REPORT OF THE COMMITTEE OF INQUIRY INTO THE DISRUPTION OF MRT TRAIN SERVICES ON 15 AND 17 DECEMBER 2011

3 JULY 2012

TABLE OF CONTENTS

ANNEXES

EXECUTIVE SUMMARY

1 Two major train service disruptions occurred on the North-South Line (NSL) operated by SMRT Trains Ltd (SMRT) on 15 and 17 December 2011.

Incident on 15 December 2011

2 During the evening rush hour on 15 December 2011, four trains lost traction power and stalled on the north-bound track between City Hall and Braddell stations. The backup power system on one train (T139) failed prematurely, leaving passengers to put up with darkness and limited ventilation before the train was hauled to a nearby station. Those on another train (T134) had to detrain onto the track and walk through the tunnel. Fortunately, apart from two passengers who fainted in the two stalled trains, there were no casualties arising from this incident.

3 The Land Transport Authority (LTA) and SMRT activated their emergency plans in response to the disruption of service in both directions between Marina Bay and Bishan. However, the bus bridging services mobilized to transport passengers between the affected stations were unable to accommodate the volume of displaced commuters. Passengers were also frustrated by inadequate information and the large crowd. Station staff tried their best to alleviate passengers' transport problems, but they were themselves hampered by limited manpower and information. Altogether, some 127,000 commuters were affected by the disruption which lasted five hours.

Incident on 17 December 2011

4 On the morning of 17 December 2011, a number of trains again encountered power supply problems. Four trains were immobilized along the

north-bound and south-bound tracks and another train was pre-emptively detrained. Fortunately, only one train (T113) needed to detrain its passengers onto the track and there were no casualties during this incident. About 94,000 commuters were affected by the ensuing seven-hour disruption which was relatively better-managed, thanks to lessons that SMRT and LTA had learnt from the incident two days before.

Causes and contributory factors

5 The immediate cause of the stalling of the trains was damage to their Current Collector Device (CCD) "shoes" due to sagging of the "third rail" which supplies electrical power to the trains. During both incidents, sections of the third rail sagged after multiple "claws" which hold up the third rail above the trackbed, were dislodged.[1] With their CCDs damaged, the trains were unable to draw electricity from the third rail to power their propulsion and other systems such as cabin lighting and air-conditioning.

Incident on 15 December 2011

6 The COI agrees with the expert witnesses that the incident on 15 December 2011 was initiated by a defective fastener in the Third Rail Support Assembly (TRSA) at chainage 61250[2] (on the north-bound track between City Hall and Dhoby Ghaut stations), which had a latent crack in its "tongue". The claw of that TRSA then dislodged, causing the third rail to sag by up to 40 mm. This by itself would not have caused disruption to train service as the spring-mounted CCD shoes have a tolerance for sagging of up to 65 mm, but

[1] These claws form part of the Third Rail Support Assemblies or TRSAs which hold the third rail above the trackbed and to the side of the running rails, the rails on which trains' wheels run.

[2] Chainage numbers serve as location markers along the track. Along the NSL, chainage numbers increase by one for every metre travelled northward.

it would render the two adjacent TRSAs more vulnerable to vibration. By unfortunate coincidence, the insulators of these two adjacent TRSAs were found later to be inherently defective. Under the effect of greater vibration over time, this caused the two TRSAs to also fail gradually. The third rail then progressively sagged further. These material defects took time[3] to develop before the incident on 15 December happened, but were regrettably not identified and remedied under SMRT's maintenance regime.

7 As the third rail gradually sagged to around 65 mm , it is believed that one or more trains that passed this incident site just before the onset of the 15 December incident experienced some damage (in the form of misalignment) to their CCD shoes that was not easily detectable which later led to the 17 December incident. Subsequently, as the last carriage of T151 passed the incident site in the evening of 15 December 2011, the third rail sagged further, damaging the two CCDs on that carriage. One broke cleanly at the frangible or designed weak link, releasing its shoe onto the ground, but the frame of the other CCD fractured, spilling debris onto the track and the third rail.

8 As subsequent trains passed the incident site, their CCD shoes were damaged by impact with the sagged third rail. Some shoes failed to break off but became twisted, still attached to the CCDs via the copper conductor strips through which electrical current is transferred to the CCDs. This was likely due to over-tightening of the bolts which secure the conductor strips to the CCDs. Some trains stalled shortly after passing the incident site as they were unable to draw adequate propulsion power from the third rail. However, others were able to travel further up the network as they were still able to draw sufficient power through their undamaged CCD shoes. In the process,

[3] The experts are unable to determine how long it took.

as their twisted shoes rubbed against the third rail covers, these trains further destabilised the third rail system elsewhere along the network.

9 Concurrently, the forces generated by the CCD shoes of multiple trains impacting the sagging third rail caused three more claws at the incident site to be dislodged, such that the third rail came to rest on the trackbed. Thereafter, this segment of the third rail became totally impassable to all trains. Overall, the experts felt that the 15 December incident was caused by a combination of factors, none of which individually would have resulted in the incident.

Incident on 17 December 2011

10 The COI believes the second incident was triggered by one or more "rogue trains" which suffered not easily detectable CCD shoe damage when passing the 15 December 2011 incident site as the third rail was progressively sagging. The COI opines that the rogue train(s) probably passed this site before T151, which sustained serious damage to its CCD shoes. However, in its haste to resume revenue service on 16 December 2011, SMRT did not conduct a sufficiently thorough check, such that the CCD shoe damage on the rogue train(s) went undetected. Otherwise, the incident on 17 December 2011 might have been prevented.

11 When the rogue train(s) operated along the NSL on 16 December 2011, the damaged CCD shoe(s) gradually became more and more misaligned as it/they brushed against the third rail covers, destabilising the third rail system. At some point that day, the rogue train(s) caused one claw at either chainage 63950 or 63955 (on the south-bound track between Newton and Orchard stations) to be dislodged, such that the third rail sagged by about 40 mm.

12 During engineering hours in the early morning of 17 December 2011, SMRT deployed its Multi-Function Vehicle (MFV) to conduct rail checks on various track sections, including the south-bound track between Newton and Orchard. Under normal circumstances, the MFV would most probably have detected the third rail sag, which the COI believes also caused the mirror on the underside of the MFV to crack. However, because of a failure of the dated software of the MFV and reactive work processes, SMRT staff failed to detect and remedy the sag.

13 Shortly after revenue service commenced on the morning of 17 December 2011, T119 passed the site where the claw had dropped earlier and its CCD shoes made unusually forceful contact with the third rail cover. This happened because, firstly, apart from leading to a sag of 40 mm, the failure of that TRSA would also allow that segment of the third rail to swing laterally, bringing it closer to the running rail when at one end of the swing. Secondly, the location was along a tight curve and the separation between the running rails and the third rail there had previously been found to be smaller than it should have been. The reduced separation might have arisen from improper manual third rail re-gauging, i.e. the adjustment of the alignment of the third rail with respect to the running rail. Thirdly, there might also have been wear to the running rail and the wheel flanges of T119, causing the train to move closer to the third rail.[4]

14 As one of the CCD shoes on T119 forcefully engaged the third rail cover between chainages 63955 and 63944/5, it caused the fresh scratch marks that were later found on the cover. Coupled with excessive vibration that could have been generated if the train had wheel flats or other defects, the

[4] Wheel flanges are the protruding rims of train wheels which keep trains from running off the track when negotiating curves.

contact with the third rail system also resulted in the dislodgement of a second claw, such that the third rail sagged further. The downward force of the sagging third rail hitting the CCD shoes then caused serious fractures to the two rearmost CCD frames of T119. The sagged third rail also caused further damage to the CCDs of the trains that passed the incident site subsequently. After T119, ten other trains passed the second incident site and were subsequently found with damaged CCD shoes. The COI believes that the rogue train(s) must have been among these eleven trains, including T119.

Recommendations on engineering and maintenance issues

15 While it may not be possible to determine with absolute certainty the exact sequence of events that resulted in the two incidents, the expert witnesses that testified in the Inquiry have jointly made a number of recommendations to address the possible root causes and contributory factors. The COI endorses these and makes a number of additional recommendations. Set out below are the key recommendations contained in the COI report. More details can be found in Chapters 9 and 12.

The third rail system

Better detection and rectification of single sags and TRSA defects

16 The two incidents have shown that single sags of the third rail, i.e. sags caused by the dislodgement of one claw, must be treated with utmost urgency as they render adjacent TRSAs more vulnerable to failure. In line with the experts' recommendation to explore ways to better detect single sags, the COI further suggests that SMRT and LTA look into the feasibility of fitting some trains with equipment that can detect such sags and running them across the NSEWL daily.

17 The experts have also recommended that SMRT formalize procedures to manage dislodged claws. In this vein, the COI suggests that SMRT consider extending its Severity Index – Urgent (SI-U) maintenance task classification, which currently applies to claw drops, to any detected defect on the TRSA.[5] This will ensure that prompt action is taken to reduce the risk of claw dislodgements.

Enhanced inspection of TRSAs and third rail

18 The incident on 15 December 2011 was attributable to two defective insulators adjacent to a defective fastener. The COI notes AGC's submission that SMRT's work instructions do not incorporate the annual TRSA inspection that was specifically required in the original MRTC Maintenance Manual. Thus, it appears that no annual inspection of the TRSA has been carried out all these years. The COI is of the view that had these checks been carried out, the incident on 15 December 2011 could have been averted. The COI therefore agrees with AGC's recommendation that SMRT should fully implement the requirements of the MRTC Maintenance Manual, in particular the checks on the TRSA, in its maintenance regime.

19 The experts have also recommended that non-destructive testing (NDT) be conducted on vulnerable segments of third rail, such as those at tight curves as well as locations with records of repeated claw drops and significant running rail wear, to check for cracks. Such cracks at joints between third rail segments can lead to "steps" which may impede smooth passage of CCD shoes. As the NSEWL has been in operation for about 25 years, the COI recommends that SMRT consider conducting NDT tests on the entire line.

[5] An SI-U defect is to be rectified within 24 hours.

Improvements to third rail claws

20 Given the ageing infrastructure, the current situation of occasional claw drops should not be allowed to continue. The COI notes that the original 1985 claw design used widely across the NSEWL has had a history of claw drops which indicates inherent reliability issues. While it might have been among the acceptable choices at that time, the COI was told that other rail systems have since adopted newer claw designs. It agrees with the experts that SMRT and LTA should work together to develop a new, more robust TRSA with a positive locking mechanism. In the meantime, the cable ties used as an interim measure to secure earlier-generation claws must be properly inspected and maintained. Furthermore, SMRT should also consider installing steel caps in addition to cable ties on these claws to further reduce the likelihood of claw dislodgements.

21 SMRT should also look into the feasibility of painting the claws in a bright luminous colour so that any dropped claws can be more easily spotted under the poor tunnel lighting conditions. Going forward, SMRT and LTA should make it a practice to continually look out for or develop improved designs for equipment such as TRSAs that can reinforce the reliability of the existing working network.

Improvements to TRSA covers

22 The COI also notes that the existing TRSA covers are opaque, such that it is difficult to visually inspect the TRSAs, for example to check for dislodged claws. It recommends that SMRT look into how to enhance the effectiveness of the current visual inspections of the TRSAs, including studying the feasibility of using a transparent material for the TRSA covers or mounting

the covers on hinges so that they can be opened more easily to facilitate inspection.

Review of third rail gauging tolerance and maintenance regime

23 A likely contributing factor in the incident on 17 December 2011 was the reduced offset between the running rail and the third rail, which may have caused a passing train to come into contact with the third rail system. The COI agrees with the experts that SMRT and LTA should review if the current maintenance tolerance for third rail gauging is appropriate. SMRT should also introduce a more robust regime to ensure compliance with this tolerance.

Upgrading of MFV capability

24 The MFV is an important part of SMRT's track maintenance regime. The 17 December 2011 incident could have been prevented if the existing MFV had been given a long-overdue software upgrade. In addition to the new MFV that SMRT has committed to purchase for the NSEWL, the COI recommends that the existing MFV should be overhauled. If this is not cost-effective, another new MFV should be purchased so that the frequency and reliability of track checks can be increased. The COI also agrees with AGC that SMRT should review its SOPs for MFV operation to ensure that staff operate it in a manner that ensures accurate track measurements.

Rolling stock

Improved monitoring and rectification of wheel defects

25 The COI agrees with the experts that wheel defects are an operational reality on railway systems. Nevertheless, severe wheel flats may cause

instability to the third rail system. Hence, the wheels of the rolling stock must be properly monitored and promptly rectified as they generate high levels of vibration which can have adverse effects.

26 The COI welcomes SMRT's decision to install a Wheel Impact Load Detection System on the NSEWL, which will allow it to monitor wheel defects more accurately in real-time. SMRT's purchase of an additional wheel lathe will also increase its wheel re-profiling capacity. These are both actions that have been recommended by the experts. The COI recommends that SMRT closely monitor whether one additional wheel lathe is adequate to ensure that wheels with defects are re-profiled in a timely manner. More fundamentally, as recommended by the experts, SMRT should also investigate the root causes of wheel defects and take the necessary actions to reduce their occurrence.

Improvements to CCD maintenance regime

27 The COI notes that during the two incidents, some CCD shoes did not detach completely at the "frangible" or weak link as designed. Instead, they were left hanging on to the trains by the copper conductor strips, possibly because the bolts that secure the conductor strips to the trains were over-tightened. The unbroken shoes may then have become twisted, destabilizing the third rail system as they contacted it. The COI therefore recommends that SMRT conduct a study to determine the optimum torque for these bolts. Thereafter, a bolt torque check should be incorporated into the CCD maintenance regime.

28 On a related note, SMRT should consider making it a standard practice to remove damaged CCD shoes from trains where they are stalled before they are hauled away, to prevent these damaged shoes from further damaging or destabilizing the third rail system, taking into the consideration the

operational implications of doing so. If deemed feasible, SMRT should also equip each station with the tools necessary to carry this out.

Improvements to backup power supply

29 During the incident on 15 December 2011, backup power supply to three cars of one train failed, leaving passengers without emergency lighting and ventilation. It was later found that the capacity of the battery serving these three cars had deteriorated since the last battery capacity check about two years earlier. As recommended by the experts, SMRT should increase the frequency of battery capacity tests so that battery defects can be rectified more promptly.

30 In addition, SMRT should look into whether the existing 45-minute backup power provision is sufficient to sustain emergency lighting and ventilation until a train is fully detrained. This should take into account realistic timelines for detrainment, as well as how actual train car battery lifespans may turn out to be shorter than the stated capacity. If a longer battery life is deemed necessary, SMRT should look into replacing existing batteries with higher-capacity ones.

On-condition monitoring of CCD shoes

31 The COI understands that there is presently no way for Train Officers (TOs) or the SMRT Operations Control Centre (OCC) to detect missing or damaged CCD shoes while a train is running on the track. This led to the TOs and OCC staff not knowing the cause of the trains' abnormal behaviour during the two incidents. The COI recommends that SMRT explore if it would be feasible for trains to be equipped with sensing devices to alert TOs and the OCC of CCD shoe problems.

Equipping older trains with TIMS

32 Today, SMRT's third and fourth-generation NSEWL trains are equipped with a Train Integrated Management System (TIMS) which provides TOs with information on trains' performance and condition and helps maintenance staff to diagnose faults. The COI recommends that SMRT and LTA study the viability of also equipping the first and second-generation trains with TIMS, as it provides TOs with valuable real-time information such as whether a particular train car is receiving propulsion power.

Review of maintenance regime for an ageing system

33 The COI agrees with the experts, the SMRT Internal Investigation Team (IIT) and LTA that SMRT's maintenance regime needs to be enhanced, especially given the increasing ridership and ageing of the NSEWL. In this respect, the COI makes the following recommendations.

Implement a risk- and reliability-based maintenance approach

34 First, the COI recommends that SMRT move towards a risk and reliability-based maintenance approach and adopt more condition monitoring and predictive maintenance, which will help to prevent recurrence of such incidents in future. In line with the SMRT IIT's observation that there was a lack of systemic failure identification by SMRT in relation to claw drops, SMRT should take Failure Modes, Effects and Criticality Analysis ("FMECA") seriously and put in place a process to track and analyse any failures so as to conduct proper investigation and analysis into its causes and effects.

Harnessing technology more effectively to enhance maintenance regime

35 The COI also encourages SMRT to look into how it can further harness technology to enhance its maintenance regime. For example, SMRT staff should be encouraged to tap the company's maintenance IT systems to better identify issues with the working network that need to be studied further and addressed. SMRT should also consider how it can leverage new technologies to conduct maintenance work more efficiently, especially given the limited hours available outside of revenue service, and to reduce the variance in work techniques among maintenance staff.

Greater collaboration among SMRT technical departments

36 Related to this, the COI also agrees with the SMRT IIT and the experts that SMRT should do more to facilitate interaction, collaboration and peer review among its technical departments as the sharing of knowledge is critical for systemic failure identification and improvement of maintenance practices.

Implement Maintenance Management System audit

37 The COI notes LTA's intention to work with SMRT to review how SMRT's current maintenance framework should be enhanced to ensure continued safe and reliable train operations. The COI recommends that LTA impose a requirement on SMRT to conduct a Maintenance Management System audit. This audit should be structured as a developmental process. SMRT should be required to self-assess its maintenance regime on a 3 or 4-yearly basis. Based on the identified strengths and weaknesses of its current maintenance management system, SMRT should then create an internal shared vision and action plans for how to continually improve its maintenance regime, as well as customer-centricity in train operations.

Improved documentation of maintenance work

38 In the course of the Inquiry, the COI observed that SMRT's documentation of maintenance tasks and inspections was not entirely satisfactory. It agrees with AGC's submission that SMRT should review its documentation processes with a view to ensuring a higher level of accuracy and reliability, as well as the experts' recommendation for SMRT to review the duration for which maintenance records are kept. One way to ensure more accurate recording of maintenance data is by using portable data loggers, as suggested by the expert witnesses.

Formalise forensic investigation procedures

39 The COI notes that while train service should be restored as soon as possible after a disruption to minimize inconvenience to commuters, preservation of evidence such as damaged components is essential for diagnostic and corrective action, as well as to facilitate learning from these episodes. Furthermore, as also recommended by the experts, SMRT and LTA should review their procedures to ensure thorough forensic investigations and risk assessments following significant incidents. For example, SMRT and LTA could build an incident site investigation plan into the overall service recovery plan.

Scheduled closures for maintenance work

40 The SMRT IIT has recommended scheduled closures of sections of the system for more comprehensive maintenance work, in the event that regular engineering hours are insufficient. The COI agrees with LTA that this proposal should be studied further, taking into account the impact to commuters, once a more comprehensive maintenance plan has been developed by SMRT.

Findings and recommendations on incident management

Overall observations on the two incidents

Overall management

41 For the incident on 15 December 2011, the COI recognises the complex challenges faced by LTA and SMRT in their management of the incident, given the trying and unprecedented circumstances. Partial resumption of service was achieved fairly quickly after around two hours, and service was fully restored another three hours later. While around 127,000 commuters were affected, there were no serious casualties and only two persons fainted in the stalled trains. For the 17 December 2011 incident, services were fully restored after about seven hours. As it was early on a Saturday morning when the incident happened, the number of affected commuters was much smaller and there were fewer complications.

42 The COI shares the view of the experts and the SMRT IIT that individual SMRT staff generally did their best during the two incidents to minimize passengers' transportation problems, despite themselves facing challenging circumstances. However, the COI also agrees strongly with the SMRT IIT that SMRT's overall incident response was skewed towards train safety and operations considerations, resulting in insufficient attention to the well-being of passengers stranded in stalled trains and at stations.

Safety not compromised

43 The COI is satisfied that SMRT exercised due prudence with regard to safety. It heard evidence of how station staff took steps to prevent overcrowding of stations. These staff, as well as TOs, were also careful to ensure that it was safe for passengers and staff to access the track. The COI

further notes the assessment of LTA and the expert witnesses that the operational manoeuvres directed by the OCC to recover the stalled trains were in accordance with SOPs and safety guidelines.

Recommendations

44 The recommendations to enhance management of large-scale incidents are as follows. More details are found in Chapters 11 and 12 of the report.

Improving communication and clarity between stakeholders

45 There appeared to be a lack of communication and clarity on the responsibilities of LTA, the Public Transport Operators (PTOs) and other stakeholders during major incidents, and when a PTO should escalate an incident to LTA so that external assistance can be activated promptly. The most senior person in charge at SMRT's "command centre" did not even know about the existence of LTA's Public Transport Crisis Management Team (PT-CMT) and the SMRT IIT did not even know that LTA was in fact exercising leadership in the management of the incident on 15 December 2011.

46 The COI notes that there is presently no integrated Land Transport Emergency Plan articulating response strategies and the roles of various stakeholders and their co-ordination protocols. This lack was reflected in the miscommunication between SMRT and LTA on 15 December 2011. SMRT was under the mistaken belief that LTA had directed them to quickly resume full services instead of investing time to conduct a thorough check for faults.[6] An

[6] Former SMRT CEO Saw Phaik Hwa testified that SMRT had received an instruction from LTA to resume service as soon as possible, rather than suspending NSL service "for the whole night" (see Transcript of Proceedings on 10 May 2012 at page 72). However, LTA staff testified that they did not direct SMRT to resume service on the night of 15 December 2011 (see Transcript of Proceedings on 17 May 2012 at pages 17 to 19. SMRT EVP Trains Khoo

integrated land transport emergency plan with clear communications protocols for critical decision making might have been able to prevent the 17 December 2011 incident. The COI recommends that LTA should take the lead in working out such an overall plan with other public transport stakeholders, and then ensure that the stakeholders document their respective supporting actions in their respective emergency plans.

Review alternative transportation options

47 The alternative transportation plan for train system failures was inadequate for the contingency faced on 15 December 2011. In particular, the activation of bus bridging services was principally to bridge the gaps along the NSL network that night. The COI agrees with the experts and the SMRT IIT that, while such an approach would be adequate for incidents involving less stations and commuters, it would not suffice for the scale of the incident on 15 December 2011. On this note, the COI is gratified to know that LTA has since worked out with the PTOs an expanded bus reinforcement plan to tap on normal regular bus services, with free rides provided to affected commuters.

48 Beyond the free bus rides, the COI encourages the PTOs and LTA to explore providing free rides on unaffected sections of the MRT network as a more efficient way to disperse passengers. More generally, easily-understandable, station-specific information on alternative transportation options should be provided, perhaps in the form of announcements, pamphlets, signs and the RATIS electronic display system.

Hean Siang also testified that he decided to resume service that night after the relevant checks such as line-clears had been carried out (see Transcript of Proceedings on 24 May 2012 at page 8).

49 As for bus bridging services, the COI agrees with LTA that the SMRT IIT's suggestions such as "hubbing" them at selected staging points should be studied further. There are however other improvements that can be made in the meantime to enhance the efficiency of bridging bus services. SMRT should consider designating dedicated bus pick-up points and having bus bridging services stop at a limited number of MRT stations before and after those affected by a disruption, so that the load of boarding and alighting traffic can be spread across a number of points. In addition, announcements regarding bus bridging services should be made only when they are actually in operation.

50 Furthermore, the COI notes that with SMRT's planned upgrading of the NSEWL signalling system, trains will be able to make bi-directional movements along a track at higher speeds. The COI recommends that SMRT and LTA further study the feasibility of using such bi-directional train movements along a single track as another way to transport passengers during a disruption of service on one track, taking safety considerations into account.[7]

Review train-to-track detrainment SOPs

51 The detrainment of two stalled trains on 15 December 2011 was of particular concern. For T134, which stalled between City Hall and Dhoby Ghaut stations, a train-to track detrainment was conducted. The time between the train stalling and the complete detrainment of all its passengers was well above an hour, beyond the 45-minute backup battery life span. For T139 which stalled about 50 metres from Orchard station, another train was directed to perform complicated manoeuvres in order to reach it to haul it to

[7] Bi-directional train movements refer to train movements which are carefully coordinated to travel in both directions along the same track.

Orchard station. Although the time taken was only slightly more than 45 minutes, it so happened that one of the train's two backup batteries regrettably failed after only 28 minutes. As the experts had pointed out, at only 50 metres from Orchard station, it would have been more effective to conduct a train-to-track detrainment for T139. On 17 December 2011, there was only one train stalled in the tunnel and detrainment onto the track was quickly decided upon and effectively carried out within 45 minutes.

52 It is uncomfortable for passengers to remain aboard trains with only emergency lighting and ventilation while awaiting detrainment. Therefore, detrainment should be done within the shortest time possible. The COI notes that LTA has specified in its revised requirements for PTOs to make a decision on train-to-track detrainment within 20 minutes of a train stalling and SMRT has set an internal guideline of commencing such detrainment within 30 minutes if there are no other options to rescue the train. However, the COI feels these are still unsatisfactory. As submitted by AGC, the COI recommends that LTA and the PTOs holistically review the SOPs for train-to-track detrainment, taking into account the life span of the backup power supply. The effectiveness of alternative life support systems, such as the tunnel lights and ventilation fans, should also be studied before assuming they are good enough as supplementary life support. LTA should eventually set a requirement on the maximum time within which detrainment should be completed, taking into account the capabilities of these life support systems.

53 Having directly observed the low tunnel light levels that would be experienced during a train-to-track detrainment, the COI also agrees with AGC's submission that SMRT should study how lighting can be enhanced to ensure safe detrainment, for example by equipping trains with portable lights,

and how the gap between the detrainment ramp and the trackbed can be reduced to allow for easier detrainment by those with mobility limitations.

Review SMRT command structure

54 The COI shares the view of the experts and the SMRT IIT that SMRT's Rail Incident Management Plan (RIMP) command and control structure should be reviewed. In particular, the COI observes that there is no facility for an overarching SMRT incident "command centre", suitably staffed and equipped to manage large-scale incidents. The COI notes that, as specified in the RIMP, some SMRT senior management will gather at the NSEWL OCC to take command in an incident and undertake various emergency roles. However, their ability to implement a holistic SMRT-wide response, for example in terms of alternative transportation arrangements, was hindered during the incidents by the inadequacy of information and of dedicated communications and staff aids in forming a composite situational picture. There did not appear to be a clear distinction between the NSEWL OCC, which is strictly speaking managing the NSEWL only, and the concept of an overarching SMRT "command centre" which should oversee all aspects of SMRT's incident management, including the Bus OCC and the Circle Line OCC, should future incidents extend to these OCCs. It is recommended that SMRT consider the set up of this "command centre".

55 Furthermore, some SMRT officers took on roles different from those assigned to them under the RIMP. As highlighted by AGC, while SMRT staff should have some flexibility to respond to emerging events, such ad hoc role changes may cause confusion as to who is in command of and accountable for the various incident management tasks. Such excessive flexibility as practised during the two incidents is not recommended.

Upgrading of OCC capability and resources

56 On 15 December 2011, the COI noted that in each of two stalled trains, a passenger fainted and SCDF paramedics were activated. As they were being despatched, SCDF alerted the OCC. However, the OCC did not seem to grasp the gravity of the situation and took no further interest in the matter, nor did it alert the Station Managers (SMs). The COI recommends that at least one OCC officer should be specifically tasked to monitor stations and ensure that information is disseminated to station staff during major disruptions. Other OCC staff must also be mindful of the need to consider station conditions and passenger well-being. At the same time, there should be a clearer delineation and definition of responsibilities among OCC staff to prevent critical tasks, such as communicating important information to SMs, from being overlooked.

57 SMRT should also upgrade the OCC's systems for communicating with stations, so that station-specific information can be broadcast simultaneously to multiple stations. In addition, OCC staff must notify station staff when the emergency services have been activated so that prompt and unimpeded access can be granted. Further, in line with the experts' recommendation to review the protocols for care of passengers who have been trapped on stalled trains for prolonged periods, LTA and the PTOs should also discuss with SCDF the possibility of pre-deploying its paramedics each time there is an extended train-to-track detrainment, in anticipation of commuters with medical needs.

Review RIMP

58 The COI agrees with the SMRT IIT that SMRT should fundamentally review the RIMP to emphasize passenger well-being as the primary

consideration. It also agrees with the incident management experts and AGC that the RIMP should incorporate timelines for actions to be taken by the relevant parties. The RIMP must also cater adequately to larger-scale disruptions, including those affecting multiple train lines and bus services. In addition, the COI agrees with the experts that simplified versions of the RIMP, customized to their work, should be provided to frontline staff for easier reference during disruptions.

59 The COI notes that following the incidents, SMRT has given Managers of the OCC (MOCCs) the authority to activate the RIMP and rostered MOCCs in the OCC throughout revenue hours. It recommends that SMRT also consider empowering Chief Controllers (CCs) to activate the RIMP in the absence of more senior staff, so that there is a sufficiently-experienced and suitably-trained officer at the OCC at all times, who can assess whether to activate the RIMP and implement it pending the arrival of senior management Adequate training should also be given to ensure all necessary tasks following RIMP activation are performed, such as alerting the Police. The OCC failed to do this on 15 and 17 December 2011.

Review station managers' role during disruption

60 The overriding priority of Station Managers (SMs) must be on station management and to provide feedback to and obtain information and guidance from the OCC and the overall SMRT "command centre". Therefore, SMRT should review its SOPs to ensure that SMs are able to focus on station management. For example, as suggested by the experts, it should look into whether train-to-platform detrainments can be carried out by TOs.

61 The COI also agrees with the experts' recommendation and AGC's submission that the roles of Station Operations Managers (SOMs) and SMs

should be reviewed to clarify who is in charge of a station during a disruption. If SMs are put in command, they must be empowered and provided with the necessary competencies to make on-the-spot decisions in response to ground conditions. In addition, to equip station staff to better manage disruptions, the COI recommends that SMRT look into providing them with station-specific information on what to do during a disruption.

Enhance effectiveness of Customer Service Teams

62 The concept of Customer Service Teams (CSTs), made up of non-frontline staff to provide additional manpower to assist passengers during disruptions, is a useful one. The COI welcomes SMRT's plans to increase the number of CSTs and their members, but CST members should be required to report to their assigned stations within a specific timeframe so that they can start assisting passengers promptly. They must also be provided with comprehensive training and required to undergo regular "refresher" training and exercises alongside station staff, so that they can be deployed without having to be briefed. In addition, SMRT should look into equipping CST members with tools for better communication with station staff.

Improve communications and information dissemination during disruptions

63 During a disruption, affected passengers and the public must be provided with information such as the expected duration and alternative travel options to reduce passengers' anxiety and avoid overloading affected train lines. The COI commends the steps that SMRT has taken following the two incidents to improve communications, such as regular announcements to passengers on trains and the use of new communication channels such as Twitter. It encourages SMRT to continually explore ways to provide timely service status updates.

64 In communicating with the public and making contingency arrangements for them to deal with the disruption, LTA should ensure that PTOs' attention is drawn to the findings from a study on passengers' needs during unplanned disruptions, conducted by Passenger Focus, an independent public body set up by the UK Government, as cited by SMRT's incident management expert.[8] The key points of this study are as follows:

(a) Accurate, timely and consistent information is critical to the effective handling of delays because it allows passengers to make informed decisions about what they do;

(b) The attitude and empathy of staff towards passengers during disruption is a key factor. Passengers do not always trust the information they are given, particularly the reasons offered for delays and cancellations;

(c) Once caught up in a problem, passengers need to know how long they will be delayed – having that knowledge allows people to judge the impact on their day; and

(d) Passengers want train companies to actively tell them if there are problems, particularly if there are cancellations or a temporary timetable is being introduced.

Post-incident briefing and training

65 The COI agrees with the experts and AGC that SMRT staff could be given more comprehensive training on how to respond to disruptions. TOs should be trained to diagnose fault indications and to calm and assist passengers in stalled trains while station staff should be given crowd control

[8] Exhibit S8 – WS Atkins Report on Rail Incident Management Plan, page 26 para 10.1.2

training, as recommended by the experts. In addition, SMRT should document lessons learnt from incidents, including the two December 2011 disruptions, as learning points to enhance response to future incidents. On a related note, relevant staff should be briefed in a timely manner about the causes and details of significant incidents so that they are better-prepared should similar incidents recur.

Review LTA PT-CMT activation

66 The COI notes that the initial hour of a disruption is typically the most critical, during which incident management measures should be implemented to resolve the transport problems. While LTA has stated that its senior management will be activated in a public transport emergency to assist its Land Transport Operations Centre (LTOC), no timeline is stipulated, except for the convening of the PT-CMT, by the two-hour mark, which is for the purpose of managing the longer-term issues rather than more immediate incident management. The COI recommends that LTA stipulate a timeline, which should be shorter than two hours, for the deployment of appropriate senior management for the reinforcement of the LTOC.

Conduct of train service disruption exercises

67 The COI commends the joint tabletop exercises that have been held following the disruptions by LTA, the PTOs and other government agencies. It encourages them to continue to carry out such exercises, including those involving ground deployments, to identify how they can enhance their incident management processes and clarify their respective responsibilities.

Review of risk identification process

68 Finally, the COI agrees with the SMRT IIT that SMRT should review its risk identification process to better identify risk scenarios for which it ought to develop preventive measures and contingency plans.

Conclusion

69 The COI concludes that both the 15 and 17 December 2011 incidents were preventable. Effective maintenance on the part of SMRT will play a critical role to prevent them from happening again. The NSEWL is ageing, and with the added strain that comes with increasing ridership, there must be increased attention paid towards the maintenance regime. Noting that it was only in 2010 that an engineering officer was routinely in attendance at SMRT Board meetings, the COI opines that there is a need to position SMRT as principally an engineering and operations company, and to view the two disruptions as an opportunity to undertake a more fundamental review of its maintenance approach to achieve maintenance excellence.

70 The COI is confident that the recommendations in this report, when carried out, would be able to greatly reduce the likelihood of similar occurrences in future. Nevertheless, the COI also recognises that beyond the specific improvements recommended in this report, LTA as the regulator should also periodically review its regulatory regime to fulfil its duty in maintaining effective oversight of the PTOs' maintenance regime. Both sides must play their part.

71 In terms of incident management, while the scale of the incidents on 15 and 17 December 2011 was overwhelming, SMRT and LTA have pro-actively identified various improvement measures, some of which have already been put in place. With the various recommendations implemented, the COI is

confident that future incidents, should they recur, will be much better managed.