

ASSURANCE ENGINEERING SAFETY MANAGEMENT

System Safety Plan Addendum For Trial Running and Trial Operations

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1 INTRODUCTION

1.1 Background

- 1.1.1 In April 2019 Crossrail Ltd (CRL) announced its strategy for Revenue Service known as the Earliest Opening Programme (EOP).
- 1.1.2 The Handover Strategy and Plan [CRL1-XRL-K1-STP-CR001-50001] was then produced to outline the EOP approach and describe the delivery detail for the successful transfer of the Crossrail Project Elements to the relevant Infrastructure Managers (IMs) in line with the Crossrail Project Development Agreement (PDA). Successful transfer is defined as delivering the Central Operating Section (COS) to Revenue Service as early as possible with a plan in place to complete any outstanding works.
- 1.1.3 A key event in the Handover Strategy was the transfer of the Routeway to Rail for London Infrastructure (RFLI) which allowed RFLI to stand up as an Infrastructure Manager under the Railway and Other Guided Systems (ROGs) regulations in March 2021.
- 1.1.4 Completion of the railway will be progressive with stages in the Handover process until the End State condition when all works are done and representing Stage 5c representing full service from Reading and Heathrow through the Central Section to Shenfield and Abbey Wood. These stages are:
- Ready for Trial Running (referred to as Entry into Trial Running or EiTR in the rest of the document)
 - Ready for Trial Operations (Entry into Trial Operations or EITO, which has been staged, see section below)
 - Ready for Revenue Service (Entry into Revenue Service or EiRS at Stage 3a)
 - Completion of Bond street station (completion of the COS for Stage 3R)
 - Integration of services from the east and west into the COS, with trains running from Reading and Heathrow through to Abbey Wood and trains running from Shenfield through to Paddington, with a peak service in the COS of 22 trains per hour (no Auto-reverse) to allow maximum service levels with no Auto-reverse (Stage 5b minus)
 - Integration of services from the east and west into the COS, with trains running from Reading and Heathrow through to Abbey Wood and trains running from Shenfield through to Paddington, with a peak service in the COS of 24 trains per hour (Stage 5b).
 - The final opening stage (Stage 5c), trains will through-run to all Elizabeth line destinations.
- 1.1.5 In September 2021, it was decided that Trial Operations will be conducted in two stages based on the expected railway risk as follows:
- Trial Operations Part A: to achieve final handovers for as many assets as possible. In this stage, there is overlapping of Trial Operations and Trial Running with System Testing with Trains (STT) and Trial Running activities only outstanding for the agreed deltas and upgrade works. The Fire Strategy limitation is maximum of 20 people per

train. Bond St (BOS) and Canary Wharf (CAW) stations will be at SC1 status. The risk profile change from Trial Running is minimal. Safety assurance will be provided.

- Trial Operations Part B: Mass evacuation exercises will be undertaken. SC2 will be implemented for BOS and CAW will be completed to S3ROGS and transferred to the IM. The safety assurance for Part B will be a light touch iteration to Part A.

1.1.6 To support delivery of the assets required to be complete at each stage in the Handover process, the documents below were produced to define the entry and exit criteria in the steps to Revenue Service.

- CRL1-XRL-O7-RSP-CR001-50003 Rev 3.1 EOP Configuration States - SC1 SC2 SC3 Definition Paper
- CRL1-XRL-O8-STP-CR001-50157 Rev 3.0 Entry Exit Criteria Route Map
- CRL1-XRL-O8-STP-CR001-50162 Rev 4.0 Dynamic Testing Exit and Trial Running Entry Criteria
- CRL1-XRL-O8-STP-CR001-50163 Rev 4.0 Trial Running Exit and Trial Operations Entry Criteria
- CRL1-XRL-O8-STP-CR001-50164 Rev 4.0 Trial Operations Exit and Revenue Entry Criteria

1.1.7 Some of the definitions used for configuration states at the time the EOP was produced have subsequently changed. The current key definitions are confirmed as follows:

- SC ROGS is a configuration state of the routeway enabling Trial Running. Staged Completion of part of the routeway can occur and once this is achieved, RFLI stands up as the IM and Routeway assets are transferred.
- SC1 is a configuration state for a station that provides an emergency access and intervention route to the platform and supports Trial Running while the station remains a construction site. It is not a Staged Completion under the PDA and no transfer of assets takes place.
- SC2 is a configuration state for a station that provides more than one emergency access and intervention route to the platform and supports Trial Operations and Stage 3a Revenue Service whilst the station remains a construction site. It is not a Staged Completion under the PDA and no transfer of assets takes place.
- SC3 is a configuration state for a station that demonstrates that the scope of the station assets delivered by the Tier 1 Contractor are largely complete and certificated. It is not a Staged Completion under the PDA and no transfer of assets takes place. This is considered as the milestone when the Tier 1 will substantially demobilise from site activities.
- SC3 ROGS is a staged completion milestone for a station at which transfer of assets to the relevant IM takes place under the Handover process.

1.1.8 An Element is a group of assets and/or systems for procuring Handover from CRL to the IM (PDA Clause 16.2(a)).

1.1.9 The following table sets out the path to completion of transfer to the IM for the various COS Elements.

| Element Type | Transfer to IMS Status | | | | | |
|---|------------------------|---------------------------------|---------------------------|--------------------------------------|---------------------------|-------------------|
| | Pre SCROGS | SCROGS (EiTR) | Trial Running | Trial Ops Part A | Trial Ops Part B | Revenue Service |
| Shafts & Portals | Landlorship | Transfer complete | - | - | - | - |
| RFLI Station - CUH | Landlorship | Transfer complete | - | - | - | - |
| RFLI Station - CAW | Sc1 | SC1 | | | Staged completion SC3ROGS | Transfer complete |
| NR/RFLI Station - ABW | NR APIS complete | - | - | Integration with CRL railway systems | - | - |
| LU Station - BOS | SC1 | SC1 | - | - | SC2 | SC2 |
| LU Station - FAR | SC1 | Staged completion SC3ROGS | - | - | Transfer complete | - |
| RFLI/LU Stations - Others | SC1 | SC1 | Staged completion SC3ROGS | - | Transfer complete | - |
| Railway Systems – Track, Traction Power, Non-traction Power | Assured ready for ROGS | Transfer complete | - | - | - | - |
| Railway Systems – TVS, PTI, Signalling, C&C and RCC | Assured ready for ROGS | Staged completion with transfer | Further configuration | Further configuration | Further configuration | Transfer complete |
| EMC, E&B, Plumstead Sidings and Maintenance Facility | Assured ready for ROGS | Staged completion with transfer | Transfer complete | - | - | - |

Table 1: COS Route to Handover

- 1.1.10 The current CRL ESM System Safety Plan [CRL1-XRL-O7-GST-CR001-00001], referred in the rest of the document as CRL SSP, addresses the ESM activities and risk assessment process required to achieve End state. It does not address the engineering safety management and risk assessment process for each phase to the route to passenger service, namely Entry into Trial Running (EiTR) and the following phases after EiTR.
- 1.1.11 This document focuses on EiTR and the following phase of Trial Operations (EiTO) up to Entry into Revenue Service (EiRS) for Stage 3a where required.
- 1.1.12 Another addendum of the CRL ESM plan will be produced in conjunction with RFLI to cover the stages 3a to 5c.

1.2 Purpose

- 1.2.1 The purpose of this document is to describe the engineering safety management (ESM) activities and risk assessment process, documentation and approvals required for the route to revenue service as described above. These activities will apply the principles outlined in the Common Safety Method for Risk Evaluation and Assessment (CSM-RA):
- a) System definition

- b) Hazard identification
- c) Risk evaluation and risk acceptance
- d) Safety requirements
- e) Hazard management
- f) Independent assessment

1.3 Scope

- 1.3.1 This document focuses on the COS infrastructure being delivered and handed over by CRL to the relevant Infrastructure Manager/Operator (RFLI/MTR-EL/LU/NR). It only addresses the ESM activities and risk assessment process for the route to passenger service Stage 3a as described in Section 1.1.4 as these are not covered in detail in the CRL SSP [CRL1-XRL-O7-GST-CR001-00001]. The CRL ESM System Safety Plan covered the End State of the COS railway.
- 1.3.2 Section 2 covered specific ESM activities relating to Element Early Handover (Landlordship). Section 3 covered specific ESM activities for entry into Trial Running (EiTR). Section 4 covers the specific ESM activities that relate to Entry into Trial Operations (EiTO). This latest update covers the change to a two-stage entry into Trial Operations as EiTO Part A and EiTO Part B, refer to section 4.2, and its effect upon the CRL ESM activities.

1.4 Generic ESM activities Applicable to Entry into Trial Running, Entry into Trial Operations and Entry into Revenue Service

- 1.4.1 New hazards identified for Entry into Trial Running and Entry into Trial Operations are managed through a hazard record specific to that phase and are referred to in this plan. The Hazard Record for EiTR [CRL1-XRL-O8-LLG-CR001-50032] for systems/elements with deferred functionality and PWHR for elements/systems in their End State will support the COS Safety Justification for EiTR. The Hazard Record for Trial Operations is to be produced following EiTR and will support the COS SJ for Entry into Trial Operations. Any hazard that is not closed following EiTO will be recorded in PWHR with its mitigated status, PWHR being the hazard record for End State.
- 1.4.2 The dependencies identified in the Safety Justifications for Entry into Trial Running, Entry into Trial Operations and Entry into Revenue Service are recorded in Crossrail Safety Justification Dependency Tracker [CRL1-XRL-O8-LLG-CR001-50028] and are managed in accordance with the 'Safety Justification Joint Dependency Closure Workshop - Terms Of Reference' [CRL1-XRL-O8-GPS-CR001-50042].
- 1.4.3 Note that there is no change in the management of hazards identified for End State. These are subject to the standard process and Programme Wide Hazard Record (PWHR) described in the CRL SSP.
- 1.4.4 A COS SJ will be produced for each milestone EiTR, EiTO Part A, EiTO Part B, EiRS 3a and EIRS 5b.
- 1.4.5 A Risk Statement Summary will be produced for each milestone:

- To state and justify the acceptability of risk at the completion of all ESM activities relevant to EiTR/EiTO Part A/EiTO Part B/EiRS.
- To support acceptance of the COS EiTR/EiTO Part A/EiTO Part B/EiRS Safety Justification (SJs).
- To support the CRL Declaration of Control of Risk (as described in the Project Authorisation Strategy).

1.4.6 At any time during the life of the project post Final Design Overview (FDO), changes introduced will be subject to the Gate Impact Review (GIR) process in line with Post IFC (Issued for Construction) Changes Internal Crossrail Guidance Note [CRL1-XRL-O7-GUI-CR001-50001] and Systemwide Post IFC (Issued for Construction) Changes Internal Crossrail Guidance Note [CRL1-XRL-O7-GUI-CR001-50008]. The change will be notified where applicable to the Approved Body, ApBo (previously known as Notified Body, NoBo) for compliance against Technical Specifications for Interoperability (TSIs) and to the Assessment Body (AsBo) for compliance against CSM.

1.5 Notification of Change for Independent Assessment

1.5.1 The notification of change to ApBo/AsBo follows the process described in Figure 1.

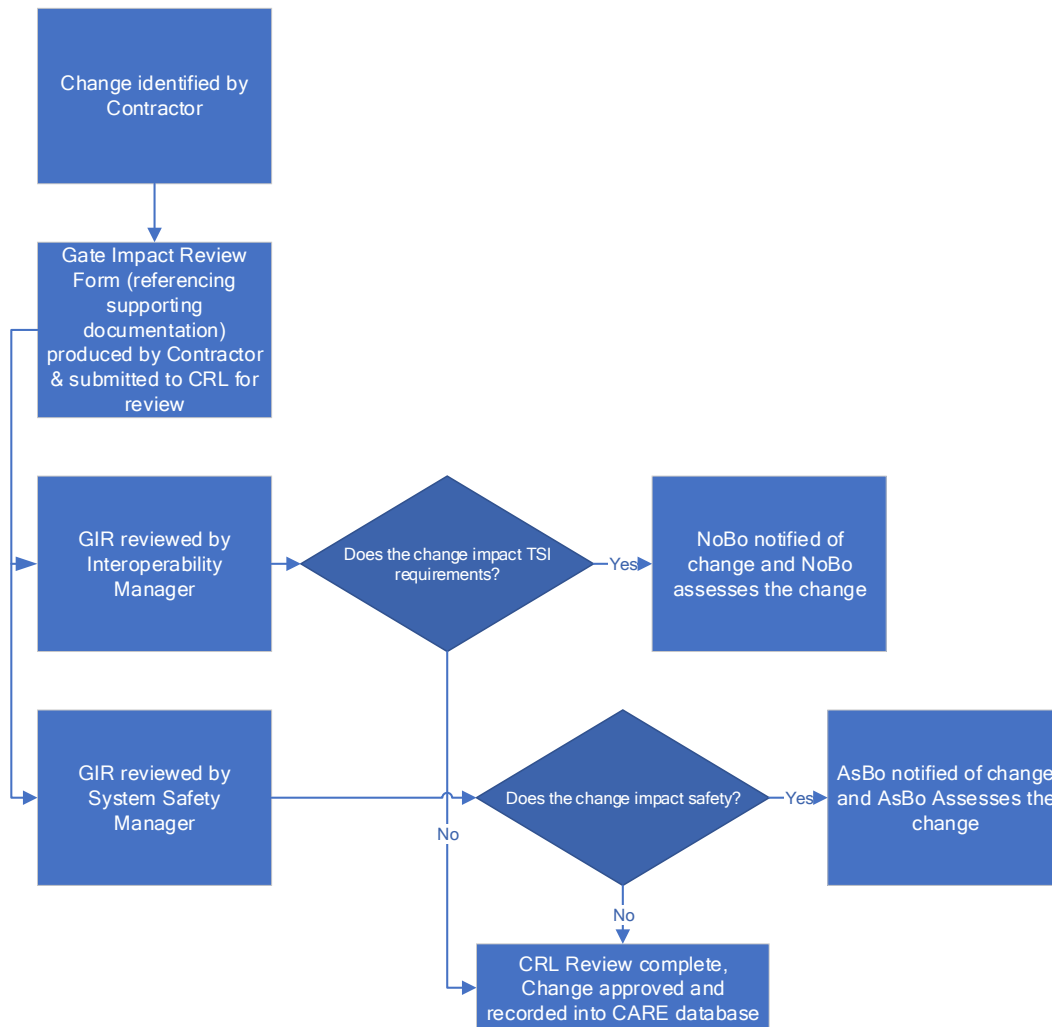


Figure 1: ApBo/AsBo Notification of Change Process

1.5.2 Any substantial/major change where previously assessed PWHR content is likely to need to be changed as part of the implementation will be notified to the AsBo. All changes affecting interoperability will be notified to the ApBo. The notification is through the standard eB document formal transmittals, with reference to the GIR held within the CRL eB document system.

2 ESM Activities and Risk Assessment for Early Handover (Landlordship)

Note: These activities were completed for the Shafts, Portals and Custom House Station in 2020.

2.1 ESM Activities and Risk Assessment

- 2.1.1 Early Handover Elements are shafts, portals and Custom House station. Railway systems within these elements are excluded from Early Handover but will be included at complete transfer to support Trial Running. The ESM activities for this phase are:
- Establish the System Definition for the Element with the deferred functionalities identified.
 - Carry out a safety review to identify risk control actions to mitigate hazards related to railway systems and other functionalities being deferred at Early Handover. The risk control actions identified from the review are recorded in the 'Element Early Handover ESM Review Action Tracker' [CRL1-XRL-O8-LLG-CR001-50027], listed in Appendix D of the Safety Justification, and tracked to closure before the Early Handover date.
 - Produce a CRL Element Safety Justification (SJ) for End State with dependencies for End State listed in Appendix B. The purpose of this approach is to gain agreement of the safety argument with RFLI.
 - Produce within the CRL Element Safety Justification for End State a Safety Statement for Early Handover accompanied with a list of dependencies to be closed for Early Handover recorded in Appendix D of the Safety Justification. Appendix D will then be removed and the SJ updated for End State. Dependencies for End State are recorded in Crossrail Safety Justification Dependencies Tracker [CRL1-XRL-O8-LLG-CR001-50032] and dependencies are tracked to closure in accordance with 'Safety Justification Joint Dependency Closure Workshop - Terms of Reference' [CRL1-XRL-O8-GPS-CR001-50042].

2.2 Independent Assessment

- 2.2.1 The Assessment Body will sample the Early Handover SJs and will provide a letter of support for the approach taken for Early Handover Elements.

2.3 Approvals and Acceptance

- 2.3.1 Upon gaining support of the Early Handover SJs from RFLI, the initial SJs will be submitted to the Railway Assurance Board-Crossrail (RAB-C) for acceptance.
- 2.3.2 The project may decide that the later Early Handover SJs only need acceptance by RFLI, and will not be submitted to RAB-C, given the low risk associated with these elements.
- 2.3.3 The statement above only applies to Shafts and Portals and excludes Custom House Station which will be submitted to RAB-C for acceptance.

3 ESM Activities for Readiness against Entry into Trial Running (EiTR)

Note: These activities were completed for the COS SC3ROGS milestone in March 2021.

3.1 Configuration of the COS at EiTR

3.1.1 The configuration status of the Central Operating Section at Entry into Trial Running (EiTR) is:

- Shafts, Portals and Custom House i.e. the Early Handover Elements complete with the C&C systems within these elements included and assured
- Stations at the SC1 configuration as a minimum with some stations having reached SC3 status but incorporating the SC1 configuration
- Civils and Railways Systems - Track, Traction Power, Non-traction Power handed over
- Railway Systems - Signalling, Communication & Control (C&C), Platform Train Interface (PTI), Route Control Centre (RCC), Tunnel Systems, Plumstead Sidings and Maintenance Facility (PSMF) and NR Interfaces at SCROGS. The status of these systems with any deferred functionality or requiring software update will be sufficient for Entry into Trial Running and demonstrated to be safe.

3.2 ESM Activities and Risk Assessment

3.2.1 Shafts, Portals and Custom House

3.2.1.1 The ESM activities for Shafts, Portals and Custom House station comprise:

- Completing closure of derived safety requirements (DSRs)/hazards that require evidence from Rail Systems and in particular the C&C systems that support Trial Running. This will follow the standard PWHR process described in CRL ESM System Safety Plan.
- Updating the Element Safety Justifications by removing Appendix D which initially covered the Early Handover Safety Statement and hence will become obsolete for this phase.
- Closing the dependencies for End State and where this is not possible mitigate the dependencies for EiTR with agreement from the IM, in this case RFLI.
- Updating the Safety Justification for Custom House Station, submit to RFLI and address their comments, then submit to RAB-C for acceptance.
- Update the Safety Justifications for Shafts and Portals and submit to RFLI for acceptance. Note that given the low risk associated with these elements, it is not intended to submit the updated Safety Justifications to RAB-C for acceptance.

3.2.2 Stations at SC1

3.2.2.1 All stations will be at SC1 configurations except for CUH and FAR stations which will be at SC3ROGS configuration.

3.2.2.2 Stations must achieve the minimum state of configuration called SC1 which demonstrates that the station is sufficiently complete to support Trial Running. Responsibility for care and maintenance is not transferred to either RFLI or LUL at SC1. The station remains a construction site under Station Tier 1 contractor arrangements.

- 3.2.2.3 Station Tier 1 contractors will provide assurance evidence documentation in accordance with 'SC1 Configuration State Evidence Paper' [CRL1-XRL-O7-RSP-CR001-50004].
- 3.2.2.4 The assurance evidence documentation provided by the Tier 1 contracts will be reviewed and approved by the Chief Engineer or representative, the IMs and the Rail Systems Project Director to confirm that all the requirements have been met.
- 3.2.2.5 A station walkthrough by the Chief Engineer and/or representative is carried out before approval of the Tier 1 assurance evidence.
- 3.2.2.6 Part of this assurance evidence is the hazard identification, identification of risk control actions to mitigate the hazards and hazard management.
- 3.2.2.7 The ESM activities for Stations at SC1 are:
- For each station at SC1, a hazard identification (HAZID) activity is carried out to identify any new hazards associate with the integrated configuration for Trial Running and related risk control actions to close or mitigate these hazards. The focus of the HAZID is on Trial Running service through the COS while the station is not handed over as a fully functional station but provides sufficient functionality to be used as a place of intervention/evacuation if required during Trial Running. This process has not been followed for ABW station as this has been delivered by NR who are a self-assured entity. ABW station has been subject to NR AsBo assessment. A Safety Assessment Report and a Declaration of Control of Risk have been produced by NR AsBo and NR respectively.
 - The HAZIDs are run by the CRL ESM team and attended by the relevant Tier 1 ESM, Project Manager, and Engineering Manager, CRL CEG and RFLI/LU representatives as appropriate. Consideration of the environment at SC1 is considered during the HAZID e.g. no passengers during Trial Running and Station under Station Tier 1 arrangements.
 - Hazards are recorded in the 'Hazard Record for EiTR' and will be managed to closure by the CRL ESM team with input from the Chief Engineers Group and the IMs (RFLI/LU/MTREL).
 - Any new Risk Control Actions for EiTR requiring closure by the IMs will be subject to the standard HRP process described in the CRL SSP but is recorded in the Hazard Record for EiTR.
 - CRL Safety Justifications for SC1 are not required. Evidence that the above activities have been completed is sufficient as a reference in the COS SJ for EiTR.
- 3.2.2.8 It should be noted that the achievement of an SC3 milestone status prior to Trial Running does not change the requirement for SC1 to be enacted. Tier 1 contractors will produce an Engineering Safety Justification (ESJ) to demonstrate that their scope of work is substantially complete for SC3. The CRL ESM team together with the Chief Engineer's Group will provide a judgement for support to SC3 milestone achievement. This does not apply to CUH station and FAR station (see 3.2.3) which are expected to be at SC3ROGS at EiTR and ABW station which has been complete and delivered by NR except of some minor works by the communications and signalling contracts. The CRL platforms will need to achieve SC1 to be brought into use for EiTR.
- 3.2.2.9 The SC3 ESJ status will be submitted to the Stations Assurance Review Panel (SARP) for agreement to support to the SC3 milestone.

3.2.2.10 The SARP is run in line with the SARP Terms of Reference [CRL1-XRL-N3-STP-CR001-50002].

3.2.3 Farringdon Station

3.2.3.1 Farringdon Station will be in SC3ROGS configuration prior to EiTR.

3.2.3.2 Any new hazards and RCAs on the IM/Operator associated with the SC3ROGS configuration prior to EiTR will be recorded and managed through the Hazard Record for EiTR.

3.2.4 Civils and Railways Systems (Track, Traction Power and Non-traction Power) Hand Over

3.2.4.1 The Civils SJ will consider the line of route civils works, civils elements of stations, shafts and portals, Silvertown footbridge and NR works. Unlike other SJs which building blocks are contractors' ESJs, the Civils SJ builds upon key design and commissioning evidence from the civils contracts for the work done by contractors responsible for the as built designs that together make up the appropriate civil works components. It is for End State and therefore uses PWHR and evidence from designer's risk assessments. Hazard management follows the existing process described in CRL SSP.

3.2.4.2 The Track, Non-traction Power and Traction Power SJs will also be produced for End State. Hazard management will follow the existing process described in CRL SSP.

3.2.4.3 These End State SJs will have dependencies which are recorded in the Crossrail Safety Justification Dependencies Tracker [CRL1-XRL-O8-LLG-CR001-50032]. Dependencies are tracked to closure by the CRL ESM team jointly with RFLI in accordance with 'Safety Justification Joint Dependency Closure Workshop - Terms Of Reference' [CRL1-XRL-O8-GPS-CR001-50042].

3.2.4.4 Where evidence to close the dependencies for End State is not yet available, the dependencies will be mitigated for EiTR with agreement from the IM, in this case RFLI. The agreement will be reached through the Structured Engineering Judgment (StEJ) Panel in line with the StEJ procedure [CRL1-XRL-07-STP-CR001-50007].

3.2.4.5 Where agreement cannot be reached, the decision is escalated to the Crossrail Risk Review Panel (CRRP) [CRL1-XRL-N3-STP-CRG02-50001] as described in the Trial Running Assurance Strategy [CRL1-XRL-O8-STP-CR001-50170].

3.2.4.6 CRRP undertakes risk-based reviews of specific issues which are impacting the programme, including achievement of handover milestones, acceptance of safety justifications and conclusion of the Crossrail Engineering Safety & Assurance Case (CESAC) process with a focus on Performance/Functionality, Safety, Operability, and Maintainability.

3.2.4.7 CRRP also acts as an intermediate step for submissions (by exception) prior to review by RAB-C in situations where an asset/system does not meet its baselined agreed configuration state. The forum will provide an independent view of the asset/system, reviewing functional gaps and operational restrictions and make a risk-based assessment and recommendation to RAB-C.

3.2.5 **Railway Systems – C&C, RCC, PTI, Signalling, Tunnel Systems, Plumstead Sidings and Maintenance Facility (PSMF), Great Eastern and Great Western Interfaces at SCROGS**

- 3.2.5.1 The Communications and Control (C&C), Platform Train Interface (PTI), Signalling, Tunnel Systems, the Route Control Centre (RCC), Plumstead Sidings and Maintenance Facility (PSMF) and Great Eastern and Great Western Interfaces (the signalling and communications components only) will not be in their final state at EiTR. To reflect this there will be a staged completion for the Railway Systems Element. Safety Justifications will be produced for EiTR and will be updated for Entry into Trial Operations.
- 3.2.5.2 Responsibility for care and maintenance of these systems will be transferred to RFLI using the Staged Completion process at the SC ROGS milestone. Complete transfer of the Railway Systems Element will occur only once the Signalling, C&C, PTI, RCC, Tunnel and NR Interfaces are in their final state.
- 3.2.5.3 The ESM activities and Risk Assessment process for these systems are:
- Establish the System Definition with the deferred functionalities identified.
 - Carry out a hazard identification to identify any new hazards raised by the deferred functionalities at EiTR. Risk control actions to mitigate the hazards are identified and the outcome are recorded in the EiTR Hazard Record [CRL1-XRL-08-LLG-CR001-50032]. The CRL ESM team with input from the Chief Engineer's Group and RFLI will manage the hazards to closure.
 - Produce a Safety Justification for EiTR with Dependencies for EiTR recorded in the Crossrail Safety Justification Dependencies Tracker [CRL1-XRL-08-LLG-CR001-50032]. Dependencies are tracked to closure in accordance with 'Safety Justification Joint Dependency Closure Workshop - Terms Of Reference' [CRL1-XRL-08-GPS-CR001-50042].

3.2.6 **Communications and Control**

- 3.2.6.1 To meet project timescales, modifications have been made to the original planned approach to produce the C&C SJ. The original plan relies on the Contractor Engineering Safety Justifications (ESJs) for each of the C&C systems being the building blocks to the integrated C&C SJ. The ESJs are replaced by Engineering Safety Statements (ESSs) covering only those communications systems required to support Trial Running.
- 3.2.6.2 Note that the ESM process up to the Final Design Overview (FDO) corresponding to the tip of the Safety V lifecycle was not subject to any change and followed the CRL SSP.
- 3.2.6.3 The modified approach ratified by the Structured Engineering Justification (StEJ) panel [CRL1-MMD-E-MRC-CRG01-50006] and noted by RAB-C is given in Figure 1 and a narrative referring to the boxes in the diagram is summarised below.

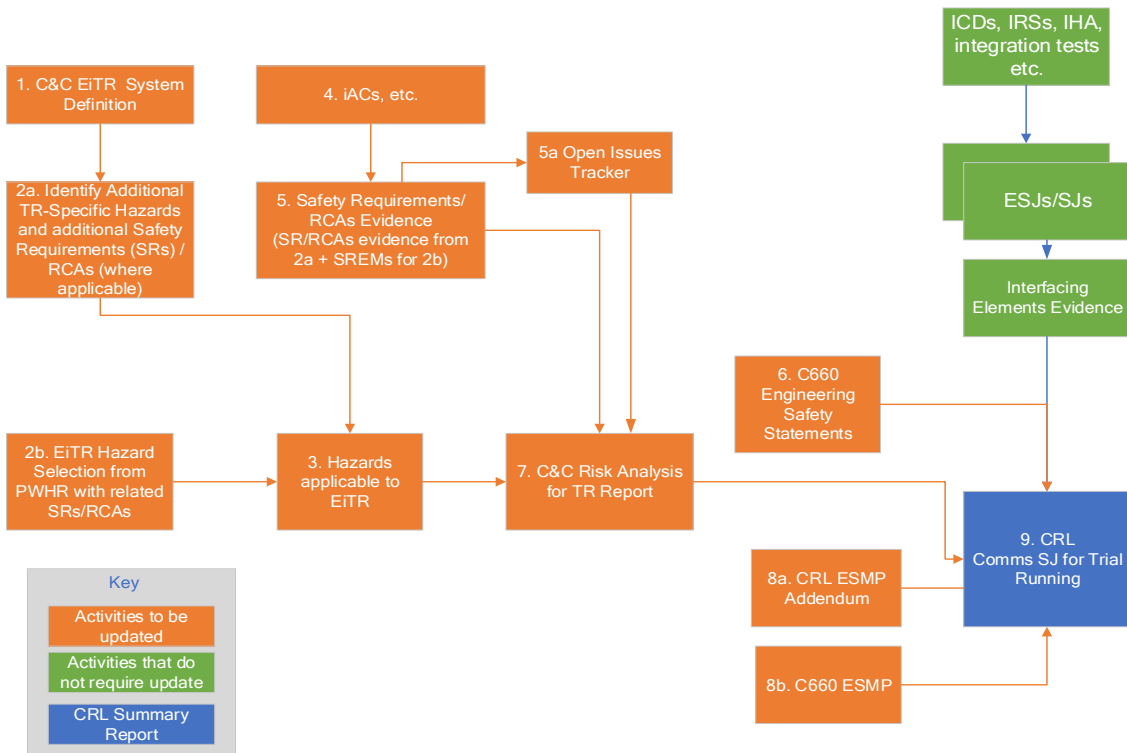


Figure 2: C&C Modified Safety Process

- 3.2.6.4 Box 1. The System Definition will provide the physical and functional definition of the system. This will provide the agreed baseline against which HAZID is undertaken, and the CRL Comms SJ for Trial Running will be scoped.
- 3.2.6.5 Hazard identification and management to ensure that all reasonably foreseeable risks associated with the Trial Running activities are identified and controlled to an acceptable level in accordance with CSM-RA is then applied. This is undertaken through two activities:
- 3.2.6.6 Box 2a. Identification of Trial Running specific hazards: The proposed activities to be undertaken during Trial Running will be assessed against the System Definition for Trial Running to identify the degree of reliance that is placed on the C&C systems for the mitigation of hazards. The HAZID will consider the impact on hazard controls where systems are fully delivered, partially delivered, not delivered, or provided for "beneficial use."
- 3.2.6.7 Box 2b. EiTR Hazard Selection from PWHR. The Project-Wide Hazard Record has been reviewed to identify applicable hazards for Trial Running. This has been undertaken in two phases; the initial hazard capture has been supplemented by a further review following the clarification of applicable subsystems that had initially been excluded.
- 3.2.6.8 Box 3. Hazards applicable to EiTR have been documented. A Hazard Record specifically for Trial Running will be produced following activity 2a. This will document the control measures to be undertaken; where practicable these will rely on the RAPs identified in CSM-RA; qualitative ERE may require engineering judgement to assess the suitability of any procedural controls necessary during the period of Trial Running to mitigate identified hazards.

- 3.2.6.9 Box 5. Safety Requirements and Risk Control Actions will be identified and supported by evidence. Safety Requirements Evidence Matrices (SREMs) have been produced for the initial set of identified safety requirements; where these have been supplemented by further HAZID, then those additional requirements will be documented. Evidence will be provided through box 4.
- 3.2.6.10 Box 4. IACs and other applicable evidence will be provided to support closure of the identified safety requirements for Trial Running.
- 3.2.6.11 Box 5a. Open items are managed through an Open Issues Tracker to track any outstanding evidence to closure. This will be referenced as a key input to item box 7. This has been produced following issue of the initial SREMs and will be supplemented by the output of the additionally HAZID activities.
- 3.2.6.12 Box 7. Risk Analysis will document the suitability of the C&C system to undertake the activities within the scope of Trial Running. This will be supported by evidence that the identified safety requirements specific to those Trial Running activities in box 5 have been met.
- 3.2.6.13 Box 9. The suitability of the safety management of the Trial Running activities will be documented in the CRL C&C SJ for Trial Running. This will summarise:
- The applicable Safety Plans associated with Trial Running.
 - The argument that suitable and sufficient hazard identification and management has been undertaken to identify and control all reasonably foreseeable hazards associated with Trial Running.
 - The physical and functional System Baseline associated with Trial Running.
 - [7] The evidence of control of the particular risks associated with the Trial Running operations.
 - [6] The evidence of control of the generic risks associated with the C660 elementary systems is documented in the C660 Engineering Safety Statements. These document the evidence of the hazard management associated with each applicable subsystem by reference to the evidence of functional and physical safety, and by identification of any outstanding items. The initial baseline of those ESS documents will be supplemented by addenda to capture any additional hazards identified through the current HAZID activities and will report progress against the status of any open items from the initial ESS baseline. The ESS documentation includes Basic Safety (e.g. materials compliance, CE Marking and EMC); Functional Safety (e.g. trespass & security, electrocution etc), and fitness for purpose (e.g. Requirements management and status of V&V).
 - Evidence of the suitability of critical interfaces, by reference to the appropriate railway system ESJs (C610/20/44/50) and their supporting evidence.

3.2.7 Route Control Centre

- 3.2.7.1 The RCC ESJ will be developed to address hazards at End State and at EiTR and this is the building block for the RCC SJ at EiTR. The EiTR hazards have already been recorded and managed through PWHR.

3.2.8 Platform Train Interface

- 3.2.8.1 A PTI SJ will be developed for End State with a Safety Statement to cover EiTR since stations are in SC1 configuration state.
- 3.2.8.2 There will be deltas between the end state and Trial Running. These deltas include some railway systems assets and stations that will not be transferred to the IM.
- 3.2.8.3 The Safety Statement will describe the activities undertaken to review and assess these deltas and confirms that the risks to persons presented by the PTI at Trial Running are acceptable subject to the dependencies being closed.
- 3.2.8.4 Dependencies for End State and EiTR are recorded in Crossrail Safety Justification Dependencies Tracker [CRL1-XRL-O8-LLG-CR001-50032] and dependencies are tracked to closure in accordance with 'Safety Justification Joint Dependency Closure Workshop - Terms Of Reference' [CRL1-XRL-O8-GPS-CR001-50042].

3.2.9 Signalling

- 3.2.9.1 In order to de-risk the programme, the Signalling SJ will be submitted for the baseline configuration of the railway and updated for the configuration required for EiTR.
- 3.2.9.2 The alignment of the Signalling SJ with the train will follow the Train Signalling Assurance Strategy CRL1-XRL-O-STP-CR001-50009.
- 3.2.9.3 Dependencies for End State and EiTR are recorded in Crossrail Safety Justification Dependencies Tracker [CRL1-XRL-O8-LLG-CR001-50032] and dependencies are tracked to closure in accordance with 'Safety Justification Joint Dependency Closure Workshop - Terms Of Reference' [CRL1-XRL-O8-GPS-CR001-50042].
- 3.2.9.4 Transferring the Operational Restrictions (ORs) to the IM/Operator is a dependency in the signalling SJ.
- 3.2.9.5 The transfer of ORs to the IM/Operator is according to the Crossrail Operational Restrictions (OR) Review Process CRL1-XRL-O8-GPS-CR001-50034.

3.2.10 Tunnel Systems

- 3.2.10.1 The Tunnel Systems & Safety (TSS) SJ building blocks are the 11 C610 ESJs ranging from tunnel lighting, through walkway to the tunnel ventilation system.
- 3.2.10.2 The Fire and Evacuation Strategy for Trial Running [C610-XRL-E1-STP-CRG03-50001] will cover any deferred functionality and impact on fire and evacuation hazards.
- 3.2.10.3 Any new hazards related to Tunnel Ventilation System (TVS) deferred functionality will be managed through the Hazard Record for EiTR. Any RCAs to IMs will be transferred through HRP and recorded in the Hazard Record for EiTR.
- 3.2.10.4 The above will be covered in the TSS SJ which will have an appendix for EiTR.

3.2.11 Plumstead Sidings and Maintenance Facility

- 3.2.11.1 As for the above deferred functionality SJs, a HAZID will be undertaken to assess the handover status at EiTR and any interim new hazards identified will be managed through the Hazard Record for EiTR.

3.2.12 NR Great Eastern and Great Western Mainline Interfaces

3.2.12.1 These Safety Justifications will be produced for the baseline configuration of signalling and final configuration of other railway systems. The SJs will be updated for the new configuration of signalling in a similar way to the Signalling SJ.

3.2.13 COS SJ for Entry into Trial Running

3.2.13.1 The COS Operational Railway for SCROGS and Trial Running will be covered by the COS Safety Justification. This will present the overall safety argument for the technical safety of the COS Operational Railway. It will complete the safety argument for interfacing and non-interference between the sub-systems and associated assets that form the COS Operational Railway, building upon the safety arguments from each supporting element/railway chapter SJ.

3.2.13.2 The first iteration of the COS SJ will cover the minimum essential scope and functions needed to enter Trial Running as defined in Ref [CRL1-XRL-07-RSP-CR001-50003]. Further updates of the COS SJ will be made to support safety assurance of significant configuration changes to the COS Operational Railway during Trial Running.

3.2.13.3 The COS SJ is expected to evolve to support entry to Trial Operations and then Stage 3a Revenue Service.

3.2.13.4 The COS SJ for EiTR is an aggregate of all elements SJs, some of which are in their end State configuration and some are not. The COS SJ will demonstrate safe integration of the COS with adjacent railways, the rolling stock, the IMs and the Operator.

3.2.13.5 The COS SJ will demonstrate how the railway level hazards and related safety requirements have been flowed down to the supply chain and CRL. It will provide evidence how these safety requirements are met using the Strategic Engineering Justifications as a basis.

3.2.13.6 The status against compliance with TSI requirements will be given in the COS SJ. Any non-compliances will be risk-assessed but where further work is expected to address the non-compliance, this will become a dependency in the COS SJ for EiTR.

3.2.13.7 The Hazard Record for EiTR together with the status of PWHR at EiTR will be submitted as separate documents with the COS SJ for EiTR.

3.3 Independent Assessment

3.3.1 The AsBo will provide letters of support for systems that have been fully assessed. For those systems for which evidence is submitted later, their assessment and support will be covered in the Safety Assessment Report for EiTR.

3.3.2 The NoBo will continue assessing compliance against TSI requirements and a status of compliance will be provided for EiTR.

3.4 Approvals and Acceptance

3.4.1 The Custom House and Farringdon stations SJs, Railway Systems SJs and the COS SJ for EiTR will all be presented to RAB-C for acceptance.

3.4.2 Shafts and Portals SJs only require approval by RFLI but the status of approval will be reported to RAB-C.

3.4.3 It was agreed with RFLI and RAB-C that SJ acceptance will undergo a two-step process whereby the SJ is first endorsed for the structure of the safety argument with the support of the IM. Then, the SJ is resubmitted with IM comments addressed and dependencies closed or mitigated. London Underground (LU) as the IM of LU stations are aware of this process through RAB-C. This process may apply to LU station Safety Justifications if required.

4 ESM Activities for Readiness against Entry into Trial Operations (EiTO)

4.1 Configuration at Trial Operations

4.1.1 Trial Operations is the configuration state where the Operators carry out operational scenarios, training and familiarisation for running the railway.

4.1.2 Routeway systems which have undergone a Staged Completion for Trial Running will complete a further Staged Completion for additional functionality to meet the required configuration to support Trial Operations. RFLI will continue to be the IM for the Shafts, Portals and Routeway including the Railway Systems assets located within a station, all of which have already been transferred except as noted in the Railway Systems & Non-Traction Power Stage Completion Report, CRL1-XRL-Z-RGN-CRG03-50021.

4.1.3 Most stations will be complete and assured for SC3ROGS in accordance with the requirements of Staged Completion. LU will be the IM for Tottenham Court Road, Farringdon, Liverpool Street and Whitechapel stations but Bond Street will remain with CRL until after Revenue Service has commenced. MTREL/RFLI will be the IM for Paddington, Canary Wharf, Woolwich, Custom House and Abbey Wood stations.

4.1.4 Staged Completion at SC3 ROGS is the process by which assets of the Station Element are brought into operational use (BIU) before complete transfer to the relevant IM and can be carried out when all critical phase 3 integration testing and the complete safety justification and handover report are in place. Evidence for SC3ROGS status is documented in SC3ROGS Stage Completion Report and the BIU Configuration Statement.

4.1.5 There are requirements to support Trial Operations which must be met by those stations which have not been through a Staged Completion or complete transfer. These requirements, described as the SC2 configuration, are applicable to Bond Street (BOS) station and include:

- Designated and protected stairwells for emergency evacuation of a full train and/or for platform access by emergency services
- Systems which support Systemwide Equipment Rooms (e.g. heating and cooling in those rooms)
- Systems which support safety (e.g. fire detection)
- Maintenance arrangements for those systems
- Access arrangements for RFLI, MTREL and the Station Contractor

- Protection measures for all systems supporting the Railway post commencement of Trial Running that allow the Station Contractor to continue with their works.

4.1.6 At SC2 no complete transfer of Station assets will occur. The environment will change as the Station worksite will be next to the operational railway and includes protected operational spaces. The assurance of SC2 is described in the 'SC2 Configuration State Assurance Paper' [CRL1-XRL-O7-RSP-CR001-50005].

4.2 Trial Operations Staged Assurance

4.2.1 Trial Operations has been planned in two phases in recognition of the remaining works to go at EITO for Railway Systems chapters covering:

- Signalling
- Platform Train Interface (PSDs)
- Tunnel Systems & Safety (TVS)
- Communications & Control
- Bond Street (BOS) and Canary Wharf (CAW) Stations.

4.2.2 EITO Part A is Trial Operations Phase 1 in which trial operations are based around the railway infrastructure support for exercises but excluding from scope the mass evacuation exercises with volunteers.

4.2.3 EITO Part B is Trial Operations Phase 2 in which trials are progressed to match the operation expected for the initial Stage 3a Revenue Service (Paddington to Abbey Wood at 12 tph using the expected level of railway infrastructure) and including mass evacuation exercises.

4.2.4 Phased Trial Operations was ratified by the Crossrail Risk Review Panel (CRRP) at a meeting on the 18 October 2021. EITO Part B assurance will reflect the following planned changes:

- Progress of BOS from Stage Completion 1 to Stage Completion 2 readiness
- Completion of CAW to an acceptable SC3ROGS status for its transfer to RFLI.
- Railway Systems updates to support operability and reliability for Signalling, PSD, TVS and Comms & Control for support to EITO Part B for mass evacuation exercises on the routeway.

4.3 ESM Activities for EITO Part A

4.3.1 The ESM activities and Risk Assessment for this phase are described below.

- Establish the System Definition for the Element/System with the deferred functionalities identified. This is described in:
 - Engineering Safety Management System Definition Central Operating Section [CRL1-XRL-08-RGN-CR001-50321] produced for End State and Engineering Safety Management Addendum to System Definition Central Operating Section for Trial Operations [CRL1-XRL-08-LRC-CR001-50577]

- Crossrail Entry into Trial Operations System Description [CRL1-XRL-O8-RGN-CR001-50494] produced for End State and Crossrail Entry into Trial Operations System Description – Deltas Document [CRL1-XRL-O8-RGN-CR001-50568]
- Carry out a safety review to identify risk control actions to mitigate hazards and dependencies related to railway systems and other functionalities being deferred.
- Update the CRL Element/Systems SJs as required
- Dependencies recorded in Crossrail Safety Justification Dependencies Tracker [CRL1-XRL-O8-LLG-CR001-50032] and dependencies are tracked to closure in accordance with 'Safety Justification Joint Dependency Closure Workshop - Terms of Reference' [CRL1-XRL-O8-GPS-CR001-50042].

4.3.2 Shafts & Portals

- Shafts and Portals Safety Justifications that have been produced to support Early Handover and EiTR will be updated for End State to close any residual comments from the previous version of the documents.
- The updates will include the latest status of dependencies.
- The SJ dependencies are recorded in the Crossrail Safety Justification Dependencies Tracker [CRL1-XRL-O8-LLG-CR001-50032]. Dependencies are tracked to closure by the CRL ESM team jointly with RFLI in accordance with 'Safety Justification Joint Dependency Closure Workshop - Terms Of Reference' [CRL1-XRL-O8-GPS-CR001-50042].
- It is recognised that a small number of dependencies may remain open, in agreement with the IM, at the time of submission of the SJs.
- RFLI acceptance of an SJ can be obtained with remaining open SJ dependencies with an agreed route to closure or mitigation through a StEJ decision. In this situation, the dependency closure is formally tracked through the SJ Dependency Master Tracker. The status of the dependency to complete the related safety justification will be reported explicitly in a Risk Statement to support final acceptance the COS SJ EiTO Part A and subsequent DoCoR.
- The Shafts and Portals SJs will undergo the review process described in Section 4.4.
- The Shafts and Portals SJs are not submitted to the Interim Technical Assurance Panel (ITAP) for acceptance as they were deemed low risk elements at Railway Assurance Board – Crossrail (RAB-C), pre ITAP. The acceptance will be through RFLI Heads of Departments.

4.3.3 Railway Systems

4.3.4 The Railway Systems SJs for EiTO Part A fall into three categories:

- Civils, Track, Energy (Traction Power and Non-Traction Power) SJs will reach a complete status with most dependencies closed. EMC and E&B SJs will also be in this category with the main open dependencies related to Bond Street Station.
- The Tunnel Systems & Safety (TSS), Signalling, Train/Signalling Integration, PTI, C&C, RCC (to include Back UP Control Facility, BUCF), Plumstead Sidings and Maintenance Facility (PSMF), GWML/GEML Fringes SJs will reach a more mature stage with potentially some dependencies mitigated for EiTO Part A.
- North Kent Line Interface SJ which is a new SJ.

4.3.5 Each of these categories are detailed below.

4.3.6 Civils, Track, Energy

- The above SJs have been produced for End State with a few dependencies mitigated and two or less Category B/C comments¹ still open at EiTR.
- The effort to update these SJs has been assessed to be low except for Traction Power. The update will address any residual comments from the previous version of the documents and will provide wherever possible evidence to close the dependencies that have been mitigated for EiTR.
- The SJ dependencies are recorded in the Crossrail Safety Justification Dependencies Tracker [CRL1-XRL-08-LLG-CR001-50032]. Dependencies are tracked to closure by the CRL ESM jointly with RFLI in accordance with 'Safety Justification Joint Dependency Closure Workshop - Terms Of Reference' [CRL1-XRL-08-GPS-CR001-50042].
- Where evidence to close the dependencies for End State is not yet available, the dependencies will be mitigated for EiTO with agreement from the IM. The agreement will be reached through the Structured Engineering Judgment (StEJ) Panel in line with the StEJ procedure [CRL1-XRL-07-STP-CR001-50007].
- Where agreement cannot be reached, the decision is escalated to Crossrail Risk Review Panel (CRRP).
- The Civils, Track and Energy SJs will undergo the review process described in Section 4.4.
- The Civils, Track and Energy (Non-Traction Power) SJs will not be re-submitted to General ITAP for acceptance as the new versions are to address the status of dependencies for Trial Ops/Revenue Service. The acceptance will be through RFLI Head of Departments and will follow the acceptance process in Section 4.8.
- The Energy (Traction Power) will be submitted to ITAP for acceptance.

4.3.7 E&B and EMC SJs

- E&B and EMC SJs will follow the same process as the Civils, Track and Energy Non-Traction Power SJs for acceptance. The main dependencies in these SJs are related to Bond Street station.
- The E&B and EMC SJs will undergo the review process described in Section 4.4.
- The E&B and EMC will not be submitted to General ITAP for acceptance. The acceptance will be through RFLI Heads of Departments and will follow the acceptance process in Section 4.8.

4.3.8 Tunnel Systems & Safety, Signalling, PTI, Train signalling Interface, RCC/BUFC, PSMF and GE/GW Interfaces

- The effort required to update these SJs has been assessed to range from medium to high. TSS, PTI, Train-Signalling Interface, PSMF, RCC/BUFC and GE/GW Interface SJs have interfaces with Signalling and any change to the signalling system will be assessed for its impact on these SJs.
- The TSS SJ will be supported by a Safety Statement for the interim TVS configuration with the undertaking that in the period of time between COS EITO and acceptance of TVS functions

¹ RFLI reviews Category comments B and C

| | |
|---|---|
| B | Issue that needs to be considered. The version under review has been accepted with comment. Responses to all comments are required and where necessary the document may need to be revised. |
| C | The version under review has been accepted without comment. If the document is subsequently revised, further review may be required. |

required to support mass evacuation exercises, limits would be applied to the number of people allowed under the fire evacuation arrangements.

- These SJs will undergo the review process described in Section 4.4.
- These SJs will be submitted to General I-TAP for acceptance.

4.3.9 C&C SJ

4.3.10 The C&C SJ will be a new document to cover EiT0 and later EIRS. Any open SJ dependencies at EiT0 Part A will be mitigated through the STEJ panel process.

4.3.11 The approach to deliver safety assurance by the C660 Communications & Control contractor has changed from their initial C660 System Safety Plan. A strategic review of the ESJ delivery has been undertaken. The original intent to provide ESJs on a per-Elementary System basis has been revisited in the C660 Engineering Safety Management Strategic Review Report [CRL1-XRL-R2-LRC-CR001-50004]. The update to C660 ESM Plan [C660-SMN-R3-STP-CR001-50011C660] and a revised approach has been determined as follow:

- Routeway ESJ (including Comms in the tunnel, Shafts and Portals, the RCC/BU CF, and the Plumstead Sidings and Maintenance Facility). This will be delivered as one single iteration for the whole routeway.
- RFLI Stations ESJ. This will be delivered incrementally, station by station. The station-specific addenda may be delivered as separate documents or may be placed immediately in the overarching RFLI Stations ESJ.
- LU Stations ESJ (Integration with LU Station Control Rooms). This will be delivered incrementally, station by station. The station-specific addenda may be delivered as separate documents or may be placed immediately in the overarching LU Stations ESJ.
- NR Interfaces (including Fringes and On-Network Works - NR stations (Phases 4 & 5)). The delivery strategy is being defined.

4.3.12 The Siemens DOO-CCTV scope is limited to the application of Bombardier Transportation (BT) generic design. The station application designs are to the BT's requirements and include RCAs transferred from BT. BT holds the overall design responsibility.

4.3.13 The IHA for interfaces between C&C systems and NR have identified no additional hazards that are not already identified more generally. The ESJ for NR interfaces is therefore to be in a simplified form (position paper), subject to no NR specific hazards being subsequently identified during the balance of the C660 ESM process. The NR interfaces safety justification produced by Siemens is for submission to CRL and is not required to comply with NR safety justification requirements.

4.3.14 The interfaces between C&C systems and LU systems are considered as interfaces arising at LU interchange stations, and the foreseeable hazards associated with the relevant C&C Elementary Systems. Such hazards are included in the Elementary System DESJ and PWHR.

4.3.15 Given the structure of C&C PWRH module, the C&C hazards can only be closed when all DSRs for each location are closed. This can only be achieved for Revenue Service, hence the CRL Element SJs will refer to the C660 ESJs for evidence of closure of DSRs, Hazards and SJ dependencies including EOWL items.

4.3.16 This is a new SJ, it will undergo the review process described in Section 4.4 and will be submitted to ITAP for acceptance

4.3.17 **NKL Interface SJ**

– This is a new SJ, it will undergo the review process described in Section 4.4 and will be submitted to ITAP for acceptance.

4.3.18 **Stations at SC3 ROGS/EiTO/EiRS**

- Stations will achieve SC3ROGS in the period between EiTR and EiTO.
- The station SJs will be produced for SC3ROGS/Revenue Service. The open dependencies for Revenue Service will be mitigated for SC3ROGS. Where required, the SJs will be updated for EiTO/EiRS.
- These SJs will undergo the review process described in Section 4.4.
- The SJs for SC3ROGS will be submitted to Stations ITAP for acceptance. Should the update for EiTO/EiRS address only the status of dependencies then the updated SJ will not be re- submitted to Stations ITAP. They will be subject to the process described in Section 4.8.

4.3.19 **ABW, CAW and BOS Stations**

4.3.20 Unlike other stations, the approach for ABW, CAW and BOS stations safety assurance is somewhat different to the approach for stations described in the main ESM Plan. The differences are explained below.

4.3.21 **ABW Station**

- In the case of On Network Works together with those works undertaken for CRL between Plumstead Portal and Abbey Wood, NR as the Project Entity is responsible for the determination of how CSM is complied with.
- For the NR provided station buildings the above is addressed by evidence prepared by NR and independently assessed for NR. For NR provided track and traction assets NR evidence supports the CRL SJs for track and traction power.
- Unlike other COS stations, an integrated CRL safety justification for the whole station (paragraph 4.7.2 and 4.7.3 of the main System Safety Plan refer) has not been required, because the Abbey Wood station building elements are handed over by the NR Project directly to the IM, in accordance with NR processes, and the review and acceptance of the safety evidence to support that handover has already been completed.
- Instead an 'Addition of CRL assets to the existing Elizabeth line platforms and buildings at Abbey Wood station Integration Safety Justification' will be produced.

4.3.22 **CAW Station**

- With no Tier 1 contractor, there is no ESJ for CAW. All safety assurance will be made through the CRL CAW SJ.

- The Historical Evidence Assurance Team (HEAT) process has underwritten assurance evidence received by CRL from CWG under the T142 contract arrangement. Gaps in expected assurance to support the CRL approach to station assurance, including for safety assurance, were identified and risk assessed jointly by CRL Chief Engineer Group and RFLI Asset Engineers. Remaining evidence gaps are to be addressed through evidence from the C239 works and C236 Engine maintenance contracts. The baseline of the HEAT process findings was underwritten in the HEAT Stage 5B paper [C100-ATK-X-ASM-CR143-50001] as accepted through a specific StEJ panel review.
- Because of some outstanding works, CAW station is in SC1 configuration at EiTO Part A. Existing SC1 safety assurance produced for EiTR applies.

4.3.23 BOS Station

- Because of some outstanding works, BOS station is in SC1 configuration at EiTO Part A. Existing SC1 safety assurance produced for EiTR applies.

4.4 ESM Activities for EiTO Part B

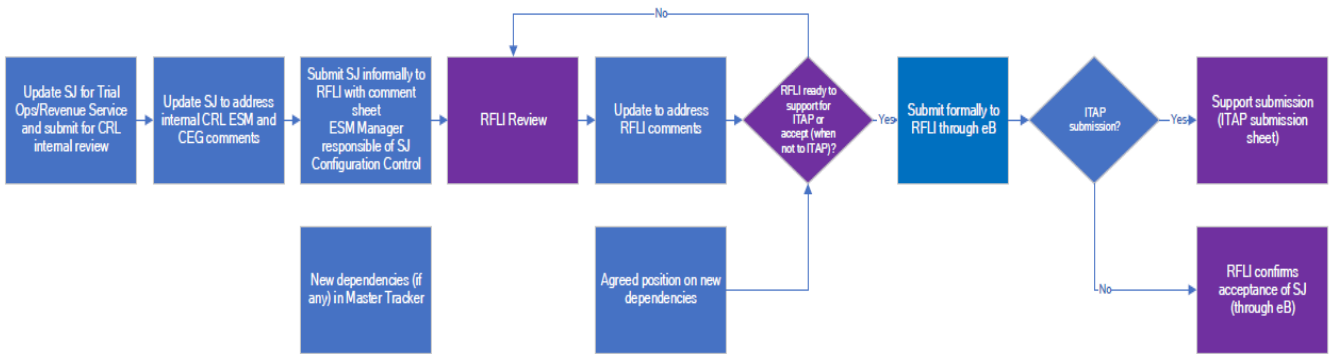
- 4.4.1 Establish the System Definition by reviewing/updating as required the documents listed in Section 4.3.1.
- 4.4.2 Expected SJ updates for EiTO Part B to address outstanding work are: TSS, PTI, Signalling, C&C, RCC, CAW and BOS SC2.
- 4.4.3 TSS and PTI SJs are supported by Safety Statements that give details of the status of dependencies to reflect the outcome of the December 2021 blockade.
- 4.4.4 The Safety Argument for ELR110, the signalling configuration for Revenue Service, will be covered by the Signalling ESJ addendum and the CRL Signalling Stage Completion Report addendum.
- 4.4.5 SJs may not need to be updated for Part B if the structure of the safety argument for Revenue Service is agreed by all stakeholders. The request for acceptance will be only through the status of dependencies revisited with the SJ acceptance status for EiTO Part B (See Proforma approach described in section 4.8.10).
- 4.4.6 CAW station SJ will be produced to finalise SC3ROGS for transfer to the IM and Bringing into Use (BIU) for EiTO Part A and Part B.

4.4.7 The only station expected to be in SC2 configuration at Revenue Service is Bond Street. Following the change of Tier1 contractor, CRL Delivery took the role of Tier 1 Contractor for assurance purposes and will produce the ESJ for SC2 in accordance with 'SC2 Configuration State Evidence Paper' [CRL1-XRL-07-RSP-CR001-50005]. The assurance evidence documentation provided by the Bond St Delivery Team will be reviewed and approved by the Chief Engineer or representative and the relevant IMs to confirm that all the requirements have been met. Part of this assurance evidence is the SC2 hazard management, including hazard identification and identification of risk control actions to mitigate the hazards. The SC2 hazard identification activity is carried out to identify any new hazards associated with the integrated SC2 configuration for Trial Operations and Revenue Service and related risk control actions to close or mitigate these hazards. Hazards are recorded in a Hazard Log 'SC2 Hazard Log' and will be managed to closure by the CRL ESM team with input from the Chief Engineers Group and the IMs (RFLI/LU/MTREL). A Bond Street Station Safety Justification for SC2 will be produced and submitted to Stations ITAP for acceptance. It is possible that the SC2 configuration for EiTO will be different from EiRS because some systems may be temporary.

4.5 SJ Review Process

- 4.5.1 To streamline the SJ review/acceptance process, the following has been agreed with IMs.
- 4.5.2 Existing SJs will be updated and submitted informally to the IM for review. They will only be formally submitted to the IM via document control once full support is obtained for acceptance.
- 4.5.3 New SJs e.g., Stations and NKL Interface SJ are submitted formally at Rev 1, such that the baseline comments can be formally recorded as an auditable trail for both RFLI and CRL evidence of configuration control of the comments. The RFLI comment sheet will be issued as normal via document control and then the 'off-line' review workstream will commence to Rev 2 which will become the accepted version that will be submitted to I-TAP for acceptance. should RFLI acceptance not be given in a timely manner, CRL will submit a signed Rev 2 SJ for consideration by the ITAP with the aim of reaching acceptance pending Chair's action against IM agreement for final support of the SJ.
- 4.5.4 ITAP acceptance of an SJ can be obtained with remaining open SJ dependencies with an agreed route to closure or mitigation through a StEJ decision. In this situation, the dependency closure is formally tracked through the SJ Dependency Master Tracker. The status of the dependency to complete the related safety justification will be reported explicitly in a Risk Statement to support final acceptance the COS SJ and subsequent DoCoR.
- 4.5.5 The SJ review process is illustrated in Figure 3.

Existing Safety Justifications



New Safety Justifications

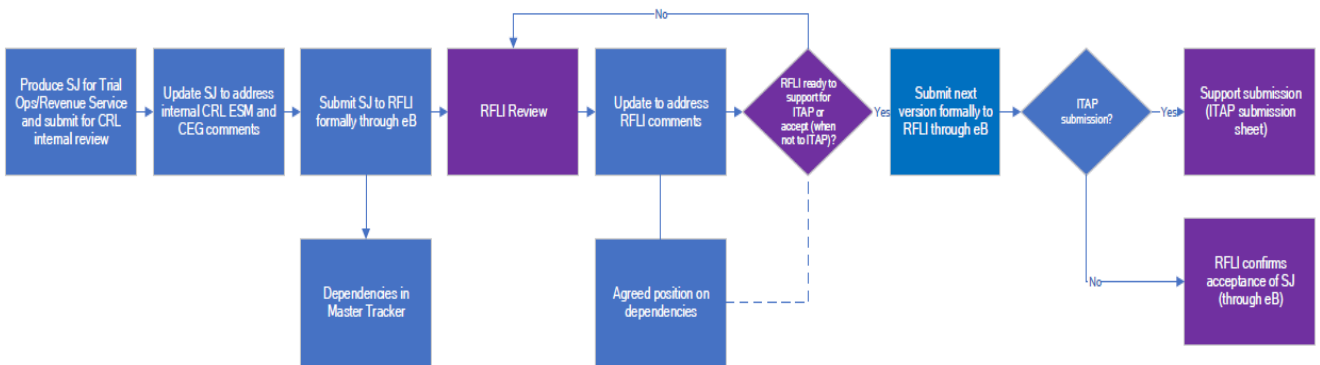


Figure 3: Streamlined Review Process (blue boxes: CRL, purple boxes: RFLI)

4.6 Hazard Records

- 4.6.1 System hazards identified during Trial Running and Trial Operations that will impact the operational railway and any associated risk control actions (RCAs) on the IMs/Operator will be recorded in PWHR. PWHR is a record of End State hazards.
- 4.6.2 Should there be hazards and associated RCAs only applicable to Trial Operations then these will be recorded in the EiTO Hazard Record. This applies to Part A and Part B.
- 4.6.3 In all cases, the RCAs will be presented to the IMs for acceptance through the Hazard Review Panel (HRP) process.
- 4.6.4 It is possible that a few RCAs, DSRs or Hazards will involve deferred works to be completed by others post revenue service. The following arrangements describe the approach for deferred work post revenue service.

- 4.6.5 If the outstanding works are related to a DSR, RCA or Hazard under a specific contract, then transfer of the works to others is through HRP or Scope Allocation Surgery (SAS) process; see SAS Terms of Reference [CRL1-XRL-Z6-STP-CR001-50010] and SAS procedure [CRL1-XRL-V3-GPS-CR001-50002]. In this case, the DSR, RCA, or Hazard are transferred from the specific contract in PWHR to the new Alternative Delivery Method (ADM) module in PWHR. This will permit the stakeholders to have all the hazards associated with deferred work from different contracts in the same place for continuity of hazard management against these planned works going forward. Any DSR, RCA or Hazard transferred to ADM has to be shown mitigated for Revenue Service with agreement of the IMs.
- 4.6.6 If the outstanding works are related to an observation or non-compliance, and their incompleteness lead to a safety issue, then a hazard needs to be raised, added to the new ADM module in PWHR and transferred to IMs through HRP/SAS.
- 4.6.7 If the works are additional scope requested by IMs, then these should be subject to IM assurance processes and will be managed by them.
- 4.6.8 Suitable ESM is to be applied to any change and reflected in the assurance provided by the entity completing the related ADM works. That evidence is then referenced in PWHR ADM module for the closure of the related hazard.
- 4.6.9 The management of ADM hazards is detailed in the ADM Hazard Management Procedure [CRL1-XRL-O8-GPD-CR001-50013].

4.7 Independent Assessment

- 4.7.1 The Assessment Body (AsBo) will continue to assess departures from CRL SSP, if any, and closing any open dependencies from their Safety Assessment Reports (SARs).
- 4.7.2 SARs produced for EiTR which are largely applicable to Revenue Service only need updating to close open Assumptions, Dependencies and Caveats (ADCs).
- 4.7.3 SAR7 will be produced to cover stations.
- 4.7.4 Table 2 lists the SARs produced by the AsBo.

| SAR | Title | Contents |
|-------|--|--|
| SAR 0 | SAR Binder | <ul style="list-style-type: none"> • Sets out the structure of the SAR Parts • Provides the introduction, background and scope of the CRL Project. • Provides the list of SAR Parts and their references. |
| SAR 1 | Overview, Planning, System Definition | <ul style="list-style-type: none"> • Overall AsBo scope for Crossrail • Overview of AsBo team and assessment approach |
| SAR 2 | Compliance Management System (CMS) | <ul style="list-style-type: none"> • Corporate safety management responsibilities • CRL System Definition • Hazard Record management • Safety Requirements management and verification • CRL's own process of independent scrutiny and approval through the Rail Approval Board - Crossrail (RAB-C) |
| SAR 3 | Projectwide Integrated and Conclusions | <ul style="list-style-type: none"> • Railway-level hazard identification and safety requirements • Strategic Engineering Safety Justifications • Central Operating Section Safety Justification • Overall projectwide conclusions from the Assessment Body |
| SAR 4 | Infrastructure | <ul style="list-style-type: none"> • Civils |

| SAR | Title | Contents |
|-------|--------------------------------|---|
| | | <ul style="list-style-type: none"> • Shafts and Portals • Platform screen doors • Tunnel ventilation • Tunnel mechanical and lighting systems • Track |
| SAR 5 | Energy | <ul style="list-style-type: none"> • Substations and interface to National Grid Traction power distribution (25kV) • Overhead line equipment (25kV OHLE) • Non-traction power distribution (22kV and 11kV) • Signalling 650v supplies • Supervisory control and data acquisition (SCADA) control and monitoring interfaces |
| SAR 6 | Signalling and Comms | <ul style="list-style-type: none"> • Communications-based train control (CBTC) signalling • Route Control Centre • General network and radio communications • SCADA • Yellow plant |
| SAR 7 | Stations | <ul style="list-style-type: none"> • LU Stations (Main Body and Chapter for each station) • RFLI stations (Chapter for each station except for ABW which will be contained in the Main Body SAR for RFLI Stations) |
| SAR 8 | Interfaces (with Network Rail) | <ul style="list-style-type: none"> • Great Eastern Mainline (GEML) • Great Western Mainline (GWML) • North Kent Line (NKL) |
| SAR 9 | GSM-R | <ul style="list-style-type: none"> • Global System for Mobile communications for Railway Applications (GSM-R) system installed across the Crossrail Central Operating System (COS). |

Table 2 AsBo SARs

4.7.5 The SARs will support the Technical Files produced by CRL which will be submitted to the ORR to gain authorisation to place into service (APIS) for the Central Operating Section under the Railway Interoperability Regulations. Fig. illustrates the input from SJs and SAR to the authorisation under Interoperability.

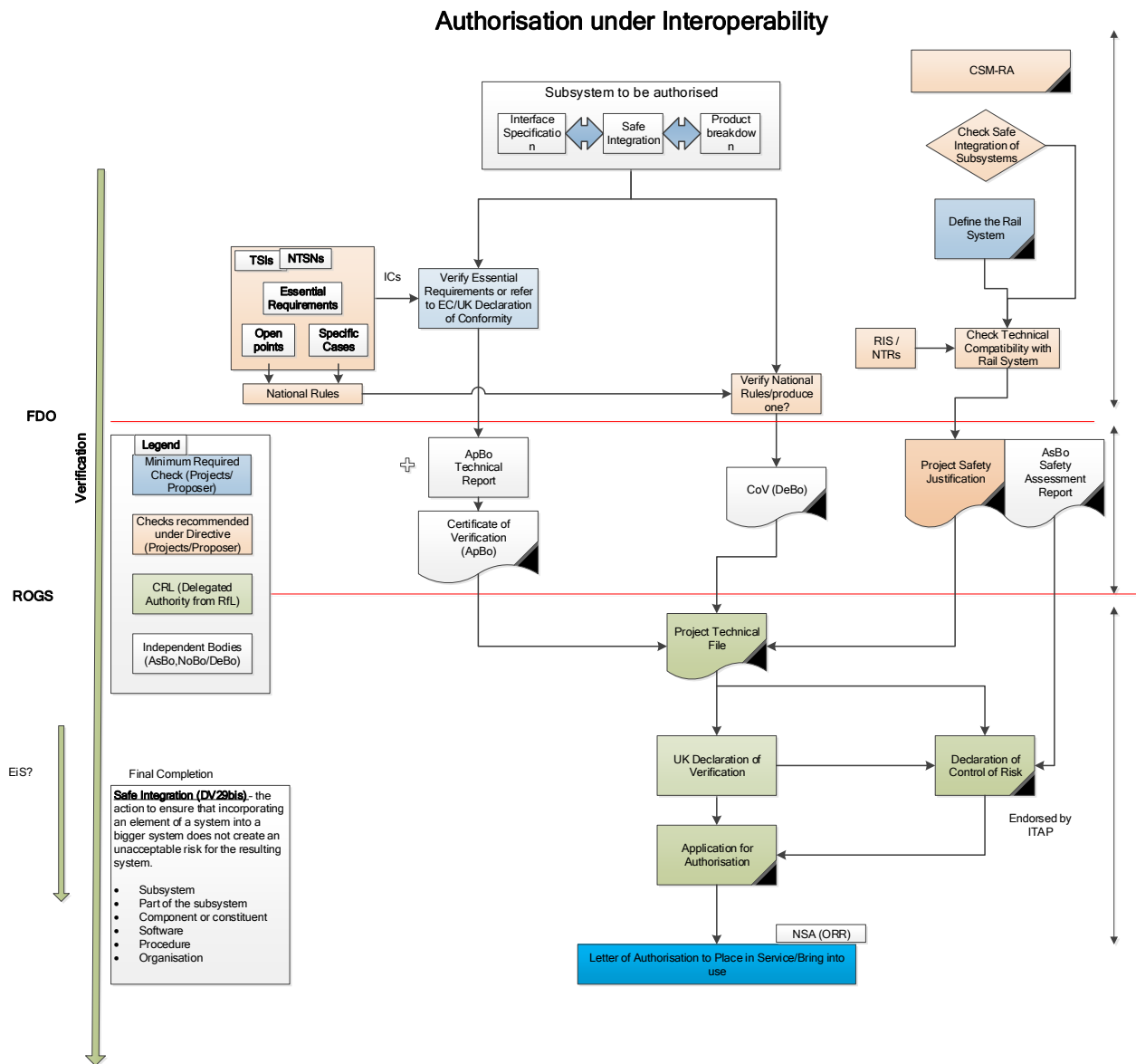


Figure 4: SJ and AsBo SAR Contribution to Authorisation under Interoperability

4.8 SJ Acceptance

4.8.1 RFLI manages change through the Change Assurance Framework (CAF). The CAF established the Change Assurance Panel (CAP) as the body to formally accept change to RFLI Managed Infrastructure.

4.8.2 For CAP to discharge this responsibility during the time that CRL continues to make changes to the routeway and stations on the RFLI Managed Infrastructure and RFLI and LU stations, CAP has established Interim Technical Assurance Panels (ITAP).

- 4.8.3 ITAP assesses the impact of change on both RFLI and other affected parties. As well as impacting physical assets the changes may result in changes to operational practices and processes which may impact a significant number of operations and maintenance staff.
- 4.8.4 There are three Interim Technical Assurance Panels which have been established in the lead up to the start of Trial Running and which remain in existence through Trial Running and Trial Operations into Passenger Service:
- Railway Systems ITAP
 - Stations ITAP
 - General ITAP
- 4.8.5 The Railway Systems ITAP's scope covers the routeway and everything that is not a station and includes all railway systems configuration changes including software.
- 4.8.6 The Stations ITAP scope covers all stations with the purpose of bringing each station into use and includes the acceptance of station Safety Justifications. As several stations are the responsibility of London Underground, LU are a member of ITAP.
- 4.8.7 The General ITAP's scope is to continue the role of RAB(C) assuring the end-state railway for entry into Trial Operations and makes recommendation to CAP on the suitability of assurance evidence for entry into Trial Operations. In particular, the General ITAP reviews and accepts updated:
- a) System Safety Justifications
 - b) COS Safety Justification
 - c) The Rolling Stock Consent to Operate
 - d) Evidence of RFLI readiness
 - e) The Crossrail Engineering and Safety Assurance Case (CESAC)
 - f) Risk Statement and Declaration of Control of Risk
- 4.8.8 All SJs submitted to ITAP require support from the IMs for their final acceptance.
- 4.8.9 Most SJs are written to support EiRS, with dependencies raised for incomplete supporting evidence. The risks associated with SJ dependencies will be considered against the risk profile for EiRS. If a dependency can be closed/mitigated for EiRS before EiTO, that is acceptable for EiTO as well. If the SJ dependency cannot be closed/mitigated against EiRS in that time frame, then mitigations are identified, with additional specific risk controls. In this situation, the SJ dependency will be mitigated for EiTO only and therefore RFLI/ITAP acceptance of the related safety justification can be for EiTO only, as not yet able to cover EiRS acceptance status. However, the SJ may not need to be updated, only the status of dependencies revisited with the SJ acceptance status for EiRS requested through the proforma approach described below.

4.8.10 Should the updated SJs address only the status of dependencies then the updated SJs will not be re-submitted to ITAP for review. In that case, a 'Safety Justification Status Update for Entry into Trial Operations/Revenue Service' shall be submitted to ITAP instead. The 'Safety Justification Status Update for Entry into Trial Operations/Revenue Service' shall be produced using the proforma [CRL1-XRL-O8-ZFM-CR001-50041], found in Appendix A of this plan. It shall be completed by the relevant CRL ESM Manager, reviewed by CRL System Safety Lead or Head of Assurance and approved by the Chief Engineer or representative. Each completed proforma will cover the following:

- Position of the dependencies since the previously accepted SJ, including those that have been closed by the SJJDCW and those that have been mitigated through the STEJ process
- Support by RFLI Heads of Department/LU of the updated SJ for EiTO/EiRS (as applicable)
- Statement that it seeks acceptance for EiTO/EiRS.

4.9 Configuration Control

4.9.1 Acceptance of the changes to the configuration of the railway handed to the IM at SCROGS is covered by the RFLI process described in the ITAP Terms of Reference [RFLI-GEN-HS-PRO-0037].

4.9.2 The System Design Authority has been delegated from the RFLI Head of Engineering to the CRL Chief Engineer. Hence, design changes will undergo the CRL assurance processes in line with the CRL Technical Assurance Plan [CRL1-XRL-O7-STP-CR001-50003] and will be reviewed by the IM.

4.9.3 These changes include:

- Changes to systems / equipment that have an impact on Trial Operations and then revenue service or on the function of interfacing systems that support or participate in Trial Operations e.g., signalling system updates, communication and control Crossrail Data Network updates, changes to Tunnel Ventilation System that affects mode tables etc.
- Changes from Temporary systems to End-state Systems.
- Temporary, Over & Back, changes to the configuration to support the verification and assurance of a proposed permanent change.

4.9.4 The CRL ESM team in these cases will assist with risk assessments where required and provide a safety statement in the Element/Railway System Staged Completion Report (SCR). Note that for EiRS 3a, CAW will be at SC3ROGS SCR and BOS station to reach SC3ROGS SCR in support of Stage 3R.

4.9.5 The configuration for Revenue Service will be detailed in the final version of the Element/Railway System SJ and the Element Completion and Handover Report (ECHR).

Appendix A SJ Proforma for SJs not Requiring Review by ITAP

Template: CRL1-XRL-08-ZFM-CR001-50041

SJ Safety Justification Status Update for Entry into *Trial Operations/Revenue Service*

Doc number: CRL1-XRL-08-RGN-CR001-50xxx Issue x.0.

(Document to be linked to applicable SJ in eB)

DD/MM/YYYY

| <i>Rev</i> | <i>Date</i> | <i>Author</i> | <i>Reviewed by</i> | <i>Approved by</i> |
|------------|-------------|---------------|--------------------|--------------------|
| | | | | |
| | | | | |

1. Purpose

The purpose of this document is to:

- Provide the updated status of *SJ* Safety Justification (SJ) *Document number, rev number Y* that has been previously accepted by Rail Assurance Board – Crossrail (RAB-C) for Trial Running *Certificate number, dated dd/mm/yyyy*.
- Seek acceptance by RFLI Interim Technical Assurance Panel (I-TAP) of *rev Z* Safety Justification for *Entry into Trial Operation (EiTO)/Revenue Service (RS) (as applicable)* without the SJ undergoing a full review by I-TAP (as agreed at ITAP meeting dated xxx and explained by ESM Plan ref xxx).

2. Safety Justification Status Update for *EiTO/RS*

2.1 Current Status of SJ

Since *rev Y* of the SJ, *x out of y* dependencies have been closed through the Safety Justification Joint Dependency Closure Workshops (SJJDCW) [Ref X]. Table 1 gives the update on dependency closure.

Add here extract of Dependencies tracker showing the dependencies that have been closed and the evidence to close them (see example in Table 1).

| Dependency reference | Element | Sub-Element | Description | Status | Dependency Closed Actual | Proposal for Closure |
|----------------------|-----------------|--|-----------------------------------|------------|--------------------------|---|
| CIV3 | 1 - Routeway | Central Operating Section Civil Works | Canary Wharf Station VAR | 4 - Closed | 05-Mar-21 | The Civils and Structures chapter of the CAW HEAT report C100-ATK-C-ASM-CR143-50014 is at Code 1. [RP 26/2/21] |
| CIV4 | 1 - Routeway | Central Operating Section Civil Works | Silvertown foot bridge VAR report | 4 - Closed | 02-Dec-20 | Silvertown foot bridge VAR report CRL1-XRL-O-RGN-CR146-50002 produced and signed off and on eB. The required information on design, concessions and completion to support the SJ is |

| Dependency reference | Element | Sub-Element | Description | Status | Dependency Closed Actual | Proposal for Closure |
|----------------------|--------------|---------------------------------------|---|------------|--------------------------|--|
| | | | | | | referenced and complete. |
| CIV5 | 1 - Routeway | Central Operating Section Civil Works | Plumstead Maintenance Facility VAR report and outstanding construction certificates | 4 - Closed | 10-Feb-21 | RP: 2/2/21 Proposed for closure, as certificates C695-ATC-O-CER-CR526-50023, 50039 and 50041 are now approved. |

Table 3: Dependencies Tracker extract for this SJ

Where full evidence was not available to close a dependency, *q out of y* dependencies have undergone Structured Engineering Judgment (StEJ) for *EiTO/EiRS (as applicable)*, see Table 2 below. The StEJ Panel has agreed the route to closure with given timescales or a mitigation for EiTO/EiRS.

Note: Where the timescales for closing a dependency extends beyond the date of this statement, then the dependency will be tracked to closure in the Risk Statement for EiTO.

Add here extract from the Dependencies Tracker showing the dependencies that have been submitted to the Structured Engineering Judgment Panel to agree either the route to closure or the mitigation for a given milestone (see example in Table 2).

| Dependency reference | Element | Sub-Element | Description | Current Project Position | Status | Formal Comments from Closure Meeting | Dependency Closed Forecast |
|----------------------|--------------|---------------------------------------|--|---|-------------------------|---|----------------------------|
| CIV9 | 1 - Routeway | Central Operating Section Civil Works | Bond Street Station Main Works sub- construction certificates | Listed in [19] with their acceptance status - not all are Code 1. Asked BOS PDE on 23/3/20 | 6 - TR Mitigated / StEJ | This dependency has been mitigated by StEJ Panel, indicating it isn't required for TR. Therefore, closure is not needed for TR. <i>Include here StEJ Form(s)/minutes relevant to this dependency for agreed route to closure or mitigation</i> | |
| CIV12 | 1 - Routeway | Central Operating Section Civil Works | Compound works are still to be completed Construction completion certificate for East and West Compounds (not for EiTR) | Compound works and is being carried out by C610 Scope of the Whole Contract Construction Certificate C315-VIN-O4-LST-CR146_ST003-50045 rev 1 does not include the compounds | 1 - Open | <i>Refer here to StEJ Form(s)/minutes relevant to this dependency for agreed route to closure or mitigation</i> | 12-Nov-21 |
| CIV25 | 1 - Routeway | Central Operating Section Civil Works | Provision of asset data for the Southeast Spur, specifically the information CRL are producing to assign labelling to describe the assets being delivered on the South East Spur, so that these can be uploaded into RFLI's Maximo system. This dependency is tracked in the Civils ECHR and also by the Trial Running Mobilisation Board (TRMB) through an action on ATC to survey South East Spur Asset Data | Currently CRL are at 70% of Drop 1 and 2. CRL aims to provide Drop 3 to RFLI before the commencement of Trial Running. | 1 - Open | <i>Refer here StEJ Form(s)/minutes relevant to this dependency for agreed route to closure or mitigation</i> | 15-Oct-21 |

Table 4: Dependencies Mitigated for EiTO/EiTR through STEJ Panel

Furthermore, *Rev Z* has been reviewed by RFLI Asset Engineers, RFLI Safety Team and has been accepted by RFLI Heads of Department.

2.2 ITAP Acceptance for EiTO/RS

Based on the above, CRL seeks acceptance of this *SJ* for *EiTO/EiRS (as applicable)*.