新聞稿

Press Release

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3 March 2020

MTR Implements Improvement Measures as Investigation Panel Concludes Dynamic Track Gauge Widening Caused East Rail Line Derailment Incident

The MTR Corporation today (3 March 2020) made public the results of its investigation into the East Rail Line ("EAL") derailment incident which occurred on 17 September 2019. It was concluded that the incident was caused by dynamic track gauge widening at a turnout near Hung Hom Station ("HUH").

Safety is of the utmost importance to MTR operations and the Corporation takes the incident very seriously. An Investigation Panel ("the Panel") comprising MTR staff from relevant disciplines and advised by external experts from the United Kingdom, Australia and Hong Kong was set up to identify the cause of the incident and recommend improvement measures. The Panel submitted a report to the Electrical and Mechanical Services Department ("EMSD") on 14 February 2020, and the EMSD has just completed its review. The Corporation also cooperated with an independent investigation by the EMSD over the incident.

The Incident

At 8:29am on 17 September 2019, an EAL train in passenger service was approaching Platform 1 of HUH when it derailed at turnout P5116, north of the station, at around 39 km/h. Three cars (4, 5 and 6) of the 12-car train derailed and cars 4 and 5 were separated. Eight passengers were reported injured in the incident on 17 September 2019 and two of them were hospitalised for two days. EAL service between Hung Hom and Mong Kok East stations was suspended on that day for site investigation and re-railing of the affected cars, and service resumed the following morning.

Cause of the Incident

The Panel concluded that the derailment was caused by the dynamic track gauge widening beyond a critical level at turnout P5116. The investigation found that, in the early hours of 4 August 2019, the EAL Track Maintenance Team replaced two worn out timber sleepers with new synthetic sleepers to correct the track gauge. Due to the special combination of rail alignment at a sharp curve, high traffic intensity and the difference in stiffness between the new synthetic sleepers and neighbouring sleepers in this particular location, this arrangement had an unintended consequence in that the two synthetic sleepers created a localised hard spot in the rail support system. This hard spot resulted in most of the sideways loading from the trains passing through this curved section being exerted onto the rail fastening of the two newly replaced synthetic sleepers, which accelerated the fastening's deterioration. Three of the fixing screws failed as a result, which allowed one of the rails to move sideways, leading to an increase in the gap between the two rails or "dynamic track gauge widening beyond a critical level" and train wheels hitting the check rail. This in turn led to the derailment.

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The Panel concluded that the rolling stock and signalling system worked normally and did not contribute to the derailment. There was no external obstruction identified. The broken rails found at the incident site were the result of the damage caused by the derailment.

Railway Asset Management and Track Maintenance

The management of railway assets and track maintenance of the MTR are in line with international standards. However, the Panel concluded that the EAL Track Maintenance Team had a knowledge gap of the effect of the special combination of circumstances at turnout P5116 for making an informed decision on the scope, timeliness and effectiveness of the remedial measures required to correct the dynamic track gauge. Similar problems with the use of synthetic sleepers had not been encountered in the ten years since their introduction in MTR.

The Panel concluded that follow up measures to inspect and rectify the track gauge in the Hung Hom area, and to prepare reports, had not always been conducted strictly in accordance with MTR procedure. Although the Maintenance Team had carried out regular patrolling and preventative maintenance, the Panel considered the team should have relied more heavily on measurement data, rather than their experience, to observe the trend of track gauge widening.

"On behalf of the Corporation, I sincerely apologise again to the passengers affected by the incident. We have learnt lessons from this incident and will spare no effort in putting in place the improvement measures recommended by the Panel to enhance our track maintenance," said Mr Adi Lau, Managing Director – Operations and Mainland Business of MTR Corporation and Co-chairperson of the Investigation Panel.

Improvement Measures

The Corporation has implemented improvement measures recommended by the Panel, and they are as follows:

- Developed measures to address changes in track stiffness after sleeper replacement;
- Replaced 2,627 EAL timber sleepers to give extra track reliability;
- Adopted a "step" approach for track maintenance works to enhance monitoring of track gauge and timely escalation;
- Enhanced change management and staff competence for relevant maintenance works when track technology new to MTR is introduced;
- Explore and implement new technology and data analytics to monitor track gauge and track integrity in traffic hours, its trend analysis for maintenance and criteria to trigger necessary escalation to senior management for attention (Installation of the new equipment commenced in February 2020).

The detailed findings of the investigation 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

Annex

Executive Summary

At 08:29 hours on 17 September 2019, a train in passenger service on the East Rail Line (EAL) approaching Hung Hom Station (HUH) platform 1 derailed at turnout P5116 north of the station. Three cars (the 4th, 5th and 6th cars) of the 12-car incident train number L094 [hereafter "Train 1"] derailed and the train was divided between the 4th and 5th cars.

An Investigation Panel (the Panel) was established to investigate and identify the cause of the incident. It concluded that dynamic track gauge widening at HUH turnout P5116 caused the derailment.

Shortly before the incident, dynamic track gauge widening at HUH turnout P5116 reached a level which led to the wheels of a preceding train number L086 [hereafter "Train 5"] damaging the check rail of turnout P5116. Subsequently, the incident Train 1 derailed at turnout P5116 at a speed of around 39km/h and travelled on the unintended route at turnout P5114.

The EAL Track Maintenance Team had been addressing track gauge widening at turnout P5116 through a series of inspections, verifications and maintenance interventions since July 2018, when the dynamic gauge threshold was first exceeded. On 3^4 August 2019, 2 out of 5 deteriorating timber sleepers of an array of 17 sleepers were replaced with 2 new synthetic sleepers at the approach of the check rail of turnout P5116.

This intervention on 3^4 August 2019 was intended to correct the track gauge at the incident location. However, this intervention, which the Maintenance Team considered according to their experience would be sufficient, created a localized uneven lateral stiffness between the 2 new sleepers and the preceding 15 sleepers. This resulted in unexpected excessive lateral force being applied to the rail under train operation which subsequently broke the coach-screws that secured the rail to the new sleepers.

Despite the intention of the Maintenance Team to rectify the gauge widening at the incident turnout P5116, the Panel considered such interventions were not sufficient. The replacement of the 2 timber sleepers created uneven lateral track stiffness at the turnout P5116 which has an atypical combination of sharp curve track geometry and high traffic intensity.

The Panel concluded that the Maintenance Team clearly had a knowledge gap of the effect of this atypical combination of circumstances to make an informed judgement on the scope, timeliness and effectiveness of remedial measures required to correct the dynamic track gauge. Similar problems had not been encountered with the use of synthetic sleepers in the 10 years since their introduction in MTR.

The Panel concluded that follow up measures to inspect and rectify the track gauge, and to prepare reports, had not always been conducted strictly in accordance with the MTR procedure since the dynamic gauge threshold was first exceeded in July 2018. The Panel considered the Maintenance Team should have relied more heavily on measurement data, rather than their experience, to observe the trend of track gauge widening, despite the fact that they had carried out the regular patrolling and preventative maintenance throughout the period.

Senior management was not aware of this situation as it was not escalated, nor was it revealed by internal management processes, such as routine management reports and audits. The Panel opined that the monitoring of compliance of track gauge should be enhanced and escalated through reinforced internal governance.

No evidence has been found to suggest that the condition or performance of the rolling stock and/or the signaling system contributed to the derailment, nor was there any evidence of external influence in the derailment. The Panel concluded that the broken rails identified at the incident site were the result of damage caused by the derailment.

The following recommendations have been made by the Panel:

a) Develop measures to address the variation in lateral stiffness when using synthetic sleepers in replacing timber sleepers to avoid prolonged stress concentration on individual coach screws. (Completed);

b) Accelerate the planned replacement of 2,627 East Rail Line timber sleepers to give extra performance resilience to track integrity. (To be completed by mid-February 2020);

c) Refine maintenance action thresholds using a “step” approach and enhance monitoring of compliance of track gauge and escalation through reinforced governance (“lines of defence”). (Completed);

d) Enhance change management of introducing track technology that is new to MTR, including site testing and staff competence enhancement to bridge any knowledge gap based on the lessons learnt. (Completed);

e) Explore and implement new technology and data analytics to monitor track gauge and track integrity in traffic hours, its trend analysis for maintenance and criteria to trigger necessary escalation to senior management for attention. (Equipment to be delivered in February 2020 for trial).

1. Introduction

1.1 At 08:29 hours on 17 September 2019, a train in passenger service on East Rail Line (EAL) approaching Hung Hom Station (HUH) platform 1 derailed at turnout P5116 north of the station at a speed of around 39km/h. Three cars (the 4th, 5th and 6th cars) of the 12-car incident train number L094 (hereafter "Train 1") derailed and the train was divided between the 4th and 5th car as shown in Annex 1.

2. The Investigation Panel

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

2.2 The Panel was chaired jointly by Adi Lau, Operations Director at the time the Panel was formed, and Peter Ewen, Engineering Director. Membership consisted of senior MTR personnel in the fields of Operations and Engineering as well as external experts, namely Ravi Ravitharan, Director of the Institute of Railway Technology (IRT), Monash University; Owen Evans, Senior Vehicle Dynamicist of Resonate Group Limited; and Professor S.L. Ho, Associate Vice President (Academic Support), Hong Kong Polytechnic University.

3. The Incident

3.1 At 08:29 hours on 17 September 2019, a train in passenger service approaching HUH platform 1 and operating in Automatic mode derailed at turnout P5116 north of the station at a speed of around 39km/h. Three cars (the 4th, 5th and 6th cars) of the 12-car incident Train 1 derailed and the train was divided between the 4th and 5th car as shown in Annex 1. At 08:32 hours, train service of EAL between HUH and Mong Kok East Station (MKK) was suspended.

3.2 At about 09:03 hours, passengers in the front 4 cars completed their detrainment to HUH Platform 1 by walking through the train compartments. Passengers in the rear 8 cars were assisted to walk to HUH platforms along the track. All the passengers in the train (about 500) completed the detrainment in a safe and orderly manner to HUH platform by about 09:43 hours.

3.3 The train service between HUH and MKK was resumed at 06:05 hours on 18 September 2019 using HUH platform 4 only. On 20 September 2019, both EAL platforms of HUH resumed service.

3.4 Eight passengers were reported injured on 17 September 2019. Two were admitted to hospital and both of them were discharged on 19 September 2019. Another 7 passengers reported unwell on 18 September 2019 and none of them were hospitalized.

3.5 Following the incident, enhanced measures were put in place at turnout P5116 and remain in effect:

- Cab ride by a supervisory grade staff twice a day
- Daily on-site day time inspection
- Speed restriction of 30 km/h was imposed

In addition, all the concerned sleepers at turnout P5116 were replaced.

3.6 HUH turnout P5116 together with all others in the vicinity were introduced as part of the interfacing works under the Kowloon Southern Link project which was opened in August 2009.

4. Cause of the Incident

4.1 Prior to the incident, at about 08:18 hours on 17 September 2019, the leading wheelset on the 8th car of Train number L086 [hereafter “Train 5”] hit the check rail of turnout P5116 and damaged it as shown in Annex 2. A check rail is laid parallel to a running rail to guide wheels through the rail crossing of all turnouts. The wheels of 3 subsequent trains [namely “Trains 4, 3 and 2”] hit and progressively further damaged the check rail but still took the

intended route to HUH platforms. Subsequent inspection found abnormal marks on the wheelsets of Trains 5, 4, 3 and 2.

4.2 At about 08:29 hours, the leading wheelset of the 5th car of Train 1 rode up on the remainder of the damaged check rail of turnout P5116 and took an unintended route towards Platforms 3 and 4 at turnout P5114 as shown in Annex 2, completely derailing the 4th, 5th and 6th cars and dividing the train between the 4th and 5th cars at a speed of around 39km/h.

4.3 The wheelset of Train 5 damaged the check rail due to widening of the dynamic track gauge (the distance between the rails under the load of a running train) beyond a critical level.

4.4 This dynamic gauge widening was initiated by:

a) lateral movement of the rail in the group of 6 synthetic sleepers (Zone 3 in Annex 3) immediately preceding the group of 5 deteriorating timber sleepers (Zones 1 and 2 in Annex 3) in front of turnout P5116 as a result of loosen/broken coach screws and elongation of the mounting holes under the baseplates. This prevented them from taking up their fair share of the lateral force resulting from train operation;

b) the subsequent localized uneven lateral track stiffness introduced after the replacement of 2 (Zone 1 in Annex 3) of the group of 5 deteriorating timber sleepers on 3^4 August 2019; then

c) the resultant high lateral force applied to the rail onto the coach-screws prompting elongation of the mounting holes of the base-plate on the sleepers and

d) the generation of excessive lateral force onto the newly replaced synthetic sleepers which contributed to the breakage of the coach-screws of the base-plate which secures the rail to the sleepers in front of the check rail of P5116,

e) the disengagement of the broken coach-screws at the

elongated mounting holes, followed by the tilting of the rail assembly, resulting in the dynamic track gauge widening beyond a level that led to the check rail being damaged by the train wheels.

4.5 The Panel concluded the cause of the derailment was due to dynamic track gauge widening at turnout P5116.

> *"Monash Institute of Railway Technology's (IRT) investigation confirmed that the excessive gauge widening contributed to the check rail impact by wheels and the subsequent derailment."*
>
> *IRT*
> *External Expert*

4.6 No evidence has been found to suggest that the condition or performance of the rolling stock and/or the signaling system contributed to the derailment. Nor was there any evidence to suggest any external influence in the derailment. The Panel concluded that broken rails identified at the incident site were the result of damage caused by the derailment.

5. Contributory Factors

5.1 There was an array of 17 sleepers preceding the check rail of P5116 as shown in Annex 3:

a) Zone 1: Two original timber sleepers replaced by synthetic ones on 3^4 August 2019;

b) Zone 2: Three original timber sleepers;

c) Zone 3: Six synthetic sleepers that replaced the original timber sleepers in 2015; and

d) Zone 4: Six original timber sleepers.

5.2 Replacement of 2 deteriorating timber sleepers with synthetic sleepers at the approach to the check rail (Zone 1 in Annex 3) on 3^4 August 2019 was intended to correct the track gauge at the incident location.

5.3 As a result of this replacement, Zone 1 had the highest track lateral stiffness and least lateral movement due to the two newly replaced sleepers and rail fastenings. Zone 2 (3 deteriorating timber sleepers) and Zone 3 (6 synthetic sleepers with elongated mounting holes) had comparatively less track lateral stiffness and hence allowed lateral movement as shown in Annex 3. The EAL Track Maintenance Team was unaware of such elongated mounting holes in the Zone 3 synthetic sleepers and its implication to the track lateral stiffness. The Zone 4 timbers had impaired but still reasonable lateral stiffness.

> *"The Maintenance Team was not aware that, after the replacement of the Zone 3 Sleepers in 2015, the Zone 3 Sleepers started to copy the oval holes in the Sleepers of Zones 1, 2 and 4. Within less than 4 years, very elongated holes were replicated in the Zone 3 Sleepers with no conspicuous visual signs because those oval holes on the Synthetic Sleepers were covered by the base-plates."*
>
> *Hong Kong PolyU*
> *External Expert*

5.4 The combination of the uneven localized track lateral stiffness over the sharp curve comprising of the 4 zones within the turnout P5116 eventually resulted in excessive lateral force on the rail at the 2 newly replaced synthetic sleepers at Zone 1, causing the coach-screws to break under load.

> *"In IRT's laboratory, for the East Rail operating conditions, the coach screw failure under fatigue mode has been recreated by when the coach screw becomes loose. The failure of the coach screws, together with the elongation of the screw holes led to a reduction of lateral- and roll- track stiffness."*
>
> *IRT*
> *External Expert*

> *"The variation in track lateral stiffness introduced additional dynamic forces to the rail, resulting from the rather abrupt reduction in dynamic gauge on the approach to the newly replaced sleepers. In addition, the lateral forces on rail along the incident turnout track were drawn to react through the stiffest path, which was essentially also at these two new sleepers. These had caused compound over-loading effects on the coach-screws in the newly replaced sleepers at Zone 1."*
>
> *Resonate Group Limited*
> *External Expert*

5.5 Follow up measures to inspect and rectify the track gauge, and to prepare reports, had not always been conducted strictly in accordance with the MTR procedure since the dynamic gauge threshold was first exceeded in July 2018. As shown in Annex 4, only 5 static follow up measurements from the 15 Track Geometry & Overhead Line Vehicle (TOV) measurements were taken in accordance with MTR procedure "Management of Track Geometry Measurement by TOV" since July 2018, though static measurements were also taken during 5 scheduled turnout maintenance activities. The Maintenance Team relied too heavily on their experience rather than the measurement data to observe the trend of track gauge widening, despite the fact that they had carried out the regular patrolling and preventative maintenance throughout the period. Senior management was not aware of this situation as it was not escalated, nor was it revealed by internal

management processes, such as routine management reports and audits.

6. Asset Management

6.1 Management of track assets is undertaken in accordance with MTR's Asset Management System (AMS) which is certified to ISO55001 – Asset Management. The AMS provides total asset lifecycle management and comprises inspection, preventive and corrective maintenance, asset condition assessment and asset replacement.

6.2 Asset replacement studies (ARS) are conducted to review asset condition and derive asset replacement programmes. A comprehensive ARS was conducted on EAL timber sleepers in 2016, followed by a condition assessment in April 2019.

6.3 The turnout P5116 is inspected using a three-tier approach in common with international practice, though the frequency varies in different countries:

a) Visual inspection by Patrolman: every 3 days

b) Inspection during Turnout Maintenance with static measurement: every 13 weeks

c) Dynamic measurement by TOV: monthly

6.4 Patrolman inspections and turnout maintenance are conducted by the EAL First Line Track Maintenance Management (MM) team and the TOV is operated by the Second Line Integrity Assurance Management (IAM) team within the Infrastructure Maintenance Department. Exception reports from the TOV are verified by the MM team and combined with preventative maintenance (PM) information from patrolmen and turnout inspections to determine the required corrective maintenance (CM) interventions.

6.5 According to MTR's procedures, track gauge measurements from the TOV which exceed a predefined threshold are to be inspected and rectified within 28 days. The MM team is required to send the "Follow Up Reports" to the IAM team for review and endorsement.

The IAM team is required to prepare a summary report of such exceedances on a quarterly basis.

6.6 To rectify the gauge exception, the following methods are be applied in the order of complexity:

a) Repair the elongated baseplate mounting holes;

b) Make a new baseplate mounting hole either by shifting the sleeper or re-orientating the baseplate;

c) Replace the sleeper completely

6.7 The majority of the existing EAL timber sleepers had been installed in the ballast track at the turnout areas since the early 1980's, while those at HUH turnout P5116 together with all others in the vicinity were introduced as part of the interfacing works under the Kowloon Southern Link project which was opened in August 2009. As timber is susceptible to wear and tear and biological degradation, a timber replacement programme was instigated in 2010 based on the then timber condition survey result. Up to the end of August 2019 approximately 4,000 synthetic sleepers were installed to replace the timber sleepers.

6.8 Synthetic sleepers were introduced, as the standard for replacement of timber sleepers since 2008 as difficulties were encountered in sourcing good quality timber sleepers from the market. Good experience of use in Japan supported the basis for its introduction. The six timber sleepers at Zone 3 of turnout P5116, as shown in Annex 3, were replaced with synthetic sleepers in 2015. Similar problems had not been encountered with the use of synthetic sleepers in the 10 years since their introduction in MTR.

6.9 Following the derailment, in November 2019 and February 2020 further rounds of condition assessment was conducted using enhanced assessment criteria. A total of 2,627 timber sleepers were identified as "high priority" and will be replaced by mid-February 2020 to give extra performance resilience to track integrity.

7. Maintenance Management

7.1 The maximum dynamic track gauge at turnout P5116, as measured by the TOV, first reached the threshold in July 2018. Fifteen rounds of TOV dynamic gauge measurement were conducted from July 2018 to August 2019. The Maintenance Team had addressed the gauge deterioration and turnout performance by five site verifications (September 2018 to July 2019) and five interleaving regular turnout preventative maintenances (27 July 2018 to 1 August 2019). Static gauge measurements in Zone 4 were within the acceptable range throughout, whereas Zone 3 first exceeded the threshold in September 2018 and Zone 2 in May 2019.

7.2 When the team confirmed the gauge at Zone 1 exceeded the threshold and Zone 2 further worsened in July 2019, the team planned the sleeper replacement.

7.3 Static follow up measurements had not always been conducted in accordance with the MTR procedure since the dynamic gauge threshold was first exceeded in July 2018. As shown in Annex 4, only 5 static follow up measurements from the 15 TOV measurements were taken in accordance with the procedure "Management of Track Geometry Measurement by TOV" since July 2018, though static measurements were also taken during 5 scheduled turnout preventative maintenances. TOV Follow Up Reports were not received by the IAM team from October 2018 and the Quarterly Exception Summary Reports of gauge exceedances were not prepared from January 2019. Senior management was not aware of this situation, nor was it revealed by internal management processes, such as audits. The panel opined that the monitoring of compliance of track gauge should be enhanced and escalated through reinforced internal governance.

7.4 The Panel considered that the existing procedures should be enhanced such that the TOV Quarterly Exception Summary Report should be submitted to the Departmental Asset Management Committee (Permanent Way), chaired by a General Manager, to enhance escalation and governance.

7.5 Other maintenance activities, such as the scheduled track patrolling and turnout PM works were conducted in accordance with the requirements. However, the panel opined that maintenance action should have been taken in accordance with the procedures once the threshold exceedance at Zone 3 had been identified. The Panel also opined that the condition of the sleepers and fastenings identified during track patrolling, particularly those before the incident, were early signs that should have warranted closer attention.

7.6 Following a TOV dynamic gauge measurement on 15^16 July 2019 which showed further dynamic gauge deterioration at the incident location, a static gauge verification measurement was conducted on 26 July 2019 and confirmed the existence of widening static track gauge. After scheduled turnout maintenance on 1 August 2019, CM was conducted to replace 2 timber sleepers (Zone 1 in Annex 3) on 3^4 August 2019, followed by special attention during inspection by the patrol team for 2 subsequent weeks. Measurement of the static gauge on completion of the sleeper replacement on 3^4 August showed the gauge widening had been reduced below the static gauge limit and as such the team believed the corrective action was effective until the TOV dynamic gauge measurement on 7^8 August 2019.

7.7 Whilst the team were aware of the gauge widening and took action to replace 2 of the deteriorating sleepers, they were unaware of the effect of the localized variation of the lateral stiffness along the sharp curve of the turnout P5116 resulting from:

a) the replacement of 6 timber sleepers by synthetic sleepers in 2015 which had embedded elongated baseplate mounting holes after some years of service,

b) the replacement of 2 timber sleepers by 2 new synthetic sleepers in Zone 1 on 3^4 August 2019, and

c) the 3 deteriorated timber sleepers in Zone 2 which had been repaired before, were effectively redundant in holding the track gauge shortly after the corrective maintenance on 3^4 August 2019.

7.8 Synthetic sleepers were first introduced in MTR 2008. With the past ten years of experience in using synthetic sleepers with no similar problems being encountered, the Maintenance Team believed that replacing 2 sleepers would suffice in correcting the track gauge.

7.9 The Panel considered there were knowledge gaps on:

a) understanding the behavior of synthetic sleepers once the baseplate mounting holes become oval i.e. Zone 3 synthetic sleepers, and

b) the effect of replacing the 2 timber sleepers i.e. Zone 1 sleepers in the array of the 17 sleepers that gave rise to the localized uneven lateral track stiffness at the sharp curve track geometry of turnout P5116.

7.10 Following replacement of the 2 sleepers on 3^4 August, the dynamic gauge measured by the TOV on 7 and 29 August had reduced slightly, but still exceeded the acceptable range. Thus, the maintenance interventions applied in addressing the track gauge at turnout P5116 were not sufficient.

> *"Maintenance staff made efforts based on their experience to correct the widen track gage at turnout P5116. The replacement of the two timber sleepers for the gauge correction on 3^4 August 2019 resulted in uneven track gauge spreading along the turnout due to a combination of several coincidental, albeit unexpected, factors. Eventually the unexpected factors caused the breakage of the mounting coachscrews of the two replaced sleepers to allow the gauge to widen within a very short time."*
>
> *Hong Kong PolyU*
> *External Expert*

> *MTR could deploy a senior maintenance manager who can combine good knowledge on ballasted track together with the lessons learnt to ensure the sleeper replacement can be realized smoothly and satisfactorily"*
>
> *Hong Kong PolyU*
> *External Expert*

7.11 The Panel considered that new technology with data analytics to monitor track gauge and track integrity in traffic hours should be implemented to assist the Maintenance Team to take proper action with criteria for escalation to senior management in a timely manner if necessary, particularly on any abnormality observed in the trend analysis. A Quarterly Exception Summary Report should be submitted to the Departmental Asset Management Committee (Permanent Way), chaired by a General Manager, to ensure reinforced governance.

8. Conclusions

8.1 The cause of the incident was dynamic track gauge widening at HUH turnout P5116.

8.2 The underlying factors contributing to the dynamic gauge widening were:

a) the interventions applied in addressing the track gauge widening at the incident turnout P5116 were not sufficient. The replacement of 2 out of a group of 5 deteriorating timber sleepers in an array of 17 sleepers created uneven lateral track stiffness at the turnout P5116 which has an atypical combination of sharp curve track geometry and high traffic intensity. This resulted in an unexpected excessive lateral force being applied to the rail under train operation which led to the breakage of the rail fastener coach screws on the two newly replaced synthetic sleepers;

b) the EAL Track Maintenance Team had a knowledge gap on the effect of this combination of circumstances to make an informed judgement on the scope, timeliness and effectiveness of remedial measures required to correct the dynamic track gauge. Similar problems had not been encountered with the use of synthetic sleepers in the 10 years since introduction in MTR.

c) follow up actions to inspect and rectify the track gauge, and to prepare reports, had not always been conducted in accordance with the MTR procedures since the dynamic gauge threshold was first exceeded in July 2018. The Maintenance Team should have relied more heavily on measurement data, rather than their experience, to observe the trend of track gauge widening, despite the fact that they had carried out the regular patrolling and preventative maintenance throughout the period. Senior management was not aware of this situation as it was not escalated, nor was it revealed by internal management processes, such as routine management reports and audits.

8.3 No evidence has been found to suggest that the condition or performance of the rolling stock and/or the signaling system contributed to the derailment, nor was there any evidence of external influence in the derailment. The broken rails identified at the incident site were the result of damage caused by the derailment.

9. Recommendations

9.1 The Panel has made recommendations as below based upon lessons learnt from this incident:

a) develop measures to address the variation in lateral stiffness when using synthetic sleepers in replacing timber

sleepers to avoid prolonged stress concentration on individual coach screws. (Completed);

b) accelerate the planned replacement of 2,627 East Rail Line timber sleepers to give extra performance resilience to track integrity. (To be completed by mid-February 2020);

c) refine maintenance action thresholds using a “step” approach and enhance monitoring of compliance of track gauge and escalation through reinforced governance (“lines of defence”), (Completed);

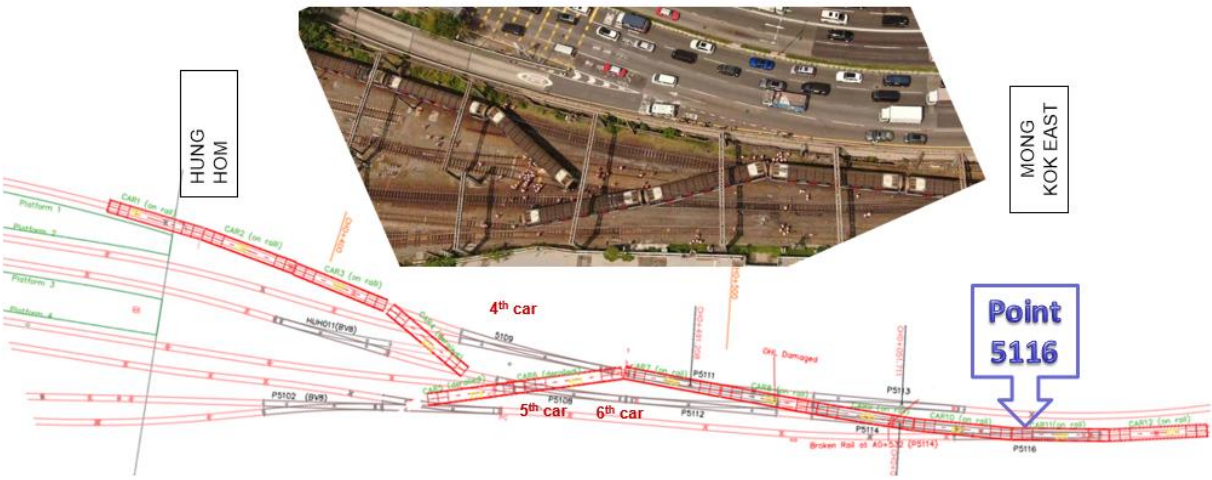
d) enhance change management of introducing new track technology, including site testing, staff competence enhancement to bridge any knowledge gap based on the lessons learnt. (Completed);

e) explore and implement new technology and data analytics to monitor track gauge and track integrity in traffic hours as well as its trend analysis for maintenance and criteria to trigger necessary escalation to senior management for attention. (Equipment to be delivered in February 2020 for trial)

Annex 1

Incident Site at North of Hung Hom Station (East Rail Line)

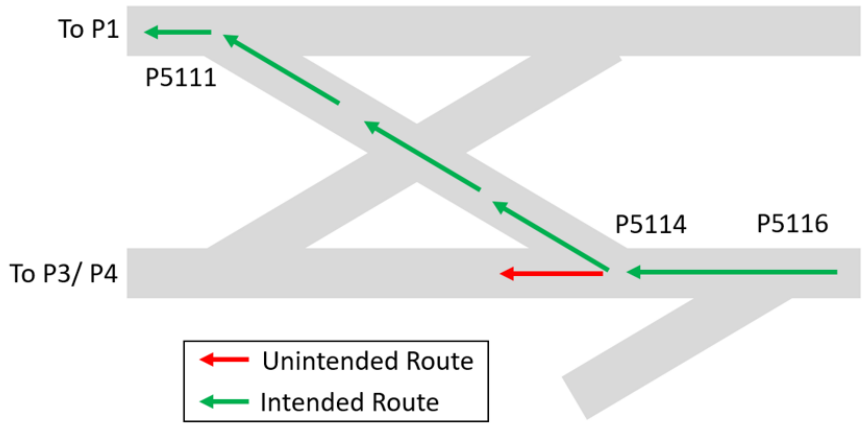
On 17 September 2019 at 08:29 hours, the train L094 ["Train 1] approaching Hung Hom Station (HUH) Platform 1 derailed at turnout P5116 north of the station. Three cars (4th, 5th and 6th car) derailed and the train was divided between the 4th and 5th car.



Annex 2

Illustration of Train Route (Intended/ Unintended) of Train 1

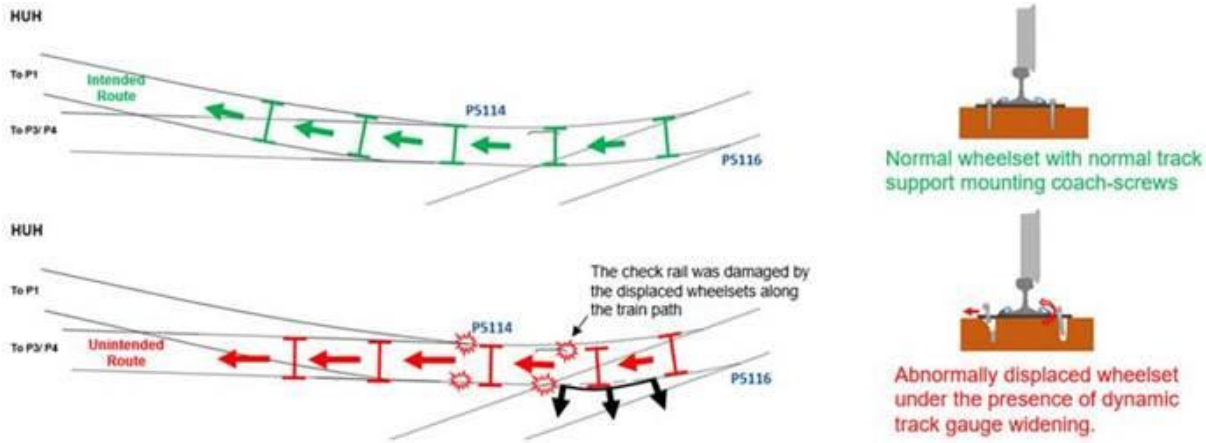
The Incident train, Train 1 travelled on diverged route at turnout P5114.



What Happened:

The immediate cause of the derailment was due to dynamic track gauge# widening at turnout P5116.

(#the distance between the rails under the load of a train)

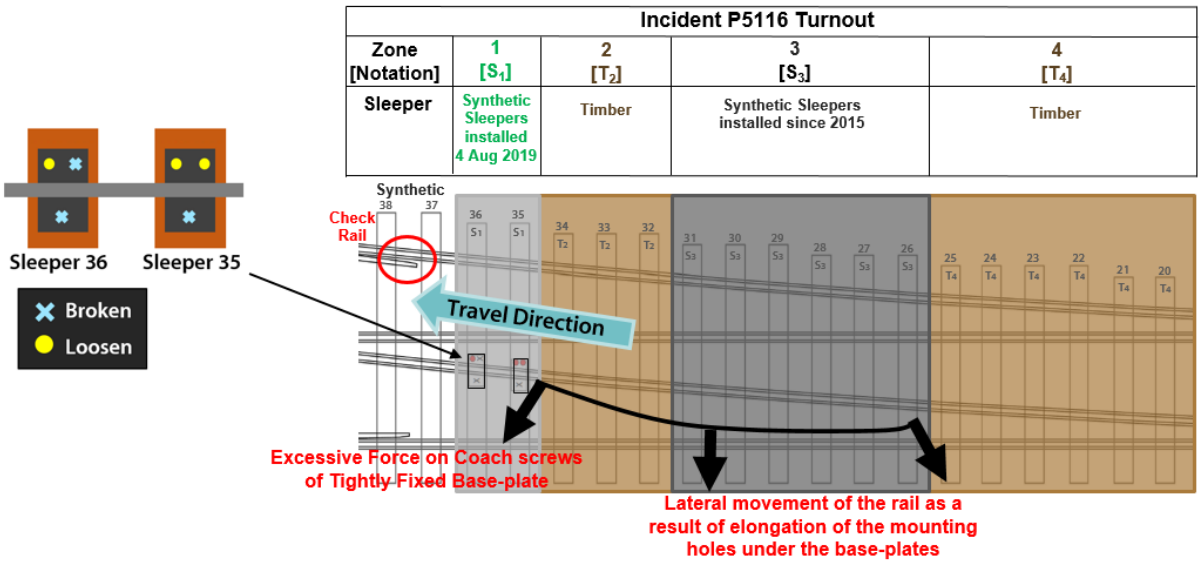


* Check rail is laid parallel to a running rail to guide wheels through rail crossing of all turnouts

Annex 3

Illustration of Sleeper Arrangement at Incident Turnout P5116

Timber sleeper (2 nos.) replacement at Zone 1 on 3^4 August 2019 to correct the track gauge had resulted in developing excessive force breaking the coach screws.



Annex 4

Track Gauge Maintenance Record at Turnout P5116 (since July 2018)

Activity	Date of measurement	Maximum dynamic gauge (mm)@	Follow-up action taken in accordance with "Management of Track Geometry Measurement by TOV"	TOV follow-up measured static gauge at sleeper #34 (Zone 2) (mm) @	Static gauge measurement (mm) @		
					Close to Zone 1 (Sleepers #37-38)	Close to Zone 3 (Sleeper #28-29)	Close to Zone 4 (Sleepers #20-21)
TOV 1	25^26 Jul 2018	1,458 [+23]	No				
Turnout M'tce 1	27 Jul 2018				1443 [+8]	1451 [+16]	1441 [+6]
TOV 2	22^23 Aug 2018	1,459 [+24]	No				
TOV 3	26^27 Sep 2018	1,460 [+25]	Static measurement on 29^30 Sept 2018	1453 [+18]	1449 [+14]	1456 [+21]	--
TOV 4	18^19 Oct 2018	1,460 [+25]	Static measurement on 29^30 Oct 2018	1451 [+16]	1443 [+8]	1456 [+21]	1451 [+16]
Turnout M'tce 2	1 Nov 2018				1443 [+8]	1446 [+11]	1443 [+8]
TOV 5	14^15 Nov 2018	1,460 [+25]	Static measurement on 17^18 Nov 2018	1454 [+19]	1450 [+15]	1456 [+21]	1446 [+11]
TOV 6	26^27 Jan 2019	1,463 [+28]	No	–			
Turnout M'tce 3	12 Feb 2019				1445 [+10]	1456 [+21]	1448 [+13]
TOV 7	24^25 Feb 2019	1,462 [+27]	No	–			
TOV 8	17^18 Mar 2019	1,464 [+29]	No	–			
TOV 9	3^4 Apr 2019	1,464 [+29]	No	–			
Turnout M'tce 4	21 Apr 2019				1453 [+18]	1459 [+24]	1433 [-2]

Activity	Date of measurement	Maximum dynamic gauge (mm)@	Follow-up action taken in accordance with "Management of Track Geometry Measurement by TOV"	TOV follow-up measured static gauge at sleeper #34 (Zone 2) (mm) @	Static gauge measurement (mm) @		
					Close to Zone 1 (Sleepers #37-38)	Close to Zone 3 (Sleeper #28-29)	Close to Zone 4 (Sleepers #20-21)
TOV 10	25^26 Apr 2019	1,466 [+31]	No	–			
TOV 11	9^10 May 2019	1,470 [+35]	Static measurement on 16^17 May 2019	1,466 [+31]	1455 [+20]	1464 [+29]	1446 [+11]
TOV 12	30^31 May 2019	1,469 [+34]	No	–			
TOV 13	15^16 Jul 2019	1,477 [+42]	Static measurement on 25^26 Jul 2019	1,471 [+36]	1463 [+28]	1466 [+31]	1446 [+11]
Turnout M'tce 5	1 Aug 2019				1454 [+19]	1460 [+25]	1444 [+9]
Sleepers replaced	3^4 Aug 2019			1,446 [+11]	1450 [+15]	1456 [+21]	1450 [+15]
TOV 14	7^8 Aug 2019	1,472 [+37]	No	–			
TOV 15	28^29 Aug 2019	1,469 [+34]	No	–			

@ The figure in the brackets "[ ]" is the difference between the measured gauge and the standard gauge (1,435 mm).