adopted from (Crespo Márquez, 2007))

(Al-Turki, 2009) believed that maintenance planning and scheduling process can divide into 3 periods are short-term planning (daily to weekly), medium-term planning (monthly to yearly) and long-term planning (several years).

1.11 Preventive Maintenance Programme and Maintenance Strategies

In terms of maintenance management framework, there are 2 schools of thought proposed by Wireman (1998 cited (Crespo Márquez, 2007)) as shown in Figure 18 and Campbell (1995 cited (Crespo Márquez, 2007)) as shown in Figure 19.

Wireman (1998 (Crespo Márquez, 2007)) believed that preventive maintenance programme is a ground step of maintenance management and we can move to the further step when in the number of corrective maintenance is in low level.

(Rungsa Em-ardchaya and Tangjitsitcharoen, 2014) proposed application of computerised preventive maintenance management system (CPMMS) integrated with failure mode and effect analysis (FMEA) for CNC machine. Setting of risk priority number (RPN) which comprises severity (S), occurrence (O) and detection (D) from FMEA can be set as a standard to generate a new preventive maintenance plan automatically. This application is able to increase overall equipment effectiveness (OEE) of CNC machine.

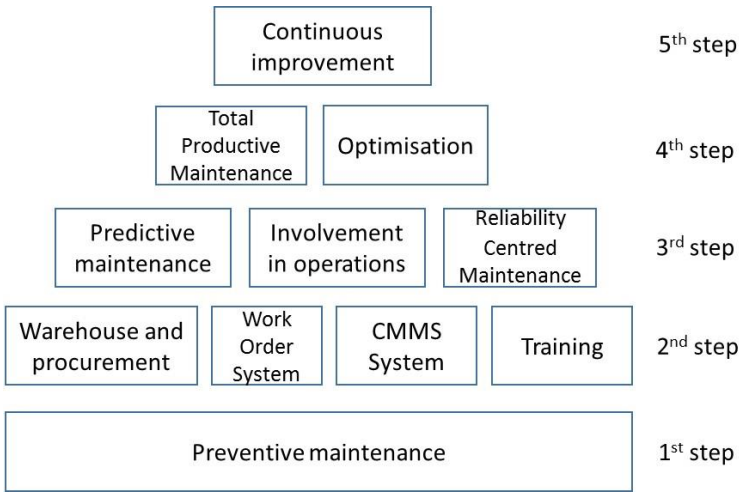


Figure 18: Wireman's maintenance framework

(Adopted from Wireman, 1998 cited in (Crespo Márquez, 2007))

Campbell (1995 cited in (Crespo Márquez, 2007)) believed that developing maintenance strategies to align with business plan and creating cultural change in organisation are the basis step of maintenance management framework.

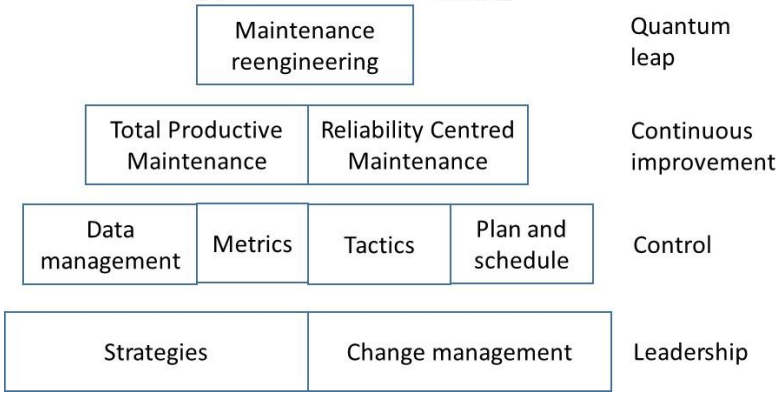


Figure 19: Campbell's maintenance framework

(Adopted from Campbell, 1995 cited in (Crespo Márquez, 2007))

1.12 Measureable Indicators and Key Factors of Maintenance Performance

(Parida and Kumar, 2009) stated that availability, mean time between failure (MTBF), failure frequency and mean time to repair (MTTR) of the machine are measurable indicators of maintenance performance. And in order to increase productivity of maintenance performance, Raouf (1994 cited in (Ben-Daya, 2009)) believed that organisation policy, management training, planner training, technical training, motivation, scheduling, preventive maintenance history, condition monitoring, information system are key factors.

1.13 Failure Mode and Effect Analysis and Reliability Centred Maintenance Team

(Ben-Daya, 2009, Crespo Márquez, 2007) stated that Failure Mode and Effect Analysis (FMEA) is an essential part of Reliability Centred Maintenance (RCM) because FMEA enables organisation to mitigate the risk of machine's failure, increase reliability, increase customer's satisfaction and optimise maintenance efforts.

To make RCM success, (Ben-Daya, 2009) believed that the organisation must build RCM team from different functions in the organisation as shown in Figure 20. It will enable everyone to have alignment, commitment, understanding and confidence (Ben-Daya, 2009).

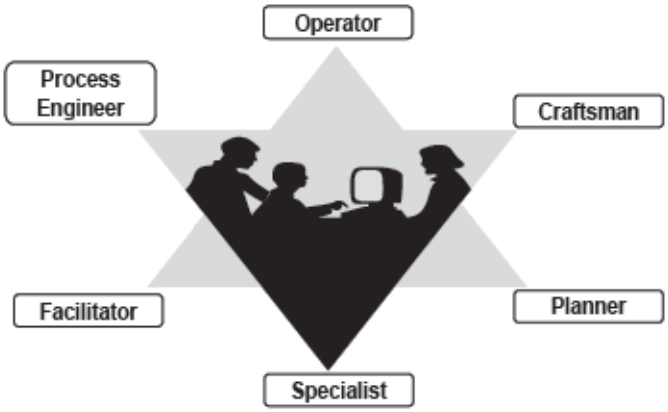


Figure 20: Example of RCM review team (Adopted from (Ben-Daya, 2009))

1.14 Tools to Increase Reliability of Metro Door System

For metro door system, there are a complex combination between mechanical and electrical component and the number of door operation is in a high frequency. (Liu et al., 2013) stated that there is a high possibility that mechanical or electrical component of door will be failure.

(Liu et al., 2013) used Fault Tree Analysis (FTA) and Fuzzy Reasoning Petri Net (FRPN) to analyse reliability of metro door system.

(Xia et al., 2013) used critical analysis of common failure modes on train door system to create door maintenance plan.

(Guo et al., 2013) used risk-based maintenance (RBM) which included FMEA tool to identify and eliminate potential failure of metro door system in order to create maintenance decision. (Guo et al., 2013) stated that the optimum cycle date of maintenance in metro door system should be 57 days.

Based on common faults of train door, (Zubrzycki, 2010) used FMEA to develop a fault tolerant train door controller in order to improve train door reliability and reduce time to identify a fault during corrective and preventive maintenance. The possible failure modes of mechanical and electrical components of train door are shown as Table 6 and Table 7 below.

Table 6: Possible failure modes of mechanical components

Failure mode	Effect of failure	Detection method
Rollers faults	- Rollers are blocked or have difficulty moving smoothly across the door guide - Motor may be not able to move door panels - The door being put out of service - Increase the door opening / closing time	- Measure time of door movement - Detect by distance sensor
Linear shaft assembly	- Increase friction - Difficulties in door movement	- Measure time of door movement - Detect by distance sensor
Push button fault	- Button cannot work when pressed	- Check during maintenance
Ball bearing fault	- Increase noise of door movement	- Monitor by system temperature or current change
Door panels misalignment	- Bang noise and lateral movement	- Detect by distance sensor or current change
System overheat	- Door controller shuts down	- Monitor by system temperature
Motor brushes wear	- Increase door motor temperature - Door motor is unable to function	- Monitor by temperature sensor - Optical encoder

Table 7: Possible failure mode of electrical components

Failure mode	Effect of failure	Detection method
Sensor fault	- Interference	- Optical encoder
Wrong motor control signal or no signal	- No door movement	- Internal micro controller function
Optical encoder failure	- High movement speed - Noise	- Additional sensor
Defective sound alert	- No sound information for passengers when door is closing	- Check during maintenance

(Pandey et al., 2013) proposed FMEA as a tool for analysing safety functions of automatic door operation of modern railway system as shown in Table 8.

Table 8: FMEA of automatic door operation of railway system

Component	Failure Modes	Effects	Mitigation
Door Open / Close	- Door does not open/close when required	- Door permanently will be in opened /closed mode	- Hardware (HW) may be damage, need to check the mechanical failures
	- Open / Close when not required	- Door open /close when train is in running mode	- HW may be damage, need to check the mechanical failures
	- Door stuck in open / close position	- Door always is in opened or closed state.	- HW may be damage, need to check the mechanical failures
Door motor failure	- Motor not working	- Door will be in opened and closed state	- HW may be damage, need to check motor condition
	- Motor stops in between	- Door will jam	- HW may be damage, need to check motor condition
	- Motor speed is high/ low	- Rapid/slow closure of door	- HW may be damage, need to check motor interfacing unit

Table 8: FMEA of automatic door operation of railway system (Cont.)

Component	Failure Modes	Effects	Mitigation
Door power supply	- High voltage	- Door will remain open/close	- HW component may get damaged due to high voltage, have to check power supply
	- Low voltage	- Door will not open/close	- Have to check power supply
	- Variable voltage	- Door will not open/close	HW component may get damaged due to unstable voltage, have to check power supply
Sensor	- Fast detection	- Door will open immediately before required time	- Have to check SW of delay time
	- Slow detection	- Door will open late after required time	- Have to check SW of delay time
	- No detection	- Door will not open/close	- HW may be damage, need to check power source
Timing	- High delay	- Door will not open/close or function properly	- HW may be damage, need to check SW of delay time
	- Low delay	- Door will not open/close or function properly	- HW may be damage, need to check SW of delay time

1.15 Door Maintenance of Elevator Business in Korea

For elevator business in Korea, (Park and Yang, 2011) used FMEA for identifying risk of failure for elevator maintenance which sources of FMEA were collected based on failure statistic. (Park and Yang, 2011) mentioned that an elevator requires regular check-up period not only to maintain original function but also to ensure performance, quality, safety, reliability and comfort which will be delivered to users. (Park and Yang, 2011) proposed a guidance of effective door maintenance for elevator as shown in Table 9.

Table 9: Door maintenance guidance for elevator (Adopted from (Park and Yang, 2011))

Part name	Inspection method	Fault features	Effect of failure	Counter-measure	Inspection cycle (month)
Guide shoe	Visual, measurement	Wear, corrosion	Door separation	Repair/change	1
Hanger roller	Visual, Operation test	Bearing fault	Noise, vibration	Repair/change	1
Interlock switch	Visual, Operation test	Aging, wear	Operation shutdown	Repair/change	3
Door motor	Visual, Operation test	Motor overheat	Operation shutdown	Repair/change	1
Door switch	Visual, Operation test	Aging	Operation shutdown	Change	1

CHAPTER III

RESEARCH METHODOLOGY

The idea of research methodology is derived from literature review and theories consideration. Since a high number of failures of door system of BCBB product is a key driver of elevator's company to immediately improve preventive maintenance plan in order to reduce number of corrective maintenances which directly affects to workload of technicians and also capacity planning of Existing Installation department.

Preventive maintenance plan is a basic step for continuously improving maintenance's strategy to align with manufacturing strategy and business's strategy as current strategy was moved to cost reduction. Therefore it also requires people from related departments for brainstorming.

A source of preventive maintenance plan of BCBB product can be constructed based on historical failures as same as an improvement of preventive maintenance of train's door system. It is because elevator's door system has similar characteristic as metro's door system in terms of transportation system, frequency of operations, design which comprise a complex combination of mechanical and electrical components.

The concept of an improvement of preventive maintenance plan of BCBB product is referred the idea from applications of FMEA in train's door system and CPMMS in CNC machine. FMEA enables engineers to systematically identify the root cause of failure from door system, assign tailored severity (S), occurrence (O) and detection (D)

and calculate RPN in order to prioritise corrective actions. An improvement of preventive maintenance plan will be implemented based on prioritisation of corrective actions as similar as CPMMS of CNC machine but it is different only there will be unable to generate plan automatically. As a result, the number of failures from door system will be reduced and MTBF score will be increased. We are able to continuously re-calculate RPN to continuously improve a preventive maintenance plan because severity and occurrence of each failure mode will be reduced continuously.

In summary, big picture of research methodology is demonstrated as Figure 21.

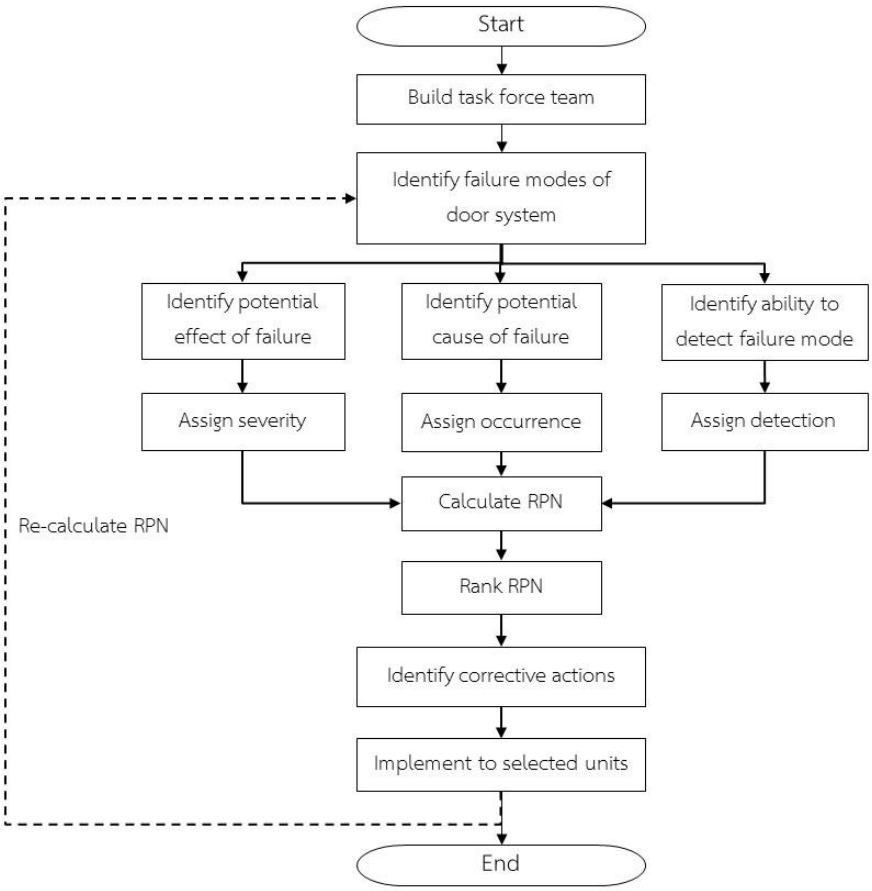


Figure 21: An improvement of preventive maintenance plan integrated with FMEA structure

1.16 Build taskforce team

Since MTBF is a KPI of Existing Installation department, Existing Installation Director was a responsible person who leaded a kick off meeting in order to build a sense of urgency to all relevant people and to form taskforce team. According to introduction chapter, Figure 22 shows where to get technical people to form taskforce team from organisation chart. Taskforce team comprised people from technical & field support department, Existing Installation department and purchasing department.

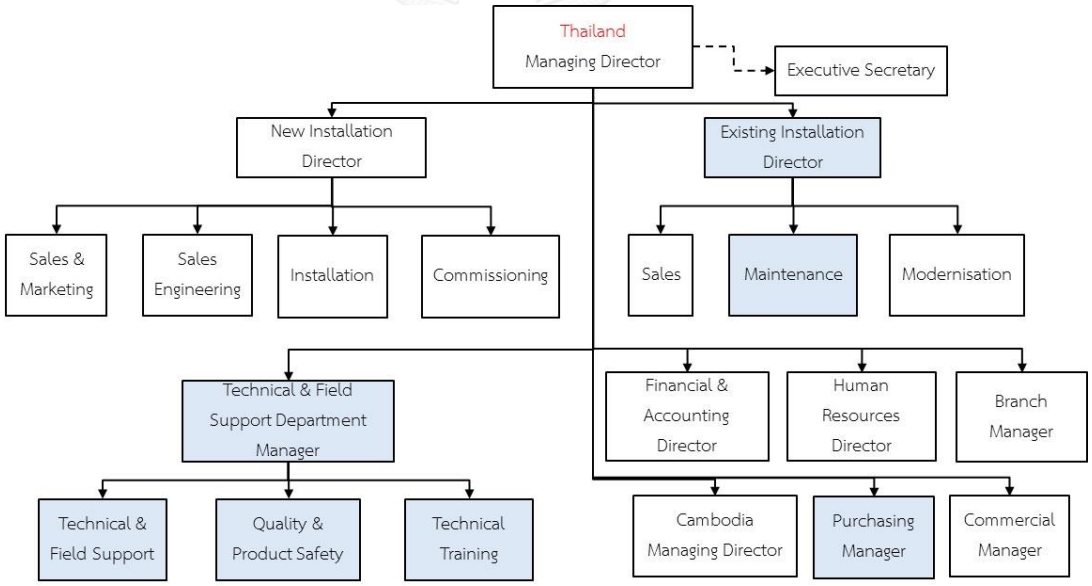


Figure 22: Organisation chart

Figure 23 shows that product line expert was an intermediate person who exchanged necessary data and information in taskforce team.

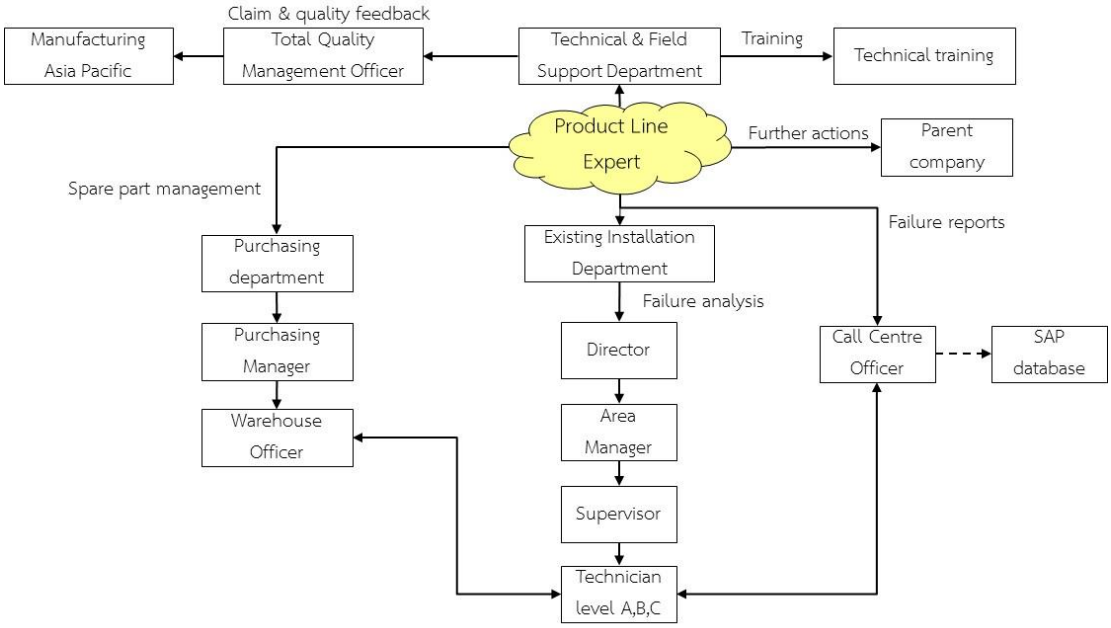


Figure 23: Structure of taskforce team

Roles & responsibilities in taskforce team are defined as Table 10 below.

Table 10: Role & responsibility of team member

No.	Role & responsibility	Who
1	- Collected failure reports from SAP database in whole year 2014	Product line expert
2	- Brainstormed for FMEA analysis and corrective actions based on failure reports	Product line expert EI director Area manager Supervisor
3	- Discussed failure reports for further actions such as analysing an elevator which has repetitive failures - Monitored MTBF score and number of elevator's failures	Product line expert EI director TF manager Parent company
4	- Developed training course and evaluation system in order to increase technical skill and certified field staffs	Product line expert Technical trainer TF manager EI director
5	- Recorded mechanical and electrical component claim for further use	Product line expert TQM officer Parent company
6	- Recorded spare part usage for further use	Product line expert Purchasing manager

Figure 24 shows that bi-weekly meeting was set up in order to start up FMEA analysis and to update progress after implementing corrective actions.

Figure 24: Bi-weekly meeting

1.17 Identify failure mode of door system

Elevator structure

Since elevator system consists of complex combination of mechanical and electrical components, it is necessary to review elevator's structure before performing FMEA of door system. Figure 25 illustrates how field staffs obtain error codes of door system from relationship between elevator's controller, car and door system.

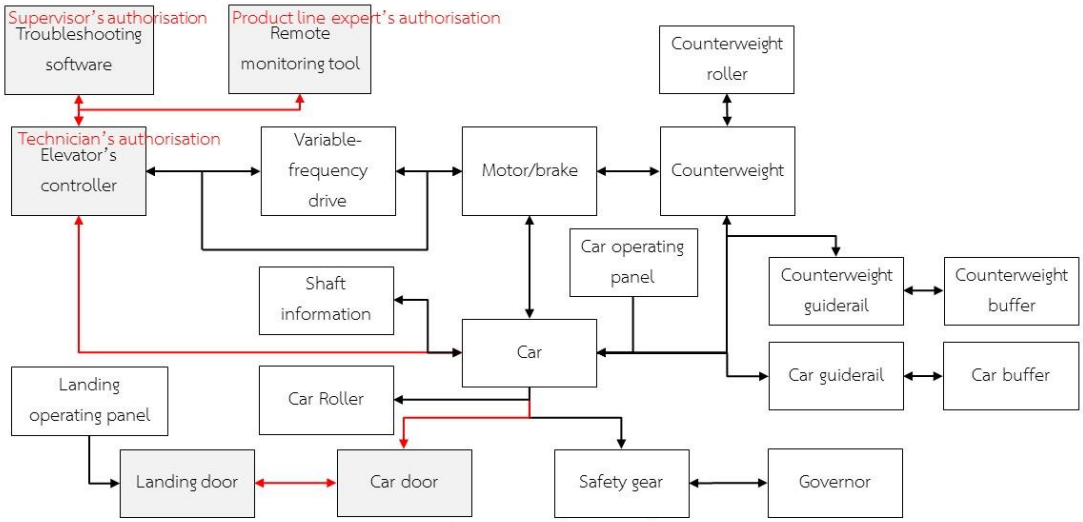


Figure 25: Elevator structure

Car door is a door which is installed at elevator's car whereas landing door is a door which is installed at every building floor. Description of how door system operate is shown in Appendix B.

In terms of electrical system, Table 11 described that elevator contains 3 types of electrical system which are power supply, safety circuit and communication.

Table 11: Electrical system of elevator

Electrical system	**Description**
Power supply	- 3 phases power supply (380 VAC) for Variable Frequency Drive and Motor - 1 phase power supply (220 VAC) for lighting and car door drive - 24 VDC transformer for controller
Safety circuit	- 24 VDC when safety circuit close - 60 VDC when safety circuit open - Safety T4 stands for car door contact - Safety T5 stands for landing door contact 
Communication	- Ethernet for elevator group control - RS422 between controller and VF Drive - 24 VDC CAN bus between controller and car - 24 VDC BIO bus between controller and landing indicator panel - 24 VDC intercom

Failure of mechanical components and electrical components of BCBB elevator are displayed in terms of error code between number 0 and 9999 which is generated and recorded by elevator's controller. However, in normal process, technicians were unable to further analyse the root cause from controller's display during preventive maintenance or corrective maintenance without special tools.

According to elevator structure (Figure 25), Table 12 shows that there are 2 special tools using for analyse failure modes of door system are troubleshooting software and remote monitoring tool. Explanation of these 2 special tools are shown in Appendix C.

Table 12: How to obtain error code

Way to analyse error code	Authorisation level	Technical skill
Troubleshooting software	Supervisors	Intermediate
Remote monitoring tool	Product line expert	Advance

In order to identify potential failure mode of door system which was the first step of performing FMEA, these 2 special tools were used for pairing failure modes of door system with the same date and time of failure reports (Appendix D) which has causes of elevator's failure from door system in whole year 2014 because there were a mix of error codes contained in log files from this 2 special tools.

Table 13 shows that there are 24 potential failure modes which comprise 23 potential failure modes which obtained from elevator's controller and another 1 potential failure mode which initiated from customer's complaint.

Table 13: Potential failure modes of door system

No.	Potential failure mode	
	Error code	**Error description**
1	148	Safety T4
2	149	Safety T5
3	202	Door Operation Error
4	203	Thermo Door Motor
5	204	Door Reverse Device Error
6	207	Close Sequence Error
7	208	Door Device Error
8	212	Open Sequence KOKB
9	214	RPHT Continuous Activation
10	217	KSKB Continuous Activation
11	252	Door Unavailable
12	709	Safety Circuit
13	832	wKET-S2 Failure
14	834	wMotor Over Temperature
15	838	eLocking Jam
16	839	eUnlocking Jam
17	840	NGT 24VDC Over 5% Limit
18	841	NGT 24 VDC Under 5% Limit
19	842	NGT 24 VDC Over 10% Limit
20	843	NGT 24VDC Under 10% Limit
21	844	ePower Door Off
22	850	eOver Voltage
23	1301	CAN Missing Node
24	-	Customer complaint

1.18 Identify potential effects of failure

According to introduction chapter, availability, reliability and quality are 3 elements of failure definition which can be perceived by customers and field staffs. Therefore potential effects of failure were collected from failure reports in whole year 2014 and from direct experience from product line expert, technicians and supervisors and customers during previous corrective maintenance and preventive maintenance.

Potential effects of failure are shown as Table 14 below.

Table 14: Potential effects of failure

No.	Potential effects of failure
1	Elevator emergency stops during normal running
2	Door close but elevator cannot start running
3	Elevator cannot start a trip
4	Car door cannot close
5	Car door cannot open
6	Landing door cannot close
7	Landing door cannot open
8	Door close and open many times before it is stuck in the middle
9	Door stop moving (close/open) during normal operation
10	Door is stuck while opening
11	Door is stuck while closing
12	Door cannot open or close
13	Elevator is temporary unavailable
14	Elevator cannot use
15	COP button cannot register a call
16	LOP button cannot register a call
17	Door close/open very slow sometimes
18	Car door panel is shaking while elevator running
19	Door close with noise
20	Scratch on car door panel
21	Scratch on landing door panel

According to Table 13 and Table 14, it can be seen from real situation that one failure mode can have more than one potential effect of failure. For example, error code 148 “Safety T4” can have car door cannot close, car door closed but elevator cannot run and elevator emergency stops during normal running as effects of failure.

1.19 Identify potential causes of failure

As same as train's door system, high number of door operation enables mechanical and electrical components of door system to have failure if there is lack of proper preventive maintenance. Hence potential causes of failure of door system can be identified based on product breakdown structure of car door and landing door.

Figure 26 shows that car door contains a complex combination of electrical and mechanical components which are equipped in 3 primary positions of car door.

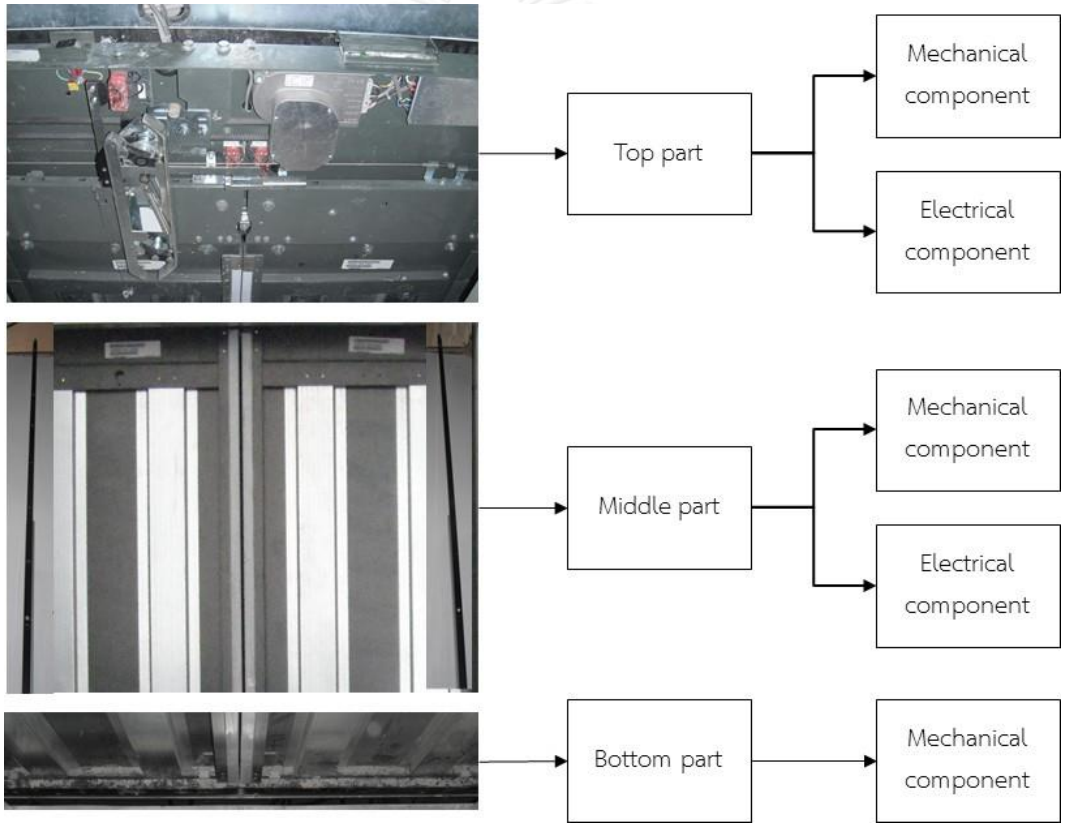


Figure 26: Car door components

Figures 27, 28 and 29 demonstrate component's picture and component's name of car door which are potential causes of failure.

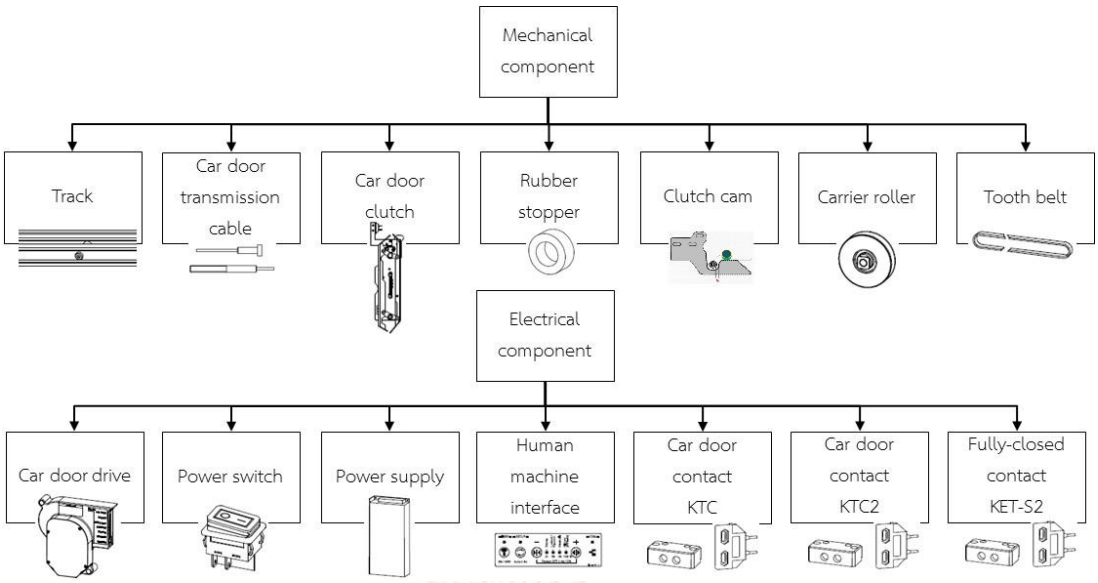


Figure 27: Top part of car door

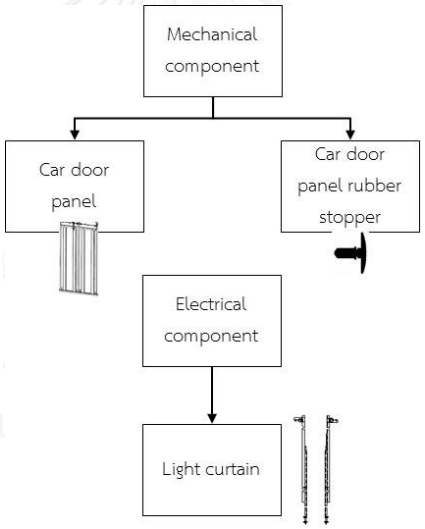


Figure 28: Middle part of car door

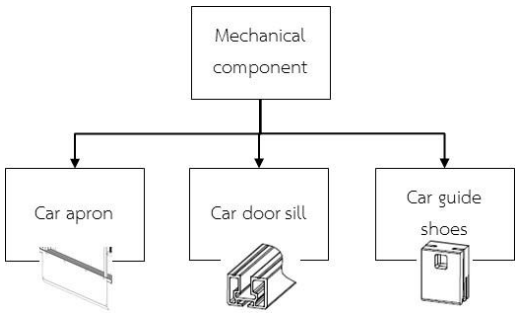


Figure 29: Bottom part of car door

Similar to car door, Figure 30 shows complex combination of mechanical components and electrical components which are equipped at 3 primary positions of landing door.

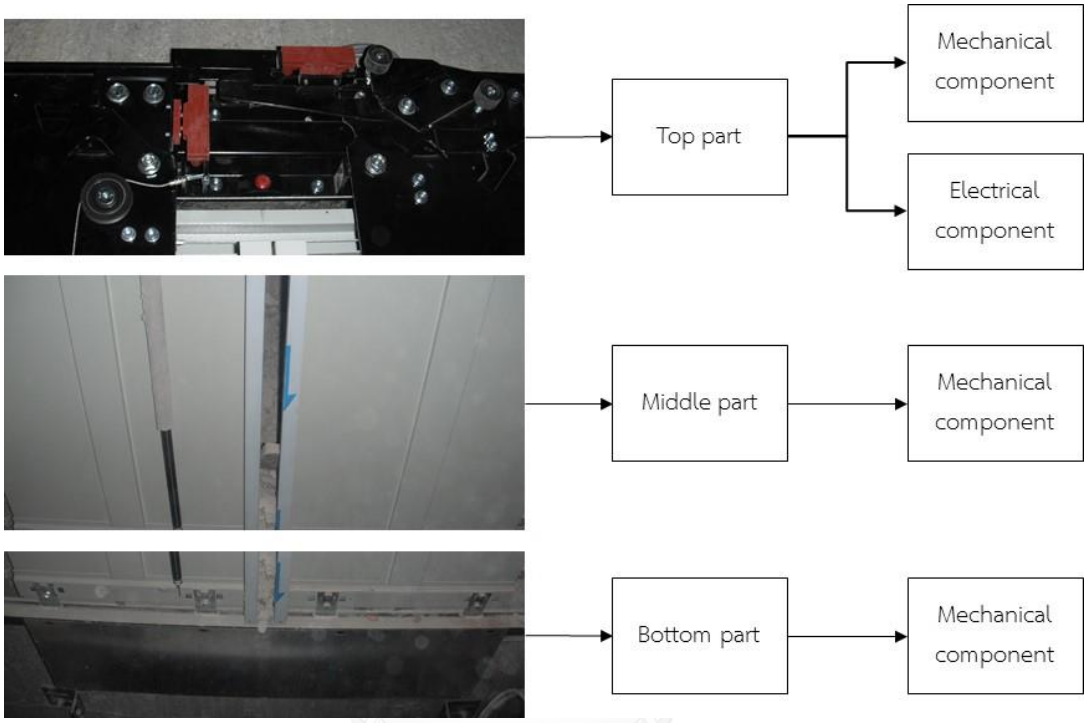


Figure 30: Landing door component

Figures 31, 32 and 33 demonstrate component's name and component's picture of car door which are potential causes of failure.

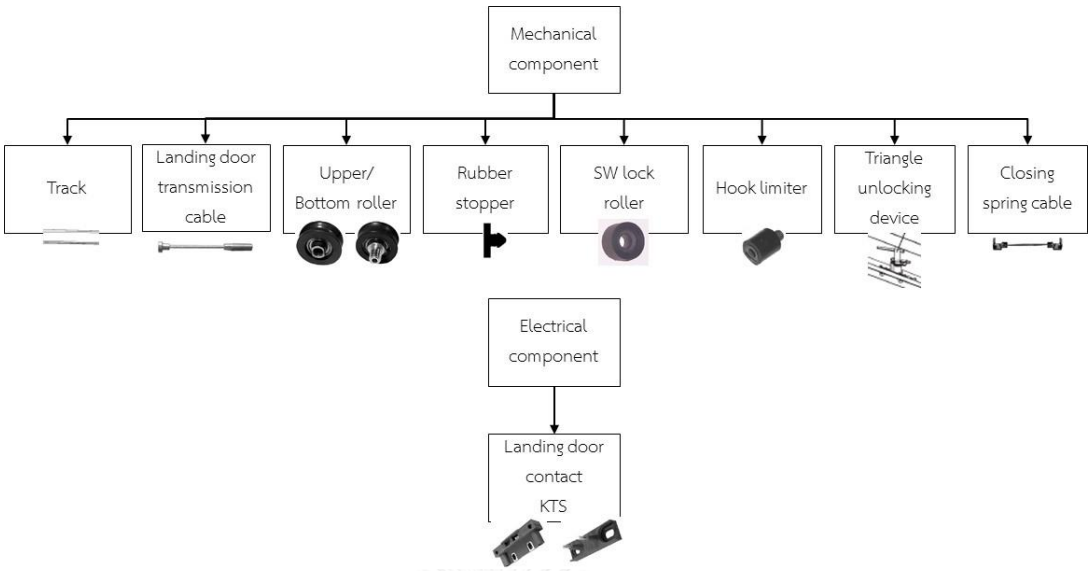


Figure 31: Top part of landing door

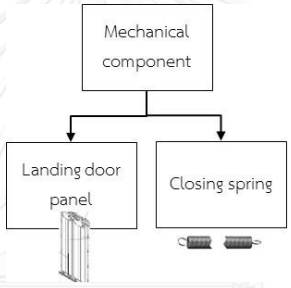


Figure 32: Middle part of landing door

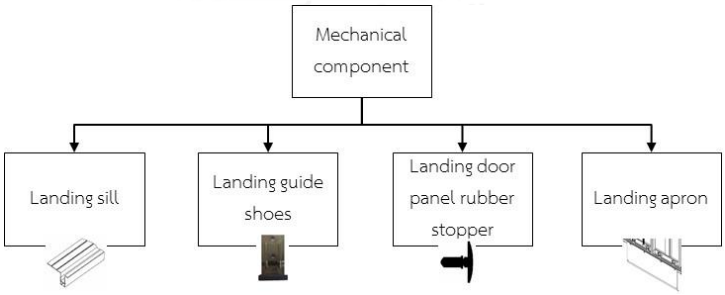


Figure 33: Bottom part of landing door

According to failure reports, Table 15 illustrates example mechanical components and electrical components which are potential causes of failure.

Table 15: Potential causes of failure

No.	Potential cause of failure	Component	Photo
1	Wear and tear	Hook limiter	
2	Broken	Landing door contact	

Table 15: Potential causes of failure (Cont.)

No.	Potential cause of failure	Component	Photo
3	Missing	Landing door panel rubber stopper	
4	Defective	Human Machine Interface	
5	Damaged	Landing door contact	

Table 15: Potential causes of failure (Cont.)

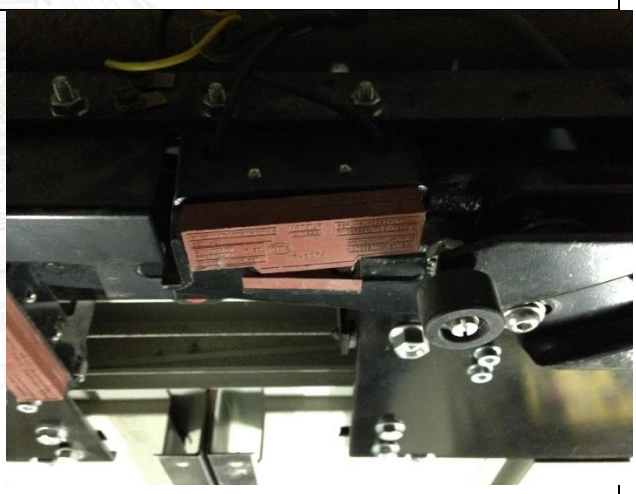
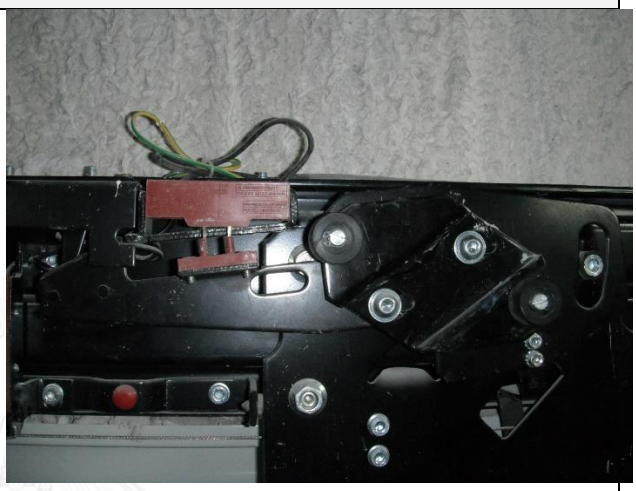
No.	Potential cause of failure	Component	Photo
6	Stretched	Car door transmission rope	
7	Misaligned	Landing door contact	
8	Dirty	Car header	

Table 15: Potential causes of failure (Cont.)

No.	Potential cause of failure	Component	Photo
9	Stuck	SW lock roller	
10	Hit	Clutch cam	

1.20 Identify ability to detect failure mode

According to company's strategy, elevator system is designed to only detect failure mode but not to rectify failure mode automatically in order to ensure safety to passenger and to not make mechanical components and electrical components have more failure.

In normal process, there are 4 useful detection methods which technicians have been used during preventive maintenance but these 4 detection methods were not clearly defined and properly used in current checklist document. 4 detection methods comprise visual, clean, measurement and function as shown in Table 16.

Table 16: 4 detection methods

Detection method	Basic Tool
Visual	Eyes, ears
Measure	Ruler, measurement tape
Function	Hands, triangle unlocking key
Clean	Vacuum cleaner, rug, brush

Since there is no special tool provided for technicians, these 4 detection methods were used as a substituted tool to guide technicians to identify potential causes of failure of mechanical components and electrical components of door system.

Table 17 demonstrates relationship between possible causes of failure of mechanical and electrical components and detection method.

Table 17: 10 characteristic of cause of failure

No.	Potential cause of failure	Detection method
1	Wear and tear	Visual / Function
2	Broken	Visual
3	Missing	Visual
4	Defective	Function
5	Damaged	Visual
6	Stretched	Measure
7	Misaligned	Visual/ Measure/Function
8	Dirty	Clean
9	Stuck	Function
10	Hit	Visual/ Function

1.21 Assign severity

To adapt the idea from (Spring, 1995), sources of assigning severity was derived from failure reports and direct experiences from field staffs and customers as mentioned earlier.

Table 18 demonstrated 10 tailored levels of severity in the perception of potential effects to passenger, elevator's component and company reputation.

Table 18: Severity level for door system

Severity	Effect to customer/ elevator's component/ company reputation	Ranking
Hazardous without warning	Car damaged while elevator is running in rated speed caused passenger to fatality and totally destroy company brand	10
Hazardous with warning	Door opened while elevator is running in rated speed caused passenger to fatality and totally destroy company brand	9
Very High	Elevator emergency stopped while running caused passenger to get major injure	8
High	Elevator emergency stopped while running caused passenger to get minor injure	7
Moderate	Elevator permanent blocked before starting or ending a trip caused passenger to trap	6
Low	Elevator temporary blocked for a few minutes before resuming as normal	5
Very Low	Elevator cannot operate / is unavailable to serve a car call and landing call	4
Minor	Door operate not smooth/ unusual noise from normal operation	3
Very Minor	Scratch on panel / quality issue/ cleanliness	2
None	No effect	1

In some failure modes such as safety T4 and safety T5 can have more than one effect of failure. Therefore, to standardise process, taskforce team decided to use the highest potential effect of failure for assigning S.

1.22 Assign occurrence

The idea of assigning occurrence was derived from MTBF calculation which is measured by number of days and from number of door operations which was derived from remote monitoring tool.

Referring to statistic between July and December 2014 of old BCBB elevator (equipment number 60004539) as shown in Appendix C, the average number of door operation per day for medium-rise building is 1,250 times. Therefore failure probability can be defined in terms of number of days or number of door operations as shown in Table 19.

Table 19: Occurrence level for door system

Failure probability	Failure probability	Failure probability	Ranking
1 day	1,250 trips	Failure is almost inevitable	10
3 days	3,750 trips	Failure is almost inevitable	9
7 days	8,750 trips	Repeated failures	8
15 days	18,750 trips	Repeated failures	7
30 days	37,500 trips	Occasional failures	6
60 days	75,000 trips	Occasional failures	5
90 days	112,500 trips	Occasional failures	4
180 days	225,000 trips	Relatively few failures	3
1 years	456,250 trips	Relatively few failures	2
> 2 years	912,500 trips	Failure is unlikely	1

1.23 Assign detection

The idea of assigning detection was derived from characteristic of elevator's failure which is designed to not automatically recover by elevator itself, investigation of failure mode and rectified activity are performed by technicians during preventive maintenance and corrective maintenance only. Therefore, detection level of each failure mode is assigned to 10.

1.24 Calculate RPN

RPN is a product of Severity (S), Occurrence (O) and Detection (D), (Spring, 1995).

Table 20 illustrates examples of RPN calculation.

Table 20: Examples of RPN calculation

Error code	Potential failure mode	Potential effects of failure	Potential causes of failure	S	O	D	RPN
148	Safety T4	Elevator emergency stops during normal running	Stretched 	6	2	10	240
148	Safety T4	Elevator emergency stops during normal running	Dirty 	6	4	10	240
149	Safety T5	Elevator emergency stops during normal running	Damaged 	6	4	10	240

Table 20: Examples of RPN calculation (Cont.)

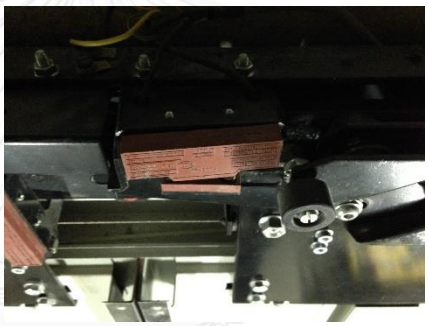
Error code	Potential failure mode	Potential effects of failure	Potential causes of failure	S	O	D	RPN
149	Safety T5	Elevator emergency stops during normal running	Stuck 	6	2	10	120
149	Safety T5	Elevator emergency stops during normal running	Misaligned 	6	5	10	300
212	Open sequence KOKB	Door is stuck while opening	Misaligned 	5	5	10	250
834	wMotor Over Temperature	LOP button cannot register a call	Hit 	4	2	10	80

Table 20: Examples of RPN calculation (Cont.)

Error code	Potential failure mode	Potential effects of failure	Potential causes of failure	S	O	D	RPN
850	eOver voltage	Door close/open very slow sometimes	Wear and tear 	4	2	10	80
-	Complaint	Door close with noise	Missing 	4	6	10	240

In summary, Table 21 illustrates all combination of potential failure modes with RPN calculation.

Table 21: All combination of failure modes with RPN calculation

Error code	Potential Failure Mode	Potential Causes of Failure	S	O	D	RPN
148	Safety T4	Worn out/broken KTC	6	4	10	240
		Misaligned KTC	6	5	10	300
		Car door transmission cable is too loose/damaged	6	2	10	120
		Rubber from carrier roller is stuck on car door track	6	8	10	480
		Rubbish is stuck inside car door sill	6	8	10	480
149	Safety T5	Worn out/broken KTS	6	4	10	240
		Misaligned KTS	6	5	10	300
		Landing door self-close spring worn out/broken	6	4	10	240
		Landing door transmission cable damaged	6	2	10	120
		Rubber from upper roller is stuck on landing door track	6	8	10	480
		Rubbish is stuck inside landing door sill	6	8	10	480
		Landing door unlocking device is stuck	6	2	10	120
202	Door Operation Error	Car door drive is defective	8	2	10	160
203	Thermo Door Motor	Hook limit roller worn out	5	2	10	100
		Misaligned SW lock roller of landing door	5	6	10	300
204	Door Reverse Device Error	Rubbish is stuck inside car door sill	6	8	10	480
		Rubbish is stuck inside landing door sill	6	8	10	480
207	Close Sequence Error	Rubbish is stuck inside car door sill	6	8	10	480
		Rubbish is stuck inside landing door sill	6	8	10	480
208	Door Device Error	This error will come with other errors	7	4	10	280
		Car door drive is defective	6	2	10	120

Table 21: All combination of failure modes with RPN calculation (Cont.)

Error code	Potential Failure Mode	Potential Causes of Failure	S	O	D	RPN
212	Open Sequence KOKB	Hook limit roller worn out	5	5	10	250
		Misaligned SW lock roller of landing door	5	6	10	300
		No gap between eccentric roller and landing door track	5	4	10	200
		Tension of car door is too loose	5	5	10	250
		Car door clutch is dirty/stuck/ worn out	5	8	10	400
		Landing door rubber stopper is missing/ worn out	5	2	10	100
214	RPHT Continuous Activation	Light curtain is dirty	5	7	10	350
217	KSKB Continuous Activation	Rubbish is stuck inside car door sill	6	8	10	480
		Rubbish is stuck inside landing door sill	6	8	10	480
		Tension of car door belt is too loose	6	5	10	300
252	Door Unavailable	Car door drive is defective	4	2	10	80
709	Safety Circuit	This error generate from drive side, so we have to check with other errors	6	8	10	480
832	wKET-S2 Failure	KET-S2 worn out/broken	6	4	10	240
		Misaligned KET-S2	6	5	10	300
834	wMotor Over Temperature	Car door drive is defective	4	2	10	80
		Misaligned SW lock roller of landing door	6	5	10	300
838	eLocking Jam	Car door drive is defective	6	2	10	120
		Distance between car door clutch and cam plate is wrong	6	4	10	240
839	eUnlocking Jam	Car door drive is defective	6	2	10	120
		Misaligned SW lock roller of landing door	6	5	10	300
		SW lock roller is worn out/broken	6	3	10	180
		Worn out Car guide rollers	6	2	10	120
		Hook limit roller worn out	6	4	10	240
840	NGT 24VDC Over 5% Limit	Direct current voltage of car door power supply is over 24VDC by 5%	4	2	10	80

Table 21: All combination of failure modes with RPN calculation (Cont.)

Error code	Potential Failure Mode	Potential Causes of Failure	S	O	D	RPN
841	NGT 24 VDC Under 5% Limit	Direct current voltage of car door power supply is lower 24VDC by 5%	4	2	10	80
842	NGT 24 VDC Over 10% Limit	Direct current voltage of car door power supply is over 24VDC by 10%	4	2	10	80
843	NGT 24VDC Under 10% Limit	Direct current voltage of car door power supply is under 24VDC by 10%	4	2	10	80
844	ePower Door Off	Car door power switch failure	8	2	10	160
850	eOver Voltage	Worn out car door rubber stopper	3	4	10	120
1301	CAN Missing Node	Car door drive is defective	8	2	10	160
-	Customer complaint	Missing car door shoes	3	8	10	240
		Car door shoe worn out	3	8	10	240
		Car door panel rubber stopper is missing/ worn out	3	5	10	150
		Landing door panel rubber stopper is missing/ worn out	3	5	10	150
		Landing door rubber stopper is missing/ worn out	3	5	10	150
		Misaligned SW lock roller of landing door	3	5	10	150
		Car door panel is hit by user	2	8	10	160
		Landing door panel is hit by user	2	8	10	160

1.25 Rank RPN

According to RPN calculations in Table 21, there are 59 combinations of failure mode from door system.

The idea of developing RPN setting was derived from MTBF score of old BCBB elevator (equipment number 60004539) which was 36.5 days, workload problem in current preventive maintenance schedule which one technician has to maintain 34 units and literature review from (Rungsa Em-ardchaya and Tangjitsitcharoen, 2014) which used RPN for proposing a new preventive maintenance plan.

Table 22 shows that RPN calculation of each failure modes can be prioritised for implement corrective actions by based on RPN setting. For high priority (H), there are 13 numbers of failure mode required to perform 1 month preventive maintenance. For medium priority (M), there are 21 numbers of failure mode required to perform 3-month preventive maintenance. For low priority (L), there are 25 numbers of failure mode required to perform 6-month preventive maintenance. Full FMEA analysis with RPN calculations and corrective actions can be seen in Appendix F.

Table 22: RPN setting

Priority	RPN Range	New preventive maintenance schedule (Corrective actions)	Number of failure modes
High (H)	> 350	1 time per 30 days (1 month)	12
Medium (M)	200 – 350	1 time per 90 days (3 months)	21
Low (L)	< 200	1 time per 180 days (6 months)	26

1.26 Identify corrective actions

Revise preventive maintenance schedule

According to result from Table 22, a revised preventive maintenance schedule has been put into 12 calendar months as shown in Table 23.

In month 1 and 7, technicians have to perform preventive maintenance for all 3 priorities (59 failure modes).

In month 4 and 10, technicians have to perform preventive maintenance for high and medium priorities (12+21 = 33 failure modes)

In month 2, 3, 5, 6, 8, 9, 11 and 12, technicians have to perform preventive maintenance for high priority (26 failure modes).

Since time frame of research schedule is limited to 6 months, it is unable to see the whole year result after implementing a revised preventive maintenance schedule to selected units.

Table 23: Revised preventive maintenance schedule

Month	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12
Priority	H,M,L	H	H	H,M	H	H	H,M,L	H	H	H,M	H	H

Create troubleshooting manual

The idea of creating a troubleshooting manual is derived from current problem in Existing Installation department. Since car door and landing door of BCBB product is manufactured by offshore manufacturing and offshore supplier, technicians didn't have experience to perform preventive maintenance and corrective maintenance before. Moreover technicians didn't have special tools to analyse failure modes of door system. Therefore creating of troubleshooting manual will be used as a substituted tool for technicians to analyse failure modes during corrective maintenance and preventive maintenance.

Troubleshooting manual were created in both Thai and English language in order to make Thai technicians fully understand guidance in troubleshooting manual. In the first section of troubleshooting manual, it comprises basic knowledge of how to read error code from controller's display of BCBB elevator. In the second section of troubleshooting manual, it contains guidance based on 4 detection methods of each failure mode which derived from FMEA analysis and integrated with mechanical components' photo, electrical components' photo, spare part ID numbers and technical document ID number.

Pairing of spare part ID number and technical document ID number with mechanical components and electrical components are shown in Appendix G

Full troubleshooting manual is attached in Appendix H.

Revise checklist document

Idea to revise existing checklist document is also derived from current problem in Existing Installation department. Since there were a high number of elevator's failures between interim of preventive maintenance in every month as we can see from MTBF of old unit (equipment number 60004539) is equal to 36.5 days, it implies that technicians were unable to effective and efficient use existing checklist document for identifying mechanical components and electrical components which have high potential to create a failure during preventive maintenance.

The structure of a revised checklist document is based on pattern of existing checklist document and integrated with a revised preventive maintenance schedule, a list of basic tools which technicians need to have for preventive maintenance, and a summarised list of mechanical components and electrical components and its detection methods from FMEA analysis.

A revised checklist document is shown in Figure 34.

Checklist for door system ☐ 1 month ☐ 3 months ☐ 6 months
☐ machine room ☐ machine room less month _____ year _____
Contract No. _____ Contract name _____
Lift No. _____ Commissioning No. _____

Necessary tools

No.	Item	Yes	No	Remark
1	Personal Protective Equipment (safety shoes, bump cap, gloves, uniform)			
2	Hex key set (no. 4, 5, 10)			
3	Spanner set (no. 10, 13, 16, 17, 18)			
4	Hammer			
5	Screw driver			
6	Torch light			
7	Door stopper			
8	Lockout Tagout			
9	Rug			
10	Lubricant spray HP68			

Car roller

No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of car roller		y	y	y		y				

Car door (Varidor 35)

No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of car door contact (KTC)		y	y	y						
2	Distance X=4 mm and alignment Y-Z of car door contact (KTC)		y	y			y	y			
3	Appearance of fully-closed contact (KET-S2)		y	y	y			y			
4	Distance X=3 mm and alignment Y-Z of fully-closed contact (KET-S2)		y	y			y				
5	Tension of car door belt		y	y			y				
6	Car door clutch	y	y	y		y		y			
7	Clutch cam		y	y	y			y			
8	Car door shoes		y	y	y		y				
9	Tension of car door transmission rope			y	y		y				
10	Appearance of car door transmission rope			y	y			y			
11	Car door sill	y	y	y		y					
12	Car door header	y	y	y		y					
13	Car door panel	y	y	y	y						
14	Car door rubber stopper			y	y						
15	Car door panel rubber			y	y						
16	Car door drive			y				y			
17	Car door power supply (24 volts)			y			y				
18	Car door human machine interface (HMI)	y	y	y				y			
19	Car door power switch (JHT)			y				y			
20	Car door light curtain		y	y		y					

Landing door (Augusta)

No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of landing door contact (KTS)		y	y	y						
2	Distance and alignment of landing door contact (KTS)		y	y			y	y			
3	Landing door eccentric roller 0.5 - 1.0 mm.		y	y			y	y			
4	Landing door transmissiong cable			y	y						
5	Self-close spring and self-close cable		y	y	y			y			
6	Landing door sill	y	y	y		y					
7	Landing door header	y	y	y		y					
8	Landing door panel	y	y	y	y						
9	Appearance of SW lock roller		y	y	y						
10	SW lock roller to reference line at car header		y	y			y	y			
11	Unlocking device			y				y			
12	Hook limit roller			y	y						
13	Landing door rubber, distance between hook and lock = 1-3 mm.			y			y	y			
14	Landing door panel rubber			y	y						

Name of field staff _____ Name of supervisor _____
Signature _____ Signature of supervisor _____
Date _____ Date _____

Figure 34: A revised checklist document

Develop technical training plan & evaluation system

Apart of troubleshooting document and checklist document, technical skill of technicians is one of causes to make BCBB elevator has a repetitive failure after performing preventive maintenance and corrective maintenance. Moreover, there was no technical training for BCBB elevator (new elevator product) provided to technicians before. Therefore developing of technical training course and evaluation system is a very important factor to reduce number of elevator's failure.

A technical trainer is a person who conducted a training to technicians before implementing an improvement of preventive maintenance plan to BCBB elevators.

A training plan (Figure 35) is set for 2 days per group. Day 1 is set for classroom training (Figure 36) and day 2 is set for on-the-job training (Figure 37).

Time	Morning				Afternoon		
	09.00 -10.30	Coffee break 15 mins	10.45 - 12.00	Lunch time	13.00 - 14.45	Coffee break 15 mins	15.00 - 16.30
Day 1	Introduction & Pre-test		How to use troubleshooting manual		How to use troubleshooting manual		How to use checklist document
Day 2	Perform preventive maintenance by using checklist document and troubleshooting manual		Perform preventive maintenance by using checklist document and troubleshooting manual		Perform preventive maintenance by using checklist document and troubleshooting manual		Post-test & closing

Figure 35: Training plan

Figure 36: Classroom training

Figure 37: On-the-job training

In terms of evaluation system, there is 20-multiple-choice test (Appendix I) were used to measure knowledge of technicians before and after conducting a training.

A technician (Figure 38) who gets post-test score ≥ 16 out of 20 (80% of total score) will become a certified field staff for BCBB product in order to perform an improvement of preventive maintenance plan. Whereas any technician who get score < 16 out of 20 won't be certified yet and must be re-attended the training in the next course.

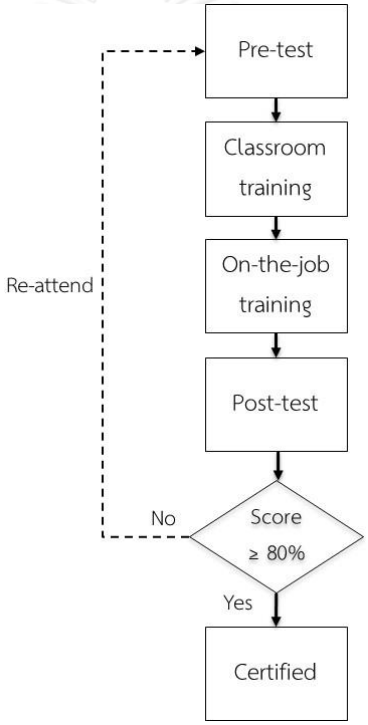


Figure 38: Evaluation system

CHAPTER IV

RESEARCH RESULTS

An improvement of preventive maintenance plan has been implemented to 2 selected BCBB elevators for 6 months between Apr 2015 and Sep 2015 and the result has been measured every month after implementation.

The first selected BCBB elevator (equipment number 60004539) is one of old units which has high numbers of failure from door system in whole year 2014 (Figure 39). This elevator is served as a passenger elevator in one of big name condominiums in Bangkok.

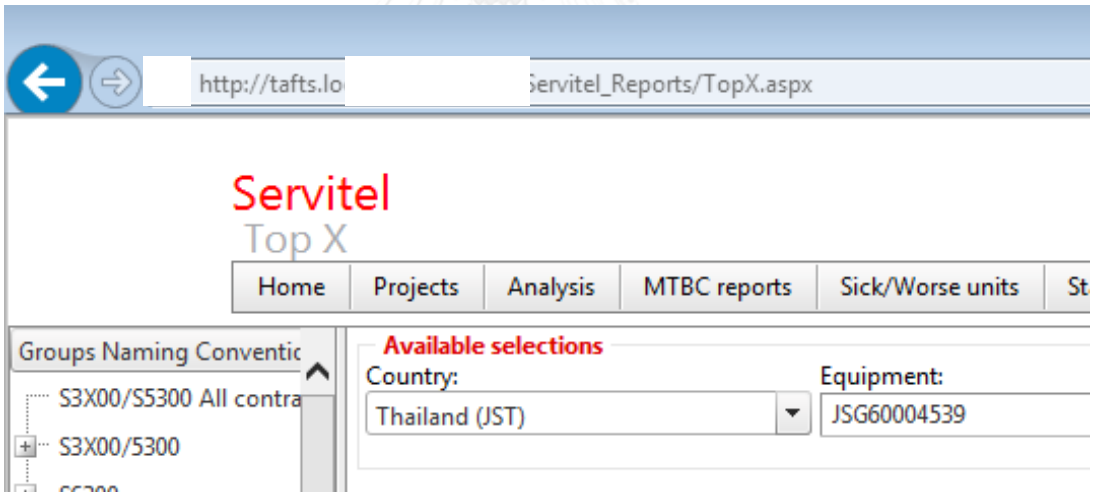


Figure 39: Equipment number 60004539

The second selected BCBB elevator (equipment number 60005943) is one of recent handed-over BCBB elevators in year 2015 (Figure 40). This elevator is served as a passenger elevator in one of condominium in Bangkok as well.

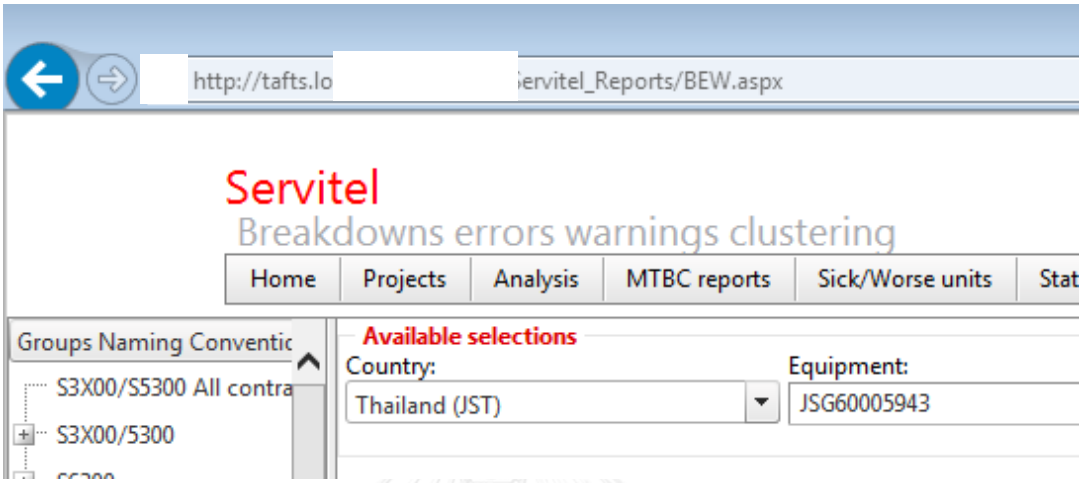


Figure 40: Equipment number 60005943

4.1 Equipment number 60004539

According to a revised preventive maintenance schedule, Table 24 shows actual implementation date of preventive maintenance in each month. The actual revised checklist document of each month is shown in Appendix J.

Table 24: Actual implementation date of preventive maintenance of equipment number 60004539

Month	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15
Schedule	1, 3, 6	1	1	1, 3	1	1
Actual date	29-Apr-15	26-May-15	26-Jun-15	29-Jul-15	26-Aug-15	28-Sep-15

Referring to a revised checklist document and a troubleshooting manual, Table 25 demonstrates example actual causes of failure which has been found by a certified technician during preventive maintenance.

Table 25: Inspected items during preventive maintenance on Apr 2015 of equipment number 60004539

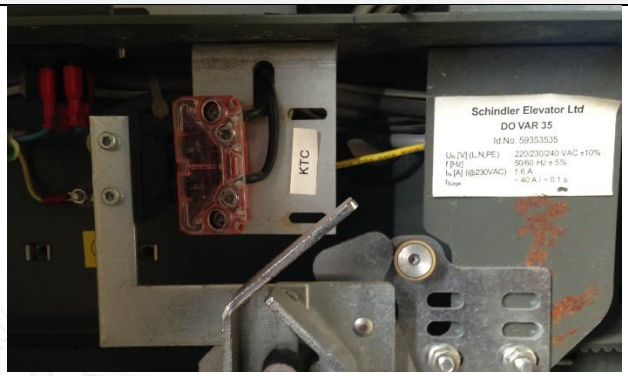
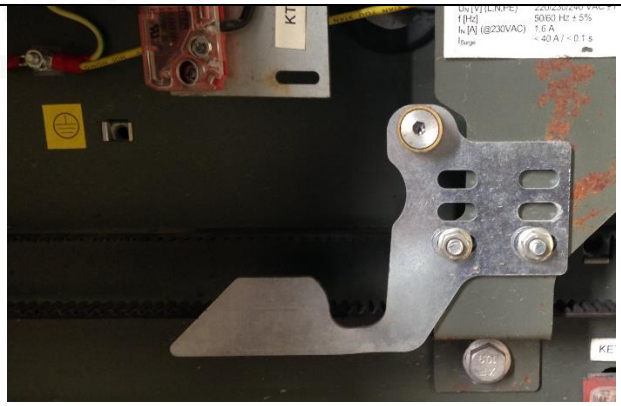
Rectified items	Photos
- Readjusted car door contact (KTC)	
- Readjusted car door contact (KTC2) and car door fully-close contact (KET-S2)	
- Readjusted clutch cam	

Table 25: Inspected items during preventive maintenance on Apr 2015 of equipment number 60004539 (Cont.)

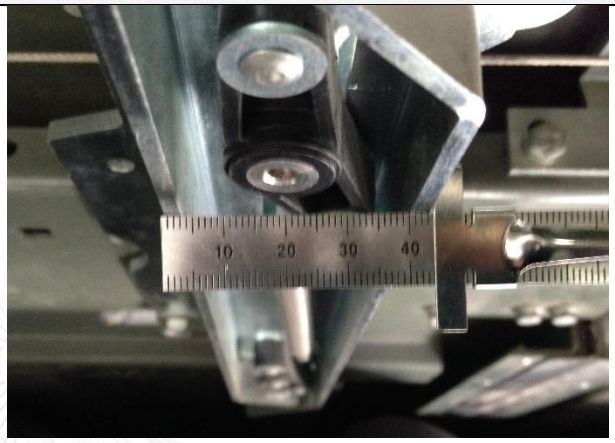
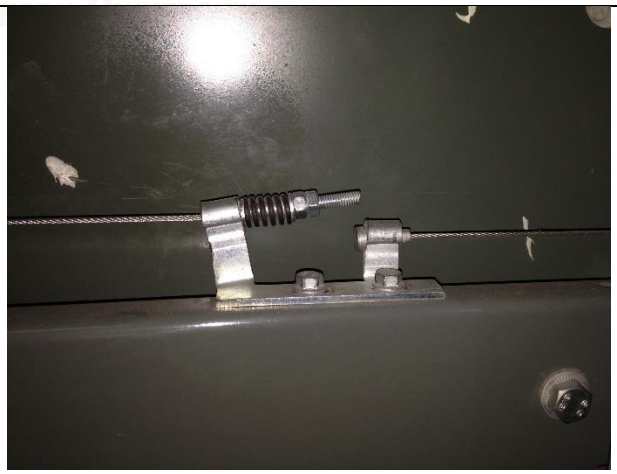
Rectified items	Photos
- Readjusted car door clutch	
- Readjusted tension of car door belt	
- Readjusted tension of car door transmission rope	

Table 25: Inspected items during preventive maintenance on Apr 2015 of equipment number 60004539 (Cont.)

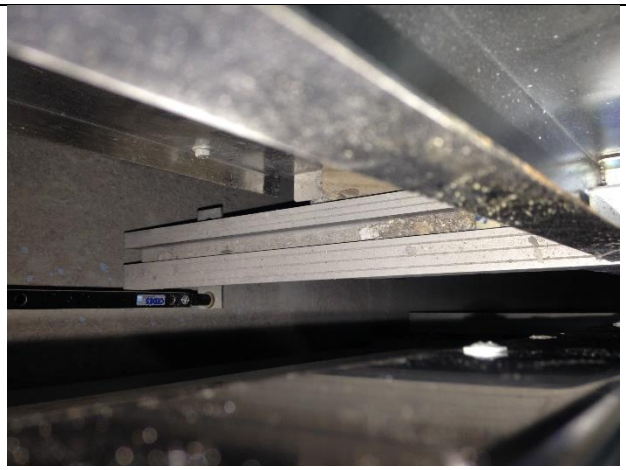
Rectified items	Photos
- Readjusted SW lock rollers to referent line	
- Cleaned car door header	
- Cleaned car door sill	

Table 25: Inspected items during preventive maintenance on Apr 2015 of equipment number 60004539 (Cont.)

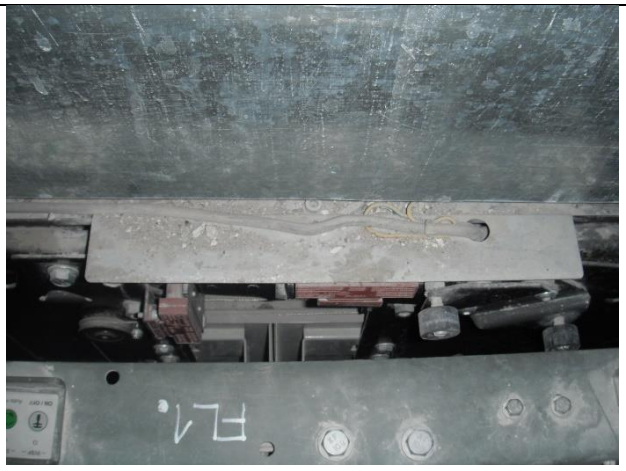
Rectified items	Photos
- Readjusted landing door contact (KTS)	
- Replaced hook limit roller	
- Cleaned landing door header	

Table 25: Inspected items during preventive maintenance on Apr 2015 of equipment number 60004539 (Cont.)

Rectified items	Photos
- Cleaned landing door sill	

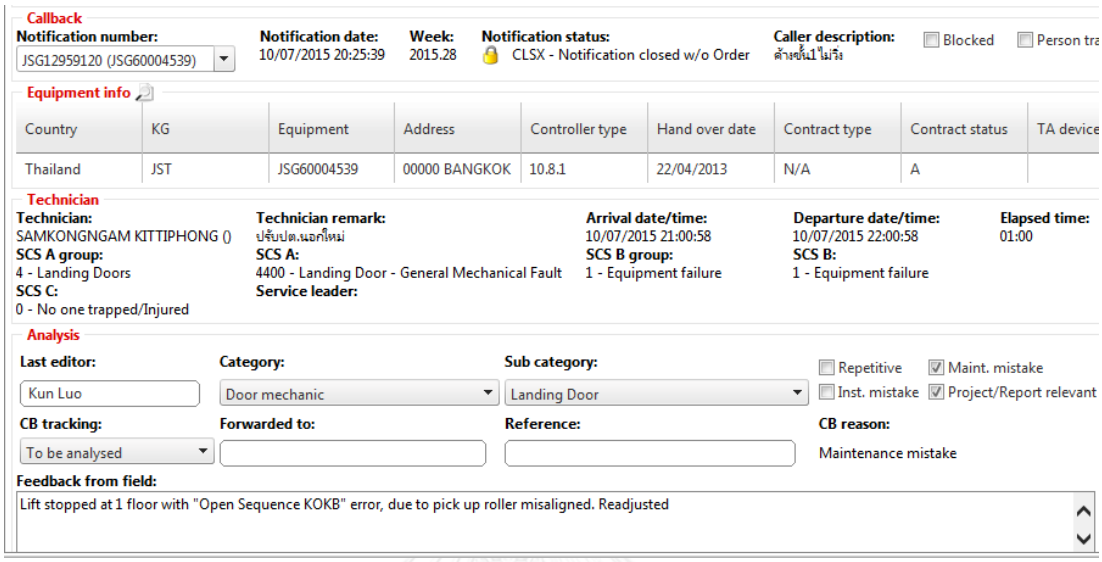
The result has been monitored everyday via company mobile phone message which sent by call centre officer. Table 26 shows that there was one failure modes from door system was happened on 10 July 2015.

Table 26: Number of failure from door system of equipment number 60004539 derived from SAP database

Number of failure from door system	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15
	0	0	1	0	0	0

A technician used a guidance from troubleshooting manual to analyse the failure and to perform corrective maintenance. A failure report (Figure 41) shows that the actual failure mode was error 212 “Open Sequence KOKB”, the actual effect of

failure was elevator cannot operate and the actual cause of failure was misaligned SW lock roller at lowest landing floor (Figure 42).



Callback

Notification number: JSG12959120 (JSG60004539) | **Notification date:** 10/07/2015 20:25:39 | **Week:** 2015.28 | **Notification status:** CLSX - Notification closed w/o Order | **Caller description:** ล้างชั้น1ไม่ริง | Blocked | Person tra

Equipment info

Country	KG	Equipment	Address	Controller type	Hand over date	Contract type	Contract status	TA device
Thailand	JST	JSG60004539	00000 BANGKOK	10.8.1	22/04/2013	N/A	A	

Technician

Technician: SAMKONGNGAM KITTIPHONG ()
Technician remark: ปรับปต.นอกใหม่
Arrival date/time: 10/07/2015 21:00:58
Departure date/time: 10/07/2015 22:00:58
Elapsed time: 01:00
SCS A group: 4 - Landing Doors
SCS A: 4400 - Landing Door - General Mechanical Fault
SCS B group: 1 - Equipment failure
SCS B: 1 - Equipment failure
SCS C: 0 - No one trapped/Injured
Service leader:

Analysis

Last editor: Kun Luo
Category: Door mechanic
Sub category: Landing Door
Repetitive | Maint. mistake | Inst. mistake | Project/Report relevant
CB tracking: To be analysed
Forwarded to:
Reference:
CB reason: Maintenance mistake
Feedback from field: Lift stopped at 1 floor with "Open Sequence KOKB" error, due to pick up roller misaligned. Readjusted

Figure 41: Failure report of equipment number 60004539 on 10 Jul 2015

A corrective action was performed by visual, measure and function checks which in accordance with guidance in troubleshooting document.

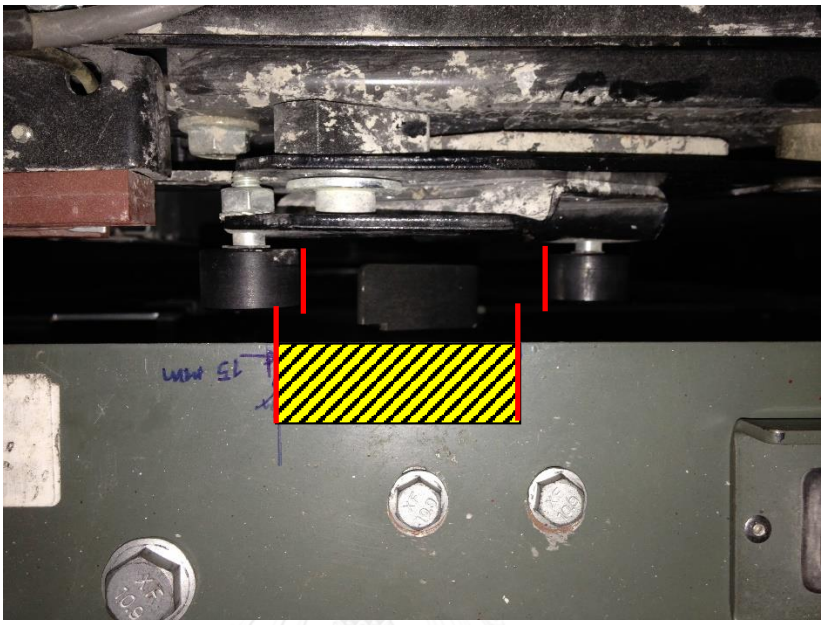


Figure 42: Misaligned SW lock roller on 1st floor of landing door of equipment number 60004539

Figure 43 demonstrated that root cause of this failure come from lack of maintenance procedure to lowest landing door. A technician was unable to use normal process (standing on elevator's roof) to perform preventive maintenance because of the design of safety clearance. Therefore this activity requires a special procedure which can be performed by 2 options.

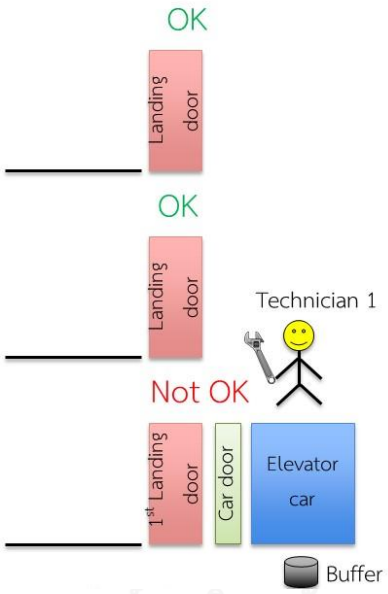


Figure 43: Normal process

Option 1 (Figure 44), if a floor-to-floor distance between a lowest floor and a second floor is not too high to exit, a technician is able to use a ladder to entre to elevator car from outside of lowest landing door.

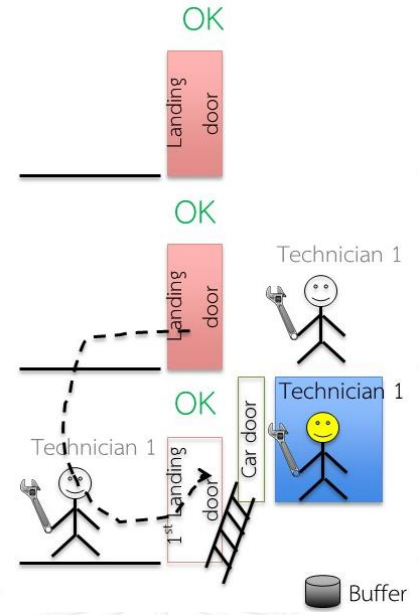


Figure 44: Option 1

Option 2 (Figure 45), there requires a second technician to operate on a roof of elevator car while a first technician is inside elevator car.

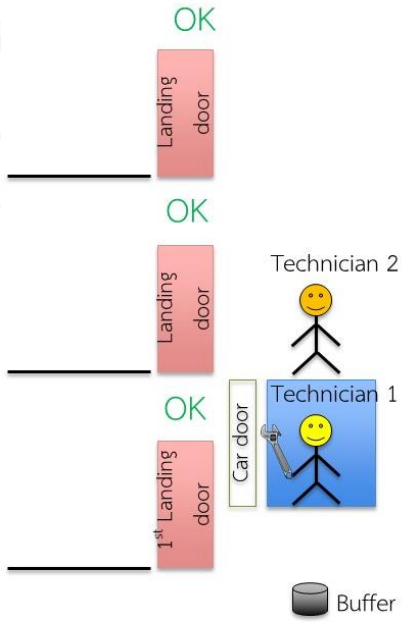


Figure 45: Option 2

In summary, Figure 46 illustrates that a number of failure of door system has a dramatic decrease from 5 failures between May and October in year 2014 to only 1 failure between May and October in year 2015 after implementing an improvement of preventive maintenance plan.

Figure 46 also shows that the proportion of failure modes from door system was reduced from 5 out of 8 failures in year 2014 (62.5%) to 1 out of 5 failures (20%) in year 2015.

In terms of MTBF, as power failure and non-technical callback are not classified in FD1. Therefore we can calculate that MTBF was increased from $\frac{180}{7}$ = 25 days in year 2014 to $\frac{180}{3}$ = 60 days in year 2015.

In comparison between same period between May and October of year 2014 and year 2015.

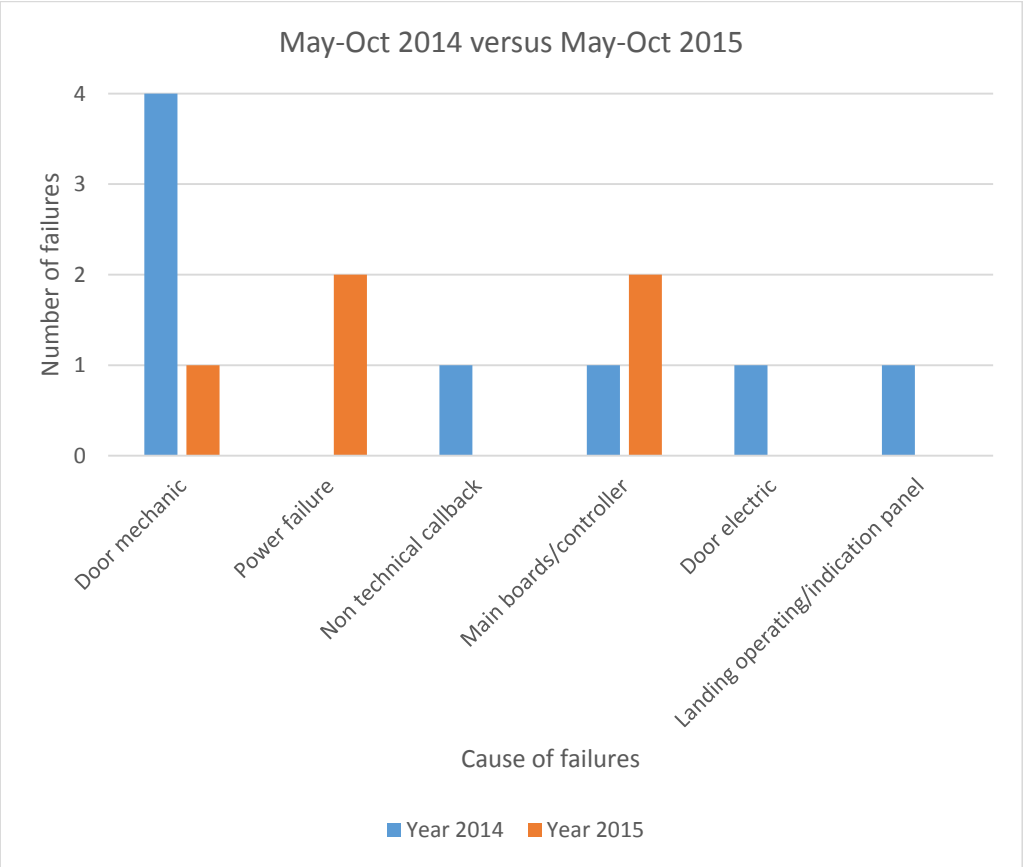


Figure 46: Comparison of causes of failure of equipment number 60004539 between May - Oct 2014 and May – Oct 2015

4.2 New handed-over unit (equipment number 60005943)

A revised preventive maintenance plan has been implemented and monitored the result as same as equipment number 60004539. The revised preventive maintenance checklist in each month is shown in Appendix J.

The actual implementation date of an improvement preventive maintenance plan is shown in Table 27.

Table 27: Actual implementation date of preventive maintenance of equipment number 60005943

Month	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15
Schedule	1, 3, 6	1	1	1, 3	1	1
Actual date	29-Apr-15	26-May-15	26-Jun-15	29-Jul-15	26-Aug-15	28-Sep-15

Referring to a guidance from a revised checklist document and troubleshooting manual, Table 28 illustrates example actual causes of failure which were found during preventive maintenance by a certified technician.

Table 28: Inspected items during preventive maintenance on 17 April 2015 of equipment number 60005943

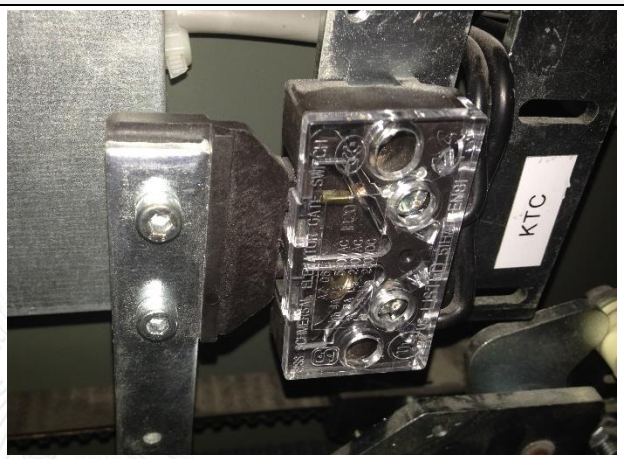
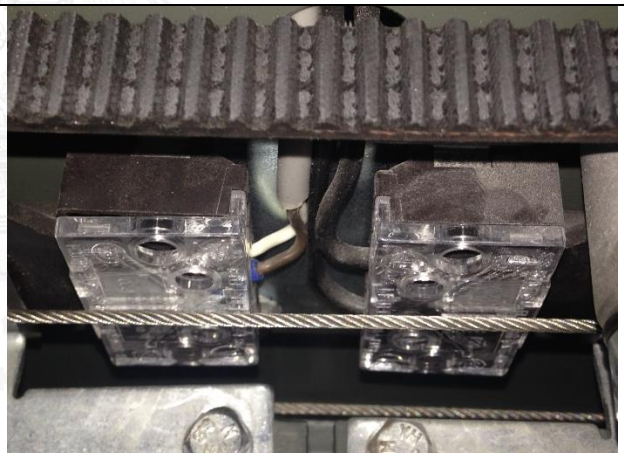
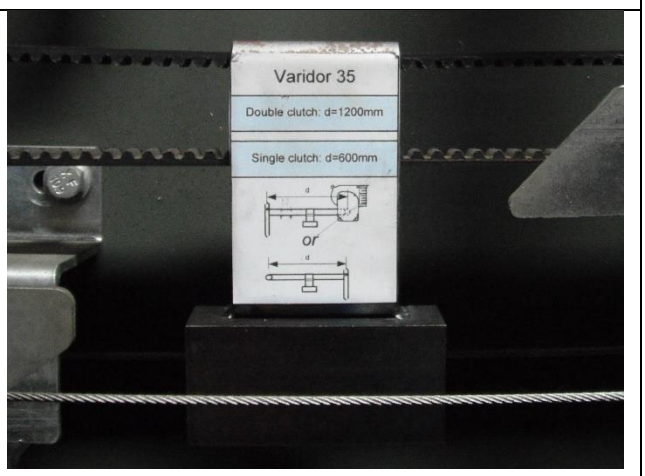
Rectified items	Photos
- Readjusted KTC	
- Readjusted KTC2 and KETS-2	
- Rechecked car door belt	

Table 28: Inspected items during preventive maintenance on 17 April 2015 of equipment number 60005943 (Cont.)

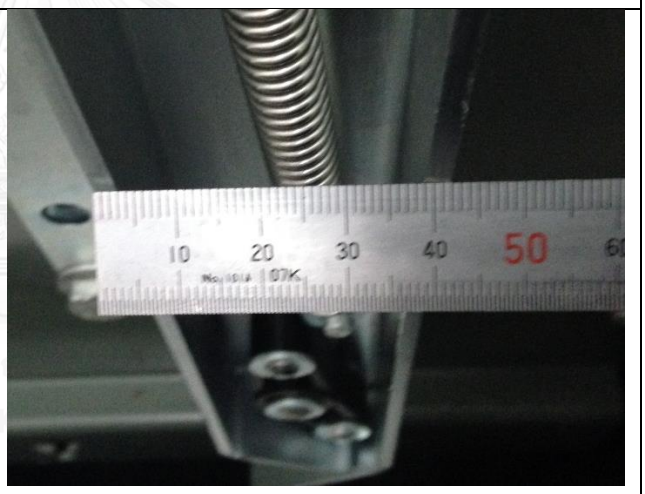
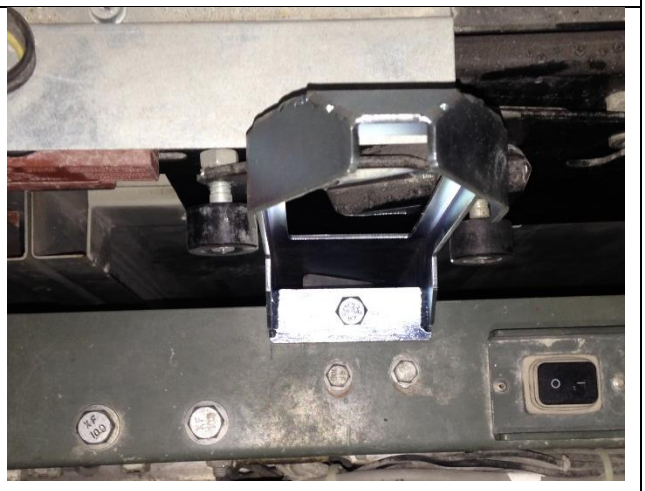
Rectified items	Photos
- Rechecked car door transmission cable	
- Rechecked car door clutch	
- Rechecked SW lock rollers with reference line	

Table 28: Inspected items during preventive maintenance on 17 April 2015 of equipment number 60005943 (Cont.)

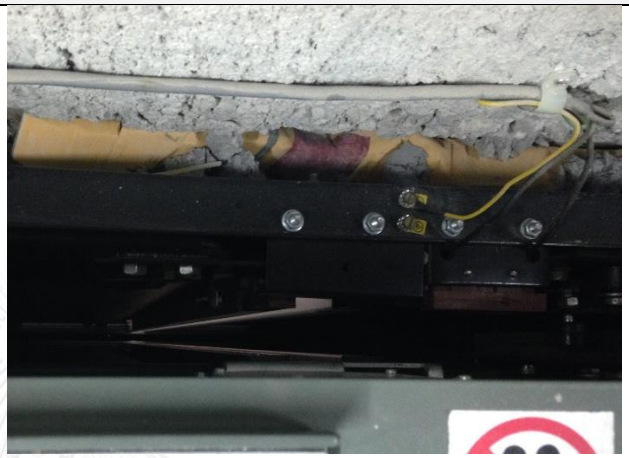
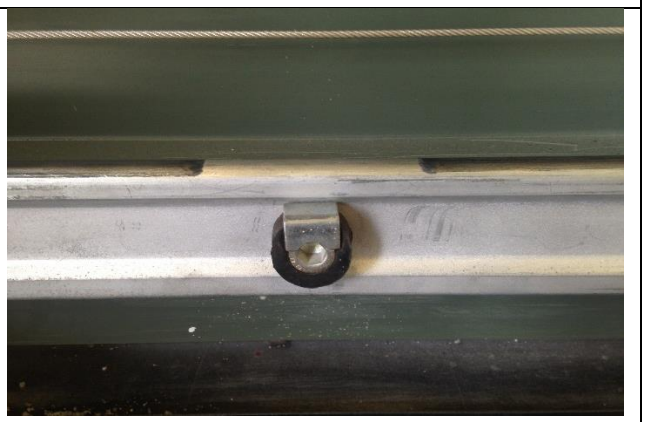
Rectified items	Photos
- Cleaned landing door header	
- Cleaned landing door sill	
- Cleaned car door header	

Table 28: Inspected items during preventive maintenance on 17 April 2015 of equipment number 60005943 (Cont.)

Rectified items	Photos
- Cleaned car door sill	

Table 29 shows that there was no failure mode from door system has been found during 6-month period.

Table 29: Result of Oct 2015 of equipment number 60005943 from SAP database

Number of failure from door system	May-15	Jun-15	Jul-15	Aug-15	Sep-15	Oct-15
	0	0	0	0	0	0

In terms of total failures, since this elevator is a new handed-over unit in year 2015. It is unable to compare the result with year 2015. Figure 47 shows that between May 2015 and Oct 2015 there were 2 failures which are not related to door system.

In terms of MTBF, as false call and power failure are not classified as FD1. It is unable to calculate MTBF during this 6 months as number of failures (FD1) was equal

to 0. Therefore a technician was able to perform preventive maintenance following the schedule.

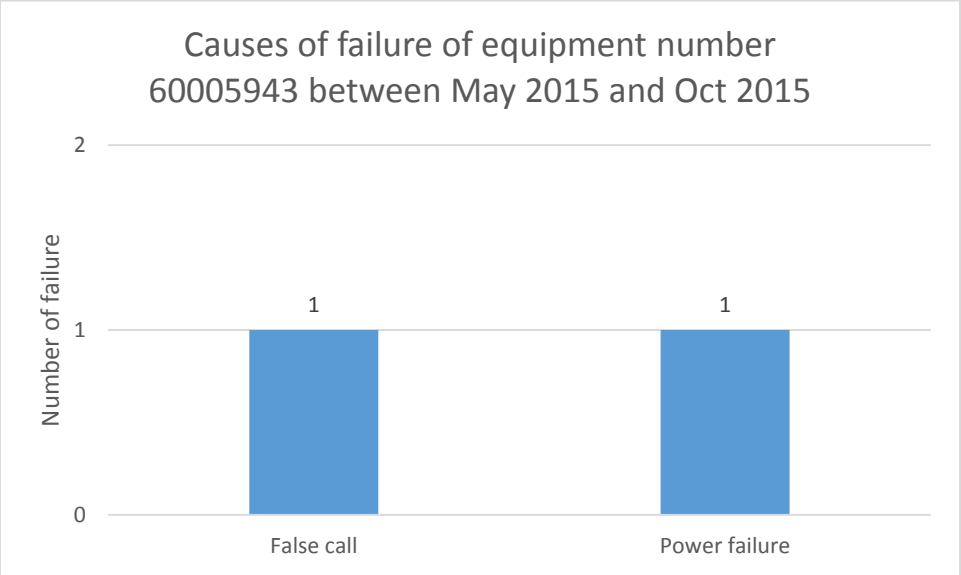


Figure 47: Causes of failure of equipment number 60005943 between May and Oct 2015

4.3 Re-calculate RPN

According to failure reports of these 2 selected BCBB elevators, it can be seen that occurrence of each failure mode was significantly reduced. For old unit, although a result shows that a number of failures from door system was reduced by 80% (5 times to 1 time), a research period was not covered full cycle of a new preventive maintenance plan. Therefore it is estimated that the occurrence of new RPN can be reduced by minimum 50% which the result already meet objective of the research.

New RPN can be re-calculated as Table 30.

Table 30: New RPN

Error code	Potential Failure Mode	Potential Causes of Failure	S	O	D	RPN	New O	New RPN
148	Safety T4	Worn out/broken KTC	6	4	10	240	**2**	**120**
		Misaligned KTC	6	5	10	300	**3**	**180**
		Car door transmission cable is too loose/damaged	6	2	10	120	**1**	**60**
		Rubber from carrier roller is stuck on car door track	6	8	10	480	**4**	**240**
		Rubbish is stuck inside car door sill	6	8	10	480	**4**	**240**
149	Safety T5	Worn out/broken KTS	6	4	10	240	**2**	**120**
		Misaligned KTS	6	5	10	300	**3**	**180**
		Landing door self-close spring worn out/broken	6	4	10	240	**2**	**120**
		Landing door transmission cable damaged	6	2	10	120	**1**	**60**
		Rubber from upper roller is stuck on landing door track	6	8	10	480	**4**	**240**
		Rubbish is stuck inside landing door sill	6	8	10	480	**4**	**240**
		Landing door unlocking device is stuck	6	2	10	120	**1**	**60**
202	Door Operation Error	Car door drive is defective	8	2	10	160	**1**	**80**
203	Thermo Door Motor	Hook limit roller worn out	5	2	10	100	**1**	**50**
		Misaligned SW lock roller of landing door	5	6	10	300	**3**	**150**
204	Door Reverse Device Error	Rubbish is stuck inside car door sill	6	8	10	480	**4**	**240**
		Rubbish is stuck inside landing door sill	6	8	10	480	**4**	**240**
207	Close Sequence Error	Rubbish is stuck inside car door sill	6	8	10	480	**4**	**240**
		Rubbish is stuck inside landing door sill	6	8	10	480	**4**	**240**

Table 30: New RPN (Cont.)

Error code	Potential Failure Mode	Potential Causes of Failure	S	O	D	RPN	New O	New RPN
208	Door Device Error	This error will come with other errors	7	4	10	280	**2**	**140**
		Car door drive is defective	6	2	10	120	**1**	**60**
212	Open Sequence KOKB	Hook limit roller worn out	5	5	10	250	**3**	**150**
		Misaligned SW lock roller of landing door	5	6	10	300	**3**	**150**
		No gap between eccentric roller and landing door track	5	4	10	200	**2**	**100**
		Tension of car door is too loose	5	5	10	250	**3**	**150**
		Car door clutch is dirty/stuck/ worn out	5	8	10	400	**4**	**200**
		Landing door rubber stopper is missing/ worn out	5	2	10	100	**1**	**50**
214	RPHT Continuous Activation	Light curtain is dirty	5	7	10	350	**4**	**200**
217	KSKB Continuous Activation	Rubbish is stuck inside car door sill	6	8	10	480	**4**	**240**
		Rubbish is stuck inside landing door sill	6	8	10	480	**4**	**240**
		Tension of car door belt is too loose	6	5	10	300	**3**	**180**
252	Door Unavailable	Car door drive is defective	4	2	10	80	**1**	**40**
709	Safety Circuit	This error generate from drive side, so we have to check with other errors	6	8	10	480	**4**	**240**
832	wKET-S2 Failure	KET-S2 worn out/broken	6	4	10	240	**2**	**120**
		Misaligned KET-S2	6	5	10	300	**3**	**180**

Table 30: New RPN (Cont.)

Error code	Potential Failure Mode	Potential Causes of Failure	S	O	D	RPN	New O	New RPN
834	wMotor Over Temperature	Car door drive is defective	4	2	10	80	**1**	**40**
		Misaligned SW lock roller of landing door	6	5	10	300	**3**	**180**
838	eLocking Jam	Car door drive is defective	6	2	10	120	**1**	**60**
		Distance between car door clutch and cam plate is wrong	6	4	10	240	**2**	**120**
839	eUnlocking Jam	Car door drive is defective	6	2	10	120	**1**	**60**
		Misaligned SW lock roller of landing door	6	5	10	300	**3**	**180**
		SW lock roller is worn out/broken	6	3	10	180	**2**	**120**
		Worn out Car guide rollers	6	2	10	120	**1**	**60**
		Hook limit roller worn out	6	4	10	240	**2**	**120**
840	NGT 24VDC Over 5% Limit	Direct current voltage of car door power supply is over 24VDC by 5%	4	2	10	80	**1**	**40**
841	NGT 24 VDC Under 5% Limit	Direct current voltage of car door power supply is lower 24VDC by 5%	4	2	10	80	**1**	**40**
842	NGT 24 VDC Over 10% Limit	Direct current voltage of car door power supply is over 24VDC by 10%	4	2	10	80	**1**	**40**
843	NGT 24VDC Under 10% Limit	Direct current voltage of car door power supply is under 24VDC by 10%	4	2	10	80	**1**	**40**
844	ePower Door Off	Car door power switch failure	8	2	10	160	**1**	**80**
850	eOver Voltage	Worn out car door rubber stopper	3	4	10	120	**2**	**120**
1301	CAN Missing Node	Car door drive is defective	8	2	10	160	**1**	**80**

Table 30: New RPN (Cont.)

Error code	Potential Failure Mode	Potential Causes of Failure	S	O	D	RPN	New O	New RPN
-	Customer complaint	Missing car door shoes	3	8	10	240	**4**	**120**
		Car door shoe worn out	3	8	10	240	**4**	**120**
		Car door panel rubber stopper is missing/ worn out	3	5	10	150	**3**	**90**
		Landing door panel rubber stopper is missing/ worn out	3	5	10	150	**3**	**90**
		Landing door rubber stopper is missing/ worn out	3	5	10	150	**3**	**90**
		Misaligned SW lock roller of landing door	3	5	10	150	**3**	**90**
		Car door panel is hit by user	2	8	10	160	**4**	**160**
		Landing door panel is hit by user	2	8	10	160	**4**	**160**

CHAPTER V

CONCLUSION AND SUGGESTIONS

4.1 Conclusion

As company's strategy is necessary to shift form differentiate to hybrid to in order to be competitive in elevator market as selling price of elevator is one of very important factors for customers to make buying decision nowadays. Door system of BCBB product is one of selected elevator parts which is affected from a change of company's strategy as car door is supplied by offshore manufacturing site instead of onshore manufacturing site and landing door is supplied by offshore supplier. The change also created a number of elevator's failure after elevators have been used in normal operation.

Based on taskforce team's brainstorming on historical failure reports, FMEA is a selected systematic tool which is used for identify potential failure modes from door system of BCBB elevators which caused from its mechanical and electrical components. Findings from FMEA enables taskforce team to assign S, O and D in order to rank RPN for prioritising corrective actions.

A revised preventive maintenance schedule, a troubleshooting manual, a revised checklist document and training & evaluation system are elements of corrective actions which enables a technician to effective and efficient perform preventive

maintenance and corrective maintenance which brought about BCBB elevator to have a reduction of failures from door system.

From the result, it is proved that an improvement of preventive maintenance plan integrated with FMEA structure enables BCBB elevators to increase MTBF by reducing a number of failures from door system which were a largest proportion of elevator's failure.

The result also implies that as BCBB elevators have a higher availability, a higher reliability and a higher quality as MTBF was increased.

A reduction of number of elevator's failures and an increment of MTBF score also increase satisfaction of parent company, top management team and customers.

In terms of resource allocation, Existing Installation department is able to reduce workload of technicians as a number of corrective maintenance was reduced.

In order to continuously improve preventive maintenance plan, it can be seen that as a number of failures from door system was reduced during 6 months of implementation period. We are able to continuously re-calculate RPN for a next cycle of an improvement of preventive maintenance plan as severity and occurrence of each failure mode will be reduced.

It also proved that this concept can be applied in other BCBB elevators, other components of BCBB elevators and other elevator models.

4.2 Suggestions

In terms of spare part management, it is suggested to use spare part list in troubleshooting documents and historical usage of spare part in SAP database to forecast availability of each mechanical and electrical component in the stock in the future as sometimes technicians found a cause of failure but they were unable to replace spare parts because spare parts were out of stock.

In terms of process, we are able to create preventive and corrective maintenance process into paper as same as troubleshooting manual in order to prevent misunderstanding of technicians as it happened one time during research period. The preventive and corrective maintenance process can be added in training course as well. Besides, Human Resource department is able to set this process as a penalty to technicians who don't follow the process.

In order to build long-term competency for technicians which is one of key success factors of best-cost strategy, it is suggested to develop a training plan for new and old technicians. New technicians must be trained and certified before performing preventive maintenance and corrective maintenance in real situation whereas old technicians must be attended refresh training and re-evaluated technical skill every year. Moreover, video clip can be used as an effective training material and can be put into self-learning centre for demonstrating know-how of each preventive maintenance and corrective maintenance activity.

In terms of resource allocation, it is suggested to record time to spend on each preventive maintenance and corrective maintenance activity in order to create a standard time for planning human resource in Existing Installation department in the future.

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APPENDICES

Appendix A

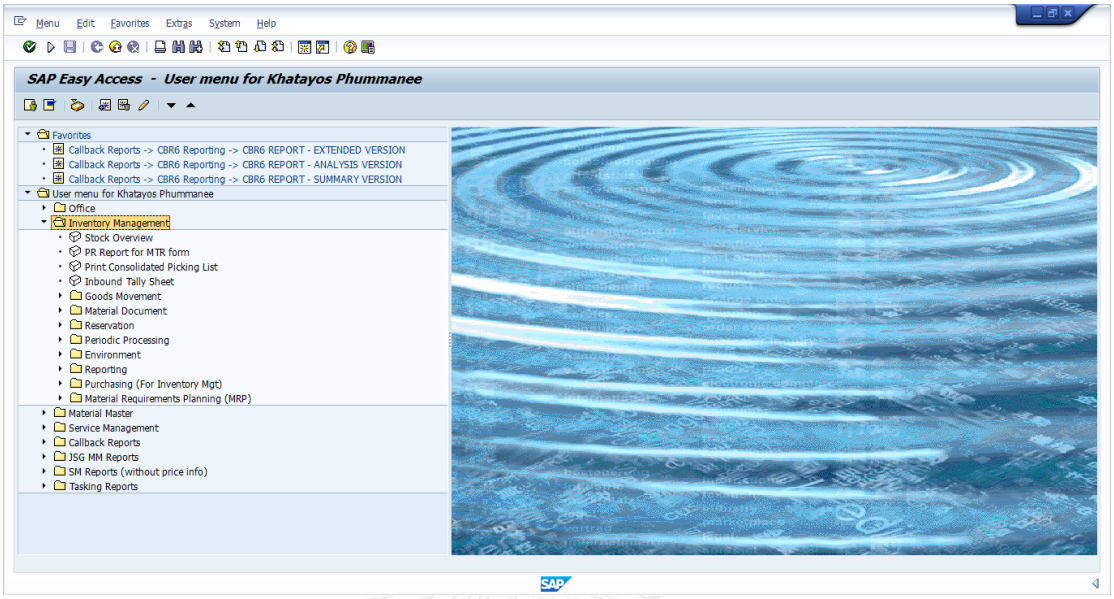


Figure 48: SAP database

Table 31: Specification of selected units

Configuration	Specification	Equipment number 60004539	Equipment number 60005943
Travel height	Up to 150 m	85.74	84.60 m
Speed	1.0 to 3.0 m/s	2.5 m/s	2.5 m/s
Load	630 to 2,500 kg	1000 kg	1000 kg
Number of stops	Up to 50 stops	31	27
Door width	800 to 1,400 mm	900	900
Door height	2,100 to 2,400 mm	2100	2100
Car groups	8	3	3

Appendix B

How door system works

After an elevator received a car call or a landing call from a passenger, controller will command motor to open brake and then will command Variable-Frequency (VF) drive to control speed of motor to make an elevator start running and stop when an elevator arrived on a building floor. Car door clutch which is important component of car door will couple with landing door SW lock roller. Afterwards, car door drive will control car door clutch to open car door and landing door together. Eventually, passengers can get in and out from elevator's car.

Appendix C

In terms of controller display (Figure 49), there requires only 4-digit password for accessing to error code. Technicians are responsible person to check error code during preventive maintenance and corrective maintenance.

Figure 49: Controller display

In terms of troubleshooting software (Figure 50), there requires intermediate authorisation level and technical skill as it needs personnel software license and specific data cable for connecting between computer and elevator's controller. Supervisors are responsible to troubleshoot error code when the problem cannot solve by technicians or during regular visit.

Lift: 1 Commission No.: 4800349
Controller Date: Mar 2015 Controller Time: 09:16:55
Control Type: MX-GC SW Version: V10.08.01 (12.12.2014)
Drive Type: VECSYS/VARIOSYS EU/AP SW Version: V1.19 (11.12.2013)
Shaft info: SALSIS SW Version: V1.01 (16.5.2012)
Door Drive Side 1 - SW Version: V5.00
****

Date - Time	Severity	Description	Id	Subsysten	Source Id	Extra Info [Hex]	Direction	Drive Pha	Drive Ava
3/11/15 - 21:51:17	Event	Elevator Operation Resumed	477	Lift	90	'00D00A00'	NONE	Standstill	No
3/11/15 - 21:51:17	Event	CAN Node Alive Again	1302	-	7	'02000010'	NONE	Standstill	No
3/11/15 - 21:51:12	Event	CAN Node Alive Again	1302	-	7	'03010010'	NONE	Standstill	No
3/11/15 - 21:51:12	Event	CAN Node Alive Again	1302	-	7	'01000000'	NONE	Standstill	No
3/11/15 - 21:51:08	Event	Elevator Operation Interrupted	476	Lift	90	'00D00A1E'	NONE	Standstill	No
3/11/15 - 21:51:08	Error	DoorDevErr	208	Car	1	'00000005'	NONE	Standstill	No
3/11/15 - 21:51:08	Error	CAN Missing Node	1301	-	7	'02000010'	NONE	Standstill	Yes
3/11/15 - 21:51:08	Error	CAN Missing Node	1301	-	7	'03010010'	NONE	Standstill	Yes
3/11/15 - 21:51:08	Error	CAN Missing Node	1301	-	7	'01000000'	NONE	Standstill	Yes
3/11/15 - 21:51:08	Warning	CAN Peripheral Controller Bus Off	1311	-	1	'00006A01'	NONE	Standstill	Yes
3/11/15 - 21:50:37	Event	Elevator Operation Resumed	477	Lift	90	'00D00A00'	NONE	Standstill	No

Figure 50: Troubleshooting software

In terms of remote monitoring tool (Figure 51), there requires advance authorisation level and technical skill. Remote monitoring tool enables a product line expert to analyse all previous error code via online database.

Installation	Descr	Event Date	Msg Text	Parameter
000000064537-03	Counter	19.03.2015 04:57:07	03-00: Trip counter	725480
000000064537-03	Info	19.03.2015 04:56:54	02FF-[39]: TX Controller Version	10.8.0
000000064537-03	Counter	19.03.2015 04:31:02	03-00: Trip counter	725461
000000064537-03	Info	19.03.2015 04:31:02	02FF-[39]: TX Controller Version	10.8.0
000000064537-03	System	19.03.2015 04:00:00	04-3D: Transaction Counter Statistic Buffer	2691
000000064537-03	System	19.03.2015 04:00:00	04-3D: Transaction Counter Statistic Buffer	2690
000000064537-03	Counter	19.03.2015 00:04:13	03-00: Trip counter	725130
000000064537-03	Info	19.03.2015 00:03:59	02FF-[39]: TX Controller Version	10.8.0
000000064537-03	Counter	19.03.2015 00:00:00	03-02: Door opening counter	Door1=2355 at Floor 31
000000064537-03	Counter	19.03.2015 00:00:00	03-02: Door opening counter	Door1=36070 at Floor 30
000000064537-03	Counter	19.03.2015 00:00:00	03-02: Door opening counter	Door1=32610 at Floor 29
000000064537-03	Counter	19.03.2015 00:00:00	03-02: Door opening counter	Door1=14748 at Floor 28
000000064537-03	Counter	19.03.2015 00:00:00	03-02: Door opening counter	Door1=19287 at Floor 27
000000064537-03	Counter	19.03.2015 00:00:00	03-02: Door opening counter	Door1=26351 at Floor 26
000000064537-03	Counter	19.03.2015 00:00:00	03-02: Door opening counter	Door1=36889 at Floor 25
000000064537-03	Counter	19.03.2015 00:00:00	03-02: Door opening counter	Door1=41156 at Floor 24
000000064537-03	Counter	19.03.2015 00:00:00	03-02: Door opening counter	Door1=33306 at Floor 23
000000064537-03	Counter	19.03.2015 00:00:00	03-02: Door opening counter	Door1=32624 at Floor 22
000000064537-03	Counter	19.03.2015 00:00:00	03-02: Door opening counter	Door1=20411 at Floor 21
000000064537-03	Counter	19.03.2015 00:00:00	03-02: Door opening counter	Door1=42934 at Floor 20
000000064537-03	Counter	19.03.2015 00:00:00	03-02: Door opening counter	Door1=41536 at Floor 19
000000064537-03	Counter	19.03.2015 00:00:00	03-02: Door opening counter	Door1=38615 at Floor 18
000000064537-03	Counter	19.03.2015 00:00:00	03-02: Door opening counter	Door1=34461 at Floor 17
000000064537-03	Counter	19.03.2015 00:00:00	03-02: Door opening counter	Door1=43343 at Floor 16

Figure 51: Remote monitoring tool

Appendix D

Notifctn	Work ctr	FunctLocDescrip.	Equi	Malf.start	MalfStrt	ArrTime	ResTime	Root cause	First name
12889885	622-P03	THE BASE	SL4	02.01.2015	13:03:18	14:20:30	16:38:30	Wornout KTS contact	SANTHAN
12890139	622-P03	WYNE SUKHUMVIT	L2	03.01.2015	10:03:20	11:12:32	12:14:32	Motor has noise	SUKCHEEP
12890765	622-P03	THE BASE	SL4	05.01.2015	9:30:10	10:30:54	11:30:54	Open Sequence KOKB	SANTHAN
12893209	624-P02	AERONAUTICAL RADIO OPERAT	L2	10.01.2015	11:40:28	11:49:20	11:49:20	Rock was stuck inside landing sill	CHATCHAWAN
12893436	622-P03	WYNE SUKHUMVIT	SL1	11.01.2015	3:03:01	8:49:21	11:55:52	Defective SALSIS	PITAKCHAI
12895208	622-P03	WYNE SUKHUMVIT	L1	14.01.2015	17:05:05	18:20:28	19:20:28	Governor rope elongation	SUKCHEEP
12895462	615-P01	PYNE BY SANSIRI	SL1	15.01.2015	8:25:45	10:00:31	12:05:31	Motor has noise	Kiadtiphon
12896041	623-P01	FUSE MOBIUS	LB3	16.01.2015	16:30:14	17:52:14	17:52:14	Governor rope elongation	SITTHISAK
12896518	622-P02	KEYNE BY SANSIRI	PL3	18.01.2015	10:25:37	11:35:42	12:30:42	Unknown root cause	SUKCHEEP
12896789	622-P03	THE BASE	L3	18.01.2015	15:46:35	16:48:02	17:48:02	Wornout COP key switch	EUD
12896843	622-P03	THE BASE	L1	18.01.2015	20:30:27	22:32:25	23:32:25	DoorDevErr	SANONG
12897415	611-P02	TEAL SATHORN TAKSIN	L2	20.01.2015	8:58:17	10:00:18	10:30:18	Misaligned pickup roller	PRASIT
12897435	622-P03	THE BASE	SL4	20.01.2015	9:00:07	10:00:54	12:00:54	LOP buffer worn out	SANTHAN
12899452	622-P03	WYNE SUKHUMVIT	L1	25.01.2015	8:10:43	9:26:40	10:30:40	Defective BCM	PITAKCHAI
12900408	612-P02	THE SEED MINGLE	L1	27.01.2015	8:45:15	9:57:07	10:57:07	Motor has noise	ANUKUL
12900887	623-P01	FUSE MOBIUS	SLA	28.01.2015	15:10:24	16:00:16	10:00:31	Misaligned pickup roller	KLAI
12901267	622-P03	THE BASE	SL4	29.01.2015	11:58:09	12:03:11	12:04:11	Defective BCM	SANTHAN
12902426	622-P03	THE BASE	L2	01.02.2015	8:15:25	9:20:56	10:22:56	Open Sequence KOKB	SUKCHEEP
12904352	622-P03	THE BASE	SL4	05.02.2015	10:33:33	11:00:17	14:28:56	Reset - unknown root cause	SANTHAN
12904815	631-P02	THE TREE BANG PO	SL1	06.02.2015	10:35:13	11:00:33	13:00:33	Defective ASIXB	SUPPACHAI

Figure 52: Failure reports which derived from SAP system



JSG60004081 –

Notification no.	Date	Error code	Cause of breakdown	Root cause	Action taken
JSG12967702	05-08-2015 07:50:32	208	Lift stopped at 4th floor with door open, DoorDevErr	see errorlog as attached	1. Cleaned KTS & track 2. Rechecked pickup roller at 4th floor

Figure 53: Failure report for discussion with parent company

Appendix E

Table 32: Trip counter of equipment number 60004539

Month	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	Average
Floor	Trip counter	Trip counter	Trip counter	Trip counter	Trip counter	Trip counter	Trip counter
31	627	495	604	586	667	654	606
30	456	601	534	600	515	408	519
29	367	400	388	562	458	424	433
28	351	382	386	316	422	370	371
27	427	372	382	400	481	442	417
26	615	511	468	392	532	540	510
25	829	726	758	684	801	732	755
24	579	461	760	674	721	622	636
23	658	725	652	602	638	604	647
22	508	583	756	688	720	660	653
21	674	581	704	798	723	666	691
20	832	831	732	826	795	706	787
19	822	653	738	604	758	728	717
18	781	729	970	784	1004	876	857
17	824	731	994	790	921	824	847
16	860	1012	922	966	861	788	902
15	658	613	696	682	668	596	652
14	841	737	824	752	750	692	766
13	730	606	840	628	810	738	725
12	1164	1091	1194	1172	1091	964	1113
11	1017	843	1138	746	996	804	924
10	1195	1140	1274	976	1063	1000	1108
9	1195	1040	1046	1022	928	852	1014
8	935	925	974	734	848	742	860
7	957	856	930	720	740	700	817
6	1055	866	942	774	848	716	867
5	1137	980	1178	946	910	844	999
4	1237	1233	1300	970	1027	950	1120
3	1158	1050	1166	762	843	650	938
2	1320	1238	1096	802	907	934	1050
1	15584	15188	15594	13400	13901	12706	14396
Total	**40393**	**38199**	**40940**	**35358**	**37347**	**33932**	**37695**

POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(PROCESS FMEA)

Print # 1 Rev. 0 FMEA Number: 1

Item: Preventive and corrective maintenance Process Responsibility: Existing Installation Dept. Prepare by: Khatayos Phummanee

Elevator Model: BCBB Key Date: N/A Date (Orig.): 1/3/2015

Error code	Potential Failure Mode	Potential Effect(s) of Failure	S	Potential Causes(s)/ Mechanism(s) of Failure	O	Current Process Controls -Prevention -Detection	D	R P N	Recommended Action(s)	Responsibility & Target Completion Date	Action Results / Actions Taken
148	Safety T4	- Car door cannot close - Door close but elevator cannot start running - Elevator emergency stops during normal running	6	Worn out/broken KTC	4	During corrective maintenance and preventive maintenance only	10	240	Visual check appearance of KTC and KTC2, replace if it is worn out	Responsible field staffs	M - 1 time per 3 months

			6	Misaligned KTC	5	During corrective maintenance and preventive maintenance only	10	300	1. Visual check alignment of KTC and KTC2 when car door is fully closed 2. Measure distance between KTC contact housing and contact bridge = 4 mm, adjust if distance is wrong	Responsible field staffs	M - 1 time per 3 months
			6	Car door transmission cable is too loose/damaged	2	During corrective maintenance and preventive maintenance only	10	120	1. Visual check appearance of car door transmission cable, replace if it is damaged 2. Use hand to press on car door transmission cable, adjust if it is too tight or too loose	Responsible field staffs	L - 1 time per 6 months
			6	Rubber from carrier roller is stuck on car door track	8	During corrective maintenance and preventive maintenance only	10	480	1. Visual check cleanliness of car door track 2. Use sharp tool (steel ruler) and rag to clean on car door track if it is dirty	Responsible field staffs	H - 1 time per month

			6	Rubbish is stuck inside car door sill	8	During corrective maintenance and preventive maintenance only	10	480	1. Visual check cleanliness of car door sill 2. Use rag or vacuum cleaner to clean car door sill if it is dirty	Responsible field staffs	H - 1 time per month
149	Safety T5	- Landing door cannot close - Door close but elevator cannot start running - Elevator emergency stops during normal running	6	Worn out/broken KTS	4	During corrective maintenance and preventive maintenance only	10	240	1. Visual check appearance of KTS, replace if it worn out	Responsible field staffs	M - 1 time per 3 months
			6	Misaligned KTS	5	During corrective maintenance and preventive maintenance only	10	300	1. Visual check alignment of KTS when landing door is fully closed 2. Measure distance between KTS contact housing and contact bridge = 1-3 mm, adjust if distance is wrong	Responsible field staffs	M - 1 time per 3 months
			6	Landing door self-close spring worn out/broken	4	During corrective maintenance and preventive maintenance only	10	240	1. Visual check appearance of landing door self-close spring	Responsible field staffs	M - 1 time per 3 months

			6	Landing door transmission cable damaged	2	During corrective maintenance and preventive maintenance only	10	120	1. Visual check appearance of landing door transmission cable	Responsible field staffs	L - 1 time per 6 months
			6	Rubber from upper roller is stuck on landing door track	8	During corrective maintenance and preventive maintenance only	10	480	1. Visual check cleanliness of landing door track 2. Use sharp tool (steel ruler) and rag to clean on landing door track if it is dirty	Responsible field staffs	H - 1 time per month
			6	Rubbish is stuck inside landing door sill	8	During corrective maintenance and preventive maintenance only	10	480	1. Visual check cleanliness of landing door sill 2. Use rag or vacuum cleaner to clean landing door sill if it is dirty	Responsible field staffs	H - 1 time per month
			6	Landing door unlocking device is stuck	2	During corrective maintenance and preventive maintenance only	10	120	1. Use triangle key to check function of unlocking device	Responsible field staffs	L - 1 time per 6 months
202	Door Operation Error	- Elevator cannot use	8	Car door drive is defective	2	During corrective maintenance and preventive maintenance only	10	160	1. Turn off car door power switch 2. Car door panel must be freely closed/opened by hand, replace if it is stuck	Responsible field staffs	L - 1 time per 6 months

203	Thermo Door Motor	- Elevator is temporary unavailable	5	Hook limit roller worn out	2	During corrective maintenance and preventive maintenance only	10	100	1. Visual check appearance of hook limit roller, replace if it is worn out	Responsible field staffs	L - 1 time per 6 months
			5	Misaligned SW lock roller of landing door	6	During corrective maintenance and preventive maintenance only	10	300	1. Move car by inspection control to verify reference line with SW lock roller 2. Measure equality and use hand to check tension of car roller 3. Readjust SW lock roller if it is misaligned with reference line	Responsible field staffs	M - 1 time per 3 months
204	Door Reverse Device Error	- Door close and open many times before it is stuck in the middle	6	Rubbish is stuck inside car door sill	8	During corrective maintenance and preventive maintenance only	10	480	1. Visual check cleanliness of car door sill 2. Use rag or vacuum cleaner to clean car door sill if it is dirty	Responsible field staffs	H - 1 time per month
			6	Rubbish is stuck inside landing door sill	8	During corrective maintenance and preventive maintenance only	10	480	1. Visual check cleanliness of landing door sill 2. Use rag or vacuum cleaner to clean landing door sill if it is dirty	Responsible field staffs	H - 1 time per month

207	Close Sequence Error	- Door close and open many times before it is stuck in the middle	6	Rubbish is stuck inside car door sill	8	During corrective maintenance and preventive maintenance only	10	480	1. Visual check cleanliness of car door sill 2. Use rag or vacuum cleaner to clean car door sill if it is dirty	Responsible field staffs	H - 1 time per month
			6	Rubbish is stuck inside landing door sill	8	During corrective maintenance and preventive maintenance only	10	480	1. Visual check cleanliness of landing door sill 2. Use rag or vacuum cleaner to clean landing door sill if it is dirty	Responsible field staffs	H - 1 time per month
208	Door Device Error	- Door stop moving (close/open) during normal operation - Elevator cannot open or close door - Elevator emergency stops during normal running	7	This error will come with other errors	4	During corrective maintenance and preventive maintenance only	10	280	Have to check surrounding error code to further analysis	Responsible field staffs	M - 1 time per 3 months
			6	Car door drive is defective	2	During corrective maintenance and preventive maintenance only	10	120	1. Turn off car door power switch 2. Car door panel must be freely closed/opened by hand, replace if it is stuck	Responsible field staffs	L - 1 time per 6 months

212	Open Sequence KOKB	- Door is stuck while opening - Door cannot open	5	Hook limit roller worn out	5	During corrective maintenance and preventive maintenance only	10	250	Visual check appearance of hook limit roller, replace if it is worn out	Responsible field staffs	M - 1 time per 3 months
			5	Misaligned SW lock roller of landing door	6	During corrective maintenance and preventive maintenance only	10	300	1. Move car by inspection control to verify reference line with SW lock roller 2. Measure equality and use hand to check tension of car roller 3. Readjust SW lock roller if it is misaligned with reference line	Responsible field staffs	M - 1 time per 3 months
			5	No gap between eccentric roller and landing door track	4	During corrective maintenance and preventive maintenance only	10	200	Use hand to check playable of eccentric roller. It needs to adjust if it is not playable, gap between eccentric roller and landing door track must be 0.5-1 mm.	Responsible field staffs	M - 1 time per 3 months
			5	Tension of car door is too loose	5	During corrective maintenance and preventive maintenance only	10	250	Use hand or belt calibration tool to measure tension of car door belt, adjust if it is too tight or too loose	Responsible field staffs	M - 1 time per 3 months

			5	Car door clutch is dirty/stuck/ worn out	8	During corrective maintenance and preventive maintenance only	10	400	Visual check appearance of car door clutch, clean or lubricate if is necessary	Responsible field staffs	H - 1 time per month
			5	Landing door rubber stopper is missing/ worn out	2	During corrective maintenance and preventive maintenance only	10	100	1. Visual check appearance of landing door rubber stopper, replace if it is missing/ worn out 2. Measure distance between hook and lock, it must be between 1.2-3 mm.	Responsible field staffs	L - 1 time per 6 months

214	RPHT Continuous Activation	- Elevator cannot close door	5	Light curtain is dirty	7	During corrective maintenance and preventive maintenance only	10	350	1. Visual check red light (obstacle) of HMI will blink or turn on 2. Turn off/on power switch (JHT) in order to check obstacle light whether is still active 3. Use dry rag to clean light curtain and check whether red light turns off 4. Light curtain has to be replaced, if obstacle light is still active	Responsible field staffs	M - 1 time per 3 months
217	KSKB Continuous Activation	- Door is stuck while closing	6	Rubbish is stuck inside car door sill	8	During corrective maintenance and preventive maintenance only	10	480	1. Visual check cleanliness of car door sill 2. Use rag or vacuum cleaner to clean car door sill if it is dirty	Responsible field staffs	H - 1 time per month

			6	Rubbish is stuck inside landing door sill	8	During corrective maintenance and preventive maintenance only	10	480	1. Visual check cleanliness of landing door sill 2. Use rag or vacuum cleaner to clean landing door sill if it is dirty	Responsible field staffs	H - 1 time per month
			6	Tension of car door belt is too loose	5	During corrective maintenance and preventive maintenance only	10	300	Use hand or belt calibration tool to measure tension of car door belt, adjust if it is too tight or too loose	Responsible field staffs	M - 1 time per 3 months
252	Door Unavailable	- LOP/COP button cannot register a call	4	Car door drive is defective	2	During corrective maintenance and preventive maintenance only	10	80	1. Turn off car door power switch 2. Car door panel must be freely closed/opened by hand, replace if it is stuck	Responsible field staffs	L - 1 time per 6 months
709	Safety Circuit	- Elevator cannot start a trip - Elevator emergency stops during normal running	6	This error generate from drive side, so we have to check with other errors	8	During corrective maintenance and preventive maintenance only	10	480	Have to check surrounding error code to further analysis such as error 148, 149	Responsible field staffs	H - 1 time per month
832	wKET-S2 Failure	- Door close but elevator cannot start running (No fully-closed symbol on SMLCD) - Elevator emergency stops during normal running	6	KET-S2 worn out/broken	4	During corrective maintenance and preventive maintenance only	10	240	Visual check appearance of KET-S2, replace if it worn out	Responsible field staffs	M - 1 time per 3 months

			6	Misaligned KET-S2	5	During corrective maintenance and preventive maintenance only	10	300	1. Visual check alignment of KET-S2 when car door is fully closed 2. Measure distance between KET-S2 contact housing and contact bridge = 4 mm, adjust if distance is wrong	Responsible field staffs	M - 1 time per 3 months
834	wMotor Over Tempera ture	- LOP button cannot register a call	4	Car door drive is defective	2	During corrective maintenance and preventive maintenance only	10	80	1. Turn off car door power switch 2. Car door panel must be freely closed/opened by hand, replace if it is stuck	Responsible field staffs	L - 1 time per 6 months

			6	Misaligned SW lock roller of landing door	5	During corrective maintenance and preventive maintenance only	10	300	1. Move car by inspection control to verify reference line with SW lock roller 2. Measure equality and use hand to check tension of car roller 3. Readjust SW lock roller if it is misaligned with reference line	Responsible field staffs	M - 1 time per 3 months
838	eLocking Jam	- Door cannot close	6	Car door drive is defective	2	During corrective maintenance and preventive maintenance only	10	120	1. Turn off car door power switch 2. Car door panel must be freely closed/opened by hand, replace if it is stuck	Responsible field staffs	L - 1 time per 6 months
			6	Distance between car door clutch and cam plate is wrong	4	During corrective maintenance and preventive maintenance only	10	240	1. Turn off Power Switch (JHT) 2. Manually open and close car door panel by hand, there must have gap between retainer of car door clutch and clutch cam about 2 mm.	Responsible field staffs	M - 1 time per 3 months

839	eUnlocking|Jam	- Door cannot open	6	Car door drive is defective	2	During corrective maintenance and preventive maintenance only	10	120	1. Turn off car door power switch (JHT) 2. Car door panel must be freely closed/opened by hand, replace if it is stuck	Responsible field staffs	L - 1 time per 6 months
			6	Misaligned SW lock roller of landing door	5	During corrective maintenance and preventive maintenance only	10	300	1. Move car by inspection control to verify reference line with SW lock roller 2. Measure equality and use hand to check tension of car roller 3. Readjust SW lock roller if it is misaligned with reference line	Responsible field staffs	M - 1 time per 3 months
			6	SW lock roller is worn out/broken	3	During corrective maintenance and preventive maintenance only	10	180	Visual check appearance of SW lock roller, replace if it is worn out/broken	Responsible field staffs	L - 1 time per 6 months

			6	Worn out car guide rollers	2	During corrective maintenance and preventive maintenance only	10	120	Use hand to check tension of car door roller and also measure distance between upright and car guide rail must be equal left and right sides, readjust if requires	Responsible field staffs	L - 1 time per 6 months
			6	Hook limit roller worn out	4	During corrective maintenance and preventive maintenance only	10	240	Visual check appearance of hook limit roller	Responsible field staffs	M - 1 time per 3 months
840	NGT 24VDC Over 5% Limit	- LOP/COP button cannot register a call	4	Direct current voltage of car door power supply is over 24VDC by 5%	2	During corrective maintenance and preventive maintenance only	10	80	Use multi-metre to measure direct current voltage (VDC) of car door power supply, replace if it is lower than 22.8 VDC or higher than 25.2 VDC	Responsible field staffs	L - 1 time per 6 months
841	NGT 24 VDC Under 5% Limit	- LOP/COP button cannot register a call	4	Direct current voltage of car door power supply is lower 24VDC by 5%	2	During corrective maintenance and preventive maintenance only	10	80	Use multi-metre to measure direct current voltage (VDC) of car door power supply, replace if it is lower than 22.8 VDC or higher than 25.2 VDC	Responsible field staffs	L - 1 time per 6 months

842	NGT 24 VDC Over 10% Limit	- LOP/COP button cannot register a call	4	Direct current voltage of car door power supply is over 24VDC by 10%	2	During corrective maintenance and preventive maintenance only	10	80	Use multi-metre to measure direct current voltage (VDC) of car door power supply, replace if it is lower than 22.8 VDC or higher than 25.2 VDC	Responsible field staffs	L - 1 time per 6 months
843	NGT 24VDC Under 10% Limit	- LOP/COP button cannot register a call	4	Direct current voltage of car door power supply is under 24VDC by 10%	2	During corrective maintenance and preventive maintenance only	10	80	Use multi-metre to measure direct current voltage (VDC) of car door power supply, replace if it is lower than 22.8 VDC or higher than 25.2 VDC	Responsible field staffs	L - 1 time per 6 months
844	ePower Door Off	- LOP/COP button cannot register a call - Elevator emergency stops during normal running	8	Car door power switch failure	2	During corrective maintenance and preventive maintenance only	10	160	Try to turn off and turn on car door power switch and check lighting status of car door from HMI, replace if it is not functioned properly	Responsible field staffs	L - 1 time per 6 months
850	eOver Voltage	- Door close/open very slow sometimes	3	Worn out car door rubber stopper	4	During corrective maintenance and preventive maintenance only	10	120	Visual check appearance of car door rubber, replace if it is worn out	Responsible field staffs	L - 1 time per 6 months

1301	CAN Missing Node	- LOP button cannot register a call - Elevator emergency stops during normal running	8	Car door drive is defective	2	During corrective maintenance and preventive maintenance only	10	160	1. Turn off car door power switch 2. Car door panel must be freely closed/opened by hand, replace if it is stuck	Responsible field staffs	L - 1 time per 6 months
-	Customer complaint	- Door panel is shaking while elevator running	3	Missing car door shoes	8	During corrective maintenance and preventive maintenance only	10	240	1. Visual check number of car door shoes 2. Install new car door shoe if old car door shoe is missing	Responsible field staffs	M - 1 time per 3 months
			3	Car door shoe worn out	8	During corrective maintenance and preventive maintenance only	10	240	Push car door panel and use filler gauge thickness 1 mm insert between car door shoes and car door sill, replace if movement is over 1 mm	Responsible field staffs	M - 1 time per 3 months
		- Door close with noise	3	Car door panel rubber stopper is missing/ worn out	5	During corrective maintenance and preventive maintenance only	10	150	Visual check appearance of car door panel rubber stopper, replace if it is missing/worn out	Responsible field staffs	L - 1 time per 6 months

			3	Landing door panel rubber stopper is missing/ worn out	5	During corrective maintenance and preventive maintenance only	10	150	Visual check appearance of landing door panel rubber stopper, replace if it is missing/ worn out	Responsible field staffs	L - 1 time per 6 months
			3	Landing door rubber stopper is missing/ worn out	5	During corrective maintenance and preventive maintenance only	10	150	Visual check appearance of landing door rubber stopper, replace if it is missing/ worn out	Responsible field staffs	L - 1 time per 6 months
			5	Misaligned SW lock roller of landing door	6	During corrective maintenance and preventive maintenance only	10	300	1. Move car by inspection control to verify reference line with SW lock roller 2. Measure equality and use hand to check tension of car roller 3. Readjust SW lock roller if it is misaligned with reference line	Responsible field staffs	M - 1 time per 3 months
		- Scratch on car door panel	2	Car door panel is hit by user	8	During corrective maintenance and preventive maintenance only	10	160	Visual check appearance of car door panel, clean and adjust if necessary	Responsible field staffs	L - 1 time per 6 months

		- Scratch on landing door panel	2	Landing door panel is hit by user	8	During corrective maintenance and preventive maintenance only	10	160	Visual check appearance of landing door panel, clean and adjust if necessary	Responsible field staffs	L - 1 time per 6 months

Appendix G

Table 33: Landing door components

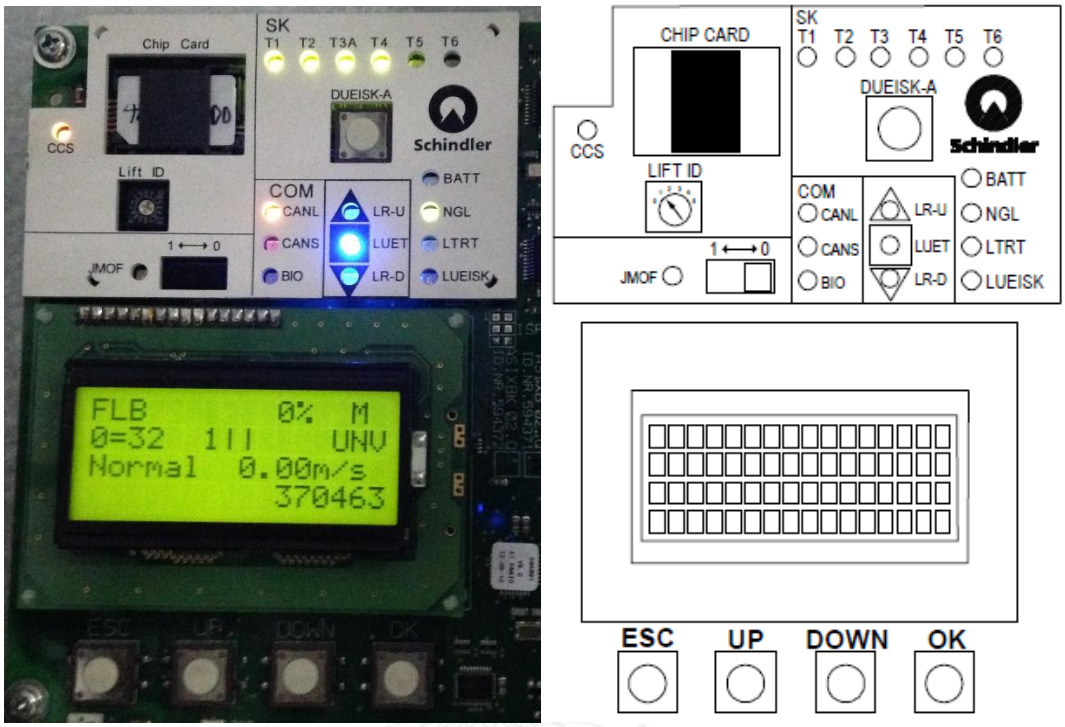
Landing door				
No.	**Component type**	**Component name**	**ID number**	**Technical document**
1	Mechanic	Track	56302814	EJ 41350877
2	Mechanic	Landing door transmission cable for door open = 900 mm	59350867	EJ 41350877
3	Mechanic	Landing door transmission cable for door open = 1000 mm	59350868	EJ 41350877
4	Mechanic	Upper roller	59352108	EJ 41350877
5	Mechanic	Bottom roller	59352109	EJ 41350877
6	Mechanic	Rubber stopper	59350870	EJ 41350877
7	Mechanic	SW lock roller	59352111	K 43402071 EJ 41350877
8	Mechanic	Hook limiter	59352112	EJ 41350877
9	Mechanic	Triangle unlocking device	57618115	EJ 41350877
10	Mechanic	Closing spring cable	59352113	EJ 41350877
11	Mechanic	Landing door panel	56302814	EJ 41350877
12	Mechanic	Landing sill for centre door open = 900 mm	59350873	EJ 41350877
13	Mechanic	Landing sill for centre door open = 1000 mm	59350874	EJ 41350877
14	Mechanic	Landing guide shoes	59350871	EJ 41350877
15	Mechanic	Landing door panel rubber stopper	59352122	EJ 41350877
16	Electric	Landing door contact bridge	51907562	EJ 41350877
17	Electric	Landing door contact housing	51907563	EJ 41350877

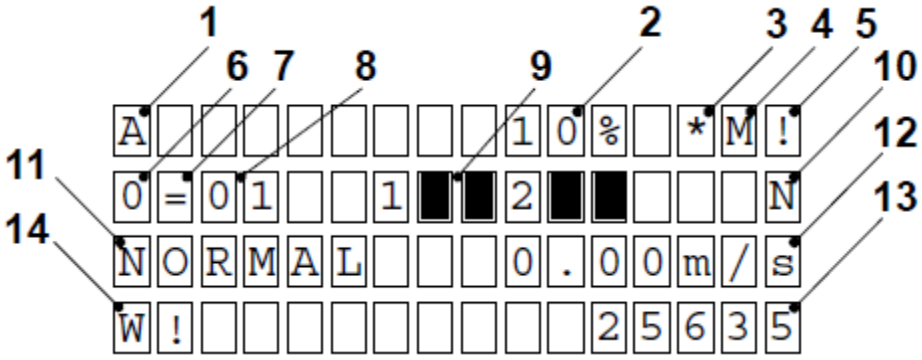
Table 34: Car door components

Car door				
No.	**Component type**	**Component name**	**ID number**	**Technical document**
1	Mechanic	Track	59350701	EJ 41350882
2	Mechanic	Car door transmission cable	59350786	EJ 41350882
3	Mechanic	Car door clutch	59350806	EJ 41350882 TT-14-0009
4	Mechanic	Rubber stopper	962052	EJ 41350882
5	Mechanic	Clutch cam	59350533	EJ 41350882 TT-14-0009
6	Mechanic	Carrier roller	57605958	EJ 41350882
7	Mechanic	Tooth belt	59350549	EJ 41350882
8	Mechanic	Car door panel	59352900	EJ 41350882
9	Mechanic	Car door panel rubber stopper	59352122	EJ 41350882
10	Mechanic	Car door sill	59350728	EJ 41350882
11	Mechanic	Car guide shoes	59300308	EJ 41350882
12	Electric	Car door drive	59350600	EJ 41350882 K 40700050
13	Electric	Power switch	59350784	EJ 41350882 EJ 41350884
14	Electric	Power supply	59350751	EJ 41350882 EJ 41350884
15	Electric	Human machine interface	59350643	EJ 41350882 EJ 41350884 K 40700050
16	Electric	Car door contact bridge for KTC, KTC2, KET-S2	966843	EJ 41350882 EJ 41350884
17	Electric	Car door contact housing for KTC, KTC2, KET-S2	969517	EJ 41350882 EJ 41350884
18	Electric	Light curtain	59341612	EJ 41350882 EJ 41350884

Appendix H

Troubleshooting manual





ตำแหน่ง (Position)	คำอธิบาย (Description)
1	ชื่อลิฟต์ในกลุ่ม Elevator designation within group
2	สถานะของเซ็นเซอร์เช็คน้ำหนักบรรทุกในลิฟต์: Load Measuring Sensor status: • CAL = ต้องปรับแต่งเซ็นเซอร์เช็คน้ำหนักใหม่ (LMS requires calibration) • UNV = เซ็นเซอร์เช็คน้ำหนักบรรทุกไม่ปรากฏ (LMS is unavailable) • DIS = ปิดการใช้งานเซ็นเซอร์เช็คน้ำหนักบรรทุก (LMS is disabled) • xx % = แสดงน้ำหนักบรรทุกเป็น % ของน้ำหนักบรรทุกสูงสุดที่รองรับได้ (Car load in % of rated load) • CALF = ต้องการเช็คน้ำหนักบรรทุกเปล่าทุกชั้น (missing floor dep. Zero load calibration)
3	สถานะเซอร์วิสวิสิตของลิฟต์) "*"กระพริบ หมายถึง เซอร์วิสวิสิตกำลังทำงานอยู่ Status service visit (blinking "*" if service visit is active, blank if service visit is inactive)
4	สถานะลิฟต์ตัวแม่ ("M" = ลิฟต์ตัวแม่(ฟต์ตัวแม่ว่างเปล่า หมายถึงไม่ใช่ลิ , Status master ("M" = this elevator is group master, blank if this elevator is not group master)
5	สถานะโหนดของลิฟต์: "%" กระพริบ หมายถึง ซอฟต์แวร์ของลิฟต์กำลังดาวน์โหลดข้อมูลอยู่ "?" ติดค้าง หมายถึง ต้องทำการฟรีซโหนดใหม่ "?" กระพริบ หมายถึง ลิฟต์กำลังฟริซโหนดอยู่ "!" กระพริบ หมายถึง Status node tree: Blinking "%" Node SW download in progress "?" Node tree freeze required Blinking "?" Executing node tree freeze Blinking "!" Nod tree freeze not successful

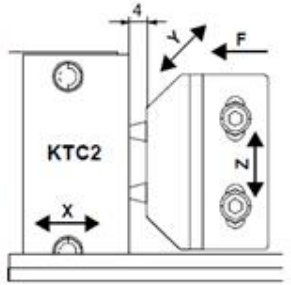
ตำแหน่ง (Position)	คำอธิบาย (Description)
	"!" Missing or new nodes found after freeze Blank Freeze completed and no changes on node Tree
6	สถานะของไดรฟ: 0 คือไดรฟอยู่กับที่ + คือไดรฟกำลังสั่งให้ลิฟต์เคลื่อนที่ด้วยความเร่ง = คือไดรฟกำลังสั่งให้ลิฟต์เคลื่อนที่ด้วยความเร็วคงที่ - คือไดรฟกำลังสั่งให้ลิฟต์เคลื่อนที่ด้วยความหน่วง F คือไดรฟไม่ปรากฏ ? คือไม่รู้สถานะไดรฟ Status drive: 0 Drive at standstill + Drive accelerating = Drive traveling at constant speed - Drive decelerating F Drive not available ? Unknown drive status
7	สถานะของตัวลิฟต์: = คือลิฟต์อยู่เสมอชั้น # คือลิฟต์อยู่นอกชั้น ↑ คือลิฟต์กำลังเคลื่อนที่ขึ้น ↓ คือลิฟต์กำลังเคลื่อนที่ลง ? คือไม่รู้สถานะของลิฟต์ Status car: = Car is at standstill within the door zone # Car is at standstill outside the door zone ↑ Car is traveling up ↓ Car is traveling down

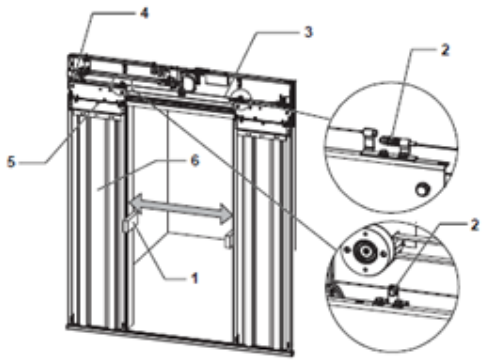
ตำแหน่ง (Position)	คำอธิบาย (Description)
	? Unknown car status
8	ตำแหน่งชั้นของตัวลิฟต์ Current group selector value (1 ... n)
9	สถานะของประตู: Status door:  1 ประตูด้านที่ 1 หรือ 2 (1 Door side) 2 ประตูเปิด (2 Door open) 3 ประตูกำลังปิด (3 Door closing) 4 ประตูกำลังเปิด (4 Door opening) 5 ประตูปิด (5 Door closed) 6 ประตูปิดสุดและล็อคแล้ว (6 Door locked) 7 ประตูหยุด (7 Door stopped) 8 ไม่รู้สถานะประตู (Status unknown)
10	สถานะ ตัวสั่งการทำงานของลิฟต์ (Control status) เช่น N = ปกติ (Normal) JAB = ปิดลิฟต์ (Out of service) JBF = ไฟไหม้ (Fire evacuation) UNV = ลิฟต์ไม่พร้อมใช้งาน (Unavailable)
11	สถานะ การควบคุมการเคลื่อนที่ของลิฟต์ (Status travel control) เวลาที่ลิฟต์เสีย error code จะถูกแสดงขึ้นดังนี้ (When in error condition, the error code is displayed alternating with the status.) BlkTemp: คอนโทรลลิฟต์จะหยุดชั่วขณะจาก error ที่เกิดขึ้น (Control temporarily blocked by an error)

ตำแหน่ง (Position)	คำอธิบาย (Description)
	BlKPerm: คอนโทรลลิฟต์จะหยุดถาวรจาก error ที่เกิดขึ้น (Control permanently blocked by a fatal error) Control: คอนโทรลกำลังสั่งให้ลิฟต์วิ่งขึ้นไปชั้นบนสุดหรือลงไปชั้นล่างสุด (Control performing a travel triggered by DFM-D/U) T1Open: ชุดวงจรเซฟตี้ตัวที่ 1 เปิด (Safety circuit open at T1) T2Open: ชุดวงจรเซฟตี้ดตัวที่ 2 เปิด Safety circuit open at T2 T3AOpen: ชุดวงจรเซฟตี้ตัวที่ 3A เปิด (Safety circuit open at T3A) T3BOpen: ชุดวงจรเซฟตี้ตัวที่ 3B เปิด (Safety circuit open on elevator car) T4Open: ชุดวงจรเซฟตี้ตัวที่ 4 เปิด (Safety circuit open at T4) T5Open: ชุดวงจรเซฟตี้ตัวที่ 5 เปิด (Safety circuit open at T5) T6Open: ชุดวงจรเซฟตี้ตัวที่ 6 เปิด (Safety circuit open at T6) JHM On: ปุ่ม stop มอเตอร์ถูกกดอยู่ (Control stopped by JHM) JHC On: ปุ่ม stop หลังคาลิฟต์ถูกกดอยู่ (Control stopped by JHC) JHC1 On: ปุ่ม stop หลังคาลิฟต์ตำแหน่งที่ 2 ถูกกดอยู่ (Control stopped by JHC1) FC_NRdy: ไดรฟไม่พร้อมให้ลิฟต์เคลื่อนที่ (Frequency control not ready for travel) DoorByp: มีการลัดวงจรเซฟตี้ประตูนอก (Landing door bypass active) KTHMH: มอเตอร์มีอุณหภูมิสูงเกิน (Hoisting motor over temperature) VFOvTmp: ไดรฟมีอุณหภูมิสูงเกิน (Frequency converter over temperature) Lift24V: ขาดแหล่งจ่ายไฟกระแสตรง 24 โวลต์ (Lack of 24 VDC supply) SB Fault: คอนโทรลลิฟต์หยุดเนื่องจากเบรก คอนแทคเตอร์ (Control stopped by a failure on brake contactor) LMSnRdy: เซ็นเซอร์เช็คน้ำหนักลิฟต์ยังไม่พร้อมใช้งาน (Load measurement system not ready) Correct: ลิฟต์กำลังเคลื่อนที่เพื่อให้เสมอชั้น (Elevator performing a correction travel)

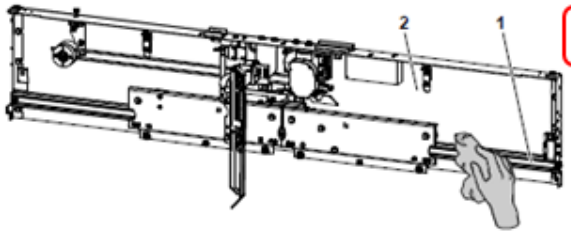
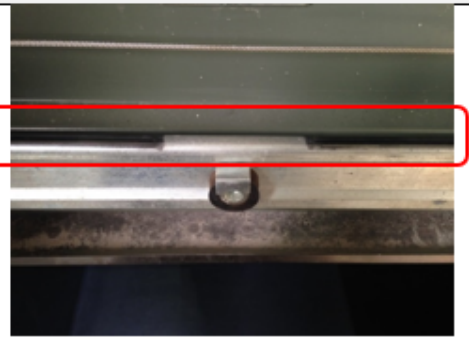
ตำแหน่ง (Position)	คำอธิบาย (Description)
	PEBOFlt: อุปกรณ์ปลดเบรคไม่สามารถใช้งานได้ (Fault has occurred on PEBO device) Creep: คอนโทรลสั่งให้ลิฟต์วิ่งครบรอบโดยการควบคุมจากตัวควบคุมความเร็ว (Control completing a travel with the speed encoder) BatFlt: แบตเตอรี่ (Fault occurred on emergency supply battery) Ovrload: น้ำหนักในตัวลิฟต์เกิน (Elevator in overload status) AccTBlk: ลิฟต์ไม่สามารถวิ่งได้หลังการทดสอบลิฟต์ (Elevator blocked after acceptance test) BMIni: กำลังรอการค้นหาการทำงานของเบรค (Brake emergency stop monitor awaits initialization) BMErr: ตัวเช็คการทำงานของเบรคกำลังทำงานอยู่ (Brake emergency stop monitor triggered) PeboBat: แบตเตอรี่สำหรับปลดเบรคไฟฟ้าเวลาลิฟต์ค้างไม่เสมอชั้น หมด (Manual evacuation battery exhausted)
12	แสดงความเร็วของลิฟต์: หรือจะแสดง error เมื่อมี error ที่เกี่ยวกับความเร็ว Traveling speed: When in error condition, the motor control status is shown alternating with the error code.
13	• ระหว่างที่ลิฟต์ถูกใช้งานทั่วไป: ค่าจากตัวนับจำนวนครั้งการวิ่งของลิฟต์จะถูกเก็บไว้ในชิปการ์ดทุกวัน (During normal operation: Value of the traction media trip counter. The value is stored daily on the chip card.) • หลังจากไฟดับเป็นเวลานาน: ตัวนับจำนวนครั้งการวิ่งของลิฟต์จะนับต่อจากค่าสุดท้ายที่เก็บไว้ในชิปการ์ด After long power failure: The trip counter re-starts at the last value stored on the chip card. • หลักจากมีการเปลี่ยนปริ้นท์ยกเว้นปริ้นท์ CPUCF: ค่าความจำ จำนวนครั้งการวิ่งของลิฟต์ After replacement of a PCBA (other than the CPUCF): The memory of the trip counter is stored on CPUCF.

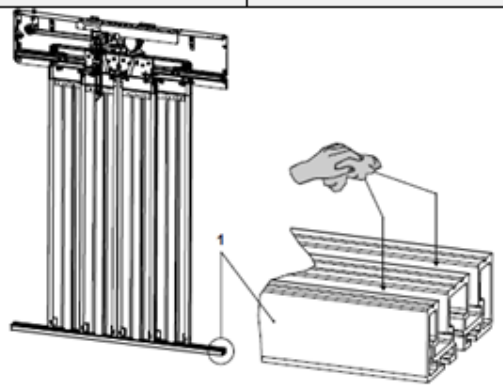
ตำแหน่ง (Position)	คำอธิบาย (Description)
	Replacement of any other PCBA is therefore irrelevant for the correct functioning of the trip counter. ● After replacement of the CPUCF: The counter of the new CPUCF compares the trip counter value stored on the chip card. – If the commissioning number of the new CPUCF and the existing chip card is identical: The trip counter is restarted with the bigger value. – If the commissioning number of the new CPUCF and the existing chip card is not identical: The trip counter is restarted with the chip card value. – If a new chip card with identical commissioning number is downloaded: The data backup area of the chip card is stored, the new content is downloaded and the backup data is then re-stored.
14	ตัวนับจำนวนเที่ยวการวิ่งของลิฟต์ (Car trip counter reading)

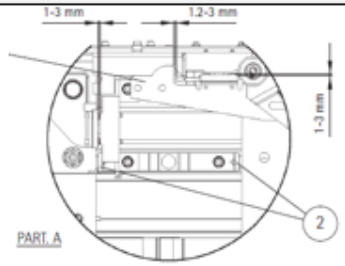
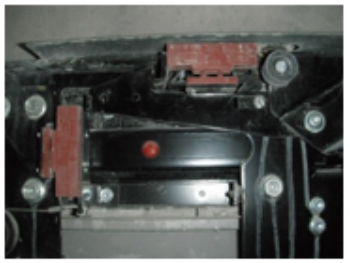
อาการลิฟต์เสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
148	Safety T4	- ประตูในปิดไม่ได้ - Car door cannot close - ลิฟต์ปิดประตูแล้วไม่สามารถออกตัวได้ - Door close but elevator cannot start running - ลิฟต์หยุดกะทันหันขณะวิ่ง - Elevator emergency stops during normal running	1.1 คอนแทคประตูใน (KTC) เสื่อม/หัก 1.1 worn out/broken KTC	1. สังเกตว่า KTC และKTC2 อยู่ในสภาพดี เปลี่ยนทันทีถ้าพบว่าเสื่อมสภาพแล้ว 1. Visual check appearance of KTC and KTC2, replace if it is worn out
			1.2 ระยะคอนแทคประตูใน (KTC) ไม่ถูกต้อง 1.2 Misaligned KTC	1. สังเกตว่า KTC และ KTC2 อยู่ตรงกลางเมื่อประตูในปิดสุด 1. Visual check alignment of KTC and KTC2 when car door is fully closed 2. วัดระยะระหว่างคอนแทคตัวผู้-ตัวเมีย = 4 มม. 2. Measure distance between KTC contact housing and contact bridge = 4 mm, adjust if distance is wrong
			   Contact housing (ตัวเมีย) ID No. = 969517 Contact bridge (ตัวผู้) ID No. = 966843 เอกสารอ้างอิง Reference document EJ 41350882	

อาการลิฟต์เสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
			1.3 สลิงเซ็นเตอร์ประตูในหย่อน/แตก 1.3 Car door transmission cable is too loose/damaged	1. สังเกตว่าสลิงเซ็นเตอร์ ประตูในอยู่ในสภาพดี เปลี่ยนเมื่อพบรอยแตก 1. Visual check appearance of car door transmission cable, replace if it is damaged 2. ใช้มือกดลงบนสลิงเซ็นเตอร์ประตูในว่าต้องมีความตึงที่เหมาะสม 2. Use hand to press on car door transmission cable, adjust if it is too tight or too loose
				

อาการสิ้นสุดเสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
			  Transmission cable C2/C4 V35 ID No.= 59350786	
			1.5 มีการสะสมของซิ้โรลเลอร์บนรางเฮดเดอร์ประตูใน 1.5 Rubber from carrier roller is stuck on car door track	1. ตรวจสอบความสะอาดบนรางเฮดเดอร์ประตูใน 1. Visual check cleanliness of car door track 2. ใช้ของมีคม(ฟุตเหล็ก)และผ้าทำความสะอาดซิ้โรลเลอร์ออกจากรางเฮดเดอร์ประตูใน 2. Use sharp tool (steel ruler) and rag to clean on car door track if it is dirty

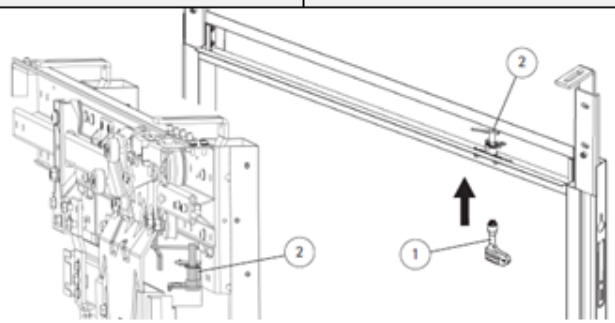
อาการลิฟต์เสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
			  เอกสารอ้างอิง Reference document EJ 41350882	
			1.6 ขยะติดร่องชิลประตูใน 1.6 Rubbish is stuck inside car door sill	1. ตรวจสอบความสะอาดที่ร่องชิลประตูใน 1. Visual check cleanliness of car door sill 2. ใช้ผ้าหรือเครื่องดูดฝุ่นทำความสะอาดร่องชิลประตูใน 2. Use rag or vacuum cleaner to clean car door sill if it is dirty

อาการลิฟต์เสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
			 เอกสารอ้างอิง Reference document EJ 41350882	
149	Safety T5 Extra info = elevator position	- ประตูนอกปิดไม่ได้ - Landing door cannot close - ลิฟต์ปิดประตูแล้วไม่สามารถออกตัวได้ - Door close but elevator cannot start running - ลิฟต์หยุดกะทันหันขณะวิ่ง - Elevator emergency stops during normal running	2.1 คอนแทคประตูนอกเสื่อม/หัก 2.1 Worn out/broken KTS	1. สังเกตว่า KTS อยู่ในสภาพดี เปลี่ยนถ้าพบว่าเสื่อมสภาพแล้ว 1. Visual check appearance of KTS, replace if it worn out
			2.2 ระยะคอนแทคประตูนอกไม่ถูกต้อง 2.2 Misaligned KTS	1. สังเกตว่า KTS อยู่ตรงกลาง 1. Visual check alignment of KTS when landing door is fully closed 2. วัดระยะห่างระหว่างคอนแทค 1-3 มม. 2. Measure distance between KTS contact housing and contact bridge = 1-3 mm, adjust if distance is wrong

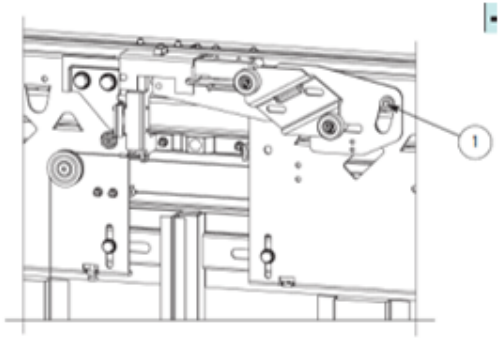
อาการลิฟต์เสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
			  Landing door contact bridge ID No.= 51907562 Landing door contact housing ID No. = 51907563 เอกสารอ้างอิง Reference document EJ41350877	
			2.3 สปริงปิดประตูนอก (self-close) เสื่อมสภาพ/ขาด 2.3 Landing door self-close spring worn out/broken	1. สังเกตว่าสปริงปิดประตูนอกอยู่ในสภาพดี 1. Visual check appearance of landing door self-close spring

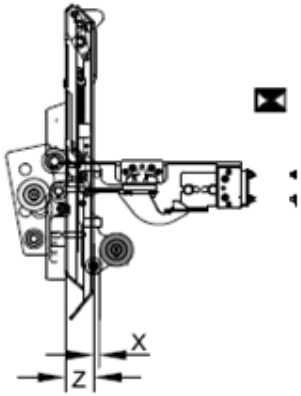
อาการลิฟต์เสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
			 Closing spring ID No. = 59352114	
			2.4 สลิงเซ็นเตอร์ประตูนอกแตก/ขาด 2.4 Landing door transmission cable damaged	1. สังเกตว่าสลิงเซ็นเตอร์ ประตูนอกอยู่ในสภาพดี 1. Visual check appearance of landing door transmission cable
				

อาการลิฟต์เสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
			Landing door transmission cable ID No.= 59350867 for BT 900 (สำหรับประตูเปิด 0.9 m) 59350868 for BT 1000 (สำหรับประตูเปิด 1 m)	
			2.5 มีการสะสมของซี่โรลเลอร์บนรางเฮดเดอร์ประตูนอก 2.5 Rubber from upper roller is stuck on landing door track	1. ตรวจสอบความสะอาดบนรางเฮดเดอร์ประตูนอก 1. Visual check cleanliness of landing door track 2. ใช้ของมีคม(ขุดเหล็ก)และผ้าทำความสะอาดซี่โรลเลอร์ออกจากรางเฮดเดอร์ประตูนอก 2. Use sharp tool (steel ruler) and rag to clean on landing door track if it is dirty
			2.6 ขยะติดร่องซิลประตูนอก 2.6 Rubbish is stuck inside landing door sill	1. ตรวจสอบความสะอาดที่ร่องซิลประตูนอก 1. Visual check cleanliness of landing door sill 2. ใช้ผ้าหรือเครื่องดูดฝุ่นทำความสะอาดร่องซิลประตูนอก 2. Use rag or vacuum cleaner to clean landing door sill if it is dirty
			2.7 กลไกกุญแจประตูนอกค้าง 2.7 Landing door unlocking device is stuck	1. ใช้กุญแจสามเหลี่ยมไขดูการทำงานของประตูนอก 1. Use triangle key to check function of unlocking device

อาการลิฟต์เสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
			 เอกสารอ้างอิง Reference document EJ41350877	
202	Door Operation Error	- ลิฟต์ไม่สามารถใช้งานได้ - Elevator cannot use	3. มอเตอร์ประตูในเสีย 3. Car door drive is defective	1. ปิดสวิทช์ตัดกระแสไฟมอเตอร์ประตูใน 1. Turn off car door power switch 2. ใช้มือลองเลื่อนเปิด/ปิดบานประตูถ้ามีอาการกระตุกระหว่างเปิด/ให้เปลี่ยนโดยทันที 2. Car door panel must be freely closed/opened by hand, replace if it is stuck

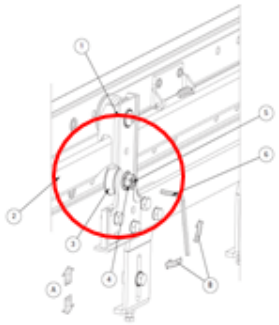
อาการลิฟต์เสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
			 DDE-V35 door drive ID No. = 59350600	
203	Thermo Door Motor	- ลิฟต์ไม่สามารถใช้งานได้ชั่วขณะ - Elevator is temporary unavailable	4.1 ยางรองชุดตอร์ลือคสึกทำให้ฮุกอยู่ตำแหน่งที่สูงเกินเวลากระตกเปิดแล้วติด 4.1 Hook limit roller is worn out	1. ตรวจสอบสภาพยางรองชุดตอร์ลือค 1. Visual check appearance of hook limit roller, replace if it is worn out
			 	

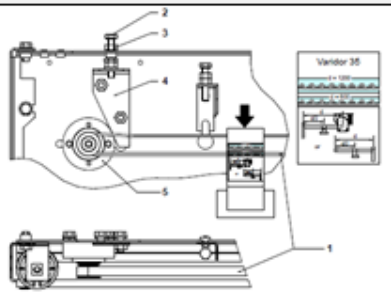
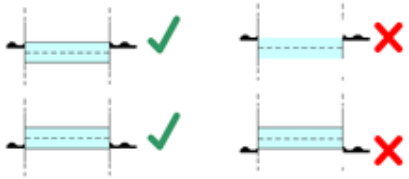
อาการลิฟต์เสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
			 Hook limit roller ID No. = 59352112	
			4.2 ระยะชุดตอร์ล็อคไม่ถูกต้อง 4.2 Misaligned SW lock roller of landing door	1. เคลื่อนลิฟต์ด้วยโหมดสโลว์สปีดเพื่อเทียบระยะจากเส้นอ้างอิงที่ติดไว้บนเฮดเดอร์หลังคากับตอร์ล็อค 1. Move car by inspection control to verify reference line with SW lock roller 2. ปรับชุดตอร์ล็อคเข้าหาเส้นอ้างอิง 2. Readjust SW lock roller if it is misaligned with reference line

อาการลิฟต์เสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
			 X [mm] WIA 15 (C2) / 21 (T2)  เอกสารอ้างอิง Reference document K 43402071	
204	Door Reverse Device Error	- ลิฟต์พยายามปิด/เปิดประตูหลายครั้งแต่หยุดกลางคัน - Elevator close and open door many times but it is stuck in the middle	1.6 ขยะติดร่องชิลประตูใน 1.6 Rubbish is stuck inside car door sill	1. ตรวจสอบความสะอาดที่ร่องชิลประตูใน 1. Visual check cleanliness of car door sill 2. ใช้ผ้าหรือเครื่องดูดฝุ่นทำความสะอาดร่องชิลประตูใน 2. Use rag or vacuum cleaner to clean car door sill if it is dirty
			2.6 ขยะติดร่องชิลประตูนอก 2.6 Rubbish is stuck inside landing door sill	1. ตรวจสอบความสะอาดที่ร่องชิลประตูนอก 1. Visual check cleanliness of landing door sill

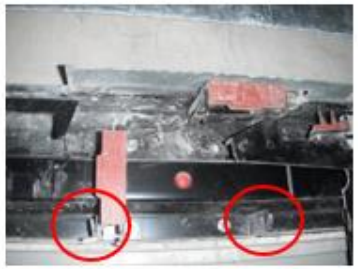
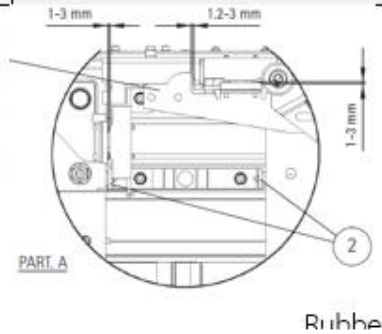
อาการลิฟต์เสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
				2. ใช้ผ้าหรือเครื่องดูดฝุ่นทำความสะอาดร่องชิลประตูนอก 2. Use rag or vacuum cleaner to clean landing door sill if it is dirty
207	Close Sequence Error	- ลิฟต์พยายามปิดประตูหลายครั้งแต่หยุดกลางคัน - Elevator tries to close door many times but it is stuck in the middle	1.6 ขยะติดร่องชิลประตูใน 1.6 Rubbish is stuck inside car door sill	1. ตรวจสอบความสะอาดที่ร่องชิลประตูใน 1. Visual check cleanliness of car door sill 2. ใช้ผ้าหรือเครื่องดูดฝุ่นทำความสะอาดร่องชิลประตูใน 2. Use rag or vacuum cleaner to clean car door sill if it is dirty
			2.6 ขยะติดร่องชิลประตูนอก 2.6 Rubbish is stuck inside landing door sill	1. ตรวจสอบความสะอาดที่ร่องชิลประตูนอก 1. Visual check cleanliness of landing door sill 2. ใช้ผ้าหรือเครื่องดูดฝุ่นทำความสะอาดร่องชิลประตูนอก 2. Use rag or vacuum cleaner to clean landing door sill if it is dirty
208	Door Device Error	- ลิฟต์เปิด/ปิดประตู แล้วหยุดกลางคัน - Door stop moving (close/open) during normal operation	5. ต้องเช็ครหัสความผิดพลาดอื่นประกอบ 5. This error will come with other errors	ต้องตรวจสอบรหัสความผิดพลาดอื่นก่อนหน้า/หลังประกอบด้วย Have to check surrounding error code to further analysis
			3. มอเตอร์ประตูในเสีย 3. Car door drive is defective	1. ปิดสวิทช์ตัดกระแสไฟมอเตอร์ประตูใน 1. Turn off car door power switch 2. ใช้มือลองเลื่อนเปิด/ปิดบานประตูถ้ามีอาการกระตุกระหว่างเปิด/ให้เปลี่ยนโดยทันที

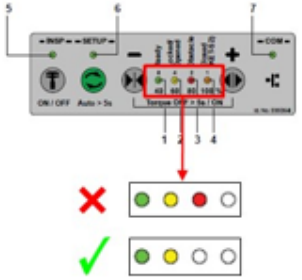
อาการลิฟต์เสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
		- ลิฟต์ไม่สามารถเปิด/ปิดประตูได้ - Elevator cannot open or close door - ลิฟต์วิ่งแล้วหยุดกะทันหัน - Elevator emergency stops during normal running		2. Car door panel must be freely closed/opened by hand, replace if it is stuck
212	Open Sequence KOKB	- ประตูเปิดแล้วติดไม่สามารถเปิดได้สุด - Door is stuck while opening - ประตูไม่สามารถเปิดได้ - Door cannot open	4.1 ยางรองชุดตอร์ล็อคสึกทำให้ฮุกอยู่ตำแหน่งที่สูงเกินเวลากระตกเปิดแล้วติด 4.1 Hook limit roller worn out	ตรวจสอบสภาพยางรองชุดตอร์ล็อค Visual check appearance of hook limit roller, replace if it is worn out
			4.2 ระยะชุดตอร์ล็อคไม่ถูกต้อง 4.2 Misaligned SW lock roller of landing door	1. เคลื่อนลิฟต์ด้วยโหมดสโลว์สปีดเพื่อเทียบระยะจากเส้นอ้างอิงที่ยึดไว้บนเฮดเดอร์หลังคากับตอร์ล็อค 1. Move car by inspection control to verify reference line with SW lock roller 2. ปรับชุดตอร์ล็อคเข้าหาเส้นอ้างอิง 2. Readjust SW lock roller if it is misaligned with reference line
			6.1 ไม่มีช่องว่างระหว่างอัพทัชโรลเลอร์กับแทรคเฮดเดอร์ 6.1 No gap between eccentric roller and landing door track	ใช้มือหมุนอัพทัชโรลเลอร์ที่ตำแหน่งประตูปิดสุดและเปิดสุด ถ้าไม่สามารถหมุนได้ ให้ปรับลูกเบี้ยวอัพทัชโรลเลอร์ที่มีช่องว่างประมาณ 0.5 -1 มม. กับรางเฮดเดอร์

อาการลิฟต์เสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
				Use hand to check playable of eccentric roller. It needs to adjust if it is not playable, gap between eccentric roller and landing door track must be 0.5-1 mm.
			 เอกสารอ้างอิง Reference document EJ41350877	
			6.2 สายพานประตูในหย่อน 6.2 Tension of car door is too loose	ใช้มือกดสายพานประตูใน หรือใช้เครื่องมือวัดความตึงสายพานประตูในวางบนสายพานประตูใน Use hand or belt calibration tool to measure tension of car door belt, adjust if it is too tight or too loose

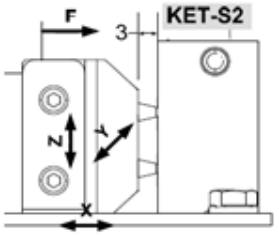
อาการลิฟต์เสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
			  Door calibration tool ID No. = 59351709 เอกสารอ้างอิง Reference document EJ 41350882	
			6.3 แค้มประตูในสกปรก/ฝืด/เสื่อมสภาพ 6.3 Car door clutch is dirty/stuck/ worn out	สังเกตสภาพแค้มประตูว่าอยู่ในสภาพดี Visual check appearance of car door clutch, clean or lubricate if is necessary

อาการลิฟต์เสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
			 Car door clutch without car door lock ID No: 59350806	
			6.4 ลูกยางเซ็นเตอร์ประตูนอกหลุด/สึก 6.4 Landing door rubber stopper is missing/ worn out	1. สังเกตสภาพลูกยางเซ็นเตอร์ประตูนอก เปลี่ยนทันทีถ้าพบว่าหลุด/เสื่อมสภาพแล้ว 1. Visual check appearance of landing door rubber stopper, replace if it is missing/ worn out 2. วัดระยะระหว่างฮุคกับล็อคต้องมีค่าระหว่าง 1.2- 3 มม. 2. Measure distance between hook and lock, it must be between 1.2- 3 mm.

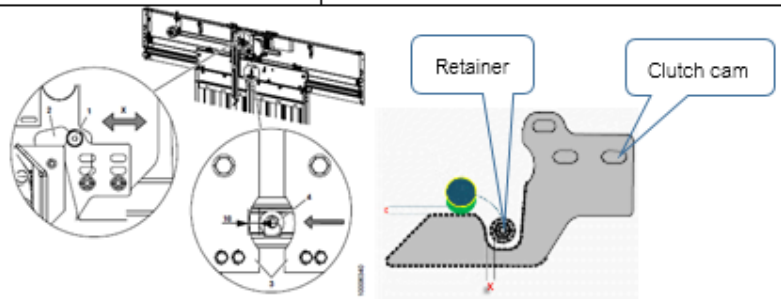
อาการลิฟต์เสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
			 Rubber stopper ID No. = 59350870 เอกสารอ้างอิง Reference document EJ41350877	
214	RPHT Continuous Activation	- ลิฟต์ไม่สามารถปิดประตูได้ - Elevator cannot close door	7. ม่านแสงสกปรก 7. Light curtain is dirty	1. สังเกตว่าไฟสีแดงที่ตำแหน่ง obstacle ของ HMI จะติดแบบกระพริบหรือติดค้าง 1. Visual check red light (obstacle) of HMI will blink or turn on 2. ให้ปิด/เปิดสวิตช์ตัดกระแสไฟมอเตอร์ประตูในแล้วสังเกตว่าไฟสีแดงที่ HMI ยังติดค้างอยู่หรือไม่ 2. Turn off/on power switch (JHT) in order to check obstacle light whether is still active 3. ใช้ผ้าแห้งเช็ดทำความสะอาดม่านแสงและสังเกตดูไฟสีแดงที่ตำแหน่ง obstacle ของ HMI ต้องดับ

อาการสิ้นสุดเสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
				3. Use dry rag to clean light curtain and check whether red light turns off 4. เปลี่ยนม่านแสงประตูในใหม่ถ้าพบว่ายังติดค้างอยู่ 4. Light curtain has to be replaced, if obstacle light is still active
			 Light curtain ID No. = 59341612	
217	KSKB Continuous Activation	- ประตูปิดแล้วติดไม่สามารถปิดได้สุด - Door is stuck while closing	1.6 ขยะติดร่องซิลประตูใน 1.6 Rubbish is stuck inside car door sill	1. ตรวจสอบความสะอาดที่ร่องซิลประตูใน 1. Visual check cleanliness of car door sill 2. ใช้ผ้าหรือเครื่องดูดฝุ่นทำความสะอาดร่องซิลประตูใน 2. Use rag or vacuum cleaner to clean car door sill if it is dirty

อาการลิฟต์เสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
			2.6 ขยะติดร่องซิลประตูนอก 2.6 Rubbish is stuck inside landing door sill	1. ตรวจสอบความสะอาดที่ร่องซิลประตูนอก 1. Visual check cleanliness of landing door sill 2. ใช้ผ้าหรือเครื่องดูดฝุ่นทำความสะอาดร่องซิลประตูนอก 2. Use rag or vacuum cleaner to clean landing door sill if it is dirty
			6.2 สายพานประตูในหย่อน 6.2 Tension of car door belt is too loose	ใช้มือกดสายพานประตูใน หรือใช้เครื่องมือวัดความตึงสายพานประตูในวางบนสายพานประตูใน Use hand or belt calibration tool to measure tension of car door belt, adjust if it is too tight or too loose
252	Door Unavailable	- ลิฟต์ไม่รับคำสั่งปุ่มกดเรียกชั้นในลิฟต์และหน้าชั้น - COP/LOP button cannot register a call	3. มอเตอร์ประตูในเสีย 3. Car door drive is defective	1. ปิดสวิทช์ตัดกระแสไฟมอเตอร์ประตูใน 1. Turn off car door power switch 2. ใช้มือลองเลื่อนเปิด/ปิดบานประตูถ้ามีอาการกระตุกระหว่างเปิด/ให้เปลี่ยนโดยทันที 2. Car door panel must be freely closed/opened by hand, replace if it is stuck
709	Safety Circuit	- ลิฟต์ไม่สามารถออกตัวได้ - Elevator cannot start a trip - ลิฟต์วิ่งแล้วหยุดกะทันหัน	8. ไดรฟตรวจพบว่าวงจรเซฟตี้เซอร์กิตต่อไม่สมบูรณ์ 8. This error generate from drive side, so we have to check with other errors	ต้องตรวจสอบรหัสความผิดพลาดอื่นก่อนหน้า/หลังประกอบด้วย เช่น รหัสความผิดพลาด 148, 149 Have to check surrounding error code to further analysis such as error 148, 149

อาการลิฟต์เสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
		- Elevator emergency stops during normal running		
832	wKET-S2 Failure	- ลิฟต์ปิดประตูแล้วไม่สามารถออกตัวได้ (สัญญาณปิดสุดบนหน้าจอ SM LCD ไม่มี) - Door close but elevator cannot start running (No fully-closed symbol on SM LCD) - ลิฟต์หยุดกะทันหันขณะวิ่ง - Elevator emergency stops during normal running	9.1 คอนแทคสัญญาณประตูปิดสุด (KET-S2) เสื่อม 9.1 KET-S2 worn out/broken	สังเกตว่าอยู่สภาพดีหรือไม่, เปลี่ยนทันทีถ้าพบว่าเสื่อมสภาพแล้ว Visual check appearance of KET-S2, replace if it worn out
			9.2 คอนแทคสัญญาณประตูปิดสุด (KET-S2) ไม่ได้ระยะที่ถูกต้อง 10.2 Misaligned KET-S2	1. สังเกตว่า KET-S2 อยู่ตรงกลางเมื่อประตูในปิดสุด 1. Visual check alignment of KET-S2 when car door is fully closed 2. วัดระยะระหว่างคอนแทคตัวผู้-ตัวเมีย = 3 มม., ปรับทันทีถ้าพบว่าระยะไม่ถูกต้อง 2. Measure distance between KET-S2 contact housing and contact bridge = 4 mm, adjust if distance is wrong
			  เอกสารอ้างอิง Reference document EJ 41350882, EJ 41350884	

อาการลิฟต์เสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
834	wMotor Over Temperature	- ลิฟต์ไม่รับคำสั่งปุ่มกดในลิฟต์และหน้าชั้น - LOP button cannot register a call	3. มอเตอร์ประตูในเสีย 3. Car door drive is defective	1. ปิดสวิทช์ตัดกระแสไฟมอเตอร์ประตูใน 1. Turn off car door power switch 2. ใช้มือลองเลื่อนเปิด/ปิดบานประตูถ้ามีอาการกระตุกระหว่างเปิด/ให้เปลี่ยนโดยทันที 2. Car door panel must be freely closed/opened by hand, replace if it is stuck
			4.2 ระยะชุดดอร์ล็อคไม่ถูกต้อง 4.2 Misaligned SW lock roller of landing door	1. เคลื่อนลิฟต์ด้วยโหมดสโลว์สปีดเพื่อเทียบระยะจากเส้นอ้างอิงที่ยึดไว้บนเฮดเดอร์หลังตากับดอร์ล็อค 1. Move car by inspection control to verify reference line with SW lock roller 2. ปรับชุดดอร์ล็อคเข้าหาเส้นอ้างอิง 2. Readjust SW lock roller if it is misaligned with reference line
838	eLocking Jam	- ประตูไม่สามารถปิดได้ - Door cannot close	3. มอเตอร์ประตูในเสีย 3. Car door drive is defective	1. ปิดสวิทช์ตัดกระแสไฟมอเตอร์ประตูใน 1. Turn off car door power switch 2. ใช้มือลองเลื่อนเปิด/ปิดบานประตูถ้ามีอาการกระตุกระหว่างเปิด/ให้เปลี่ยนโดยทันที 2. Car door panel must be freely closed/opened by hand, replace if it is stuck

อาการลิฟต์เสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
			11. ระยะระหว่างพลาสติกสีดำประคองคลัชท์ประตูในด้านหลังและแผ่นประคองด้านหลังไม่ถูกต้อง 11. Distance between car door clutch and cam plate is wrong	1. ปิดสวิทช์จ่ายกระแสไฟของมอเตอร์ประตูใน 1. Turn off Power Switch (JHT) 2. ใช้มือลองเลื่อนเปิด/ปิดบานประตูในเพื่อตรวจสอบระยะห่างระหว่าง รีเทนเนอร์ของคลัชท์ประตูในและแผ่นประคองด้านหลังต้องห่างกันประมาณ 2 มม. ตลอดแนว 2. Manually open and close car door panel by hand, there must have gap between retainer of car door clutch and clutch cam about 2 mm.
				

Damaged from user during evacuation without turn off main switch (JH)
ช่วยผู้โดยสารโดยไม่ปิด JH ทำให้ clutch cam โดนชน

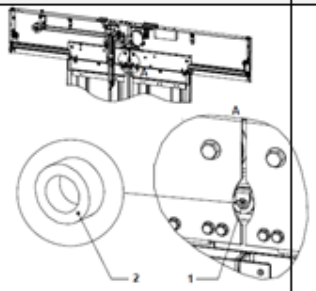
อาการลิฟต์เสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
			  เอกสารอ้างอิง Reference document EJ 41350882, TT-14-0009	
839	eUnlocking Jam	- ประตูไม่สามารถเปิดได้ - Door cannot open	3. มอเตอร์ประตูในเสีย 3. Car door drive is defective	1. ปิดสวิทช์ตัดกระแสไฟมอเตอร์ประตูใน 1. Turn off car door power switch 2. ใช้มือลองเลื่อนเปิด/ปิดบานประตูถ้ามีอาการกระตุกระหว่างเปิด/ให้เปลี่ยนโดยทันที 2. Car door panel must be freely closed/opened by hand, replace if it is stuck
			4.2 ระยะชุดตอร์ล็อคไม่ถูกต้อง 4.2 Misaligned SW lock roller of landing door	1. เคลื่อนลิฟต์ด้วยโหมดสโลว์สปีดเพื่อเทียบระยะจากเส้นอ้างอิงที่ยึดไว้บนเฮดเดอร์หลังคากับตอร์ล็อค 1. Move car by inspection control to verify reference line with SW lock roller

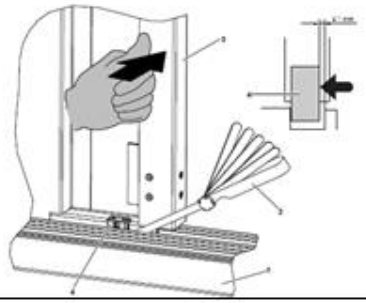
อาการลิฟต์เสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
				2. ปรับชุดดอร์ล็อคเข้าหาเส้นอ้างอิง 2. Readjust SW lock roller if it is misaligned with reference line
			12.1ลูกล้อดอร์ล็อคสึก/แตก 12.1 SW lock roller is worn out/broken	สังเกตว่าลูกล้อดอร์ล็อคอยู่ในสภาพดี เปลี่ยนทันทีถ้าพบว่าเสื่อมสภาพแล้ว Visual check appearance of SW lock roller, replace if it is worn out/broken
			 SW lock roller ID No.= 59352111	
			12.2 โรลเลอร์ลิฟต์เสื่อมสภาพ 12.2 Worn out Car guide rollers	1. ใช้มือหมุนโรลเลอร์บนหลังคาลิฟต์ทั้งด้านซ้ายและด้านขวาพร้อมทั้งเช็คระยะจากอัพโรท์ถึงหน้ารางทั้งด้านซ้ายและด้านขวาต้องแบ่งเท่าๆกัน, ปรับแต่งใหม่ทันที ถ้าพบว่าไม่เท่ากัน

อาการลิฟต์เสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
				Use hand to check tension of car door roller and also measure distance between upright and car guide rail must be equal left and right sides, readjust if requires
			6.2 ยางรองชุดดอร์ล็อคสึกทำให้ฮุกอยู่ตำแหน่งที่สูงเกินเวลากระตกเปิดแล้วติด 6.2 Hook limit roller worn out	ตรวจสอบสภาพยางรองชุดดอร์ล็อค Visual check appearance of hook limit roller
840	NGT 24VDC Over 5% Limit	- ลิฟต์ไม่รับคำสั่งปุ่มกดเรียกชั้นในลิฟต์และหน้าชั้น - LOP/COP button cannot register a call	13. ความต่างศักย์หม้อแปลงประตูในสูงเกิน 24VDC 5% 13. Direct current voltage of car door power supply is over 24VDC by 5%	ใช้มัลติมิเตอร์วัดความต่างศักดิ์กระแสตรง ต้องมีค่าไม่ต่ำกว่า 22.8 VDC และไม่สูงกว่า 25.2 VDC ถ้าเกินค่าที่กำหนด ให้เปลี่ยนหม้อแปลงประตูในใหม่ Use multi-metre to measure direct current voltage (VDC) of car door power supply, replace if it is lower than 22.8 VDC or higher than 25.2 VDC
841	NGT 24 VDC Under 5% Limit	- ลิฟต์ไม่รับคำสั่งปุ่มกดเรียกชั้นในลิฟต์และหน้าชั้น - LOP/COP button cannot register a call	14. ความต่างศักย์หม้อแปลงประตูต่ำเกิน 24VDC 5% 14. Direct current voltage of car door power supply is lower 24VDC by 5%	ใช้มัลติมิเตอร์วัดความต่างศักดิ์กระแสตรง ต้องมีค่าไม่ต่ำกว่า 22.8 VDC และไม่สูงกว่า 25.2 VDC ถ้าเกินค่าที่กำหนด ให้เปลี่ยนหม้อแปลงประตูในใหม่ Use multi-metre to measure direct current voltage (VDC) of car door power supply, replace if it is lower than 22.8 VDC or higher than 25.2 VDC

อาการลิฟต์เสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
842	NGT 24 VDC Over 10% Limit	- ลิฟต์ไม่รับคำสั่งปุ่มกดเรียกชั้นในลิฟต์และหน้าชั้น - LOP/COP button cannot register a call	15. ความต่างศักย์หม้อแปลงประตูในสูงเกิน 24VDC 10% 15. Direct current voltage of car door power supply is over 24VDC by 10%	ใช้มัลติมิเตอร์วัดความต่างศักย์กระแสตรง ต้องมีค่าไม่ต่ำกว่า 22.8 VDC และไม่สูงกว่า 25.2 VDC ถ้าเกินค่าที่กำหนด ให้เปลี่ยนหม้อแปลงประตูในใหม่ Use multi-metre to measure direct current voltage (VDC) of car door power supply, replace if it is lower than 22.8 VDC or higher than 25.2 VDC
843	NGT 24VDC Under 10% Limit	- ลิฟต์ไม่รับคำสั่งปุ่มกดเรียกชั้นในลิฟต์และหน้าชั้น - LOP/COP button cannot register a call	16. ความต่างศักย์หม้อแปลงประตูต่ำเกิน 24VDC 10% 16. Direct current voltage of car door power supply is under 24VDC by 10%	ใช้มัลติมิเตอร์วัดความต่างศักย์กระแสตรง ต้องมีค่าไม่ต่ำกว่า 22.8 VDC และไม่สูงกว่า 25.2 VDC ถ้าเกินค่าที่กำหนด ให้เปลี่ยนหม้อแปลงประตูในใหม่ Use multi-metre to measure direct current voltage (VDC) of car door power supply, replace if it is lower than 22.8 VDC or higher than 25.2 VDC
				

อาการลิฟต์เสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
			Car Door Power Supply 150W 230VAC/24VDC ID No. = 59350751	
844	ePower Door Off	- ลิฟต์ไม่รับคำสั่งปุ่มกดเรียกชั้นในลิฟต์และหน้าชั้น - LOP/COP button cannot register a call - ลิฟต์วิ่งแล้วหยุดกะทันหัน - Elevator emergency stops during normal running	17. สวิตช์ตัดกระแสไฟมอเตอร์ประตูในเสีย 17. Car door power switch failure	ลองทดสอบปิด/เปิดสวิทช์ตัดกระแสไฟมอเตอร์ประตูใน และสังเกตไฟสถานะการทำงานจากปุ่มควบคุมประตูใน (HMI) เปลี่ยนทันทีถ้าพบว่ามีการทำงานที่ผิดปกติ Try to turn off and turn on car door power switch and check lighting status of car door from HMI, replace if it is not functioned properly
			 Power Switch ID No.= 59350784	
850	eOver Voltage	- ลิฟต์เปิด/ปิดประตูช้าเป็นบางครั้ง	18. สต๊อปเปอร์ลูกยางประตูในสึก 18. Worn out car door rubber stopper	สังเกตว่าสต๊อปเปอร์ลูกยางประตูในอยู่สภาพดี เปลี่ยนทันทีถ้าพบว่าเสื่อมสภาพแล้ว Visual check appearance of car door rubber, replace if it is worn out

อาการลิฟต์เสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
		- Door close/open very slow sometimes	 Rubber stopper ID No. = 962052	
1301	CAN Missing Node	- ลิฟต์ไม่รับคำสั่งปุ่มกดเรียกชั้นในลิฟต์และหน้าชั้น - LOP button cannot register a call - ลิฟต์วิ่งแล้วหยุดกะทันหัน - Elevator emergency stops during normal running	3. มอเตอร์ประตูในเสีย 3. Car door drive is defective	1. ปิดสวิทช์ตัดกระแสไฟมอเตอร์ประตูใน 1. Turn off car door power switch 2. ใช้มือลองเลื่อนเปิด/ปิดบานประตูถ้ามีอาการกระตุกระหว่างเปิด/ให้เปลี่ยนโดยทันที 2. Car door panel must be freely closed/opened by hand, replace if it is stuck
-	ลูกค้าบ่น Customer complaint	- ลิฟต์วิ่งแล้วมีเสียงกระพือจากบานประตู - Door panel is shaking while elevator running	19.1 เกือกประตูในหาย 19.1 Missing car door shoes	1. ตรวจเช็คชูว์ประตูในว่ายังอยู่ครบหรือไม่ 1. Visual check number of car door shoes 2. นำมาใส่ใหม่ ถ้าพบว่าสูญหาย 2. Install new car door shoe if old car door shoe is missing

อาการลิฟต์เสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
			19.2 เกือกประตูในสึก 19.2 Car door shoe worn out	ตรวจเช็คชูว์ประตูในว่ายังอยู่สภาพดี โดยการผลักบานประตูใน แล้วใช้ฟิลเลอร์เกจขนาด 1 มม. เสียบลงที่ชูว์ประตูใน เปลี่ยนทันทีถ้าพบว่าบานประตูเคลื่อนที่ได้เกิน 1 มม. Push car door panel and use filler gauge thickness 1 mm insert between car door shoes and car door sill, replace if movement is over 1 mm
			 	

อาการลิฟต์เสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
			Guide shoe ID No. = 59300308 เอกสารอ้างอิง Reference document EJ 41350882	
		- ประตูปิดเสียงดัง - Door close with noise	19.3 ลูกยางบานประตูในหลุด/เสื่อมสภาพ 19.3 Car door panel rubber stopper is missing/ worn out	ตรวจเช็คสภาพลูกยางบานประตูใน เปลี่ยนทันทีถ้าพบว่าหลุด/เสื่อมสภาพแล้ว Visual check appearance of car door panel rubber stopper, replace if it is missing/worn out
			 Panel rubber stopper ID No.= 59352122	
			19.4 ลูกยางบานประตูนอกหลุด/เสื่อมสภาพ 19.4 Landing door panel rubber stopper is missing/ worn out	สังเกตสภาพลูกยางบานประตูนอก เปลี่ยนทันทีถ้าพบว่าหลุด/เสื่อมสภาพแล้ว

อาการลิฟต์เสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
				Visual check appearance of landing door panel rubber stopper, replace if it is missing/ worn out
			 Panel rubber stopper ID No.= 59352122	
			19.5 ลูกยางเซ็นเตอร์ประตูนอกหลุด/สึก 19.5 Landing door rubber stopper is missing/ worn out	สังเกตสภาพลูกยางเซ็นเตอร์ประตูนอก เปลี่ยนทันทีถ้าพบว่าหลุด/เสื่อมสภาพแล้ว Visual check appearance of landing door rubber stopper, replace if it is missing/ worn out
			4.2 ระยะชุดดอร์ล็อคไม่ถูกต้อง 4.2 Misaligned SW lock roller of landing door	1. เคลื่อนลิฟต์ด้วยโหมดสโลว์สปีดเพื่อเทียบระยะจากเส้นอ้างอิงที่ขีดไว้บนเฮดเดอร์หลังคากับดอร์ล็อค 1. Move car by inspection control to verify reference line with SW lock roller 2. ปรับชุดดอร์ล็อคเข้าหาเส้นอ้างอิง

อาการลิฟต์เสีย (Potential failure modes)		ผลกระทบที่อาจจะเกิดขึ้น (Potential effect of failure)	สาเหตุ (Potential cause/ Mechanism of failure)	การตรวจเช็ค (Detection procedures)
รหัสความผิดพลาด (Error code)	คำอธิบายความผิดพลาด (Error description)			
				2. Readjust SW lock roller if it is misaligned with reference line
			19.7 ประตูในโดนชนจากการใช้งาน 19. 7 Car door panel is hit by user	สังเกตสภาพประตูใน ทำความสะอาด,ปรับทันทีถ้าจำเป็น Visual check appearance of car door panel, clean and adjust if necessary
			19.8 ประตูนอกโดนชนจากการใช้งาน 19.8 Landing door panel is hit by user	สังเกตสภาพประตูนอก ทำความสะอาด,ปรับทันทีถ้าจำเป็น Visual check appearance of landing door panel, clean and adjust if necessary

Appendix I

BCBB elevator – ชุดทดสอบความรู้ Page 1/6

Created by Khatayos Phummanee (Technical & Field Support Department)

27 March 2015

ชื่อ _____ นามสกุล_____ ตำแหน่ง _____

1. ลิฟต์ BCBB ใช้ประตูในรุ่นอะไร

ก. Varidor 30

ข. Fermator

ค. Varidor 35

ง. Sematic

2. ลิฟต์ BCBB ประกอบด้วยแผ่นปริ้นท์หลักๆ อะไรบ้าง

ก. ASIXA, LONIC, GCIO

ข. ASIXB, CANIC, GCIOCF

ค. SMIC, SCPU, SDIC

ง. ผิดทุกข้อ

3. Error code “149” Safety T5 open ของลิฟต์ BCBB มีความหมายว่าอะไร

ก. ปุ่ม Stop หลังคาลิฟต์ถูกกดอยู่

ข. คอนแทคประตูในไม่ต่อ

ค. คอนแทคบัฟเฟอร์ถูกกดอยู่

ง. คอนแทคประตูนอกไม่ต่อ

4. เราจะสามารถเช็ค error ทั้งหมดของลิฟต์ BCBB จากหน้าจอ SMLCD ได้อย่างไร

ก. Login (ABCD) -> Command -> Clr Blocking Err

ข. Errorlog -> Show

ค. Login (ABCD) -> Errorlog -> Show All

ง. Login (ABCD) -> Statistic

5. ถ้าลิฟต์ขึ้น error “212” Open Sequence KOKB เราต้องตรวจเช็คอะไร

ก. VF Drive และ Motor

ข. ปริ้น GCIOCF

ค. ชุด mechanic ประตูในและประตูนอก

ง. สายพาน STM

6. Parameter -> Car -> Final Timer -> 0 Sec มีความหมายว่าอย่างไร

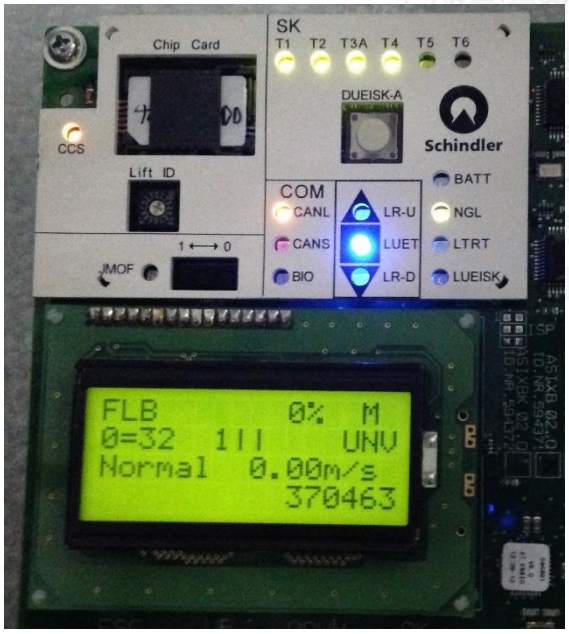
ก. ยกเลิกการทำงานของ Final Timer, ประตูในจะเปิดค้างได้ตลอดเวลาโดยไม่มีเสียงร้องเตือน

ข. ประตูในจะปิดทันทีหลังจากประตูในเปิดสุดแล้ว

ค. ถูกทั้ง ก และ ข

ง. ไม่มีข้อใดถูกต้อง

7. รูปด้านล่างหมายความว่าอะไร



ก. ลิฟต์ใช้งานได้ปกติ

ข. CLC2 (ตัวเช็คน้ำหนักลิฟต์มีปัญหา)

ค. Battery เสื่อม

ง. ประตูใน และ ประตูนอก มีปัญหา

8. ข้อใดกล่าวถูกต้อง

ก. ระยะ KET-S2 = 3 มม. , KTC = 4 มม.

ข. ระยะ KET-S2 = 4 มม. , KTC = 4 มม.

ค. ระยะ KET-S2 = 4 มม. , KTC = 3 มม.

ง. ระยะ KET-S2 = 3 มม. , KTC = 3 มม.

9. ถ้าลิฟต์ขึ้น Error “1301” CAN Missing Node ต้องตรวจสอบอะไรบ้าง

ก. ตรวจเช็ค Extra info ที่มุมขวาของจอ SMLCD เพื่อหาว่าอุปกรณ์ที่สื่อสารด้วย CAN Bus ส่วนใดมีปัญหา

ข. กดปุ่ม Reset แล้วไปซ่อมลิฟต์ที่อื่นต่อ

ค. เปลี่ยนปริ้น BCM ใหม่

ง. เปลี่ยน GCIOCF ใหม่

10. Error “148” Safety T4 Open หมายถึงชุดเซฟตี้จุดไหนไม่ต่อ

ก. ประตูใน

ข. ประตูนอก

ค. ประตูฉุกเฉิน

ง. Stop ก้นบ่อ

11. อุปกรณ์ในรูปนี้เอาไว้ใช้ทำอะไรและเกิดอะไรขึ้น

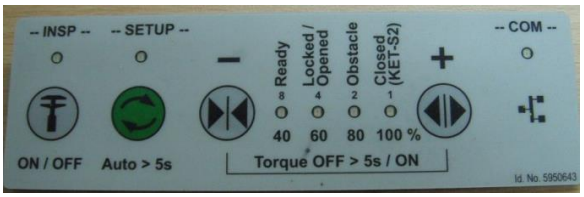
ก. ตัวที่ทำให้แค้มประตูใน ให้หุบและเปิดได้เวลาประตูปิดสุด, โดนกระแทกจากการช่วยผู้โดยสารติดลิฟต์โดยไม่ Off main breaker (JH)

ข. ตัวที่ช่วยประคองแค้มประตูใน, โดนกระแทกจากการเหยียบก่อนก้าวขึ้นหลังคาลิฟต์

ค. ถูกทั้ง ก และ ข

ง. ไม่มีข้อใดถูกต้อง

12. ถ้าลิฟต์ขึ้น Error “214” RPHT Continous Activation และเมื่อมาดูที่หลังคาลิฟต์พบว่าสัญญาณ Obstacle ติดอยู่แล้วประตูในปิดไม่ได้ เราจะทำอย่างไรได้บ้าง



ก. ลองปิด/เปิดปุ่ม JHT ตัดต่อตัวจ่ายไฟมอเตอร์ประตูใน เพื่อดูว่าสัญญาณ Obstacle จะถูก reset หรือไม่

ข. ลองทำความสะอาดโปรการ์ดดู

ค. เปลี่ยนโปรการ์ดใหม่

ง. ถูกทุกข้อ

13. Command -> Clr Blocking Err เอาไว้ใช้ทำอะไร

ก. ใช้สำหรับเคลียร์ error ที่ทำให้ลิฟต์ บล็อค

ข. ลบ errorlog ออกทั้งหมด

ค. ถูกทั้ง ก และ ข

ง. node ของปุ่มกดหน้าชั้น (LOP)

14. เราจะ save PCT ของลิฟต์ BCBB ด้วย SD/MMC card ได้อย่างไร

ก. ใส่ MMC card -> กด reset -> Command -> SD Card -> Save Config -> OK

ข. ใส่ MMC card -> กด reset -> Command -> SD Card -> Save Log -> OK

ค. ไม่สามารถทำได้ ต้องใช้ CADI GC เท่านั้น

ง. ใส่ MMC card -> กด reset -> Parameter -> SD Card -> Save Config -> OK

15. ID No. = 59350600 คือ ID ของอุปกรณ์อะไร

ก. มอเตอร์ประตูใน

ข. HMI

ค. เซ็นเซอร์ม่านแสงประตูใน

ง. ซิลประตูนอก

16. เอกสารเลขที่ EJ41350877 ใช้สำหรับอ้างอิงส่วนใดของลิฟต์

ก. การตรวจเช็คประตูใน

ข. การตรวจเช็คประตูนอก

ค. การติดตั้งประตูใน

ง. การติดตั้งประตูนอก

17. ถ้าตรวจพบ error 709 ต้องทำอย่างไร

ก. ลบ error ทิ้งได้เลย

ข. ตรวจสอบ error อื่นๆ ประกอบ

ค. กด reset ที่ GCIOCF

ง. ไม่มีข้อใดถูกต้อง

18. ถ้าตรวจพบ สลิงเซ็นเตอร์ประตูนอกแตกดังภาพ ต้องทำอย่างไร

ก. ใช้เทปกาวพันไว้ก่อน

ข. ปล่อยไว้เฉยๆ

ค. หา ID number ที่ถูกต้องและเข้าไปเบิกอะไหล่

ง. ถูกทุกข้อ

19. วงจรเซฟตี้ของลิฟต์ BCBB ใช้ความต่างศักดิ์ชนิดใด และมีขนาดเท่าไหร่

ก. 220 V AC

ข. 380 V AC

ค. 24 – 60 V DC

ง. 110 V AC

20. หลักการตรวจเช็คลิฟต์ประกอบด้วยอะไรบ้าง

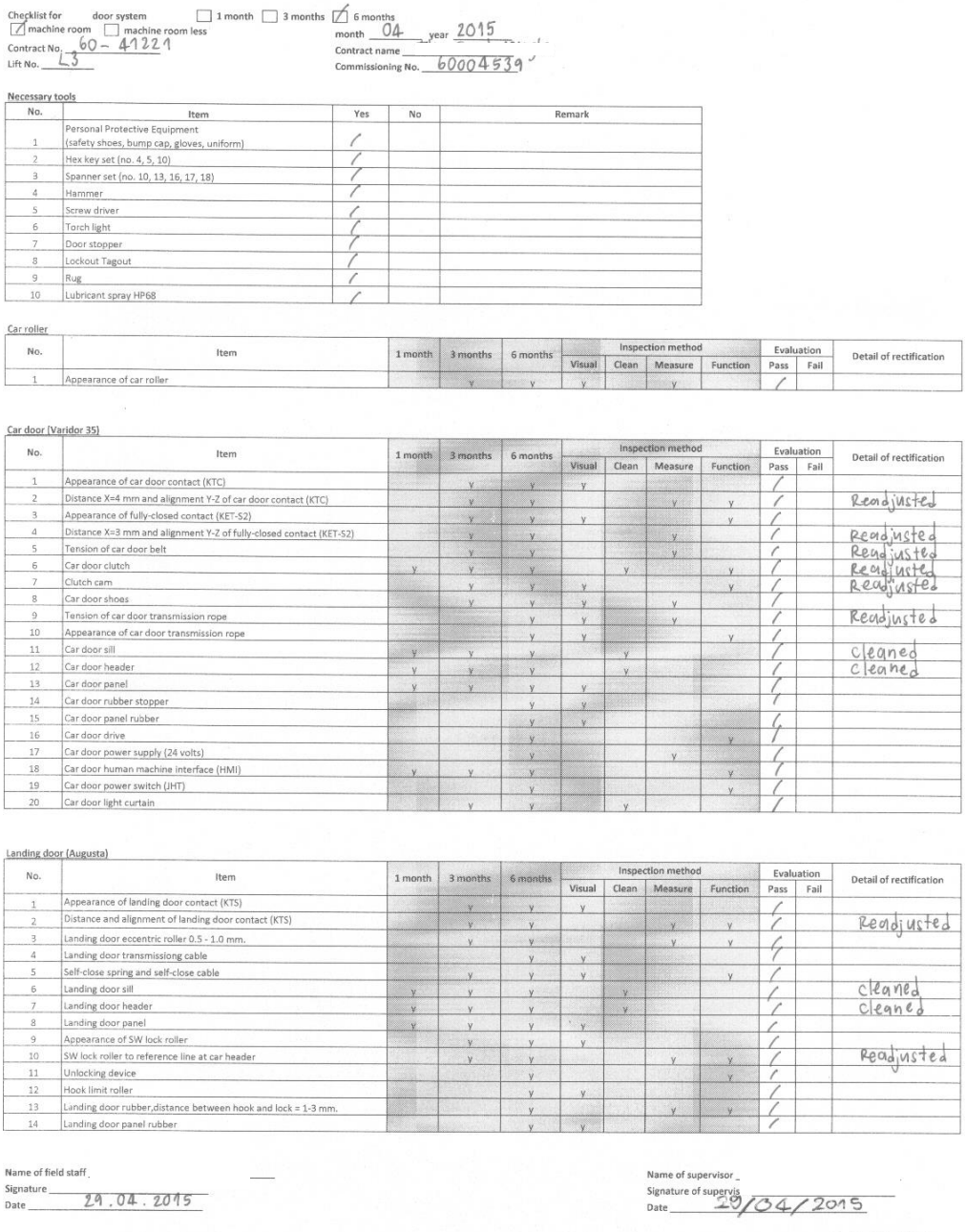
ก. วัด, ขัด, ดู, อ่าน

ข. ฟังเสียง, ดู, ตรวจสอบ, ทำความสะอาด

ค. ตรวจสอบ, จด, ทำความสะอาด, วัด

ง. ดู, วัด, เช็คการทำงาน, ทำความสะอาด

Appendix J



Checklist for door system ☐ 1 month ☐ 3 months ☑ 6 months
☑ machine room ☐ machine room less
Contract No. 60 - 41221
Lift No. L3
month 04 year 2015
Contract name
Commissioning No. 60004539

Necessary tools

No.	Item	Yes	No	Remark
1	Personal Protective Equipment (safety shoes, bump cap, gloves, uniform)	/		
2	Hex key set (no. 4, 5, 10)	/		
3	Spanner set (no. 10, 13, 16, 17, 18)	/		
4	Hammer	/		
5	Screw driver	/		
6	Torch light	/		
7	Door stopper	/		
8	Lockout Tagout	/		
9	Rug	/		
10	Lubricant spray HP68	/		

Car roller

No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of car roller		y	y	y		y		/		

Car door (Varidor 35)

No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of car door contact (KTC)		y	y	y				/		
2	Distance X=4 mm and alignment Y-Z of car door contact (KTC)		y	y			y	y	/		Readjusted
3	Appearance of fully-closed contact (KET-S2)		y	y	y			y	/		
4	Distance X=3 mm and alignment Y-Z of fully-closed contact (KET-S2)		y	y			y		/		Readjusted
5	Tension of car door belt		y	y			y		/		Readjusted
6	Car door clutch	y	y	y		y		y	/		Readjusted
7	Clutch cam		y	y	y			y	/		Readjusted
8	Car door shoes		y	y	y		y		/		
9	Tension of car door transmission rope			y	y		y		/		Readjusted
10	Appearance of car door transmission rope			y	y			y	/		
11	Car door sill	y	y	y		y			/		cleaned
12	Car door header	y	y	y		y			/		cleaned
13	Car door panel	y	y	y	y				/		
14	Car door rubber stopper			y	y				/		
15	Car door panel rubber			y	y				/		
16	Car door drive			y				y	/		
17	Car door power supply (24 volts)			y			y		/		
18	Car door human machine interface (HMI)	y	y	y				y	/		
19	Car door power switch (JHT)			y				y	/		
20	Car door light curtain		y	y		y			/		

Landing door (Augusta)

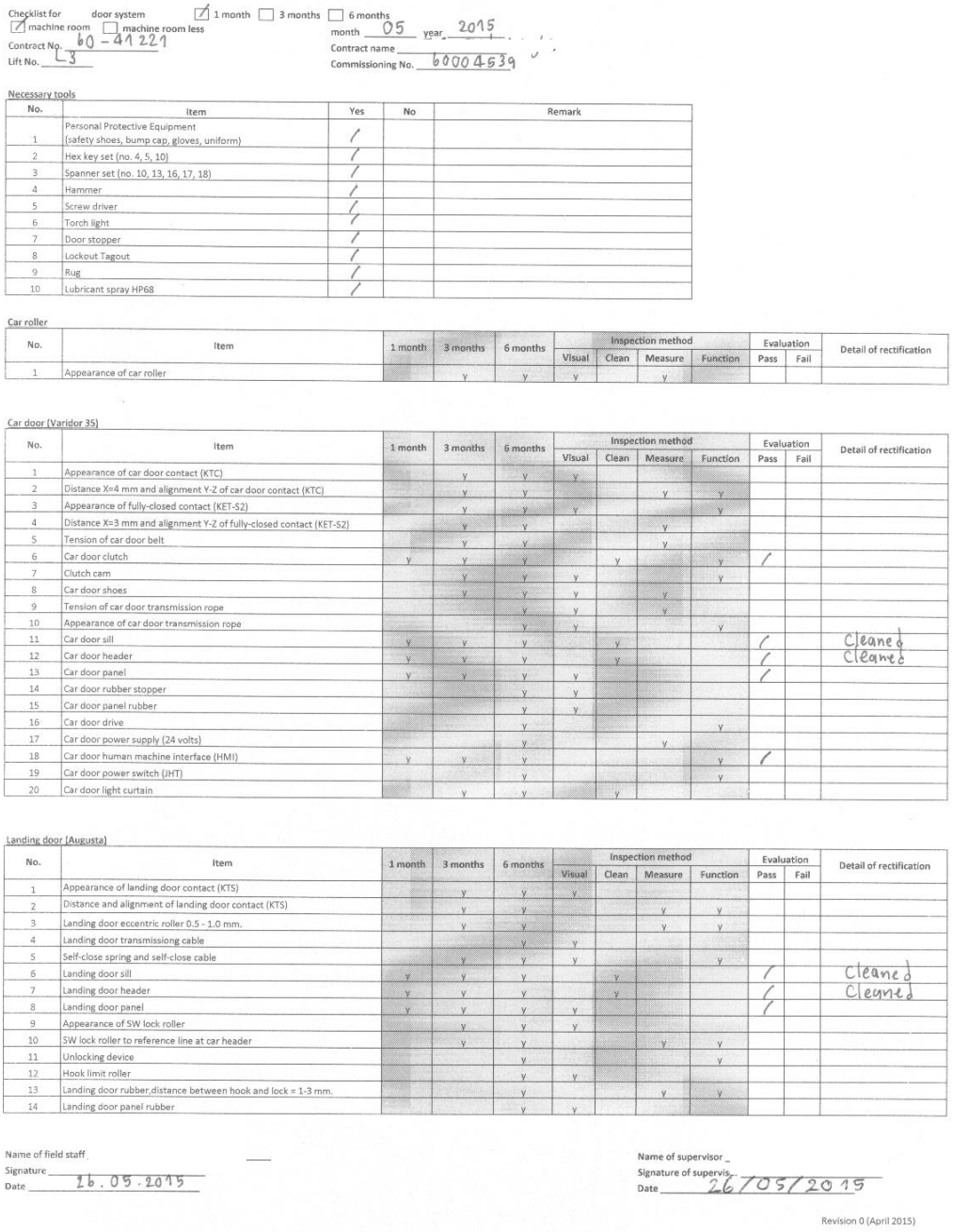
No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of landing door contact (KTS)		y	y	y				/		
2	Distance and alignment of landing door contact (KTS)		y	y			y	y	/		Readjusted
3	Landing door eccentric roller 0.5 - 1.0 mm.		y	y			y	y	/		
4	Landing door transmissiong cable			y	y				/		
5	Self-close spring and self-close cable		y	y	y			y	/		
6	Landing door sill	y	y	y		y			/		cleaned
7	Landing door header	y	y	y		y			/		cleaned
8	Landing door panel	y	y	y	y				/		
9	Appearance of SW lock roller		y	y	y				/		
10	SW lock roller to reference line at car header		y	y			y	y	/		Readjusted
11	Unlocking device			y				y	/		
12	Hook limit roller			y	y				/		
13	Landing door rubber,distance between hook and lock = 1-3 mm.			y			y	y	/		
14	Landing door panel rubber			y	y				/		

Name of field staff
Signature
Date 29.04.2015

Name of supervisor
Signature of supervis
Date 29/04/2015

Revision 0 (April 2015)

Figure 54: An actual checklist document of May 2015 of equipment number 60004539



Checklist for door system ☑ 1 month ☐ 3 months ☐ 6 months
☑ machine room ☐ machine room less
month 05 year 2015
Contract No. 60-41221
Contract name
Lift No. L3
Commissioning No. 60004539

Necessary tools

No.	Item	Yes	No	Remark
1	Personal Protective Equipment (safety shoes, bump cap, gloves, uniform)	/		
2	Hex key set (no. 4, 5, 10)	/		
3	Spanner set (no. 10, 13, 16, 17, 18)	/		
4	Hammer	/		
5	Screw driver	/		
6	Torch light	/		
7	Door stopper	/		
8	Lockout Tagout	/		
9	Rug	/		
10	Lubricant spray HP68	/		

Car roller

No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of car roller		y	y	y		y				

Car door (Varidor 35)

No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of car door contact (KTC)		y	y	y						
2	Distance X=4 mm and alignment Y-Z of car door contact (KTC)		y	y			y	y			
3	Appearance of fully-closed contact (KET-S2)		y	y	y			y			
4	Distance X=3 mm and alignment Y-Z of fully-closed contact (KET-S2)		y	y			y				
5	Tension of car door belt		y	y			y				
6	Car door clutch	y	y	y		y		y	/		
7	Clutch cam		y	y	y			y			
8	Car door shoes		y	y	y		y				
9	Tension of car door transmission rope			y	y		y				
10	Appearance of car door transmission rope			y	y			y			
11	Car door sill	y	y	y		y			/		Cleaned
12	Car door header	y	y	y		y			/		Cleaned
13	Car door panel	y	y	y	y				/		
14	Car door rubber stopper			y	y						
15	Car door panel rubber			y	y						
16	Car door drive			y				y			
17	Car door power supply (24 volts)			y			y				
18	Car door human machine interface (HMI)	y	y	y				y	/		
19	Car door power switch (JHT)			y				y			
20	Car door light curtain		y	y		y					

Landing door (Augusta)

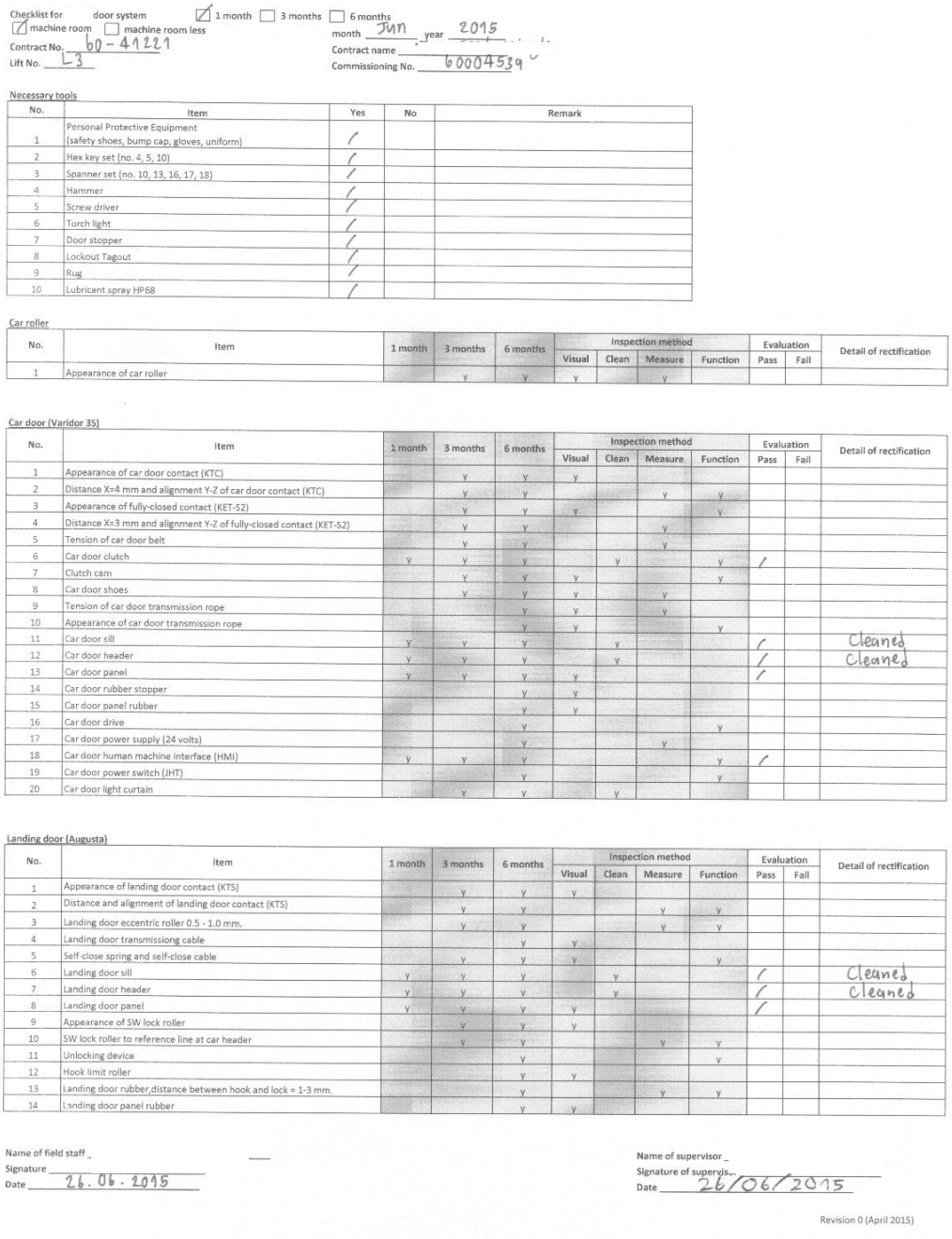
No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of landing door contact (KTS)		y	y	y						
2	Distance and alignment of landing door contact (KTS)		y	y			y	y			
3	Landing door eccentric roller 0.5 - 1.0 mm.		y	y			y	y			
4	Landing door transmissiong cable			y	y						
5	Self-close spring and self-close cable		y	y	y			y			
6	Landing door sill	y	y	y		y			/		Cleaned
7	Landing door header	y	y	y		y			/		Cleaned
8	Landing door panel	y	y	y	y				/		
9	Appearance of SW lock roller		y	y	y						
10	SW lock roller to reference line at car header		y	y			y	y			
11	Unlocking device			y				y			
12	Hook limit roller			y	y						
13	Landing door rubber,distance between hook and lock = 1-3 mm.			y			y	y			
14	Landing door panel rubber			y	y						

Name of field staff
Signature
Date 16.05.2015

Name of supervisor
Signature of supervis...
Date 26/05/2015

Revision 0 (April 2015)

Figure 55: An actual checklist document of Jun 2015 of equipment number 60004539



Checklist for door system ☑ 1 month ☐ 3 months ☐ 6 months
☑ machine room ☐ machine room less
Contract No. 60-41221
Lift No. L3
month Jun, year 2015
Contract name
Commissioning No. 60004539

Necessary tools

No.	Item	Yes	No	Remark
1	Personal Protective Equipment (safety shoes, bump cap, gloves, uniform)	/		
2	Hex key set (no. 4, 5, 10)	/		
3	Spanner set (no. 10, 13, 16, 17, 18)	/		
4	Hammer	/		
5	Screw driver	/		
6	Torch light	/		
7	Door stopper	/		
8	Lockout Tagout	/		
9	Rug	/		
10	Lubricant spray HP68	/		

Car roller

No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of car roller		y	y	y		y				

Car door (Varidor 35)

No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of car door contact (KTC)		y	y	y						
2	Distance X=4 mm and alignment Y-Z of car door contact (KTC)		y	y			y	y			
3	Appearance of fully-closed contact (KET-52)		y	y	y			y			
4	Distance X=3 mm and alignment Y-Z of fully-closed contact (KET-52)		y	y			y				
5	Tension of car door belt		y	y			y				
6	Car door clutch	y	y	y		y		y	/		
7	Clutch cam		y	y	y			y			
8	Car door shoes		y	y	y		y				
9	Tension of car door transmission rope			y	y		y				
10	Appearance of car door transmission rope			y	y			y			
11	Car door sill	y	y	y		y			/		Cleaned
12	Car door header	y	y	y		y			/		Cleaned
13	Car door panel	y	y	y	y				/		
14	Car door rubber stopper			y	y						
15	Car door panel rubber			y	y						
16	Car door drive			y				y			
17	Car door power supply (24 volts)			y			y				
18	Car door human machine interface (HMI)	y	y	y				y	/		
19	Car door power switch (JHT)			y				y			
20	Car door light curtain		y	y		y					

Landing door (Augusta)

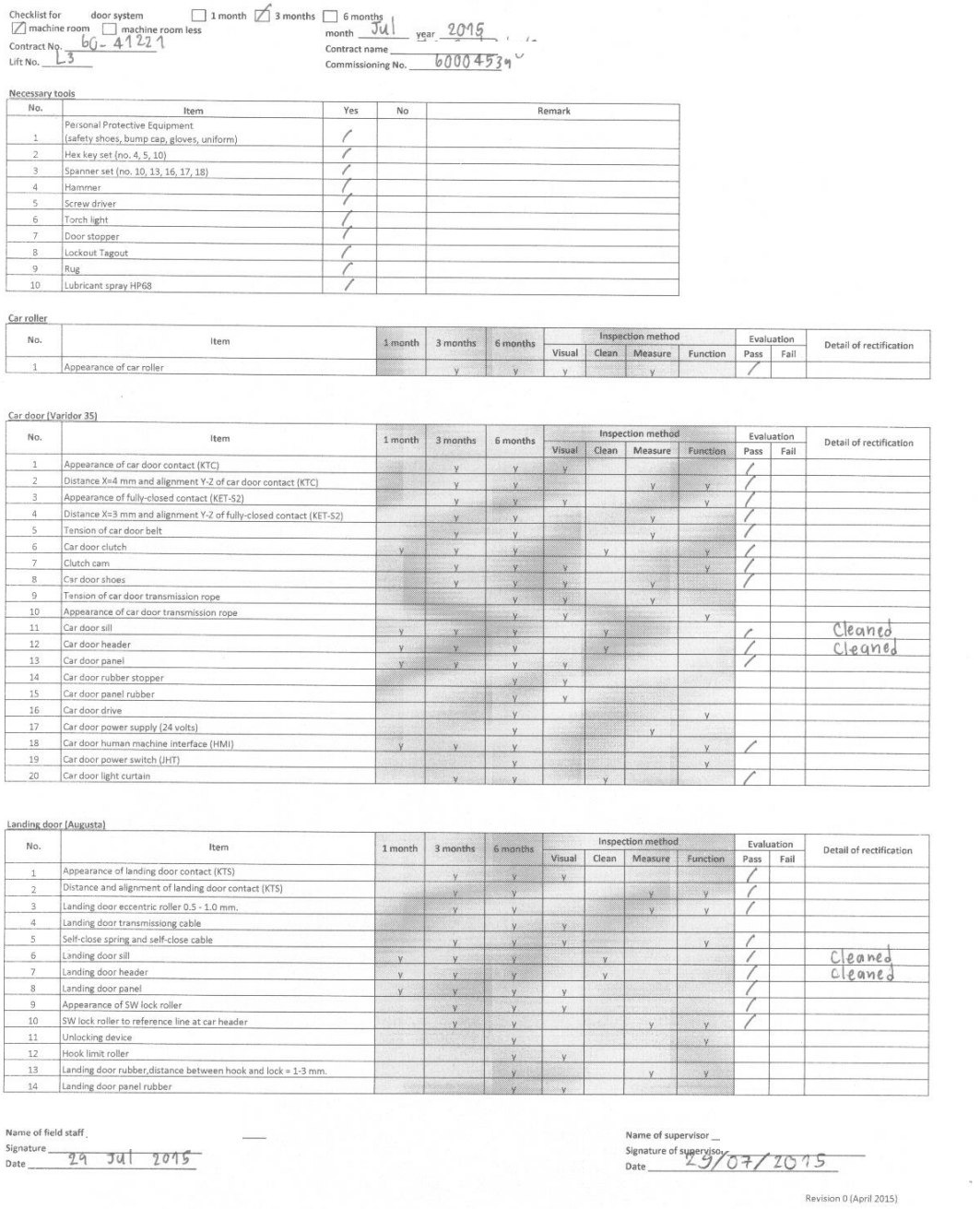
No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of landing door contact (KTS)		y	y	y						
2	Distance and alignment of landing door contact (KTS)		y	y			y	y			
3	Landing door eccentric roller 0.5 - 1.0 mm.		y	y			y	y			
4	Landing door transmissiong cable			y	y						
5	Self-close spring and self-close cable		y	y	y			y			
6	Landing door sill	y	y	y		y			/		Cleaned
7	Landing door header	y	y	y		y			/		Cleaned
8	Landing door panel	y	y	y	y				/		
9	Appearance of SW lock roller		y	y	y						
10	SW lock roller to reference line at car header		y	y			y	y			
11	Unlocking device			y				y			
12	Hook limit roller			y	y						
13	Landing door rubber,distance between hook and lock = 1-3 mm.			y			y	y			
14	Landing door panel rubber			y	y						

Name of field staff
Signature
Date 26.06.2015

Name of supervisor
Signature of supervis...
Date 26/06/2015

Revision 0 (April 2015)

Figure 56: An actual checklist document of Jul 2015 of equipment number 60004539



Checklist for door system ☐ 1 month ☑ 3 months ☐ 6 months
☑ machine room ☐ machine room less
Contract No. 60-41221
Lift No. L3
month Jul year 2015
Contract name
Commissioning No. 60004539

Necessary tools

No.	Item	Yes	No	Remark
1	Personal Protective Equipment (safety shoes, bump cap, gloves, uniform)	/		
2	Hex key set (no. 4, 5, 10)	/		
3	Spanner set (no. 10, 13, 16, 17, 18)	/		
4	Hammer	/		
5	Screw driver	/		
6	Torch light	/		
7	Door stopper	/		
8	Lockout Tagout	/		
9	Rug	/		
10	Lubricant spray HP68	/		

Car roller

No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of car roller		y	y	y		y		/		

Car door (Varidor 35)

No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of car door contact (KTC)		y	y	y				/		
2	Distance X=4 mm and alignment Y-Z of car door contact (KTC)		y	y			y	y	/		
3	Appearance of fully-closed contact (KET-S2)		y	y	y			y	/		
4	Distance X=3 mm and alignment Y-Z of fully-closed contact (KET-S2)		y	y			y		/		
5	Tension of car door belt		y	y			y		/		
6	Car door clutch	y	y	y		y		y	/		
7	Clutch cam		y	y	y			y	/		
8	Car door shoes		y	y	y		y		/		
9	Tension of car door transmission rope			y	y		y				
10	Appearance of car door transmission rope			y	y			y			
11	Car door sill	y	y	y		y			/		Cleaned
12	Car door header	y	y	y		y			/		Cleaned
13	Car door panel	y	y	y	y				/		
14	Car door rubber stopper			y	y						
15	Car door panel rubber			y	y						
16	Car door drive			y				y			
17	Car door power supply (24 volts)			y			y				
18	Car door human machine interface (HMI)	y	y	y				y	/		
19	Car door power switch (JHT)			y				y			
20	Car door light curtain		y	y		y			/		

Landing door (Augusta)

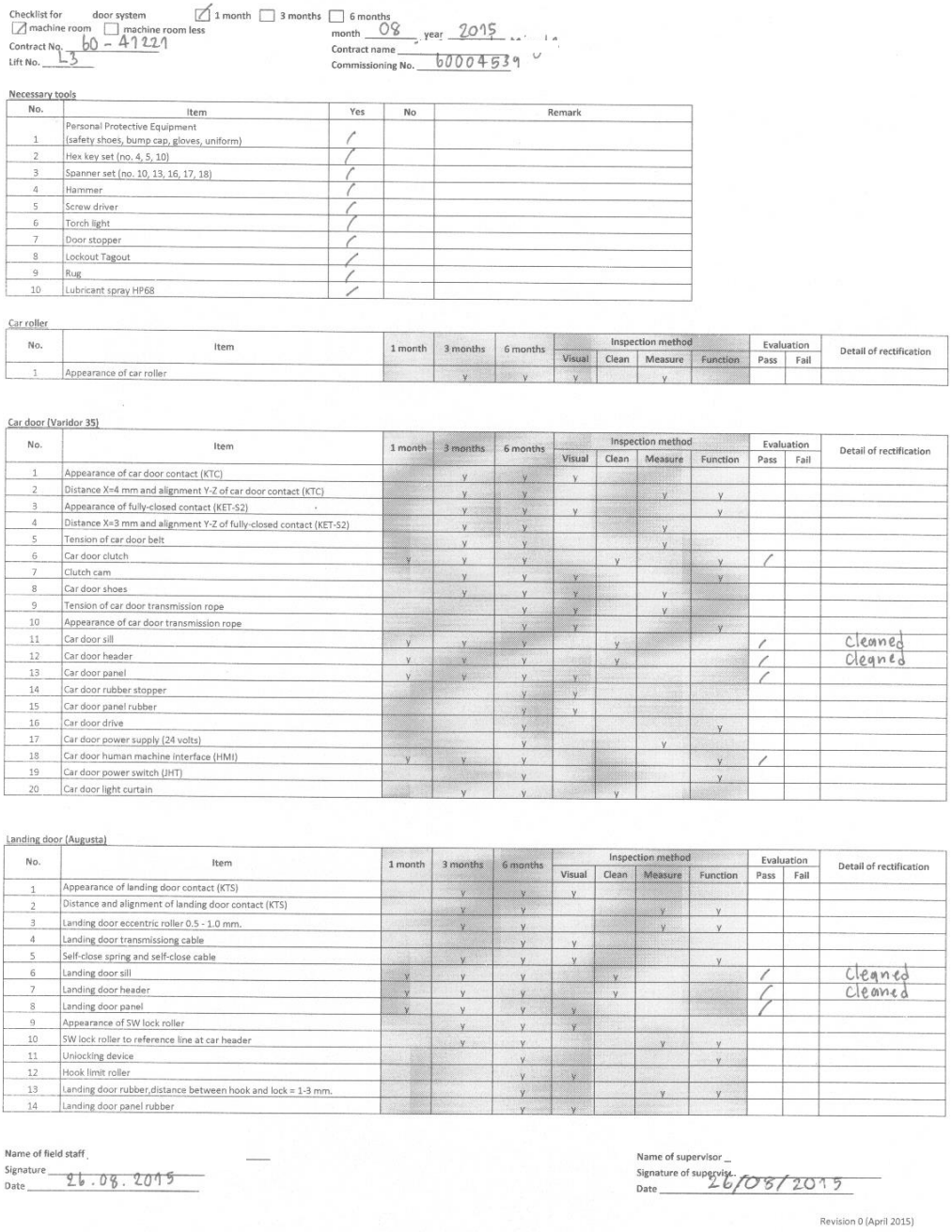
No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of landing door contact (KTS)		y	y	y				/		
2	Distance and alignment of landing door contact (KTS)		y	y			y	y	/		
3	Landing door eccentric roller 0.5 - 1.0 mm.		y	y			y	y	/		
4	Landing door transmissiong cable			y	y						
5	Self-close spring and self-close cable		y	y	y			y	/		
6	Landing door sill	y	y	y		y			/		Cleaned
7	Landing door header	y	y	y		y			/		Cleaned
8	Landing door panel	y	y	y	y				/		
9	Appearance of SW lock roller		y	y	y				/		
10	SW lock roller to reference line at car header		y	y			y	y	/		
11	Unlocking device			y				y			
12	Hook limit roller			y	y						
13	Landing door rubber,distance between hook and lock = 1-3 mm.			y			y	y			
14	Landing door panel rubber			y	y						

Name of field staff
Signature
Date 29 Jul 2015

Name of supervisor
Signature of supervisor
Date 29/07/2015

Revision 0 (April 2015)

Figure 57: An actual checklist document of Aug 2015 of equipment number 60004539



Checklist for door system ☑ 1 month ☐ 3 months ☐ 6 months
☑ machine room ☐ machine room less
Contract No. 60 - 41221
Lift No. L3
month 08 year 2015
Contract name
Commissioning No. 60004539

Necessary tools

No.	Item	Yes	No	Remark
1	Personal Protective Equipment (safety shoes, bump cap, gloves, uniform)	/		
2	Hex key set (no. 4, 5, 10)	/		
3	Spanner set (no. 10, 13, 16, 17, 18)	/		
4	Hammer	/		
5	Screw driver	/		
6	Torch light	/		
7	Door stopper	/		
8	Lockout Tagout	/		
9	Rug	/		
10	Lubricant spray HP68	/		

Car roller

No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of car roller		y	y	y		y				

Car door (Varidor 35)

No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of car door contact (KTC)		y	y	y						
2	Distance X=4 mm and alignment Y-Z of car door contact (KTC)		y	y			y	y			
3	Appearance of fully-closed contact (KET-S2)		y	y	y			y			
4	Distance X=3 mm and alignment Y-Z of fully-closed contact (KET-S2)		y	y			y				
5	Tension of car door belt		y	y			y				
6	Car door clutch	y	y	y		y		y	/		
7	Clutch cam		y	y	y			y			
8	Car door shoes		y	y	y		y				
9	Tension of car door transmission rope			y	y		y				
10	Appearance of car door transmission rope			y	y			y			
11	Car door sill	y	y	y		y			/		Cleaned
12	Car door header	y	y	y		y			/		Cleaned
13	Car door panel	y	y	y	y				/		
14	Car door rubber stopper			y	y						
15	Car door panel rubber			y	y						
16	Car door drive			y				y			
17	Car door power supply (24 volts)			y			y				
18	Car door human machine interface (HMI)	y	y	y				y	/		
19	Car door power switch (JHT)			y				y			
20	Car door light curtain		y	y		y					

Landing door (Augusta)

No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of landing door contact (KTS)		y	y	y						
2	Distance and alignment of landing door contact (KTS)		y	y			y	y			
3	Landing door eccentric roller 0.5 - 1.0 mm.		y	y			y	y			
4	Landing door transmissiong cable			y	y						
5	Self-close spring and self-close cable		y	y	y			y			
6	Landing door sill	y	y	y		y			/		Cleaned
7	Landing door header	y	y	y		y			/		Cleaned
8	Landing door panel	y	y	y	y				/		
9	Appearance of SW lock roller		y	y	y						
10	SW lock roller to reference line at car header		y	y			y	y			
11	Uniocking device			y				y			
12	Hook limit roller			y	y						
13	Landing door rubber,distance between hook and lock = 1-3 mm.			y			y	y			
14	Landing door panel rubber			y	y						

Name of field staff
Signature
Date 26.08.2015

Name of supervisor
Signature of supervisor
Date 26/08/2015

Revision 0 (April 2015)

Figure 58: An actual checklist document of Sep 2015 of equipment number 60004539

Checklist for door system ☑ 1 month ☐ 3 months ☐ 6 months
☑ machine room ☐ machine room less
Contract No. 60-41221
Lift No. L3
month 09 year 2015
Contract name
Commissioning No. 60004539

Necessary tools

No.	Item	Yes	No	Remark
1	Personal Protective Equipment (safety shoes, bump cap, gloves, uniform)	/		
2	Hex key set (no. 4, 5, 10)	/		
3	Spanner set (no. 10, 13, 16, 17, 18)	/		
4	Hammer	/		
5	Screw driver	/		
6	Torch light	/		
7	Door stopper	/		
8	Lockout Tagout	/		
9	Rug	/		
10	Lubricant spray HP68	/		

Car roller

No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of car roller		y	y	y		y				

Car door (Varidor 35)

No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of car door contact (KTC)		y	y	y						
2	Distance X=4 mm and alignment Y-Z of car door contact (KTC)		y	y			y	y			
3	Appearance of fully-closed contact (KET-52)		y	y	y			y			
4	Distance X=3 mm and alignment Y-Z of fully-closed contact (KET-52)		y	y			y				
5	Tension of car door belt		y	y			y				
6	Car door clutch	y	y	y		y		y	/		
7	Clutch cam		y	y	y			y			
8	Car door shoes		y	y	y		y				
9	Tension of car door transmission rope			y	y		y				
10	Appearance of car door transmission rope			y	y			y			
11	Car door sill	y	y	y		y			/		Cleaned
12	Car door header	y	y	y		y			/		Cleaned
13	Car door panel	y	y	y	y				/		
14	Car door rubber stopper			y	y						
15	Car door panel rubber			y	y						
16	Car door drive			y				y			
17	Car door power supply (24 volts)			y			y				
18	Car door human machine interface (HMI)	y	y	y				y	/		
19	Car door power switch (JHT)			y				y			
20	Car door light curtain		y	y		y					

Landing door (Augusta)

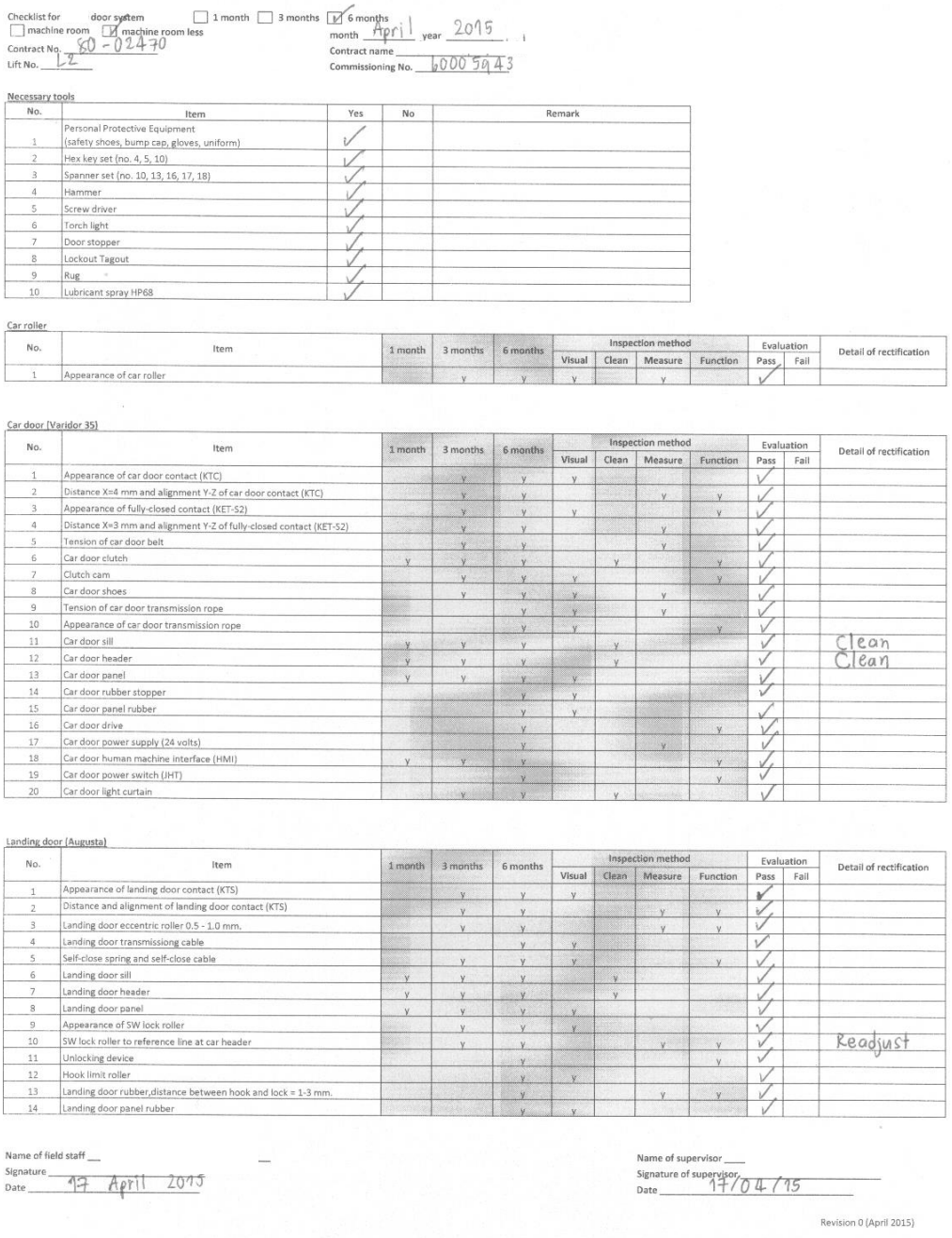
No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of landing door contact (KTS)		y	y	y						
2	Distance and alignment of landing door contact (KTS)		y	y			y	y			
3	Landing door eccentric roller 0.5 - 1.0 mm.		y	y			y	y			
4	Landing door transmissiong cable			y	y						
5	Self-close spring and self-close cable		y	y	y			y			
6	Landing door sill	y	y	y		y			/		Cleaned
7	Landing door header	y	y	y		y			/		cleaned
8	Landing door panel	y	y	y	y				/		
9	Appearance of SW lock roller		y	y	y						
10	SW lock roller to reference line at car header		y	y			y	y			
11	Unlocking device			y				y			
12	Hook limit roller			y	y						
13	Landing door rubber,distance between hook and lock = 1-3 mm.			y			y	y			
14	Landing door panel rubber			y	y						

Name of field staff
Signature
Date 28.09.2015

Name of supervisor
Signature of supervisor
Date 28/09/2015

Revision 0 (April 2015)

Figure 59: An actual checklist document of Aug 2015 of equipment number 60004539



Checklist for door system ☐ 1 month ☐ 3 months ☑ 6 months
☐ machine room ☑ machine room less
month April year 2015
Contract No. 80-02470
Contract name
Lift No. 12
Commissioning No. 60005943

Necessary tools

No.	Item	Yes	No	Remark
1	Personal Protective Equipment (safety shoes, bump cap, gloves, uniform)	✓		
2	Hex key set (no. 4, 5, 10)	✓		
3	Spanner set (no. 10, 13, 16, 17, 18)	✓		
4	Hammer	✓		
5	Screw driver	✓		
6	Torch light	✓		
7	Door stopper	✓		
8	Lockout Tagout	✓		
9	Rug	✓		
10	Lubricant spray HP68	✓		

Car roller

No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of car roller		y	y	y		y		✓		

Car door (Varidor 35)

No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of car door contact (KTC)		y	y	y				✓		
2	Distance X=4 mm and alignment Y-Z of car door contact (KTC)		y	y			y	y	✓		
3	Appearance of fully-closed contact (KET-52)		y	y	y			y	✓		
4	Distance X=3 mm and alignment Y-Z of fully-closed contact (KET-52)		y	y			y		✓		
5	Tension of car door belt		y	y			y		✓		
6	Car door clutch	y	y	y		y		y	✓		
7	Clutch cam		y	y	y			y	✓		
8	Car door shoes		y	y	y		y		✓		
9	Tension of car door transmission rope			y	y		y		✓		
10	Appearance of car door transmission rope			y	y			y	✓		
11	Car door sill	y	y	y		y			✓		Clean
12	Car door header	y	y	y		y			✓		Clean
13	Car door panel	y	y	y	y				✓		
14	Car door rubber stopper			y	y				✓		
15	Car door panel rubber			y	y				✓		
16	Car door drive			y				y	✓		
17	Car door power supply (24 volts)			y			y		✓		
18	Car door human machine interface (HMI)	y	y	y				y	✓		
19	Car door power switch (JHT)			y				y	✓		
20	Car door light curtain		y	y		y			✓		

Landing door (Augusta)

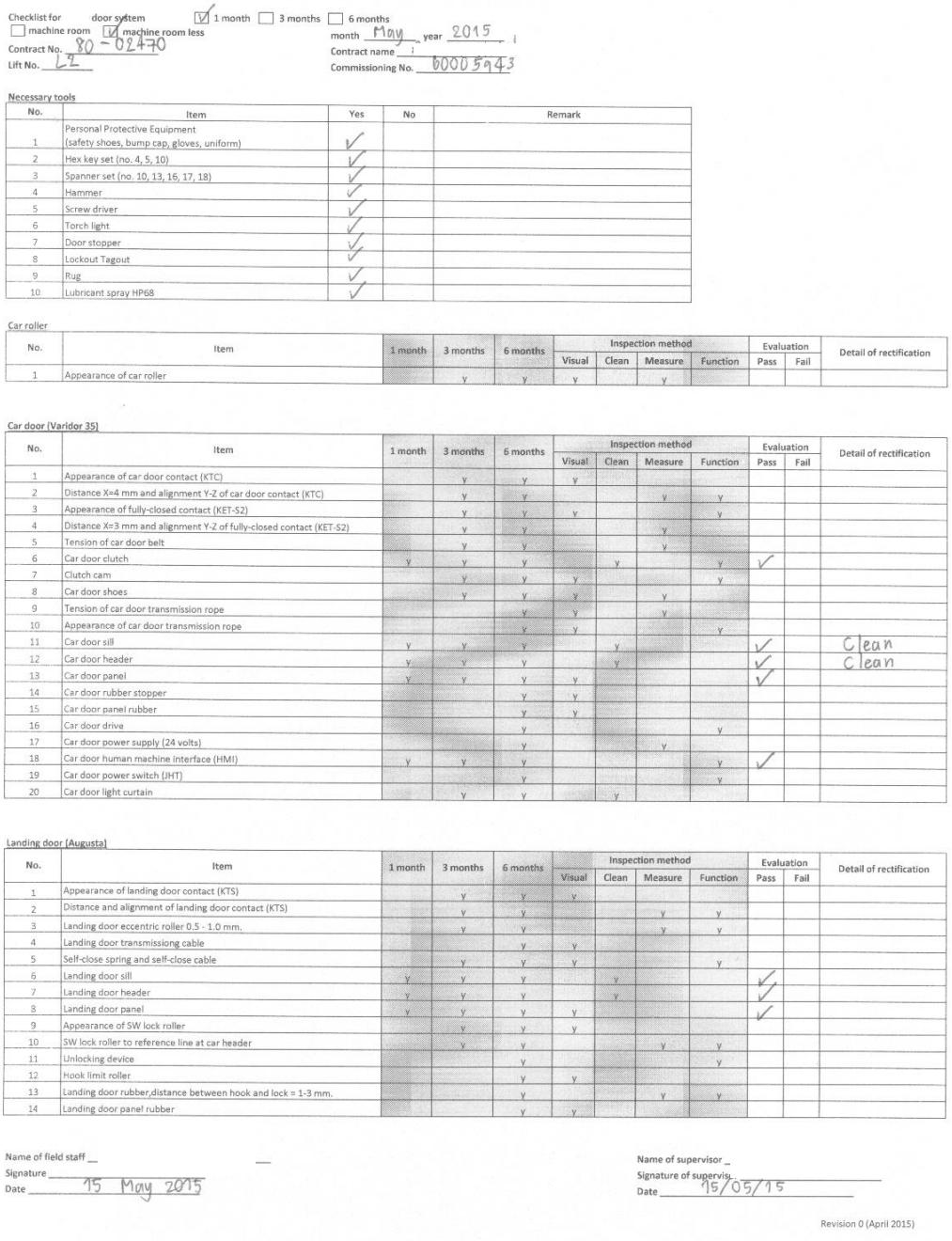
No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of landing door contact (KTS)		y	y	y				✓		
2	Distance and alignment of landing door contact (KTS)		y	y			y	y	✓		
3	Landing door eccentric roller 0.5 - 1.0 mm.		y	y			y	y	✓		
4	Landing door transmissiong cable			y	y				✓		
5	Self-close spring and self-close cable		y	y	y			y	✓		
6	Landing door sill	y	y	y		y			✓		
7	Landing door header	y	y	y		y			✓		
8	Landing door panel	y	y	y	y				✓		
9	Appearance of SW lock roller		y	y	y				✓		
10	SW lock roller to reference line at car header		y	y			y	y	✓		Readjust
11	Unlocking device			y				y	✓		
12	Hook limit roller			y	y				✓		
13	Landing door rubber,distance between hook and lock = 1-3 mm.			y			y	y	✓		
14	Landing door panel rubber			y	y				✓		

Name of field staff
Signature
Date 17 April 2015

Name of supervisor
Signature of supervisor
Date 17/04/15

Revision 0 (April 2015)

Figure 60: An actual checklist document of Apr 2015 of equipment number 60005943



Checklist for door system ☑ 1 month ☐ 3 months ☐ 6 months
☐ machine room ☑ machine room less
Contract No. 80-02470
Lift No. LZ
month May, year 2015
Contract name
Commissioning No. 60005943

Necessary tools

No.	Item	Yes	No	Remark
1	Personal Protective Equipment (safety shoes, bump cap, gloves, uniform)	✓		
2	Hex key set (no. 4, 5, 10)	✓		
3	Spanner set (no. 10, 13, 16, 17, 18)	✓		
4	Hammer	✓		
5	Screw driver	✓		
6	Torch light	✓		
7	Door stopper	✓		
8	Lockout Tagout	✓		
9	Rug	✓		
10	Lubricant spray HP68	✓		

Car roller

No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of car roller		y	y	y		y				

Car door (Varidor 35)

No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of car door contact (KTC)		y	y	y						
2	Distance X=4 mm and alignment Y-Z of car door contact (KTC)		y	y			y	y			
3	Appearance of fully-closed contact (KET-S2)		y	y	y			y			
4	Distance X=3 mm and alignment Y-Z of fully-closed contact (KET-S2)		y	y			y				
5	Tension of car door belt		y	y			y				
6	Car door clutch	y	y	y		y		y	✓		
7	Clutch cam		y	y	y			y			
8	Car door shoes		y	y	y		y				
9	Tension of car door transmission rope			y	y		y				
10	Appearance of car door transmission rope			y	y			y			
11	Car door sill	y	y	y		y			✓		Clean
12	Car door header	y	y	y		y			✓		Clean
13	Car door panel	y	y	y	y				✓		
14	Car door rubber stopper			y	y						
15	Car door panel rubber			y	y						
16	Car door drive			y				y			
17	Car door power supply (24 volts)			y			y				
18	Car door human machine interface (HMI)	y	y	y				y	✓		
19	Car door power switch (JHT)			y				y			
20	Car door light curtain		y	y		y					

Landing door (Augusta)

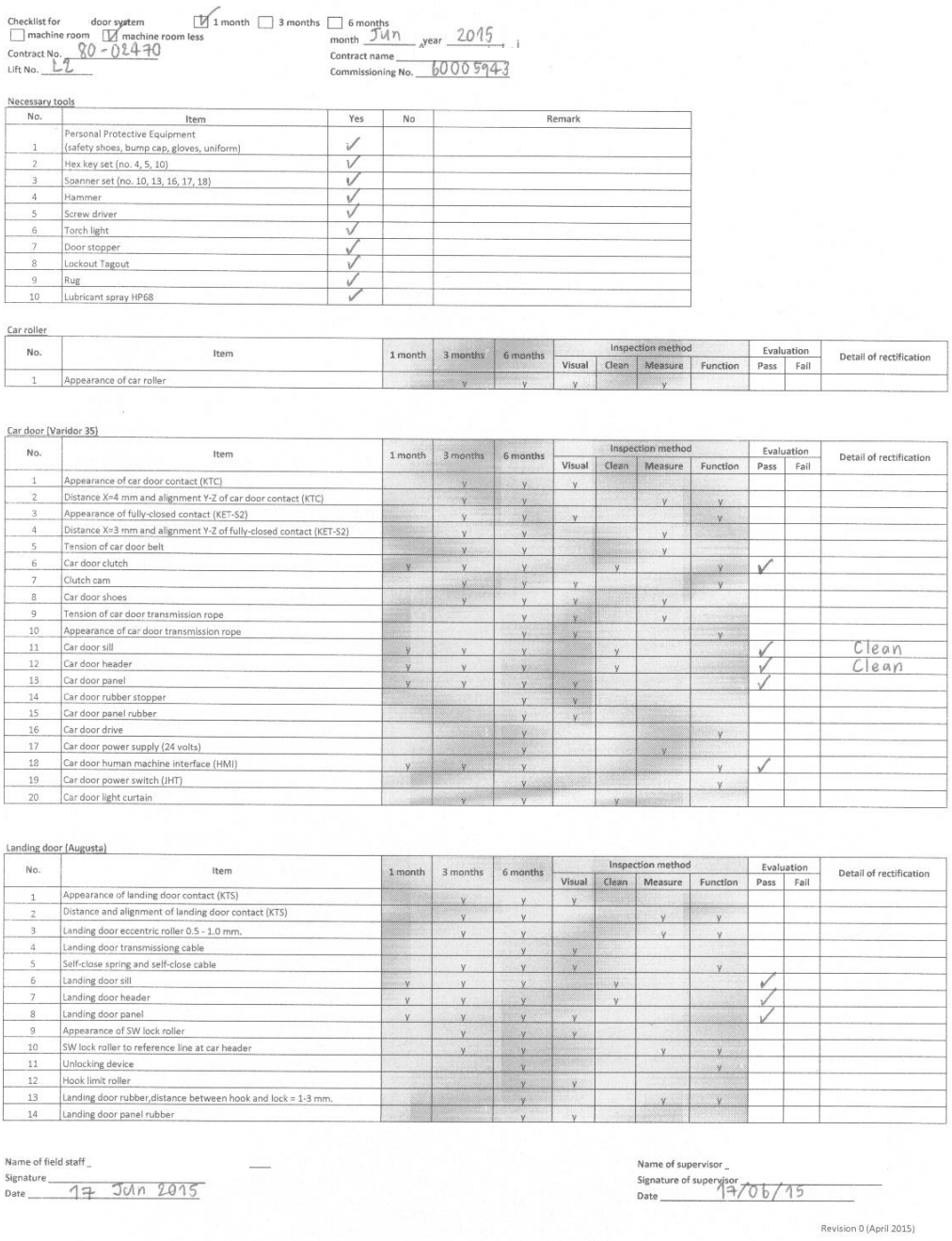
No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of landing door contact (KTS)		y	y	y						
2	Distance and alignment of landing door contact (KTS)		y	y			y	y			
3	Landing door eccentric roller 0.5 - 1.0 mm.		y	y			y	y			
4	Landing door transmissiong cable			y	y						
5	Self-close spring and self-close cable		y	y	y			y			
6	Landing door sill	y	y	y		y			✓		
7	Landing door header	y	y	y		y			✓		
8	Landing door panel	y	y	y	y				✓		
9	Appearance of SW lock roller		y	y	y						
10	SW lock roller to reference line at car header		y	y			y	y			
11	Unlocking device			y				y			
12	Hook limit roller			y	y						
13	Landing door rubber,distance between hook and lock = 1-3 mm.			y			y	y			
14	Landing door panel rubber			y	y						

Name of field staff
Signature
Date 15 May 2015

Name of supervisor
Signature of supervisi
Date 15/05/15

Revision 0 (April 2015)

Figure 61: An actual checklist document of May 2015 of equipment number 60005943



Checklist for door system ☑ 1 month ☐ 3 months ☐ 6 months
☐ machine room ☑ machine room less
Contract No. 80-02470
Lift No. L2
month Jun year 2015
Contract name
Commissioning No. 60005943

Necessary tools

No.	Item	Yes	No	Remark
1	Personal Protective Equipment (safety shoes, bump cap, gloves, uniform)	✓		
2	Hex key set (no. 4, 5, 10)	✓		
3	Spanner set (no. 10, 13, 16, 17, 18)	✓		
4	Hammer	✓		
5	Screw driver	✓		
6	Torch light	✓		
7	Door stopper	✓		
8	Lockout Tagout	✓		
9	Rug	✓		
10	Lubricant spray HP68	✓		

Car roller

No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of car roller		y	y	y		y				

Car door (Varidor 35)

No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of car door contact (KTC)		y	y	y						
2	Distance X=4 mm and alignment Y-Z of car door contact (KTC)		y	y			y	y			
3	Appearance of fully-closed contact (KET-S2)		y	y	y			y			
4	Distance X=3 mm and alignment Y-Z of fully-closed contact (KET-S2)		y	y			y				
5	Tension of car door belt		y	y			y				
6	Car door clutch	y	y	y		y		y	✓		
7	Clutch cam		y	y	y			y			
8	Car door shoes		y	y	y		y				
9	Tension of car door transmission rope			y	y		y				
10	Appearance of car door transmission rope			y	y			y			
11	Car door sill	y	y	y		y			✓		Clean
12	Car door header	y	y	y		y			✓		Clean
13	Car door panel	y	y	y	y				✓		
14	Car door rubber stopper			y	y						
15	Car door panel rubber			y	y						
16	Car door drive			y				y			
17	Car door power supply (24 volts)			y			y				
18	Car door human machine interface (HMI)	y	y	y				y	✓		
19	Car door power switch (JHT)			y				y			
20	Car door light curtain		y	y		y					

Landing door (Augusta)

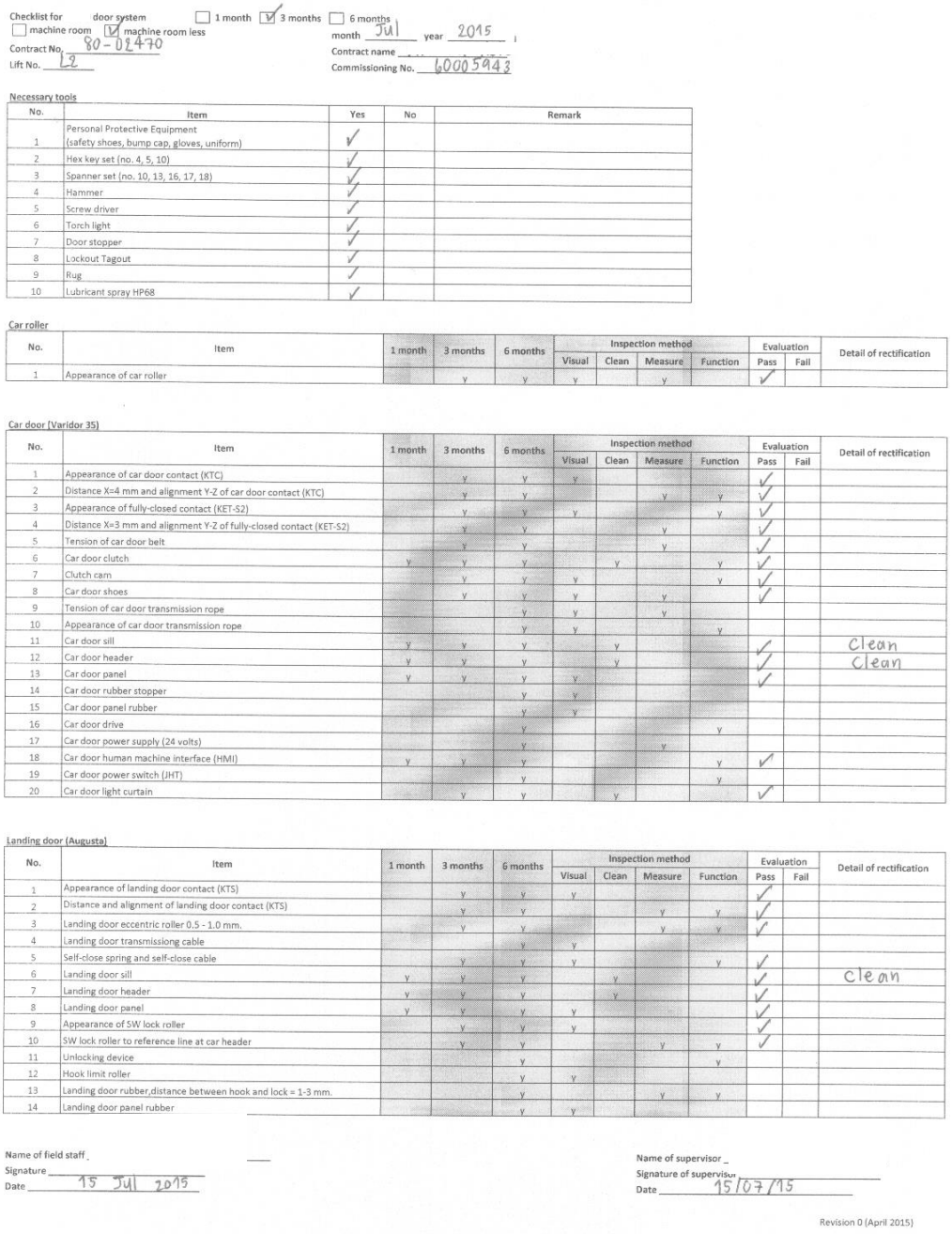
No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of landing door contact (KTS)		y	y	y						
2	Distance and alignment of landing door contact (KTS)		y	y			y	y			
3	Landing door eccentric roller 0.5 - 1.0 mm.		y	y			y	y			
4	Landing door transmissiong cable			y	y						
5	Self-close spring and self-close cable		y	y	y			y			
6	Landing door sill	y	y	y		y			✓		
7	Landing door header	y	y	y		y			✓		
8	Landing door panel	y	y	y	y				✓		
9	Appearance of SW lock roller		y	y	y						
10	SW lock roller to reference line at car header		y	y			y	y			
11	Unlocking device			y				y			
12	Hook limit roller			y	y						
13	Landing door rubber,distance between hook and lock = 1-3 mm.			y			y	y			
14	Landing door panel rubber			y	y						

Name of field staff
Signature
Date 17 Jun 2015

Name of supervisor
Signature of supervisor
Date 19/06/15

Revision 0 (April 2015)

Figure 62: An actual checklist document of Jun 2015 of equipment number 60005943



Checklist for door system ☐ 1 month ☑ 3 months ☐ 6 months
☐ machine room ☑ machine room less
month Jul year 2015
Contract No. 80-02470
Contract name
Lift No. L2
Commissioning No. 60005943

Necessary tools

No.	Item	Yes	No	Remark
1	Personal Protective Equipment (safety shoes, bump cap, gloves, uniform)	✓		
2	Hex key set (no. 4, 5, 10)	✓		
3	Spanner set (no. 10, 13, 16, 17, 18)	✓		
4	Hammer	✓		
5	Screw driver	✓		
6	Torch light	✓		
7	Door stopper	✓		
8	Lockout Tagout	✓		
9	Rug	✓		
10	Lubricant spray HP68	✓		

Car roller

No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of car roller		y	y	y		y		✓		

Car door (Varidor 35)

No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of car door contact (KTC)		y	y	y				✓		
2	Distance X=4 mm and alignment Y-Z of car door contact (KTC)		y	y			y	y	✓		
3	Appearance of fully-closed contact (KET-S2)		y	y	y			y	✓		
4	Distance X=3 mm and alignment Y-Z of fully-closed contact (KET-S2)		y	y			y		✓		
5	Tension of car door belt		y	y			y		✓		
6	Car door clutch	y	y	y		y		y	✓		
7	Clutch cam		y	y	y			y	✓		
8	Car door shoes		y	y	y		y		✓		
9	Tension of car door transmission rope			y	y		y				
10	Appearance of car door transmission rope			y	y			y			
11	Car door sill	y	y	y		y			✓		clean
12	Car door header	y	y	y		y			✓		clean
13	Car door panel	y	y	y	y				✓		
14	Car door rubber stopper			y	y						
15	Car door panel rubber			y	y						
16	Car door drive			y				y			
17	Car door power supply (24 volts)			y			y				
18	Car door human machine interface (HMI)	y	y	y				y	✓		
19	Car door power switch (JHT)			y				y			
20	Car door light curtain		y	y		y			✓		

Landing door (Augusta)

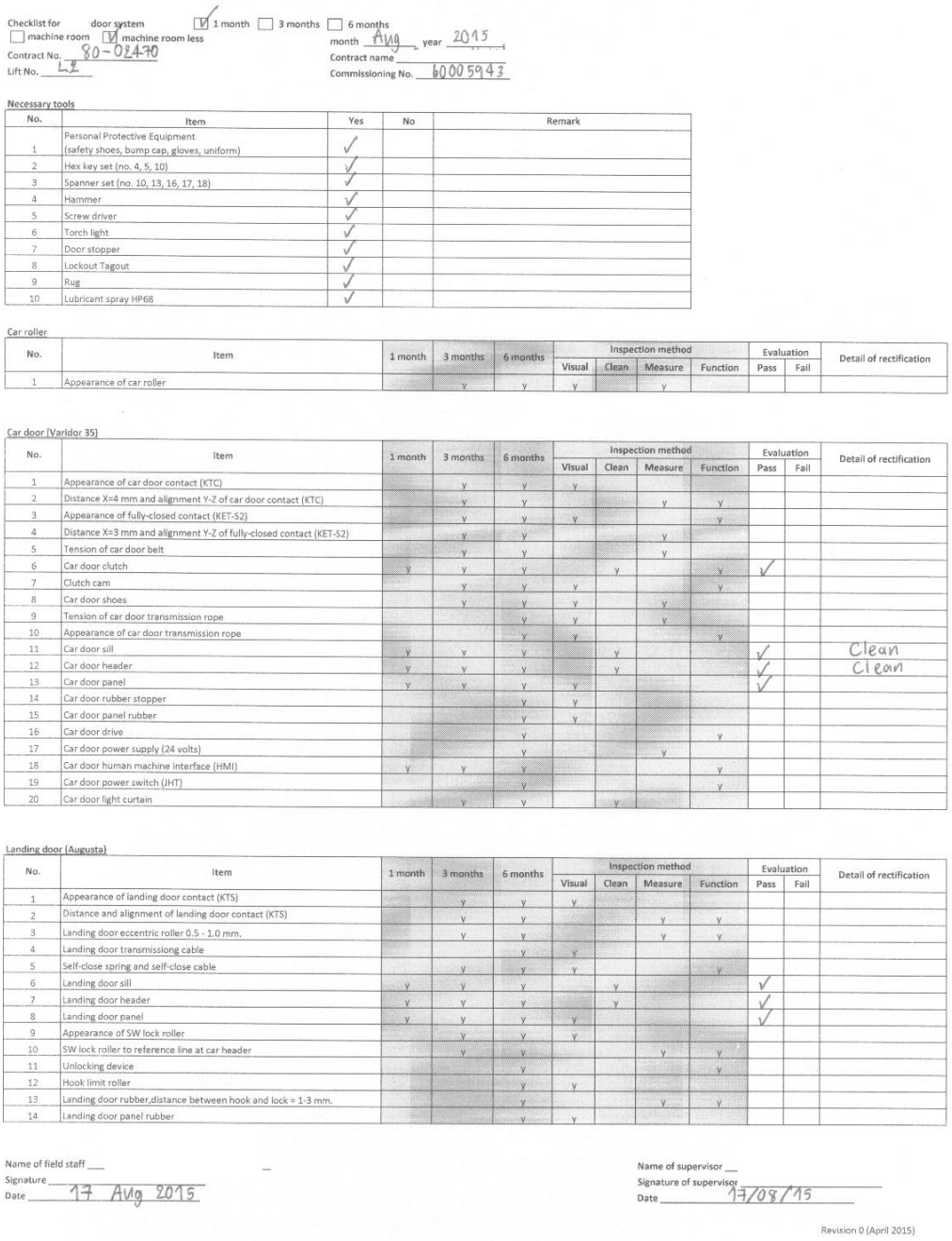
No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of landing door contact (KTS)		y	y	y				✓		
2	Distance and alignment of landing door contact (KTS)		y	y			y	y	✓		
3	Landing door eccentric roller 0.5 - 1.0 mm.		y	y			y	y	✓		
4	Landing door transmissiong cable			y	y						
5	Self-close spring and self-close cable		y	y	y			y	✓		
6	Landing door sill	y	y	y		y			✓		clean
7	Landing door header	y	y	y		y			✓		
8	Landing door panel	y	y	y	y				✓		
9	Appearance of SW lock roller		y	y	y				✓		
10	SW lock roller to reference line at car header		y	y			y	y	✓		
11	Unlocking device			y				y			
12	Hook limit roller			y	y						
13	Landing door rubber,distance between hook and lock = 1-3 mm.			y			y	y			
14	Landing door panel rubber			y	y						

Name of field staff
Signature
Date 15 Jul 2015

Name of supervisor
Signature of supervisor
Date 15/07/15

Revision 0 (April 2015)

Figure 63: An actual checklist document of Jul 2015 of equipment number 60005943



Checklist for door system ☑ 1 month ☐ 3 months ☐ 6 months
☐ machine room ☑ machine room less
Contract No. 80-02470
Lift No. L9
month Aug year 2015
Contract name
Commissioning No. 60005943

Necessary tools

No.	Item	Yes	No	Remark
1	Personal Protective Equipment (safety shoes, bump cap, gloves, uniform)	✓		
2	Hex key set (no. 4, 5, 10)	✓		
3	Spanner set (no. 10, 13, 16, 17, 18)	✓		
4	Hammer	✓		
5	Screw driver	✓		
6	Torch light	✓		
7	Door stopper	✓		
8	Lockout Tagout	✓		
9	Rug	✓		
10	Lubricant spray HP68	✓		

Car roller

No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of car roller		y	y	y		y				

Car door (Varidor 35)

No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of car door contact (KTC)		y	y	y						
2	Distance X=4 mm and alignment Y-Z of car door contact (KTC)		y	y			y	y			
3	Appearance of fully-closed contact (KET-S2)		y	y	y			y			
4	Distance X=3 mm and alignment Y-Z of fully-closed contact (KET-S2)		y	y			y				
5	Tension of car door belt		y	y			y				
6	Car door clutch	y	y	y		y		y	✓		
7	Clutch cam		y	y	y			y			
8	Car door shoes		y	y	y		y				
9	Tension of car door transmission rope			y	y		y				
10	Appearance of car door transmission rope			y	y			y			
11	Car door sill	y	y	y		y			✓		Clean
12	Car door header	y	y	y		y			✓		Clean
13	Car door panel	y	y	y	y				✓		
14	Car door rubber stopper			y	y						
15	Car door panel rubber			y	y						
16	Car door drive			y				y			
17	Car door power supply (24 volts)			y			y				
18	Car door human machine interface (HMI)	y	y	y				y			
19	Car door power switch (JHT)			y				y			
20	Car door light curtain		y	y		y					

Landing door (Augusta)

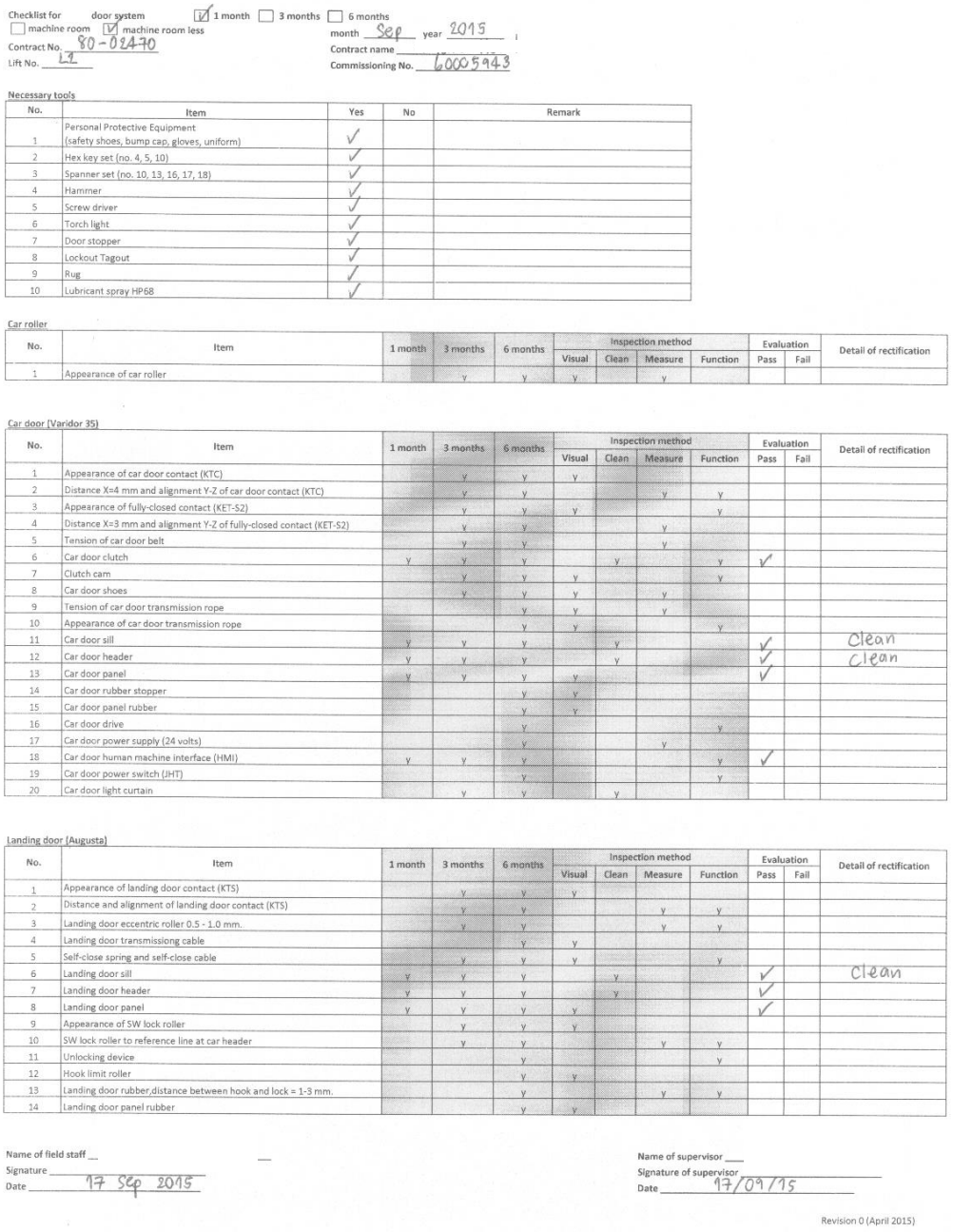
No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of landing door contact (KTS)		y	y	y						
2	Distance and alignment of landing door contact (KTS)		y	y			y	y			
3	Landing door eccentric roller 0.5 - 1.0 mm.		y	y			y	y			
4	Landing door transmissiong cable			y	y						
5	Self-close spring and self-close cable		y	y	y			y			
6	Landing door sill	y	y	y		y			✓		
7	Landing door header	y	y	y		y			✓		
8	Landing door panel	y	y	y	y				✓		
9	Appearance of SW lock roller		y	y	y						
10	SW lock roller to reference line at car header		y	y			y	y			
11	Unlocking device			y				y			
12	Hook limit roller			y	y						
13	Landing door rubber,distance between hook and lock = 1-3 mm.			y			y	y			
14	Landing door panel rubber			y	y						

Name of field staff
Signature
Date 17 Aug 2015

Name of supervisor
Signature of supervisor
Date 17/08/15

Revision 0 (April 2015)

Figure 64: An actual checklist document of Aug 2015 of equipment number 60005943



Checklist for door system ☑ 1 month ☐ 3 months ☐ 6 months
☐ machine room ☑ machine room less
month Sep year 2015
Contract No. 80-02470
Contract name
Lift No. L1
Commissioning No. 60005943

Necessary tools

No.	Item	Yes	No	Remark
1	Personal Protective Equipment (safety shoes, bump cap, gloves, uniform)	✓		
2	Hex key set (no. 4, 5, 10)	✓		
3	Spanner set (no. 10, 13, 16, 17, 18)	✓		
4	Hammer	✓		
5	Screw driver	✓		
6	Torch light	✓		
7	Door stopper	✓		
8	Lockout Tagout	✓		
9	Rug	✓		
10	Lubricant spray HP68	✓		

Car roller

No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of car roller		y	y	y		y				

Car door (Varidor 35)

No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of car door contact (KTC)		y	y	y						
2	Distance X=4 mm and alignment Y-Z of car door contact (KTC)		y	y			y	y			
3	Appearance of fully-closed contact (KET-S2)		y	y	y			y			
4	Distance X=3 mm and alignment Y-Z of fully-closed contact (KET-S2)		y	y			y				
5	Tension of car door belt		y	y			y				
6	Car door clutch	y	y	y		y		y	✓		
7	Clutch cam		y	y	y			y			
8	Car door shoes		y	y	y		y				
9	Tension of car door transmission rope			y	y		y				
10	Appearance of car door transmission rope			y	y			y			
11	Car door sill	y	y	y		y			✓		clean
12	Car door header	y	y	y		y			✓		clean
13	Car door panel	y	y	y	y				✓		
14	Car door rubber stopper			y	y						
15	Car door panel rubber			y	y						
16	Car door drive			y				y			
17	Car door power supply (24 volts)			y			y				
18	Car door human machine interface (HMI)	y	y	y				y	✓		
19	Car door power switch (JHT)			y				y			
20	Car door light curtain		y	y		y					

Landing door (Augusta)

No.	Item	1 month	3 months	6 months	Inspection method				Evaluation		Detail of rectification
					Visual	Clean	Measure	Function	Pass	Fail	
1	Appearance of landing door contact (KTS)		y	y	y						
2	Distance and alignment of landing door contact (KTS)		y	y			y	y			
3	Landing door eccentric roller 0.5 - 1.0 mm.		y	y			y	y			
4	Landing door transmissiong cable			y	y						
5	Self-close spring and self-close cable		y	y	y			y			
6	Landing door sill	y	y	y		y			✓		clean
7	Landing door header	y	y	y		y			✓		
8	Landing door panel	y	y	y	y				✓		
9	Appearance of SW lock roller		y	y	y						
10	SW lock roller to reference line at car header		y	y			y	y			
11	Unlocking device			y				y			
12	Hook limit roller			y	y						
13	Landing door rubber,distance between hook and lock = 1-3 mm.			y			y	y			
14	Landing door panel rubber			y	y						

Name of field staff
Signature
Date 17 Sep 2015

Name of supervisor
Signature of supervisor
Date 17/09/15

Revision 0 (April 2015)

Figure 65: An actual checklist document of Sep 2015 of equipment number 60005943

VITA

For education background, Mr. Khatayos Phummanee received bachelor's degree in Electrical Engineering from Chulalongkorn University in academic year 2009.

For working background, he had 1-year working experience in project engineer department in multinational consumer product's company after graduation. Afterwards until now, he has been working for 5 years in technical & field support department in multinational elevator company.