

23 May 2019

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Dear Simon

Crossrail PRep Project Status Report 124 – Period 1

Attached for your consideration is a copy of our Project Status Report 124, Period 1 FY 2019/20.

As highlighted in previous reports, whilst CRL has made multiple interventions in addressing optimism bias, it is our opinion that CRL is still exhibiting various degrees of optimism bias within the programme. Integration of RfL maintenance teams has made great strides and is highly commended, but further implementation is necessary to maximise the opportunity.

I would also like to take this opportunity to highlight the key issues from the period report that we consider require further action or explanation by the CRL Leadership Team.

- a) The AFCDC increased in the period to £14.819bn. Noting there are still a number of key issues, such as Tier 1 contractor full buy-in to the forecast, that are not included in the latest figures, we anticipate this figure to increase further. Could CRL respond to this view and define what mitigation plans are in place to arrest the potential increase?
- b) Due to management bandwidth, CRL is having to concentrate on multiple 'near-term' issues. Whilst understandable, this approach runs the risk of neglecting longer term issues, that require robust plans to be put in place now to mitigate the risk. What is CRL's plan to get 'ahead of the curve' going forward?

Please let me know if you have any questions or concerns.

Yours sincerely,



Project Representative



Crossrail Project Representative

Crossrail Joint Sponsor Team

Project Status Report 124

Period 1 FY2019-20

1 April 2019 – 27 April 2019

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Note: This report relies on the information set out in CRL's Period 1 reports augmented by more current information received by PRep during the course of our routine discussions with CRL since the Period close on 27 April 2019. Note that information emerging after the close of Period 13 is subject to formal confirmation by CRL in its Period 1 reports. This report is supplemented by our weekly reports to JST and regular meetings with JST staff.

Document history and status

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2	23 May 2019	PSR 124 Period 01 FY 2019-20 v1.17 ~ Final	PRep Core Team	XXXXXXXXXX	XXXXXXXXXX

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Executive Summary

HEALTH and SAFETY PERFORMANCE

Poor safety performance has continued during the period. As part of its response to this, CRL will no longer consider targets going forward, but will instead benchmark itself against thresholds, in line with industry best practice. We support this approach. RIDDOR and Lost Time AFR thresholds have been reduced to increase the potential for intervention and we expect these thresholds to be breached with the progressive reduction in hours worked as the programme completes.

COMMERCIAL

CRL has increased the AFCDC in Period 1 by £419m, to £14,819m, following its cost analysis and risk quantification of the EOP and the Period 1 AFC reviews. CRL is presently developing a more detailed integrated control schedule (DCS) which will form the reference to the cost baseline. Notwithstanding the further cost and risk reviews that CRL is carrying out on its DCS and the potential impact from Contractors, productivity, risk and time pressures continue to exacerbate current forecasts. Both Cost-to-Go and Project Risk have increased in the period. Our review suggests a significant portion of risk is already committed and mitigation provisions are limited.

We expect further increases arising from CRL's development of the DCS and from the ongoing current cost growth trends; these increases may exceed the current funding envelope of £14.963m.

UNDERPINNING OF THE DELIVERY CONTROL SCHEDULE (DCS)

The Stage 3 Opening schedule and the accompanying cost forecast are being re-constructed by CRL taking a similar approach to that commonly used in a project 'commercial bid'. While it was recognised that the work undertaken by the end of April 2019 was considered insufficient by CRL to pass a corporate 'Go-No/Go' review, allowances were made by the CRL team to take account of the lack of underpinning work; in our opinion, this approach was successful in delivering a considered and balanced outcome.

CRL's intention was to complete the underpinning work by the end of June 2019, in order to provide increased confidence in on-time delivery and adherence to the budget; this has now slipped to the end of July. Interim releases of the developing DCS will ensure that pressure is maintained on the Programme to deliver the required outputs. However, it is a concern that the tasks considered necessary to provide a robust, deliverable schedule still may not be completed prior to the baseline being set.

The robustness of the schedule is fundamental to providing sponsors, stakeholders and the CRL team, with the confidence to deliver on time and in line with public expectations. If the work necessary to underpin the schedule is not completed or takes longer than anticipated, it may result in the delivery of the Stage 3 Opening being compromised.

FORWARD-LOOKING APPROACH TO DELIVERY

We have noted in previous reports that CRL has faced a huge challenge in concurrently: a) producing a commercial bid; b) mobilising a project; and c) delivering a project. These activities are normally carried out sequentially. As a consequence, the 'management bandwidth' has narrowed, forcing CRL to (correctly) focus upon the task immediately to hand.

One of the downsides of this predicament is that a number of longer-term risks may not be receiving the focus necessary, to ensure that the schedule and cost are delivered in line with expectations. As a result, CRL management is tending to focus upon near-term rather than long-term priorities in areas such as Health and Safety, Assurance, Testing & Commissioning and Risk Management.

The 'predictability-to-productivity' philosophy of the Visualisation Boards has sought to address this issue with the four-week look-ahead. However, the methodology is not yet consistently applied, and does not cover all of the areas set out above. An approach similar to Network Rail's 'T-Minus' management of major possession works possessions, which forces project teams to consider future requirements and implications, would benefit all Crossrail Programme activities, and not just delivery.

Notwithstanding the hard work currently being carried out, it is almost inevitable that the project will be impacted by risks that might be avoided if a more forward-looking approach were adopted now by CRL.

STAGE 5A ROLLING STOCK ISSUES

We have growing concerns with the Rolling Stock Full Length Units (FLUs) for Stage 5A. The FLUs were not approved for passenger service in May 2019 (originally planned for November 2018), resulting in delay to FLU/RLU swap-out. This, in turn, delays FLU reliability growth and increases the risk of FLUs not being available for Stage 5. The Contractor believes the delay to the swap out is likely to be weeks, but we remain cautious.

In a related issue, our previous reports have highlighted the potential benefits of utilising 'merged' train software for mileage accumulation and reliability growth. It was envisaged that this software could be introduced on Stage 5A passenger services in December 2019, which would have allowed the knowledge and experience from passenger service conditions to be transferred for the benefit of Stage 3 operations. We understand the BT programme is under heavy strain and this valuable opportunity is receding.

1 Cost

1.1 Summary

CRL continues to provide transparency of its commercial strategy and evolving commercial assurance. In addition to ad-hoc and weekly clarification discussions with key CRL personnel, access is afforded to AFC and Common Incentive Framework (CIF) Reviews and the Investment Committee.

The AFCDC at Period 1 increased by £419m to £14,819m mainly due to the cost analysis and risk quantification carried out by CRL of the EOP and the Period 1 AFC reviews. Consequently, CRL is reporting that the forecast CTG to complete the project at Period 1 has increased by £179m to £956m. CRL is presently developing a more detailed integrated control schedule (known as the Delivery Control Schedule, or DCS) which will be the reference for the cost baseline. Completion and formal issue by CRL of the DCS will now be deferred until the end of July 2019¹.

Although the step-increase in AFCDC we anticipated in around Period 3/4 has occurred earlier, we still expect further increases in those periods. Consequently, the Period 1 AFCDC is still regarded by us to be understated pending conclusion of CRL's detailed analysis and the necessary confirmation input from the Tier 1 contractors. We still expect further increases arising from the DCS development and from the continuing cost growth trends, which will challenge existing financial authorities.

From Period 1 2019/2020, we will not be reporting AFCDC against the PDA Intervention Points, as they are no longer considered appropriate by Sponsors. The focus of our AFCDC analysis and reporting going forward will be upon CRL's efforts to remain within the funding threshold. CRL is reporting a funding package of £14,963m at Period 1.

1.2 AFCDC and Intervention Points

As IP2 was breached in Period 13, 2017/2018, and continues to be exceeded by current forecasts, no further comment is relevant or necessary. The AFCDC at Period 1 has increased in the period to £14,819m, principally driven by the EOP. The Sponsor Delegated Authority has not changed this period at £14,200m. The CRL Period 1 AFCDC exceeds the proposed increased Sponsor Delegated Authority by £619m. The headroom of AFCDC to Funding Envelope has reduced to £144m.

The AFCDC period movement and elemental breakdown is shown in Figure 1 - 1.

¹ As detailed in the CRL mobilisation plan set out in the Level 0 Vis Room at Endeavour Square.

(£ millions)	Period 13	Period 1	Delta	Movement
Forecast				up
Project QRA				up
Subtotal				up
Central QRA				down
Indirects and Board Risk				same
AFDCDC total	14,400	14,819	419	up
Sponsor Delegated Authority (SDA)	14,200	14,200	0	same
SDA Headroom	-200	-619	-419	down
Funding Envelope	14,963	14,963	0	same
FE Headroom	563	144	-419	down

Figure 1 - 1 ~ AFDCDC Headroom to Intervention Points

We continue to expect further increases to the AFDCDC; the Period 1 AFDCDC, in our opinion, continues to be understated and will remain so until the impact of EOP and DCS has been agreed with the Tier 1 Contractors.

We continue to have concerns with increasing defined cost forecasts, the continued rate of COWD spend, prolonged post-TOSD demobilisation and undervalued risk, especially when considering the complex EOP and DCS interfaces. A misaligned forecasting approach across the project teams is also diluting confidence in Programme AFDCDC. The approach taken for URTs, Risk and EOP allowances is being considered differently by each of the project teams within their forecasting. Although the gap between CRL assessments and Contractors' estimates are coincident, our analysis of the forecast Target and Defined Cost data contained in the Period 1 Consolidated Cost Report (CCR) still continues to show the trend of increasing CRL assessments, rising in conjunction with the Contractors' increasing estimates.

CRL reported the actual spend rate in Period 1 is less than planned; however, CRL is reporting that the level of supply chain accruals each period is not visible and the period accuracy is not established. The rate of ACWP continues to maintain an underlying near-linear trend, fluctuating around £100m. Direct Costs were £16m lower than the previous period forecast; this is driven more by lower productivity (and missed milestones therefore being deferred) rather than reduced cost. Indirect Costs were £2m higher than forecast, offsetting the previous period's underspend.

The period ACWP was a reduction against the last period but is forecast to increase again next period; thereafter the forecast shows that the ACWP reduces period-on-period. CRL's latest forecast of COWD shows greater spend month-on-month than previous periods, reflecting the increase in AFC. CRL's CTG is based on individual project forecasts and does not take full account of the new Delivery Control Schedule (DCS) – formerly the 'new Master Schedule' – and the phasing of project risks. The remaining emerging cost elements within the Supplemental Agreements are also contributing to the prolongation of costs.

The CRL project costs reviews for each of the contracts in Period 1 continue to identify AFDCDC growth which threatens CRL's risk and contingency provisions. 30% of Period 1 QRA (£ [redacted] URTs out of a [redacted] QRA) is expected to be transferred to Trends and ultimately to CTG. Outputs from project AFC reviews carried out by CRL in Period 2 will further exacerbate the situation, as it was noted that several had yet to make allowance for DCS. CRL continues to report that it will give a new QRA forecast after the DCS is accepted.

Our linear forecast at Period 1 continues to indicate that AFDCD and COWD do not become coincident, as illustrated in Figure 1 - 2. This is because AFDCD continues to rise and is expected to increase further as a consequence of the re-baselining of schedule, cost and risk. We are awaiting from CRL the backup of CTG projections as requested to allow us to develop a forecasting analysis to form a more accurate COWD forecast. The AFDCD forecast will also be remodelled once cost from the EOP is assured. Presently, it is not appropriate for us to present any reasonable or accurate forecasting until CRL's EOP and DCS development is concluded.

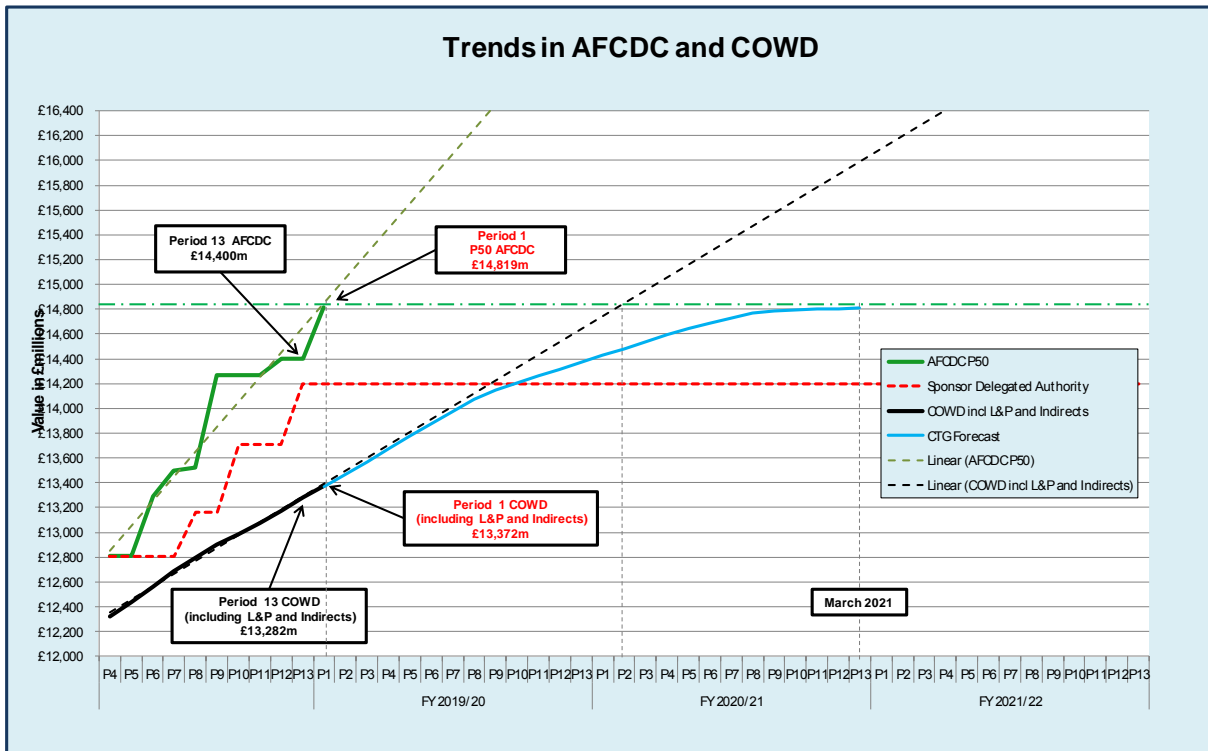


Figure 1 - 2 ~ AFDCD Headroom to Sponsor Delegated Authority

1.3 Cost: Central Operating Section (COS)

During Period 1, we progressed our ongoing detailed review of the projected outturn costs. We have continued reviewing the detailed supporting documentation that feeds the Station elements of the Board Report, following recent discussions with CRL's Project Controls Team.

Our review has highlighted the projected extended duration of the emerging costs elements of the remaining station works. This has also been reflected by increases shown in the latest CCR. While the projected numbers do take account of the impacts of the EOP proposal, this approach appears to be inconsistent. It should be noted that these reported numbers are still CRL's view and do not take account of the Tier 1 views of the EOP proposal. It is anticipated that the input from the Tier 1s will not be available until Period 3 or 4. The projected out-turn cost therefore is still fluid and potentially subject to significant change.

We have continued our in-depth review of [redacted] focusing on the apparent project cost increases which have occurred since the issue of the Combined Supplemental Agreement [redacted]. During Period 2, we will arrange meetings with the appropriate CRL personnel to examine the veracity of the projected costs-to-go and the basis of their development by CRL [redacted]. As the detailed DCS is developed, we will

monitor any impact this may have of [REDACTED]. We are in the process of preparing a review paper which we will issue in the next period.

This period, we have also started a review of the ongoing costs associated with [REDACTED]
[REDACTED]
[REDACTED]

Both the Target and Defined Cost gaps between Contractors' estimates and CRL assessments continue to close, with more contracts having coincident values for both because of recent Supplemental Agreements and project cost reviews. However, both Target and Defined Cost forecasts continue to show a persistent trend of increase.

Figure 1 - 3 illustrates the comparisons and trends of CRL and Contractors' Forecast Defined Costs and Target Costs. The trends for both Defined Costs and Target Costs for Period 13 have been modelled on data taken from the CRL Period 13 CCR report, and these continue to show increasing forecast projections.



Figure 1 - 3 ~ Forecast Defined Cost and Target Cost

In summary, we set out the principal indicators that indicate continuing cost escalation:

- The analysis of the burn rates for COWD and CTG, which also include the forecast outturn for Defined Costs indicate a continuing growth trend;
- The tracking of the TOSD demobilisation glide path and the management of the emerging cost component is indicating a trend of increasing emerging costs over a longer period;
- The lack of the final EOP schedule and cost plan is contributing to cost uncertainty.

The cost of opportunities and mitigations is excluded from the current risk assessments which, if achievable, may offer a reduction to the overall risk cost profile.

The Common Incentive Framework (CIF) proposals were approved by the CRL Investment Committee on 17 April 2019, with [REDACTED] Investment Authority granted to proceed with trial incentive milestones. [REDACTED]

[REDACTED] These will provide valid incentives with tangible and measurable criteria for completion. [REDACTED]

[REDACTED] CRL is seeking fair and visible distribution of incentives by the Tier 1 contractors to their respective appropriate and contributing Tier 2 subcontractors.

CRL has identified and is implementing two trial incentives and is leading behavioural workshops to cascade the proposals to Tier 1 contractors:

- [REDACTED]
- [REDACTED]

[REDACTED]

[REDACTED]

- [REDACTED]
- [REDACTED]
- [REDACTED]
- [REDACTED]

CRL is proactively undertaking regular weekly reviews of the CIF progress and development to which PRep attends.

1.4 Contingency and Risk

The total funding package reserved by Sponsors for CRL remains at £14,963m, £750m of which is a contingency arrangement between TfL and DfT in the form of a loan facility. From this total funding package, Sponsors have delegated to CRL Procurement Authority up to £14,200m on 1 April 2019. CRL has allocated investment authority to £13,762m and proposes that [REDACTED] is allocated to Board Contingency and [REDACTED] to Programme Contingency.

[REDACTED]

² CRL CIF Meeting held on 8 May 2019.

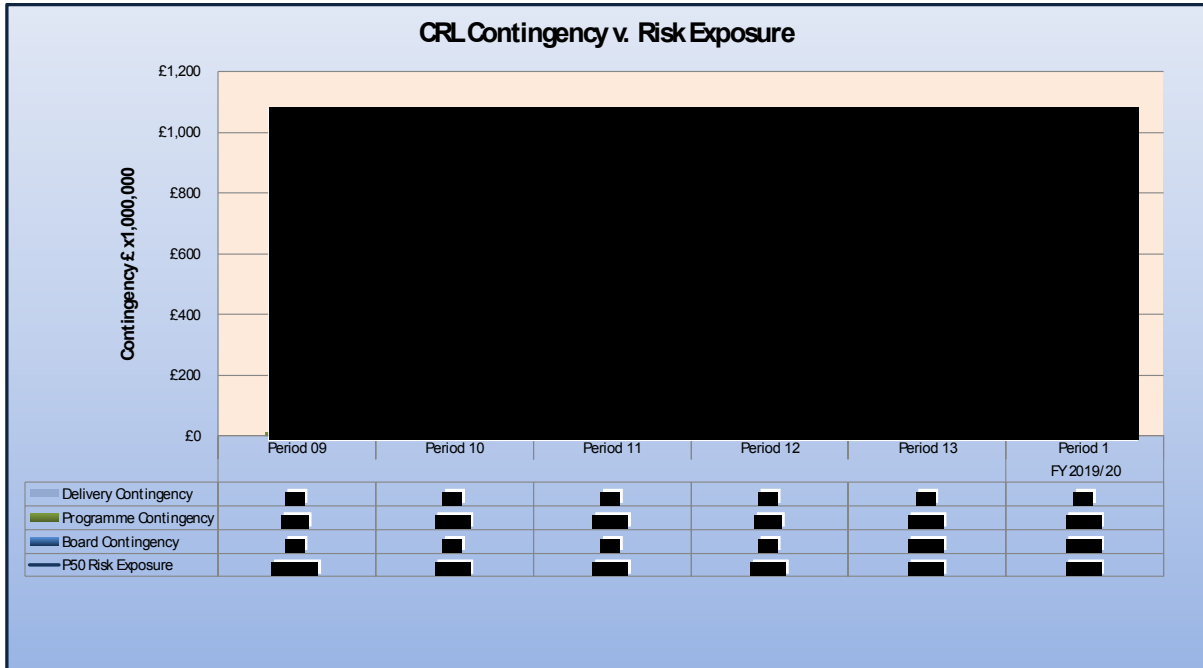


Figure 1 - 4 ~ Risk Exposure versus Contingency

CRL reports that CTG has increased by £179m in Period 1, from £777m in Period 13 to £956m in Period 1, [REDACTED]

[REDACTED]

Period	AFCDC	QRA	URT's	Project QRA	Central QRA	Indirects and Board	Pure Risk
	£m	£m	£m	£m	£m	£m	£m
P12	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
P13	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
P01	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]

Figure 1 - 5 ~ Elemental Breakdown of Risk Allowances³

We are concerned that systemic/strategic risk does not seem to be addressed by CRL. There is an expectation that Risks will be resolved at the project level. The project risk register does not seem to be used for risk analysis/assurance or the development of mitigation strategies but rather for the simple development of the contingency sums, which change constantly. CRL may

³ £108m added for Period 13 due to information post the submission of the Period 13 PSR.

want to consider revisiting strategic risks in order to control and/or mitigate many of the risks which stretch across the enterprise, and to reduce volatility in the QRAs.

During Period 1, the number of Risks has increased from 223 to 289. However, the problems in conceptualising Risk remain, with confusion around the difference between risk, uncertainty and causes. These issues not only make it difficult to define Risks, but also to develop precise mitigations. With Risk articulated at such a high level, the probability of overlap and duplication in QRAs is increased. This is likely to be contributing to the volatility in QRAs and would benefit from central risk assurance.

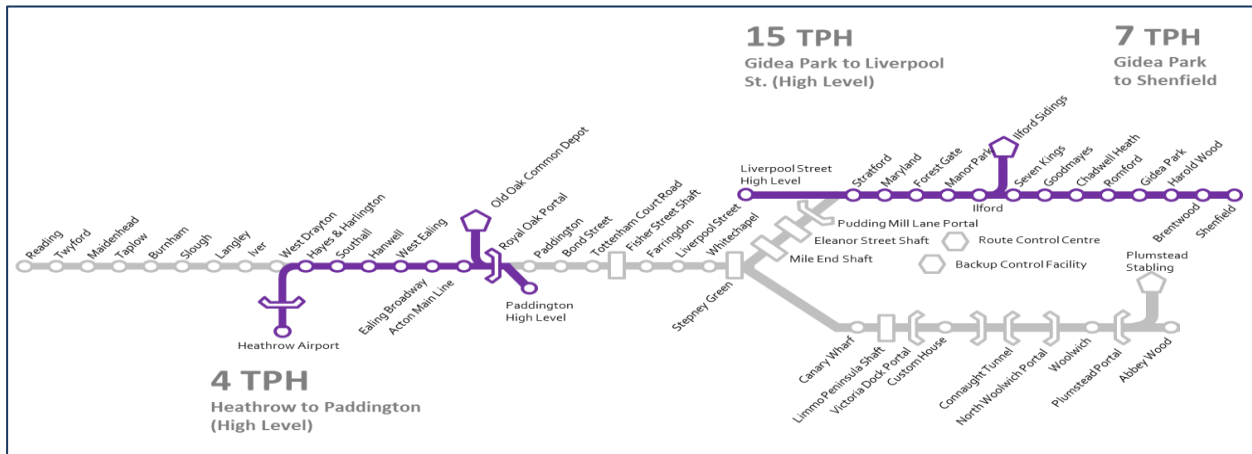
Although Risks around Scope have decreased, technical Risks (Technical Assurance Management, Design Management and Document Development) and Service Delivery/Contractor Risks have increased significantly, particularly around Quality, Productivity and Damage/Re-work. This means that emerging costs are more likely derived from poor productivity, poor scheduling and poor access management than uncertainty in the work. However, where such Risk resides with the contractor, incentivisation plans are less likely to succeed. In turn, these problems can push up interface risks, such as Asset Protection. If systemic risks are not alleviated, then poor productivity will be compounded by both a lack of service capacity (resources), coupled with an inability to deploy staff between contracts.

1.5 On Network Works

CRL reports that the total ONW funding has been reconciled as part of the NR CP5/6 funding arrangements. The Crossrail ONW funding has increased to £2,807m in Period 1 following the approval of the additional £70m NR internal funding, and £66m cash being made available for Enhanced Stations (West). The total secured funding at Period 1, including third party and cash funding supporting other projects, has increased to [REDACTED]. This includes the original KD1A allowances, additional NR Portfolio Board Funding, and additional funding from the DfT, CRL and other NR funded projects.

CRL reports that the total Period 1 NR ONW AFC, inclusive of risk, has increased to [REDACTED], mainly due to the inclusion of those costs funded by the £70m and £66m additional funding described above. This results in targeted savings reducing to zero. At Period 1, NR reports the Forecast Final Outturn Cost (FFOC) at £2,587m; this value equals the RAB funding made available (£2,587m) and represents the NR Programme Costs applicable to CP5 which will be final accounted accordingly.

2 Stage 2 Phase 2: Paddington to Heathrow - Opening TBC



TPH figures based upon original programme – DCS may lead to change

2.1 Summary

There is currently no confirmed start date for Stage 2 Phase 2, but internally CRL is targeting [REDACTED]. The principal risks to that date are delays in train software development and safety authorisation. There are also secondary issues with the ETCS wayside system that NR needs to resolve to stop them becoming schedule critical.

There is a high risk that of not achieving the target date. The length of delay is uncertain at this time, but from CRL’s schedule and reports we think it prudent to assume a period of up to 4 months. Accordingly, we believe it would be advisable to ensure appropriate [REDACTED] measures are available⁴.

2.2 Operational Readiness Assessment

CRL’s Period 1 Stage 2-2 Dashboard has retained an overall rating of ‘red’, with no date given for the start of passenger service. CRL is still targeting [REDACTED] however, the Dashboard Gantt Chart has approximately 4 months of indicative risk included within it. If all of that is realised, then the start date would be in [REDACTED]. The Dashboard ranks the issues in the following order of priority and they are further described in the Sections below.

1. Train software development and assurance programme;
2. Train software authorisation programme;
3. Trackside ETCS – resolution of issues arising from testing;
4. Finalisation of programme for formal ETCS integration tests, driver training and passenger services;
5. Trackside ETCS – Putting into Use.

RLU-FLU swap-out on the GWML is now monitored in Section 5 of this report

⁴ Primarily [REDACTED] as described in previous reports.

2.3 Phase 2 Opening

Rolling Stock

BT's dates for software configurations are unchanged from the previous period (and are repeated below). However, we are aware that CRL is expecting to receive a revised programme imminently. [REDACTED]

Configuration	[REDACTED]	[REDACTED]	Comment
Y 1.2	[REDACTED]	[REDACTED]	This configuration ⁶ allows testing to be carried out without requiring an SPZ.
Y 1.3	[REDACTED]	[REDACTED]	This is the configuration that will be authorised by the ORR, and from which Driver Training is currently planned to start.
Z 1.0	[REDACTED]	[REDACTED]	Passenger service approved software.

Figure 2 - 1 ~ BT Software Configuration

Software development remains a significant risk. BT is currently testing with Configuration Y1.150, the original issues with which had been resolved; unfortunately, further issues have since emerged, the fixes for which need to be assigned to later software releases. This is a typical scenario which leads to the software development period having to be extended. There is also a lack of clarity about the software authorisation process. CRL is trying to gain visibility from BT as to how BT will gain the necessary approvals from the ORR and NR⁸. The relative novelty of the BT software product suggests that the securing of authorisations will not be straightforward, and it is important that the process is transparent to all parties.

The uncertainty concerning the train's development progress means there is currently no robust integrated programme that brings together BT software development, authorisation periods from approval bodies, MTR-C's approval, driver training activities and CRL integration tests. This is a significant omission. Without it, the different stakeholders will not be able to properly co-ordinate their inputs and activities. We expect this situation to be addressed in the new DCS.

Infrastructure

The testing of the train has identified 3 faults with [REDACTED] ETCS. These are: [REDACTED] These all need to be rectified before passenger service can start. NR believes it can fix these issues by September 2019, but CRL requires the date to be brought forward to assist its testing.

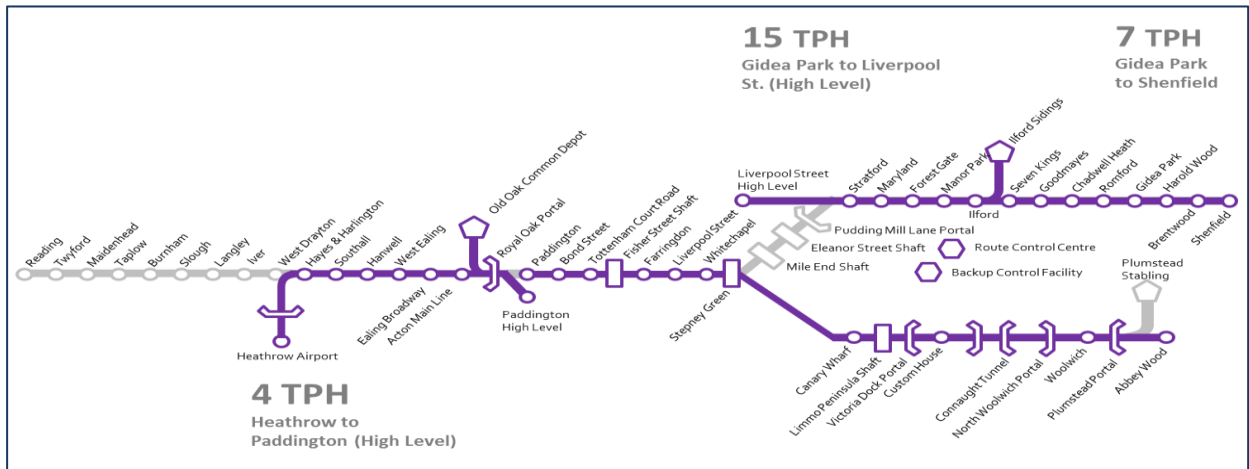
The ETCS wayside has received its APIS from the ORR, but still needs its 'Putting into Use' certificate from the W&W ETCS group. This has been outstanding since November 2018 and needs to be resolved by NR before the issue becomes schedule critical.

⁵ [REDACTED]
⁶ Configuration comprises TCMS, ETCS, TPWS and CBTC.

⁷ This was forecast to be end of [REDACTED] in Period 12. The Period 13 CRL Executive Board Report states it will be end of [REDACTED]

⁸ HALARP as well, but that organisation will take a lead from ORR and NR.

3 Stage 3: Paddington to Abbey Wood - Opening TBC



TPH figures based upon original programme – DCS may lead to change

3.1 Schedule

As announced during the CRL press briefing on 3 May 2019, the date for Stage 3 Opening is the midpoint of September 2020 and March 2021. The EOP assumes that Bond Street Station will not be available to passengers at that time.

An interim DCS was issued on 3 May 2019 detailing an 8 week look-ahead of milestones. This approach was selected to drive the project to a meaningful schedule (replacing the MOHS) until the full DCS is ready. The full DCS is now planned to be baselined in preparation for approval at the CRL Board Meeting of 18 July 2019, ahead of formal issue at the end of July 2019.

As per the EOP [redacted] date for Stage 3 Trial Running of [redacted] Bond Street Station will be completed to stage SC1. During Trial Running and following Stage 3 Opening, Bond Street will be used as an evacuation route only.

A key issue for achieving the dates in the DCS is a continued delay in the submission of testing and commissioning documentation. The bulk of the testing documents are still to be handed over to the IMs and there are limited IM resources for review and acceptance.

CRL resources remain lower than required and assumed productivity rates are not being achieved; it is an ongoing concern as to whether or not CRL can deliver the [redacted] in practice.

3.2 Stations, Shafts and Portals (SSP)

3.2.1 General

Slippage against forecast milestone and documentation submission dates has continued across most of the Stations, Shafts and Portals. Productivity of IRNs, PCCs and PACs remains low as installation, T&C and certification documentation submission continues to underperform against the forecast. Installation, Testing and Commissioning activities are also taking longer than planned, and the subsequent forecast Staged Completion and Handover dates are being delayed as a consequence.

The Vis-Board process is well established at all the SSP sites and is starting to show benefits in bringing CRL, Tier 1 and Tier 2 contractors together daily for the identification and resolution of “blockers”. The station sites are, however, still failing to predictably achieve the levels of productivity necessary to meet both their forecast and planned installation (IRN) and T&C (PCC and PAC) certification sign-off targets. Appendix B contains a detailed breakdown of IRN, PCC and PAC testing and commissioning progress for each of the SSP sites. This shows that contractors need to substantially increase their levels of productivity on the station physical works, to close-out Phase 2.1 testing and handover.

The Period 1 Vis-Board reviews suggests that the forecast dates for SSP are under continued pressure and some are still slipping. We are unable to show corresponding evidence of the forecast delays to ██████ dates, as the DCS is still under development and the Interim Baseline⁹ (DCS Version 0.1) has not yet been released. Forecast ██████ dates for SC, for the Stations (LUL and RfL), Portals and Shafts can be seen in Figure 3 - 1, Figure 3 - 2 and Figure 3 - 3 in Sections 3.2.2, 3 and 4 respectively, below.

We remain concerned that forecast productivity levels are still not being met, suggesting that aspirational targets may have been used in the development of the DCS and its key milestone dates. The assumption and application of unrealistic productivity levels has been a significant problem in the past, with their inclusion in various iterations and re-baselining of MOHS. CRL needs a ‘realistic’ DCS for the remaining works to completion, based upon proven rates of performance that can be predictably delivered.

A record of the causation factors which contribute to under-performance against forecast productivity is only just starting to be introduced and analysed across each of the station contracts in the Vis-Board Reviews. The causation analysis will help drive improved predictability of planned output. PRep would like to see CRL’s plan for full implementation of causation analysis across all active contracts and to understand how its effectiveness is reported to senior management.

Actual completion of IRNs¹⁰ and PCCs/PACs¹¹ is approximately three periods behind the ██████ baseline contained in the unapproved November 2018 MOHS. We do not yet have sight of the DCS. However, CRL’s productivity when trended forwards continues to suggest that delays to the achievement of the sign-off of these documents continues and could still be several months later than forecast.

⁹ CRL is introducing an “Interim Baseline”. This will be structured around the evolving forecast key dates as the programme transitions from the MOHS (November 2018) into the new DCS. The aim is to provide sufficient detail for CRL to measure its performance in the short term.

¹⁰ Installation Release Notes (Phase 2.1).

¹¹ Pre-Commissioning Certificates Phase 2.2 and Partial Acceptance Certificates Phase 2.3.

The current percentage completion of IRNs, PCCs and PACs, at the close of Period 1, for all Stations, Portals and Shafts, is set out in Figure 3 - 1 below.

	% Complete		
	Period 12	Period 13	Period 1
IRNs	66%	71%	72%
PCCs	0.29	0.32	38%
PACs			27%

Figure 3 - 1 ~ Percentage completion of IRNs, PCCs and PACs for all SSP contracts

Slow progress (slightly lower than in Period 13) has been made with the sign-off of IRNs, suggesting an increasing risk of further delays and date slippages to the Station SC and Handover dates. Contractors must substantially increase their delivery rates for physical works at Stations in order to close-out Phase 2.1 (IRN) Testing and Handover.

We have not yet received a copy of CRL’s [REDACTED] report for Period 1 and have therefore been unable to fully update our summary of the current forecast SSP dates for the remaining TOSD and Staged Completions. Refer to the figures below and Appendix B. The forecast dates may not become available until CRL releases its Interim Baseline and/or the formally issued DCS. However, it has been possible to use revised forecast dates quoted in the end-of-period Vis-Board reviews.

We note that leadership changes are being made within CRL’s and the contractor’s delivery teams. PRep is looking for evidence of the anticipated step-change in performance, following the introduction of the new project leaders.

Bond Street, Tottenham Court Road and Woolwich Stations have discovered [REDACTED]
[REDACTED]
[REDACTED] The need for resolution increases the risk of schedule delay.

3.2.2 Stations – LU

LU is starting to look at readiness indicators for the key dates SC1, SC2 and SC3 across all of its stations. The focus is currently on SC3, but there is a need to consider SC1, particularly in respect of the anticipated documentation submission “bow wave”. The new DCS will help give some visibility of progress towards the [REDACTED] dates and T-minus reviews will provide greater detail into the readiness schedule. However, we note that the forecast completion dates for SC3 reported for three of the stations have slipped in the Period. Refer to Figure 3 - 2 below.

Contract	Location	TLA	[REDACTED]
C412	Bond Street	BOS	[REDACTED]
C422	Tottenham Court Road	TCR	[REDACTED]
C435	Farringdon	FAR	[REDACTED]
C502	Liverpool Street	LIS	[REDACTED]
C512	Whitechapel	WHI	[REDACTED]

Figure 3 - 2 ~ LU Stations – Forecast Staged Completion (SC3) Dates

[REDACTED]

[REDACTED] A decision will have to be taken by CRL as to how this issue will be managed on the new railway and how it will impact the connection of new Crossrail equipment and systems into existing station SOR systems. Either decision, to downgrade the data from Crossrail systems into the existing BMS software, or to upgrade the older TfL (LUL/RfL) BMS software used in the existing SORs has the potential to impact on Crossrail's cost and schedule.

The contractor has been asked by CRL to submit a detailed and fully integrated programme for the works up to and including SC1, SC2, SC3 and HO. [REDACTED]

[REDACTED] The current CRL forecast date for SC, has improved to 28 October 2019 in the period. [REDACTED]

Bond Street Station's forecast TOSD date is [REDACTED]. We anticipate that ongoing design support and documentation close-out requirements will hold the office-based staffing levels and extend the cost profile beyond the declared TOSD date.

The connection of the permanent power supply for Bond Street Station's ETH was achieved by mid-May 2019, as forecast. Permanent power supply to the WTH is forecast by the end of [REDACTED]

[REDACTED] Our primary concern is with the small number of IRN/PCC/PAC submissions that have been achieved to date.

Physical installation of the MEP works at Tottenham Court Road is substantially complete, but the submission of Phase 2.1 IRN documentation is not forecast for completion until [REDACTED]. The submission rate of both PCCs and PACs remains low and remains a risk of further delaying SC.

Considering its state of near substantial physical completion, it is difficult to understand why the SC target date of [REDACTED] is so late. We note, however, that there remains a significant backlog of document submission. While steady progress is being achieved with the sign-off of the IRNs and the submission of the PCCs (now 46% complete); progress on the PACs remains low (still only 3% complete). We are concerned at the scale of effort that will be required to close out the PACs. The forecast requires the closure of 15 to 20 PACs per week, while the average achieved to date has only been 9 per week. The slow rate of document submission suggests that the assumptions made in targeting an earlier SC and HO may be overly optimistic and unachievable.

We remain concerned with [REDACTED] works (PAVA, Radio etc.) and its Phase 2.3 testing slipped by almost 3 weeks last Period. [REDACTED] delays were attributed to [REDACTED] requiring the dismantling of GFRC cladding panels. Completion of IRNs and handover to [REDACTED] has been blocked until the PAVA and Radio design models have been verified.

[REDACTED] The full scope of additional work can only be determined after testing the current installation. This has the potential to impact both cost and schedule. See also Section 3.3.

Delays to the forecast TOSD2 date for the LU/LO platform works and the new concourse at Whitechapel Station are driven by [REDACTED]. We believe these issues mean there is an ongoing risk of further delays to completion of Phase 2.1 and 2.3 testing [REDACTED] making it difficult to accurately forecast the SC and HO dates.

3.2.3 Stations – RfL

The current rate of review and return of comments, and close-out of certification and handover documentation for the RfL Stations is taking much longer than has been assumed by CRL. Concern has been raised at Vis-Board Reviews¹² that over 500 documents need to be accepted by RfL at the point of Handover, and that the current rate of review (5 per week) will impact on station handover dates if the rate is not increased. RfL will need to increase the level of resource available to achieve the required rate of review. We believe that CRL needs greater visibility of the number of documents and their review status, to closely monitor its progress towards achieving Code 1 acceptance status from RfL. Refer also to Section 3.2.4 associated with RfL resource constraints and its impact on document review.

We note that the forecast dates for SC have slipped on 3 of the 4 RfL stations. Refer to Figure 3 - 3 below.

Contract	Location	TLA
C405	Paddington	PAD
M072	Canary Wharf	CWS
C520	Custom House (Incl full Handover)	CUH
C530	Woolwich	WOO

Figure 3 - 3 ~ RfL Stations – Forecast Staged Completion (SC3) Dates

We have previously reported that the inclusion of additional scope at Canary Wharf Station, [REDACTED]. The T&C programme is well advanced although some tests may need to be repeated on any equipment installations that have subsequently been modified, once the additional Project 4 works are complete. Phase 3 testing pass rates are lower than anticipated, and we note with concern that forecast completion of Phase 3 testing has slipped by 6 weeks to the end of [REDACTED]. This will impact on, and likely delay, the forecast SC date.

Acceptance certification for Custom House Station is being delayed by the time being taken by CEG for documentation review. There is no float allowed for in the schedule for possible re-submission. The site team is relying on pre-reviews with the IM to help mitigate possible delays. A joint (CEG/IM) competence register could help ensure that appropriate resource is available for the review and that only unresolved issues are sent to CEG for decision. Staff changes and resource leaving the project are impacting the review process. Both CRL and the IM are finding that the lack of availability of suitable staff in the market place is a major constraint.

C660’s Radio network testing at Woolwich Station has been delayed by [REDACTED] in the period, due to failed tests. Re-testing has started, but rework and replacement cable pulling may be required if damage is found to be the cause of the test failures. This could have a major impact on the schedule, as C660’s works are on the critical path.

¹² RfL Stations, Shafts and Portals Vis-Board Reviews held on 9 April 2019.

3.2.4 Portals and Shafts – RfL

Testing and Commissioning progress on the Portals and Shafts is still slow and delays are particularly evident in the forecast dates for completion of Phase 2.3 and 3 testing. These dates are on the critical path, as they underpin then railway safety case and ATU, ready for Handover. However, we note that the forecast dates for HO are generally being held, except at [REDACTED]. Refer to Figure 3 - 4 below. We remain, however, concerned that the assumed rates for the submission of certification documentation on all Portals and Shafts [REDACTED] and that further delays could still occur.

Contract	Location	TLA
C530	Connaught Tunnel	CON
C336	Royal Oak Portal	ROP
C530	North Woolwich Portal	NWP
C360	Mile End Shaft	MEP
C340	Victoria Dock Portal	VDP
C350	Pudding Mill Lane Portal	PML
C360	Fisher Street Shaft	FIS
C360	Limmo Peninsula Shaft	LIM
C530	Plumstead Portal	PLU
C360	Eleanour Street Shaft	ELS
C360	Stepney Green Shaft	STG

Figure 3 - 4 ~ Shafts and Portals – Forecast Staged Completion (SC3) / Handover Dates

Acceptance of the fire safety documentation, O&M Manuals and the Health & Safety Files for the Portals and Shafts is being delayed by a lack of appropriate RfL resource to undertake the necessary reviews. CRL has arranged a series of documentation review workshops to help mitigate some of the resultant delays. We have previously noted concerns that the bow-wave of submissions will overwhelm both CRL and RfL fire safety team, unless the level of resourcing for the reviews is increased. Fire safety documentation sign-off to date remains slow and could threaten the forecast dates for ATU and HO across the Portals and Shafts.

CRL is closely monitoring the progress of the Shafts against the submission of the remaining assurance and testing documentation. RfL has started its T-Minus process for the HO of the Portals and Shafts. Consideration is also being given to measuring the percentage completion of scenario testing and the number of approvals linked to ATUs. CRL will need raw data to help understand what underpins progress on these latter stages ahead of Handover and where support is, or may be, needed. The valuable lessons learnt from these handovers can then be applied to the larger stations. See Figure 3 - 4 above for current key Portals and Shafts handover dates.

3.3 Completion and Handover of Integrated Systems¹³

Rail Systems installation and integration on the Central Section continues in line with the unapproved MOHS dated November 2018. Despite CRL’s acknowledgement¹⁴ that the MOHS is now effectively redundant and on the verge of withdrawal, it still provides the strategic level schedule framework for delivery, pending the anticipated release of the new DCS. We expect to

¹³ The Crossrail generic testing sequence is as follows: Phase 1 - Factory Acceptance Testing; Phase 2 – Static Testing; Phase 3 – Static Integration Testing; Phase 4 – Dynamic Testing; Phase 5 – Trial Running.

¹⁴ CRL Period 1 Stage 3 Critical Path PDB Review held on 7 May 2019.

be able to provide commentary upon CRL's new schedule proposals for completion of all Rail Systems next period. See Section 3.1 above.

As planned, construction work instead of dynamic testing was carried out during MDT 4 and 7; MDT 12 is still set aside for Rail Systems completion (see Section 3.4.1). There will be a continuing need for managed compromise between the competing demands for construction and dynamic testing at least until the start of Trial Running, currently targeted for January 2020. In order to make works planning more efficient, a meeting room at Westferry Circus is being fitted-out for the use of CRL and contractors. The intention is to allow site access, electrical isolation, plant and resources and other works planning initiatives to be delivered in a bespoke 'control room' environment. CRL expects the room to be fully functional before the formal issue of the new DCS at the end of May 2019.

Further details are provided below on the principal completion workstreams necessary for Handover and the delivery of Stage 3 Opening.

1. Completion of Routeway (C610)

Tunnel Lighting Power Panels (TLPPs) and Tunnel Pumped Drainage (TPD) remain the most critical of the Rail Systems to be completed, with significant numbers of their Phase 2.2, 2.3 and 3 tests not yet carried out. Outstanding SSP deliverables (such as power supplies, discharge consents and the need to modify or re-configure existing installations) remain to allow completion of these systems.

Good progress has been made with the testing of Tunnel Fire Main installations, and Phase 2.3 tests are forecast to be completed during the construction window created by the release from dynamic testing of MDT 12. Close co-ordination with the SSP contractors will still be necessary to facilitate technical support and site access for Phase 3 flow testing.

C610 is investigating with the ORR the further extension of the ROGS exemption expiry date of October 2019, for the Construction & Commissioning Railway Rule Book (CCRRB). This is line with the need for C610 to continue in its current role as Principal Contractor, and as the entity with overall responsibility for the safe conduct of dynamic testing in Central Section, until the completion of Trial Running.

2. Tunnel Ventilation (C610)

CRL's concerns with the completion of Tunnel Ventilation remain unchanged from last period. Tunnel access, integration testing with the SSPs, and permanent power provision at Bond Street are critical to the final stages of whole-system testing.

As a result, the achievement of 'air-tightness' throughout the Central Section is now recognised by CRL as a critical issue. It is an important pre-requisite to the re-testing that has become necessary, and to any remaining air flow testing. Resolution will introduce further delay to the completion of Tunnel Ventilation, which has yet to be quantified by CRL. CRL has reported¹⁵ that

3. Radio (C660)

C660's radio priorities remain the completion of GSM-R radio and Fire Brigade radio (LFEPA), in the SSPs and along the route.

¹⁵ CRL Period 1 Stage 3 Railway Systems PDB Review held on 7 May 2019.

Phase 2 radio system testing has been completed at Tottenham Court Road, and the results are under review with LU Connect. This is the first site at which testing has been carried out on what is effectively an extension by CRL of existing 3rd party operational radio infrastructure.

CRL reports that radio installation completion and T&C will be subject to further delay at Paddington because of [REDACTED]. Extra antennae will be required to address the adverse impact upon radio coverage caused by [REDACTED]. Schedule recovery proposals have not yet been developed by CRL.

4. Traction Power (C644)

Padding Mill Lane Feeder Station remains ‘off line’ while re-configuration of the traction power supply control arrangements continues. While testing has been completed, residual issues prevent the take-over of control by NR: the development of Operating Manuals and Control Room Training has yet to be completed; and there are concerns with some HV supply cables that are currently submerged in groundwater. CRL has plans for the resolution of all of these issues, sufficient to allow formal transfer of control to NR, at the end of [REDACTED]. This is later than the planned completion date of [REDACTED] but the delay will have no impact upon the supply of traction power for dynamic testing in the meantime.

5. SCADA and Communications (C660)

Siemens continues to provide installation, testing and commissioning support to Rail Systems and SSP site delivery, on a short-notice reactive basis. Period performance measures show a close correlation between asset installation completion by the SSPs and follow-up testing by C660, with very little lag. However, [REDACTED] poor performance remains a concern and asset availability to C660 is significantly behind plan, frustrating C660’s ability to plan support activities.

[REDACTED] It is intended that the centralised management of these formal permissions in a new ‘control room’ at Westferry Circus (see above) will help to resolve this.

6. Stations, Shafts and Portals (SSP) Rail and Non-Rail Systems Completion

Integration of all SSP Rail and Non-Rail Systems into SCADA and other C660 networks has been the most difficult area of delivery for CRL to address during EOP development. CRL continues with detailed schedule iterations to provide clarity of integrated scope and a schedule for completion. Notwithstanding the ongoing effort, we understand¹⁶ that the earliest version of the DCS will still not fully capture integration of systems at a detailed level. There is much pressure on the CRL SSP management teams to complete this work in time for the final DCS release planned for the end of July 2019.

Slippage has occurred against Period 13 forecasts, and post-installation damage to equipment installed in areas which remain subject to construction activity continues to emerge. Further damage and re-work can be expected (with associated cost and schedule implications) until appropriate protections and controls are imposed in the construction environment. See Section 3.2 for general SSP progress.

¹⁶ CRL Period 1 Stage 3 SSP PDB Review held on 7 May 2019.

3.4 Dynamic Testing

3.4.1 Dynamic Testing Strategy

Preparations have been made for the utilisation of test blocks MDT 7 and 12 for construction. The MDT regime will continue in its current form at least until MDT 17¹⁷, scheduled to start on 24 July 2019, although internal development by CRL of plans beyond that date is already taking place. In practice, a robust schedule for dynamic testing will not be confirmed until the DCS has been issued, following the conclusion of the various EOP initiatives (see Section 3.2).

Two signalling irregularities remain under investigation by CRL:

- Wrong-side failure which occurred during MDT on 17 February 2019;
- Timer irregularity reported by Siemens¹⁸ on 25 March 2019.

The embargo on further multi-train dynamic testing remains in place, while CRL's responses to the preliminary investigation findings are developed¹⁹. However, much planning and preparatory work is already being undertaken by CRL, Siemens and BT to ensure readiness for resumption of testing. For example, temporary fixes are already planned to be introduced into interim software releases for dynamic testing on the Central Section at the earliest opportunity. While we are broadly supportive, we are concerned that the [REDACTED] dates being planned for are not achievable because of an unrealistic reliance upon a 'right-first-time' approach to the completion of the various change control documents and their subsequent safety acceptance. From a strategic perspective, CRL must carefully guard against over-optimism and ensure that the DCS contains sufficient schedule provision for outcomes which fall outside of its control. Obvious examples of this include dependencies upon the supply of documents by external parties or the securing of independent approvals, such as from RAB(C).

BT has also proposed a strategic software development, testing and approval pathway (including for merging of the TCMS ETCS and CBTC products) which identifies schedule targets for assurance and authorisation²⁰. This ultimately delivers version Y0.380, intended to be sufficiently well developed and proven to secure Consent to Operate Stage 3 Passenger Services, between [REDACTED]. We await the release of the new DCS to understand the alignment of these targets with the new strategic delivery milestones.

The impact of implementing CEG's integration tests²¹ 'for routeway systems and related installations' is still being reviewed by the CRL Systemwide Delivery organisation. It is understood that the requirements for these tests have been formally instructed to the SSP contractors; however, issue to the Rail Systems contractors awaits completion of the Delivery review.

3.4.2 Dynamic Testing Progress

The impact of the signalling irregularities set out in Section 3.4.1 above has been to severely restrict the amount of dynamic testing possible in multi-train mode. The opportunity has been taken to carry out non-signalling dynamic testing, with a total of 35 out of 81 non-signalling tests

¹⁷ T&C Visualisation Room, 23 May 2019.

¹⁸ RAB(C) meeting held on 27 March 2019.

¹⁹ Signalling Irregularity Investigation Interim Final Report (CRL1-XRL-R2-LCR-CR001-50002).

²⁰ CRL Period 1 Stage 3 Rolling Stock PDB Review held on 7 May 2019.

²¹ As described in the document 'Integration Tests for Routeway Systems and Related Installations' (CRL1-XRL-Z-RGN-CR001-50511 Rev. 3.0).

passed to date²². The status of signalling tests completed as of 7 May 2019 is summarised below.

OUTCOME	COS	GW	GE	NKL	Totals
Passed	30	0	1	0	31
Partial Pass	32	2	11	0	45
Failed	19	7	7	0	33
Blocked	48	7	5	3	63
Not Attempted	28	7	8	0	43
Totals	157	23	32	3	215

Note: Consolidation of test scope has resulted in the reduction in total from 222 to 215 tests since Period 13.

Figure 3 - 5 ~ C620 Signalling Test Case Summary

The use of the T&C Visualisation Room at Westferry Circus is increasing, but the potential benefits of improving collaborative behaviours are proving slow to realise. It is possible that the programme of meetings currently established for multi-stakeholder planning and approval of T&C initiatives cannot be properly supported by existing resources. This situation might be due to the combined disruptive effects of the current restrictions upon dynamic testing and the lack of a strategic schedule. While some rationalisation of meetings might be necessary in the future, we suggest that this issue is kept in view until after the DCS has been implemented.

3.5 Approvals, Assurance and Agreements

3.5.1 RAB(C)

RAB(C) has accepted CRL’s Safety Strategy for Stage 3 Opening with deferred functionality²³. This is an important assurance document aligned with the outputs from CRL’s recently-completed EOP initiative, which will act as an ‘umbrella document’ for the more detailed safety submissions to follow.

CRL has updated its register of RAB(C) submissions and it is now aligned with the EOP [REDACTED] targeting the start of Trial Running in [REDACTED]. While we expect the register to be refined and re-calibrated against the corresponding DCS in due course, the exercise has been instructive in illustrating the likely assurance workload. The register anticipates significant peaks of activity as early as June and July 2019 to support Shafts and Portals handovers, with further and smaller spikes for Stations in September and October 2019. Safety and Rail Systems assurance submissions dominate in January 2020.

CRL is confident that it already has, or is able to secure, the necessary resources to support these peaks; however, the greatest risk to success is the ability of the contractors to produce the foundation documents upon which the safety submissions are based. We do not believe that the contractors yet understand the significance of the role they have in contributing to whole-railway assurance and, given past poor contractor performance, CRL must work very closely with them to ensure that key submission dates are met.

²² CRL Period 1 Stage 3 Dynamic Testing PDB Review held on 7 May 2019.

²³ RAB(C) meeting held on 9 May 2019.

RAB(C) awaits evidence that the recent signalling irregularities have been properly investigated and the findings addressed, and to be assured that the basis of previous safety approvals has not been compromised.

3.5.2 Regulatory Approvals

CRL is behind the required rate of delivery for closure of Hazards and delivery of Assurance products. For instance, the required rate for Hazard closure to support Trial Running for Period 1 was 189 per period; the achieved rate was 45 per period. CRL must significantly increase the rate as soon as possible (and IMs must work collaboratively with CRL to accept the material) if Trial Running is to be achieved in [REDACTED]. There will also need to be a period towards the end of Dynamic Testing when the delta between the railway's designed level of functionality, and the actual level of functionality provided, is evaluated and the Safety Case revised accordingly.

Other issues and risks remain much as described in our reports from Period 11 to 13 and reflect the status of the build programme.

Engineering Safety Management

- Rate of closure of Hazards – Current performance does not support approval of Safety Case for Trial Running by [REDACTED]. Transfer of Risk Control Actions (RCA) to IMs blocked by lack of O&Ms and T&C evidence;
- C620 Signalling interface design at NR fringes – This is not complete (Degraded Mode & HF outstanding) thus delaying the completion of the transition safety cases;
- C660 T&C evidence – This is reliant from all locations (~70 sites) before complete closure of hazards. Therefore, progress is slow until this is completed;
- RAB-C submissions – These have flatlined. A new submission schedule reflecting EOP is to be released soon;
- TSI compliance – the lack of T&C evidence has been a blocker to the NoBo completing the Technical File for the ORR.

Technical Assurance

- FDO – The IMs require an accepted design in order to go through the completion and Handover process. Failure to close out these FDOs will put this at risk. Currently, the closing out of Red/Amber issues is slow. There are 11 outstanding FDO reports.
- CARE – Failure to deliver the required assurance products and to pass them in CARE will risk Handover of the assets to the IMs. CRL need to increase production and passing of deliverables in the CARE system, and the IMs to increase rate of acceptance.
- Open concessions – If the requirements for concessions are not identified in the near term and large volumes are submitted towards the end of construction then there is a risk that it will not be feasible to obtain acceptance of concessions in time to support Handover. A large number needs to be submitted, and there is a risk that the total number is not currently known.

3.6 Operational Readiness Assessment

Delta between designed and delivered railway: There will be a delta between the designed railway, which the training and RCAs have been developed for, and the delivered railway at the end of Dynamic Testing (DT). The size of the delta, and how it will affect the preparations of the IMs (most notably RfL), is not yet known. The IMs will need time towards the end of DT to assess the delta and implement new training if required. RfL may also need to revise some of

the RCAs which affect the safety case. It is important that CRL and the IMs are transparent at all times in order to avoid a bow wave of work just prior to Trial Running.

Signalling Simulator not working: The last software update to the simulator was designed to mimic CBTC PD+8 and was installed at the end of March 2019. Unfortunately, it was found to be very unreliable, and as a result exercises have had to be suspended until the beginning of July whilst a revised version is produced. These exercises are important, as they raise the competencies of the RCC staff prior to TR. They also expose any deficiencies in training or procedures that would then need to be revised. This delay of (currently) three months is a block to that work.

Other areas of concern for operational readiness are:

Lack of access to RCC Signalling Terminals: There would be benefit to the RfL RCC staff in having access to the terminals in the RCC, operating under C620 instruction. This helps staff familiarisation (especially without a functioning simulator) and gives them a role whilst opening is delayed.

Lack of a functional Performance Management System (PMS): RfL is concerned that the PMS will not be able to function as RfL envisaged, whether due to poor system definition or data accessibility. This does not affect Safety or Operations but means that the ability to identify performance improvement measures during TR and TO could be lost. The result would be that RCC staff will not be informed as to the most appropriate measures to take to improve/maintain the railway's performance.

3.7 Rolling Stock

The top-level schedule from BT shows no change from Period 13. Software configuration Y0.380 is forecast to be authorised for Passenger Service (and Trial Running) by [REDACTED] with a risk of delay to the end of [REDACTED]. Further software configurations are planned before passenger services start. We are aware that the forecast dates in BT's existing programme have little or no float, and that a revised programme from BT is expected at the end of May 2019. Primary concerns are the late releases of the TCMS, CBTC and ETCS components of the various train software configurations.

Other issues that require resolution are:

- DMI – Driveability;
- Brakes & Accurate Stopping Position;
- Auto-Reverse, unlikely to deliver for TR;
- Transitions;
- PSD/Train Door Functionality;
- CSDE – some progress but remains problematic.

The reliability growth for FLUs is improving, but it needs to be at a faster pace if the FLU is to be a reliable component of DT, Trial Running and Trial Operations.

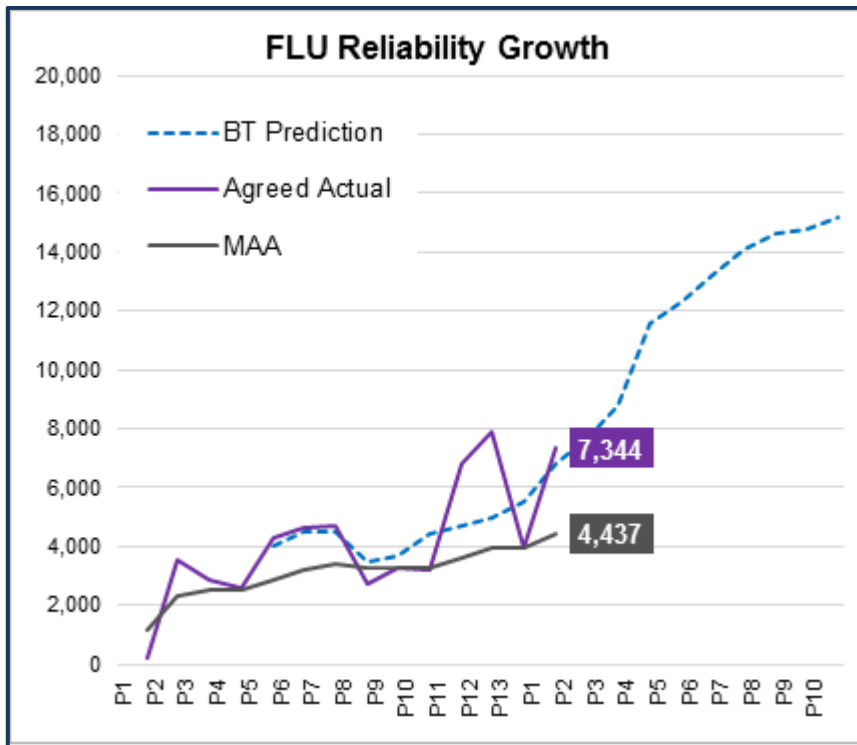


Figure 3 - 6 ~ FLU Reliability Growth Chart (MTIN)

3.8 Handover

As with our previous reports, our message is that the pace of delivery of Handover materials does not match that required by the programme.

Section 3.5.2 of this report describes how CARE is behind programme. This is recognised by CRL, and it is recruiting more resource to raise the pace of delivery.

The issues affecting the delivery of O&M manuals that were described in our last report continue. Of a total of 735 manuals 135 are at Code 2 (Substantial Completion) and 21 accepted. To repeat our Period 13 report message, Contractors need to improve their quality and meet promised delivery dates and RfL needs to reduce its review time and re-assess what constitutes a material comment. All parties need to be more collaborative than they are at present.

As-built Drawings are also well behind. Of the (now) 24,000 MEPA and 5,000 C600 drawings, 11% and 3% have been accepted respectively. The IMs will accept Red Line drawings for Substantial Completion, but the current state of those is not clear. There is little time left to implement improvement measures and a bow-wave of activity seems inevitable.

We are seeking clarity upon the assurance handover relating to the different stages of SC1, 2 and 3. We will investigate the change in the level of workload caused by the disaggregation of the submissions.

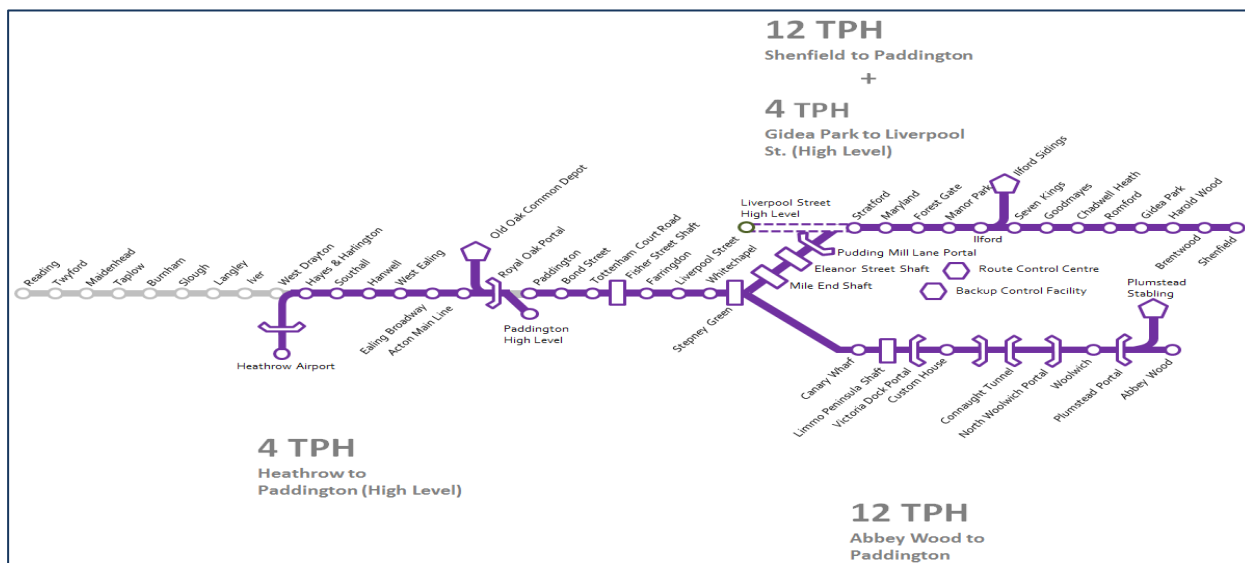
3.9 Trial Running and Trial Operations

The issues described in Section 3.6 have an influence on the success of Trial Running and Trial Operations. There are two further issues.

The first is the importance of the period at the start of ROGS for the RfL RCC staff to raise their competencies, and transition from holding an Entry Level Certificate to receiving an Authority to Work. It is likely that CRL would want to overlay its Trial Running activities during this period, but that could prove counter-productive if the staff are not ready for such tasks.

The second is that the IMs must agree with CRL what the criteria is for entering Trial Running and Trial Operations. The IMs must then lead on what the criteria for entering passenger service are.

4 Stage 4: Paddington to Abbey Wood & Shenfield - Opening TBC



TPH figures based upon original programme – DCS may lead to change

4.1 Summary

CRL has given an overall RAG rating of ‘red’ for Stage 4 Opening. This is because the works are contracted between CRL and NR to complete in [REDACTED] but some are at risk of not meeting that date. However, in the context of the overall Crossrail programme, Stage 4 [REDACTED] [REDACTED]²⁴. This is likely to be either [REDACTED]. None of the at-risk works threaten the [REDACTED] date, so the actual risk of delay to Stage 4 probably merits a ‘green’ rating.

4.2 Operational Readiness Assessment

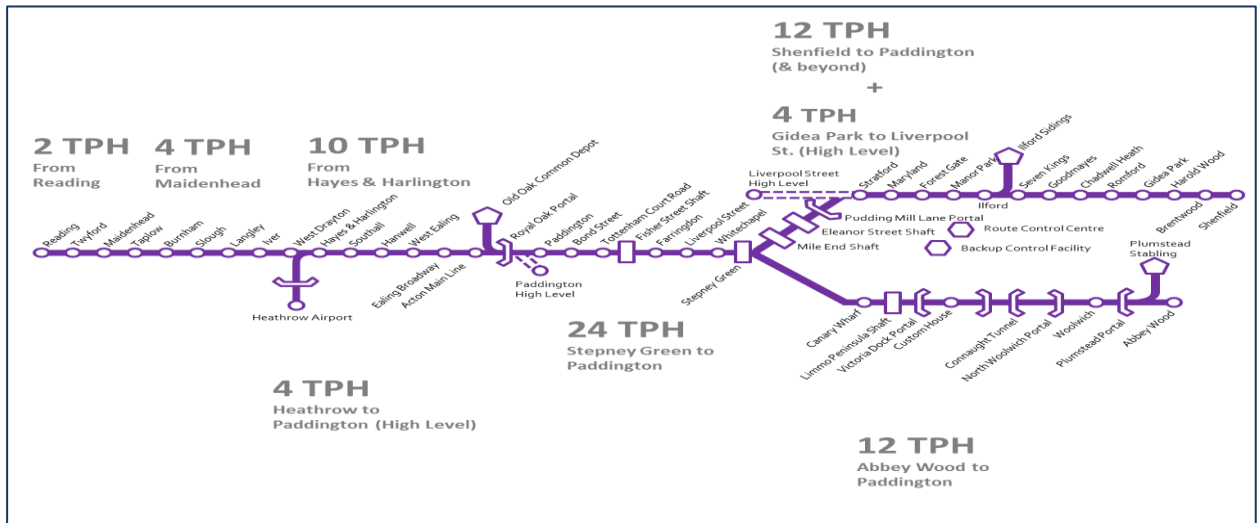
Key issue is:

- Station Information and Security System (SISS)**
 NR’s surveys of the works are taking longer than expected, and a delivery strategy to install the equipment at the Stations needs to be formulated. This has the potential of extending installation beyond the NR KO6 date in [REDACTED]. The interface with the RCC also has to be agreed between C660 and CRL’s TAG. We repeat that mitigating measures should be identified by RfL and MTR-C should the facility not be available at time of Opening.

The other issues in the Stage 4 Operational Readiness Dashboard are DOO CCTV at Shenfield and Stratford; ticket offices and lifts at Gidea Park & Goodmayes and GEML traction power upgrade. We will comment upon these in future reports if they become risks to Stage 4 Opening.

²⁴ The other constraint is that Opening must coincide with an NR timetable change in a May or December.

5 Stage 5: Reading & Heathrow to Abbey Wood - Opening TBC



TPH figures based upon original programme – DCS may lead to change

5.1 Summary

CRL has given an overall rating of ‘red’ for Stage 5A Opening in its Period 1 PDB Dashboard. The completion by NR of its works, most notably at Maidenhead, Twyford and Slough, remains key. NR does not believe the additional access²⁵ that was available will significantly improve the programme and is proceeding on that basis.

It is important that NR and CRL quickly develop project mitigations and contingencies that can be deployed to allow Stage 5A to start. We also note the issues with the introduction of the train, and the likelihood that the Y0.256 software configuration will be used for Stage 5A rather than the merged Z1.00 software. This will reduce opportunities to grow FLU reliability.

CRL has given an overall rating of ‘green’ for Stage 5B Opening in its Period 1 PDB Dashboard. This is because the activities required for the stage are all likely to be complete once the implementation date is confirmed. Confirmation of that date will come when there is greater certainty of a Stage 3 opening date.

5.2 RLU – FLU swap out

The swap-out is important for Stage 5A, as it starts to build reliability of the FLU prior the stage (albeit operating Y0.256 rather than Z1.00 train software configuration). That is why CRL is reporting this activity within its section 5A dashboard.

As we described in our Period 13 report, the key to the swap out is MTR-C SVP approving the Class 345 Y0.256 configuration. For that to happen, the SVP will want to see evidence that:

- 4 trains have completed 1,250 fault-free miles;
- The list of driver defects and control measures is manageable, with a plan for rectification;

²⁵ Weeks 24 – 27, currently 33 hours could be extended to 52 hours.

- Technical assurance documentation is complete.
- ORR letter of no objection

The RSSB Deviation risk has reduced, as MTR-C is supporting BT's application to the RSSB to extend the Deviation to December 2019. If it is not successful, then the train delivery workstream would move closer to the critical path.

There would have been is a high risk that four trains will not have completed their fault free running by the SVP meeting²⁶, and/or that the defects and control measures are judged too onerous. However, the ORR decided not to provide a letter of no objection and requires the train to be re-authorised. BT believes this task will take a matter of weeks, not months.

For the other issues, the fault-free running issue could be completed in a matter of weeks. The defects and controls issue could be harder to address, as removal of any rejected item or group of items may be dependent upon a specific software release date.

5.3 Stage 5A Opening

As we have reported previously, the key activity for Stage 5A is the successful completion of NR's platform extension and DOO CCTV works. NR has created an integrated programme and carried out a QSRA. That shows 7 stations have a P80 probability of submitting DOO CCTV SATS before 7 October 2019 and one by 31 October 2019. This does provide the majority of stations with some float.

Two stations are expected to be fully authorised during November 2019 (Slough and Maidenhead) and one in December 2019 (Twyford). As well as NR trying to improve that position, we believe it prudent for NR and CRL to devise programme mitigations (e.g. temporary platform lighting) and contingencies (ASDO, GWR services stopping) now and have them in place should the need arise.

The programme above assumes the four access periods in July each remain 33 hours in length, rather than 52 hours. It cites the results of its current programme, the lack of contractor resource and disruption to passengers as reasons why 52 hours of access is not required. CRL wants NR to confirm its reasoning and position in writing. It is unlikely that the access will now be obtainable.

Our previous reports have highlighted the potential benefits of utilising 'merged' train software for mileage accumulation and reliability growth. It was envisaged that this software could be introduced on Stage 5A passenger services in December 2019, which would have allowed the knowledge and experience from passenger service conditions to be transferred for the benefit of Stage 3 operations. We understand the BT programme is under heavy strain and this valuable opportunity is receding. The most likely scenario now is that the trains will continue to use the Y0.256 configuration used for the swap-out.

²⁶ SVP Meeting held on 14 May 2019.

5.4 Stage 5B Opening

Stage 5B Opening is rated 'green' in the Period 1 PDB Dashboard, with a proposed opening date to be confirmed. We surmise that date to be December 2021, based on the assumption built into the EOP that it must occur 12 months after Stage 3 Opening. In that context, there are no workstreams that are on the critical path for that date. There is of course a cost imperative in completing them as soon as reasonably possible.

- **Western Inner Station Enhancement.** Work Packages 2 and 3 awarded and both scheduled to be substantially complete in July - September 2020;
- **NR ETCS Programme.** NR's ETCS project team remains focussed upon completing ETCS Stage B at Easter 2020, subject to planning and contractor resources;
- **Liverpool Street (High Level) Platform Extension Works.** No change from last period. An MTR-C proposal to deliver the works needs to be worked through, with NR to confirm its acceptability. Performance issues are likely, particularly under perturbed conditions, if the extensions are not constructed in time.

6 Health & Safety

6.1 Health & Safety Performance

Poor safety performance has continued during the period. As part of its response, CRL will no longer consider targets going forward, instead it will follow a benchmark activation level, in line with industry best practice. The following levels have been reduced to increase the potential intervention and we expect these levels to be breached as the number of hours on the projects reduce with the programme nearing completion.

- RIDDOR 0.15 to 0.11 – Current performance 0.09.
- Lost time AFR 0.23 to 0.17 – Current performance 0.15.

Two additional RIDDORs have occurred in the period. This takes the number of RIDDORs up to 9 over the last 4 periods (Note: 7 RIDDORs occurred in the previous 10 months). CRL has experienced a number of behavioural issues and is looking to re-focus on its safety culture as part of the Safety Step-Up campaign. A key commitment for the upgrading of the HSPI to represent a more forward-looking approach, which we fully support, is still to be completed. As reported in the previous period, we would have expected this to have been resolved as a matter of priority. The project teams are still exhibiting signs that they are concentrating too much on the immediate period and not spending enough time looking ahead at the risks that are likely to occur in the next few months.

Health and Safety key performance indicators are shown below in Figure 6 - 1.

H&S KPI	Target	Aim	Period 13	Period 1
HSPI	2.20	-	2.60	2.62
PCs scoring over 2.20	11	11	10	11
RIDDOR AFR	0.15	0.06	0.08	0.09
LTC AFR	0.23	0.15	0.13	0.15

Figure 6 - 1 ~ Health and Safety Performance COS

6.2 Safety Step-Up

This campaign forms part of CRL’s Target Zero strategy to reinforce safety to all staff and to re-launch of the “Golden Rules”. The goals of the campaign include:

- Reignite and embed safety culture for all delivering Crossrail;
- Educate and share best practices;
- Celebrate safety success;
- Spread the word.

These goals are intended to be achieved via a number of key themes:

- Embed Target Zero language;
- Follow the rules;
- Consequences;
- Focus on high potential near misses.

7 Areas of Concern

The purpose of this section is to highlight areas of concern that do not warrant inclusion in the Executive Summary but are issues which, if left unresolved, have the potential to become a serious concern.

The Current Reference sign-posts the location in this report at which further information can be found.

	Issue	First Raised	Current Reference
1.	Completion of Phase 2 testing by SSP contractors is in delay and continues to be subject to optimistic forecasting.	PSR 117	PSR 124 Section 3.2
2.	Productivity is still well below desired levels and cannot be predicted by CRL.	PSR 122	-
3.	392 vacant roles to fill – will take significant time to fill these.	PSR 121	PSR 124 Section 3.1
4.	Delivery of the Station Information and Security System for Stage 4 lacks a plan.	PSR 115	PSR 124 Section 4.2
5.	Liverpool Street High Level Platform Extensions completion.	PSR 116	PSR 124 Section 5.4
6.	Development of a Service Level Agreement with NR for the provision GSM-R functionality and service to support CRL dynamic testing.	PSR 122	-
7.	Future RAB(C) workload.	PSR 121	PSR 124 Section 3.5.1
8.	Schedule and cost impact of implementing CEG “Routeway Systems and Related Installations” tests.	PSR 121	PSR124 Section 3.4.1
9.	Train mileage accumulation and reliability growth.	PSR 119	PSR124 Section 3.7
10.	Completion of NR modifications to PML Feeder Station.	PSR 120	PSR 124 Section 3.3
11.	Process of IRN sign-off and use of IRN delivery as a KPI.	PSR 118	-
12.	Introduction by CEG of changes to fire management systems at Stations.	PSR 122	-
13.	Exemption by ORR for Enhanced TPWS delayed until October 2019.	PSR 115	-
14.	Prioritisation to implement a forward-looking HSPI.	PSR123	PSR 124 Section 6.1

Note: Not in order of priority.

Figure 7 - 1 ~ Areas of Concern



Appendices

Appendix A

Corporate Milestones & Anchor Milestone Progress

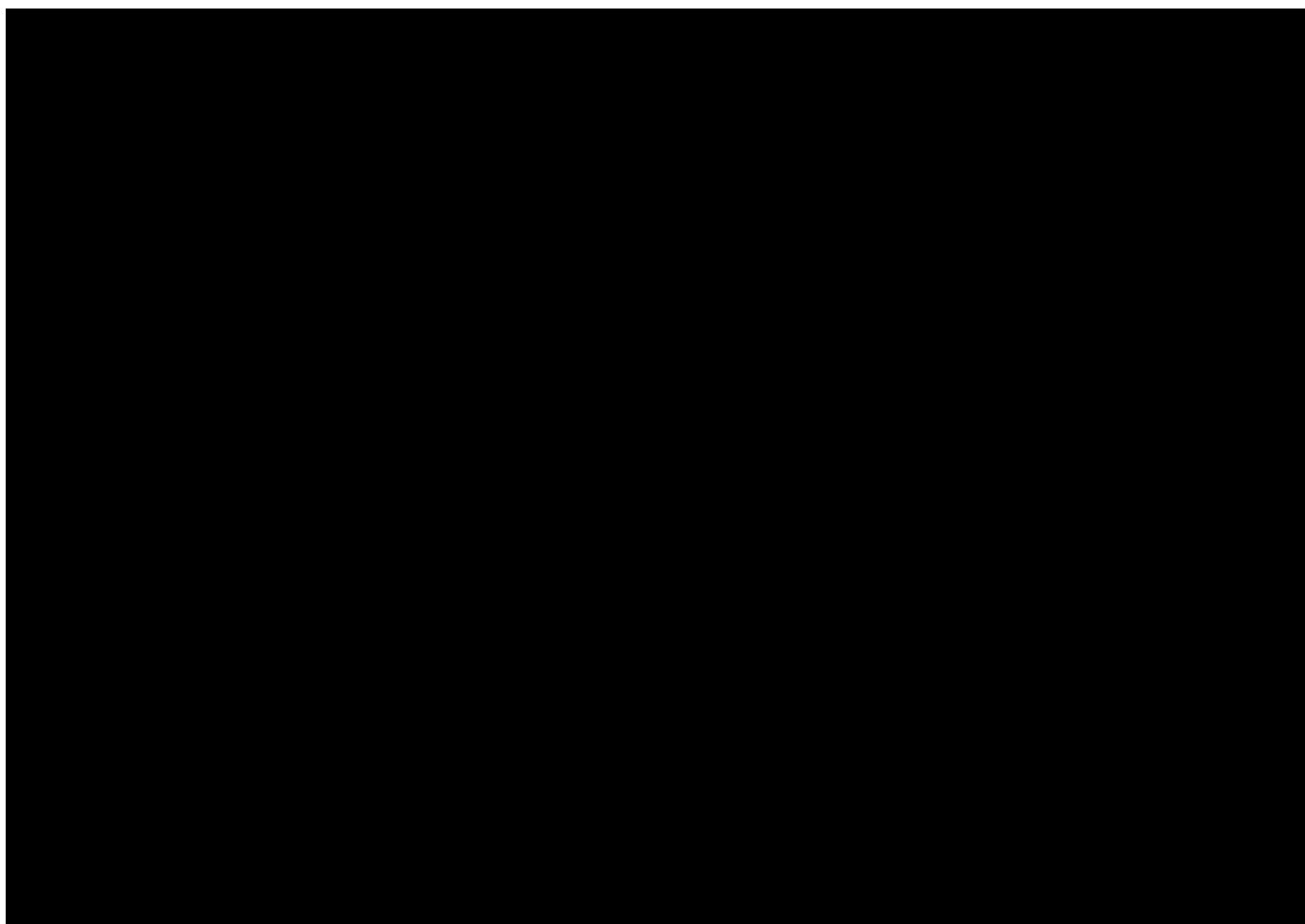


Figure A - 1 ~ Crossrail Anchor Milestones

Appendix B SSP IRN/PCC/PAC Performance & Target Dates

Installation, Testing and Commissioning - Stations

The Figures below summarise the current (Period 1) status of MEP installation (IRNs), testing and commissioning (PCCs/PACs), for each of the stations.

IRNs		% of IRNs Achieved			PCCs		% of PCCs Achieved		
Phase 2.1 Testing		Period 12	Period 13	Period 1	Phase 2.2 Testing		Period 12	Period 13	Period 1
PAD		66	72	74	PAD		16	26	28
BOS		5	5	5	BOS		0	1	1
TCR		80	85	89	TCR		0	18	27
FAR		75	74	70	FAR		28	28	46
LIS		79	82	86	LIS		47	61	51
WHI		53	57	61	WHI		0	0	0
CWS		73	82	97	CWS		79	89	92
CUS		97	100	100	CUS		94	99	100
WOO		49	75	76	WOO		54	55	64
Total IRNs		4308			Total PCCs		1832		
Achieved		2991			Achieved		617		
%		69%			%		34%		

PACs		% of PACs Achieved			Notes:	
Phase 2.3 Testing		Period 12	Period 13	Period 1		
PAD		0	0	0		<ul style="list-style-type: none"> The information contained in the tables has been abstracted from CRL's Period Handover Dashboards and the Period Vis-Board reviews. Please note that the count of PCCs and PACs includes both Tier 1 and C660 sign-offs. The forecast delay for completion of the station's IRNs, based on their current rate of delivery, is 9 Periods. The forecast delay for completion of the PCCs/PACs is 12 Periods.
BOS		0	0	30		
TCR		0	0	0		
FAR		3	3	3		
LIS		0	2	10		
WHI		6	6	6		
CWS		50	66	75		
CUS		27	50	67		
WOO		8	17	16		
Total PACs		650				
Achieved		125				
%		19%				

Installation, Testing and Commissioning – Portals and Shafts

The Figures below summarise the current (Period 1) status of MEP installation (IRNs), testing and commissioning (PCCs/PACs), for each of the Portals and Shafts.

IRNs		% of IRNs Achieved			
		Period 12	Period 13	Period 1	
Phase 2.1 Testing					
Portals	ROP	91	94	93	Total IRNs 282 Achieved 253 % 90%
	VDP	86	96	97	
	PLU	75	85	86	
	NWP	77	87	89	
	PML	91	100	88	
Shafts	FSS	93	100	100	Total IRNs 169 Achieved 161 % 95%
	STG	63	83	85	
	LIM	77	77	97	
	MES	90	100	100	
	ESS	91	91	97	

PCCs		% of PCCs Achieved			
		Period 12	Period 13	Period 1	
Phase 2.2 Testing					
Portals	ROP	91	91	91	Total IRNs 111 Achieved 106 % 95%
	VDP	88	88	91	
	PLU	54	86	100	
	NWP	66	73	94	
	PML	100	100	100	
Shafts	FSS	100	100	100	Total IRNs 42 Achieved 37 % 88%
	STG	25	22	44	
	LIM	100	100	100	
	MES	100	100	100	
	ESS	100	100	100	

PACs		% of PACs Achieved			
		Period 12	Period 13	Period 1	
Phase 2.3 Testing					
Portals	ROP	14	15	20	Total IRNs 99 Achieved 53 % 54%
	VDP	54	62	69	
	PLU	17	17	45	
	NWP	14	48	52	
	PML	60	60	83	
Shafts	FSS	63	63	63	Total IRNs 80 Achieved 45 % 56%
	STG	6	19	19	
	LIM	59	56	63	
	MES	63	63	69	
	ESS	56	63	69	

Notes:
 The information contained in the tables has been abstracted from CRL's Period Handover Dashboards and the Period Vis-Board reviews. Please note that the count of PCCs and PACs includes both Tier 1 and C660 sign-offs.

Forecast Staged Completion dates for Stations, Portals and Shafts

All baseline dates for Stations, Shafts and Portals are currently under review, pending completion and approval of the DCS. We will not make any further comparison to the MOHS (November 2018) forecasts, but will resume once the DCS is released. The new baseline dates will be provided upon receipt and inserted into the new tables created below.

The following tables give forecast dates, as noted in the Period 1 Vis-Board Reviews and CRL’s 8 Week Milestone look-ahead report received on 13 May 2019. The dates have been tabulated for comparison against the previous 2 Period forecasts. Dates may also have been abstracted from the Vis-Board Reviews held after Period Close. Our commentary regarding CRL forecasts is provided in Section 3.1.

Period forecasts highlighted in bold text reflect a change to the date reported in the previous Period. A red shaded cell indicates a delayed date and a green shaded cell an improved date.

SHAFTS AND PORTALS

TOSD has been achieved at CON, NWP, PML, MES, VDP, ESS, PLU, FIS, LIM and ROP. Stepney Green Shaft is the last site yet to achieve TOSD.

Contract	Location	TLA
C360	Stepney Green Shaft	STG

Figure B - 1 ~ Shafts and Portals - Forecast TOSD dates

Contract	Location	TLA
C530	Connaught Tunnel	CON
C336	Royal Oak Portal	ROP
C530	North Woolwich Portal	NWP
C360	Mile End Shaft	MEP
C340	Victoria Dock Portal	VDP
C350	Pudding Mill Lane Portal	PML
C360	Fisher Street Shaft	FIS
C360	Limmo Peninsula Shaft	LIM
C530	Plumstead Portal	PLU
C360	Eleanor Street Shaft	ELS
C360	Stepney Green Shaft	STG

Figure B - 2 ~ Shafts and Portals – Forecast Staged Completion (SC3) / Handover dates

LU STATIONS

LU Stations – TOSD achieved at FAR, WHI (CRL areas), TCR and LIS.

Contract	Location	TLA
C412	Bond Street WTH	BOS
C412	Bond Street ETH	BOS
C512	Whitechapel (LU/LO & Concourse)	WHI

Figure B - 3 ~ LUL Stations – Forecast TOSD dates

Contract	Location	TLA
C412	Bond Street	BOS
C422	Tottenham Court Road	TCR
C435	Farringdon	FAR
C502	Liverpool Street	LIS
C512	Whitechapel	WHI

Figure B - 4 ~ LUL Stations – Forecast Staged Completion (SC3) dates

RfL STATIONS

TOSD has been achieved at CUH, WOO and PAD.

Contract	Location	TLA
M072	Canary Wharf	CW

Figure B - 5 ~ RfL Stations – Forecast TOSD dates

Contract	Location	TLA
C405	Paddington	PAD
M072	Canary Wharf	CWS
C520	Custom House (Incl full Handover)	CUH
C530	Woolwich	WOO

Figure B - 6 ~ RfL Stations – Forecast Staged Completion (SC3) dates

Appendix C CRL Period 1 Board Report Extract

EARLIEST OPENING PROGRAMME

The Earliest Opening Programme (EOP) was approved by the Board at the end of the Period and subsequently an opening date range for Stage 3 was announced to the public of between September 2020 and March 2021. Work has now commenced on a bottom up exercise to create a more detailed schedule of work that will form the Delivery Control Schedule (DCS).

[Redacted]



Figure C - 1 ~ Earliest Opening Programme

Project Representative Team

Project Team

- ██████████ : Project Representative, Safety
- ██████████ : Signalling, Railway Systems, Integration, T&C
- ██████████ : Compliance & Change, Operations, RSD, Assurance
- ██████████ : Commercial, Cost Control, Financial
- ██████████ : PM
- ██████████ : Rail Systems and Rolling Stock
- ██████████ : Stations
- ██████████ : Cost Control
- ██████████ : Cost Control
- ██████████ : Risk
- ██████████ : Schedule

Glossary of Terms and Contracts

Abbr.	Description	Abbr.	Description
3LoD IAF	Three Lines of Defence Integrated Assurance Framework	LFB	London Fire Brigade
A&M	Access & Maintenance	LFEP	London Fire and Emergency Planning Authority
ABB	ASEA Brown Boveri	LIM	Limmo Peninsula Shaft
ABW	Abbey Wood	LIS	Liverpool Street
AC	Acceptance Certificate	LMU	London Metropolitan University
ACBs	Air Circuit Breakers	LO	London Over ground
ACJV	Alstom Costain Joint Venture	LoNo	Letter of No Objection
ACWP	Actual Cost of Work Performed	LoR	Line of Route
AEA	Abellio East Anglia	LTC	Lost Time Case
AEN	Adverse Event Notice	LTIFR	Lost Time Incident Frequency Rate
AFC	Anticipated Final Cost	LU	London Underground
AFC	Approved for Construction status	LUL	London Underground Limited
AFCDC	Anticipated Final Crossrail Direct Cost	LV	Low Voltage
AFR	Accident Frequency Rate	M&E	Mechanical & Electrical
AGA	Abellio Greater Anglia (now known as 'GA')	MAID	Mandatory Asset Information Deliverables
AHU	Air Handling Units	MCR	Material Control Requirement
AIP	Approved in Principle	MCS	Master Control Schedule
AM	Anchor Milestones	MDT	Main Dynamic Testing
AMS	Agreements Management System	MDTR	Main Dynamic Testing Regime
APIS	Authorisation to Place into Service	MENTOR	Mobile Electrical Network Testing, Observation and Recording
ARS	Automatic Route Setting	MEP	Mechanical Electrical & Public Health
AsBo	Assurance Body - Ricardo Rail	MEPA	Mechanical, Electrical, Public Health, Architecture
ASLEF	Associated Society of Locomotive Engineers and Firemen	MES	Mile End Shaft
AT	Autotransformer	MFF	Multi-Functional Framework
ATC	Automatic Train Control	MIRP	Maintenance Integration Review Panel
ATF	Auto Transformer	MML	Mott MacDonald Ltd
ATFS	Autotransformer Feeder System	MOHS	Master Operational Handover Schedule
ATO	Automatic Train Operation	MOS	Member of Staff
ATP	Automatic Train Protection	MPS	Master Plan Shaft
ATS	Automatic Train Supervision	MTIN	Miles Per Technical Incident Number
ATS	Auto Transformer Station	MTIN	Miles Technical Incident Number
ATU	Authority to Use	MTR SMS	MTR Safety Management System.
AWS	Automatic Warning System	MTR-C	Mass Transit Railway - Crossrail
B&PC	Board & Programme Contingency	MTT	Multi Train Testing
BBMV	Balfour Beatty Morgan Vinci	MV	Medium Voltage
BCA	Bilateral Connection Agreement	MVP	Minimum Viable Product
BCWP	Budgeted Cost of Work Performed (Earned Value)	NCE	Notified Compensation Event
BCWS	Budgeted Cost of Work Scheduled (Planned Value)	NCR	Non Conformance Report
BFK	Bam Ferrovial Kier	NEC	New Engineering Contract
BH	Berkeley Homes	NG	National Grid
BIU	Bringing Into Use	NGET	National Grid Electricity Transmission
BLL	Bakerloo Line Link	NKL	North Kent Line
BMS	Building Management Systems	NoBo	Notified Body
BOS	Bond Street Station	NOW	North Woolwich

BP	Business Plan	NR	Network Rail
BREEAM	Building Research Establishment Environmental Assessment Methodology	NR PDB	Network Rail Programme Delivery Board
BSP	Bulk Power Supply Point	NSACS	New Sector Area Cost Summary
BT	Bombardier Transportation	NWP	North Woolwich Portal
BT / PC	Bombardier Transportation / Prime Contractor	O&M	Operations and Maintenance
BTH	Blomfield Ticket Hall	OBCUs	On-Board Control Units
BUCF	S	OCS	Overhead Catenary Systems
BUF	Bottom Up Forecast	OLE	Overhead Line Equipment
C&CSC	Commercial and Change Sub-committee	OMC Building	Operations Maintenance Centre
CAR	Corrective Action Report	OME	Order of Magnitude Estimate
CARE	Crossrail Assurance Reporting Environment	ONFR	On Network Functional Requirements
CBTC	Communications Based Train Control	ONSIP	On Network Station Improvements Programme
CCB	Current Control Budget	ONW	On Network Works
CCP	Commitments Compliance Plans	OOC	Old Oak Common
CCR	Consolidated Cost Report	OOCPA	Old Oak Common Paddington Approaches
CCRB	Construction and Commissioning Railway Rule Book	OPEX	Operational Expenditure
CCRRB	Crossrail Construction Railway Rule Book	Ops	Operations
CCSA	Contract Commercial Status Analysis	ORAT	Operational Readiness & Transfer Group
CCSC	Commercial & Change Sub-Committee	ORR	Office of Rail & Road
CCTV	Closed Circuit Television	ORSG	Operational Readiness Steering Group
CD/RA	Closed Door / Right Away	OSD	Over Site Development
CDG	Competence Design Group	OSP	Operations Safety Procedures
CDL	Central Door Locking	OTIS	OTIS escalators (company)
CDM	Construction Design & Management Regulations	OTP	Overall Target Price
CDN	Crossrail Data Network	P2R	Paddington to Reading
CDT	Commitments Delivery Tracker	PA	Public Address
CE	Compensation Events	PAC	Partial Acceptance Certificate
CEC	Chief Engineer's Communications	PAD	Paddington station
CEEQUAL	Civil Engineering Environmental Quality Assessment Scheme	PC	Principal Contractors
CEG	Central Engineering Group	PCC	Pre-Commissioning Certificate
CEO	Chief Executive Officer	PDA	Project Development Agreement
CER	Communications Equipment Room	PDB	Programme Delivery Board
CFCCB	Contingency Finance Current Control Budget	PES	Platform Edge Screen
CFO	Chief Financial Officer	PES	Permanent Earthed Sections
CIF	Crossrail Integration Facility	Ph3C	Phase 3 Complete
CIF	Common Incentive Framework	PIP	Paddington Integration Project
CIS	Customer Information System	PIR	Potential Incident Report
CMR	Crossrail Managed Risk	PLU	Plumstead
CMS	Central Management System	PM	Project Manager
CoL	City of London	PMI	Project Manager Instruction
CON	Connaught	PML	Pudding Mill Lane
COS	Central Operating Section	PMO	Project Management Office NR
COWD	Cost of Work Done	PNY	Paddington New Yard
CPFR	Crossrail Programme Functional Requirements	PPE	Personal Protective Equipment
CPI	Cost Performance Index	PPF	Property Partnership Framework
CPO	Compulsory Purchase Order	PPM	Passenger Performance Measurement
CRAF	Completion Readiness Assessment	PRep	Project Representative

	Framework		
CRL	Crossrail Limited	PRISM	Cost Management Software
CRV	Crossrail Requirements Variation	PRM	Persons of Reduced Mobility
CSCS	Construction Skills Certification Scheme	PSD	Platform Screen Door
CSDE	Correct Side Door Enabling	PSG	Performance Steering Group
CSJV	Costain Skanska Joint Venture	PSR	Project Status Report
CSM	Construction Safety Management	PTYSC	Property Sub-Committee
CSM-RA	Common Safety Method – Risk Assessment	PWay	Permanent Way
CT	Computerized Tomography	PWHR	Project Wide Hazard Records
CTG	Cost to Go	QBR	Quarterly Baseline Review
CTOC	Crossrail Train Operating Concession	QCRA	Quantified Cost Risk Assessment
CUH / CHS	Custom House Station	QRA	Quantified Risk Assessment
CW	Canary Wharf	QSRA	Quantified Schedule Risk Assessment
CWG	Canary Wharf Group	RAB	Regulatory Asset Base
CWS	Canary Wharf Station	RAB (C)	RfL Assurance Board for Crossrail
D&A	Drugs and Alcohol	RAG	Red, Amber, Green Matrix
DA	Development Agreement	RAM	Route Asset Manage.
DCS	Delivery Control Schedule	RAP	Remedial Action Plan
DeBo	Designated body	RBC	Remote Block Computer
DESJs	Design Engineering Safety Justifications	RCA	Risk Control Actions
DfT	Department for Transport	RCC	Route Control Centre
DLO	Direct Labour Organisation	RfL	Rail for London
DLR	Docklands Light Railway	RfL-I	Rail for London - Infrastructure
DMI	Driver Machine Interface	RFT	Right First Time
DOO	Driver Only Operation	RIA	Railway Integration Authority
DPS	Depot Protection System	RIBA	Royal Institute of British Architects (Structure of Construction Stages)
DT	Dynamic Testing	RIDDOR	Reporting of Injuries Diseases & Dangerous Occurrences Regulations 1995
Dwall	Diaphragm wall	RIRP	Railway Integration Review Point
DWWP	Delivery of Works Within Possession	RLU	Restricted Length Unit
E&B	Earthing & Bonding	ROC	Rigid Overhead Conductor
EA	Environment Agency	ROC	Regional Operational Centre
EAC	Estimate at Completion	ROGS	The Railways and Other Guided Transport Systems (Safety) Regulations 2006
EB	Eastbound	ROP	Royal Oak Portal
ECHR	Element Completion Handover Report	RP4.2	Review Point 4.2
ECI	Early Contractor Involvement	RR	Ricardo Rail
ECP	Employers Completion Process	RRV	Road / Rail Vehicles
ECS	Empty Coach Stock	RS	Rolling Stock
EDBL	Early Date Baseline	RSC	Return Screen Conductor
EDORs	ETCS Data Only Radio	RSD	Rolling Stock & Depot
EDT	Early Dynamic Testing	RSSB	Rail Safety & Standards Board
EED	Emergency Exit Door	RTU	Remote Telemetry Unit
EFC	Estimated Final Cost	S&C	Switches & Crossings
EFC	Economic and Financial Committee	SA	Supplementary Agreement
EiS	Entry into Service	SACR	Semi Annual Construction Report
ELCBT	Elizabeth Line Countdown Board Tracker	SAP	System Applications Products
ELRSG	Elizabeth Line Readiness Steering Group	SAR	Safety Assessment Report
ELSSG	Elizabeth Line Strategic Steering Group	SAT	Site Acceptance Test
EMC	Electromagnetic Compatibility	SC	Staged Completion
EMU	Electrical Multiple Unit	SCADA	Supervisory Control and Data Acquisition
EOP	Earliest Opening Programme	SCL	Sprayed Concrete Lining
EOWL	Element Outstanding Work List	SCN	Sponsor Change Notice
ERTMS	European Rail Traffic Management Systems	SDG	Signalling Design Group
ESJ	Engineering Safety Justification	SDO	Selective Door Operation

ESM	Engineering Safety Management	SDS	Scheme Design Specification
ESS	Eleanor Street Shaft	SEJ	Safety Engineering Justification
ETCS	European Train Control System	SER	Signalling Equipment Room
ETH	Eastern Ticket Hall	SES	South East Service
EVM	Earned Value Management	SESR	South East Signalling Room
ExCom	Executive Committee	SFA	Sponsor Funding Account
FAR	Farringdon	SHELT	Safety and Health Leadership Team
FCCB	Finance Current Control Budget	SIM	Simulation Room
FDC	Framework Design Consultant	SIRP	Systems Integration Review Panel
FDO	Final Design Overview	SISS	Station Information and Security System
FDS	Final Design Statements	SJR	Safety Justification Report
FFOC	Final Forecast Outturn Cost	SLD	Single Line Diagrams
FGW	First Great Western	SMS	Safety Management System
FHO	Full Handover	SMTA	Smithfield Market Traders Association
FIS	Fisher Street Shaft	SOC	Statement of Compatibility
FLU	Full Length Unit	SONIA	Sterling Overnight Index Average
FoI	Freedom of Information	SOR	Stations Operation Room
FRAG	Fraud Risk Assurance Group	SORBA	Shaping Architecture Company (sub cladding contractor)
FTS	Floating Track Slab	SPI	Schedule Performance Index
GAF	Greater Anglia Franchisee	SPS	Secondary Part Steel
GE	Great Eastern	SPZ	Signal Protection Zone
GEBR	Guaranteed Emergency Brake Rate	SR	Sponsors Requirement
GEFF	Great Eastern Furrer & Frey	SRP	Safety Review Panel
GEML	Great Eastern Main Line	SSE	Scottish & Southern Electricity
GFRC	Glassfibre Reinforced Concrete	SSP	Stations, Shafts, Portals
GLA	Greater London Authority	STG	Stepney Green Shaft
GPE	Great Portland Estates	STS	Standard Track Slab
GRC	Glass Reinforced Concrete	SVP	Safety Verification Panel
GRC	Governance, Risk Management and Compliance	T&C	Testing & Commissioning
GRIP	Governance for Railway Investment Projects	TAG	Technical Assurance Group
GSM-R	Global System for Mobile Communication - Railway	TAP	Technical Assurance Plan
GW	Great Western	TBM	Tunnel Boring Machine
GWML	Great Western Main Line	TC&HSG	Testing, Commissioning and Handover Steering Group
GWR	Great Western Railway	TCCRP	Testing Commissioning Configuration Review Panel
H&S	Health & Safety	TCMS	Train Control Management System
HAL	Heathrow Airport Limited	TCR	Tottenham Court Road
HALARP	Heathrow Airport Limited Assurance Review Panel	TCRW	Tottenham Court Road West
HAS	High Attenuation Sleeper	TDR	Technical Director's Report
HAVS	Hand Arm Vibration Syndrome	TDY	Tunnel Drive Y
HEP	Handover Execution Plans	TfL	Transport for London
HEX	Heathrow Express	TO	Taken Over
HIA	Heathrow Implementation Agreement	TO	Trial Operations
HM	Her Majesty	TOC	Train Operating Company
HMDL	Handover Master Deliverable List	TOSD	Tier One Substantial Demobilisation
HO	Handover	TPA	Tunnel Planning Authority
HPNM	High Potential Near Misses	TPH	Trains Per Hour
HRW	Heathrow Airport	TPS	Train Protection System
HSPI	Health & Safety Performance Indicator	TPWS	Train Protection & Warning System
HTR	Heathrow	TR	Trial Running

HV	High Voltage	TRAIL	Transport Reliability Availability Integrated Logistics
HVAC	Heating Ventilation & Air Conditioning	TRH	Temporary Rehousing
I/O	Input / Output	TSI	Technical Standard for Interoperability
IA	Interim Acceptance	TTO	Temporary Ticket Office
ICD	Interface Control Document	TTVS	Temporary Tunnel Ventilation System
IDT	Interim Dynamic Testing	TUCA	Tunnelling & Underground Construction Academy
IECC	Integrated Electronic Control Centre	TWAO	Transport & Works Act Order
IEP	Intercity Express Programme	TXM	TXM Plant
IFC	Issued For Construction	U&A	Undertakings & Assurances
IFD	Ilford Yard	UKPN	UK Power Networks
IM	Infrastructure Manager	UR	Urban Realm
IOSH	Institution of Occupational Safety and Health	URT	Unresolved Trends
IP	Intervention Point (0, 1, & 2)	UTX	Under Track Crossings
IR35	Inland Revenue Taxation Regulation 35	VAP	Verification Assurance Procedure
IRM	Incident Response Management	VDP	Victoria Dock Portal
IRN	Installation Release Note	VERP	Value Engineering Review Panel
IRSG	International Regulatory Strategy Group	VFL	Volker Fitz Patrick
ISA	Independent Safety Assessment	VN	Variation Notice
ISJ	Interim Safety Justification	VT	Voltage Transformer
ISV	Intermediate Statements of Verification	W&W	Wales & West
ISV	Intermediate Statements of Verification	WAD	Works Authorisation Document
ITP	Inspection & Test Plan	WBP	Westbourne Park
ITT	Invitation to Tender	WBS	Work Breakdown Structure
JST	Joint Sponsor Team	WC	World Class
KBR	Knorr-Bremse Rail	WCC	Westminster City Council
KD	Key Deliverable	WCCC	Whole Contract Construction Certificate
KE	Kinematic Envelope	WHI	Whitechapel
KG	Kensal Green	WiFi	Wireless Fidelity
KO	Key Output	WITI	Western Inner Track Infrastructure
KPI	Key Performance Indicator	WOE	Western Outer Electrification
KPMG	Klynveld Peat Marwick Goerdeler	WOO	Woolwich Station
L&P	Land and Property	WOTI	Western Outer Track Infrastructure
LB	London Borough	WTH	Western Ticket Hall
LBTH	London Borough of Tower Hamlets	YC	Yard Control
LDBL	Late Date Baseline	YC	Yard Control

Contract No.	Contract Name	Contract No.	Contract Name
A013	Paddington Station Urban Realm	C501	Liverpool Street Station (Piling & DWall)
A014	Bond Street Urban Realm	C502	Liverpool Street Station (Main Station Works)
A015	TCR Urban Realm	C503	Liverpool Street Station (Civil Advance Works)
A016	FAR Urban Realm	C510	Station Tunnels East - Early access Shafts and SCL Works
A036	TCR Undertaking Consultants - rdy	C511	Whitechapel Station (Piling & DWall)
Ax12	TCR OSD revisions to Goslett Yard	C512	Whitechapel Station (Main Station Works)
C100	Architectural components	C520	Custom House (Main Station Works)
C102	Material and Workmanship Specifications	C530	Woolwich station
C121	Sprayed Concrete Linings (SCL)	C610	Systemwide Main Works
C122	Bored Tunnels	C620	Signalling Systems
C123	Intermediate Shafts	C631	Platform Screen Doors
C124	Aero-dynamics and ventilation, M&E, rail systems	C641	Kensal Green Bulk Supply Point
C130	Paddington Station	C643	Pudding Mill Lane Bulk Supply Point
C131	Paddington Integrated Project	C644	Central Section Track power infrastructure
C132	Bond Street Station	C650	Non Traction High Voltage Power
C134	Tottenham Court Road Station	C651	Limmo Bulk Supply Point
C136	Farringdon Station	C660	Communications and Control Systems
C138	Liverpool Street Station	C695	Plumstead Maintenance Facility
C140	Whitechapel Station	C701	Instrumentation & monitoring
C146	Custom House Station	C730	Lifts
C150	Royal Oak Portal	C740	Escalators
C152	Pudding Mill Lane Portal	C750	Schedule of Defects Surveys
C154	Victoria Dock Portal	C751	Schedule of Defects Surveys
C156	North Woolwich and Plumstead Portal	C752	Schedule of Defects Surveys
C158	Woolwich	C801	Operation and Logistics Centre
C164	Bulk Power Supply	C802	Transportation Control
C166	Route Control Centre	C803	Traffic Signage
C170	Communications and Control Systems	C806	Wallasea Temporary Jetty
C175	Crossrail Tunnelling Academy Design	C807	Marine Transportation
C176	Wallasea Island	C808	Removal of Wallasea Temporary Jetty
C178	Westbourne Park elevated bus deck	C809	Noise insulation
C181	Scott Wilson - Continuity	C810	Noise insulation
C182	Atkins - Continuity	C815	Tunnelling Academy
C183	Mott Macdonald - Continuity	C828	Ilford Yard Stabling sidings
C184	Instone Wharf Surveys	CXX5	Management of First Buses at WBP
C185	(OCN1169) EWMA	LU01	LU Works -Westbourne Park, incl WS
C300	Tunnel Drive X - Royal Oak to Farringdon	LU02	Farringdon Barbican IMR Relocation
C305	Tunnel Drive Y - Limmo to FAR & Drive Z , SGJ to PML & Drive G, Limmo to Victoria Dock Portal	LU03	Bond Street
		LU04	TCR Goslett Yard Main Works
C310	Tunnel Drive H - Thames Tunnel	LU06	LU – Liverpool Street Station Works
C315	Connaught Tunnel refurbishment	LU07	LU – WHI Plain Lining and West Ham Turn-back
C330	Royal Oak Portal (Civil Works)	LU10	Griffiths House Bulk Supply Point
C335	Shaft and Portal Finishing Works	LU11	Station Operations Rooms (SOR)
C336	Paddington New Yard	M004	General Paddington
C340	Victoria Dock Portal Civil Works	M005	Bond St Highway Alterations
C350	Pudding Mill Lane Portal Civil Works	M011	Bond St Third Party Costs
C360	Eleanor Street & Mile end Shafts Civil Works	M019	Bakerloo Link & Increase PAD Passage
C400	PAD - Box Works/Piling & DWall	M020	TCR Office Accommodations
C405	Paddington Station (Main station works, Fit out)	M022	Bond Street Site Accommodation
C410	Station Tunnels West - Early access Shafts and SCL Works	NR	Network Rail Invest Authority and APA PML
C411	Bond Street Station (Pilling & Dwall)	NR01	Network Rail Interface Works

C412	Bond Street Station (Main works, Fit out)	NR04	Network Rail Interface Works
C420	TCR Access Shafts & SLC Works	NR07	Surface Works - Design
C421	Tottenham Court Road (Piling and Dwall)	NR08	IA & APA Works
C422	Tottenham Court Road (Main Station Works)	R131	PIP - C131 Recharge to LU
C430	Farringdon Station (Shaft Piling & Dwall)	R132	Bond St Recharge
C435	Farringdon Station (Main Station Works)	R271	PIP - C271 Recharge to LU
		R272	PIP - C272 Recharge to LU