Real-time Track Monitoring System to be Extended Across MTR Network to Further Enhance Railway Track Monitoring and Maintenance

The MTR Corporation today (10 February 2021) released the results of the investigation into the Light Rail derailment incident which occurred on 29 August 2020. The Corporation announced that a real-time dynamic track performance monitoring system which is currently used on the East Rail Line will be installed across the railway network in phases within two years to further enhance railway track monitoring, maintenance measures, and train service reliability.

Installation of the monitoring system will start in two Light Rail Vehicles (LRVs) as recommended by the Investigation Panel which was set up after the Light Rail derailment incident. The first LRV is targeted to put into operation by end March of this year, followed by the second LRV in the second quarter of this year.

By installing the related equipment on the trains, the real-time dynamic track performance monitoring system continuously monitors the condition of the track in real-time throughout traffic hours including track gauge and vibration so that the maintenance team can monitor any changes in the main track parameter trends by using a data analytic tool. This will enable them to arrange any necessary maintenance follow-up in a more effective and timely manner.

Regarding the Light Rail derailment incident which occurred on 29 August 2020, an Investigation Panel comprising external experts was set up to identify the cause and make recommendations to prevent any recurrence. The Investigation Panel concluded that localised gauge widening arising from a side-worn switch blade on the concerned section resulted in unfavourable wheel/rail interaction conditions which led to the derailment. The newly machined wheels of the LRV involved had a rougher contact surface between wheel and rail, thus causing reduced lubrication which was also a contributory factor. The Investigation Panel also concluded that Light Rail maintenance personnel had carried out track maintenance work in accordance with internal procedures.

Immediately after the incident, the Corporation replaced the relevant turnout switch rail, stock rail and external check rail and carried out inspections on all the critical turnouts in the Light Rail system to make sure they were in good condition for operations. In addition to installing the real-time track dynamic performance monitoring system on two LRVs, the Corporation has also followed up and implemented a number of enhancement measures recommended by the Investigation Panel to prevent a recurrence of similar incidents in the future. These include increasing the frequency of rail lubrication at wheel/rail interfaces at turnouts; revamping turnout maintenance procedures, including the timeframe for rail defect follow-up action, gauge monitoring and maintenance; the use of a new tool to assess turnout rail-wearing conditions; and establishing a high-level steering group to monitor the progress of enhancement works.
“Safety is of utmost importance to MTR operations. The Corporation is keen to ride on new technology to enhance operational efficiency. Introducing the real-time dynamic track performance monitoring system and implementing the enhancement measures recommended by the Investigation Panel will further strengthen our monitoring of railway tracks. We can then follow up with preventive measures and conduct any necessary repairs quickly when an irregularity is detected. By doing so, we can make our overall train service smoother and more reliable,” said Dr Tony Lee, Operations Director of MTR Corporation.

The detailed findings of the investigation into the Light Rail derailment incident on 29 August 2020 are set out in the Annex.

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About MTR Corporation

Every day, MTR connects people and communities. As a recognised world-class operator of sustainable rail transport services, we are a leader in safety, reliability, customer service and efficiency.

MTR has extensive end-to-end railway expertise with more than 40 years of railway projects experience from design to planning and construction through to commissioning, maintenance and operations. Going beyond railway delivery and operation, MTR also creates and manages dynamic communities around its network through seamless integration of rail, commercial and property development.

With more than 40,000 dedicated staff*, MTR carries over 13 million passenger journeys worldwide every weekday in Hong Kong, the United Kingdom, Sweden, Australia and the Mainland of China. MTR strives to grow and connect communities for a better future.

For more information about MTR Corporation, please visit www.mtr.com.hk.

*includes our subsidiaries and associates in Hong Kong and worldwide
By installing the related equipment on the train bogie (the device circled in yellow in the photo), the dynamic track performance monitoring system continuously monitors the condition of the track in real-time throughout traffic hours. This allows the railway maintenance team to decide on timely maintenance interventions and enhances train service reliability.
**Annex**

**Executive Summary**

At around 20:25 hours on 29 August 2020, a Light Rail Vehicle (LRV) in passenger service derailed at Point T129 while approaching Light Rail Siu Hong Stop platform 1 at a speed of around 15 km/h with all the four wheels of the rear bogie off the rail.

An Investigation Panel (the Panel) was established to investigate and identify the cause of the incident. It concluded that the localized wide gauge arising from the side-worn switch blade at Point T129, involving unfavorable wheel / rail interaction conditions, contributed to the wheel climbing. The cause of the incident is the inadequacy of current maintenance arrangement in monitoring of rapid change in rail asset condition and timely escalating long outstanding rerailing works. Immediately after the incident, the replacement of incident turnout rail components including the external check rail of T129 were completed on 29^30 August 2020.

The Light Rail Track Maintenance Team had scheduled to replace the switch blade, stock rail and external check rail of T129 during the non-traffic hours on 4^5 September 2020 based on their judgement.

The Investigation Panel made the following recommendations for preventing the recurrence of similar incident:

a) Increase frequency of rail lubrication at wheel/rail interfaces. (Completed)

b) Revamp and update turnout maintenance procedure, including time-frame for rail defect follow-up action, gauge monitoring and maintenance, and the use of New Tool (Go/No Go Gauge) to assess rail-wearing conditions. (Work in progress, target completion by Q1/2021)

c) Install track dynamic performance monitoring system on two LRVs to monitor running track integrity for timely maintenance intervention and escalation for management attention. (Work in progress, target completion by Q2/2021 with the first one by Q1/2021)

d) Establish a steering group to monitor the progress of enhancement works, including the implementation of the refined processes to take timely maintenance intervention and escalation. (Completed)
1. Introduction

1.1 At around 20:25 hours on 29 August 2020, a Light Rail Vehicle (LRV) in passenger service derailed at Point T129 while approaching Light Rail Siu Hong Stop platform 1 at a speed around 15 km/h with all the four wheels of the rear bogie off the rail.

2. The Investigation Panel

2.1 The Corporation was greatly concerned with the incident and therefore set up an Investigation Panel to investigate and identify the cause of the incident, and make recommendations to prevent the recurrence of any similar incident.

2.2 The Panel was chaired by Dr Tony Lee, Operations Director. Membership consisted of senior MTR personnel in the fields of Operations and Engineering as well as external experts, namely Ravi Ravitharan, Director of Institute of Railway Technology (IRT), Monash University; and Professor S.L. Ho, Associate Vice President (Academic Support), Hong Kong Polytechnic University.

2.3 The investigation focused on four areas namely: (i) Track conditions, (ii) Train conditions, (iii) Wheel / rail interaction, and (iv) Asset maintenance.
3. The Incident

3.1 At around 20:25 hours on 29 August 2020, an LRV in passenger service on Route 610 running from Tuen Mun Ferry Pier Stop to Yuen Long Stop derailed at T129 while approaching Light Rail Siu Hong Stop platform 1 at a speed of around 15 km/h. All the four wheels of the rear bogie were found off the rail. An overview of the incident location is shown in Annex 1.

3.2 Service diversion started from around 20:30 hours and first LRV diverted to use Siu Hong Platform 3 at around 20:36 hours. At around 20:41 hours, all the 20 passengers on board were detrained from the incident LRV and were assisted to walk to Light Rail Siu Hong Stop in a safe and orderly manner. No injury was caused in the incident. All Light Rail routes affected by the incident were diverted to other routes.

3.3 Repair works started at around 01:17 hours of 30 August 2020 after the last LRV in passenger service had left Light Rail Siu Hong area. The works was completed before start of Light Rail service and the service of 30 August 2020 was not affected.

4. Causes of the Incident

4.1 At the incident site, running marks exhibited on the external check rail (ECR) and stock rail of Point T129 between sleepers 1 and 8 as shown in Annex 2. These evidences show that the wheel climbing initiated at Point T129.

4.2 The wheel climbing was due to the localized wide gauge arising from the side-worn switch blade which led to higher angle of attack and lateral force, involving unfavorable wheel / rail interaction conditions, at the turnout (sharp curve of 50m radius) with 15kph operating speed at Point T129.

4.3 The loss of flange support and shallow flange contact angle due to the side-worn switch blade contributed to wheel climb on top of blade and over stock rail at Point T129 under the wheel climbing force as illustrated in Annex 3. The side-worn ECR also failed to stop the wheel climbing.
From the maintenance records, both the turnout and ECR maintenance activities for Point T129 in the previous 12 months prior to the incident were completed in compliance with the maintenance cycle. Subsequent to the ECR maintenance on 12 July 2020 that the track gauge at one out of the 14 measured points had reached the Safety Intervention Limit (SL) of 1460mm as specified in the Operations Engineering standard, track alignment adjustment was conducted by the First Line Maintenance Team to reduce the track gauge below the SL as an interim rectification prior to rail replacement scheduled on 4^5 September, 2020. At the time of incident, the track gauge was below the SL.

Rerailing request for Left Hand Switch and Stock Rails of T129 was raised on 15 April 2016. Before the planned replacement was conducted, condition of T129 was monitored by patrolmen and during regular turnout maintenance and ECR maintenance tasks. The wear of the switch rail was also minimized through the use of ECR. The replacement of T129 Left Hand Switch and Stock Rails was planned on 4^5 September 2020. Scheduling of turnout replacement involving wear on switch rail profile was based on the judgement of the maintenance staff. In recent two years, the ECR of T129 was replaced by the Second Line Rerailing Team on 10 September 2018, 23 May 2019, 26 October 2019 and 23 June 2020 respectively in response to replacement requests raised by the First Line maintenance team.

The Investigation Panel opined that the LR Track Maintenance Team can make better informed judgement on the timeliness of the rerailing works by monitoring the trends of the key track parameters using technologies and data analytics.
worn switch blade, stock rail and ECR during the non-traffic hours on 4^5 September 2020, i.e. six days later than the incident day. Hence, the inadequacy of current maintenance arrangement in monitoring of rapid change in rail asset condition and timely escalating long outstanding rerailing works at incident location is considered as the cause of the incident.

4.8 The wheels of the incident LRV were newly machined one day before the incident (i.e. on 28 August 2020) with new surface roughness that would be smoothened normally after mileage build-up. However, after a few passes at the incident turnout, the newly machined wheels with rougher surface limited the effectiveness of lubrication under the current wheel / rail lubrication practice, is considered a secondary contributory factor.

“Utilising switch rail profiles measured after the incident, the worn switch blade was confirmed to be the primary cause of unfavourable wheel-rail contact conditions that resulted in the derailment at turnout T129. The newly machined wheels, with rougher contact surfaces and associated reduction in effective lubrication, is considered to be a secondary factor.”

Monash IRT
External Expert
5. **Asset Maintenance**

5.1 The Preventive Maintenance (PM) of Point T129 is carried out as follows:
   a) Visual Inspection by Patrolman: two times per week
   b) Turnout maintenance with static measurement: every 90 days
   c) ECR maintenance with static measurement: every 60 days

5.2 The turnout maintenance of 3-month cycle consists of inspection, measurement, greasing and minor repair of the turnout which include the switch and stock rails, crossing, lead rail, closure rail and check rails. As the ECR is designed to act as a means to minimize the wear on the switch thereby reducing the likelihood of derailment, the inspection and measurement of ECR is also conducted in a 2-month cycle.

5.3 In addition, visual inspection, as well as manual rail greasing if required, is conducted by patrolmen twice a week. The patrolling, turnout maintenance and ECR maintenance are conducted by the Light Rail First Line Track Maintenance team. Furthermore, rail replacement requests generated from findings during preventive maintenance (PM) are handled by the Second Line Rerailing Team.

5.4 Immediately after the incident, Point T129 Left Hand Switch and Stock Rails and ECR were replaced on 29^30 August 2020.

5.5 The LR maintenance team engaged Monash IRT in 2019 to develop a customized tool to effectively monitor the switch rail profile and wear of switch rail. By early September 2020, a prototype tool was delivered for trial usage by the LR Maintenance Team. Its usage was then conducted with appropriate rectification measures starting in September 2020.
6. Conclusions

6.1 It was concluded that the localized wide gauge arising from the side-worn switch blade at Point T129, involving unfavorable wheel/rail interaction conditions, contributed to the wheel climbing. The cause of the incident is the inadequacy of current maintenance arrangement in monitoring of rapid change in rail asset condition and timely escalating long outstanding rerailing works.

6.2 The maintenance team had scheduled for replacement of the switch blade on 4^5 September 2020. The maintenance team should therefore be aided with enhanced tooling, adoption of technology, and refined processes to make more timely maintenance intervention and escalation for management.

“The Maintenance Team had been making the prioritization of their maintenance work based on their past experiences and professional judgement. These judgements are largely sound but they might not be timely enough to prevent the occurrence of incidents. Hence it is recommended that the Maintenance Team should source suitable instruments, such as Go/No Go gauges to help to provide some quantifiable parameters for the Maintainers to make an informed judgement.”

Poly U
External Expert
7. **Recommendations**

The Investigation Panel made the following recommendations for preventing the recurrence of similar incident:

7.1 Increase frequency of rail lubrication at wheel/rail interfaces. (Completed)

7.2 Revamp and update turnout maintenance procedure, including time-frame for rail defect follow-up action, gauge monitoring and maintenance, and the use of New Tool (Go/No Go Gauge) to assess rail-wearing conditions. (Work in progress, target completion by Q1/2021)

7.3 Install track dynamic performance monitoring system on two LRVs to monitor running track integrity for timely maintenance intervention and escalation for management attention. (Work in progress, target completion by Q2/2021 with the first one by Q1/2021)

7.4 Establish a steering group to monitor the progress of enhancement works, including the implementation of the refined processes to take timely maintenance intervention and escalation. (Completed)
Annex 1

Overview of Incident Location
Annex 2

Incident Site near Light Rail Siu Hong Stop

Wheel climbing of the incident LRV rear bogie initiated at Point T129.
Annex 3

Illustration of Wheel/ Rail Interaction at the Incident Point T129

Unfavourable wheel/ rail interaction conditions at the incident turnout involving the side-worn switch rail at Point T129.

New Switch Rail and ECR conditions

Incident Switch Rail