



Technical Directorate

Crossrail System Safety Plan Implementation Strategy

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1 Purpose

This implementation strategy sets out the actions and associated responsibilities that will be carried out by the CRL Technical Directorate and Delivery Contractors in order to implement:

Crossrail Engineering Safety Management System Safety Plan CRL1-XRL-O7-GST-CR001-00001 Rev 3.0 (the System Safety Plan)

Previous Revision 3 of this implementation strategy had concluded that there had been no significant changes to engineering safety management requirements outlined in the Plan Rev 3.0 that would require CRL to implement new or additional processes and procedures compared with the Plan Rev 2.0. For this reason the Revision 2 of the strategy remained valid and no significant revision was made at this time.

However the Assessment Body employed by Crossrail to assess the compliance of the CRL ESM with the Common Safety Method Regulation have raised some comments on the System Safety Plan Rev 3 which require clarifications and supplements which are given in this Version 3.1 of the Implementation Strategy.

For this purpose, this document completes the Version 2 of the Implementation Strategy.

2 Scope

The System Safety Plan is mandatory across the Technical Directorate and all other Crossrail Directorates as specified in the document.

The Technical Directorate will specify to the Procurement Department the requirements and format of the actions identified for implementation by Delivery Contractors in order that they can be included into the appropriate Contract.

Crossrail Programme

Crossrail will run from Reading and Heathrow Airport in the west to Shenfield and Abbey Wood in the east through new twin tunnels under central London via the West End, the City of London and Canary Wharf and nine new London stations.

Crossrail is a complex programme of interrelated projects and works that need to be integrated to create the new rail service. CRL is responsible for development and delivery of the new infrastructure, in accordance with the requirements of the Sponsors, up to the point at which it is accepted by the long-term operators of the infrastructure.

The scope of Crossrail is derived from the requirements defined in the following documents:

- Crossrail Project Development Agreement and associated Sponsors Requirements (CR-XRL-Z8-AAG-CR001-00459);
- Crossrail Programme Functional Requirements (CRL1-XRL-O8-RSP-CR001-50015, CRL's detailed interpretation of the Sponsors Requirements);
- On-Network Functional Requirements (CRL1-XRL-O8-RRS-CR001-00001, defines the Infrastructure Capability for the On-Network Works to be delivered by Network Rail).

The Programme and Project Scope Book (CRL1-XRL-N2-RSW-CR001-00001) summarises the high level design and sets out a description of the individual work elements that when integrated, form the infrastructure necessary to support the Crossrail railway service.



The programme comprises the following elements:

◆ Central Section Works

The Central Section Works are comprised of activities undertaken across central London from Portobello Junction in the west to Pudding Mill Lane Junction in the east, with a branch from Stepney Green to Plumstead Portal in the south east (the area is referred to as the Central Core Area in the PDA).

The Central Section Works are inclusive of the activities to deliver the shafts, track, signalling, communications, control and route control centre, traction power, and enabling and utilities works.

The works associated with the following new stations and work required for oversite development are also part of the Central Section Works: Paddington, Bond Street, Tottenham Court Road, Farringdon, Liverpool Street, Whitechapel, Canary Wharf, Custom House and Woolwich.

There will also be asset protection and implementation works in relation to the interfaces with Network Rail, London Underground and Docklands Light Railway (DLR) assets.

◆ Crossrail Surface (On Network Works)

All of the works on the following sections of the national rail network including infrastructure modifications and enhancements, station modifications and upgrades, signalling and control and stabling.

- Crossrail Surface West - The western section on the Great Western Main Line between Reading, Heathrow and Portobello Road;
- Crossrail Surface East - The eastern section on the existing electric suburban tracks of the Great Eastern Main Line between Pudding Mill Lane Junction and Shenfield; and
- Crossrail Surface South East – between Plumstead portal and Abbey Wood, including works to the existing electric suburban tracks of the North Kent line.

◆ New depot and rolling stock

New rolling stock fleet and depot, including stabling, maintenance facilities and accommodation.

◆ London Underground congestion relief works

London Underground is also delivering works outside the Crossrail programme but without which Crossrail could not open with full functionality. These are congestion relief works at Bond Street and station upgrade works at Tottenham Court Road (including a new ticket office, escalators and interconnecting passageways)

Crossrail Organisation

The main parties involved in the delivery of Crossrail are as follows (cf. CRL Delivery Strategy, CR-XRL-Z-GST-CR001-00001):

- CRL is a Nominated Undertaker as defined in the Crossrail Act and, through the PDA, is accountable for the development and delivery of the whole of Crossrail including all of its component projects. In fulfilling this role CRL has to provide an overall programme management role and has duties in relation to the delivery of the Central Section Works and other projects.
- Rail for London (RfL) has three main roles as follows:



- The Infrastructure Manager and future operator of the Crossrail stations at Paddington, Canary Wharf, Custom House and Woolwich;
- The Infrastructure Manager for the running tunnels and end-to-end railway systems for the Central Operating Section; and
- The procurer of the Crossrail Train Operating Company (CTOC) to operate Crossrail services and owner of the operating cost model.

As future Operator, RfL is engaged in the technical assurance process and is acting as the shadow train operator.

- Network Rail (NR) which has three primary roles in Crossrail:
 - To undertake Crossrail Surface;
 - To undertake works directly for CRL at the interfaces between Crossrail Surface and the Central Section Works; and
 - To act as Operator and Infrastructure Manager for Crossrail Surface
- London Underground (LU) has three primary areas of involvement with Crossrail:
 - Works within the existing Underground curtilage;
 - The protection of London Underground's assets from Crossrail works in the vicinity; and
 - The acceptance of responsibility for five stations as (Bond Street, Tottenham Court Road, Farringdon, Liverpool Street and Whitechapel).
- Rolling stock and depot Service Provider to part-finance, design, build, supply and maintain the train fleet and depot.

3 Definitions

ALARP	As Low As Reasonably Practicable
CBA	Cost Benefit Analysis
CRL	Crossrail Limited
CSM	Common Safety Method
ESM	Engineering Safety Management
ETA	Event Tree Analysis
FMECA	Failure Modes and Effects Criticality Analysis
FTA	Fault Tree Analysis
HAZID	Hazard Identification study
HAZOP	Hazard and Operability Study
IHA	Interface Hazard Analysis
IM	Infrastructure Manager
NNTR	Notified National Technical Rule
NoBo/DeBo	Notified Body/Designated Body
ONW	On Network Works
PWHR	Project Wide Hazard record (hazard log)
RIR	Railway Interoperability Regulations
SIL	Safety Integrity Level
SIRP	System Integration Review Panel



SSP	System Safety Plan
TA	Task Analysis
TSI	Technical Specification for Interoperability

4 Requirements

Appendix A shows the details of the implementation strategy, the various columns in the matrix are explained below.

Section – section reference number from the System Safety Plan;

Plan Requirement – engineering safety requirement from the System Safety Plan (the references [] are to those in the System Safety Plan and not this implementation strategy);

Implementation/Delivery Responsibility– explanation of how the engineering safety management requirement will be fulfilled;

Document Reference – reference to the documentary evidence the engineering safety requirement of the System Safety Plan is met.

The Head of System Safety in the Technical Directorate will take the lead, except where shown otherwise in the matrix, in ensuring that suitable arrangements are made to implement the requirements shown. Principally, this will be achieved through the development of appropriate processes and procedures as are shown in the “Document Reference” column of Appendix A and listed in Appendix B.

Revision 2 of the implementation strategy covered all requirements of the System Safety Plan. This revision of the implementation strategy clarifies and supplements some arrangements in System Safety Plan Implementation Matrix in order to answer the Assessment Body comments on Revision 3 of the System Safety Plan, and add Appendix C which describes the key roles and responsibilities regarding Crossrail’s System Safety Organisation.

Appendix A - System Safety Plan Implementation Matrix

Requirements of Crossrail Engineering Safety Management System Safety Plan CRL1-XRL-O7-GST-CR001-00001 v3.0			
Section	Plan Requirement	Implementation/Delivery Responsibility	Document Reference
1.2.1	The SSP is mandatory across..., Designers and Contractors who undertake Design and Build contracts (refer to glossary). It applies for the duration of the Crossrail Programme up to the point of Handover of the infrastructure to the IMs and Transport Undertakings to put into service.	To note the SSP is mandated to all Crossrail Delivery Contractors (See 2.2.5).	Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001)
1.2.2	The scope of ESM described in this plan applies to all aspects of railway operations (day to day running including degraded, abnormal, emergency and maintenance activities) as well as technical matters. This includes the control of risks to As Low As Reasonably Practicable (ALARP) for passengers, workforce, maintainers, adjacent railways, neighbours, and members of the public	Crossrail has established a <u>Hazard Management Procedure</u> to explain the control of identified safety hazards to ALARP. The procedure is mandated to all Crossrail Delivery Contractors & suppliers (See 2.2.5).	Crossrail Engineering Safety Management Hazard Management Procedure (CRL1-XRL-O8-GPD-CR001-50002)
2.2.4	The Contractor shall develop and manage their own safety management systems in accordance with their contract and to support this SSP.	Crossrail Delivery Contracts will define the engineering safety management requirements of Contractors using a standard form of Contract. Contractors are required to prepare a System Safety Plan for acceptance by the Crossrail Project.	Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001)
2.2.5	The principles of the EC Regulation on Common Safety Methods of Risk Assessment and Evaluation [22] shall be used to provide a mechanism to demonstrate that the project has achieved an ALARP position.	Crossrail Delivery Contractors are required to conform to the EC Regulation on Common Safety Method of Risk Assessment <u>except</u> for those parts of the central section stations named in 2.3.1. This will be specified in Crossrail Delivery Contracts by reference to the applicable Crossrail procedure.	Crossrail Common Safety Method Hazard Assessment Process (CRL1-XRL-O8-GPS-CR001-50003) Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001) explains the implications of RSSB's withdrawal of the "Yellow Book". See also 2.3.1.
2.2.6	CRL Systems Integration Management Plan [9] describes the processes that shall be used to assure the various interfacing Duty Holders that the safety risk at the engineered interface will be ALARP.	Crossrail Delivery Contractors are required to prepare an Interface Hazard Analysis which involves the interfacing Duty Holders and a Design Interface Engineering Safety Justification which will be submitted to the relevant Duty Holders for approval.	Project Works Information Volume 2B – General Requirements – Part 32 – Contractor's Engineering Safety Management Requirements: <ul style="list-style-type: none"> • Systemwide (CRL1-XRL-O8-XWI-CRG03-50002) • Stations, Shafts and Portals (CRL1-XRL-O8-



Requirements of Crossrail Engineering Safety Management System Safety Plan CRL1-XRL-O7-GST-CR001-00001 v3.0			
Section	Plan Requirement	Implementation/Delivery Responsibility	Document Reference
		All hazards are managed through the PWHR which collates evidence to justify that the design can be operated and maintained to a level that is tolerable and ALARP. The PWHR will be handed over to the future Duty Holders. See also section 3.7.8 in the SSP and in this document about the roles of SIRP, MIRP and Operations Concepts.	XWI-CRG03-50005) Engineering Safety Management Hazard Management Procedure (CRL1-XRL-O8-GPD-CR001-50002)
2.2.7	The Crossrail Programme Functional Requirements [10] shall be met.	The Crossrail Functional Programme Requirements will be traced to successful resolution in accordance with the <u>Requirements Management Plan</u> . To be specified by Head of Requirements & Integration.	Crossrail Requirements Management Plan (CRL1-XRL-O8-STP-CR001-50005)
2.2.8	The CRL Project Safety Requirements shown in section 2.3 of this document shall be met.	Crossrail Delivery Contractors are required to prepare a <u>Safety Requirements Specification</u> – as per BS EN 50126 (alternatively may be flagged as safety related in the overall System Requirements Specification for the system, if one is prepared)	Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001)
2.2.9	The management of assumptions in accordance with the CRL Engineering Management Plan [12] shall be met.	Assumptions will be managed in accordance with the CRL <u>Assumptions Management Process</u> . To be specified by Head of Requirements & Integration	Central Section Assumption Management Process (CRL1-XRL-O8-GIN-CR001-00002)
2.3.1	Application of the Railways Interoperability Regulations 2011 [RIR] Crossrail has determined that the RIR shall be applied to: <ul style="list-style-type: none"> the railway sub-systems in the Central Section, Paddington, Canary Wharf, Custom House, and Woolwich Stations, the LUL stations Bond Street, Tottenham Court Road, Farringdon, Liverpool St and Whitechapel up to and including the Platform Screen Doors only. All other elements of the station design on the platform side of the Platform Screen Doors shall be excluded from the scope of the RIR at these stations, CRL Rolling Stock, 	Where the Contractor is required to design as well as build infrastructure or systems to be located where the RIR are to be applied, then the design and construction shall be subject to assessment by a NoBo/DeBo appointed by Crossrail (Contracting Entity). Regarding engineering safety management Crossrail Delivery Contractors are required to conform to the EC Regulation on Common Safety Method of Risk Assessment, <u>except</u> for those parts of the central section stations named in 2.3.1. However they may choose to comply voluntarily as it represents good practice.	Baseline Requirement - Included as part of the Interoperability Services procurement document Contract X2228 Volume 2A Scope of Services. CRL Technical Directorate. Crossrail Common Safety Method Hazard Assessment Process (CRL1-XRL-O8-GPS-CR001-50003) Where the RIR 2011 do not apply it is not mandatory to apply the CSM Regulation although it is recognised as a good practice but its use in voluntary. The alternative approach for non-RIR 2011 would be to apply the "Yellow Book": Crossrail Delivery Contracts Standard Engineering Safety



Requirements of Crossrail Engineering Safety Management System Safety Plan CRL1-XRL-O7-GST-CR001-00001 v3.0			
Section	Plan Requirement	Implementation/Delivery Responsibility	Document Reference
	<ul style="list-style-type: none"> and so far as those Regulations apply, to the depots. <p>Designers and Project Engineers for the central section works and the rolling stock and depot are therefore required to ensure that their designs are compliant to all the relevant Technical Specifications for Interoperability (TSIs) and associated Notified National Technical Rules (NNTRs) for Crossrail, with the exception of those parts of stations as detailed above.</p> <p>Each TSI covers the interfaces with the other TSIs, together with all other aspects of interoperability specified in that TSI. For other parts of the railway being constructed, where the TSIs are silent, it will be necessary to apply other standards. For example the thickness of the tunnel walls or the interlocking processes used by a signalling system. For items not covered by TSIs the selection of relevant standards and the evidence of compliance will be subject to the requirements shown in this System Safety Plan.</p> <p>CRL will apply for any necessary derogations from the Competent Authority (currently the DfT) for TSIs and propose any necessary NNTRs to cover the derogation. This will require supporting information to be provided from Designers. Details of the derogations obtained, together with any mitigation required will be published in the Standards Baseline. Designers shall take account of such information in their designs. At the time of preparation of this edition of the SSP, derogations have been obtained against part of the Infrastructure TSI, and the signalling element of the Control, Command and Signalling TSI.</p> <p>During construction and testing activities the NoBo(s) and DeBo(s) appointed by CRL will require to review evidence supplied by the Design and Build Contractors to demonstrate compliance with the TSIs and NNTRs. By virtue of their appointment under the RIR Schedule 6 they shall have permanent right of access to offices and sites etc. to undertake audits and checks, site visits and to observe testing and commissioning activities.</p>	<p>On request from the Crossrail Project the Contractor shall provide any supporting information to enable the preparation of NNTRs for consideration of the Competent Authority (i.e. the DfT under current RIR) prior to notification to the European Commission. To be defined by Crossrail Head of Systems Safety.</p>	<p>Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001) explains the implications of RSSB's recent withdrawal of the "Yellow Book" to account for the widespread implementation of the CSM Regulation as the best practice in the UK. . The Crossrail Project has therefore decided to implement an engineering safety management system consistent with the CSM Regulation to all areas of the central section delivery, and irrespective of whether or not the RIR 2011 applies. However, the withdrawn "Yellow Book" may be used as a reference source of accepted Engineering Safety Management methodologies to apply in support of the CSM Regulation.</p> <p>CRL Process for Managing Technical Specifications for Interoperability and Notified National Technical Rules (CRL1-XRL-O8-GPS-CR001-50011)</p>



Requirements of Crossrail Engineering Safety Management System Safety Plan CRL1-XRL-O7-GST-CR001-00001 v3.0			
Section	Plan Requirement	Implementation/Delivery Responsibility	Document Reference
2.3.3	<p><i>UK National Legislation- Crossrail Policy</i></p> <p>CRL together with Designers and Contractors shall ensure that the completed railway can be operated by the Duty Holders in accordance with all relevant UK legislation. In particular the risks to safety of the passengers, workforce (including contractors) and members of the public who may be affected by it shall be reduced to tolerable and As Low As Reasonably Practicable (ALARP) through design. In achieving this account shall be taken of the good practice shown in the current RSSB Strategic Safety Plan and the London Underground Safety Plan.</p> <p>Where ALARP cannot be achieved by design and further mitigation (e.g. through an operational control) is required, then this will be dealt with as detailed in paragraphs 3.6.6 to 3.6.10 below. Further requirements to deliver compliance with UK legislation will be found in sections 3.5 and 3.6 of this System Safety Plan.</p>	<p>Crossrail has established the System Integration Review Panel (SIRP) who will run workshops to check the integrated designs are consistent with the Crossrail Concept of Operations and other requirements of the IMs etc.</p> <p>Where this applies, and the Delivery Contractor intends to transfer responsibility for the control of the hazard, he shall comply in full with the Hazard Management Procedure [5]. This transfer shall be achieved through the Crossrail <u>Project Wide Hazard Record</u>. Where a Contractor wants to transfer the mitigation of a hazard to a future IM or RU this must be approved by the Hazard Review Panel (HRP)</p>	<p>CRL Central Section System Integration Review Panel (SIRP) Workshop Guidelines (CRL1-XRL-O8-GUI-CR001-50001) and Action Tracker (CRL1-XRL-O8-LLG-CR001-50007)</p> <p>Crossrail Engineering Safety Management Hazard Management Procedure (CRL1-XRL-O8-GPD-CR001-50002)</p> <p>Crossrail - Project Wide Hazard Record Process (CRL1-XRL-O8-GPS-CR001-50013)</p> <p>Crossrail Hazard Review Panel (Terms of Reference (CRL1-XRL-O8-GPS-CR001-50009)</p>
2.3.5	<p><i>Checking of Safety of Design Requirements and Adoption of Good Practice by use of CSM -(i) Crossrail Policy</i></p> <p>CRL through the activities of the Crossrail Suppliers and Designers, shall take account of good, practice shown by the initiatives detailed in the current Railway Strategic Safety Plan (RSSP) 2009 to 2014 published by RSSB; and in respect of the LUL stations any relevant LUL current safety plan for stations. They shall ensure that the safety performance of their designs is at least as good as that shown in these Plans and wherever reasonably practicable, is improved upon. The demonstration that the Design is ALARP shall be achieved by either quantitative or qualitative argument based on control of risks in accordance with the EC Regulation Common Safety Method on Risk Evaluation & Assessment [22].</p>	<p>The achievement for ALARP & good practice in systemwide designs is a requirement of Crossrail Delivery Contracts.</p> <p>The overall confirmation of ALARP is traced in the Project Wide Hazard Record relating to the Contract. This will be either semi-quantitative risk matrix assessment or by quantitative risk analysis for high risk, new/novel or bespoke designs. Where quantitative analysis is justified, this will be in accordance with RSSB's Taking Safe Decisions [8] giving guidance for the factors to consider when undertaking Cost Benefit Analysis.</p> <p>Crossrail's System Safety organisation will support the Project Manager in progress meetings with Contractors to review the</p>	<p>Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001)</p> <p>Crossrail Engineering Safety Management Hazard Management Procedure (CRL1-XRL-O8-GPD-CR001-50002)</p> <p>Crossrail - Project Wide Hazard Record Process</p>



Requirements of Crossrail Engineering Safety Management System Safety Plan CRL1-XRL-O7-GST-CR001-00001 v3.0			
Section	Plan Requirement	Implementation/Delivery Responsibility	Document Reference
	<p>At the LUL stations (listed in 2.3.1) on the platform side of the Platform Screen Doors the EC Regulation is not mandatory, however it is adopted by the CRL Project as best practice. The CRL shall use the Engineering Safety Management Hazard Management Procedure [5] to check whether the hazard identification and associated risk assessments used by the Designer(s) have reduced the risks to tolerable and ALARP.</p> <p>For ONW it shall be the responsibility of NR to determine how the EC Regulation CSM on Risk Assessment & Evaluation shall be applied.</p>	<p>PWHR for the system to ensure suitable and sufficient depth of risk assessment prior to closure of identified hazards.</p> <p>Where the scope of the contract covers the design of infrastructure located where this clause applies, then the Delivery Contractor shall detail in his SSP the process that will be used to demonstrate that the safety risks associated with the design are tolerable and ALARP.</p>	(CRL1-XRL-O8-GPS-CR001-50013)
2.3.5	<p>(ii) The demonstration that the process used to comply with the CSM Regulation has been applied on the central section and for the Crossrail rolling stock shall be reviewed by an Independent Assessor in accordance with the Regulation. The outputs of the risk assessment shall be reviewed and endorsed by CRL. The results of the risk assessments shall be incorporated into the relevant Technical Files.</p> <p>In the case of On Network Works, NR as the Project Entity shall be responsible for the determination of how the CSM Regulation shall be complied with.</p>	<p>Crossrail Technical Directorate will appoint an Independent Assessor under the CSM Regulations and manage these activities.</p> <p>Crossrail Delivery Contracts define the standard ESM deliverables requirements and the approval routes internally for the Contractor, and by the Crossrail Project. The Crossrail Technical Directorate will maintain an overall <u>ESM Deliverables Schedule</u> to trace the timely approvals of these documents. This will include deliverables from all Delivery Contractors as well as those from Crossrail.</p>	<p>Baseline Requirement - Included as part of the Interoperability Services procurement document Contract X2228 Volume 2A Scope of Services. CRL Technical Directorate.</p> <p>Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001)</p>
2.3.5	<p>(iii) So far as the CRL is concerned the construction of a new railway, comprising the sub systems within the central section that are the subject of TSIs, shall be deemed to be significant, and hence subject to the CSM Regulation.</p>	<p>With the exception of those parts of the infrastructure specified in the second paragraph of 2.3.5 (i) above, Delivery Contractors are required to conform to the EC Regulation on Common Safety Method of Risk Assessment.</p>	Crossrail Common Safety Method Hazard Assessment Process (CRL1-XRL-O8-GPS-CR001-50003)
2.3.5	<p>(iv) The CSM Regulation identifies that hazards can be analysed and evaluated using one or more of the following principles</p> <ul style="list-style-type: none"> <input type="checkbox"/> the application of codes of practice <input type="checkbox"/> comparison with similar systems (reference systems) <input type="checkbox"/> an explicit risk estimation. 	Refer to 2.3.5 (iii) above.	Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001)



Requirements of Crossrail Engineering Safety Management System Safety Plan CRL1-XRL-O7-GST-CR001-00001 v3.0			
Section	Plan Requirement	Implementation/Delivery Responsibility	Document Reference
2.3.5	(v) For the central section Crossrail would expect the Designers and Project Engineers to use a combination of the 3 principles shown in (iv) above depending upon the sub system(s) concerned, to show that the safety risks have been reduced to tolerable and ALARP.	Refer to 2.3.5 (iii) above.	Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001)
2.3.5	vi) For the Crossrail Rolling Stock and depot the Designers shall take account of the requirements of the Crossrail policy shown in (i) above.	<p>The achievement for ALARP & good practice in designs is a requirement of all Crossrail Contracts. It is expected that rolling stock & depot will adopt a similar approach to other Delivery Contracts. To be defined by Crossrail Rolling Stock and Depot Manager.</p> <p>The overall confirmation of ALARP is traced in the Project Wide Hazard Record relating to the Contract. This will be either semi-quantitative risk matrix assessment or by quantitative risk analysis for high risk, new/novel or bespoke designs. Where quantitative analysis is justified, this will be in accordance with RSSB's Taking Safe Decisions [8] giving guidance for the factors to consider when undertaking Cost Benefit Analysis.</p>	Rolling Stock and Depot contract is managed by RfL on behalf of CRL and will follow a different approach which will mirror the principles of this implementation strategy. RfL deliver Safety Justifications for Rolling Stock and the Depots in accordance with the CRL SSP. See meeting minutes CRL1-XRL-O8-MRC-CR001-50001
2.3.5	vii) CRL have developed a Safety Risk Model in order to assist in showing that the operational railway, once built, is safe to operate and maintain. It models the low frequency high consequence events such as collisions between trains and derailments. The model provides a design baseline to which significant changes to the design basis or operating concept can be evaluated. It can be used as a tool to inform decisions on the proposed changes by assessing risk reduction associated with implementing different proposed control measures. The model results can be an input into CBA studies and used to demonstrate that the risk of railway operation has been reduced to ALARP.	<p>Crossrail Delivery Contracts require the Contractor to prepare a <u>System Safety Integrity Level (SIL) Requirements Report</u> – to determine and agree the requirements, if any, for SILs assigned to system safety functions.</p> <p>SILs will be derived in accordance with the advice previously given by Crossrail in the preliminary SIL determination document.</p>	<p>Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001)</p> <p>Crossrail Preliminary SIL Determination (CR-SYI-PRW-X-RT-00001)</p>
3.1.1	CRL retains overall responsibility for the ESM programme.	Delivery Contractors to note.	This implementation document described how Crossrail will discharge this responsibility.



Requirements of Crossrail Engineering Safety Management System Safety Plan CRL1-XRL-07-GST-CR001-00001 v3.0			
Section	Plan Requirement	Implementation/Delivery Responsibility	Document Reference
3.1.2	The CRL's Project Engineers will be responsible for managing and coordinating the individual contract work packages within their areas of responsibility, ensuring that the Contractors concerned provide the relevant Engineering Safety Justifications together with the relevant assurance evidence.	Crossrail Delivery Contracts will define the engineering safety management requirements of Contractors using a standard form of Contract document.	Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-08-GPD-CRG03-50001)
3.1.3	<p>The safety of any system comes from a combination of the engineering, operations and maintenance arrangements and CRL is responsible for the delivery of a fully functioning railway that meets the Joint Sponsors' requirements. CRL will be responsible for developing and integrating the design and the interfaces, so as to enable the railway to be operated and maintained to meet the Joint Sponsors' requirements.</p> <p>The above requirements will be demonstrated by the delivery of the Engineering Safety Justifications that have been integrated across systems and subsystems using the process described in section 3.1.4.</p>	<p>Crossrail Delivery Contracts require Contractors to prepare an Interface Hazard Analysis (IHA), and to explain in their <u>System Safety Plan</u> how interface hazards are addressed to a successful resolution. The IHA will be included in the Engineering Safety Justification and /or Safety Justification for review and acceptance by the Crossrail Project.</p> <p>Regarding integration of system safety justifications Crossrail will use the SIRP workshops to confirm this has satisfactorily been achieved (see 3.1.4 below).</p>	Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-08-GPD-CRG03-50001)
3.1.4	<p>CRL will assess whether the Engineering Safety Justifications integrate satisfactorily with each other to enable the railway to function correctly to deliver the Joint Sponsors' requirements. This will be done by testing the initial design against a series of scenarios in the Operations Concepts using a "HAZOP type" approach. Subsequent changes to the design or Operations Concept must be rechecked by reiteration. A fuller description of this process is given in section 3.7.8.</p>	Crossrail has established the System Integration Review Panel (SIRP) who will run workshops to ensure the integrated designs are consistent with the Crossrail Concept of Operations and other requirements of the IMs.	CRL Central Section System Integration Review Panel (SIRP) Workshop Guidelines (CRL1-XRL-08-GUI-CR001-50001) and Action Tracker (CRL1-XRL-08-LLG-CR001-50007)
3.1.5	Where the Railways Interoperability Regulations [14] apply and a NoBo / DeBo has produced a Technical File, this will be incorporated or referenced in the relevant Safety Justification. Where this is the case no further check of the evidence contained in the Technical File concerning the applications of TSIs and NNTRs shall be made by CRL Directorates and their Project Engineers. In accordance with the Regulations this is	The SSP in section 3.7 Safety Evidence describes the Safety Evidence that is required to be provided. In brief these are the top level Safety Justifications and the supporting Engineering Safety Justifications which are required to be integrated into the appropriate Safety Justification. Where the RIR apply the evidence provided must be in the form required by the relevant TSI / NNTR.	Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-08-GPD-CRG03-50001)



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	the responsibility of the ORR prior to the authorisation of the File. However the Certificate(s) of Verification produced by a NoBo or DeBo shall be taken as evidence by future Duty Holders that the structural sub system concerned meets the Essential Requirements for Interoperability. No further tests or assessments are required in accordance with the RIR of the part of the Safety Justification containing the Technical File. This includes the safe integration of the Structural Sub System concerned with other structural sub systems, as this is checked by the NoBo in accordance with the RIR.	<p>The Delivery Contractor is required to provide, as appropriate to the contract, <u>Design Engineering Safety Justification(s)</u> – preliminary document to confirm design is fit for purpose prior to installation, testing & commissioning AND <u>Engineering Safety Justification(s)</u> – final document prepared at successful completion of T&C such that the sub sub-system can be safely brought into service.</p> <p>Such Engineering Safety Justifications will be available to Crossrail Technical Directorate who are managing the Interoperability interface with the NoBo/DeBo.</p>			Crossrail Process and Format for Engineering Safety Justifications for Systems (CRL1-XRL-O8-GPS-CR001-50004)																									
3.1.6	Further information regarding the responsibilities of the parties with respect to safety and assurance is detailed in the CRL Technical Assurance Strategy (TAS) [2].	<p>The TAS specifies that future Duty Holders will receive evidence of safe design and integration and maintainability via Operator's assurance packages. These will contain authorised Technical Files, Accepted Engineering Safety Justifications, Safety Justifications, maintenance manuals etc. To be defined by Head of Technical Assurance.</p> <p>Responsibilities of the parties regading the Authorisation To Place Into Service (ATPIS):</p> <table border="1"> <thead> <tr> <th>Technical scope</th> <th>Central section works & RfL stations</th> <th>LU stations beyond the PSDs</th> <th>On Network Works (inc. South East Spur)</th> <th>Rolling Stock & Depot</th> </tr> </thead> <tbody> <tr> <td>Regulation</td> <td>RIR</td> <td>ROGS</td> <td>RIR</td> <td>RIR</td> </tr> <tr> <td>Project Entity (RIR)</td> <td>CRL</td> <td>(NA)</td> <td>NR</td> <td>RfL (CTOC)</td> </tr> <tr> <td>Responsible for ESM</td> <td>CRL</td> <td>CRL</td> <td>NR</td> <td>RSD Service Provider</td> </tr> <tr> <td>Safety Authority</td> <td>ORR</td> <td>LU (minor works)</td> <td>ORR</td> <td>ORR</td> </tr> </tbody> </table>			Technical scope	Central section works & RfL stations	LU stations beyond the PSDs	On Network Works (inc. South East Spur)	Rolling Stock & Depot	Regulation	RIR	ROGS	RIR	RIR	Project Entity (RIR)	CRL	(NA)	NR	RfL (CTOC)	Responsible for ESM	CRL	CRL	NR	RSD Service Provider	Safety Authority	ORR	LU (minor works)	ORR	ORR	Defined by CRL Technical Assurance Plan CRL1-XRL-O4-GPD-CR001-50005 & reference TAP 10 - Final Design Overviews (FDO I, FDO II) and the agreed completion Handover Package.
Technical scope	Central section works & RfL stations	LU stations beyond the PSDs	On Network Works (inc. South East Spur)	Rolling Stock & Depot																										
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Responsible for ESM	CRL	CRL	NR	RSD Service Provider																										
Safety Authority	ORR	LU (minor works)	ORR	ORR																										
3.1.7	For ONW only, Network Rail will manage the assessment of new or amended product safety cases where these extend the scope of existing equipment to a new environment or introduce a new product for use on NR managed infrastructure.	<p>Crossrail Delivery Contracts require the Contractors to prepare a <u>Product Breakdown Structure(s)</u> – to confirm the existing proven use of equipment proposed in the system design prior to procurement.</p> <p>Contractors must also prepare <u>Product Safety Case(s)</u> – as,</p>			Crossrail Process and Format for Product Breakdown Structures for Systems (CRL1-XRL-O8-GPS-CR001-50002)																									



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	<p>For all other locations the <i>Contractor</i> shall develop the safety justification for the product or system and this shall be checked by the associated Project Engineer as appropriate before submitting it for acceptance by the appropriate acceptance body.</p> <p>Where the RIR are applicable to the product or system then the relevant NoBo/DeBo will assess its compliance to the applicable TSI/NNTR. In this situation it may be necessary for CRL to propose a new NNTR valid for Crossrail only to the Competent Authority.</p>	<p>and if, required owing to the proposed use of new/novel or bespoke equipment and prior to procurement. The format is to be as BS EN 50129.</p> <p>The Project Engineer in charge is the CRL Lead Engineer of the relevant domain.</p> <p>The appropriate acceptance body are the relevant bodies of the future IMs which will apply their own Safety Management System:</p> <ul style="list-style-type: none"> • RfL Approval Body (C) – RAB(C), • LU Directors' Risk Assurance and Change Control Team – DRACCT, • NR zone SRP as mandated by NR Approval Panel (NRAP) for each NR relevant zone. 	
3.2.1	<p>The Crossrail project safety organisation is shown in the Connect on Line>Company Information >Organisation Charts home page. It has been developed to take decisions required for the project, including safety related decisions. It shows the ESM responsibilities of the relevant CRL Directors and their relevant direct reports and will be kept up to date by CRL.</p> <p>It is not anticipated that external organisations will need the above detail, but further information regarding ESM responsibilities with the Crossrail Project can be obtained from the CRL Technical Director.</p>	<p>Crossrail Delivery Contracts require Contractors to demonstrate ESM competency to confirm the relevant Contractor engineering safety management staff are suitably qualified and experienced.</p>	<p>Crossrail Competency Management Procedure (CR/QMS/DEV/P/0131)</p> <p>Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001)</p>
3.3.1	<p>CRL has established a Project Wide Hazard Management Procedure [5] to which all Contractors, CRL's Directorates shall conform. The hazard management process shall also satisfy the hazard identification, risk analyses and evaluation requirements mandated in the European Union Regulation on CSM Risk Assessment and Evaluation [22].</p>	<p>Crossrail Delivery Contracts will define the engineering safety management requirements of Delivery Contractors using a standard form of Contract document.</p> <p>Each Contractor is required to prepare a <u>System Safety Plan</u> for acceptance by the Crossrail Project– to establish a consistent ESM approach, agree preliminary list of contract ESM deliverables and programme for their delivery.</p>	<p>Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001)</p>
3.3.2	<p>The hazard management process shall be subject to assurance by CRL. In addition the Project Wide Hazard Review Panel detailed in [5] shall approve hazards that are</p>	<p>The Hazard Management Procedure [5] details the process by which Delivery Contractors shall identify record and rank hazards and the process to be followed when a contractor</p>	<p>Crossrail Engineering Safety Management Hazard Management Procedure (CRL1-XRL-O8-GPD-</p>



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	proposed for mitigation by transfer to future Duty Holders.	wishes to transfer a hazard to another Contractor, Crossrail or future Duty Holder. The Contractor shall reference this process in his SSP. The process is managed via the Project Wide Hazard Record.	CR001-50002) Crossrail - Project Wide Hazard Record Process (CRL1-XRL-O8-GPS-CR001-50013)
3.5.1	<p>Strategy</p> <p>The project strategy is to take cognisance of the NR programme process, known as Governance for Railway Investment Projects (GRIP) as described by the NR Policy Manual and Project Management [31] and the requirements of London Underground 1-538 standard [32].</p> <p>The safety activities shall be carried out during the various stages of the project, and follow the requirements of the EC Regulation on CSM on Risk Assessment & Evaluation as specified in 2.3.5 above. Where the Regulation does not apply the general guidance of BS EN 50126 [18], 50128 [19] and 50129 [20] and the Yellow Book [6] may be used. It is a requirement of the project that a V lifecycle model is used for the development and application of appropriate safety activities at the correct part of the life cycle.</p>	<p>The engineering design has been delivered so far under the eleven stages (A to L) of the Royal Institute of British Architects (RIBA) project lifecycle. Formal stage gate reviews are carried out before the project can progress between stages and ESM is an agenda item of these reviews.</p> <p>Future Delivery Contracts require each Designer to update a progressive <u>Stage Gate ESM Report</u> –to confirm suitable and sufficient ESM progress relating to the particular stage gate (at 30, 60 & 90% design). The ESM Report is reviewed and approved by Crossrail Project.</p>	<p>Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001)</p> <p>Crossrail FDC Assurance Stage Gate Engineering Safety Management Review Process (CRL1-XRL-O8-GPS-CR001-50005)</p> <p>Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001)</p>
3.5.2	Safety Life Cycle Activities	The responsibilities of the different contractors over the whole lifecycle are as below:	CRL Technical Assurance Plan CRL1-XRL-O4-GPD-CR001-50005



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Detailed design	FDC	unmodified design FDC D&BC modified design																			
Building	D&BC	D&BC																			
3.5.2	<p>(i) <i>Design Development (Detailed Design)</i></p> <p>The Contractor shall develop a safety management process that meets the requirements of the Crossrail System Safety Plan (this document), and undertake (as appropriate);</p>	See below for each bullet point.		N/A																	
	<input type="checkbox"/> Creation of a suitable Safety Plan/Strategy document	See 2.2.5.		N/A																	
	<input type="checkbox"/> Hazard identification workshops for the single design option.	See 3.6.6		N/A																	
	<input type="checkbox"/> Focussed Quantified Risk Assessments may be undertaken if required, or as identified and commissioned by CRL.	See 3.6.10.		N/A																	
	<input type="checkbox"/> SIL assessments of the safety related functions of proposed E/E/PES	See 2.3.5.		N/A																	
	<input type="checkbox"/> Development of a Safety Risk Profile assessment as necessary to demonstrate how requirement in 2.3.5 (ii) will be achieved	See 2.3.5.		N/A																	
	<input type="checkbox"/> Maintenance of Hazard records in accordance with the Crossrail Hazard Management Procedure [5].	See 3.6.7.		N/A																	
	<input type="checkbox"/> Progressive development of a Safety Assessment Report to summarise the safety risk assessment activities and present	See 3.5.1.		N/A																	



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	the ALARP justification for the design.		
	<p>□ Collection of safety evidence. The safety evidence may take the form of product, generic and application Engineering System Safety Justifications from manufacturers and sub-system and system safety justifications from the Suppliers, Conformity Certification, and qualitative/quantitative risk assessments. Where the RIR apply, the NoBo/DeBo will produce a Technical File to contain evidence as mandated by the TSI concerned.</p> <p>System safety requirements are specified in section 2.3 of this document.</p> <p>Designers must recognise and contribute to the provision of assurance evidence presented in the form of an Operator's Assurance package that complies with the Final Concept of Operations (refer to 3.7.8 of this document) to enable Duty Holders to accept the handover of the completed railway.</p>	See 4.1.1. Crossrail Technical Directorate will maintain an overall <u>ESM Deliverables Schedule</u> . This will define all Crossrail Project safety documentary evidence required in support of safety approvals of the Crossrail railway under the applicable railway legislation. To be defined by Crossrail Head of System Safety.	CRL Overall ESM Deliverables Schedule (CRL1-XRL-O8-TSC-CR001-50001)
3.5.2	<p>(ii) Main Construction</p> <p>The Crossrail Project System Safety Plan (this document) and the Suppliers' System Safety Plans will be revised as required to ensure suitability for the next stages of the project.</p> <p>Hazard records, safety evidence, and safety justifications will be updated and collected as necessary.</p> <p>For the purpose of the 'placing into service' authorisation, evidence of construction conformity must be collected at this stage and provided to the relevant Verification or Assessment Body. (Refer to CRL Engineering CRL Verification & Validation Strategy [16]).</p>	<p>The Delivery Contractor is required to provide, as appropriate to the contract, <u>Design Engineering Safety Justification(s)</u> – preliminary document to confirm design is fit for purpose prior to installation, testing & commissioning AND <u>Engineering Safety Justification(s)</u> – final document prepared at successful completion of T&C such that the sub sub-system can be safely brought into service.</p> <p>Such Engineering Safety Justifications will be available to Crossrail Technical Directorate who are managing the Interoperability interface with the NoBo/DeBo.</p>	Crossrail Process and Format for Engineering Safety Justifications for Systems (CRL1-XRL-O8-GPS-CR001-50004)



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3.5.2	<p>iii) System Integration, Commissioning, Testing and Trial Running</p> <p>The safety planning and activities concerning this phase of the project will be defined in testing and commissioning plans, or Safety Verification plans, later during the project. The safety activities will be designed to validate the safety requirements and the assumptions, dependencies and caveats in the project safety documentation and to provide the evidence needed for safety authorisation / acceptance.</p> <p>For the purpose of the 'placing into service' authorisation, evidence of safety in testing must be collected at this stage and provided to the relevant Verification or Assessment Body. Where the RIR apply to a particular subsystem, the NoBo / DeBo will require such evidence and has the right to observe some or all of the tests.</p> <p>A CRL Data Reporting, Analysis & Corrective Action System (DRACAS) will be used at this stage to report and respond to incidents occurring during this phase of the project.</p>	<p>As the testing and commissioning strategy develops it may be necessary to prepare cases for safety to demonstrate the current status of design and installation is fit for purpose. Such evidence will be defined by the testing and commissioning strategy. To be defined by Crossrail Testing & Commissioning Manager.</p>	<p>Standard Contract Requirement - Volume 2B – Part 28 – Testing and Commissioning Process (CRL1-XRL-V3-XWI-CR001-50028)</p>
3.5.2	<p>(iv) Service</p> <p>For 'placing into service', the safety analysis, compliance evidence, and the safety evidence and arguments that risks are ALARP will be collated by CRL into a series of Operator Safety and Assurance Packages (see the Crossrail Technical Assurance Strategy [2]), which will be submitted for acceptance to the relevant</p> <p>Acceptance Body on behalf of the future Infrastructure / Station Operators or to the relevant TU depending upon the agreement with the relevant Duty holder.</p> <p>Subsequently, all project safety documentation will be retained by the Operators for maintenance and inspection during the lifetime operation of Crossrail.</p>	<p>Crossrail Delivery Contracts identify the engineering safety deliverables to be completed to confirm successful testing & commissioning prior to "placing into service". Specifically at the end of design it is required to prepare final <u>Design Engineering Safety Justification(s)</u> to support the overall <u>Engineering Safety Justifications</u> – final documents prepared at successful completion of T&C such that system can be safely brought into service AND <u>System Project Wide Hazard Record</u> – final hazard log to confirm all hazards are successfully resolved such that the system(s) can be safely brought into service.</p>	<p>Crossrail Process and Format for Engineering Safety Justifications for Systems (CRL1-XRL-O8-GPS-CR001-50004)</p> <p>Crossrail - Project Wide Hazard Record Process (CRL1-XRL-O8-GPS-CR001-50013)</p>
3.6.1	<p>CRL and Contractors are required to use recognised safety analysis methodologies based on the processes described in the EC Regulation on Common Safety Methods on Risk</p>	<p>Crossrail Delivery Contracts require the Contractor to prepare a <u>System Safety Plan</u> – to establish a consistent ESM approach, agree preliminary list of contract ESM deliverables and</p>	<p>Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CR003-50001)</p>



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	Evaluation & Assessment [22] and supplemented by the Yellow Book [6] where necessary. Examples of recognised methodologies include those shown in the ORR Guidance to the EC Regulation, British Standards BS EN 50126 [18], BS N50128 [19], BS EN50129 [20] and BS EN 61508 [21], LU 1-526 [3] and in accordance with CRL Hazard Management Procedure [5], but this is not an exhaustive list..	programme for their delivery. The Plan is accepted by the Crossrail Project.	
3.6.2	The EC Regulation Common Safety Method on Risk Evaluation & Assessment [22] represents good practice and shall be complied with as described in 2.3.5.	Crossrail Delivery Contractors are required to conform to the EC Regulation on Common Safety Method of Risk Assessment, <u>except</u> for those parts of the central section stations named in 2.3.1.	Crossrail Common Safety Method Hazard Assessment Process (CRL1-XRL-O8-GPS-CR001-50003)
3.6.3	The scope of the Project Engineers and Contractor's engineering safety analysis shall be required to: <ul style="list-style-type: none"> <input type="checkbox"/> Consider a comprehensive range of safety issues such as interfaces, operation, human factors, normal conditions, degraded conditions, emergency conditions, and credible fault conditions of the CRL systems and subsystems <input type="checkbox"/> Demonstrate that in all cases the system remains legally compliant with safety requirements. <input type="checkbox"/> Demonstrate that the risk introduced by the Crossrail systems and subsystems is tolerable and ALARP <input type="checkbox"/> Demonstrate that the requirements of section 2.3 of this SSP have been met. <input type="checkbox"/> Gain acceptance from the relevant organisations with respect to fulfilling their requirements for safety assurance. 	Crossrail Delivery Contracts require the Contractor prepare <u>System Safety Plan (SSP)</u> – to establish a consistent ESM approach, agree preliminary list of contract ESM deliverables and programme for their delivery. The Plan is accepted by the Crossrail Project.	Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001)
3.6.6	Hazard Identification Hazard identification shall take a variety of forms depending upon the function under review. Designers may undertake structured brainstorming sessions as well as reference to existing hazard identification for railway operations. Where appropriate other techniques such as FMECA and the HAZOP process shall be employed. Hazards identified during informal	Crossrail Delivery Contracts require contractors to specify hazard identification techniques and processes to be used in the <u>System Safety Plan</u> . These to include HAZID, HAZOP, IHA, TA, ETA, FTA, FMECA, as appropriate. Planning and reporting of structured hazard identification is in	Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001) CRL Guidelines and Etiquette for Undertaking HAZID and HAZOP Workshops (CRL1-XRL-O8-



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	sessions are also valid. All hazards identified during these different types of processes shall be recorded. When a programmed hazard identification exercise has been undertaken, a draft report shall be produced and released to the participants and assurance representatives for comment within two weeks.	accordance with the Crossrail's guidance document.	GPS-CR001-50010)
3.6.7	The initial hazard identification by the Contractors undertaking Reference Designs shall be forwarded by CRL to the Contractor who is taking forward development of the Design. However the latter Contractor shall be instructed to carry out his own hazard identification based upon his own design.	Crossrail Delivery Contractors to note and comply with this requirement. A preliminary Project Wide Hazard Record is provided in the Contract Works Information. See 3.6.8.	Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001)
3.6.8	Hazard Management. As stated in 3.5.2 and 3.6.7, Contractors are responsible for identifying hazards, maintaining records of them and tracking progress of hazard close out. Where, following the hazard mitigation structure shown in 3.6.5 (iii) above it is necessary to transfer that responsibility for close out to a Duty holder, then this shall be done in accordance with the Hazard Management Procedure [5]. For further information refer to section 4.2 of this System Safety Plan.	Crossrail Delivery Contracts require Contractors to maintain a system <u>Project Wide Hazard Record</u> – a hazard log to confirm all identified hazards are traced to successful resolution. The PWHR will be reviewed by the Crossrail System Safety organisation during progress meetings with the Contractor.	Crossrail - Project Wide Hazard Record Process (CRL1-XRL-O8-GPS-CR001-50013)
3.6.9	CRL shall ensure that Designers use an appropriate method of quantitative or qualitative risk assessment, depending upon the where in the Life Cycle the project has reached and the nature of the risks under consideration to evaluate them and the effectiveness of the controls that are developed. As an example, changes to a SIL 4 system shall be the subject of a rigorous quantitative risk assessment process to demonstrate that risks have been reduced to ALARP.	Crossrail Delivery Contracts require Contractors to use suitable & sufficient depth of risk assessment depending on the perceived risk, or whether the design is bespoke of included new/novel equipment. The approach is to be compliant with the EC Common Safety Method Regulation (CSM), with the exception at the central stations noted in 2.3.1 above.	Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001)
3.6.10	CRL's Directorates covering the central section and the rolling stock and depot are required to use the EC Regulation on CSM on Risk Assessment & Evaluation [22] to ensure that risks have been reduced to ALARP. CRL shall ensure that where it is considered to be appropriate, Cost Benefit Analysis (CBA) shall be carried out by Designers (based upon quantified analysis of collective risk) in support of demonstrating that risks have been reduced so	The overall confirmation of ALARP is traced in the Project Wide Hazard Record (PWHR) relating to the Delivery Contract. This will be either semi-quantitative "risk matrix" assessment or by quantitative risk analysis for high risk, now/novel or bespoke designs. Where quantitative analysis is justified, this will be in accordance with RSSB's Taking Safe Decisions [8] giving guidance for the factors to consider when undertaking Cost Benefit Analysis (CBA). Specific CBA risk assessments, where	Crossrail - Project Wide Hazard Record Process (CRL1-XRL-O8-GPS-CR001-50013) Crossrail Engineering Safety Management Hazard



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Section	Plan Requirement	Implementation/Delivery Responsibility	Document Reference
	<p>far as is reasonably practicable (SFAIRP). The ORR's Internal Guidance on CBA in Support of Safety-related Investment Decisions [23] and RSSB's Taking Safe Decisions [8] may be used by Designers as guidance for the factors to consider when undertaking CBA. It is to be noted that a CBA cannot form the sole determinant of a SFAIRP decision. When undertaking CBA, the most up to date figure of the Value of Preventing a Statistical Fatality shall be used.</p>	<p>required, will be referenced from the PWHR.</p> <p>For semi-quantitative assessment the CRL agreed risk matrix will be used (as per the Hazard Management Plan). For full quantitative risk assessment the Contractor will carry out analysis as previously advised and agreed in their <u>System Safety Plan</u>.</p>	<p>Management Procedure (CRL1-XRL-O8-GPD-CR001-50002)</p> <p>Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001)</p>
3.7.1	<p>The CRL's Directorate's are required to produce Engineering Safety Justifications or other means to demonstrate the efficacy of the design and that it can be constructed safely, operated and maintained safely in accordance with the relevant standards such that the associated safety risks will be tolerable and controlled to ALARP.</p> <p>In the case of civils infrastructure where a <i>Contractor</i> has been appointed to build a CRL engineer's design, the <i>Contractor</i> shall produce the evidence that he has built the specified design. CRL and relevant designer shall produce the Engineering Safety Justifications in accordance with the preceding paragraph.</p> <p>The Engineering Safety Justifications shall be integrated into the top level Safety Justifications, which are as follows:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Systemwide Safety Justification (covers signalling, track, traction power, data transmission systems, communications including radio) <input type="checkbox"/> Tunnels Safety Justification (also covers tunnel systems including ventilation systems) <input type="checkbox"/> Rolling Stock Safety Justification <input type="checkbox"/> Depot Systems Safety Justification <input type="checkbox"/> Station Safety Justifications (one for each station) <p>The up to date list of Safety Justifications and Engineering Safety Justifications that are to be produced shall be</p>	<p>The Delivery Contractor is required to provide, as appropriate to the contract, <u>Design Engineering Safety Justification(s)</u> – preliminary document to confirm design is fit for purpose prior to installation, testing & commissioning AND <u>Engineering Safety Justification(s)</u> – final document prepared at successful completion of T&C such that the sub sub-system can be safely brought into service.</p> <p>Such Engineering Safety Justifications will be available to Crossrail Technical Directorate who are managing the Interoperability interface with the NoBo/DeBo.</p> <p>(Refer also to 3.1.5 above).</p> <p>The relevant Project Engineers within the Crossrail Technical Directorate shall prepare the Safety Justifications for Systemwide, and Tunnels. The Operations Director shall prepare the Rolling Stock and Depot Systems Safety Justification. CRL shall prepare the Station Safety Justifications and provide input to LUL for each Central Stations Safety justification. To be defined by Crossrail Head of System Safety.</p>	<p>Crossrail Process and Format for Engineering Safety Justifications for Systems (CRL1-XRL-O8-GPS-CR001-50004)</p> <p>CRL Overall Safety Justification Format & Process (CRL1-XRL-O8-GPS-CR001-50012)</p>



Requirements of Crossrail Engineering Safety Management System Safety Plan CRL1-XRL-O7-GST-CR001-00001 v3.0			
Section	Plan Requirement	Implementation/Delivery Responsibility	Document Reference
	maintained by the CRL Technical Directorate.		
3.7.2	Each of the top level Safety Justifications defined in 3.7.1 and supporting Engineering safety Justifications above shall correctly interface with each other. This shall be done in accordance with the process described in section 3.7.8 below and this shall be checked in accordance with the Technical Assurance Strategy [2] by prior to submission, where this has been agreed, or to the relevant acceptance body.	Crossrail has established the System Integration Review Panel (SIRP) who will run workshops to ensure the integrated designs are consistent with the Crossrail Concept of Operations and other requirements of the IMs.	CRL Central Section System Integration Review Panel (SIRP) Workshop Guidelines (CRL1-XRL-O8-GUI-CR001-50001) and Action Tracker (CRL1-XRL-O8-LLG-CR001-50007)
3.7.3	For each station a single integrated safety justification shall be produced. There will not be a Safety Justification covering all the stations. The project has carried out extensive modelling of passenger flows for normal, abnormal, degraded, emergency operations, and evacuation, for each station taking into account the LUL Station Planning Standards and Guidelines and the CPFR and this has led to design requirements for each station which have been agreed with the representative of each of the future station IMs. This has also been used as part of the development of the Operations Concept [11]. The process that will be used to check the integration of each Station Safety Justification with the interfacing Safety Justifications is detailed in 3.7.8 of this SSP. Once accepted the Safety Justification will be used to produce an Operator's Assurance package (refer to [2]) to enable the future Duty Holder to adopt the appropriate requirements into its Safety Management System.	Crossrail has established the System Integration Review Panel (SIRP) who will run workshops to ensure the integrated designs are consistent with the Crossrail Concept of Operations and other requirements of the IMs. CRL shall prepare the Station Safety Justifications and provide input to LUL for each Central Stations Safety Justification. To be defined by Crossrail Head of System Safety.	CRL Central Section System Integration Review Panel (SIRP) Workshop Guidelines (CRL1-XRL-O8-GUI-CR001-50001) and Action Tracker (CRL1-XRL-O8-LLG-CR001-50007) CRL Overall Safety Justification Format & Process (CRL1-XRL-O8-GPS-CR001-50012)
3.7.4	The Engineering Safety Justifications shall provide evidence to support the contents of Operators' Assurance packages as specified in the Technical Assurance Strategy [2]. Part of each Engineering Safety Justification and the Rolling Stock System Safety Justification will consist of the Technical File(s) prepared by the NoBo containing the evidence of compliance with the relevant TSIs and NNTRs, together with the independent assessment report as mandated by the Common Safety Method for Risk Assessment Regulation, and other evidence as required by the RIR.	Crossrail will advise the Delivery Contractor of the format of the Engineering Safety Justification as required by the CRL System Safety Plan section 3.7.1. The Contractor provided Engineering Safety Justifications will be supporting documents to the overall Crossrail Safety Justification(s) – see 3.7.1.	Crossrail Process and Format for Engineering Safety Justifications for Systems (CRL1-XRL-O8-GPS-CR001-50004)
3.7.5	Required Engineering Safety Justifications / other safety documentation covering assets or systems for which LUL is	Crossrail will advise the Delivery Contractor of the format of the Engineering Safety Justification as required by the CRL System	Crossrail Process and Format for Engineering Safety Justifications for Systems (CRL1-XRL-O8-GPS-



Requirements of Crossrail Engineering Safety Management System Safety Plan CRL1-XRL-O7-GST-CR001-00001 v3.0			
Section	Plan Requirement	Implementation/Delivery Responsibility	Document Reference
	designated as the IM, shall be produced in conformity with LUL's Safety Certificate / Authorisation document.	Safety Plan section 3.7.1. The Contractor provided Engineering Safety Justifications will be supporting documents to the overall Crossrail Safety Justification(s) – see 3.7.1.	CR001-50004)
3.7.6	<p>The safety of any system comes from a combination of the engineering, operations and maintenance arrangements. CRL shall be responsible for the first and last of these factors by ensuring that the individual contract packages for which they are responsible are correctly designed and built with suitable maintenance instructions, and are properly integrated to enable the delivery of a complete railway, using the process described in 3.7.8.</p> <p>CRL is responsible for developing the Concept of Operations with the support of relevant stake holders, to specify the operating assumptions which the design must take account of. Ultimately these will lead to the Rule Book, Minimum Operating Requirements, the Engineering Access Statement and Planning Rules for Crossrail.</p> <p>The objective is that the Engineering Safety Justifications integrate with each other such that the engineering, operational and maintenance functions will enable the railway to function correctly as per the Concept of Operations and meet the Joint Sponsors' and legal requirements. This evidence will be checked by CRL prior to submission to the appropriate acceptance body. (See also 3.7.8 below)</p>	<p>The Delivery Contractor is required to provide, as appropriate to the contract, <u>Design Engineering Safety Justification(s)</u> – preliminary document to confirm design is fit for purpose prior to installation, testing & commissioning AND <u>Engineering Safety Justification(s)</u> – final document prepared at successful completion of T&C such that the sub sub-system can be safely brought into service.</p> <p>(Refer also to 3.1.5 above)</p> <p>Contractors have also to prepare an Interface Hazard Analysis (IHA), and to explain in their <u>System Safety Plan</u> how interface hazards are addressed to a successful resolution. The IHA will be reviewed and accepted by the Crossrail Project and is an input to the Engineering Safety Justifications prepared by the Contractor.</p>	Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001)
3.7.7	The precise make up and scope of the different elements of the safety evidence will evolve as the design develops, and shall be agreed between the CRL Directorates, Project Engineers and CRL Technical Director. The planned delivery process is illustrated in Figure 1 below.	Crossrail will advise the Contractor of the format of the Engineering Safety Justification as required by the CRL System Safety Plan section 3.7.1.	Crossrail Process and Format for Engineering Safety Justifications for Systems (CRL1-XRL-O8-GPS-CR001-50004)
3.7.8	The method of integration of the top level System Safety Justifications with the Concept of Operations shall be as follows:	Crossrail has established the System Integration review Panel (SIRP) who will run workshops to ensure the integrated designs are consistent with the Crossrail Concept of Operations and other requirements of the IMs.	CRL Central Section System Integration Review Panel (SIRP) Workshop Guidelines (CRL1-XRL-O8-GUI-CR001-50001) and Action Tracker (CRL1-XRL-O8-LLG-CR001-50007)



Requirements of Crossrail Engineering Safety Management System Safety Plan CRL1-XRL-O7-GST-CR001-00001 v3.0			
Section	Plan Requirement	Implementation/Delivery Responsibility	Document Reference
3.8.1	Safety activities associated with the Crossrail project shall be in accordance with the safety requirements contained in the relevant TSIs, NNTRs, NSRs, EC Regulation on CSM on Risk Assessment and Evaluation, together with those standards listed in the Standards Baseline	Crossrail Delivery Contractors are required to prepare a <u>Safety Requirements Specification</u> – as per BS EN 50126 (alternatively may be flagged as safety related in the overall System Requirements Specification for the system, if one is prepared)	Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001)
3.8.3	It is anticipated that CRL and Contractors shall have to draw up specific standards for adoption by the future Duty Holders, in addition to Operating and Maintenance Manuals. After internal review by the Project Engineers as appropriate these shall be submitted via the CRL to the relevant Acceptance Body on behalf of the future Duty Holder depending upon the agreement with that Duty Holder. Where applicable under the RIR, standards shall be proposed to the Competent Authority by CRL as Notified National Technical Rules applicable to Crossrail.	The Contractor prepared maintenance schedules demonstrate that the design permits the maintenance of the system to be carried out safely and to have the specified RAM. These are to be incorporated into the relevant Engineering Safety Justification for the system.	Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001)
3.8.4	The Standards Management Procedure [26] defines the process for obtaining acceptance for non-compliance or derogations to standards.	Crossrail Delivery Contracts require Contractors to confirm in their <u>System Safety Plan</u> how concessions against standards are to be safety justified and reported in the Engineering Safety Justifications.	Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001)
3.9.3	CRL shall undertake regular audits and surveillance of the Designers' engineering safety management activities through out the life cycle of the Project.	Crossrail Delivery Contracts require Contractors to define the schedule of safety auditing against system(s) lifecycle activities (may be included in QA programme). This is to include both internal and external auditing & surveillance.	Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001)
3.9.4	Where the CRL Directorate or associated Contractor, proposes the use of an Independent Safety Assessor (ISA) or an Independent Software Assessor (ISwA), for example where the use of software requiring a particular Safety Integrity Level that has not been previously justified, the proposer shall provide evidence of the competence of the ISA or ISwA. In particular CRL shall confirm (or otherwise) the acceptance of the competence of the individual(s) concerned and their remit prior	Crossrail Delivery Contracts require Contractors to identify in advance in the <u>System Safety Plan</u> and <u>System Software Safety Plan</u> the requirements for Independent Safety Assessment and Independent Software Assessment. The proposed organisations to carry out these independent assessments are to be agreed in advance with the Crossrail Project.	Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001)



Requirements of Crossrail Engineering Safety Management System Safety Plan CRL1-XRL-O7-GST-CR001-00001 v3.0			
Section	Plan Requirement	Implementation/Delivery Responsibility	Document Reference
	to their appointment. For the ONW NR shall be responsible for determining their own arrangements in accordance with their SMS.		
3.9.5	The appointment of an Independent Assessor under the EC Regulation on CSM on Risk Assessment and Evaluation shall meet the requirements specified in that Regulation.	Crossrail Technical Directorate will appoint an Independent Assessment Body under the CSM Regulations and manage these activities.	Baseline Requirement - Included as part of the Interoperability Services procurement document Contract X2228 Volume 2A Scope of Services. CRL Technical Directorate.
3.9.6	It should be noted that in accordance with the RIR the NoBo(s) / DeBo(s) have the right to undertake audits as required by the relevant TSIs /NNTRs.	Delivery Contractor to note and allow access as required. Crossrail Technical Directorate will directly manage the activities of the NoBo/DeBo.	Baseline Requirement - Included as part of the Interoperability Services procurement document Contract X2228 Volume 2A Scope of Services. CRL Technical Directorate.
3.10.1	The Project Contractors have contractual obligations to produce and operate their own Safety Plan that shall take into account the requirements of this CRL System Safety Plan. All Contractors' System Safety Plans are subject to approval by the CRL before any design work commences.	At the tender stage prospective Contractors are required to prepare a <u>Preliminary System Safety Plan</u> – to enable Crossrail to evaluate each tender's ESM capabilities. A points scoring system will be used based on the recommended contents of the Crossrail ESM <u>System Safety Plan</u> . The same process will be used to evaluate final <u>System Safety Plans</u> to be provided at award of Contract.	Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001)
3.10.2	The processes being developed within the procurement strategy shall ensure that Project Contractors follow ESM practice that is appropriate to the services they are providing as part of the project.	Crossrail Delivery Contracts require the Contractors to prepare prior to procurement a <u>Product Breakdown Structure(s)</u> – to confirm the existing proven use of equipment proposed in the system design prior to procurement AND <u>Product Safety Case(s)</u> – as, and if, required owing to the proposed use of new/novel or bespoke equipment and prior to procurement	Crossrail Process and Format for Product Breakdown Structures for Systems (CRL1-XRL-O8-GPS-CR001-50002)
3.10.3	The activities of the Project Contractor shall be planned and defined in their relevant safety plans, which shall be reviewed by the relevant Project Engineer as appropriate.	Crossrail Delivery Contracts require the Contractor prepare <u>System Safety Plan</u> – to establish a consistent ESM approach, agree preliminary list of contract ESM deliverables and programme for their delivery. The Plan is accepted by the Crossrail Project.	Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001)
3.12.1	Competence requirements for staff leading safety analysis activities on the Crossrail Project and the process for assuring this competence are described in the Competence	Crossrail Delivery Contracts require Contractors to demonstrate ESM competency to confirm the relevant Contractor engineering safety management staff are suitably qualified and	Crossrail Competency Management Procedure (CR/QMS/DEV/P/0131)



Requirements of Crossrail Engineering Safety Management System Safety Plan CRL1-XRL-O7-GST-CR001-00001 v3.0			
Section	Plan Requirement	Implementation/Delivery Responsibility	Document Reference
	Management Procedure [28].	experienced.	Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001)
4.1.1	CRL shall undertake the review and approval of documentation (such as Safety Justifications) produced both internally by the project and externally for the Central Section and its interfaces. For each of the other Safety Justifications, the document(s) shall be accepted according to the process agreed by CRL with the Duty Holder under the ROGs.	Crossrail Delivery Contracts define the standard ESM deliverables requirements and the approval routes internally for the Contractor, and by the Crossrail Project. The Crossrail Technical Directorate will maintain an overall <u>ESM Deliverables Schedule</u> to trace the timely approvals of these documents. This will include deliverables from all Delivery Contractors as well as those from Crossrail.	Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001) CRL Technical Directorate - Crossrail Review and Approval of Contract Engineering Safety Management Deliverables (CRL1-XRL-O8-GPS-CR001-50015)
4.1.2	Documents shall be produced to the standards detailed in 3.8 above.	Crossrail Delivery Contracts require Contractors to specify in their <u>System Safety Plan</u> the format and contents of the key engineering safety deliverables for agreement in advance of their preparation.	Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001)
4.1.3	Documents due to be submitted to Duty Holders shall be subject to review and endorsement by appropriate personnel within the CRL Project prior to their submission.	Crossrail Delivery Contracts require Contractors to outline the internal approval process for engineering safety deliverables in their System Safety Plan.	Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001)
4.2.1	The Hazard Management Procedure [5] specifies the process by which hazards shall be managed across the project.	The Hazard Management Procedure details the process by which Contractors shall identify record and rank hazards and the process to be followed when a contractor wishes to transfer a hazard to another Contractor, Crossrail or future Duty Holder. The Contractor shall reference this process in his SSP.	Crossrail Engineering Safety Management Hazard Management Procedure (CRL1-XRL-O8-GPD-CR001-50002)
4.2.2	The Safety Issues File will be a 'live document' maintained by the CRL Technical Director, which records details of hazards and risk control actions for the future Duty Holders identified during safety analyses of the Works design and which have been transferred between parties or to Duty Holders with the agreement of CRL.	Crossrail has established a <u>Safety Issues File</u> database to trace to successful resolution those risks to be mitigated through operational, emergency and maintenance procedures. The database will be populated following review of the various Contractor's PWHR, and other risk assessments and analyses.	Crossrail Safety Issues File (SIF) and Action Tracker Report (CRL1-XRL-O8-LLG-CR001-50001)
4.2.3	Hazard mitigation shall be as described in 3.6.7 of this System	Crossrail will ensure Delivery Contractors comply with the	Standard Engineering Safety Management



Requirements of Crossrail Engineering Safety Management System Safety Plan CRL1-XRL-O7-GST-CR001-00001 v3.0			
Section	Plan Requirement	Implementation/Delivery Responsibility	Document Reference
	Safety Plan.	hazard mitigation requirements described in 3.6.7. Proposed mitigation requirements are recorded in the PWHR for the system. The Crossrail engineering safety organisation will review these proposals during progress meetings with the Contractor.	Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001)
4.2.4	CRL shall ensure that Hazard Records being populated by the Designers for which they responsible are properly maintained through the lifecycle of the project, as part of their Engineering Safety Management (ESM) activities. Hazards that are transferred in accord with the Hazard Management Procedure shall be recorded in the Safety Issues File by CRL.	Crossrail will comply in full with the Hazard Management Procedure [5].	Crossrail Engineering Safety Management Hazard Management Procedure (CRL1-XRL-O8-GPD-CR001-50002)
4.2.5	All hazards identified and recorded in the Safety Issues Log will become project safety issues and tracked until closed out. Those hazards within the Safety Issues Log that relate to design issues and referred back to the relevant Designers shall be tracked until CRL agree that they have been closed out.	The method of closure of issues in the Safety Issues File will be managed via the <u>Crossrail Hazard Review Panel</u> as defined in the Terms of Reference.	Crossrail Hazard Review Panel Terms of Reference (CRL1-XRL-O8-GPS-CR001-50009)
4.3.1	The Project Engineer shall ensure that an appropriate Data Reporting, Analysis & Corrective Action System (DRACAS) will be used by their contractors to gather information on the types and causes of faults arising during the testing and commissioning process, and investigating all incidents from the point at which a version of the system approximating to the final operational version is available. This will ensure that action to correct faults will be taken in a controlled manner. This system will also be used to initiate any changes to the systems that are required during system testing, trial running and commissioning.	The Testing and Commissioning process is describes in the Testing & Commissioning Strategy (where DRACAS is named Punchlist). A DRACAS type system is to be implemented post issue of IRN for a system. This will be covered in the Testing and Commissioning Plan. This will record assessment of investigations into fault. The assessment of faults will include investigations into the cause and effect of possible faults. The effects of the faults will be ranked and candidate solutions provided for unacceptable effects. The assessment of the effects of faults may be co-ordinated together with the RAM(S) Engineering activities, as both are concerned with the identification of potential faults and their subsequent effects on system operability.	Testing and Commissioning Strategy (CRL1-XRL-O8-STP-CR001-50008)
5.1.4	CRL shall review and accept or otherwise lists of safety documentation produced by Designers.	Crossrail Delivery Contracts define the standard ESM deliverables requirements and the approval routes internally for the Contractor, and by the Crossrail Project. The Crossrail Technical Directorate will maintain an overall <u>ESM Deliverables Schedule</u> to trace the timely approvals of these documents. This will include deliverables from all Delivery Contractors as	Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-O8-GPD-CRG03-50001)



Requirements of Crossrail Engineering Safety Management System Safety Plan CRL1-XRL-07-GST-CR001-00001 v3.0			
Section	Plan Requirement	Implementation/Delivery Responsibility	Document Reference
		well as those from Crossrail.	
6.1.2	CRL shall ensure that Contractors undertaking design activities produce System Safety Plans covering their ESM activities, which shall be reviewed and accepted by CRL Verification and Validation.	Crossrail Delivery Contracts require the Contractor prepare <u>System Safety Plan</u> – to establish a consistent ESM approach, agree preliminary list of contract ESM deliverables and programme for their delivery. The Plan is accepted by the Crossrail Project.	Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification (CRL1-XRL-08-GPD-CRG03-50001)



Appendix B - Crossrail Technical Directorate – Engineering Safety Management Process Procedures

Document Number	Document Title
CRL1-PDP-Z-ZTM-CR001-00003	CRL Technical Directorate - Engineering Safety Management – System Safety Plan
CRL1-XRL-O8-STP-CR001-50007	CRL Technical Directorate - Engineering Safety Management - System Safety Plan Implementation Strategy
CRL1-XRL-O8-GPD-CRG03-50001	Crossrail Delivery Contracts Standard Engineering Safety Management Requirements Specification
CRL1-XRL-O8-GUI-CR001-50001	CRL Central Section System Integration Review Panel (SIRP) Workshop Guidelines
CRL1-XRL-O8-TSC-CR001-50001	CRL Overall ESM Deliverables Schedule
CRL1-XRL-O8-GPD-CR001-50002	Crossrail Engineering Safety Management Hazard Management Procedure
CRL1-XRL-O8-GPS-CR001-50013	Crossrail Central - Project Wide Hazard Record (PWHR) Process
CRL1-XRL-O8-GPS-CR001-50010	CRL Guidelines and Etiquette for Undertaking HAZID and HAZOP Workshops
CRL1-XRL-O8-GPS-CR001-50002	Crossrail Process and Format for Product Breakdown Structures for Systems
CRL1-XRL-O8-GPS-CR001-50003	Crossrail Common Safety Method Hazard Assessment Process
CRL1-XRL-O8-GPS-CR001-50004	Crossrail Process and Format for Engineering Safety Justifications for Systems
CRL1-XRL-O8-GPS-CR001-50005	Crossrail FDC Assurance Stage Gate Engineering Safety Management Review Process
CRL1-XRL-O8-GPS-CR001-50006	Crossrail Delivery Contracts Engineering Safety Management Surveillance and Audit Process
CRL1-XRL-O8-GPS-CR001-50009	Crossrail Hazard Review Panel Terms of Reference
CRL1-XRL-O8-LLG-CR001-50007	Crossrail SIRP Workshop Action Tracker Status Report
CRL1-XRL-O8-LLG-CR001-50001	Crossrail Safety Issues File (SIF) and Action Tracker Report (including process procedure)
CRL1-XRL-O8-GPS-CR001-50007	Crossrail Process and Format for Comparative Risk Assessments
CRL1-XRL-O8-GPS-CR001-50011	CRL Process for Managing Technical Specifications for Interoperability and Notified National Technical Rules.
CRL1-XRL-O8-GPS-CR001-50012	CRL Overall Safety Justification Format & Process
CRL1-XRL-O8-GPS-CR001-50014	Crossrail Design & Build Contract Assurance Stage Gate Engineering Safety Management Review Process
CRL1-XRL-O8-GPS-CR001-50015	Crossrail Review and Approval of Contract Engineering Safety Management Deliverables



Appendix C - ESM Roles and Responsibilities

C.1. Overview

- C.1.1. The Crossrail Project safety organisation is shown in Crossrail's intranet Connect Online>Organisation home page.
- C.1.2. The key responsibility of hazard management lies within the CRL Technical Directorate under the direction of the Head of System Safety. Figure 2 below shows the structure within the CRL System Safety Team.

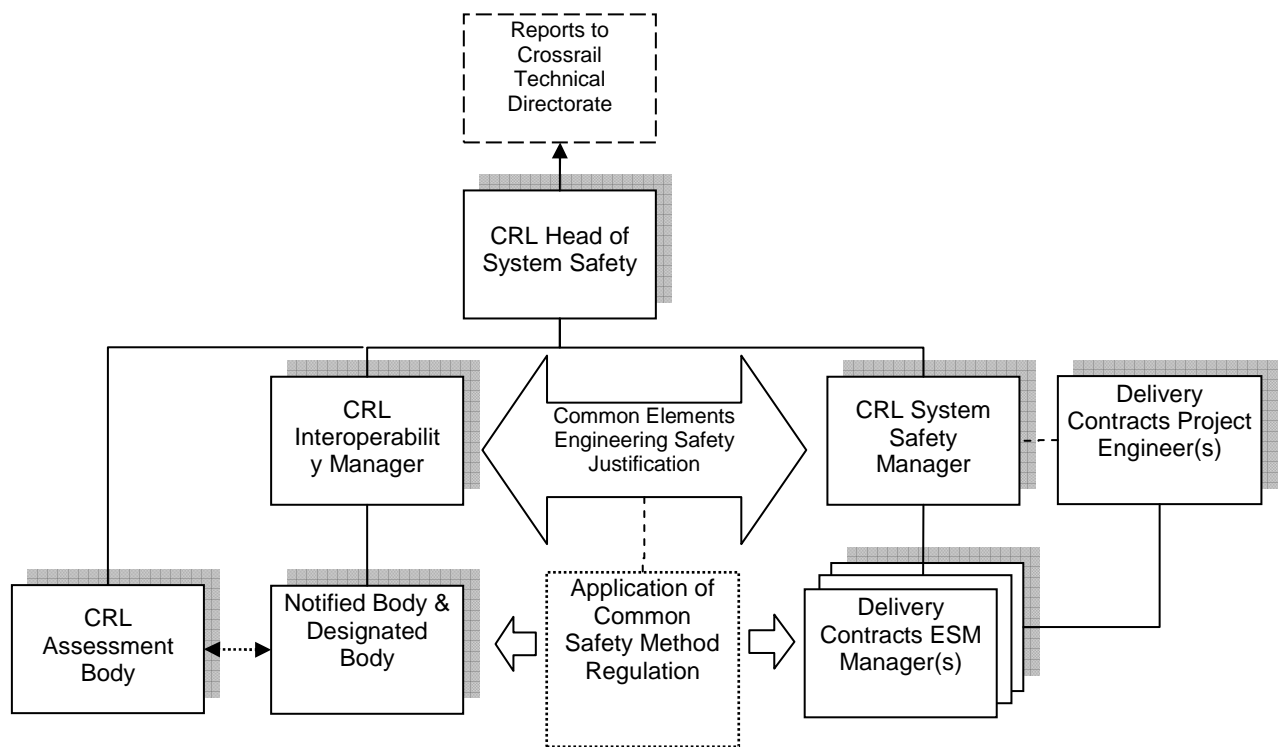


Figure 2 – Crossrail's System Safety Organisation

- C.1.3. The key responsibilities for those roles and bodies responsible for hazard management are given in the following sections.

C.2. CRL Head of System Safety

- C.2.1. The responsibilities of the CRL Head of System Safety include:

- Developing, implementing and maintaining Crossrail's ESM System Safety Plan [1] and to provide evidence of compliance with the relevant railway legislation including RIR, ROGS and CSM Regulation;
- Providing a framework for ESM activities to be undertaken by the Designers;
- Reviewing System Safety Plans developed by Designers;



- Acting as a point of contact for the client and stakeholders for all ESM issues and liaising with Designers;
- Managing the development of the PWHR [4];
- Having overall control of the PWHR and strategy for hazard closure;
- Chairing the HRP and responsible for managing SIF;
- Managing the independent Assessment Body (AsBo) in its assessment of conformity of CRL and its Contractors with CSM Regulation;
- Checking that the risk information in the PWHR is kept up to date by contributors;
- Checking that the Crossrail Project HRP is made aware of any assistance or support that is required;
- Liaising with the Systems Integration Review Panel (SIRP) and the Maintenance Integration Review Panel (MIRP).

C.3. CRL System Safety Manager

C.3.1. The responsibilities of the CRL System Safety Manager include:

- Reviewing System Safety Plans developed by Contractors;
- Liaising with the Contractors Safety Engineers;
- Monitoring ESM activities undertaken by the Designers;
- Carrying out surveillance to check that the identification of operational risks is being undertaken by the Designers, including the tracking and close out actions needed to control those risks;
- Having overall control with full editorial rights to add entries and to modify entries in the PWHR;
- Responsibility for reviewing hazards and endorsing any change of hazard status and reporting to the HRP;
- Actively seeking to arbitrate on difficult safety issues and facilitate appropriate transfer of hazards between Design teams;
- Reviewing Safety Reports generated by the Contractors;
- Assisting in the management of the AsBo in its assessment of conformity of CRL and its Contractors with CSM Regulation.

C.4. CRL Interoperability Manager

C.4.1. The responsibilities of the CRL Interoperability Manager include:

- Managing the NoBo/DeBo in developing, maintaining and monitoring an overall plan to facilitate TSI/NNTR compliance of CRL and its Contractors in conformance with the RIR;
- Assisting in the management of the AsBo in its assessment of conformity of CRL and its Contractors with CSM Regulation;



- Leading the identification of the need for derogations against TSIs and the requirement for CRL specific NNTRs;
- Checking that the development of applications for derogations are robust;
- Reviewing Safety Reports generated by the Contractors;
- Supporting the management of the PWHR, including reviewing hazards and endorsing any change of hazard status.

C.5. Contractors

C.5.1. The Contractors are responsible for appointing a person(s) to carry out the following responsibilities:

- Discharging the ESM requirements of contracts including development of Engineering Safety Justifications;
- Cooperating with the CRL NoBo/DeBo/AsBo in providing the necessary evidence to confirm compliance with the RIR and CSM Regulation;
- Undertaking Hazard Assessments, including risk mitigation of the elements of the design that are the responsibility of their organisation;
- Keeping the records of the hazards within the design that are the responsibility of their organisation up to date in the PWHR [4];
- Liaising with the CRL Head of System Safety for all ESM issues.

C.6. Assessment Body

C.6.1. The AsBo is an independent organisation appointed by CRL and responsible for:

- An independent assessment of the correct application of the risk management process under the CSM Regulation [2];
- Preparing Safety Assessment Report(s) as required by the CSM Regulation.

C.6.2. Duplication of work carried out by the NoBo or DeBo in accordance with the CSM Regulation should be avoided.