RELEASE OF REPORT OF COI INTO 15 AND 17 DECEMBER 2011 MRT DISRUPTIONS

Annex A

Likely Causes and Sequence of Events Leading to
15 and 17 December 2011 Incidents

1. The immediate cause of trains stalling was damage to their Current Collector Device (CCD) "shoes", resulting from contact with a sagging "third rail". The third rail supplies electrical current to trains and is held up above the track-bed by "claws". During both incidents, sections of the third rail were found to have sagged after multiple claws were dislodged. With damaged CCD shoes, affected trains were unable to draw electricity from the third rail to power their propulsion and other systems such as cabin lighting and air conditioning.

15 Dec 2011 incident

2. The incident on 15 Dec 2011 was initiated by a defective fastener on one of the Third Rail Support Assemblies (TRSAs) on the north-bound stretch between City Hall and Dhoby Ghaut stations. This caused the claw of that TRSA to dislodge, and the third rail to sag by up to 40mm. By itself, this would not have caused disruption to train services as the spring-mounted CCD shoes have a tolerance for sagging of up to 65mm. However, it rendered the adjacent TRSAs more vulnerable to vibration.

3. By unfortunate coincidence, the insulators of the two adjacent TRSAs were also defective. Coupled with the effect of greater vibration over time, these two TRSAs also failed gradually. The third rail then progressively sagged further. As the third rail gradually sagged to around 65mm, passing trains' CCD shoes were subjected to abnormal force. (It is believed that as one or more trains passed this incident site just before the onset of the 15 Dec incident, CCD shoes on some trains experienced damage that was not easily detectable, such as misalignment, which later led to the 17 Dec incident.)

4. The COI is of the view that in the evening of 15 Dec, the third rail sagged beyond 65mm, damaging two CCD shoes on Train 151 as it passed the incident site. The CCD shoes of subsequent trains passing the incident site were also damaged by impact with the sagged third rail. Some trains thus stalled after passing the incident site as they were no longer able to draw sufficient power from the third rail. At the incident site, multiple trains impacting the sagging

third rail eventually caused three more claws to dislodge, such that a 40m stretch of third rail came to rest on the track-bed. Thereafter, this segment of the third rail was rendered impassable to all trains.

5. Overall, the 15 Dec incident is assessed to be caused by a combination of factors, none of which individually would have resulted in the incident. The incident could nonetheless have been prevented. Amongst others, the COI agrees with the expert witnesses that the material defects in the fastener and insulators likely took time to develop before the 15 Dec incident, but were not identified and remedied by SMRT's maintenance regime.

17 Dec 2011 incident

6. The COI attributes the incident on 17 Dec 2011 to one or more possible "rogue train(s)" that suffered not easily detectable CCD shoe damage when passing the 15 Dec incident site during the period of time when the third rail was progressively sagging. Although SMRT conducted CCD shoe checks on its trains on the night of 15 Dec, the COI is of the view that these were not sufficiently thorough, such that CCD shoe damage on the "rogue train(s)" was not detected.

7. As the "rogue train(s)" operated along the North-South Line on 16 Dec during revenue service, it is believed that their CCD shoe(s) became increasingly misaligned as it/they brushed against third rail covers, thereby destabilising the third rail system. At some point that day, the "rogue train(s)" caused one claw on the south-bound track between Newton and Orchard stations to dislodge, resulting in sagging of the third rail by about 40mm.

8. Although SMRT deployed its Multi-Function Vehicle (MFV) to conduct checks on various sections of the track in the early morning of 17 Dec, the sag in the third rail was not detected due to a failure of the MFV's software compounded by shortcomings in SMRT's maintenance work culture.

9. After revenue service commenced on 17 Dec 2011, due to the additional contributory factor of the offset between the running and third rails being smaller than it should have been (resulting from possibly improper manual third rail re-gauging, rail head and wheel flange wear, and excessive vibration if the train had wheel defects), Train 119's CCD shoes forcefully engaged the sagging third rail, dislodging an adjacent claw. This then caused a further sag of

the third rail[1], which caused damage to the CCDs of Train 119 and the trains that passed after it. Four of these trains subsequently stalled as they were no longer able to draw sufficient power and another was pre-emptively detrained.

10. As with the incident of 15 Dec 2011, whilst the incident of 17 Dec 2011 was caused by a combination of factors, it could nonetheless have been prevented.

[1] T119 was subsequently also identified as one of the trains generating high levels of vibration due to wheel flats and thinned wheel flanges.