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# TECHNICAL ASSURANCE

## Technical Assurance Plan (TAP)

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## Contents

<b>1 Purpose and Scope</b> .....	<b>5</b>
1.1 Purpose .....	5
1.2 Scope .....	5
1.3 Ownership.....	5
<b>2 Definitions and Abbreviations</b> .....	<b>6</b>
<b>3 Technical Assurance Delivery Responsibilities</b> .....	<b>7</b>
<b>4 Roles and Responsibilities</b> .....	<b>10</b>
4.1 Crossrail Limited .....	10
4.2 RfL, NR and LU Roles and Responsibilities .....	10
4.3 Transport Undertaking (TU) Roles and Responsibilities .....	10
<b>5 CRL Assurance Approach - Principles</b> .....	<b>11</b>
<b>6 CRL Assurance Alignment to Operators Assurance</b> .....	<b>12</b>
6.1 Overarching obligations .....	12
6.2 LU Assurance .....	12
6.3 RfL Assurance .....	12
6.4 NR Interface Assurance .....	12
6.5 MTR[C] Assurance .....	12
6.6 Rolling Stock and Depot Assurance .....	13
<b>7 Technical Authority</b> .....	<b>13</b>
<b>8 Building Control</b> .....	<b>14</b>
<b>9 Crossrail Assurance Reporting Environment</b> .....	<b>14</b>
<b>10 Assurance throughout Crossrail Programme lifecycle</b> .....	<b>15</b>
10.1 Requirements Management.....	15
10.2 Verification and Validation Management .....	15
10.3 Verification Activity Plans.....	15
10.4 CRL Competency Assessment.....	15
10.5 Electro-Magnetic Compatibility (EMC).....	16
10.6 Engineering Safety Management (ESM) Process.....	16
10.7 Human Factors .....	16
10.8 Process for Escalation .....	16
<b>11 Design Assurance</b> .....	<b>17</b>
11.1 Design Management.....	17
11.2 Design Review and Acceptance Process .....	17
11.3 Engineering Gates Process .....	17
11.4 The Design Certification Procedure.....	18
11.5 Issue of Design Documentation for Construction.....	18

11.6	Design Interfaces.....	18
11.7	Reliability, Availability, Maintainability (RAM).....	18
11.8	Progressive Design Assurance.....	18
<b>12</b>	<b>Construction Assurance .....</b>	<b>19</b>
12.1	Construction Quality Management.....	19
12.2	Materials Compliance.....	19
12.3	Construction Certification .....	19
12.4	Monitoring and Surveillance.....	20
12.5	Project Technical Request.....	20
12.6	Snagging & Outstanding Works.....	20
12.7	Completion & Control of the Works .....	20
12.8	Employer’s Completion Process.....	20
12.9	London Underground Interface.....	20
12.10	Network Rail Interface.....	21
<b>13</b>	<b>Post Design Readiness Gates .....</b>	<b>21</b>
<b>14</b>	<b>Testing and Commissioning Assurance.....</b>	<b>21</b>
14.1	Testing and Commissioning Strategy.....	21
14.2	Testing and Commissioning Plan .....	22
14.3	Testing and Commissioning Certification .....	22
14.4	Dynamic Testing.....	22
<b>15</b>	<b>Handover .....</b>	<b>22</b>
15.1	Element Completion Handover Report (ECHR).....	22
15.2	Element Completion Handover Certificate (EHC).....	23
15.3	Safety Assurance and Authorisation .....	23
15.4	Railway Assurance Board [Crossrail].....	23
<b>16</b>	<b>Trial Running.....</b>	<b>24</b>
<b>17</b>	<b>Trial Operations .....</b>	<b>24</b>
<b>18</b>	<b>TAP Reference Table .....</b>	<b>25</b>
<b>19</b>	<b>Reference Documents.....</b>	<b>27</b>
<b>20</b>	<b>Standard Forms / Templates.....</b>	<b>28</b>
	<b>Appendix A- CRL Alignment to LU Assurance Standard S1538.....</b>	<b>29</b>
	<b>Appendix B- Crossrail Progressive Assurance &amp; Integration Model .....</b>	<b>31</b>
	<b>Appendix C- Assurance V Life-Cycle .....</b>	<b>32</b>
	<b>Appendix D- Assurance Overview Stages .....</b>	<b>33</b>
	<b>Appendix E- CRL Project Lifecycle – Key Assurance Processes.....</b>	<b>34</b>
	<b>Appendix F- CRL Project – Assurance Process Flow to Handover.....</b>	<b>35</b>

# 1 Purpose and Scope

## 1.1 Purpose

The purpose of the Technical Assurance Plan (TAP) is to support the requirements of the CRL Delivery Strategy [2] and Programme Assurance Strategy [3]. It clarifies the role of CRL, and the processes it will use, to progressively deliver the technical assurance evidence to the Infrastructure Managers (IMs) that will support acceptance by demonstrating that a safe, operable, maintainable, railway - that achieves the required levels of performance and capacity - has been delivered.

## 1.2 Scope

This document applies across the whole of the Crossrail Project, including its end-to-end interfaces, from Reading in Berkshire and from Heathrow in the London Borough of Hillingdon through central London through to Shenfield in the County of Essex, and Abbey Wood in the London Borough of Greenwich in accordance with the Sponsors requirement, until such time as the Infrastructure Managers and the Crossrail Train Operating Company (CTOC) obtain Safety Certification for the necessary authorisations for passenger service on the Crossrail route.

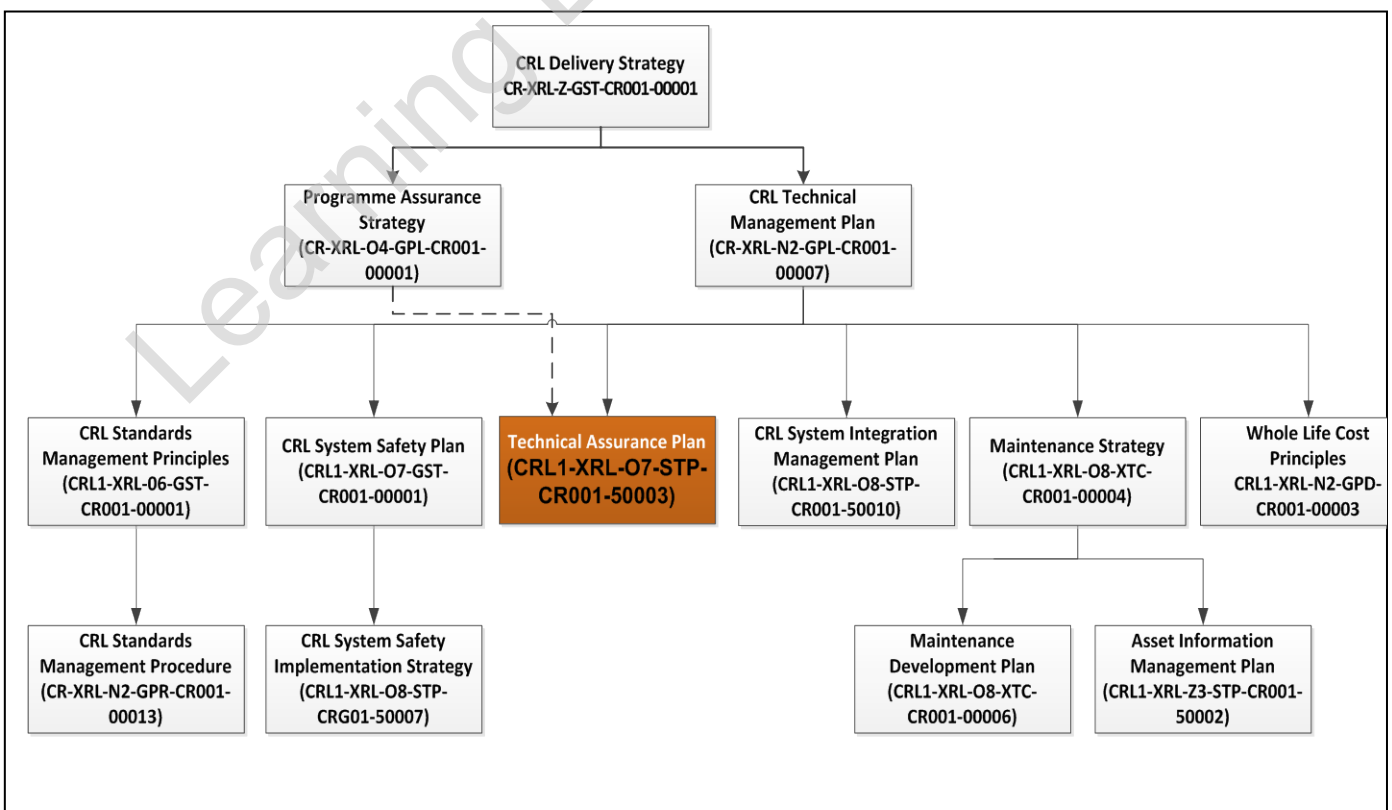
It applies to all areas of Crossrail that deliver, receive, co-ordinate and interface with Technical Assurance; including Industry Partners (including LUL, RfL, NR, Canary Wharf Group, Berkeley Homes, and CTOC), CRL (including Contractors) and the Rolling Stock and Depot Contractor (RSD).

This document excludes works undertaken for, and by, Docklands Light Railway (DLR) and the also that relating to Over-Site Developments (OSD) as these entities will apply their own assurance regimes and comply with building regulations respectively. For the avoidance of doubt, the interfacing of these works with the Crossrail infrastructure sits within the scope of this document.

## 1.3 Ownership

The overall Technical Authority (see Section 7) for the Crossrail Central Section works lies with the Crossrail Chief Engineer, who is responsible for this plan.

**Figure 1 - Relationship to other Crossrail technical and assurance documents**



## 2 Definitions and Abbreviations

CARE	Crossrail Assurance Reporting Environment
CPFR	Crossrail Programme Functional Requirements
CRL	Crossrail Limited
CWG	Canary Wharf Group
CSW	Central Section Works
DOORS	Dynamic Object Oriented Requirements System
ECHR	Element Completion and Handover Report
Element	Elements are as per the definitions in the Handover Strategy
EMC	Electromagnetic Compatibility
FDC	Framework Design Consultant
FDS	Final Design Submission
FDO	Final Design Overview
LU	London Underground (Limited)
ICD	Interface Control Document
IDO	Interim Design Overview
IM	Infrastructure Manager
IRS	Interface Requirements Specification
ITT	Invitation to Tender
M&E	Mechanical and Electrical
MIRP	Maintenance Integration Review Panel
NNTR	Notified National Technical Rule
NR	Network Rail
ONFR	On Network Functional Requirements
RAM	Reliability, Availability, Maintainability
RfL	Rail for London
RSD	Rolling Stock and Depot
SIRP	Systems Integration Review Panel
T&C	Test and Commissioning
TSI	Technical Specification for Interoperability

### 3 Technical Assurance Delivery Responsibilities

Crossrail (CRL) is accountable for delivering the Crossrail Project and holds Technical Authority for the purposes of discharging its obligations under the Project Development Agreement (PDA). It is CRL's responsibility to demonstrate that the end-to-end Crossrail railway system is safe, operable, maintainable, and will deliver the required capability and performance.

The Crossrail Delivery Strategy [2] sets out how this will be achieved through the organisations and parties engaged in the delivery of the programme, including industry Partners, contractors and stakeholders. Each Industry Partner will produce assured designs, and deliver assets compliant with the Crossrail requirements, in line with their own assurance plans.

Table 1 below clarifies scope of delivery and associated responsibilities for the delivery of Technical Assurance by Crossrail and its Industry Partners. Figure 1 illustrates CRL's responsibility as systems integrator across the end-to-end Crossrail railway.

**Table 2 - Technical Assurance Delivery Responsibilities**

<b>Organisation</b>	<b>Technical Assurance Delivery Responsibilities</b>
CRL	<p>CRL is accountable for the overall delivery, programme management, design, construction, testing, handover, trial running and completion of the Crossrail Programme.</p> <p>CRL is responsible for delivering an integrated and assured Central Section Railway (1) including end-to-end interface works with Network Rail and all other relevant works.</p> <p>CRL is also responsible for integrating all the assurance evidence of the end to end railway in order to demonstrate that all works delivered by both CRL and its Industry Partners are fully integrated and the performance will meet the Sponsors' requirements and support acceptance by the relevant Operators (2).</p>
Canary Wharf Group:	<p>Canary Wharf Group (CWG) is an Industry Partner responsible for delivering the Canary Wharf Station structure with pre-defined "station MEP systems" which include finishes, escalators (with fire detection), ventilation, heating and lighting but not the systemwide elements (including the Station Operations Room) and connections to the Route Control Centre. CWG is responsible for demonstrating their assurance evidence meets the relevant project requirements. CRL is responsible for providing all other assurance evidence required for Handover.</p>
Berkeley Homes:	<p>Berkeley Homes (BH) is an Industry Partner responsible for delivering the Woolwich Station structure. BH has a dedicated Technical Assurance Plan for these works against which the works will be delivered. BH is responsible for demonstrating their associated assurance evidence to Crossrail. CRL will provide all other evidence required for Handover.</p>
London Underground (Interface Works):	<p>London Underground is responsible for delivering specific interface works (e.g. station upgrades at Bond Street and Tottenham Court Road Stations). Assurance will be demonstrated through LU Standard S1538</p>

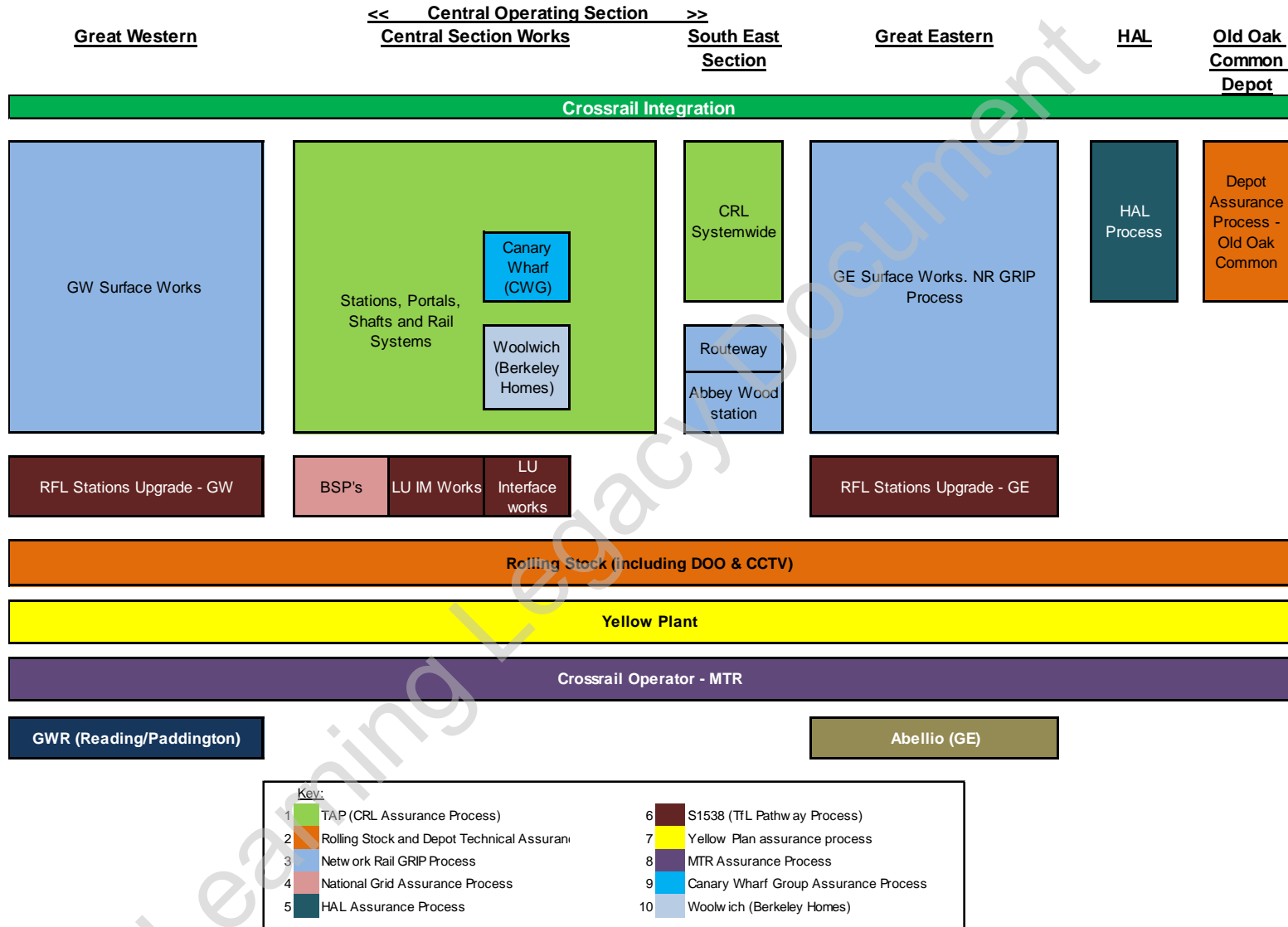
<b>Organisation</b>	<b>Technical Assurance Delivery Responsibilities</b>
London Underground: Delivery of Station Operations Room Integration (SORI) at Bond Street, Tottenham Court Road, Farringdon, Moorgate and Whitechapel Station complexes.	<p>SORI works are undertaken by London Underground in compliance with LU Category 1 Standard – Assurance S1538.</p> <p>A Project Assurance Plan (PAP) will be produced to detail the key assurance deliverables and the process to be adopted throughout the life of the project to meet the accepted Works Package Plan (WPP) for Station Operations Room Integration.</p>
Network Rail – On Network Works:	<p>NR is an Industry Partner engaged by CRL to deliver the On Network Works (ONW) including the South East (SE) spur, which is part of the Central Operating Section.</p> <p>NR has established its own GRIP based assurance plan, which sets out the method for providing technical assurance during the design, construction and hand back stages of all projects within the ONW.</p> <p>Crossrail shall validate that Network Rail has sufficiently demonstrated compliance with the On Network Functional Requirements throughout the NR GRIP process. CRL is also required to consult with NR regarding any Central Section works that may impact on the national rail network.</p>
Rolling Stock and Depot (RSD):	<p>The Rolling Stock and Depot contractor is responsible for delivering assured rolling stock and the Old Oak Common depot (3), in line with their own technical assurance plan, which will be compliant with the CRL technical assurance requirements. The RSD contractor is also responsible along with CTOC for obtaining approval to run the rolling stock over the Network Rail network in line with standard industry processes (GE/RT8270). The RSD shall also support Crossrail to assure the interfaces to the Central Section works.</p>

**Notes:**

1. Central Section Railway includes the integration, testing and operation of the Crossrail Rolling Stock over the Central Operating Section (as defined in the PDA). Overall Technical Authority for the Crossrail Central Section including end-to-end interfaces works lies with the Crossrail Chief Engineer.
2. “Operators” means a Transport Undertaking or Infrastructure Manager as defined in the Railways and Other Guided Transport Systems (Safety) Regulations (ROGS)
3. For Ilford and Plumstead Depots, please see CRL organisation responsibilities above



Figure 2 - Technical Assurance Map



## 4 Roles and Responsibilities

### 4.1 Crossrail Limited

CRL is responsible as the Employer for appointing competent designers and Contractors to design and build the Central Operating Section. CRL is also responsible for accepting both the designs and built assets with the technical assurance evidence necessary to assure that it complies with the Sponsor's Requirements.

The processes that designers and contractors apply to deliver their technical assurance evidence will be subject to CRL acceptance for compliance.

Each design organisation will assure their design through certifying compliance with the relevant CRL functional, performance, safety & legal requirements for their scope of design works including the interfaces for which they have responsibility.

During delivery the Contractors are responsible for providing self-certified assurance evidence that the works are constructed in accordance with the Works Information. This shall be reviewed by CRL using a risk based approach as described through the CRL Verification Activity Plans [Section 10.3] and accepted by CRL progressively.

CRL shall also directly produce supplementary assurance evidence where necessary to demonstrate that the rail systems, rolling stock and infrastructure combined with operations and maintenance requirements deliver a safe, operational railway that meets Sponsors' Requirements.

### 4.2 RfL, NR and LU Roles and Responsibilities

Assets will be handed over by CRL to RfL, LU and NR. This will be done on the basis of the certification issued by CRL, the designers and the constructors, supported by the assurance evidence described in this plan and any other required verification and validation activities as described in the CRL Verification Activity Plans (VAPs).

The assurance evidence shall be accepted by CRL who will compile and add to this evidence to provide RfL, LU and NR with the integrated assurance evidence. RfL, LU and NR will release letters of acceptance as appropriate.

### 4.3 Transport Undertaking (TU) Roles and Responsibilities

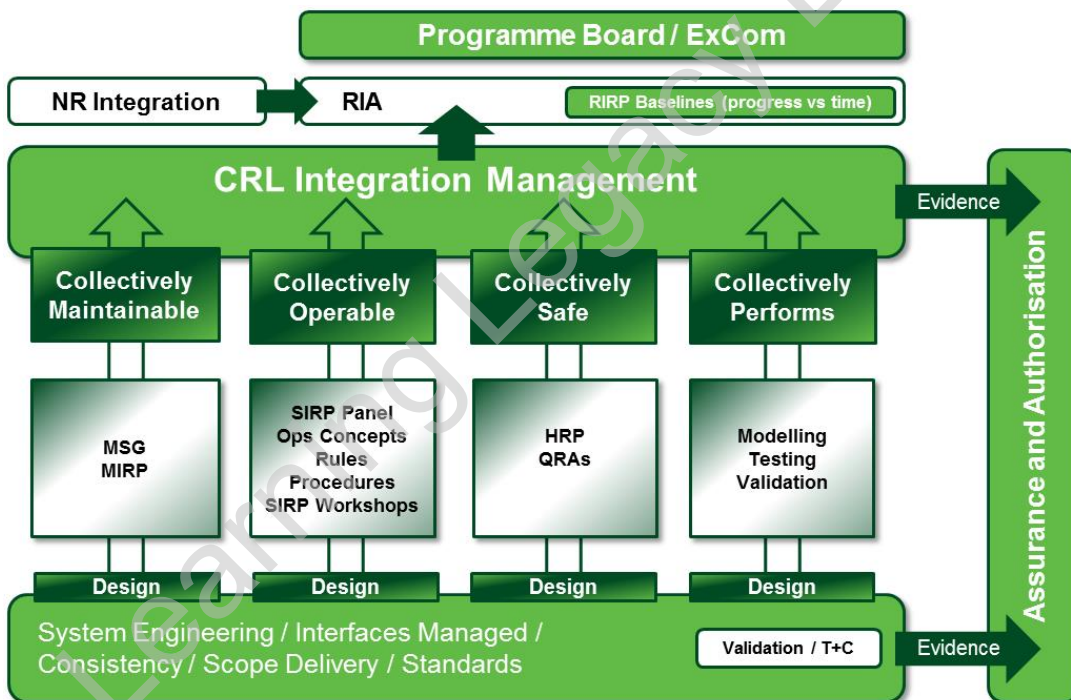
The Transport Undertaking for Crossrail (otherwise known as MTR [Crossrail]) will require authorisation from the Office of Rail Regulation (ORR) to operate vehicles in the relevant parts of the Crossrail infrastructure. To achieve this milestone, MTR[C] and RfL need to demonstrate that their Safety Management System reflects the constraints and function of the assets they will utilise to safely perform their duties.

Therefore, although MTR[C] do not directly receive Technical Assurance from CRL, they are a customer of evidence generated in line with this Technical Assurance Plan and will undertake verification activities [40] on RfL's assurance process [39].

## 5 CRL Assurance Approach - Principles

Crossrail have established an assurance approach whereby the aggregated outputs are tested against the four pillars of technical assurance:

1. **Verify that the railway is collectively safe:** CRL management and execution of the hazard identification and review process, railway risk evaluation and demonstration of ALARP principles through generation of engineering safety justifications as described in the Engineering Safety Management System Safety Plan [23] (SSP).
2. **Verify that the railway is collectively maintainable:** Use of risk based Maintenance Integration Review Panel (MIRP) workshops to test the alignment and integration of the collective designs with maintenance boundaries, concepts, access, resource, and logistics constraints, including interfaces between IMs.
3. **Verify that the railway is collectively operable:** Use of risk based Systems Integration Review Panel (SIRP) workshops to test the alignment and integration of the collective designs with the suite of CRL operations concepts.
4. **Verify that the railway will collectively perform to required levels of capability:** Delivery of re-aggregated RAM analysis and deployment of agreed suite of simulation / modelling to evidence that the railway shall meet end-to-end performance and capacity targets.



All the technical assurance processes contained within this Technical Assurance Plan underpin the four pillars. Further detail regarding how the above is applied to end-to-end railway systems is contained within the System Integration Management Plan [15].

The CRL Progressive Assurance and Integration Model (Appendix B) demonstrates how the CRL assurance outputs (above) relate to those produced by the contractors.

## **6 CRL Assurance Alignment to Operators Assurance**

### **6.1 Overarching obligations**

In accordance with the PDA, Crossrail has developed an assurance process that will enable it to manage and deliver the Crossrail Project in compliance with the Crossrail Programme Functional Requirements (CPFR) and the Sponsors Requirements. As per the Programme Assurance Strategy [3] this will be done using controlled processes and competent persons in a manner that will oblige the Operators to accept Handover of assets and/or systems (“Elements”) after satisfactory completion of dynamic testing. The aggregate of the Elements will constitute the complete railway.

### **6.2 LU Assurance**

In line with the LU Development Agreement, CRL has developed its technical assurance process (the “Assurance Plans”) for the submission and acceptance of technical assurance deliverables in order to set out how it will assure itself that the CRL project works meet the CPFR and Standards, and satisfy the assurance requirements of the LUL Assurance Standard S1538 [1] in respect of both the IM Works and the Interface Works. CRL compliance is as shown in Appendix A for Station, Portals, Shafts, Tunnels and Railway Systems.

### **6.3 RfL Assurance**

CRL compliance is shown in Appendix A for Station, Portals, Shafts, Tunnels and Railway Systems. RfL also require the same level of demonstration of compliance in satisfying the LU Assurance Standard S1538 as set out in the Memorandum of Understanding (MoU).

RfL will accept CRL staged assurance submissions.

For Railway Systems designs wherever the RIR apply, a Notified Body/Designated Body (NoBo/DeBo) will assess the compliance with the Technical Standards for Interoperability (TSIs) and Non-Notified National Rules (NNTRs), and will produce technical files to be incorporated into the relevant engineering safety justifications, part of the overall safety justification to be produced by CRL. The Independent Assessment Body (AsBo) will provide assurance that engineering design safety risks have been controlled and reduced to as low as reasonably practical.

### **6.4 NR Interface Assurance**

The NR Approved Assurance Procedures set out the arrangements governing NR’s involvement as the adjacent IM for the rail network at interfaces with the Central Operating Section.

The NR GRIP assurance plan describes how NR obtains engineering assurance in accordance with its Safety Management System as regulated by the ORR. This will include acceptance bodies such as Network Rail Acceptance Panel, Competent Independent Person (CIP), NoBo, and Engineering Specification Panel. NR will apply both an internal and HQ audit process.

It is the responsibility of CRL to demonstrate the assurance of the interfaces with NR, both to NR and to RfL. CRL is also required to consult with NR regarding any Central Operating Section works that may impact on the national rail network. For interface works with NR infrastructure, assurance evidence shall demonstrate the compatibility of the Crossrail works with the existing On-Network NR infrastructure. This approach is set out in the NR Group Standard GE/RT8270.

### **6.5 MTR[C] Assurance**

MTR[C] is the Infrastructure Manager responsible for managing and operating the RfL stations. MTR [Crossrail] assurance is described in the MTR[C] Assurance Plan [40] and focuses on:

- Safety management - to ensure MTR[C] meets its statutory obligations,
- Operability - to ensure the system as developed is operable by MTR[C] staff, and that they are suitably competent, and

- Performance - to get the best from the delivered systems and ensure their exposure to performance penalty risks through the concession performance regime is acceptable.

## **6.6 Rolling Stock and Depot Assurance**

The Rolling Stock and Depot Contractor is responsible for delivering assured rolling stock and the Old Oak Common depot in line with the Guidance Note for RSPA Progressive Assurance Process for Rolling Stock [49] and the Guidance Note for Old Oak Common Depot - Progressive assurance Process for Rolling Stock [50]. These set out the full Rolling Stock Provision Agreement (RSPA) process for achieving assurance acceptance of the design stages, and are both compliant with the CRL technical assurance requirements. Future revisions will incorporate the process for unit manufacture.

These documents do not include for Ilford Yard or for Plumstead sidings, which follow the standard CRL processes as listed within this TAP. In the case of Ilford Yard, the Ilford Yard Project Assurance Plan [51] describes Bombardier, the GE TOC and NR as the ultimate recipients and users of the facility that could request assurance from CRL.

The RSD contractor is also responsible along with CTOC for obtaining approval to run the rolling stock over the Network Rail network in line with standard industry processes (GE/RT8270).

The RSD contractor shall also support Crossrail to assure the interfaces to the Central Section works. This will include how they intend to present to CRL at an assurance review meeting, demonstrating the method by which RfL will receive assurance from Bombardier, and of the subsequent RfL assurance acceptance process.

## **7 Technical Authority**

The Crossrail Chief Engineer is the Technical Authority for Crossrail. Technical Authority is responsible for assuring that all CRL works comply with this Technical Assurance Plan.

The Chief Engineers Group (CEG) consists of Heads of Disciplines for the following areas:

- Civil and Structural Engineering;
- Underground Construction;
- Architecture;
- Geotechnical;
- MEP;
- Route Systems; (Track, OHLE, Ventilation, HV power non-traction)
- Signalling;
- Bulk Power;
- Communications and Control
- Human Factors

CEG controls the overall engineering assurance process. It is the final acceptance body that provides overall completion certification for the Crossrail Central Section including its end-to-end interfaces works with the other Industry Partners such as London Underground (LU), Rail for London (RfL), DLR, CWG and Network Rail (NR). CEG is supported by the Integration and Assurance team whom control the technical, operations and maintenance, system safety, requirements and interface management assurance through the Head of Integration.

The Heads of Discipline are accredited by LU and RfL who accept their signature as evidencing that the document signed off has complied with the Crossrail Technical Assurance Plan (this document).

CEG relies on supporting certification generated through Crossrail Designers and Contractors, which is verified by risk-based activities carried out in accordance with the VAP Implementation and Progressive Assurance Procedure [9].

The CEG review body is independent of the CRL delivery team. This assures the Technical Compliance of the Works with the Crossrail Requirements.

## 8 Building Control

Crossrail is exempted by the Crossrail Act from the Building Control regulations. However, Crossrail's Contractor Works Information include requirements to comply with Building Regulation criteria and contractors follow a robust assurance process to do this, independently of any external regulation. This ensures that the new assets that form part of the Central Section main works are designed and constructed to ensure the health and safety of users, contribute to access of disabled people, and are both energy efficient and sustainable.

For the Central Section stations for which LU becomes the IM (Bond Street, Tottenham Court Road, Farringdon, Liverpool Street and Whitechapel) LU will apply the procedure defined within their Work Instruction W0008 "Building Control Procedure". LU has developed this procedure as a light touch approach to Building Control.

CRL will exercise effective control throughout the CRL Project lifecycle; including materials, fitting, finishes and fixtures. This is as described under Section 10 of this document 'Assurance throughout Crossrail Programme lifecycle'. Each stage of the Works from shall be verifiable and recorded to provide evidence of effective and continued control over the executed work.

The demonstration of compliance and control is described in this Technical Assurance Plan (TAP) and the VAP Implementation and Progressive Acceptance Procedure (VIPAP) [9] as outlined in the table below:

<b>Building Control principle</b>	<b>Document</b>	<b>Section</b>
Demonstration of competency:	TAP	12.6
Key design control procedures:	TAP	12.1-12.12
Key construction control procedures	TAP	13.1 – 13.16
Verification and Progressive Assurance	TAP; VIPAP [9]	11.3; 7.2
Verification Record and Site Inspection	VIPAP [9]	9.1 – 9.3
Continual Improvement	VIPAP [9]	9.4
Completion Certification	VIPAP [9]	9.5

## 9 Crossrail Assurance Reporting Environment

The Crossrail Assurance Reporting Environment (CARE) – as described in the Crossrail Assurance Reporting Environment (CARE) System (Including User Guidance)[6] - is a configuration tool which facilitates the visibility of key CRL assurance evidence through an application interface with eB, the Crossrail Project's document management system.

The CARE system will ensure all the required assurance evidence (to support S1538) is apposite to the eventual Elements by which Crossrail will handover the railway to the IMs. The packages of assurance evidence will follow the agreed system breakdown structure in determining the totality of assurance evidence required for each Element.

CRL will take full responsibility for the determination of which documents are deposited and how they are grouped.

## **10 Assurance throughout Crossrail Programme lifecycle**

The processes below are applied throughout the Crossrail programme lifecycle.

### **10.1 Requirements Management**

Requirements traceability with the Employer's Requirements is maintained in accordance with the Engineering Requirements Management Plan [7] which is conducted throughout the programme lifecycle.

All CRL designers and contractors are responsible for ensuring that at each stage their works meet the relevant apportioned Requirements and evidence collated in the CRL Dynamic Object Oriented Requirements System (DOORS) database. The CRL requirements engineer reviews the acceptance of this evidence as part of the CRL gates assurance process. Delivery partners such as CWG and LUL are not mandated to use DOORS however they will demonstrate to CRL through agreed means that their requirements have been discharged.

There are a number of Employer's Requirements which only CRL can demonstrate have been met (e.g. route performance) or that the requirement has been allocated to CRL to discharge (e.g. project governance commitments). In these cases, CRL shall take responsibility and a co-ordinating role in demonstrating that the requirements have been met.

### **10.2 Verification and Validation Management**

Verification and validation activities are planned and implemented throughout the Crossrail Programme lifecycle in order to provide evidence in a progressive manner that Crossrail will meet the Sponsors' Requirements. The Verification & Validation Plan [8] provides further information upon how this is delivered.

### **10.3 Verification Activity Plans**

CRL Verification Activity Plans (VAP's) are used to plan the verification activities that Crossrail will undertake against potentially high-risk areas throughout the project lifecycle to build its confidence in the effective and continued control of the Works. This supports progressive acceptance of the Works and therefore mitigates the risk of undesirable outcomes against the Crossrail Programme Functional Requirements (CPFR) prior to completion of the CRL Employer's Completion Process for Handover.

The Technical Directorate of Crossrail is responsible for setting design standards for the Works and to verify that the final design output complies with CRL standards baseline. During construction, testing and commissioning, on-going verification and site inspections are carried out in collaboration with the Operators in order to verify that the contractors are exercising effective control measures in any asset related works.

The CRL VAP Implementation and Progressive Acceptance Procedure [9] provides further information upon how this is delivered.

### **10.4 CRL Competency Assessment**

CRL Competency Assessment - Guidelines [20] defines the process for assessing that all key CRL post-holders whose work has a direct or indirect impact on design assurance, construction, operations or maintenance safety are competent. The process is aligned with the requirements of the London Underground Procedure for Assessment of Crossrail Engineers.

CRL Delivery also have a procedure called Competency Management Procedure for Delivery Team [21]

## **10.5 Electro-Magnetic Compatibility (EMC)**

The EMC requirements for each and individual system have been specified in the works information for the contractor in accordance with the CRL EMC Management Plan.

The contractor is responsible for demonstrating at each design and implementation stage that these requirements have been met and evidence generated through EMC deliverables which are subject to CRL review and acceptance.

## **10.6 Engineering Safety Management (ESM) Process**

The ESM requirements apply specifically to the design, engineering and provision of railway systems, mechanical systems, electrical systems, fire, public health and architecture.

Crossrail will demonstrate the integrated safety by the application of the ESM System Safety Plan. [23].

To ensure progressive assurance and to facilitate the acceptance of future Safety Justifications, Crossrail will draft an Intermediate Safety Justification based on the Design Engineering Safety Justification from Stations and Infrastructure and on the 60% Design Stage Gate ESM report from Systemwide Contractors. This will form part of the Final Design Overview (11.11) and help demonstrate that Systems, Stations and Infrastructure are safely integrated.

During construction, Contractors shall update their hazard records, safety evidence, and safety justifications in line with any relevant changes that occur post design in accordance with the System Safety Plan.

## **10.7 Human Factors**

Human factors issues and risks will be identified and managed in accordance with the relevant Human Factors standards contained in the Crossrail Standards Baseline and the Human Factors Management Plan [44]. Designers will ensure their designs take into account the relevant Human Factors requirements and CRL will co-ordinate and ensure that these requirements are applied consistently across the Central Section and its interfaces.

## **10.8 Process for Escalation**

Throughout the Crossrail Project life cycle, issues may arise that cannot be resolved at the local engineering management level. Where all other means of resolution have been exhausted the Technical Issue Escalation (TIE) Process [46] may be used.

The TIE process requires input from the most senior level of engineering management: CRL Chief Engineer, LU Head of Engineering and RfL Head of Engineering. The Engineering Resolution Group (ERG) is the forum for all parties to discuss TIEs, and to formally define the actions required to achieve a solution.

Solutions will be tested against the four pillars of Assurance, as defined within section 5 of this plan, to enable the declaration that the railway is collectively “safe”, “maintainable”, “operable”, and “performs” to the required level of capability.

TIEs should not be raised without evidence that due process has been followed to demonstrate compliance with the four pillars of Assurance.



## **11 Design Assurance**

All design follows the V-Lifecycle as shown in Appendix C to provide progressive assurance evidence during the design stages to assure the objectives of the project are achieved and that the project can progress successfully to the next stage.

### **11.1 Design Management**

The Design Management Process [10] governs the civil infrastructure and stations approach to design including the mechanical electrical and power (MEP) & architectural designs. The process defines the safe, economic and efficient management of design outputs that conform to the relevant standards and the project requirements delivered for the Central Section through FDC's and D&B contractors.

The Systemwide design process is governed through the Systemwide Execution Plan [11] and Works Information to assure the safe, economic and efficient management of design outputs conforming to standards and the project requirements.

The System Integration Management Plan [15] defines the CRL approach to Systems Integration and the processes CRL intends to use to ensure that a safe, operational, maintainable railway is delivered that meets the Sponsor's requirements.

This will include the integration of all the Crossrail railway systems, electrical and mechanical systems and the civil infrastructure together with the rolling stock to deliver a resilient operational railway.

CRL is responsible for the overall management of systems integration.

### **11.2 Design Review and Acceptance Process**

The Design Review Procedure [12] manages and controls the review of the design outputs through CRL for all designs.

Design acceptance is carried out on a risk basis and agreed with each contractor via the CMDL. In order to discharge their responsibilities the Chief Engineer's Group and embedded engineers will actively participate in the design review process including attendance at IDRs and SDRs, and will review assurance evidence as work proceeds.

### **11.3 Engineering Gates Process**

Engineering Design Assurance Gates Procedure [13] (for Stations & Infrastructure) provides a control mechanism to support progressive assurance where evidence is reviewed at defined stages to confirm that the stations and infrastructure meet the four pillars.

The Systemwide designs are assured through the Systemwide Design Gate Review Procedure [14] which defines the railway systems design gates assurance process to its final approval stage for the Central Section along with the relevant interfaces at stations, portals, shafts and to the other industry partners such as LU, RfL & NR.

A Gate Pass Certificate will be issued at the 30%, 60% and 90% stages, confirming that the respective design gate reviews have been successful.

In addition, at the Issue for Construction (IFC) stage, which is either 60% or 90% depending on the asset or system, CRL will declare through a Gates Declaration Certificate that the design will deliver a resilient railway meeting Sponsors' requirements on Safety, Performance, Operations & Maintenance.

The above gate procedures also manage the impact of changes to assured designs

## **11.4 The Design Certification Procedure**

Design Certification Procedure [16] manages the generation of design certificates through the FDC's and D&B Contractor design elements associated with the construction packages.

CRL is responsible for accepting the certificates and to provide auditable trail for work packages for assurance evidence. The Design Completion Certificate (DCC) presented by the designers at the Gates confirms that the design has been prepared in accordance with the requirements of the Standard Baselines and Legislation.

The Systemwide D&B Contractors self-certify that their designs are compliant with the accepted Design Statement generated per elementary systems at 30, 60, & 90% design reviews. A design review release certificate will be issued as part of the review process. The certificate and supporting evidence are subjected to Technical Authority acceptance.

The Design Certificate is only issued following the end of the testing and commissioning phase as this phase produces some of the evidence of compliance. This is further explained in the Project Testing and Commissioning Strategy [17]. The completion of works is subject to Technical Authority acceptance.

## **11.5 Issue of Design Documentation for Construction**

Issue of Design Documentation for Construction [18] manages the engineering governance for issuing completed and gates approved design packages to support construction work packages.

## **11.6 Design Interfaces**

The Procedure for Interface Management [22] manages the interfaces between the rail systems and the civil and M&E works to confirm that adequate space-proofing and access requirements for systemwide works have been defined and agreed between the interfacing parties.

## **11.7 Reliability, Availability, Maintainability (RAM)**

The RAM requirements have been specified in the Central Section RAM Requirements [24].

The designer/contractor is responsible for demonstrating at each design stage that these requirements have been met and evidence generated through RAM deliverables which are subject to CRL review and acceptance. CRL shall, at the FDO Stage (below) demonstrate that the various design integrate to deliver the system-level targets defined by the RAM requirements.

## **11.8 Progressive Design Assurance**

In order to mitigate CRL design risks and demonstrate integrated assurance to the IMs, Crossrail will carry out a two stage assurance review of each Element of Crossrail. These comprise:

### **Interim Design Overview (IDO)**

The Interim Design Overview (IDO) certificate for each Element captures the Infrastructure design up to RIBA Stage F, MEP & Architectural designs up to RIBA Stage E, Railway Systems Design Statement at 30% gate review and CRL integration evidence as per Appendix D. This is the initial staged submission, building towards the Final Design Overview. The outputs from the IDOs will be fed back into the final MEP, Architecture and Systemwide designs.

### **Final Design Overview (FDO)**

The final design overview scope is related to each Element (as defined in the Handover Strategy and Plan) through Final Design Overview (FDO) Components.

The Final Design Overview (FDO) for each Component reflects complete Civils, MEP, Architecture and Systemwide designs which are coordinated and integrated into the final design for the Component. A Handover Element may comprise a single component (e.g. for Stations) or multiple components (e.g. Railway Systems), as described in the Final design Review Overview (FDO) Procedure.

CRL will produce and submit a Final Design Overview (FDO) report and Component Integration Certificate for acceptance by RfL and LU for each Component of the Crossrail railway, which satisfies the assurance requirements in LU Assurance Standard (Compliance Submission) Clause 3.17 to demonstrate integrated design assurance for each Component to the Infrastructure Managers.

The FDO provides therefore provides final design assurance declaration for the Component.

In respect of final design assurance for the Element:

1. Where an Element comprises multiple Components – it is recognised that some parts of the system design will only be completed after the testing and commissioning phase (e.g. final software revisions) - a declaration will be made by CRL that the various Components have been integrated into the final design of the Element in the form of an Element Integration Certificate.
2. Where the Element comprises a single Component, the Element Integration Certificate will be identical to the Component Integration Certificate.

The Element Integration Certificate will therefore provide the final design assurance declaration and will be referred to within the Element Completion Handover Report (ECHR).

Both the interim and final design overview stages are reflected in Appendix D. These are also described within the Interim Design Overview Process [25] and Final Design Overview (FDO) Process [26]

## **12 Construction Assurance**

All designs assured through the CRL Gates Process will be constructed, tested and commissioned by the Contractor under the management of CRL Delivery. CRL Delivery applies a set of approved processes and procedures that are described below.

### **12.1 Construction Quality Management**

For all construction contracts, the Contractor is responsible under the Works Information for providing their own Contractor's Quality Management System (QMS) and to provide their own surveillance as part of their self-certification regime.

CRL Delivery is responsible for oversight, monitoring and surveillance of the Contractor's activities in accordance with the Construction Management Plan [27] and the Construction Quality Plan [28].

The Supervisor's Rep reviews and accepts construction deliverables, observation, inspection and surveillance both on and off site, manages and administers the Non-Compliances Register (NCR) and Snagging/Outstanding Works process, and monitors the compliance and progressive compilation of certificates and quality records.

In addition, the Technical Directorate's Quality Team independently monitors performance of the Field Engineering Teams and Contractors through a regime of surveillance, and reports on any concerns regarding effectiveness of both CRL Delivery and Contractors.

### **12.2 Materials Compliance**

The Demonstration of Materials Compliance Procedure [29] manages the process for the review and acceptance of materials.

### **12.3 Construction Certification**

The Construction Certification for Structures and Civil Engineering Works Procedure [30] requires the Contractor to submit a list of Sub-Construction and Construction Certificates that they intend to produce during the currency of the constructed works.

These certificates lead to the generation of a Whole of Contract Construction Certificate which is issued when all other certificates have been delivered and countersigned by CRL. This final certificate signifies completion of the constructed works.

## **12.4 Monitoring and Surveillance**

The Monitoring and Surveillance Procedure [31] describes the process for the planning and monitoring through the use of inspection, test interventions and surveillance.

## **12.5 Project Technical Request**

The Project Technical Request (RFI-NCR-FCD) Procedure [33] outlines the controlled identification, notification and resolution of:

- Project initiated technical questions,
- Request for Information, between parties under the control or interface management of CRL Delivery.
- Field Change Documents, relating to alterations to the assured design documents issued for permanent and temporary project systems and facilities and non-conformances found in the Central Section works including those that arose through an audit undertaken by the Quality team.

This procedure applies to the design, construction and testing phases of the project for D&B Contractors.

## **12.6 Snagging & Outstanding Works**

The Snagging and Outstanding Works (Punchworks) Procedure [32] describes the process for the recording and tracking to close out of outstanding works and defects. Construction certificates may be issued subject to agreement with the CRL Delivery with a Consolidated Outstanding Works List which will be an export from the Punchworks at the time of certificate issue.

## **12.7 Completion & Control of the Works**

The Completion of the Works (Project Manager's Duties) [34] procedure describes the process for establishing that the Works have been completed in accordance with the Contract and the process for managing the Works up until Takeover of the Works by the Employer. A series of Site Surveys take place prior to the contract completion date with a view to the generation of a Consolidated Outstanding Works List (COWL). These surveys will involve the relevant Infrastructure Manager.

## **12.8 Employer's Completion Process**

The Employer's Completion Process (ECP) [35] describes how Crossrail will exercise due diligence prior to acceptance of Crossrail Central Section Works contracts.

## **12.9 London Underground Interface**

Interface Works undertaken by CRL will follow the CRL assurance process and the Infrastructure Protection Plan - LU assets [38]. Those works requiring early bringing into use and/or handover to LU will follow the Procedure for Bringing into Use, Completion and Handover to LU of CRL Interface Works [37].

Interface Works undertaken by London Underground will follow LU processes and procedures, in accordance with an agreed works package plan, and provide necessary assurance to CRL.

## 12.10 Network Rail Interface

Works impacting Network Rail (NR) shall be managed in accordance with:

- Relevant project procedures and NR standards
- Network Rail Scope Book Procedure
- Crossrail Worksite Possession on Network Rail- Booking and Implementation

## 13 Post Design Readiness Gates

A series of post design readiness gates have been established to allow Crossrail to review the readiness of Elements to be tested in an integrated manner as the Crossrail assets and railway systems complete, and as the railway proceeds through its final configuration states prior to completion and handover to Dutyholders.

These gates are reflective of the step-changes in risk as the construction and operational environment changes as the railway completes, and includes:

- **R1 - Element Readiness Review (interim acceptance):** an Element Readiness Review assessment point will be held to assess the readiness of the Element in advance of Handover for all stations, shafts and portals and linewise systems.
- **R2 – Energisation Readiness Review:** a readiness to energise hold point will be undertaken to assess the readiness of Zones 1 and 2, and Zones 3 and 4, respectively, to become an energised traction power environment.
- **R3 - Readiness to Start Dynamic Testing:** a readiness to start dynamic testing hold point will also be held prior to the commencement within zones 1 and 2, and zones 3 and 4, respectively.
- **IM1 - Readiness to Start Trial Running:** a readiness to start trial running hold point will assess the readiness of Infrastructure Managers and the Train Operator (including LU, RfL and MTR) to start trial running across the whole Central Operating Section.
- **IM2 - Readiness to Start Trial Operations:** a readiness to start trial operations hold point will be held that will be led by the Infrastructure Managers and the Train Operator (including LU, RfL and MTR) to assess the readiness of the Central Operating Section to start trials with passengers and staff.

This approach is illustrated in Appendix C Assurance V-Lifecycle.

## 14 Testing and Commissioning Assurance

### 14.1 Testing and Commissioning Strategy

The key processes and arrangements deployed for the testing and commissioning (T&C) of the Railway Systems and MEP works on Stations, Portals and Shafts works shall be in accordance with CRL Testing & Commissioning Strategy [17]

## **14.2 Testing and Commissioning Plan**

The testing and commissioning phases will be applied appropriately to all works and associated interfaces in accordance with the Crossrail Programme Testing and Commissioning Management Plan [45].

CRL is responsible for management of this process for the Central Operating Section, including bringing into service the interfaces with other industry partners and operators.

## **14.3 Testing and Commissioning Certification**

Testing and commissioning certification is part of the assurance process and will be produced at each respective stages of testing. The certificates will be accompanied by test reports duly signed off by the Contractor(s) lead testers and further subjected to CEG and Systemwide team verification acceptance.

These will include:

- Factory Acceptance Certificates (FAC) - at the end of phase 1 Factory Acceptance Tests;
- Installation Release Notices (IRN) – at the end of phase 2.1 Intermediate Static Tests;
- Pre-commissioning Certificates (PCC) – at the end of phase 2.2 Pre-commissioning Static Tests;
- Partial Acceptance Certificates (PAC) – at the end of phase 2.3 System Static Tests; and
- Acceptance Certificates (AC) – at the end of phase 3 Static Integration Tests (or during phase 4 Dynamic Testing if a system requires further phase 4 tests before being fully validated).

## **14.4 Dynamic Testing**

Dynamic testing is the stage of testing that requires the movement of trains to demonstrate those functions that cannot be fully demonstrated by static testing alone. It demonstrates that the infrastructure and trains work together in an integrated manner and meet the required performance specification

Crossrail will undertake dynamic testing in two stages: early dynamic testing on zones 1 and 2 and then across zones 3 and 4. An exemption from ROGS shall be required from the ORR.

## **15 Handover**

Crossrail's infrastructure has been broken into groups of assets for the purpose of Handover to the final owners. Each group of assets is called an 'Element'.

Elements are defined within Appendix 3 of the Handover Strategy and Plan [41]. An example of an Element is a station, including works completed by all CRL contractors within the station demise.

The final owner of each asset has been defined and agreed in the IM Boundaries Document [42].

### **15.1 Element Completion Handover Report (ECHR)**

Handover evidence will be collated and demonstrated through the Element Completion and Handover Report (ECHR). The IM Boundaries document [42] lists the asset boundaries on Crossrail and the interfaces with other locations and systems.

The ECHR meets the requirements of a Completion Consent to Operate Report as defined in LU Standard 1538. It is the final report to be submitted to the party receiving Handover of an Element (the final owner, LU or RfL).

CRL will be producing an ECHR for the Elements for which CRL are responsible for Handover to LU or RfL. At the five LU stations, CRL will include assurance for RfL assets within the ECHR submitted to LU.

LU will gain assurance from RfL for those assets, and RfL will gain assurance vice-versa from LU for having assets within an LU station. The terms and process for this agreement are included in the LU/RfL Acceptance Protocol (to be written).

## **15.2 Element Completion Handover Certificate (ECHC)**

The Element Completion and Handover Certificate (ECHC) is prepared and signed by CRL, and counter-signed by the final owner, to declare:

- The Element is ready for Handover
- Acceptance of the Element by the final owner, and agreement that responsibility for operation and maintenance for the Element is successfully transferred from CRL to the final owner

Further information is contained within the Procedure for Completing the Element Completion and Handover Report, Element Completion Handover Certificate and Staged Completion Report [36]

## **15.3 Safety Assurance and Authorisation**

Contractors will update their hazard records, safety evidence, and safety justifications in line with the outputs of the testing and commissioning phase to allow CRL to finalise the overall Safety Justifications in accordance with the System Safety Plan prior to Handover.

The completion of the Safety Justifications will support the IM's finalisation of their Safety Management System (SMS).

Completion of dynamic testing will allow the Technical Files to be updated and all relevant evidence submitted to the Office of Rail and Road (ORR) in order for CRL to obtain Authority to Place into Service (APIS).

Authority to Place into Service (APIS) is not required for Trial Running but is required prior to RfL submitting their application for Safety Authorisation.

The application will detail the SMS that RfL have developed to manage the hazards of RfL's operational and maintenance activities to (As Low As Is Reasonably Practicable) ALARP.

## **15.4 Railway Assurance Board [Crossrail]**

The Railway Assurance Board [Crossrail] (RAB[C]) serves three separate purposes in assuring that the Crossrail end-to-end railway is safe:

1. CRL's Safety Review Panel (SRP) – for all Central Operating Section assets, including the integration of Rolling Stock within it, and reviewing the Safety Justifications (SJs) for all Elements for acceptance
2. RfL's Infrastructure Manager Safety Review Panel (SRP) – independently assuring that RfL can accept assets "into use", with the necessary organisation, resources and processes
3. Co-ordinator of Duty Holders – RAB[C] acting as Lead Duty Holder with accountability for satisfying itself that RfL's operational and maintenance activities are integrated between all other Duty Holders (e.g. CRL/NR/LU) and MTR[C] (the CTOC) across the end-to-end railway, in accordance with the principles of Railway Group Standard GE/RT8270.

The purposes are complimentary with much of the safety assurance reviewed both through (1) as CRL's SRP and through (2) to allow acceptance of the assets by RfL from the SRP.

Where the roles differ is in authorising the railway infrastructure to be brought into use. In this case, RAB [C] is additionally required to review and approve RfL's demonstration and evidence of Operational Readiness and Maintenance Readiness (3).

Further information is contained within the Rail Approval Board (Crossrail) RAB (C) Terms of Reference [48]

## **16 Trial Running**

The trial running period is required to facilitate the Contractors and CRL to carry out their final dynamic tests, where the nature of the tests mandates that they are performed under the aegis of the Operator's rule book and safety management system. The purpose of the trial running period is to demonstrate that the railway is capable of meeting the required levels of performance under normal, degraded, maintenance and emergency modes of operations.

Crossrail Trial Running Strategy [43] defines the principles for trial running and outlines the types of trials to be performed leading to substantial completion of the railway infrastructure.

CRL will require the assurance outputs from trial running to support the substantial completion report to the Sponsors.

## **17 Trial Operations**

On completion of trial running, the operators will conduct trial operations to prepare for and demonstrate that the new railway assets are capable of being operated in accordance with the Sponsors' requirements and the operators' safety management systems. CRL shall support and assist the operator until the end of trial operations period or as necessary. The output from Trial Operations form part of RfL's assurance activities, but do not play a final role in the CRL TAP – this section is included for information only.



## 18 TAP Reference Table

The following TAP reference table signposts the key CRL processes summarised within this TAP to the detailed procedures that further describe them.

No.	Undesirable Outcomes	Technical Assurance Process	TAP ID	Procedure	Owner	Ref <sup>1</sup>
1	Crossrail is not technically compliant <ul style="list-style-type: none"> <li>• COS</li> <li>• On-Network works</li> </ul>	Technical Assurance	n/a	CRL Management Plans; TAP; V&V Plan; SIMP; Crossrail – Network Rail Protocol; Network Rail Client Requirements	Chief Engineer Surface Director	8 & 15
2	Crossrail Engineers are not technically competent to verify the design		10.4	CRL Competency Assessment – Guidelines Delivery Competency Management Procedure	Chief Engineer Delivery Director	20 21
3	Design Requirements/ Specifications do not meet Technical Compliance/ Quality  Insufficiently advanced designs at Gate3	Verification Activity Plans (VAPs)	10.3	VAP Implementation and Progressive Acceptance Procedure	Chief Engineer	9
		Design Management	11.1 & 11.2	Design Management Process/ The Systemwide Execution Plan	Chief Engineer / Systemwide Director	10 & 11
		Design Assurance Gates	11.3	Engineering Design Gates Procedure; Systemwide Design Gate Procedure	Chief Engineer	13 & 14
		Progressive Design Assurance	11.8	Design Certification Procedure Interim Design Overview Procedure Final Design Overview Procedure	Chief Engineer	16 25 26
		Process for escalation	10.8	Technical Issues Escalation (TIE) Process	Chief Engineer	46
		Materials Compliance	12.2	Demonstration of Materials Compliance Procedure	Chief Engineer	29
4	Design Requirements/ Specifications do not meet Programme Requirements	Verification & Validation	10.2	Verification & Validation Plan	Head of Integration	8
		Requirements Management	10.1	Engineering Requirements Management Plan	Head of Integration	7
5	Constructed assets are not compliant to the approved design	Construction Assurance	12	Monitoring and Surveillance Procedure	Head of Quality	31
				Construction Certification for Structures and Civil Engineering Works Procedure	Delivery Director	30
				Construction Quality/Management Plan	Delivery Director	27 & 28
				Snagging & Outstanding Works (Punchworks) Procedure	Delivery Director	32
				Completion & Control of the Works procedure	Delivery Director	34
				Employer's Completion Process (ECP)	Delivery Director	35
6	Design does not deliver a maintainable railway (req'ts not met or RAM targets cannot be shown to be met)	RAM Management	5	RAM Management Plan	Head of O&M Interface	52
			5	MIRP Process	Head of O&M Interface	15

No.	Undesirable Outcomes	Technical Assurance Process	TAP ID	Procedure	Owner	Ref <sup>1</sup>
7	Design does not deliver an operable railway	RfL	5	Operations Concepts SIRP Process	Head of O&M Interface	15
8	Unable to demonstrate sufficient technical assurance evidence	Collation of assurance evidence	9	CARE user guide	Head of Technical Assurance	6
9	Elementary System does not deliver the intended functions or are unable to deliver functions when interfaced with other systems	Test and Commissioning	14	Project Test and Commissioning Strategy	Rail Systems and Commissioning Director	17
		System Integration	5	System Integration Management Plan	Chief Engineer	15
10	Interface Requirements not fully identified and agreed within Systemwide & other parties	Interface Management	11.6	Procedure for Interface Management	Head of Integration	22
11	Crossrail cannot be demonstrated as safe for operation	Engineering Safety Management	10.6	ESM System Safety Plan	Head of System Safety	23
		Safety Approval	15.4	Railway Assurance Board [Crossrail] ToR	Head of Integration	48
12	Human factors not integrated into the design for Passenger interface, Operations or Maintenance	Human Factors	10.7	Human Factors Management Plan	Chief Engineer	44
13	Lack of compliance with EMC regulations. Failure to provide EMC assurance for the interfaces with existing infrastructure.	EMC Management	10.5	EMC Control Plan	Chief Engineer	53
14	Failure to manage the handover of technical documentation and evidence	Handover	15	Handover Strategy and Plan;	Head of Integration	41
			15	IM Boundaries Document	Head of O&M Interface	42
			15.1 & 15.2	Procedure for Completing the ECHR, ECHC & Staged Completion Report	Handover Manager	36
15	Failure to integrate CRL technical assurance evidence with MTR[C]	Crossrail Train Operator	4.3	MTR[C] Assurance Plan	MTR Assurance Manager	40
16	Failure to demonstrate infrastructure technical assurance integration with rolling stock and depots	Rolling Stock and Depots	6.5	Progressive assurance for Rolling Stock; Old Oak Common Depot, and the Ilford Yard Project Assurance Plan	RfL and Head of Technical Assurance	49, 50 & 51

<sup>1</sup>A fuller list of all references is contained within Section 19 – References Documents

## 19 Reference Documents

Ref:	Document Title	Document Number:
1.	LUL Assurance Standard	S1538
2.	CRL Delivery Strategy	CR-XRL-Z-GST-CR001-00001
3.	Programme Assurance Strategy	CR-XRL-O4-GPL-CR001-00001
4.	Not used	Not used
5.	Technical Paper - Application of Approved Documents for MEP	CRL1-XRL-M-RGN-CR001-50001
6.	Crossrail Assurance Reporting Environment (CARE) System (Including User Guidance)	CRL1-XRL-O7-GUI-CR001-50004
7.	Engineering Requirement Management Plan	CRL1-XRL-O8-STP-CR001-50005
8.	Verification & Validation Plan	CRL1-XRL-O8-STP-CR001-50006
9.	VAP Implementation and Progressive Acceptance Procedure	CRL1-XRL-O7-GPD-CR001-50021
10.	Design Management Process	CRL1-XRL-O7-GPS-CR001-50005
11.	Systemwide Execution Plan	CRL1-XRL-R-STP-CRG03-50001
12.	Design Review Procedure	CRL1-XRL-O4-GPD-CR001-50003
13.	Engineering Design Assurance Gates Procedure	CRL1-XRL-O7-GPD-CR001-50015
14.	Systemwide Design Gate Review Procedure	CRL1-XRL-O7-GPD-CR001-50012
15.	System Integration Management Plan	CRL1-XRL-O8-STP-CR001-50010
16.	Design Certification Procedure	CRL1-XRL-O4-GPD-CR001-50001
17.	Project Testing and Commissioning Strategy	CRL1-XRL-O8-STP-CR001-50008
18.	Issue of Design Documentation for Construction	CRL1-XRL-O4-GPD-CR001-50007
19.	Design Change Management Process	CRL1-XRL-O7-GPS-CR001-50002
20.	CRL Competency Assessment - Guidelines	CRL1-XRL-O7-GUI-CR001-50002
21.	Competency Management Procedure for Delivery Team	CRL1-XRL-Z2-GPD-CR001-50001
22.	Procedure for Interface Management	CRL1-XRL-O8-GPD-CR001-50001
23.	Engineering Safety Management System Safety Plan	CRL1-XRL-O7-GST-CR001-00001
24.	Central Section RAM Requirements	CRL1-XRL-O8-RRS-CR001-00002
25.	Interim Design Overview Process	CRL1-XRL-O7-GPS-CR001-50003
26.	<b>Final Design Overview (FDO) Process</b> - draft	CRL1-XRL-O7-GPS-CR001-50009
27.	Construction Management Plan	CRL1-XRL-N2-STP-CR001-50002
28.	Construction Quality Plan	CRL1-XRL-N2-STP-CRG03-50004
29.	Demonstration of Materials Compliance Procedure	CRL1-XRL-N2-GPD-CR001-50007
30.	Construction Certification for Structures and Civil Engineering Works Procedure	CRL1-XRL-O4-GPD-CR001-50006
31.	Monitoring and Surveillance Procedure	CRL1-XRL-Z-GPD-CR001-50001

Ref:	Document Title	Document Number:
32.	Snagging and Outstanding Works (Punchworks) Procedure	CRL1-XRL-O4-GPD-CR001-50010
33.	Project Technical Request (RFI-NCR-FCD) Procedure	CRL1-XRL-Z-GPD-CR001-50006
34.	Completion of the Works (Project Manager's Duties)	CRL1-XRL-O4-GPD-CR001-50017
35.	Employer's Completion Process	CRL1-XRL-O4-GPD-CR001-50018
36.	Procedure for Completing the Element Completion and Handover Report, Element Completion Handover Certificate and Staged Completion Report	CRL1-XRL-K1-GPD-CR001-50002 TBC
37.	Procedure for Bringing into Use and Handover of Interface Works to LU	CRL1-XRL-Z-GPD-CR001-50021
38.	Infrastructure Protection Plan – LU Assets	CRL1-XRL-N2-STP-CR001-50003
39.	RfL VAP Process	TBC
40.	MTR[C] Assurance Plan	MTR-PGM-GEN-PLN-0002 (non eB)
41.	Handover Strategy and Plan	CRL1-XRL-K1-STP-CR001-50001
42.	IM Boundaries Document	CRL1-XRL-O8-XTC-CR001-00005
43.	Crossrail Trial Running Strategy	CRL1-XRL-R-STP-CR001-50001
44.	Human Factors Management Plan – must be approved via CMS work order	CRL1-XRL-O8-STP-CR001-50020
45.	Crossrail Programme Testing and Commissioning Management Plan	CRL1-XRL-Z-STP-CR001-50017
46.	Technical Issues Escalation (TIE) Process	CRL1-XRL-O7-GPD-CR001-50009
47.	Handover Procedure	TBC
48.	Rail Approval Board (Crossrail) RAB (C) Terms of Reference	CRL1-RFL-O-GPD-CR001-50001
49.	Guidance Note for RSPA - Progressive assurance Process for Rolling Stock	Q234/XRL/R1/GUI/CR001/50005
50.	Guidance Note for Old Oak Common Depot - Progressive assurance process for Rolling Stock	Q234/XRL/Z1/GUI/CR001/50002
51.	Ilford Yard Project Assurance Plan	CRL1-XRL-N2-GPD-CR112_SD007_1-50002
52.	RAM Plan (Reliability, Availability and Maintainability)	CRL1-XRL-O8-STP-CR001-50004
53.	Systems Engineering - EMC Management Plan – Must be a CMS document & approved via CMS work order	CRL1-XRL-O8-STP-CRG03-50003

## 20 Standard Forms / Templates

Ref:	Document Title	Document Number:
A.	None	
B.		

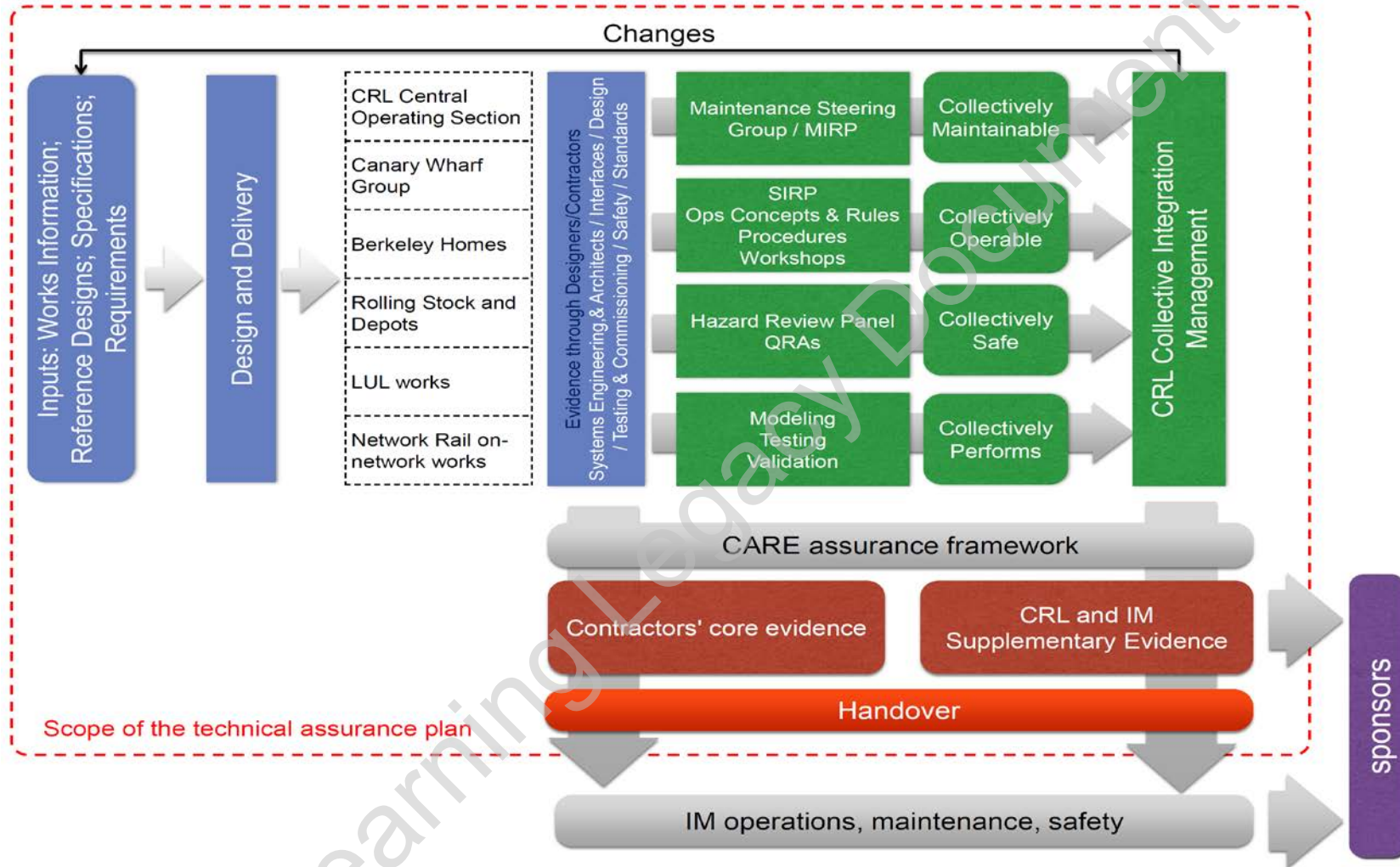
## Appendix A- CRL Alignment to LU Assurance Standard S1538

LU Assurance Standard S1538 Term	Stations, Portals, Shafts & Tunnels Submission to RfL & LUL	Railway Systems Submissions to RfL & LUL
<b>Conceptual Design Statements Clause 3.15</b>	<p>CRL will submit the CDS to satisfy Assurance Standard S1538 Clause 3.15 in the form of Design Certificates which includes Conceptual Design Overview (CDO), Conceptual Design Statements (CDS's) and Staged Design Compliance Certificates SDCC's/FDS (a) post concept for each LU/RfL operated Station including Portals, Shafts &amp; Tunnels.</p>	<p>CRL will submit Design Statements @ 30% design maturity per elementary systems to satisfy Assurance Standard S1538 Clause 3.15, supported by additional evidence as per the Appendix D- IDO Table.</p> <p>This Staged Submission will be supported by CRL IDO Certificate for each Interim Design Overview (IDO) Packages as per Appendix D.</p>
<b>Compliance Submission Clause 3.17</b>	<p>CRL will produce and submit a Final Design Overview (FDO) certificate for acceptance for each LU/RfL operated Station and Portals, Shafts &amp; Tunnels.</p> <p>The FDO, which is equivalent to LUL compliance submission, will comprise evidence in the form of component FDS's (Civils, MEP/Architectural) and the relevant Systemwide Design Statements at either 60% and 90% gate. Each FDO shall also contain CRL integration activities evidence in line with Appendix D. For LUL Stations this will include the LUL compliance submission for the works on the SOR.</p> <p>To comply with Railway Interoperability Regulations (RIR) CRL will submit Interim Certificate of Conformity through NoBo/DeBo.</p> <p>FDSs and Systemwide Design Statements will be accepted and issued progressively by CRL for each asset group.</p>	<p>CRL will produce and submit a Final Design Overview (FDO) for the railway systems elements.</p> <p>The FDO, which is equivalent to LUL compliance submission, shall comprise of evidence in the form of the relevant Systemwide Design Statements at either 60% and 90% gate. Each FDO shall also contain CRL integration activities evidence in line with Appendix D.</p> <p>To comply with RIR CRL will submit Interim Certificate of Conformity through NoBo/DeBo.</p> <p>Systemwide Design Statements will be accepted and issued progressively for each Element.</p>
<b>Consents to Test/Trial Report Clause 3.18</b>	<p>CRL will submit Consents to Test/Trial report when testing is either reliant on, or will impact upon, LU/RfL existing assets or the operational railway. See procedure for Bringing into Use and Handover of Interface Works to LU [37]</p> <p>To support this report, CRL will (amongst others) provide evidences in the form of Factory Acceptance Tests (FAT), Site Acceptance Test Records (SAT), Installation Release Notices (IRN), integration test evidences- Pre Commissioning Certificates (PCC), Partial Acceptance Certificates (PAC) and Acceptance Certificates (AC). See Crossrail Programme Testing and Commissioning Management Plan [45].</p>	

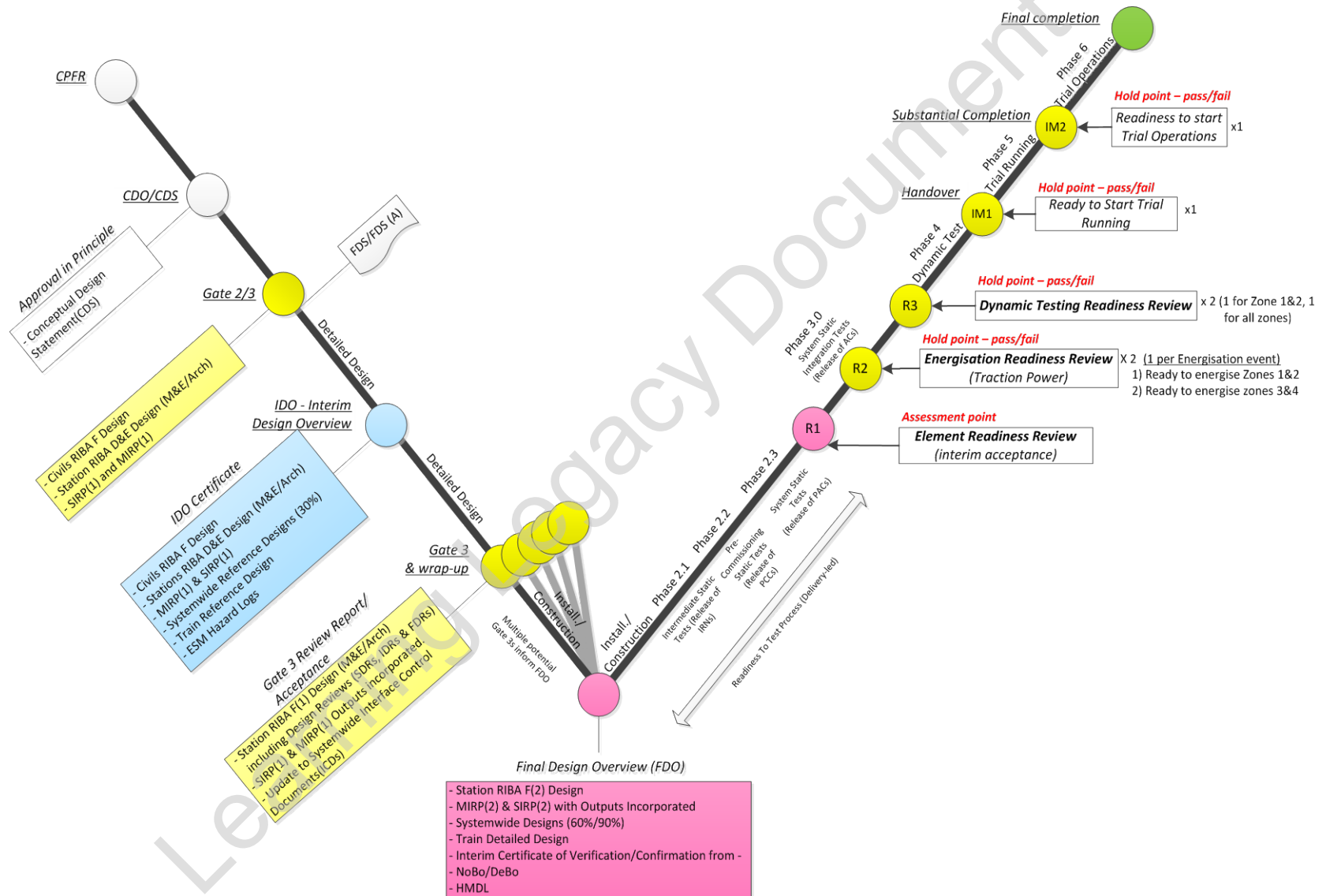
LU Assurance Standard S1538 Term	Stations, Portals, Shafts & Tunnels Submission to RfL & LUL	Railway Systems Submissions to RfL & LUL
<b>Staged Completion Report Clause 3.19</b>	CRL will submit Staged Completion Reports as set out in the handover programme to confirm all the certified design requirements have been met during the delivery phase and validated during Testing & Commissioning, including any certified changes post design. See Procedure for Completing the Element Completion and Handover Report, Element Completion Handover Certificate and Staged Completion Report [36].	
<b>Completion and Consent to Operate Report Clause 3.20</b>	<p>Following completion of Dynamic Testing and prior to Trial Operations CRL will submit an Element Completion Handover Report (ECHR) as per Appendix D to satisfy Assurance Standard S1538 Clause 3.20.</p> <p>The details of the CRL processes and requirements for the Completion of the works and handover submissions will be reflected in the CRL Handover Procedure [TBC] and the Element Handover and Completion Report (EHCR) procedure [36].</p>	

Learning Legacy Document

### Appendix B- Crossrail Progressive Assurance & Integration Model

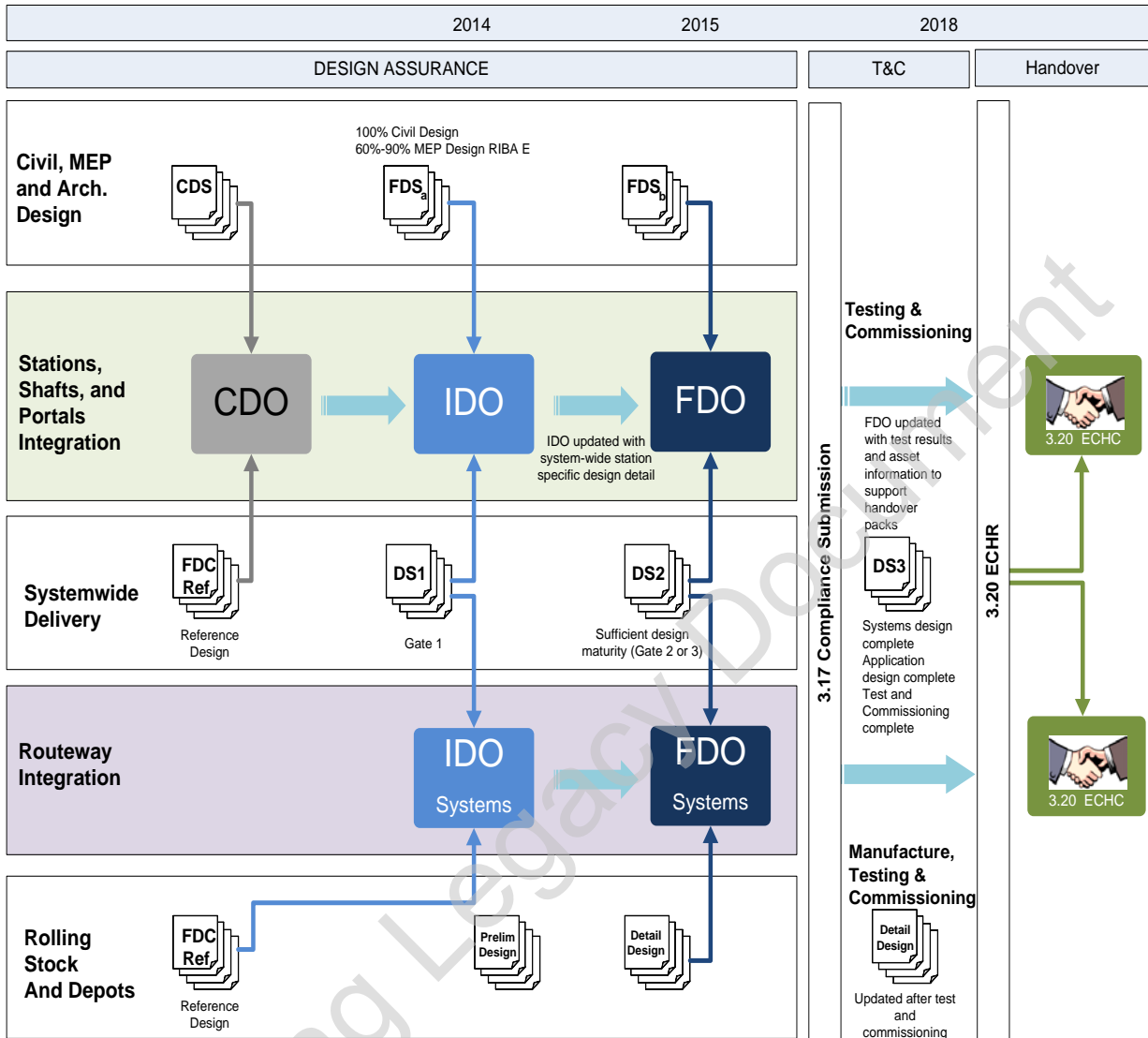


Appendix C- Assurance V Life-Cycle

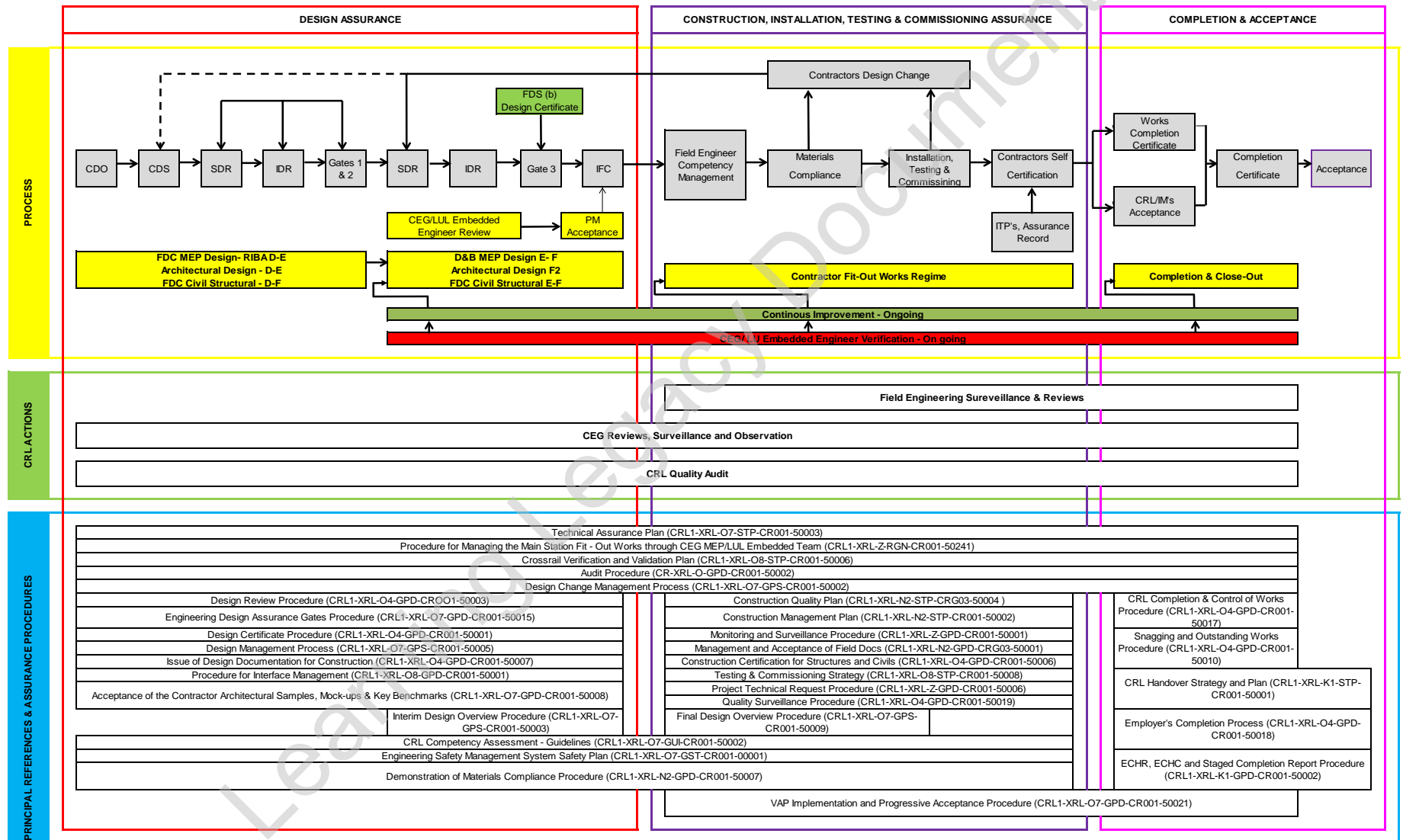




### Appendix D- Assurance Overview Stages



### Appendix E- CRL Project Lifecycle – Key Assurance Processes



Appendix F- CRL Project – Assurance Process Flow to Handover

