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Analysis oOn Installation, Testing aAnd Commissioning oOf Automatic Platform Gate (APG) aAnd Platform Screen Door (PSD)

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Abstract: Railway transit is one of the most common modes of public transportation for people nowadays. Therefore, when developing public rail transit, one of the most critical considerations is safety. Automatic Platform Gate (APG) and Platform Screen Door (PSD) is one of the precautionary measures that has been implement by railway services in railway station to improve the safety. It is a system that separates the platform from the train track to prevent the passenger from accidently fall into the track. However, the issue that arises here is that failure of component happened during installation and testing procedure. Hence, the objective of this project is to investigate the failure and root causes during installation and testing procedure of APG/PSD. The design of APG/PSD system is discussed in the literature review chapter of this project. While doing the testing procedure the faulty component will be recorded. Result of investigation shows that the limit switch is one of the failures that always happened. Therefore, a new model of limit switch will be used to replace the previous one. Before the new model can be implement at stations, it needs to be tested first. Only after it pass the requirement needed, the new model can be used at stations.

Keywords: Automatic Platform Gate, Platform Screen Door, Limit Switch, KVMRT2

1. Introduction

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Today, public transportation is extremely important in both urban and rural areas, and the quality, availability, and accessibility of public transportation services affects most people directly or indirectly[1][2]. It is now well acknowledged that reliance on automobiles is a very detrimental trend that has resulted in traffic congestion, environmental issues, noise, accidents, and air pollution in most places across the world[2]. As a result, providing good public transportation systems that provide a high-quality and inexpensive option for citizens and reduce the usage of private vehicles is one of the most important stages in maintaining sustainability[3]. By offering low-cost public transportation that meets the capacity needs of travellers, the number of traffic accidents would be minimised[4]. Therefore, safety is one of the most important things to look at when developing public rail transportation[3]. To address such legitimate concerns, rail service providers would be prudent to implement preventative measures that make both rail trains and train stations safer for customers, which is installing the Automatic Platform Gate (APG) and Platform Screen Door (PSD) at stations. APG and PSD is subsystem in a railway station, for safety reason, mainly to prevent passenger accidently fell to track from platform[5][6][7]. APG is often use on the elevated station while PSD is used in underground station. The purpose of this research is to study the testing and commissioning procedure for both APG and PSD. There are 4 part of testing and commissioning which are the Post Installation Test (PIT), Partial Acceptance Test (PAT), System Acceptance Test (SAT) and System Integration Test (SIT).

1. To study how APG and PSD works as a subsystem in a station.
2. To investigate the failure and root causes during installation, testing and commissioning procedure of APG and PSD.
3. To develop new ~~procedure or~~ model to solve the failure that occurred during installation, testing, and commissioning.

The scope of this project is research of APG and PSD of Project Mass Rapid Transit Line 2 which is KVMRT Putrajaya Line starting from Kwasa Damansara until Putrajaya. Figure 1~~.1~~ shows the map routing of KVMRT Putrajaya Line. APG is used on the elevated station while PSD is used at underground station. This project will focus more on investigation of one of the faulty equipment or components of APG and PSD while doing the installation and testing procedure for APG and PSD. The data then will be ~~analysed~~analyzed and investigate to find the causes of the failure.

2. Materials and Methodology

2.1 Introduction~~Materials~~

APG or PSD is a subsystem in railway station which are used to divide the platform from the train tracks at some train, rapid transit, and light rail systems[8]. They are primarily utilised to ensure the safety of passengers[9]. They are a recent addition to several metro systems across the world, with some being adapted into existing systems[5].PSD can apply to both full-height and half-height barriers, while the names are typically used interchangeably[10]. In Malaysia, half-height platform screen doors are referred to as APG since they do not reach the ceiling and hence do not constitute a total barrier. Full-height platform screen doors are total barriers between the station floor and ceiling[11]. APG are normally half the height of full-screen doors, but they might occasionally approach the train's height[12]. These two varieties of platform screen doors are the most common in the world right now[13].PSD, which require more iron framework for support, are more expensive to install than APG. As a result, some train operators may prefer APG to improve platform safety while keeping expenses low and non-air-conditioned platforms naturally ventilated[14]. APG, on the other hand, are less effective than full PSD at preventing persons from jumping onto the tracks on purpose[15][16].

Benefit of APG/PSD:

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1. Effectively improves the safety on the platform and prevent passenger from falling off the track[5][7].
2. Prevent or lessen the amount of wind felt by passengers as a result of the piston effect, which can cause people to lose their balance in particular situations[17][18].
3. Prevent the air from being polluted by fumes produced by train wheels grinding against the tracks on underground or indoor platforms[19].
4. Reduce train noise and provide passenger with a comfortable environment[20][21].

Their disadvantages are that they restrict the types of rolling stock that can be used on a line by requiring train doors to be the same width as platform doors[22]. The doors themselves also are a safety hazard[23]. The main danger is that individuals will become stuck between the platform doors and the train carriage and will be crushed as the train moves[24]. This is an uncommon occurrence that may be due to door design.

2.2 Methodology

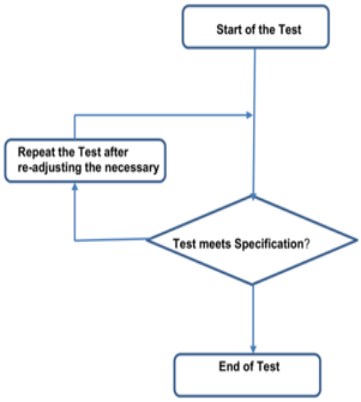

Figure 11 : General Flow chart of Testing and Commissioning

Figure 3.2 shows the general flow chart of testing and cmmissioing procedure.While doing the Partial Acceptance Test (PAT), System Acceptance Test (SAT) and System Intergration Test (SIT). Master Monitoring System(MMS) software is used to monitored APG/PSD. Figure 3.3 shows the interface of MMS. Each time any failure of equipment occurred, it will be recorded. The data then will be analyze to check which failure most frequeny happened.

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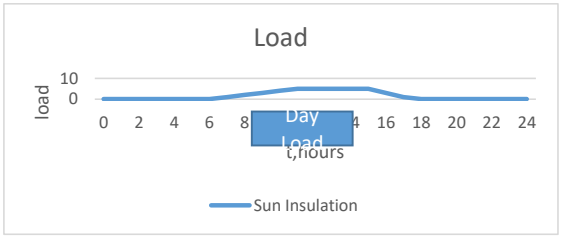

Figure ~~2~~2 : Master Monitoring System (MMS)

2.2 PAT ~~PAT~~ Funtion Test of ASG/ASD

The function test will observe the status of ASG, GOIL, LED strip and Buzzer during operational. During this procedure, all faulty equipment will be recorded. Table ~~3.~~1 shows the test instruction and expected result for ASG/ASD function test.

Table ~~1~~1: ~~PAT~~ Function Test of ASD

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Test No	Test Instruction	Expected Result
1	Operate Local Control Key Switch (LCKS) to "ISOLATE" mode: Turn the LCKS to "ISOLATE" position. Check GOIL, LED strip and Buzzer	GOIL, LED strip and Buzzer: 1. GOIL is ON (Red). 2. LED strip is OFF. 3. The buzzer is mute
2	Operate Local Control Panel (LCP) to Open/Close platform doors	All ASG will not response LCP door open/close command
3	Operate LCKS to open ASG: Turn the LCKS to "MAINTENANCE" position and push "DOOR OPEN" button. Check ASG, GOIL, LED strip and Buzzer during ASG opening	ASG: 1. ASG starts to open until fully opened. GOIL, LED strip and Buzzer (ASG opening): 2. GOIL is ON (Blue). 3. LED strip is ON. 4. The buzzer chimes on. GOIL, LED strip and Buzzer (ASG fully opened): 5. GOIL is ON (Blue). 6. LED strip is ON. 7. The buzzer is mute
4	Operate LCKS to close ASG: Turn the LCKS to "MAINTENANCE" Push "DOOR CLOSE" button. Check ASG, GOIL, LED strip and Buzzer during ASG closing	ASG: 1. ASG starts to close until fully closed and locked. GOIL/LED strip and Buzzer (ASG closing): 2. GOIL is Flashing (Blue). 3.LED strip is Flashing. 4. The buzzer chimes on GOIL, LED strip and Buzzer (ASG closed & locked): 5. GOIL is ON (Red). 6. LED strip is OFF. 7. The buzzer is mute

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5	Operate LCKS to "AUTO" mode: Turn the LCKS to "AUTO position. Set ASG in closed & locked. Check GOIL, LED strip and Buzzer	GOIL, LED strip and Buzzer: 1. GOIL is OFF. 2. LED strip is OFF. 3. The buzzer is mute.
6	Use LCP to open ASG. Check GOIL, LED strip and buzzer performance during ASG opening	ASG: 1. ASG starts to open until fully opened. GOIL, LED strip and Buzzer (ASG opening): 2. GOIL is ON (Blue). 3. LED strip is ON. 4. The buzzer chimes on. GOIL, LED strip and Buzzer (ASG fully opened): 5. GOIL is ON (Blue). 6. LED strip is ON. 7. The buzzer is mute.
7	Use LCP to close ASG. Check GOIL, LED strip and buzzer performance during ASG opening	ASG: 1. ASG starts to close until fully closed and locked. GOIL/LED strip and Buzzer (ASG closing): 2. GOIL is Flashing (Blue).

2.3 PAT and SAT Cyclic Test

The ASG will be set the cycle data of the doorways for minimum 2 hours at 2 cycles per minute. Table ~~3.~~2 shows instruction for Pat Cyclic test. PAT is considered pass if the door cycle 240 times without failure. SAT is considered pass if the door cycle 1000 times without failure. During this procedure, all faulty equipment will be recorded

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Table ~~2~~2: Test Instruction PAT and SAT Cyclic Test

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Test no	Test Instruction		Expected Result
	Test item	Test Procedure	
1	ASG 101	set the cycle data of the doorways for minimum 2 hours at 2 cycles per minute	1000 times
2	ASG 102		1000 times
3	ASG 103		1000 times
4	ASG 104		1000 times
5	ASG 105		1000 times
6	ASG 106		1000 times
7	ASG 107		1000 times
8	ASG 108		1000 times
9	ASG 109		1000 times
10	ASG 110		1000 times
11	ASG 111		1000 times
12	ASG 112		1000 times
13	ASG 113		1000 times
14	ASG 114		1000 times
15	ASG 115		1000 times
16	ASG 116		1000 times

3. Results and Discussion

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During testing procedure, we record all the faulty and equipment happened and found out that one of the main problems during the testing procedure of APG is limit switch. Appendix B shows the data of faulty equipment from 1st March. When doing 240 open and close cycle doors for PAT and 1000 cyclic for SAT, limit switch failure always happened. Also, during test run for phase 1 of MRT Line 2 which is from Kwasa Damansara Station until Kampung Batu Station, we often found out that that we need to replace limit switch and adjust the ELD. Figure 4.1 shows the frequency of limit switch failure.

Table ~~3~~3: Data of Faulty Equipment From 1st March

Date	Item reported	Details	Qty
1/3/2022	EOIL	Faulty lights	2
1/3/2022	Limit Switch	Faulty limit switch	1
4/3/2022	ELDL	ELD not push back,	2
5/3/2022	ELDR	ELD not push back	1
5/3/2022	Limit Switch	Not functioning	1
6/3/2022	FS2 right top hood	Visual defect,	1
9/3/2022	EML	EML not receiving power	1
9/3/2022	ELDR	Faulty limit switch	2
13/3/2022	Limit switch	Faulty limit switch	5
15/3/2022	IPC	Software issue, returned to rectify	1
15/3/2022	GCU	Port 2 power fault - 2pcs, Port 4 power fault - 1pcs	3
16/3/2022	POIL	Not functioning	1
17/3/2022	EOIL	Not functioning	1
18/3/2022	Limit switch	Faulty limit switch	1
19/3/2022	EOIL	Not receiving input power	2
20/3/2022	GOIL Right	GOIL LED different design	1
20/3/2022	POIL	Not receiving input power	1
21/3/2022	Limit Switch	Faulty limit switch	2
22/3/2022	ELDR	ELD not push back	1
25/3/2022	GCU	Cannot receive input power	2
25/3/2022	Limit Switch	Faulty limit switch	2
27/3/2022	Motor right	Hall fault	1
29/3/2022	GCU	J4 port no power	2
29/3/2022	Limit Switch	Faulty Limit switch	1
2/4/2022	Limit switch	Faulty Limit switch	1
4/4/2022	JB	JB board damaged by glue	1
6/4/2022	Limit switch	Faulty Limit switch	1
6/4/2022	ELD	ELD intermittent lost contact	4
10/4/2022	GCU	Port J2-J no input	1
14/4/2022	ELD limit switch	Intermittent signal fault	2
18/4/2022	Limit switch	Faulty Limit switch	1
22/4/2022	GOIL Left	GOIL not lighting up	1
26/4/2022	POIL	POIL cap lost	2
28/4/2022	Limit switch	No continuity	1
30/04/2022	Limit switch	Faulty Limit switch	1
4/5/2022	ELDL	Solenoid not operating	2
8/5/2022	Motor right	Suspected motor drive fault	1
10/5/2022	Motor right	Cable bitten by rat	1
10/5/2022	Limit switch	Faulty Limit switch	1
12/5/2022	GCU	J4 port no power	1
14/5/2022	ELDR	Pin stuck	1
14/5/2022	ASG stopper bracket	Bracket damaged and broken	1

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16/5/2022	Limit switch	Faulty Limit switch	1
18/5/2022	Limit switch	Faulty Limit switch	1

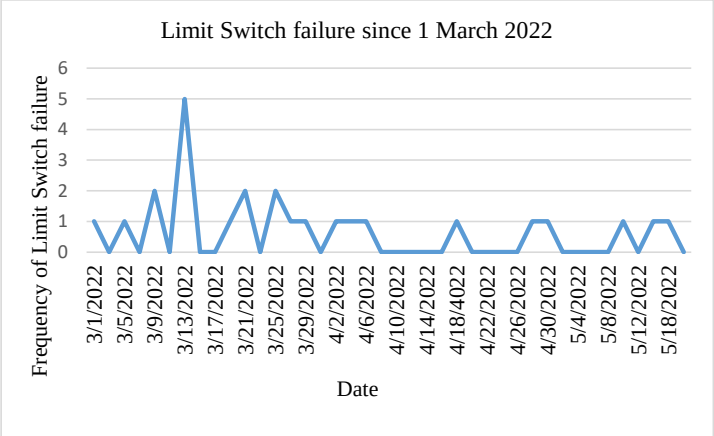

Figure 33: Limit Switch Failurge

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3.1 Reliability Test of New Limit Switches

After received the fault feedback of the limit switch, the supplier company recommended another model of limit switch for replacement, which is fully compatible and has at least an equivalent performance to the old limit switch. The design of limit switch includes the Electrical Locking Device (ELD) which serves to lock the doors in place after it has been fully closed. This is part of a safety measure on the system and forms part of the All Doors Closed and Locked (ADCL) loop. Before the new limit switch model can be replace, it must be tested first. The test is performed to demonstrate the reliability of the new limit switch during open and close cycle operation.

The testing scope involves proving the reliability of the new model limit switch over the over 1 million open and close cycle operation. The test includes dimension inspection of mechanical parts of limit switch, limit switch contact resistance and limit switch contact operation count. The diagram setup for the test is shown in Appendix B. The testing procedure as following:

1. 6 units of limit switches are installed on 3 separate ELDs.
2. The ELDs are placed on a test bed and cycled for 1 million cycles. Each cycle intervals 3 seconds. After every 2 seconds, the ELD is activated for 0.3 seconds, the switches are released and actuated again at the same time.
3. The limit switches are looped by 2 loops segregated by the normally open (NO) contacts and normally closed (NC) groups. Each loop is attached to a counter which is counted once when the ELD are cycled.
4. Every 80,000 cycles, the limit switches are taken out and inspected to ensure they meet the required test specifications as follows
   i) Contact resistance: Less than 100mΩ
   ii) Distance Roller to body: 18.4±0.5(mm)

Table below show the result of reliability test for each of the new limit switches model after 1 million cycles.

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Table ~~4~~4: Result of Limit Switch Reliability Test after 1 million cycles

Limit Switch	NO contact ≤100 (mΩ)	NC contact ≤100 (mΩ)	Distance Roller to body 18.4±0.5(mm)	Result
1	18.91	4.08	18.5	Pass
2	8.83	4.18	18.7	Pass
3	51.78	11.23	18.4	Pass
4	9.43	3.67	18.7	Pass
5	10.38	8.61	18.4	Pass
6	8.83	4.12	18.7	Pass

Overall, all the limit switches met the requirement and pass the reliability test. After 1 million cycles, the resistance value of NC and NO for all limit switch is below 100 mΩ, and the distance between roller and body is 18.4±0.5 mm. All the limit switches are now ready to be implement at stations.

3.2 Implementation of new limit switch

After the new limit switch has passed the criteria and the requirement needed, the old limit switch now can be replaced with the new limit and tested at station. We begin replacing the new limit switch at 1 station which is Cyberjaya City Centre Station (CCCS), and rerun SAT open and close cycle 1000 times with the new limit switch. The result of SAT shows that all doors cycle 1000 times without any failure. After that we replace all limit switch at elevated station and rerun SAT to make sure there is no fault limit switch. Figure 4~~.2~~ shows that there is no more failure of limit switch for Phase 1 stations after replacing with the new model for over 4~~20~~ days.

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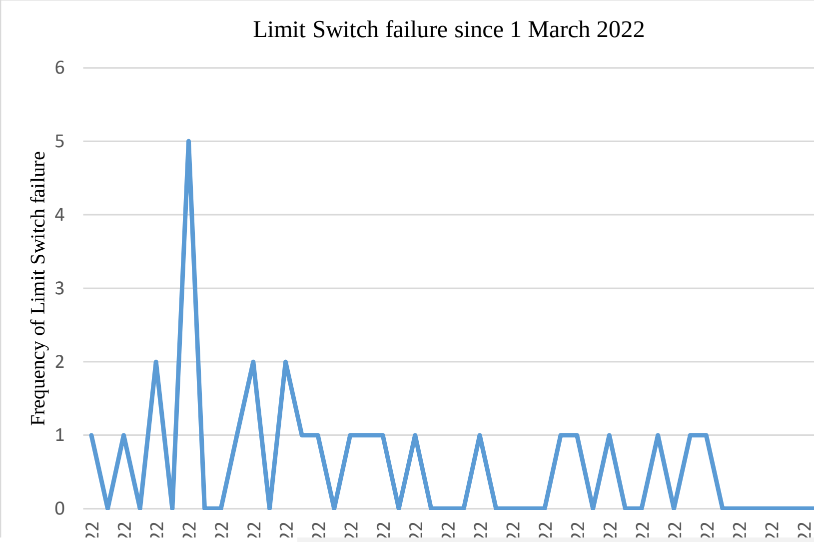

Figure 44: Frequency of limit switch failure after replacement

4. Conclusion

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As shown in the result section the main issue we found out during the testing procedure is limit switch failure. The new limit switch model needs to undergo reliability test before it be used at stations. Result of the reliability test shows that the new model limit switch met the requirement needed, therefore it can used at stationsBy replacing the limit switch with the new model, there are no problem or failure related to limit switch when doing the testing for APG. There are no more problem or failure related to limit switch when doing the testing for APG. All station for MRT line 2 from Kwasa Damansara Station until Putrajaya Sentral Station is now using the new model limit switch. When doing the test run of MRT line 2 for Phase 1, limit switch failure has not happened for more than 44 days [illegible]

The suggestion and recommendation that can be made to improve this project is to develop a new model of limit switch instead of getting it from the supplier company. Other failure that can also be found during the testing procedure is faulty ELD. Therefore, ELD also ca.n be investigated to find out if it also needs to be replaced and increase the performance of APG/PSD.

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