COMMISSION OF INQUIRY INTO THE CONSTRUCTION WORKS AT AND NEAR THE HUNG HOM STATION EXTENSION UNDER THE SHATIN TO CENTRAL LINK ("SCL") PROJECT

("THE COMMISSION")

CLOSING SUBMISSIONS OF THE GOVERNMENT

ON EXPERT EVIDENCE FOR THE EXTENDED INQUIRY ("COI-2")

A. Overview of Investigations and Findings – Verification Proposal

1. In view of the deficiencies in site inspection records, material testing records and design change records for the structures in the North Approach Tunnels ("**NAT"**), South Approach Tunnels ("**SAT"**) and Hung Hom Stabling Sidings ("**HHS"**), a Verification proposal ("**the Verification Proposal**") is formulated to verify the as-constructed conditions (including quality, workmanship and design changes) of the structures of NAT, SAT and HHS, ascertain the structural integrity and ensure the quality assurance of the structures **[BB8/5125-5146]**.

2. The Verification Proposal consists of two parts,

   (1) Part 1:

      (a) Part 1a: Consolidation and verification of available construction records with a view to identifying any gaps in site inspection records, material testing records and design change records.

      (b) Part 1b: Review and ascertain the as-constructed conditions including design changes, and the quality and workmanship of

the as-constructed structures so as to close the gaps identified in Part 1a.

(2) Part 2: Structural review of the structures and study of schematic "suitable measures" (" **"suitable measures"** ")to address gaps that cannot be closed out in Part 1.

3. On 18 July 2019, the Final Verification Study Report on As-constructed Conditions of the NAT, SAT & HHS ("**the Verification Report**") **[BB16/9952-10000]** was duly submitted to the Commission.

4. The key findings of the Verification Report are as follows.

Part 1a: Consolidating and Verification of Available Construction Records

Site Inspection Records

5. For the purpose of the Verification Report, two hold-point inspections are considered essential: "Fixing of reinforcement and Cathodic Protection" (also known as "**Rebar Check**") and "Pre-pour check for reinforcement fixing, alignment, level, formwork, cleanliness" (also known as "**Pre-pour Check**"). These two hold-point inspections are recorded in the rebar RISC forms and pre-pour RISC forms respectively **[BB16/9963 §3.1.1]**.

6. The availability of the RISC forms for NAT, SAT and HHS is shown in the table below **[BB16/9963 Table 1]**:

Structures	**No. of RISC forms required**		**No. and % of available RISC forms**		**No. and % of unavailable RISC forms**	
NAT	Rebar	64	21	33%	43	67%
	Pre-pour	59	13	22%	46	78%
SAT	Rebar	42	23	55%	19	45%

	Pre-pour	44	27	61%	17	39%
HHS	Rebar	659	287	44%	372	56%
	Pre-pour	611	344	56%	267	44%

7. The Verification Report also records the following incidents which are relevant to the missing RISC forms. These incidents were investigated during the factual evidence for COI-2:

   (1) The RISC forms for the coupler installation works at the Variable Refrigerant Volume Plant ("**VRV**") Room was rejected prior to concrete pouring, but concreting proceeded nevertheless. The Verification Report made it clear that the relevant works has not been accepted by MTRCL and will be rectified by Leighton **[BB16/9964 §3.1.3]**.

   (2) In late 2017, water seepage was observed at three stitch joints at NAT. Investigation were carried out and defective coupler connections were identified. It was also found that at that time, RISC forms were not submitted by Leighton for the stitch joint construction. The three stitch joints were subsequently reconstructed in mid-2018 **[BB16/9964 §3.1.4]**.

   (3) In light of the stitch joint incident, an investigation of the connection joint at the Shunt Neck was completed in March 2018 and defective coupler connections were also identified **[BB16/9964 §3.1.5]**.

Material Testing Records

8. For the purpose of the Verification Report, the availability of (1) concrete cube testing records; (2) rebar testing records and (3) sand replacement test records is reviewed.

9. Concrete cube tests records are substantially available for the NAT, SAT and HHS structures. However, there are five locations without concrete cube testing records at trough walls of HHS **[BB16/9964-9965 §§3.1.7-3.1.8]**. Thus, further tests are carried out under Part 1b to address the missing test records (see §22 below).

10. For sand replacement test records, the number of test record is generally more than the required minimum number. There are two missing sand replacement test records at a localised area of HHS for stormwater pipe replacement works. As the missing test record amounts to a very small percentage, it is considered that the effect on the performance of the structure is insignificant **[BB16/9966 §§3.1.11-3.1.12]**.

11. The more controversial item is the rebar testing records. In the course of COI-2, Leighton gave evidence that approximately 7% of the rebar delivered to site under Contract No. 1112 was not sampled for testing by a Hong Kong Laboratory Accreditation Scheme accredited laboratory (see Karl Speed's evidence: **[Transcript on 5.6.2019/40:20-42:7]**). Investigation reveals that, based on Leighton's delivery summary, the rebars that have not been sampled for testing were about 3,500 tons which may have been used in NAT, SAT and HHS structures, but not for the accommodation blocks **[BB16/9965 §3.1.10]**. As elaborated below, a rebar strength reduction factor of 4% and 13% for rebars of a diameter of 16mm or more, and 13% for rebars of a diameter of 12mm or less respectively is adopted for the purpose of the structural review under Part 2 **[BB16/9972 Table 5 item (b)]**.

Design change records

12. Upon comparing the latest amendment drawings (as-constructed) provided by Leighton with the available objective evidence, it was found that

couplers had been used by Leighton to replace the lapped bars specified in the original accepted design at some of the construction joints in the structures of NAT, SAT and HHS **[BB16/9967 §3.1.13].**

13. Conversely, for the connection between the diaphragm wall ("**D-wall**") and NSL track slab of SAT, Leighton replaced the Type 2 couplers originally specified in the accepted design with drill-in bars at some of these locations. However, there is no record of any pull-out test having been carried out for the said drill-in bars **[BB16/9967 §3.1.16]**.

14. These changes to the works were further studied in Part 1b by reference to available site photos and the results of cover meter scans.

15. However, in view of the missing pulled-out test records for the drill-in bars, the strength of the drill-in bars is ignored for the structural review in Part 2 **[BB16/9973 Table 5 item (f)]** (see §27 below).

Part 1b: Review and Ascertain the As-constructed Conditions of Structures

16. For the purpose of closing the gaps in RISC forms identified in Part 1a, objective evidence such as site photos, MTRCL's site dairies, WhatsApp messages and other quality assurance records are collated with a view to assessing the as-constructed conditions of the structures **[BB16/9968-9969 §§3.2.1-3.2.2]**.

17. Upon completion of the review, some objective evidence was identified for certain unavailable RISC forms. The results are summarised in the table below **[BB16/9971 Table 4]**:

Structures	No. and % of unavailable RISC forms			No. and % of unavailable RISC forms with objective evidence identified	No. and % of unavailable RISC forms without objective evidence
NAT	Rebar	43	67%	39	4
	Pre-pour	46	78%	46	0
SAT	Rebar	19	45%	13	6
	Pre-pour	17	39%	17	0
HHS	Rebar	372	56%	191	181
	Pre-pour	267	44%	219	48

18. The considerable proportion of missing RISC forms at NAT, SAT and HHS structures raised questions as to whether or not the required site supervision and control had been implemented at the relevant hold points and whether or not the works had been carried out to the required standards **[BB16/9971§3.2.11]**.

19. In order to address the issue of missing records, a strength reduction factor is applied in areas where coupler connections have replaced lapped bars for the purpose of the structural review under Part 2 (see §26 below).

Non-Destructive Test

20. In addition to collating other objective evidence, scanning by cover meter was carried out to over 400 locations (of about 1m by 1m each) in NAT, SAT and HHS. Upon scanning, it is found that the spacing of rebars is appropriate; no anomalies showing noticeable deviation of the size and spacing of the main rebar from the accepted drawings were found. **[BB16/9972 Table 5 item (a)]**. However, 9% of the locations scanned are of insufficient concrete cover **[BB16/9969 §§3.2.3-3.2.4]**.

21. To address the problem of insufficient concrete cover, fire proof coating and concrete thickening were proposed **[BB16/9969 §3.2.4]**.

Concrete Cube Test Records

22. 15 concrete cores were taken from various locations of trough walls where there were no records of cube tests. Further, Schmidt Hammer tests were carried to other locations where there is not enough records of cube tests. The test results show that the works in question comply with the design strength requirement. For other locations, the results of the available concrete cube tests conducted during construction were satisfactory **[BB16/9969 §3.2.5]**.

23. Given that the test results are satisfactory, the concrete of the as-constructed structures is assumed to have the required strength as specified in the accepted drawings **[BB16/9972 Table 5 item (c)]**.

<u>Part 2: Structural review</u>

24. For the purpose of the structural review, a comparison was made between the deduced spare structural capacity and the assumed strength reduction factor for coupler installations **[BB16/9974 §4.1.2]**.

25. The results for the structural review are as follows.

Coupler connections

26. Due to the lack of full records of the coupler connection works, MTRCL decided to apply a strength reduction factor of 35% in areas where coupler connections have replaced lapped bars on account of the uncertainty of workmanship. MTRCL considered that the figure 35% is comparable to the strength reduction factor applied in respect of the NSL platform slab in

the adjacent station box structure which is adjoining to the NSL tunnel at SAT **[BB16/9976 §4.2.6]**.

27. As mentioned above, the strength of any drill-in bars between the D-wall and NSL track slab at SAT has been ignored in the structural review since the required pull-out test records are not available **[BB16/9973 Table 5 item (f)]**.

28. The results are as follows:

    (1) For NAT and SAT structures, the spare structural capacity at critical coupler locations is greater than the assumed strength reduction factor of 35%. No "suitable measures" was therefore required.

    (2) However, for HHS structures, the spare structural capacity at critical coupler locations of trough wall kickers near movement joints of a total length of about 150m is less than the assumed strength reduction factor of 35%. Hence, "suitable measures" were proposed **[BB16/9978 §§4.5.1-4.5.2]**.

Untested rebar

29. As mentioned above, approximately 7% of the rebar delivered to site was not sampled for testing. To address the missing testing records, on the basis of the previous rebar tensile tests records, MTRCL applied a strength reduction factor of 4% for rebars of a diameter of 16mm or above, and 13% for rebars of a diameter of 12mm or below **[BB16/9977 §4.3.2]**.

30. The results are as follows:

    (1) <u>Shear capacity:</u> the spare structural capacity at critical shear locations of the NAT, HHS and SAT structures are greater than the assumed

strength reduction factor of 4% or 13% depending on rebar size. However, in view of the concern about the unsatisfactory shear link placement in Area A of the NSL slab of the station box structure, which is adjoining SAT, "suitable measures" were proposed to enhance the shear strength at the NSL tunnel box **[BB16/9978 §§4.5.3-4.5.4]**.

(2) Bending capacity: the spare structural capacity in bending at critical locations with rebar diameter of 16mm or above and without coupler connections is greater than the assumed strength reduction factor of 4%. "Suitable measures" are therefore not required **[BB16/9979 §4.5.6]**.

Conclusion

31. Based on results of the structural review,

(a) because of the adoption of a 35% strength reduction factor for the undocumented coupler connections in the trough walls of HHS, "suitable measures" are required to be carried out to the trough walls near the movement joints **[BB16/9980 §5.1 & 9998-1000 Appendix C]**;

(b) to address the shear link placement issue by ignoring the contribution of shear links that may exist, "suitable measures" are required to be carried out at certain critical locations of the NSL tunnel box at SAT **[BB16/9980 §5.2 & 9997 Appendix C]**;

(c) no "suitable measures" are required as a result of the missing rebar testing records **[BB16/9980 §5.3]**.

32. Further, in view of the gaps identified in Part 1a, a long-term monitoring scheme including instrumentation monitoring and inspections was

proposed by MTRCL to monitor the structural integrity of the NAT, SAT and HHS structures. Suitable restrictions and precautionary arrangements, which are in connection with the use of updated design assumptions, will also be put in place as appropriate **[BB16/9980 §5.4]**.

33. It is considered that, given the findings in the Verification Report and with the implementation of the proposed "suitable measures", the concern about the structural integrity of NAT, SAT and HHS arising from the missing RISC forms and other relevant reported issues will be adequately addressed **[BB16/9974 §4.1.1]**.

B. Structural Engineering Evidence

B1. Background

34. In the Interim Report, the Commission, having considered the evidence available adduced in Part 1 of the Inquiry ("**COI-1**"), concluded that the Hung Hom Station ("**HUH**") Extension D-wall and platform slab construction works are safe **[A2/721 & 824-827]**. In the meantime, the Commission was informed of the progressive developments and findings of the Holistic Proposal for Verification & Assurance of As-constructed Conditions and Workmanship Quality of the HUH Extension ("**the Holistic Proposal**"), that the Stage 3 Structural Assessment (under the Holistic Proposal) ("**Stage 3 Structural Assessment**") would be conducted, and that the issue regarding the need for and the extent of the remedial works (if required) would also be addressed.

35. The Final Holistic Proposal Report ("**the Holistic Report**") and the Verification Report were released in July 2019. Upon considering the contents of the reports, the Commission sought clarifications from the Government and MTRCL on various issues relating to the question of

structural safety and also the need to implement the remedial works (defined as "suitable measures") **[OU5/3356-3359]**.

36. Both the Government and MTRCL provided their replies and also answers to the Commission's Requests for Information (see Government: **[OU5/3377-3379];** MTRCL: **[OU5/3374-3376])**.

37. By letter dated 7 August 2019 **[OU5/3354-3355]**, the Commission asked all involved parties to indicate if they would adduce structuring engineering expert evidence on various matters including three major topics namely, coupler connection, shear links and horizontal construction joint between EWL slab and D-wall panels in Areas B and C.

38. On 7 August 2019, Messrs. O'Melveny & Myers ("**OMM**") (for Leighton) wrote to the Commission seeking to adduce structural engineering expert evidence "*to consider and make an assessment of the suitable measures proposed in the [Holistic and Verification Reports]*" and also expert evidence from a statistician in relation to rebar testing **[OU5/3380-3382]**.

39. By email dated 14 August 2019 to the Commission, Department of Justice ("**DOJ**") (for the Government) stated at §4 **[OU5/3426]**:-

"In light of the said agreement to implement the "suitable measures" as recorded in the Holistic Report, we are of the view that further structural engineering or statistical expert evidence, or arguments on the details of the assessment performed by MTRCL or the "suitable measures" proposed (which in any event are yet to be further developed) would not be necessary. In particular, further arguments on the question of whether the Station (without the implementation of "suitable measures") can generally be described as "safe" without making any reference to agreed design standards, benchmark or any statutory requirements in Hong Kong would

not be helpful to the Commission or the public. Moreover, as the Government and MTRCL have agreed to proceed with the "suitable measures", the question of whether some or all of the "suitable measures" proposed are necessary in the circumstances (whether under the Contract or otherwise) would, in our view, be primarily a matter of civil liability, which ought to be resolved in a separate forum."

40. Hence, DOJ informed the Commission that it was the Government's view that no structural engineering or statistical expert evidence would be required on the Government's own accord, and that any expert report on the Government's part would only be responsive in nature **[OU5/3427]**.

41. By letter dated 16 August 2019, OMM informed the Commission that Leighton would be "prepared to withdraw its request to adduce expert evidence on statistics regarding coupler connections if the Commission acknowledges that the key parties have different opinions in relation to the quality of the coupler connections and allows the parties to resolve such differences in other appropriate forums (if necessary)" **[OU6/3736]**.

42. By emails dated 25 August 2019 and 29 August 2019, the Commission gave directions on the expert evidence relating to statistical matters and structural engineering respectively **[AA1/266-269; OU7/9691-9692]**.

B2. Safety and fitness for purpose

43. By letter dated 4 October 2019, the Commission wrote to all involved parties stating that in view of the fact that it was concluded in the Holistic Report and the Verification Report that "suitable measures" would need to be carried out, the Commission took a tentative view that the structural engineering experts ("**the SE experts**") should focus on whether the relevant works as constructed are safe and fit for purpose and whether the

"suitable measures" are necessary for safety and statutory or code compliance and invited all involved parties to make submissions on whether this should be the appropriate focus of the structural engineering evidence **[AA1/419-420]**.

44. The Government's submissions on the issue of structural safety were filed on 10 October 2019 **[AA2/441-446]**. The key points can be summarised as follows.

(1) 'Safety' is a broad concept and can be subject to variations in different people's interpretations. However, the question of whether the relevant works as constructed are 'safe' can only be meaningfully answered by reference to some objective building standards.

(2) The Code of Practice for Structural Use of Concrete 2004 ("**the Code**") **[H8/2818-3015]** and the Buildings Ordinance ("**BO**") reflect the level of structural safety expected and required to be achieved in all building structures in Hong Kong. There is no reason why another set of structural safety standards should be applied to the construction works at the HUH Extension, NAT, SAT and HHS.

(3) Hence, the Code and the BO are intrinsically linked to structural safety required to be achieved in Hong Kong and the two cannot be artificially segregated.

(4) In addition, there are other provisions contained in, for example, CS2 **[BB2/1178-1213]** and the Code of Practice for Fire Safety in Buildings 2011 (in relation to concrete cover to maintain the stability of the structural elements in case of fire) which also concern structural safety of structures and all relevant codes are collectively referred to as "**the Applicable Codes**".

(5) The Government would only consider a structure to be 'safe' if both its design and construction comply with the requirements of the BO and the Applicable Codes, not only in respect of loads or strength, but also serviceability, durability, fire resistance and robustness so as to cater for unforeseen and exceptional circumstances or adversities like fire. The same standards were adopted by MTRCL in the original design as well as the Stage 3 Structural Assessment.

(6) Upon the Stage 3 Structural Assessment and the further investigation and assessment carried out pursuant to the Verification Proposal, it is concluded that without the implementation of the "suitable measures" (although the exact details and extents are yet to be determined) the as-built structures fail to comply with the requirements of the BO, the Applicable Codes and MTRCL's New Works Design Standards Manual ("**NWDSM**"). This is common ground between the Government and MTRCL. However, it is also common ground between the Government and MTRCL that one can safely conclude that upon the implementation of the "suitable measures" the structures are 'safe' according to a set of objective standards as enshrined in the BO and the Applicable Codes.

(7) The Commission should not be concerned with the question of whether some part(s) of the "suitable measures" proposed by MTRCL may be excessive, and thus unnecessary. It is because the "suitable measures" as proposed in the Holistic Report and Verification Report will have to be carried out in any event as agreed between and jointly announced by the Government and MTRCL (and there is no reason why they should not be entitled to do so) for the purpose of ensuring that the requisite building standards are complied with and the requirements of NWDSM are met.

(8) Insofar as Leighton (who was not privy to Stage 3 Structural Assessment and the assessment work under Verification Proposal) intends to establish that the "suitable measures" are excessive or unnecessary believing that it may have an impact on the extent of its legal liability under Contract 1112, this is a matter entirely between MTRCL and Leighton, which if required should be resolved by way of civil litigation between them instead of this Inquiry.

(9) If Leighton attempts to prove that the as-built structures are 'safe' without the implementation of the "suitable measures" while making no reference to the BO and the Applicable Codes, it is submitted that such exercise does not serve any meaningful purpose because, as explained above, the Applicable Codes and the BO reflect the standards required in Hong Kong for the purpose of ensuing safety.

(10) It is not in dispute that the structures do not have any imminent risk or danger of collapsing. The Government has accepted the description in MTRCL's Holistic Report and Verification Report that 'for ongoing construction activities, the structure is safe'. However, a structure which is capable of taking up its existing loads without any present risk of collapsing does not mean it is 'safe' for any further loads, including those under unforeseen and/or exceptional circumstances that it may experience during the lifetime of the structure. Hence, if any involved party wishes to rely on any calculations only in terms of loads or strength in the hope that it can demonstrate that the structure built is safe, the consideration of loads or strength is insufficient and it falls short of the standards applicable to all other building structures in Hong Kong.

(11) By the same token, in order to answer the question as to whether the as-built structures are 'fit for purpose', one has to first ascertain the 'purpose' for which the structures are built. It is indisputable that MTRCL was commissioned by the Government (and Leighton was appointed as main contractor by MTRCL) to build the structures in question as part of the railway systems in Hong Kong. Hence, if the structures are not allowed to be put into use as such because they do not achieve the level of structural safety required under the Applicable Codes and the BO, they cannot be said to be 'fit for the purpose' for which they are intended.

45. Upon considering parties' written submissions and oral submissions at the hearing on 11 October 2019, the Commissions gave directions on 12 October 2019 **[OU8/10561-10562]** that the SE experts should focus on "*whether the as-constructed works are safe and fit for purpose from a structural engineering perspective*" and "*the SE experts shall not be required to look into the question of whether the "suitable measures*" (as agreed in the Holistic Report or Verification Report, or subsequently) are required for statutory or code compliance".

46. The above directions are intended to require the SE experts to analyse the structural issues (including the issues of "suitable measures") not from a point of view of strict adherence to the Applicable Codes but from "a structural engineering perspective". Further, by email dated 25 November 2019 **[OU9/10978-10979]**, the Commission clarified that the above directions do not preclude any reference to relevant statutes or codes, in particular if such reference is necessary for the SE experts to explain their analyses on whether the structures are safe and fit for purpose.

47. Different SE experts may analyse the above issues by adopting different approaches or from different angles. However, it is submitted that there are certain parameters which must be considered. In this regard, it appears from the evidence given by all four SE experts that they have all considered the primary factors such as strength and longevity/durability while Dr Lau (for the Government) has referred to further details on the relevant factors which should be considered. But, after all, it seems that there is no major dispute on the applicable parameters.

48. Other than the questions of whether partially engaged coupler connections should be taken into account and whether the contribution of shear links that may exist in the slabs should be ignored in the structural assessment, the main difference between the SE experts appears to lie in the minimum levels of the factor of safety which should be applied to the analysis of the issues identified in the Commission's directions. Dr Lau takes the view that in considering the level of factor of safety, the standards and requirements laid down under the Applicable Codes shall be met as it reflects the community's expectation and consensus reached among the industry practitioners taking into account of the circumstances in Hong Kong **[ER2/item 17.1/Lau1 §§32-34]**. The other SE experts, namely, Mr Nick Southward (for Leighton), Dr Mike Glover (for MTRCL) and Professor Don McQuillan (for the Commission) think otherwise. They considered that lower levels of safety factor (which deviate from those required under the Applicable Codes) could be applied in the assessment.

49. The above reflect the differences between the experts in terms of the approach they have taken in this exercise. Obviously, Dr Lau's opinion is that the issues of "safety" and "fitness for purpose" need to be assessed by looking at the relevant parameters and also adopting the levels of factor of safety stipulated under the Applicable Codes because, as mentioned above,

the standards required under the Applicable Codes are closely and intrinsically linked to the questions of safety and fitness for purpose. However, the other three SE experts have provided their opinions from a "forensic engineering" perspective on whether the structures are safe by applying the levels of factor of safety which they consider acceptable even though they fall short of the requirements under the Applicable Codes in Hong Kong. However, if one takes such an approach, it is important to explain how the proposed reduction could be objectively ascertained and measured. Further, a forensic engineering approach should involve sufficient field investigation and detailed examination of the structures concerned supported by systematic and comprehensive laboratory test results. Nonetheless, it appears that no detailed information regarding such investigation and examination is contained in their evidence.

B3. Are the as-built structures (i.e. without the implementation of "suitable measures") safe from a structural engineering perspective?

50. For the purpose of bringing the as-built structures up to the safety level required under the Code, the BO and MTRCL's NWDSM, "suitable measures" are being carried out by Leighton and MTRCL on site. Upon completion of such "suitable measures", certain parts of the as-built structures will be rectified and strengthened. Hence, the present question relating to structural adequacy or safety of the as-built structures should not affect the need for and also the actual implementation of the "suitable measures".

51. As submitted above, there is no benchmark or text-book definition for determining whether a structure is safe and fit for purpose from a structural engineering perspective. There may be variations in different people's mind regarding whether their perceived "safety" requirements have been

met. Naturally, different structural engineers may have different views and they may place different levels of emphasis on the relevant parameters and/or what they consider to be the required level of factors of safety.

52. However, it is submitted that the question of whether the relevant works as constructed are 'safe' can only be meaningfully answered by reference to some objective building standards. No doubt, different experts may apply a certain degree of their own engineering judgments in the analysis of safety and it is always easy to say that this ultimately boils down to "a matter of common sense" (see Southward's evidence: **[Transcript on 2.1.2020/106:5]**); however, it is inappropriate and dangerous to evaluate building safety by resorting to subjective elements of expectations and perceptions. This is the reason why different jurisdictions will have their own building codes and standards tailor-made and published for engineers to design structures to attain an acceptable level of safety specific to these countries and areas. Mr Southward agrees that different countries have different ways of approaching and using factors of safety (see Southward's evidence: **[Transcript on 2.1.2020/119:17-20]**).

53. In the present case, the relevant standards in Hong Kong are the Code and the BO. The Code was drawn up by a steering committee, comprising relevant building professionals representing professional institutions and stakeholder organisations, academia and representatives of relevant government departments, and upon formal consultation with the construction industry in Hong Kong via established consultative committees. It therefore represents the collective wisdom and consensus reached to suit the particular circumstances in Hong Kong and reflects the level of structural safety expected and required by the society to be achieved in all building structures in Hong Kong. Hence the Building Authority would only raise no objection to the certification submitted for

the completion of the works in question if and only if the works are designed and constructed to achieve the level of structural safety required in, *inter alia*, the BO and the Code.

54. Dr Lau was a member of the said steering committee. He was involved in the consultation process and drafting of the Code, thus the setting of the said minimum safety standard **[Transcript on 3.1.2020/97:14-20; on 6.1.2020/7:6-8]**. Whilst Dr Lau has identified various parameters for ascertaining the questions of safety and fitness for purpose, he takes the view that in considering the level of factor of safety, the standards laid down under the Code and BO would need to be applied **[Transcript on 6.1.2020/48:6-11]**. In other words, a structure will only be considered safe and fit for purpose if the standards governing the factor of safety in relation to each of the relevant parameters (as set out in the Code and BO) are fulfilled **[Transcript on 6.1.2020/54:14-55:4]**. According to Dr Lau, to satisfy the fit-for-purpose requirement, one also has to comply with the requirements of the client as set out in the contract, a relevant part of which is the NWSDM **[Transcript on 3.1.2020/103:3-12; 104:13-22; 114:21-115:3]**. In fact, Mr Southward agrees that in assessing whether a structure is fit for purpose, it is necessary to consider the purpose that the structure intended to serve under the client's requirements **[Transcript on 2.1.2020/111:19-23].**

55. On the basis of the structural assessment done by MTRCL's designers, Atkins and AECOM, Dr Lau is of the view that the as-built structures are not safe and fit for purpose. It is because they fail to achieve at least the same level of safety required by the Code and BO. In particular, Dr Lau is primarily concerned with (a) the risk of trough walls hitting the existing columns that support the podium above when they are subject to the design

impact load of a derailed train, and (b) the possible complete lack of shear links at critical locations where shear links are required.

56. Other experts consider that the as-built structures are safe from a structural engineering perspective by reference to different benchmarks. Dr Glover highlights the fact that some uncertainties a designer faced at design stage would be removed upon completion of the construction. Hence a reduced factor of safety could be adopted for post-construction structural assessment, and he would therefore adopt the approach used in forensic analysis **[Transcript on 8.1.2020/4:18-5:3]**. Professor McQuillan takes a similar view that for the purpose of determining whether the as-built structures are safe and fit for purpose from a structural engineering perspective, if appropriate, one can adopt different design loads (other than those specified in design codes) and apply a somewhat lower level of factor of safety in the assessment **[Transcript on 9.1.2020/12:1–15:3]**. However, when Dr Glover was asked to comment whether it would be difficult to quantify the reduction in partial load factor in the structural assessment, Dr Glover acknowledged that it was "*on the basis of your expectation of the variation in that load going forward*" **[Transcript on 7.1.2020/165:10-25]**. Dr Glover also said that it ultimately would depend on whether the reduction was within a reasonable range and as such the adoption of the partial factors of safety in the Code by Atkins in Stage 3 Structural Assessment is not unreasonable **[Transcript on 7.1.2020/162:4-168:24]**. This seems to further confirm that, other than verification against the Code and BO, there is no objective way to assess and to quantify the reduction which should be applied in the structural assessment.

57. In any event, it is to be noted that some of the uncertainties/unknown at the design stage referred to by Arup and Professor McQuillan, e.g., in relation to load conditions and actual geometry of the structure, have in fact already

been taken into account by MTRCL and its designer when the parameters for the Updated Design were developed and agreed with the Government: see: Holistic Report **[OU5/3239-3240 §§35, 38 to 41]**; Verification Report **[BB16/9956-57 §§12 & 13]**.

58. In COI-2, the two specific structural issues being considered by the SE experts are (a) integrity of the trough walls in HHS, and (b) the shear capacity of the NSL slab in SAT. They are further discussed below.

Trough wall in HHS

59. There is no issue regarding the adequacy of the original design of the trough walls in HHS. Hence, if all the coupler connections at the kicker of the trough walls are properly connected as per the requirements of BOSA, the as-built trough walls would be safe and able to serve its intended purpose.

60. Although MTRCL indicated in its Verification Proposal that opening up investigation would be considered if, after the completion of verification work under Part 1a of the Verification Proposal, there remained gaps in the construction records **[BB8/5133 §5.3.4]**, no opening up was however carried out to ascertain the quality of the coupler connections at the kicker of the trough walls.

61. In view of the discovery of defective coupler connections (including those coupler assemblies that are found to be unconnected) in the platform slabs, and further due to the lack of full records of the coupler connection works at the trough walls, MTRCL considered prudent to apply a strength reduction factor in areas where coupler connections have replaced lapped bars on account of the uncertainty of workmanship. In the absence of any other alternative evidence or data, MTRCL decided to apply similar

defective rate found (statistically) for the coupler connections in the NSL platform slab in the structural assessment of the trough walls. A reduction factor of 35% was therefore adopted **[BB16/9976 §4.2.6]**.

62. Dr Lau said he would also prefer having information on the quality of the coupler connections from opening-up investigation. Without such data, given the condition of the coupler assembly works done by the steel fixers in the original stitch joints, the Shunt Neck joint at EWL and in VRV room, he is of the view that the adoption of a similar defective rate found for the platform slabs is not unreasonable in the circumstances **[Transcript on 6.1.2020/9:3-25, 11:1-5 & 15:2-5]**.

63. Upon detailed assessment by MTRCL's design consultant, "suitable measures" are found to be necessary and therefore recommended at locations near the movement joint of the trough walls and in close proximity of an exiting column supporting the podium structure above **[BB16/9978 §4.5.2 & 9998-10000 Appendix C]**.

64. With the application of the said strength reduction factor, Mr Southward seeks to justify the structural adequacy of the as-built trough walls at those locations by yield line method. It is not in dispute that yield line method is allowed in the Code for the purpose of design. Yield line analysis is based on plastic design under which it is assumed that, at failure, the structure would undergo plastic deformation. In the circumstances, on failure, the location of the yield line would behave like a hinge and the part of the trough wall above it would rotate and sway sideward **[Transcript on 8.1.2020/92:19-93:10]**. Dr Lau is therefore concerned with the risk of the wall hitting the existing column when it is subject to the design impact load caused by a derailed train. In cross-examination, Mr Southward admitted that he had not checked the corresponding deflection of the wall

[Transcript on 3.1.2020/80:21-81:1]. Dr Glover, under cross examination, also agrees that it is a concern and have to be checked **[Transcript on 8.1.2020/97:20-98:5]**.

65. As to the suggested further resistance that may be provided by the soil backfill behind the trough wall and the possible sharing of the impact load to the trough wall on the opposite side through a concrete slab, it is submitted that the concrete slab referred to by Dr Glover is, according to the staff of MTRCL attending the site visit with the structural experts, in actual fact a layer of lean concrete **[Transcript on 8.1.2020/99:7-100:12]**. Even if it was a concrete slab, both the slab thickness and concrete strength are unknown, the 'slab' may not even be reinforced, it is not prudent to assume there is extra capacity in the trough walls by reason of the presence of soil backfill and a concrete layer on top of the soil backfill.

66. Professor McQuillan refers to Arup's report **[BB18/10964]** and further points out a number of "mitigating factors" suggesting that in view of those factors there is a further margin of safety which has not been taken into account in the assessment **[ER(COI2)1/item 11/McQuillan2 §35]**. It is submitted that not only has the suggested further margin of safety not been quantified by Arup or Professor McQuillan, some of these apparent further mitigating factors, e.g. the derailed train would not be fully loaded or would be running inside the HHS at a reduced speed, and in case of derailment, the train will not be hitting at a right angle to the surface of trough wall, may not always be present during accidents.[1] In any event, if

[1] (a) In Atkin's structural assessment, the design impact load has already been reduced from the specified 1000KN **[cl. 4.4.12.4 at OU9/11138]** to 400 KN to account for the fact that the train running inside the HHS will be reduced to 25 km/hour **[cl. 1.2.1 to 1.2.3 at DD18/18493, App A at DD18/18512]**, (b) it is common practice that the load specified for the design of a continuous wall is expressed as a force acting perpendicular to the wall surface, it does not necessary mean that the angle of impact is perpendicular to the wall **[Transcript on 9.10.2020/40:24-41:4]**. It is submitted that the

one has to rely on any of these further mitigating factors to make the trough walls safe, it has to be clearly stated in the conclusion of the assessment.

Inadequate shear capacity at NSL of SAT

67. The wide spread non-compliant shear reinforcements found in the EWL slab soffit raised questions as to the workmanship of the shear link placement in the NAT and SAT structure. **[BB16/9970 §3.2.6]**.

68. The position taken by MTRCL at the time was that in view of the concern about the unsatisfactory shear link placement in Area A of the NSL slab adjoining SAT, for the purpose of structural assessment, the contribution of the shear links that may exist is to be ignored **[AA2/509 & 563]**. Dr Lau is also of the view that ignoring the contribution of any shear links (of a somewhat uncertain arrangement) in the slab is justified and appropriate in the circumstances **[ER2/Item 17.1/Lau1 §§119 & 137; ER2/item 17.11/Lau's slide 28]**. In view of the fact that 16 out of 40 locations at the soffit of the EWL platform slab inspected are found to be without trace of shear links, Dr Lau is concerned with the risk of complete lack of shear link at critical locations where they are required **[ER2/Item 17.1/Lau1 §§121, 124, 126, 135 & 137; Transcript on 6.1.2020/3:3-6 and 10:12-17]**. As a result, "suitable measures" are required at certain locations of the slab. **[BB16/9978 §4.5.4; 9997 Appendix C]**.

69. In respect of the suggestion that excessive shear force acting on the NSL slab of SAT (which necessitates the implementation of "suitable measures") would be redistributed through the internal wall (hanger wall) to the upper slab at mezzanine level, and after such redistribution, the shear stress in the

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value specified for the design may only represent the component of the impact load acting perpendicular to the wall.

NSL slab would be reduced and no "suitable measures" would be required[2], it is submitted that such argument does not stand as a matter of engineering principle. According to section 10.2 of Atkins's structural assessment for SAT, the effect and contribution of the said internal/hanger wall, if any, has been taken into account by Atkins in the structural analysis as the said hanger wall has been modelled as part of the SAT structure **[ER(COI2)1/item 13.1/Lau2 §§39(1) & (2); AA2/553 §10.2; AA2/748]**. Yet, the utilisation in respect of shear at some locations still exceeded 100%.

70. Further, as opined by Dr Lau **[ER(COI2)1/Item 13.1/Lau2 §39(3)]**, "*redistribution of internal forces would require sufficient ductility for displacement to take place before any internal forces could be transferred to or taken up by other section.*" And as shear failure is a brittle failure, the occurrence of which is sudden and without warning, it does not involve ductility, there can be no redistribution of shear forces before failure of the section overstressed **[ER(COI2)1/Item 13.1/Lau2 §§39(4) & (5)]**.

71. As to the suggestion by both Dr Glover and Professor McQuillan that the NSL slab at SAT cannot possibly fail in shear because it was cast on top of and therefore supported by the underlining earth **[ER(COI2)1/Item 12.2/Glover's slide 10; Transcript on 7.1.2020/87:14-88:11; Transcript on 8.1.2020/173:12-17]**, it is submitted that, if it is true, one should only conclude that the as-built NSL slab is safe without the implementation of "suitable measures" <u>on condition</u> that the existing ground underneath the slab will not further settle over its entire designed working life of 120 years.

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[2] See Southward's expert report for COI-2 **[ER(COI2)1/item 10.1/Southward2 §5.3.2]** and Professor McQuillan's expert report for COI-2 **[ER(COI2)1/item 11/McQuillan2 §§91 & 92]**

B4. Are the as-built structures (i.e. without the implementation of "suitable measures") fit for purpose from a structural engineering perspective?

72. In order to answer the question as to whether the as-built structures are 'fit for purpose', one has to first ascertain the 'purpose' for which the structures are built. It is indisputable that MTRCL was commissioned by the Government (and Leighton was appointed as main contractor by MTRCL) to build the structures in question as part of the railway systems in Hong Kong. Hence, if the structures are not allowed to be put into use as such because they do not achieve the level of structural safety required under the Code and the BO, they cannot be said to be 'fit for the purpose' they are intended.

73. There is no dispute that certain parts of the as-built structures fail to comply with the requirements of the Code and/or BO. Although the SE experts may disagree on the extent and aspect of such non-compliances[3], without the implementation of any "suitable measures", the works cannot be put in operation due to such non-compliances. To that extent, they cannot possibly serve its intended purpose and hence are not fit for purpose.

74. It is to be noted that at the moment, there is no detailed study on the effect of the partially engaged couplers on the structures **[Transcript on 8.1.2020/60:10-62:7].** Although Mr Southward pointed out in his oral presentation **[ER(COI2)1/item 10.7/Southward's slides 7-9]** that the station box structure is only subject to 'Exposure Condition 1' which, pursuant to Note 1 of Table 7.1 of the Code **[H8/2928]**, the crack width would have no impact on the durability of the structure, it is submitted the station box structure and the approach tunnels in their present location

3 The Commission is however not required to resolve the differences between the SE experts in this regard.

could not possibly be subject to 'Exposure Condition 1'. Pursuant to the classification in Table 4.1 of the Code **[H8/2857]**, internal concrete surfaces exposed to high humidity, e.g. bathrooms and kitchens, are considered to be subject to 'moderate' exposure (i.e. Exposure Condition 2) while structures on or near the coast have to be designed as subject to 'severe' exposure (i.e. Exposure Condition 3). From the concrete cover specified by Atkins for the concrete works of the station box structure and the approach tunnels, it is clear that Atkins did not consider that the station box, NAT and SAT in question is only subject to Exposure Condition 1 for the purpose of the Code[4]. Further, the diaphragm walls were installed between the sea and the station box and there is no reason why they would not be subject to a high level of humidity.

75. Dr Lau is of the view that the station box structure is subject to an exposure condition between 'moderate' (i.e. Exposure Condition 2) and 'severe' (i.e. Exposure Condition 3) **[Transcript on 6.1.2020/31:2-3]**. This is in line with the concrete cover specified by Atkins for the station box structure. Although the discussions so far were not focused on the effect of partially engaged couplers on the crack width at and its impact on the durability of the NAT and SAT structures, it is likely that there would be similar concerns for those structures due to the possible presence of partially engaged couplers.

[4] Pursuant to Table 4.2 of the Code **[H8/2858]**, the concrete cover for grade 40 concrete required for structure subject to Exposure Condition 1 and 2 are 30mm and 35mm respectively. In Atkins' design, the concrete covers specified for the EWL top slab and 'Diaphragm Wall-Non Soil Face' are 40mm and 95mm respectively **and the crack width limit is 0.3mm for providing adequate durability [Table 5.5 at H14/19168]**, it is therefore plain that Atkins considered and designed the station box structure as a structure to be subject to an exposure condition more severe than Exposure Condition 2.

C. Project Management – Recommended Enhancement Measures Relating to the Government

76. Mr Steve Rowsell, i.e. the Commission's project management expert, in his COI-2 Report, made a number of recommended enhancement measures relating to the Government. These recommendations, to a certain extent, overlap with the recommendations made by the Commission in the Interim Report, as well as those contained in Mr Rowsell's COI-1 Report.

77. Paragraphs 78-85 and 87-94 below are contained in our Closing Submissions on Expert Evidence for COI-1. In view of the Commission's direction that separate sets for submissions should be made for COI-1 and COI-2, we now reproduce those submissions below for the Commission's easy reference.

78. The Government welcomes the Commission's recommendations in its Interim Report on strengthening the existing supervision, monitoring, control and management systems of the Government.

79. Since the making of the Interim Report, the Government has been proactively implementing the improvement measures suggested by the Commission and Mr Rowsell. To update the Commission on the steps taken by the Government so far in implementing those recommendations and the further steps which the Government intends to take to further strengthen its monitoring system, we have prepared two tables as follows:

(1) **Table A**: Progress Report Regarding the Commission's Specific Recommendations for the Government Set Out in the Interim Report.

(2) **Table B**: Progress Report Regarding Mr Rowsell's COI-1 Recommendations for the Government Set Out in Appendix F to the Interim Report.

80. In short, all of these recommendations are either implemented or in the process of being implemented.

81. For example, in relation to the Commission's recommendations on promotion of partnership, collaboration and communication, the Government wishes to report that the Highways Department ("**HyD**") and MTRCL established a high-level Steering Group on Communications ("**SGC**") for the SCL project in May 2019. The SGC aims to enhance the effectiveness of communication between the Government and MTRCL and ensure that the reporting of project matters from MTRCL to the Government is timely, with appropriate context and pitched at the right level. The SGC does not supervise the project *per se*, but focuses on promoting collaborative working relationships and culture in delivering the SCL project to achieve a quality outcome.

82. Guided by the SGC, some other recommendations made by the Commission have been implemented.

(1) First, a Senior Leadership Round-table workshop was held among the senior representatives from the Government, MTRCL and key contractors/subcontractors of active contracts under the SCL project on 10 January 2020. Senior leaders discussed the challenges in project delivery and exchanged views in such areas as cross-party collaboration, trust and reward to staff. As a follow-up, there will be a bi-monthly survey on partnering behavioural changes until December 2020.

(2) Second, a review of the three-tier project supervision structure (i.e. the Project Supervision Committee Meeting, Project Coordination Meeting and Project Progress Meeting) has been completed. With the SGC's endorsement, enhancement measures have been implemented to rationalise the arrangement for escalating issues from lower tier to higher tier meetings. PSC meetings have also been divided into two parts, with Part II, attended by a smaller number of more senior members, dealing with more strategic and sensitive issues.

(3) Third, co-location working arrangement between the Government and MTRCL has started. Since Q3 July 2019, a HyD's in-house inspectorate team is stationed at MTRCL's site offices. With first hand understanding of the up-to-date arrangement of site works, especially the critical work fronts, HyD can monitor the site works and its progress more closely and independently, i.e. without having to place excessive reliance on MTRCL's reporting. More frequent site inspections, including surprise checks, are being carried out to verify the quality of works as well as effectiveness of MTRCL's supervision regime.

83. Some recommendations made by the Commission are in the course of being implemented. For example, on rationalising and clarifying rules and requirements, the Buildings Department ("**BD**") is taking two follow-up actions. The first one is a new drafting a new practice note, which will consolidate various requirements relating to specific tasks and testing of materials (e.g. quality supervision plan ("**QSP**") for installation of ductility coupler splicing assemblies, on-site sampling for testing, etc.). The second one is drafting amendments to the Code of Practice for Site Supervision 2009 **[B5/2676-2795]**, which will, among others, clarify the definition of

supervision, record keeping requirements and non-conformance reporting as well as strengthening the requirements on obligations of the site supervisory personnel and the communication among the site supervisory personnel to ensure delivery of design intent in the construction. BD plans to consult the industry on the two draft documents in February 2020.

84. BD is also working with MTRCL on the introduction of a fast track consultation process so that certain types of "minor changes" could be processed within a shorter period of time (e.g. within 7 days) through an enhanced communication system and working arrangement with MTRCL and its designers consultants/contractors.

85. The Commission's other recommendations, especially those concerning governance and monitoring and verification of railway projects, are subject to further studies and planning. The Government will commission, by the end of January 2020, a consultancy to look into the Government's monitoring and control regime, as well as delivery approach in implementing future railway projects. Specifically, it will study delivery approaches adopted in major rail infrastructure projects overseas, the pros and cons of the "check the checker" mechanism under the concession approach and the monitoring mechanism under the ownership approach, and issues relating to establishing a new department specifically tasked to handle and supervise railway planning and delivery matters, etc.

86. The Government also welcomes further recommendations made by Mr Rowsell in his COI-2 Report. The Government is already in the process of implementing some of these measures. The progress achieved so far, and the steps which the Government will take, are set out in the **Table C** annexed hereto.

D. Other Aspects of Project Management Evidence

D1 "Full-time and continuous supervision"

87. Another issue regarding project management relates to the meaning of the requirement of "full-time and continuous supervision" **[Transcript on 8.10.2019/2:13-3:10]** that Leighton intends to re-open and re-argue.

88. This issue has already been dealt with by the Commission (*albeit* provisionally) in the Interim Report:

(1) During COI-1, the Commission heard evidence that Leighton's factual witnesses understood "full-time supervision" to mean simply that the person carrying out the supervision must be fully engaged on the project as opposed to working part-time, whereas "continuous supervision" meant no more than a normal daily supervision and inspection regime: Interim Report §282 **[A2/803]**.

(2) The Commission rejected such understanding and accepted the contrary interpretation advanced by Mr Rowsell, in that:-

(a) The requirement that the quality supervision should be full-time and continuous was because it was recognized that the process would be technically difficult with a high risk of problems being encountered;

(b) Full-time and continuous supervision means that Leighton's supervisor needs to be present at all times where mechanical coupler works are underway. The objective is to ensure that the work is done properly in accordance with the specifications and any problems are resolved without delay;

(c) This obligation also means that Leighton's supervisor needs to be present at the site of the work activity rather than being present elsewhere on site or in the site office carrying out other tasks. Clause G3.9.1 of the General Specification **[C3/2040]** requires that the work shall be arranged so that the works are supervised at a minimum ratio of one supervisor to no more than 10 workers. Therefore, if the number of workers involved in the coupler works is greater than 10 then there should be more than one supervisor in attendance.

(Interim Report §§281-293 **[A2/803-806]**)

89. In the course of hearing evidence on project management in COI-2, Leighton's expert witness, Mr George Wall, argues that:

(1) There is a difference between the standard of "full time and continuous" supervision and the allegedly lower standard of merely "full-time supervision". The "continuous" requirement is allegedly only applicable if the coupler works are subject to a ductility requirement as determined by the working drawings made available to Leighton by MTRCL **[ER(COI2)1/item 5/Wall §75]**.

(2) It is not practical to have an engineer present on site looking at the coupler works all of the time that the works are being carried out. Instead, the fact that the engineers supervising the coupler works tended to spend approximately 70% of their day on-site supervising the works (i.e. 3 to 4 hours in the morning followed by a further 3 to 4 hours in the afternoon) is broadly in line with industry practice on construction sites in Hong Kong, and such practice would purportedly fulfil the requirements of "full-time and continuous supervision" **[ER(COI2)1/item 5/Wall §§74 & 76]** .

(3) The supervision ratio of 1:10 as specified in Clause G3.9.1 of the General Specification allegedly relates only to health and safety and not quality assurance matters **[ER(COI2)1/item 5/Wall §73]** .

(4) It has also been repeatedly mentioned by counsel for Leighton that the requirement of "full-time and continuous supervision" does not mean "man-marking" **[Transcript of 4.10.2019/114:13-16; on 10.10.2019/38:15]**.

90. In response, Mr Rowsell again expressly rejected the interpretation of the phrase "full-time and continuous supervision" put forward on behalf of Leighton:

(1) The supervision requirement flows from BD's Acceptance Letters (see e.g. **[H9/3901-3903]**) and the QSP which MTRCL submitted to BD **[H9/4265-4280**; **Transcript on 10.10.2019/37:12-23]**.

(2) For situations where there are ductile couplers, QSPs are required and those QSPs required full-time and continuous supervision, but where there are couplers without the ductility requirement, there is still a need for full-time supervision **[Transcript on 10.10.2019/37:23-38:2]**.

(3) "Full-time supervision" and "full time and continuous supervision" mean the same thing. "Full-time" would mean the full-time presence of the supervisor on site. "Continuous" would be indicative that those supervisors should be dedicated to a supervision role **[Transcript on 10.10.2019/38:4-14]**.

(4) While the requirement does not mean man-marking, what is required is a continuous presence of the supervisors. Under the General Specification there is a requirement of a minimum of one supervisor

for every ten workers. In a working area, one supervisor can probably quite easily see generally what those 10 workers are doing, whether they are working in a safe manner, and whether they are generally following the quality procedures **[Transcript on 10.10.2019/38:16-39:14]**.

(5) Ultimately, it is a simple, pragmatic view that the supervisor needs to be there full-time and continuously supervising, in view of the need to ensure that in those high-risk areas, the works are properly built and properly supervised **[Transcript on 10.10.2019/39:15-40:2]**.

(6) It is not correct for Leighton to suggest that the ratio stipulated in Clause G3.9.1 of the General Specification **[C3/2040]** does not cover quality assurance matters. The provision is clearly about site supervision, and is included there because one of the aspects of supervision is to ensure that all works on site are carried out safely **[Transcript on 10.10.2019/54:9-55:11]**.

91. The Government agrees with the observations of Mr Rowsell. Ultimately, the applicability and the meaning of the supervision requirements must accord with common sense.

92. As the Commission rightly observed, the requirement of "full-time and continuous supervision" should be understood in the context that the objective of such supervision is to ensure that "*the works are carried out in a way that, when they are presented for inspection, they will pass that inspection*" **[Transcript on 10.10.2019/45:6-15 & 47:21-48:8]**. Mr Rowsell's understanding of the requirements will ensure that such fundamental objective will be achieved. In practice, such requirement can be complied with by assigning a supervisor (with proper training and

knowledge of the requirement of BOSA couplers) to station at the work area where coupler connection works are being carried out. According to the factual evidence adduced in COI-1, different parts of the platform slabs were constructed in phases (EWL: **[B17/24198-24199]** and NSL: **[B5/2903]**), and the area covered in each phase was not particularly extensive. With the presence of a supervisor, there can be no cutting of threaded bars on site. Any problems encountered can be timely resolved and any non-conformities can be readily identified and rectified.

93. The Commission would also recall that Mr Ho Hon Kit, Assistant Director of BD, explained the rationale behind the requirement of "full-time and continuous supervision" as follows, namely to deter non-compliant / corner-cutting activities **[Transcript on 18.12.2018/93:3-21]**:

"I believe that as long as the quality control coordinator, during the process of bar fixing, including screwing in of rebar with couplers, as long as the supervision was done within his line of sight -- well, perhaps it was at a time when some bars, they may be ordinary bars or threaded rebars, that had been lifted onto the site -- during the continuous supervision, the coordinator could conduct visual inspection on the length of the thread, to see if they were shorter. At the site, no one could do anything like cutting the threaded rebar. At the same time, the coordinator could supervise on bar fixing and the installation of coupler with rebar. The coordinator was fully aware of the situation. As I said, as soon as he knew that the screwing in was completed, he would go over to conduct compliance check to ensure that it was fully screwed in. In the entire process, he has met the requirement of full-time and continuous supervision."

94. In any event, as Leighton's expert witness Mr Wall acknowledged, as a matter of fact Leighton failed to provide full-time supervision of the coupler works **[Transcript on 4.10.2019/118:12-119:2]**.

D2. Failings of Leighton and MTRCL

95. The Government has made detailed submissions on the failings of both Leighton and MTRCL during COI-2: see **[Closing Submissions of the Government on Factual Evidence for COI-2, Sections C to H]**. We do not intend to repeat those submissions here. That notwithstanding, we wish to highlight in this regard a number of salient points arising in the course of the project management expert evidence, and in particular the evidence of Leighton's expert Mr Wall.

96. In his expert report, Mr Wall contends that:

(1) Leighton generally complied with the RISC procedures. It is said that from reading the witness statements, there is no evidence that could support any assertion that inspections did not take place **[ER(COI2)1/item 5/Wall §54]**;

(2) The fact that there was a lack of availability of the latest working drawings to all members of the inspection teams (cf Mr Rowsell's COI2 Report at **[ER(COI2)1/item 1/Rowsell §§52(k) & 57]**) is of little significance (except for the stitch joints at the NAT, where it is acknowledged that the updated drawings showing the different type of couplers used by Gammon would likely assist the inspection teams to conduct the inspections) **[ER(COI2)1/item 5/Wall §78(h)]**.

97. However, as Mr Steven Huyghe (project management expert for MTRCL) explained during his oral testimony:

(1) In the absence of a complete set of the RISC forms, it would be rather difficult to verify or ascertain whether and how inspections at hold points were in fact carried out or not **[Transcript on 4.10.2019/117:18-118:11]**;

(2) The defective coupler connections cast doubt as to whether proper supervision of the coupler works was in fact carried out **[Transcript on 4.10.2019/119:14-120:24]**.

98. Mr Wall also acknowledged under cross-examination that:

(1) Without the RISC forms, it would be difficult to verify whether and also how inspection work had been carried out **[Transcript on 8.10.2019/134:23-135:4]**;

(2) The defective coupler works (in particular the disconnections) were not difficult to spot, and if the supervisor on site had done their job properly, these defects ought to have been spotted **[Transcript on 8.10.2019/135:5-24]**. These defects cast doubt on whether the inspections actually took place or not **[Transcript on 8.10.2019/138:13-24]**;

(3) The defects relating to the VRV room (where concrete was poured despite not passing hold point inspection and the defects not being rectified) is a serious problem **[Transcript on 8.10.2019/139:8-140:22]**;

(4) If the inspection staff did not have copies of the latest working drawings, it will be difficult for them to ensure that the work has been constructed as per the design, namely that there is a risk of constructing something that is incorrect **[Transcript on 8.10.2019/142:22-146:2]**.

99. In other words, the failings of Leighton and MTRCL identified so far (including the lack of contemporaneously-filled RISC forms and the lack of availability of latest working drawings to Leighton's inspection teams) are serious issues of project management that need to be addressed.

Dated 17 January 2020.

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Table A

Commission of Inquiry into the Construction Works
at and near the Hung Hom Station Extension under the Shatin to Central Link Project
Progress Report Regarding the Commission's Specific Recommendations for the Government Set Out in the Interim Report

Item	Reference (Interim Report §)	Recommendation	Actions taken / to be taken
(1)	442, 444	Government sponsorship of rail enhancement projects – there should be the establishment of a single point of responsibility within the Government. To critically address the way in which the Government executes its multiple roles in relation to railway enhancement projects, active consideration should be given to creating an overall Government "sponsor" role for all individual projects to take responsibility on behalf of the Government.	- To be implemented subject to findings of a consultancy which looks into the Government's monitoring and control regime, as well as delivery approach in implementing future railway projects ("**the Consultancy**"). - The Consultancy will be commissioned in January 2020 and is expected to complete in a year. - The Government would take the consultant's findings into account when considering the structure and composition of any new department specifically tasked to handle and supervise railway planning and delivery matters.
(2)	451	Foster collaboration – there should be created a more collaborative (as opposed to adversarial) culture between the Government, MTRCL and contractors, with a leading role taken by the Government.	- Implemented. - HyD and MTRCL established a high-level Steering Group on Communications ("**SGC**") in May 2019, aiming to enhance the effectiveness of communication between the Government and MTRCL and ensure that the reporting of the Shatin-to-Central Link ("**SCL**") Project matters from MTRCL to the Government is timely, with

			appropriate context and pitched at the right level. It also focuses on promoting collaborative working relationships and culture in delivering the SCL project to achieve a quality outcome. - HyD directorate officers have started meeting with senior representatives from the MTRCL construction team, the Monitoring and Verification ("**M&V**") consultant, contractors, sub-contractors and suppliers of construction materials during their regular visits to sites at key construction stages.
(3)	452	The Buildings Department may work much more closely with MTRCL and its designers and contractors in order to facilitate dialogue on all engineering matters.	- Implementation underway. - BD is working with MTRCL on the introduction of a fast track consultation process so that certain types of "minor changes" could be processed within a shorter period of time (e.g. within 7 days) through an enhanced communication system and working arrangement with MTRCL and its design consultants/contractors.
(4)	454	There should be the introduction of new contract forms such as NEC3 and NEC4 and the introduction of collaborative initiatives such as partnering and alliancing.	- Implemented. - The adoption of collaborative approach (by NEC form) in the procurement and management of public works projects has been an established Government policy. Up to 2019, more than 180 NEC works contracts have been awarded.

			- As regards rail projects, while the project manager should determine the most appropriate contract form and contract package, HyD organised an experience-sharing session with MTRCL on the implementation of NEC contracts in public works projects under HyD's management on 13 December 2019.
(5)	454	Building Information Modelling ("**BIM**") should also be utilised to improving trust and performance on performance delivery.	- Implemented. - The Government set out in end 2017 the requirement to use BIM technology in major capital works projects (exceeding $30M) to enhance project management. It is also exploring wider use of BIM through trial projects to facilitate off-site prefabrication, site supervision, asset management and integration with geospatial data for smart city planning. - Insofar as public works projects are concerned, as at end December 2019, 224 consultancy agreements/works tenders with BIM adoption have been invited and 162 consultancy agreements/works tenders have been awarded. - For future railway projects, HyD will impose the use of BIM as a standard requirement. Additionally, HyD organised an experience sharing session with MTRCL on the implementation of BIM in projects under HyD's management on 6 December 2019.

(6)	455, 471	There may also be established a Senior Leadership Forum, comprising the Government, MTRCL, its contractors and leaders of major sub-contractors in order to monitor working relationships and cultural aspects of service delivery and to agree ways of developing collaborative working.	- Implemented. - A Senior Leadership Round-table, with participation of senior representatives from the Government, MTRCL, contractors and major subcontractors, was held on 10 January 2020. Senior leaders discussed the challenges in project delivery and exchanged views in such areas as cross-party collaboration, trust and reward to staff. - A bi-monthly survey on partnering behavioural changes will be carried out from March to December 2020.
(7)	460	Ongoing monitoring of station structure – the east and west diaphragm walls and EWL and NSL platform slabs should be instrumented to detect movement during the operational phase of the station, by way of fibre optics or other approved measures.	- Implementation underway. - To allay public concerns, we remain supportive of the Commission's recommendation in its Interim Report in relation to long-term monitoring. In fact, Preliminary Recommendation No. 2.6 in the EAT's Interim Report No. 1 is consistent with the Commission's recommendation, namely that "*MTRCL should consider supplementing the automatic deformation monitoring system with other monitoring devices, such as those that could record small structural strains and deformation, to measure and monitor the structural health of the platform slabs and diaphragm walls in the Hung Hom Station Extension.*" The same idea of long-term monitoring was also proposed by MTRCL in the Final Holistic Report and Verification Report - It is incumbent on MTRCL to propose the suitable form and details of the monitoring system, taking into account the latest expert evidence. The proposed system should minimise disturbance to the railway operation while providing reliable

			information and an alert system on any signs of abnormal structural behaviours. As regards the potential false alarm due to high sensitivity, it could be minimised by calibration. - In addition, in view of the concern on poor workmanship, the Government has asked MTRCL to provide additional quality assurance and/or undertakings in respect of the structures.
(8)	473-474	Ensure competence of personnel – the Government should review the "competence" requirements for personnel engaged in project management/sponsorship roles and should review checks and procedures to ensure ongoing competence of project-related staff. Effective measures should also be in place to reduce the risk of failure.	- Implementation underway. - The Railway Development Office ("**RDO**") of HyD is reviewing the competence requirements for its project-related staff. Subject to the results of the review, a framework for the required qualification, working experience and training requirements will be promulgated for RDO professionals. HyD is also preparing new operation procedures and/or work instruction to regularise (i) staff competence review and (ii) training for RDO professional staff, so as to ensure their ongoing competence. - HyD has been holding quarterly experience-sharing sessions for its project management staff. The experience in relation to Hung Hom Station Extension incident will be included in future experience-sharing session(s) upon the conclusion of the present inquiry. HyD will also ensure that Government site and non-site supervisory staff will receive integrity training regularly.

(9)	475	The Government should address the way in which it executes multiple roles in relation to railway enhancement projects, in particular its role as “client” and its role as “sponsor”.	See Item (1) above in relation to the Consultancy.
(10)	476	A Project Board should be established for future railway enhancement projects to provide strategic direction, comprising appropriate Government officials as board members, supported by external non-executive members from specialist backgrounds.	See Item (1) above in relation to the Consultancy.
(11)	477	Consideration should be given as to whether rail projects should remain within the portfolio of the Director of Highways, or whether a new distinct Director of Rail Development role should be established.	See Item (1) above in relation to the Consultancy.
(12)	478	Consideration should also be given as to the appropriate model to be fused for future projects, i.e. whether there should be used the “Concession” model, “Ownership” model, or the creation of a “Special Purpose Vehicle” approach with a dedicated Board and delivery organization.	See Item (1) above in relation to the Consultancy.

Table B

Commission of Inquiry into the Construction Works at and near the Hung Hom Station Extension under the Shatin to Central Link Project

Progress Report Regarding Mr Steve Rowsell's COI-1 Recommendations for the Government Set Out in Appendix F to the Interim Report

Item	Reference (Appendix F §)	Recommendation	Actions taken / to be taken
(1)	6	Review communication channels and reporting lines – the Government should review how it manages its interests in railway projects, with an aim to provide greater clarity in communication and reporting lines and more efficient project controls.	See Items (1)-(3) in Table A.
(2)	7	Clear summary of relevant requirements – the relevant requirements in relation to the Buildings Ordinance and the consultation process could be pulled together into a clearer and more precise description.	- Implementation underway. - BD is preparing a new practice note to consolidate various requirements relating to specific tasks and testing of materials (e.g. quality supervision plan for installation of ductility coupler splicing assemblies, on-site sampling for testing, etc.) imposed under the Buildings Ordinance when granting approval (or specified in the acceptance letter under the Instrument of Exemption) with a view to providing clearer and more precise description of the requirements and responsibilities. - BD plans to consult the industry via the Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers Committee

			("**APSEC**") and the Building Sub-Committee ("**BSC**") of the Land and Development Advisory Committee in the next joint APSEC and BSC meeting scheduled for February 2020. - Also see Item (3) in Table A.
(3)	8	Extend role of M&V consultant – the role of the M&V consultant should be extended to provide a wider "eyes and ears" role to help protect Government's interests, and should provide high level monitoring of the operation of the project quality assurance systems, and also cost and programme issues. The M&V role could be developed into a Government's Project Representative role that works more closely within the MTRCL organisation.	- To be implemented subject to findings of the Consultancy (as mentioned in Item 1 in Table A). - The Consultancy will review the pros and cons of the "check the checker" mechanism under the concession approach and the monitoring mechanism under the ownership approach. The Government will then consider how the existing duties of the M&V consultant can be extended to help protect the Government's interests during project delivery. - For the SCL Project, owing to contractual limitations, HyD has since July 2019 deployed in-house inspectorate staff on various sites serving as the Government's "eyes and ears" to carry out site inspections and audits, including those surprise (unscheduled) checks. The Government has also encouraged more proactive involvement of the M&V consultant since mid-2018, such as inviting the M&V consultant to join all of the three-tier project supervision meetings and increasing the number of site visits and on-site record checks.

(4)	9	Develop working arrangements with MTRCL – working arrangements should be made such that Government staff would be integrated within MTRCL teams on a regular basis to help ensure common understanding of requirements, improve communications, undertake joint forward planning and to resolve issues more efficiently.	- Implemented. - For the SCL Project, HyD has since July 2019 deployed in-house inspectorate staff to station at MTRCL's site offices. Similar arrangements have been extended to HyD's engineers, who commenced working together with MTRCL staff at a site office initially for half a day at monthly interval since December 2019.
(5)	10	Review Project Supervision Committee ("**PSC**") – the Government should ensure that PSC operates as intended, as a high level committee focusing on strategic issues and performance, and that the reporting arrangements provide PSC with reliable performance data.	- Implemented. - For the SCL Project, starting from September 2019: (i) PSC meetings has been divided into two parts, with Part II, attended by a smaller number of more senior members, dealing with more strategic and sensitive issues; and (ii) the escalation of issues from Project Progress Meeting to Project Co-ordination Meeting ("**PCM**") and from PCM to PSC has been formalised. - On HyD's request, MTRCL has been submitting performance data on site supervision and communication, and other issues relevant to works quality, project cost and progress for review and monitoring at the PSC meetings.
(6)	11	Review Building Department's Code of Practice ("**CoP**") – the CoP should be reviewed to give clarity on the definition of supervision, record keeping requirements and non-conformance reporting. It should also set out requirements of the communication of the supervision plan and associated obligations. The overall	- Implementation underway. - BD will make amendments to the CoP with a view to further enhancing its clarity on the definition of supervision, record keeping requirements and non-conformance reporting, strengthening the requirements on obligations of the site supervisory personnel and the communication among the site

		supervisory arrangements should provide an adequate role for the designer to give assurance that the intent of the design is delivered in the construction process.	supervisory personnel to ensure delivery of design intent in the construction. - BD plans to consult the industry on the proposed amendments to the CoP in the next joint APSEC and BSC meeting scheduled for February 2020.
(7)	12	Develop a conflicts of interest policy.	- To be implemented in future contracts. - There is established policy on conflict of interest for civil servants. - HyD has requested and MTRCL has agreed to review their policy on conflict of interest. Subject to legal advice and negotiation with MTRCL, this requirement will be added to the relevant entrustment agreement or project agreement of future railway projects.
(8)	13	Review the lump sum contractual arrangement used to employ the M&V consultant – the Government should consider options which would provide a more effective incentive to the M&V consultant to be proactive in the execution of its duties.	- To be implemented subject to findings of the Consultancy (as mentioned in Item 1 in Table A). - For future railway projects, taking into account the findings in relation to the role of the M&V consultant under the Consultancy, the procurement approach and remuneration arrangement of the M&V consultant will be reviewed. - For the SCL Project, additional services would be ordered from the M&V consultant if such services are necessary and justified under the M&V agreement. -
(9)	14	Clarify requirements in M&V consultants' brief – clearer requirements should be stipulated in relation to site audits and surprise checks.	- To be implemented subject to findings of the Consultancy (as mentioned in Item 1 in Table A). - For future railway projects, taking into account the findings in relation to the role of the M&V consultant

			under the Consultancy, HyD will ensure that the requirements related to site inspections, audits and/or surprise checks are clearly set out in the M&V consultants' briefs. - For the SCL Project, HyD will continue discussing with the M&V consultant at their monthly meetings the requirements and details of site inspections and audits, such as the frequency, location and scope.
(10)	15	Ensure sufficiency of resources of M&V consultants – the Government should ensure that companies appointed to M&V roles have access to the necessary levels of resource if the level of monitoring by the M&V consultant has to be increased due to concerns about poor performance.	- Implemented. - HyD would continue monitoring the level of resources of the M&V consultant to ensure it has sufficient resources to deliver its tasks. A standing item for reviewing the level of resources of M&V consultant has been included in the monthly progress meeting since October 2019.
(11)	16	Consider options of recovering M&V audit costs – consideration should be given to recovering M&V audit costs from the defaulting party if poor performance by the contracting parties resulted in additional audits being required.	See Item (8) above in relation to the Consultancy.

Table C

Commission of Inquiry into the Construction Works at and near the Hung Hom Station Extension under the Shatin to Central Link Project

Progress Report Regarding Mr Steve Rowsell's COI-2 Recommendations for the Government

Item	Reference (Rowsell COI2 Report §)	Recommendation	Actions taken / to be taken
(1)	164	Review requirements for as-built records – the Government should review and confirm its requirements for as-build records, particularly in relation to the need for hard copies of RISC forms, taking into account the increase use of technology to create drawings and records.	- The use of hard copy RISC forms is a requirement stipulated by MTRCL for the SCL project. The Government welcomes MTRCL's recent efforts in adopting digital RISC form through an online platform called "iSuper". - Requirements for other construction records to be submitted under IoE/IoC are set out in the respective IoE/IoC. The Government is also exploring the receipt of site records and enhancement of their traceability through digitisation.
(2)	165	Review consultant procedures – the Government should review its consultant procedures for design revisions and clarify arrangements for fast-tracking the process for minor design changes	See Item (2) of Table B.

(3)	166	Review requirements regarding Project Management Plans ("**PMPs**") – the Government should ensure PMPs cover all key aspects and consideration should be given to inclusion of matters concerning (a) resource planning; (b) training and development plans for project purposes; (c) project communication strategies; (d) interface risk management; and (e) leadership roles in establishing appropriate culture and behaviours.	- The Government will be pleased to take into account Mr Steve Rowsell's recommendations when considering any relevant proposed revisions to the PMPs by MTRCL.
(4)	167	Review liaison and communication channels between RDO, BD and MTRCL – consideration should be given as to whether the aim of a partnering approach to facilitate close communication has been achieved, and ways of improving communications, such as more frequent site visits at a working level by members of RDO and BD, should be explored.	See Items (1)-(3) of Table A.
(5)	168	Review steel testing requirements – the Government should review its requirements for the testing of steel that has been delivered to sites from quality accredited sources in line with the long-term objectives set out in CS2:1995.	- It remains the Government's long term objective to rely on the third party certification of product conformity based on testing and continuous product surveillance and on the quality assurance of the stockists. - However, in the initial stages of introducing this scheme, the end purchaser testing of quality assured reinforcement should continue and be monitored over a period, after which a review of the purchaser testing requirements will be undertaken.

(6)	169	Review role of M&V consultant – the Government should consider the following: (a) The M&V role should include construction quality and checks on construction records; (b) The Government should review its procedures for satisfying itself that the M&V consultant has sufficient resource capacity and flexibility of resource to deliver required services; (c) The Government should review its commercial arrangements for M&V contracts to ensure that they do not act as a disincentive to the delivery of comprehensive services; (d) On major complex contracts, consideration should be given as to whether more than one M&V consultant should be appointed; (e) The Government should ensure that M&V consultants treat interface risks as potential key risks as part of their risk-based approach; (f) The Government should consider ways to ensure that M&V consultants are advised promptly of construction problems and defective work which may require remedial works and could have significant cost and programme implications.	- (a)&(f): See Item (3) of Table B. In addition - ■ More proactive involvement of the M&V consultant had been taken since mid-2018, such as inviting the M&V consultant to join all of the three-tier meetings and increasing the number of site visits and on-site record checks. ■ The M&V consultant was also requested to perform other duties specifically covering the quality issue, such as the health check for site supervision and construction control, and the technical and procedural review of NCRs issued by MTRCL, etc. ■ The number of site walks/audits by the M&V consultant has been expanded since August 2018. From August 2018 to 15 January 2020, a total of 156 site walks have been conducted. - (b): See Item (10) of Table B. - (c)&(d): See Item (8) of Table B. - (e): The M&V consultant has been regularly reviewing and updating the risk registers which have already covered contractual interfaces. In view of Mr Rowsell's recommendation, HyD will remind the M&V consultant to review the latest risk register to ensure that relevant interface risks could be assigned with appropriate weighting. For future consultancy, HyD will specify requirements in relation to interface risks in the consultancy brief.