CRL Railway-Level Hazard Structure

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Technical Assurance

CRL Railway – Level Hazard Structure

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Document History:

Rev	Date:	Prepared by:	Checked by:	Approved by:	Reason for Issue
0.1	31-1-2017	J Bates	-	-	Initial discussion at RABC
1.0	22-3-2017	P Brown J Bates	C Wong	M Kilby	Endorsement at RABC
2.0	27-4-2017	J Bates	C Wong	M Kilby	Update with RABC comments
3.0	28-4-2022	R Nobile	M Scoble	H Zerkani	Issued for Information
Signature					

Revision Changes:

Revision	Status / Description of Changes
1.0	New
2.0	RABA-C comments addressed
3.0	Safety requirements listed in the RLHS have been aligned with the latest 12 SEJs approved by RAB-C and AsBo

Contents

Introduction

As part of the overall safety justification for Crossrail Central Operating Section (plus interfaces), CRL has produced a Railway-Level Hazard Structure in order to describe how the railway will mitigate to ALARP the most significant hazards.

This Railway-Level Hazard Structure should be utilised by the project and RAB(C) in assessing the overall coverage and logic of the many separate safety justifications (SJs) for each system, station, shaft and portal. This should contribute to the overall integration of Crossrail across contractual boundaries and provide assurance that the combination and integration of each of the SJs add up to a safe overall system.

This work builds upon the established Engineering Strategy documents which shaped the initial design stage (completed by the Framework Design Consultants) and have been cascaded into the Design and Build contracts for the final design.

A number of workshops were held in January 2017 to progress this work, the conclusions of which are presented in this paper. A draft of this paper was discussed at the RAB-C meeting on 1 February 2017. The comments received at RAB-C were addressed in revision 2 of this document.

1 Purpose

The purpose of this document is to present the Railway-Level Hazard Structure for the Central Operating Section and interfaces with the surface sections (GE, GW and NKL).

This analysis allows the logical link to be understood between the following:

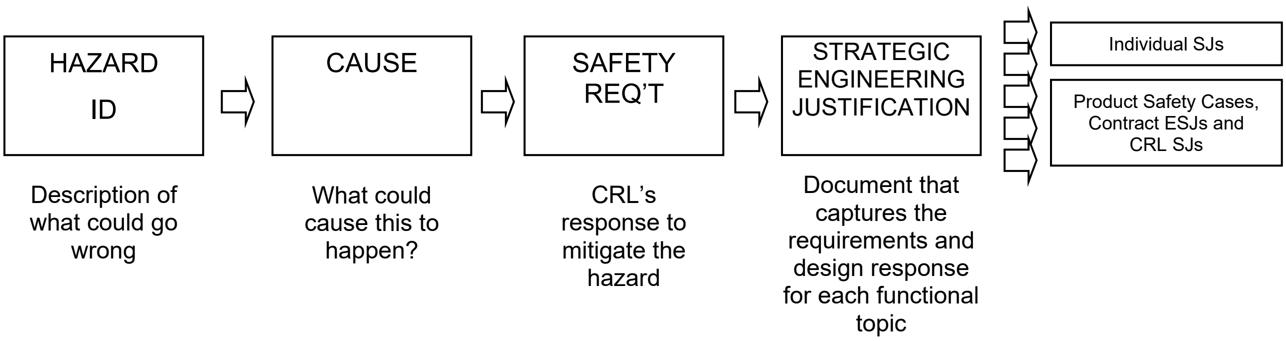

Figure 1: Logic flow from Hazard ID through to Engineering Justification

Through demonstration of this hazard structure, the overall safety argument as to how CRL has mitigated the significant hazards is supported. This informs the Project (and RAB-C) as to how the requirements have been captured in appropriate documentation to deliver the intended mitigations (see section 7).
This should facilitate the approval of individual safety justifications for Elements or systems as it allows their contribution to the overall safety case to be better understood. It also enables the individual safety justifications to be simplified and avoid repetition of the line-wide safety arguments in each one.

1.1 Compliance with CSM

ORR guidance on Common Safety Method for risk evaluation and assessment [ref 1] states that “when any significant safety related change of a technical, operational or organisational nature is proposed to the mainline railway, compliance with the risk management process of the CSM RA should produce a suitable and sufficient risk assessment for that change”.

The framework of the risk management process is based on the analysis and evaluation of hazards using one or more of the following risk acceptance principles:

- application of codes of practice;
- comparison with similar systems (reference systems); and
- explicit risk estimation.

The Strategic Engineering Justifications have therefore identified which of the above methods have been used in arriving at their conclusions. It should also be noted that this approach is integrated into the project lifecycle, therefore the Railway-Level Hazard Structure should be viewed as an evolving document and has been updated as the project moved through the conclusion of design, test & commissioning and trial running.

The CSM risk management process also calls for Safety Requirements to be identified as a result of the risk assessment. In this case, those requirements have been articulated in detail within the Strategic Engineering Justifications and outlined at a high level within the Railway-Level Hazard Structure (see section 7).

CSM requires capture of the hazards within a hazard record – as such, the output of this workstream has been populated into a hazard log within the PWHR to capture all credible railway-level hazards and their proposed risk control actions (RCA’s).

CRL is confident that this is a comprehensive Railway-Level Hazard Structure with all credible hazards identified because:

- Based on the RSSB Hazardous Event Description [Ref 3]
- Builds upon the CRL PWHR Generic hazard list [Ref 2]
- Checked against LULs Network Risk Profile [Ref 4]
- Input from the train accident risk model
- Reviewed in a series of workshops with competent participants

However, it is fully recognised that this is a live document and has been updated during the project life cycle and handed over to the Duty Holders.

2 Scope

The scope of this document is limited to the Central Operating Section of Crossrail, including interfaces with the NR surface sections. It also includes interfaces with the Rolling Stock and Yellow Plant. The scope includes consideration of how the technical systems interact with the people, processes and systems of the various Operators.

The scope has covered high level railway hazards for normal, amended, degraded and emergency at the design stage.

3 Physical / Political / Societal Constraints (parameters) on Crossrail with related safety consequences

To build the COS within the existing constraints of subterranean London and interface with existing LU infrastructure and the NR surface routes, presented significant physical, political and societal challenges. In overcoming these challenges, the physical infrastructure resulted in a number of characteristics which have safety related consequences which need to be addressed by the design wherever possible, but many require the future IM to apply RCAs.
For example, but not limited to:

1. Steep gradients (1:30 and 1:27.5 to interface with NR on the GW and GE respectively) These gradients have safety consequences which require both design and operational mitigations.
2. Track alignment (with consequences on RCF, Rail durability, Noise, Ride Quality)
3. Different signalling systems on surface section - safety over the transitions
4. Noise and vibration requirements - soft track, constrains TVS
5. Limits of Deviation (LoD) – limits flexibility of infrastructure e.g. Tunnel diameter and Cross passages limited by alignment of tunnels in some locations
6. Architectural vision – e.g. GFRC panels, Working at height
7. Passenger numbers – physically sizes the stations
8. Maintenance window (limited time)
9. Interface with existing (old) infrastructure

4 High level design principles to achieve a safe railway

The constraints identified in section 3 above were provided as inputs into the design process at the beginning of the project and were evolved together with the concept design utilising some high-level principles. The principles were collated into one list via a series of workshops held in January 2017. They were assembled from the inputs of subject matter experts across the various disciplines and then peer reviewed.

A number of these design principles are identified in the hazard model as key mitigations for the hazards.

TRAIN DESIGN

1. Train Infrastructure Interface Specifications (TIIS) and Depot Interface Specifications (DIS) were established to achieve safe train to infrastructure/depot design. (Using a reference train design)
2. Wherever possible, keep the train moving in the event of a failure/fault/emergency in order to reach next station as this is the safest and quickest method of evacuating passengers
   - Train design – dual traction architecture etc.
   - Traction Power and Overhead line equipment (fixed beam)
   - Station design

   - Signalling reliability and intervention features, and timetabling combined – designed to avoid holding trains between stations
3. Reduce train driver human error through use of ATP and ATO (CBTC)
4. Minimise risk of heat exhaustion / effects on passengers on train and stations through:
   - Minimise tunnel heating; utilise TVS to provide cooling
   - Air-conditioned trains which remain operational within tunnel section when stopped (integrated with TVS)
   - Station extract / temp regulation through movement of air
5. Train is designed to facilitate passenger movement through open gangways
   - Security benefit
   - Ability to move away from a localised fire / incident
   - Reduces vandalism
   - Maximise passenger numbers safely to mitigate overcrowding
   - HVAC system “fire mode” on train
6. Optimise alignment to suit specific train characteristics and ATO speed profile. Minimise RCF generation by integrated wheel/rail interface design resulting in head hardened rail, correct wheel profile, flange lubrication (on board and trackside), maintenance regime with rail milling machine/profiler, defect detection via train monitoring system. Lightweight trains, minimise unsprung mass, bogie dynamics (T gamma and rotational stiffness)

GENERAL

7. Use of proven technology (minimising the use of new/novel technologies/systems)
8. Use of recognised, applicable and coherent set of standards wherever possible
9. Plan for force majeure e.g. flooding, storms, heat
10. Minimise consequences of “failure on demand” incidents e.g. utilise reliable systems that are generally in use. (“if you don’t use it, it might not work when you need it”). Good example is tunnel vent system where it is used regularly in non-emergency mode.
11. Use of Operational and Maintenance Concepts to check integrated functionality that delivers a safe railway that can be operated and maintained safely. These concepts were developed building on existing rules and regulations from HAL / LUL and NR railways. Signalling Operating Principles further detailed this for signalling systems use case.
12. Line-wide strategies to address key hazards

RAIL SYSTEMS

13. Wherever possible, avoid single point of failure of any system or combination of systems (e.g. A&B HV supply, UPS, Data network, Traction Power supply)
14. Minimise human interaction with physical infrastructure wherever possible through use of Remote Condition Monitoring, on-train infrastructure monitoring and analytics. Minimise trackside equipment (e.g. signalling equipment at stations, not along track)

15. Derailment containment only require in areas of high consequence e.g. cross overs, Stepney green junction, Connaught tunnel. All plain line tunnel sections do not require this (confirmed via QRA study, based on secondary collision being avoided)

TUNNELS / EVACUATION / INTERVENTION

16. If evacuation in tunnel is required, create a place of relative safety in the tunnel through the use of tunnel ventilation (smoke removal), high level walkway, illumination, signage, communication, evacuation points
17. Provide quick and safe access for emergency services via the non-incident tunnel (utilising intervention shafts and cross passages)
18. Reduce human error in other rail systems through use of automated (and semi-automated), standardised responses
    - Tunnel vent
    - Possession management
    - RCM reduces physical intervention
19. Guided by sub surface regulations (section 12). Compliance with TSIs and RGS 8270 (compatibility)

STATIONS

20. Stations design:
    - Legion and PED modelling – appropriate special design (e.g. platform width)
    - Evacuation modelling / sizing
    - Integrated stations with single control (at LUL stations), incorporating separation
    - Platform screen doors
21. Terrorism – blast loading for station components, bollards etc.
22. Manage PTI risk via level boarding and PSDs on underground stations. Use of DOO CCTV to manage PTI on surface stations. Platform plungers on Custom House / Abbey Wood
23. Controlling smoke at stations. Full height PSD/PED. Over platform extraction.

5 Description of Hazard Model

The Railway-Level Hazard Structure was developed with reference to the CRL PWHR Generic hazard list [Ref 2], the RSSB Hazardous Event Description [Ref 3] and LULs Network Risk Profile [Ref 4]. It has been structured in compliance with the CSM Risk Assessment process and identified high level safety requirements which have been demonstrated subsequently in the Strategic Engineering Justifications.

The top level of the model is split into 7 sections (Fig 2), with the modes of operation based upon the RfLI Minimum Operating Requirements definition [Ref 6]:

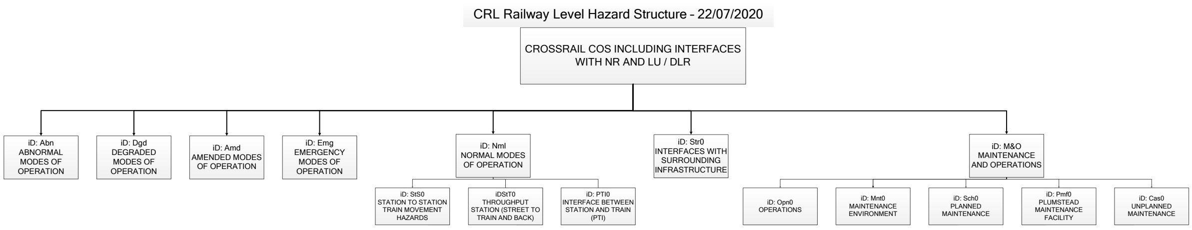

Fig 2: Railway Level Hazard Structure

In each of the sections, the main hazards, causes and requirements are structured as per Figure 3 below:

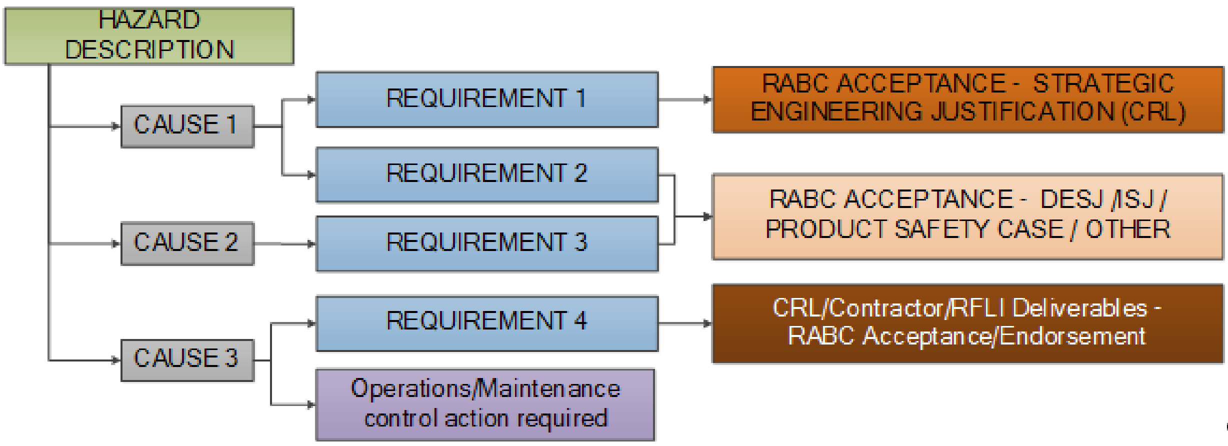

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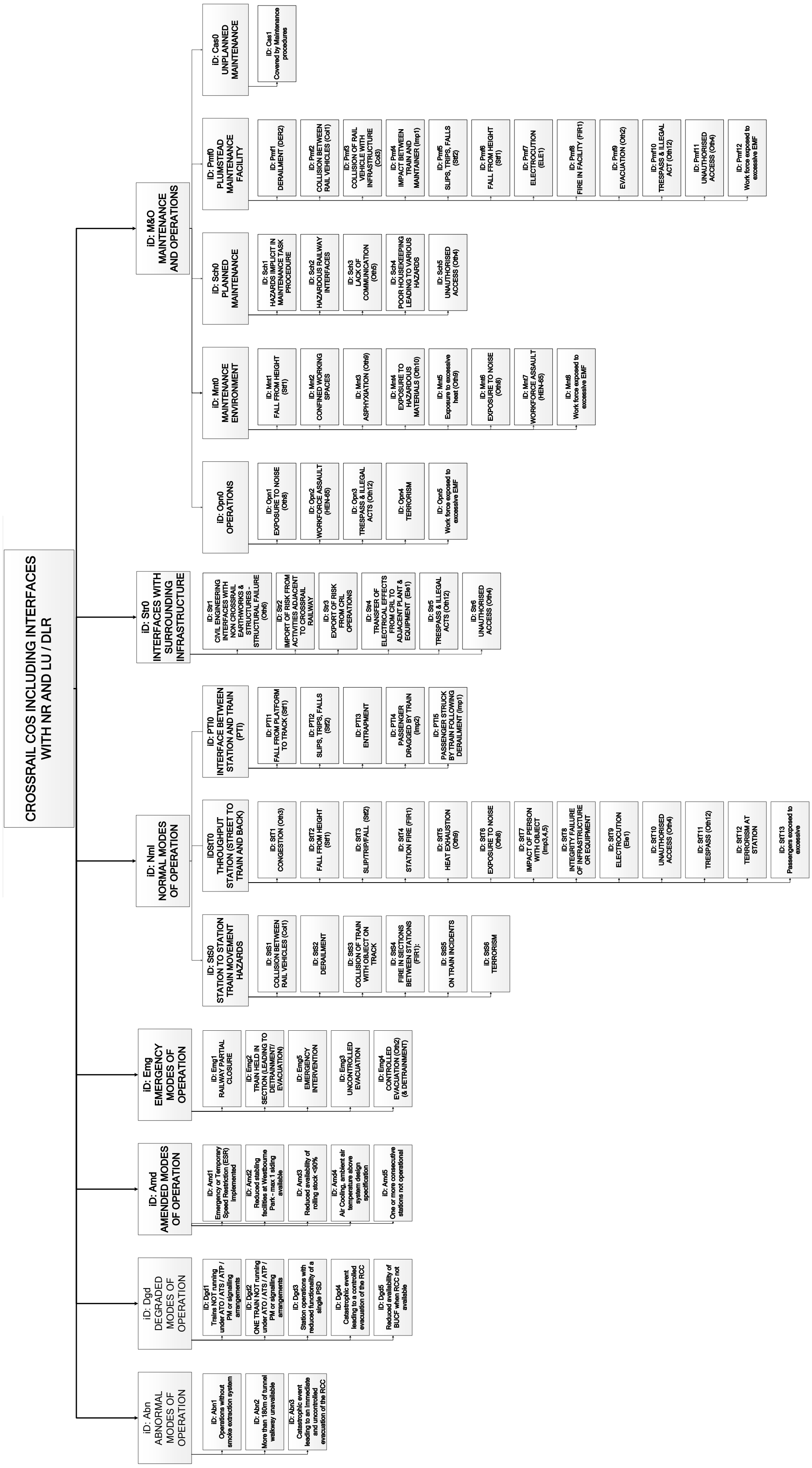
Fig 3: Generic Structure

Purple colour denotes a Duty Holder and can mean LUL, RfLI, MTR-EL, NR, DLR, LO etc.

A more detailed overview of the hazard structure is shown below:



6 Strategies & Strategic Engineering Justifications

The process by which the Railway-Level Hazard Structure and the associated requirements, safety justifications are produced is outlined in figure 4 below:

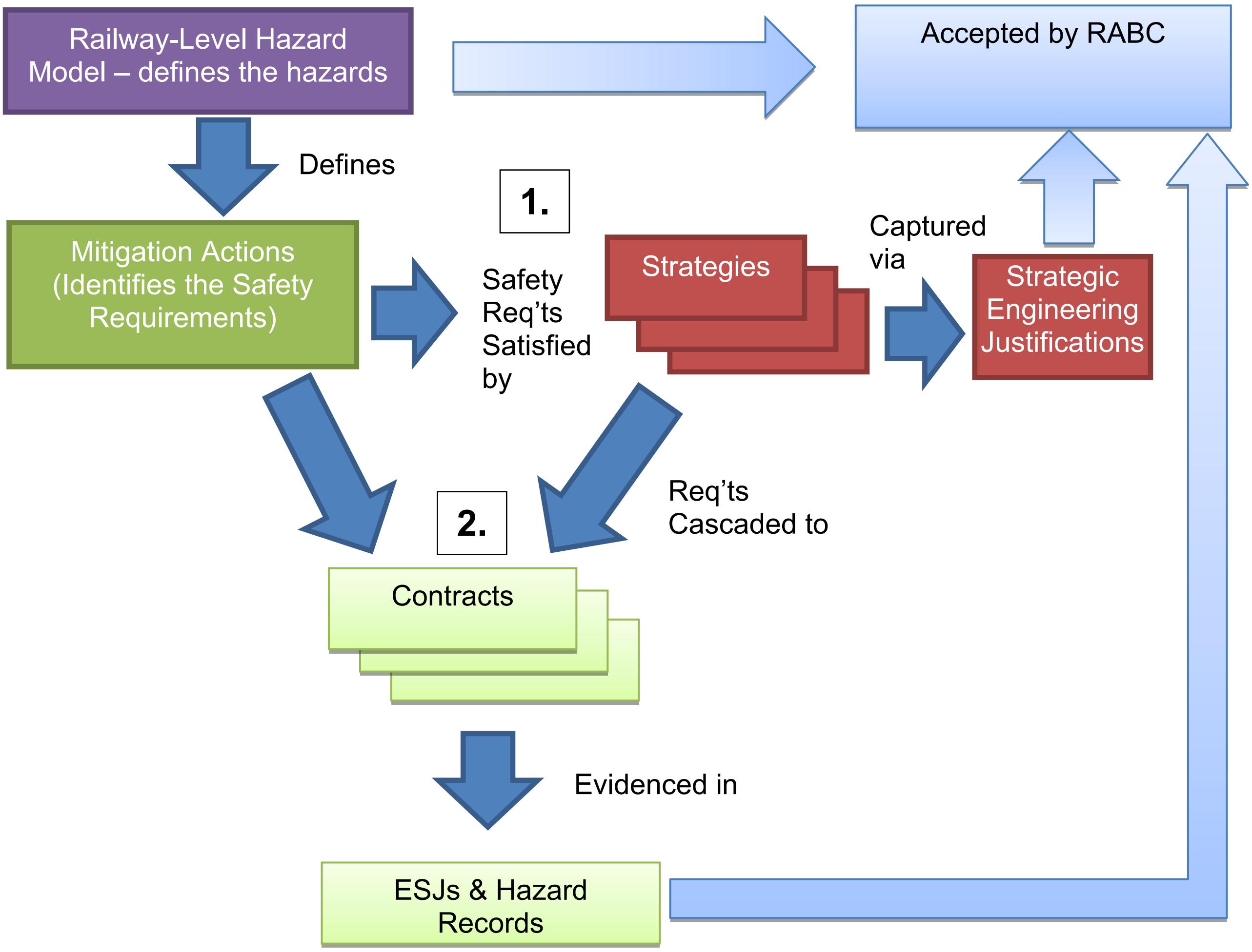


Figure 4: Process Flow

The important sub-processes within this flow that still require demonstration are noted below:

1. The line-wide Strategic Engineering Justifications need to articulate how they have satisfied the Safety Requirements and mitigate the hazards through safety justifications

2. As part of the Engineering V Lifecycle, CRL needs to re-confirm that these safety requirements have been accurately and consistently delivered by the contracts as part of the final design and implementation.

The Railway-Level Hazard Structure analysis has identified key integrated railway-level strategies and/or specific Strategic Engineering Safety Justifications that should together provide the holistic set of evidence needed to validate this model – these are listed in table 1 below:

Strategic Engineering Justification

Title	Reference Number
1. Fire, Evacuation & Ventilation	CRL1-XRL-O8-RGN-CR001-50206
2. EMC	CRL1-XRL-O8-RGN-CR001-50243
3. Earthing & Bonding	CRL1-XRL-O8-RGN-CR001-50242
4. Tunnel Drainage & Flood Protection	CRL1-XRL-O8-RGN-CR001-50208
5. Alarms & Security	CRL1-XRL-O8-RGN-CR001-50210
6. Cyber Security	CRL1-XRL-O8-RGN-CR001-50240
7. Lighting	CRL1-XRL-O8-RGN-CR001-50211
8. Platform-Train Interface	CRL1-XRL-O8-RGN-CR001-50209
9. Civil Design	CRL1-XRL-O8-RGN-CR001-50212
10. Maintenance	CRL1-XRL-O8-RGN-CR001-50213
11. Station Crowding / Sizing	CRL1-XRL-O8-RGN-CR001-50216
12. Train Collision and Derailment	CRL1-XRL-O8-RGN-CR001-50207

Table 1: Key Strategic Engineering Justifications

Other key supporting documents:

- Contractors' Engineering Safety Justifications (ESJs);
- CRL Elements Safety Justifications (SJs); and
- Final COS Safety Justification (COS-SJ).

The process by which CRL has produced the necessary evidence is outlined below:

1. Review the relevant documents (in some cases the strategy is expressed in more than one document)
2. Extract from the strategy the safety requirements
3. Through interviews with the strategy owners and review of documentation, confirm that the requirements have not changed through design development after publication of the strategy
4. Through interviews with the strategy owners and review of documentation, identify for each safety requirement a CSM-compliant safety argument to show that it adequately mitigates the hazards identified by the CRL model. This may use any of the three CSM justifications (application of codes of practice; comparison with similar systems (reference systems); and explicit risk estimation
5. Obtain the necessary evidence to support the justification and obtain the support of the strategy owner for the justification
6. Compile the evidence and the argument into a Strategic Engineering Justification document for agreement with the discipline lead, who owns the document. The

document has been checked by the Systems Safety Team and approved by the Chief Engineer.

The list of Top-Level Hazards has been compiled into a matrix which describes the relationships between them and the various pieces of evidence that the Project is delivering to support the safety case (fig 5 below provides an high-level example):

Safety Evidence → / Hazards ↓	Strategic Engineering Justifications														Risk Assessments			ISJ: Interim Safety Justifications for Elements						Systems DESJs/ Product Safety Cases		Other safety docs
	Fire & Evacuation	Earthing & Bonding	EMC	Tunnel Drainage	Ventilation	Flood Protection	Alarms & Security	Cyber Security	Lighting	PTI	Civil Design	Access & Maintenance Strategies	Station Crowding/Sizing	Train collision and Derailment	RA1	RA2	RA3 etc	Routeway	Portals	Shafts	LU Stations	RfL Stations	Depots	Product Safety Cases	Systemwide DESJs	e.g. Operators response plans / NR safety cases
Station To Station Train Movement - StS0															X			X	R	R	R	R	X	X	X	
Throughput Station /shaft /portal		X			X		X		X				X			X		R	R	R	R	R				
PTI (Sub Surface Station)										X							X	X			R	R				
PTI (Surface Station)										X				X			X								X	X
Interfaces with surrounding infrastructure		X	X				X				X							X	X	X	X	X	X			X
Operations							X	X	X			X						X	X	X	X	X	X			X
Maintenance Environment							X		X			X						X	X	X	X	X	X			
Planned Maintenance		X					X					X		X												
Plumstead Maintenance Facility		X					X					X		X												
Emergency Modes Of Operation	X			X	X	X			X		X		X					R	R	R	R	R	R			
Amended Modes Of Operation					X									X				X							X	
Degraded Modes Of Operation														X				X							X	
Abnormal Modes Of Operation																										

Fig 5: Alignment of safety evidence to the key hazards

R	= Reference made to Strategic Engineering Justifications
X	= Evidence contained within SJ itself

There are 5 groups of safety evidence referenced in the matrix:

1	Strategic Engineering justifications	Articulates how the key line-wide strategies have satisfied the Safety Requirements and mitigated the hazards through safety justifications
2	Risk assessments	Specific and detailed risks assessments conducted to assist design development and options decisions
3	Safety Justifications	Integrated safety justifications per Element
4	Product Safety Cases / DESJs	New / Novel / Complex systems – product safety cases and/or design safety justifications
5	Other	NR Safety Case(s) NR Interface Safety Justifications Train Interface with COS (ICA) / Safety Case RfL / MTR Emergency Response Plans Operational & Maintenance Procedures CCEP: Congestion Control & Evacuation Plan Operational / Maintenance Readiness Yellow Plant Safety Case

Figure 5 illustrates the **concept** of the matrix – the complete matrix with all the detailed hazards and safety justifications is shown in Appendix 3 [Ref 8]

7 Railway-Level Hazard Structure

The Railway-Level Hazard Structure is a large Visio file which does not lend itself for presentation in a readable form in this paper. The scale and layout of the model is shown below in Fig.6 for illustration.

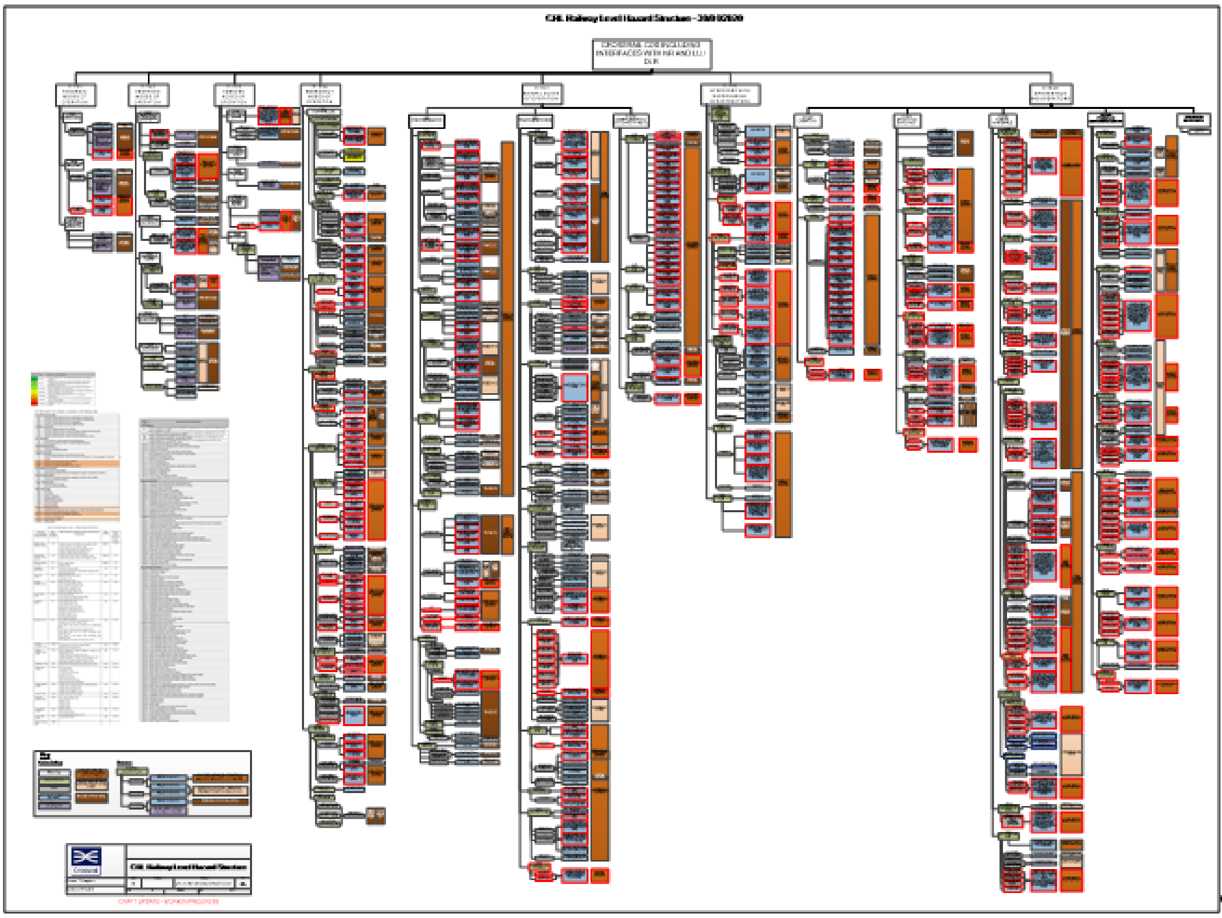


Fig. 6 Railway Level Hazard Structure Illustration

A more detailed example is shown in Appendix 1 for Collision between rail vehicles, and the full structure can be accessed by double-clicking on the link provided in Appendix 2

The source file is located in eB: as CRL1-XRL-O8-XMO-CR001-50001 [Ref 7]

8 Development of the Railway-Level Hazard Structure

In January 2017 a series of workshops were convened to develop the hazard structure. A cross section of personnel from the project and some independent experts were selected to participate, and it was agreed at a sub-group session of RAB-C on 4th Jan 2016 that this group of attendees was competent to conduct the exercise.

Prior to the workshops a briefing note was issued which explained the purpose, method and some background information [ref 5]

Three workshops were held, attendees are shown in the table below:

No.	Invited Attendee	Affiliation	Workshop 1: 6/1/17	Workshop 2: 13/1/17	Workshop 3: 24/1/17
1	Jeremy Bates	Meeting Chair (Head of Integration)	Y	Y	Y
2	Carol Bloxsome	RfL Safety Engineer	Y	Y	Y
3	Michael Kilby	Head of System Safety and Interoperability (workshop facilitator)	Y	Y	Y
4	Chris Binns	CRL Chief Engineer	Y	N	Y
5	Paul Robins	RABC chair	Y	Y	Y
6	Steve Doherty	SIRP lead	Y	N	N
7	Vince Murtagh	Ricardo Rail	Y	Y	Y
8	Chi Wong	ESM lead	Y	Y	Y
9	Matt Harris	MTR Assurance lead	Y	Y	Y
10	David Canham	RfL Head of Engineering	Y	N	Y
11	Michael Brown	RfL Head of Operations	Y	Y	N
12	Chris Bainbridge	LUL Safety Lead	Y	N	N
13	Alex Ferguson	LUL Safety Lead	N	Y	N
14	Paul Brown	CRL ESM Manager	N	Y	Y

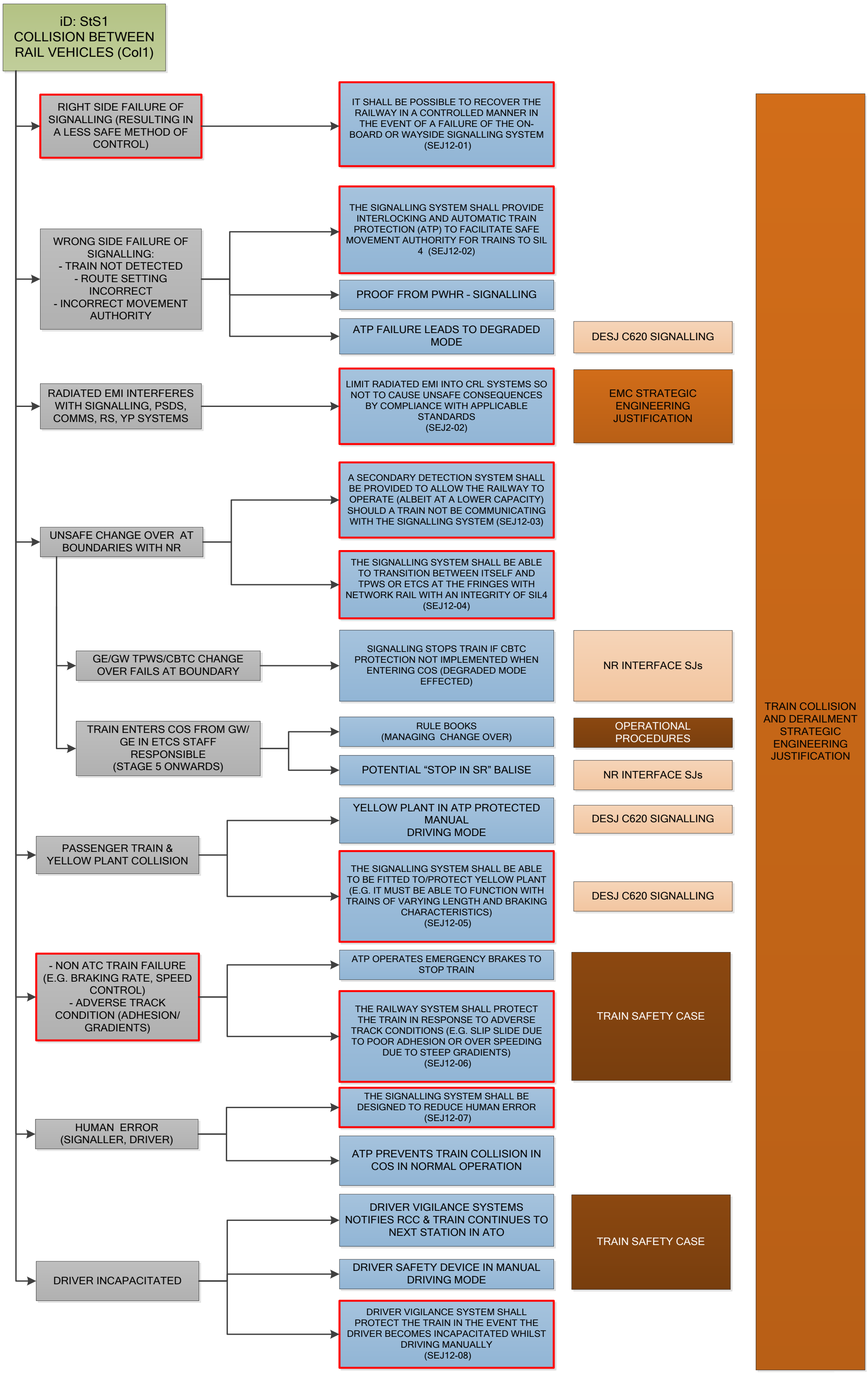
The hazard structure was systematically reviewed and amended through the 3 workshops and then reviewed in draft at the RABC meeting on 1 Feb 2017 to ensure that the panel supported the approach. The comments received at RAB-C were addressed in revision 2 of this document.

9 References

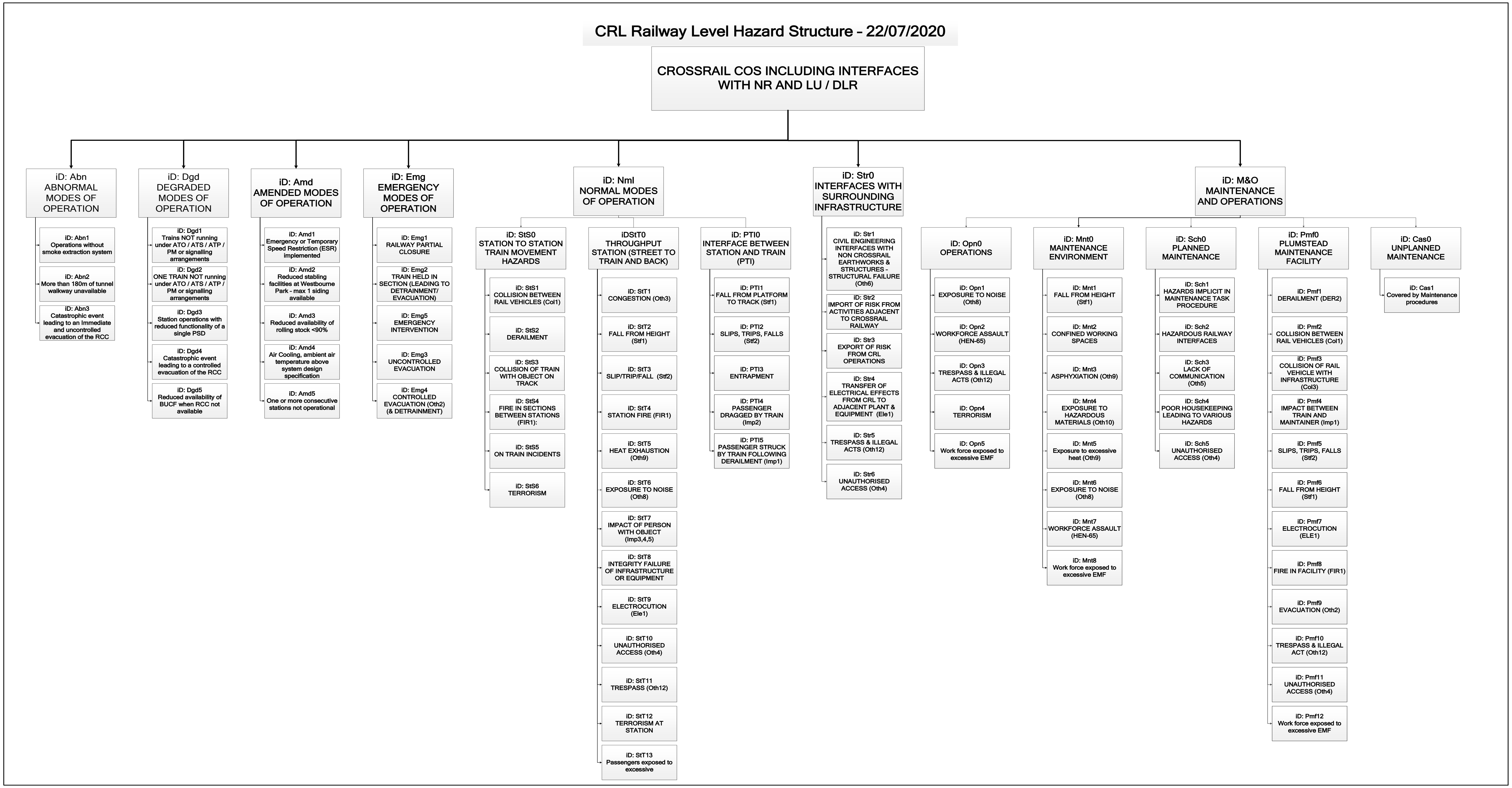
Ref 1	Common Safety Method for risk evaluation and assessment Guidance on the application of Commission Regulation (EU) 402/2013 March 2015
Ref 2	CRL PWHR Generic hazard list – Appendix A in the Project Wide Hazard Record Process CRL1-XRL-O8-GPS-CR001-50013 Rev 2.0
Ref 3	RSSB Hazardous Event Description – Appendix B in the Project Wide Hazard Record Process CRL1-XRL-O8-GPS-CR001-50013 Rev 2.0
Ref 4	London Underground Quantified Risk Assessment (LUQRA) October 2014 HSE/SRA/14/08
Ref 5	CRL Top Level Hazards Workshops Briefing Note CRL1-XRL-O8-GPS-CR001-50026
Ref 6	RfL MOR Reference for the modes of Operation RFLI-OPS-PE-SPE-0001
Ref 7	Railway Level Hazard Structure source Visio file: CRL1-XRL-O8-XMO-CR001-50001
Ref 8	Alignment of safety evidence to the key hazards - Railway Level CRL1-XRL-O8-XMO-CR001-50002

Appendix 1: Worked Example – Collision between rail vehicles

Note: The boxes highlighted in red indicate the changes made as per the latest SEJs approved by AsBo.



Appendix 2: CRL Railway-Level Hazard Structure:



Note: For more details of each scenarios listed in this diagram (e.g. hazards, causes, safety requirements, duty holders, etc.), a PDF file has been created and can be accessed by double-clicking on the PDF icon below.

CRL1-XRL-O8-XMO-CR001-50001 Rev 3.0

Appendix 3: Alignment of safety evidence to the key hazards

R = Reference made to Strategic Engineering Justifications
X = Evidence contained within SJ itself

Strategic Engineering Justifications

#	HAZARDS	Ref	Fire Evacuation & Ventilation	Earthing & Bonding	EMC	Tunnel Drainage & Flood Protection	Alarms & Security	Cyber Security	Lighting	PTI	Civil Design	Access & Maintenance	Station Crowding/Sizing	Train collision and Derailment
1	**Station To Station Train Movement - StS0**													
2	Collision between rail vehicles	StS1												X
3	Derailment	StS2												X
4	Collision of train with object on track	StS3												X
5	Fire in sections between stations	StS4	X											
6	Assault on train	StS5												
7	Trespass & other illegal acts	StS5.2					X							
8	Slips, trips falls on train	StS5.3												
9	Exposure To Noise	StS5.4												
10	Terrorism	StS6												
11	**Throughput Station /shaft /portal**													
12	Congestion	StT1											X	
13	Fall from height	StT2												
14	Slips, Trips Falls	StT3							X					
15	Fire	StT4	X										X	
16	Heat Exhaustion	StT5	X											
17	Exposure To Noise	StT6												
18	Impact of person with object	StT7												
19	Integrity failure of infrastructure/equip	StT8												
20	Electrocution	StT9		X			X							
21	Unauthorised Access	StT10					X							
22	Trespass	StT11					X							
23	Terrorism	StT12					X							
24														
25	**PTI (Sub Surface Station)**													
26	Fall from Platform to Track	PTI1								X				
27	Slips trips and falls	PTI2								X				
28	Entrapment	PTI3								X				
29	Passenger dragged by train	PTI4								X				
30	Passenger struck by train (derailment)	PTI5								X				
31	**PTI (Surface Station)**													
32	Fall from platform to track	PTI1								X				
33	Slips, trips falls	PTI2								X				
34	Entrapment in train doors	PTI3												
35	Passenger dragged by train	PTI4								X				
36	Passenger struck by train (derailment)	PTI5								X	X			X
37														
38	**Interfaces with surrounding infrastructure**													
39	Civil engineering interfaces	Str1									X			
40	Import of risk from adjacent activities	Str2									X			
41	Export of risk from CRL operations	Str3									X			
42	EMI	Str3.2			X									
43	Transfer of electrical effects from CRL	Str4		X										
44	Trespass & Other Illegal Acts	Str5					X							
45	Unauthorised access	Str6					X							
46														
47	**Operations**													
48	Exposure To Noise	Opn1												
49	Workforce Assault	Opn2					X		X					
50	Illegal acts	Opn3					X					X		
51	Terrorism	Opn4					X	X						
53	**Maintenance Environment**													
54	Fall from height	Mnt1										X		
55	Confined working spaces	Mnt2										X		
56	Asphyxiation	Mnt3										X		
57	Exposure to hazardous materials	Mnt4										X		
58	Exposure to excessive heat	Mnt5												
59	Exposure to noise	Mnt6												
60	Workforce Assault	Mnt7					X		X			X		

Risk Assessments / Models (conducted to date)

#	HAZARDS	Ref	Train Accident Risk Model	Platform Invert HAZID Report (RA01)	Tunnel Walkway Height & Offset (RA02)	Area above PSD	Platform Overhead Duct	Provision of Lineside Telephony	Train Speed Restrictions For Manual Driving M	Connaught Tunnel - derailment containment	Silvertown Footbridge - derailment containme	Auto reverse at Abbey Wood / Custom House	Platform Screen Doors - entrapment	SE Spur Evacuation and Detrainment (RA011)	Fire on train - stopping in an open section of t	Escalators & lifts being put into service remot	Secondary means of escape from Custom Ho	PEDs at Abbey Wood and Custom House	Emergency Transformer Plungers at PML	Platform Plungers at Custom House / Abbey V	Yellow Plant Fire Risk (RA018)	Removal of fire duct mounted smoke detector	Chainage	Emergency kill button in transformer rooms
1	**Station To Station Train Movement - StS0**																							
2	Collision between rail vehicles	StS1	X						X			X												
3	Derailment	StS2	X							X	X													
4	Collision of train with object on track	StS3	X						X			X												
5	Fire in sections between stations	StS4	X												X						X			
6	Assault on train	StS5																						
7	Trespass & other illegal acts	StS5.2																						
8	Slips, trips falls on train	StS5.3																						
9	Exposure To Noise	StS5.4																						
10	Terrorism	StS6																						
11	**Throughput Station /shaft /portal**																							
12	Congestion	StT1														X	X							
13	Fall from height	StT2																						
14	Slips, Trips Falls	StT3														X								
15	Fire	StT4					X										X				X	X		
16	Heat Exhaustion	StT5					X																	
17	Exposure To Noise	StT6																						
18	Impact of person with object	StT7																						
19	Integrity failure of infrastructure/equip	StT8																						
20	Electrocution	StT9																						
21	Unauthorised Access	StT10																						
22	Trespass	StT11																						
23	Terrorism	StT12																						
24																								
25	**PTI (Sub Surface Station)**																							
26	Fall from Platform to Track	PTI1	X																					
27	Slips trips and falls	PTI2	X																					
28	Entrapment	PTI3	X										X											
29	Passenger dragged by train	PTI4	X																					
30	Passenger struck by train (derailment)	PTI5	X																					
31	**PTI (Surface Station)**																							
32	Fall from platform to track	PTI1	X									X						X		X				
33	Slips, trips falls	PTI2																						
34	Entrapment in train doors	PTI3	X																					
35	Passenger dragged by train	PTI4	X									X						X		X				
36	Passenger struck by train (derailment)	PTI5	X																					
37																								
38	**Interfaces with surrounding infrastructure**																							
39	Civil engineering interfaces	Str1																						
40	Import of risk from adjacent activities	Str2																						
41	Export of risk from CRL operations	Str3																						
42	EMI	Str3.2																						
43	Transfer of electrical effects from CRL	Str4																						
44	Trespass & Other Illegal Acts	Str5																						
45	Unauthorised access	Str6																						
46																								
47	**Operations**																							
48	Exposure To Noise	Opn1																						
49	Workforce Assault	Opn2																						
50	Illegal acts	Opn3																						
51	Terrorism	Opn4																						
53	**Maintenance Environment**																							
54	Fall from height	Mnt1				X																		
55	Confined working spaces	Mnt2	X	X		X																		
56	Asphyxiation	Mnt3																						
57	Exposure to hazardous materials	Mnt4																						
58	Exposure to excessive heat	Mnt5																						
59	Exposure to noise	Mnt6																						
60	Workforce Assault	Mnt7																						

ISJ: Interim Safety Justifications for Elements

#	HAZARDS	Ref	1 Railway Systems incl. RCC	2 Non-traction power HV	3 COS Tunnels (and structures)	4 Plumstead Maintenance Facility	5 Plumstead Sidings	6 North Woolwich Portal	7 Pudding Mill Lane Portal	8 Victoria Dock Portal	9 Royal Oak Portal	10 Plumstead Portal	11 Stepney Green Shaft	12 Mile End Shaft	13 Eleanor St Shaft	14 Limmo Peninsula Shaft	15 Fisher St Shaft	16 Liverpool Street station	17 Bond Street Station	18 Tottenham Court Road Station	19 Farringdon Station	20 Whitechapel Station	21 Custom House Station	22 Canary Wharf Station	23 Woolwich Station	24 Paddington Station	26 Old Oak Common Depot	27 Ilford Yard Stablings
			Routeway					Portals					Shafts					LU Stations					RfL Stations				Depots	
1	**Station To Station Train Movement - StS0**																											
2	Collision between rail vehicles	StS1	X																									
3	Derailment	StS2	X																									
4	Collision of train with object on track	StS3	X		R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	X	X
5	Fire in sections between stations	StS4	X		R	R	R	R	R	R	R	R															X	X
6	Assault on train	StS5																										
7	Trespass & other illegal acts	StS5.2	X		X	X	X	X	X	X	X	X	X	X	X	X	X										X	X
8	Slips, trips falls on train	StS5.3																										
9	Exposure To Noise	StS5.4																										
10	Terrorism	StS6	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
11	**Throughput Station /shaft /portal**																											
12	Congestion	StT1						R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R		
13	Fall from height	StT2						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
14	Slips, Trips Falls	StT3						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
15	Fire	StT4						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
16	Heat Exhaustion	StT5	R		R			R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R		
17	Exposure To Noise	StT6						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
18	Impact of person with object	StT7						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
19	Integrity failure of infrastructure/equip	StT8						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
20	Electrocution	StT9						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
21	Unauthorised Access	StT10						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
22	Trespass	StT11																										
23	Terrorism	StT12						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
24																												
25	**PTI (Sub Surface Station)**																											
26	Fall from Platform to Track	PTI1																R	R	R	R	R	R	R	R	R		
27	Slips trips and falls	PTI2																R	R	R	R	R	R	R	R	R		
28	Entrapment	PTI3	X															R	R	R	R	R	R	R	R	R		
29	Passenger dragged by train	PTI4	X																									
30	Passenger struck by train (derailment)	PTI5	X																									
31	**PTI (Surface Station)**																											
32	Fall from platform to track	PTI1																										
33	Slips, trips falls	PTI2																										
34	Entrapment in train doors	PTI3																										
35	Passenger dragged by train	PTI4																										
36	Passenger struck by train (derailment)	PTI5																										
37																												
38	**Interfaces with surrounding infrastructure**																											
39	Civil engineering interfaces	Str1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
40	Import of risk from adjacent activities	Str2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
41	Export of risk from CRL operations	Str3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
42	EMI	Str3.2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
43	Transfer of electrical effects from CRL	Str4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
44	Trespass & Other Illegal Acts	Str5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
45	Unauthorised access	Str6	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
46																												
47	**Operations**																											
48	Exposure To Noise	Opn1	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
49	Workforce Assault	Opn2																										
50	Illegal acts	Opn3																										
51	Terrorism	Opn4																										
53	**Maintenance Environment**																											
54	Fall from height	Mnt1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
55	Confined working spaces	Mnt2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
56	Asphyxiation	Mnt3																										
57	Exposure to hazardous materials	Mnt4																										
58	Exposure to excessive heat	Mnt5																										
59	Exposure to noise	Mnt6	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
60	Workforce Assault	Mnt7	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Systems DESJs/Product Safety Cases

#	HAZARDS	Ref	Axle Counter	Westrace MkII	LED Signal	MCT Acceptance	TGMT Sub System	ATS Sub System	Points Machine	Tunnel Vent Control System	DESJ: Signalling	DESJ: Comms	DESJ: Traction Power	DESJ: Platform Screen Doors	DESJ: Main Works Track	DESJ: Main Works OHLE	DESJ: Tunnel Vent	DESJ: RCC/BUCF
			Product Safety Cases								DESJs							
1	**Station To Station Train Movement - StS0**																	
2	Collision between rail vehicles	StS1	X	X	X	X	X	X			X							
3	Derailment	StS2							X		X				X			
4	Collision of train with object on track	StS3									X							
5	Fire in sections between stations	StS4								X	X	X						
6	Assault on train	StS5																
7	Trespass & other illegal acts	StS5.2																
8	Slips, trips falls on train	StS5.3																
9	Exposure To Noise	StS5.4																
10	Terrorism	StS6																
11	**Throughput Station /shaft /portal**																	
12	Congestion	StT1																
13	Fall from height	StT2																
14	Slips, Trips Falls	StT3																
15	Fire	StT4										X						
16	Heat Exhaustion	StT5								X								
17	Exposure To Noise	StT6																
18	Impact of person with object	StT7																
19	Integrity failure of infrastructure/equip	StT8																
20	Electrocution	StT9											X			X		
21	Unauthorised Access	StT10																
22	Trespass	StT11																
23	Terrorism	StT12																
24																		
25	**PTI (Sub Surface Station)**																	
26	Fall from Platform to Track	PTI1																
27	Slips trips and falls	PTI2																
28	Entrapment	PTI3									X			X				
29	Passenger dragged by train	PTI4																
30	Passenger struck by train (derailment)	PTI5									X			X				
31	**PTI (Surface Station)**																	
32	Fall from platform to track	PTI1									X							
33	Slips, trips falls	PTI2																
34	Entrapment in train doors	PTI3																
35	Passenger dragged by train	PTI4																
36	Passenger struck by train (derailment)	PTI5																
37																		
38	**Interfaces with surrounding infrastructure**																	
39	Civil engineering interfaces	Str1																
40	Import of risk from adjacent activities	Str2																
41	Export of risk from CRL operations	Str3													X			
42	EMI	Str3.2											X			X		
43	Transfer of electrical effects from CRL	Str4											X			X		
44	Trespass & Other Illegal Acts	Str5																
45	Unauthorised access	Str6																
46																		
47	**Operations**																	
48	Exposure To Noise	Opn1																
49	Workforce Assault	Opn2																
50	Illegal acts	Opn3																
51	Terrorism	Opn4																
53	**Maintenance Environment**																	
54	Fall from height	Mnt1																
55	Confined working spaces	Mnt2																
56	Asphyxiation	Mnt3																
57	Exposure to hazardous materials	Mnt4								X							X	
58	Exposure to excessive heat	Mnt5								X							X	
59	Exposure to noise	Mnt6																
60	Workforce Assault	Mnt7																

Other safety documentation

#	HAZARDS	Ref	NR Safety Case(s)	NR Interface Safety Justifications	Train Interface with COS (ICA) / Safety Case	RfL/MTR Emergency Response Plans	Operational & Maintenance Procedures	CCEP: Congestion Control & Evacuation Plan	Operational / Maintenance Readiness	Yellow Plant Safety Case
1	**Station To Station Train Movement - StS0**									
2	Collision between rail vehicles	StS1		X	X		X			
3	Derailment	StS2			X		X		X	
4	Collision of train with object on track	StS3			X		X		X	
5	Fire in sections between stations	StS4			X		X			
6	Assault on train	StS5			X					
7	Trespass & other illegal acts	StS5.2			X					
8	Slips, trips falls on train	StS5.3			X					
9	Exposure To Noise	StS5.4			X					
10	Terrorism	StS6			X					
11	**Throughput Station /shaft /portal**									
12	Congestion	StT1					X	X		
13	Fall from height	StT2					X			
14	Slips, Trips Falls	StT3					X		X	
15	Fire	StT4					X		X	
16	Heat Exhaustion	StT5			X		X			
17	Exposure To Noise	StT6			X					
18	Impact of person with object	StT7								
19	Integrity failure of infrastructure/equip	StT8					X			
20	Electrocution	StT9					X			
21	Unauthorised Access	StT10					X			
22	Trespass	StT11					X			
23	Terrorism	StT12					X			
24										
25	**PTI (Sub Surface Station)**									
26	Fall from Platform to Track	PTI1								
27	Slips trips and falls	PTI2			X					
28	Entrapment	PTI3					X			
29	Passenger dragged by train	PTI4			X		X			
30	Passenger struck by train (derailment)	PTI5			X					
31	**PTI (Surface Station)**									
32	Fall from platform to track	PTI1	X				X			
33	Slips, trips falls	PTI2	X				X			
34	Entrapment in train doors	PTI3			X		X			
35	Passenger dragged by train	PTI4			X		X			
36	Passenger struck by train (derailment)	PTI5			X					
37										
38	**Interfaces with surrounding infrastructure**									
39	Civil engineering interfaces	Str1	X							
40	Import of risk from adjacent activities	Str2	X							
41	Export of risk from CRL operations	Str3								
42	EMI	Str3.2			X					X
43	Transfer of electrical effects from CRL	Str4								
44	Trespass & Other Illegal Acts	Str5								
45	Unauthorised access	Str6								
46										
47	**Operations**									
48	Exposure To Noise	Opn1			X		X			
49	Workforce Assault	Opn2			X		X			
50	Illegal acts	Opn3	X				X			
51	Terrorism	Opn4			X					
53	**Maintenance Environment**									
54	Fall from height	Mnt1								
55	Confined working spaces	Mnt2								
56	Asphyxiation	Mnt3								
57	Exposure to hazardous materials	Mnt4								
58	Exposure to excessive heat	Mnt5								
59	Exposure to noise	Mnt6								
60	Workforce Assault	Mnt7								

R = Reference made to Strategic Engineering Justifications
X = Evidence contained within SJ itself

Strategic Engineering Justifications

	HAZARDS		Fire Evacuation & Ventilation	Earthing & Bonding	EMC	Tunnel Drainage & Flood Protection	Alarms & Security	Cyber Security	Lighting	PTI	Civil Design	Access & Maintenance	Station Crowding/Sizing	Train collision and Derailment
62	**Planned Maintenance**													
63	Manual Handling	Sch1.1										X		
64	Heavy object impact with maintainer	Sch1.2										X		
65	Pointed/sharp object with maintainer	Sch1.3										X		
66	Exposure to hazardous materials	Sch1.4										X		
67	Exposure to hot objects	Sch1.5										X		
68	Electrocution	Sch1.6		X								X		
69	Slips, Trips Falls	Sch2.1										X		
70	Contact with overhead lines	Sch2.2										X		
71	Maintainer struck by train	Sch2.3										X		X
72	Collision between rail vehicles	Sch2.4										X		X
73	Possession interface	Sch2.5										X		X
74	Lack of communication	Sch3										X		
75	Inadequate co-ordination of maintenance	Sch3.1												
76	Loss of data comms	Sch3.2												
77	Inadequate Housekeeping	Sch4										X		
78	Unauthorised access	Sch5					X					X		
79														
80	**Plumstead Maintenance Facility**													
81	Derailment	Pmf1												X
82	Collision between rail vehicles	Pmf2										X		X
83	Collision of rail vehicle with structure	Pmf3										X		X
84	Impact between train and maintainer	Pmf4										X		X
85	Slips, trips falls	Pmf5										X		
86	Fall from height	Pmf6										X		
87	Electrocution	Pmf7		X								X		
88	Fire in facility	Pmf8										X		
89	Evacuation	Pmf9												
90	Trespass & illegal acts	Pmf10					X							
91	Unauthorised access	Pmf11					X							
92														
93	**Emergency Modes Of Operation**													
94	Structural Failure	Emg1.1									X			
95	Flood	Emg1.2				X					X			
96	Train Held In Section	Emg2	X											
97	Uncontrolled Evacuation	Emg3	X										X	
98	Controlled Evacuation	Emg4	X						X				X	
99	Emergency Intervention	Emg5	X											
100	Emergency Services intervention	Emg5.1	X											
101	Train rescue intervention	Emg5.3												
102														
103	**Amended Modes Of Operation**													
104	Speed Restrictions	Amd1												X
105	Reduced Stabling	Amd2												
106	Reduced Availability of Rolling Stock	Amd3												
107	High Ambient Air Temperature	Amd4	X											
108	Consecutive Stations Not Operational	Amd5												
109														
110	**Degraded Modes Of Operation**													
111	ATC lost	Dgd1												X
112	ATC lost on single train	Dgd2												X
113	Single PSD lost at station	Dgd3								?				
114	RCC Controlled Evacuation	Dgd4												
115	Reduced BUCF during RCC failure	Dgd5												
116														
117	**Abnormal Modes Of Operation**													
118	No Smoke Extraction	Abn1	X											
119	(180m) Tunnel Walkway Unavailable	Abn2	X											
120	RCC Uncontrolled Evacuation	Abn3											X	

Risk Assessments / Models (conducted to date)

	HAZARDS		Train Accident Risk Model	Platform Invert HAZID Report (RA01)	Tunnel Walkway Height & Offset (RA02)	Area above PSD	Platform Overhead Duct	Provision of Lineside Telephony	Train Speed Restrictions For Manual Driving M	Connaught Tunnel - derailment containment	Silvertown Footbridge - derailment containme	Auto reverse at Abbey Wood / Custom House	Platform Screen Doors - entrapment	SE Spur Evacuation and Detrainment (RA011)	Fire on train - stopping in an open section of t	Escalators & lifts being put into service remot	Secondary means of escape from Custom Ho	PEDs at Abbey Wood and Custom House	Emergency Transformer Plungers at PML	Platform Plungers at Custom House / Abbey W	Yellow Plant Fire Risk (RA018)	Removal of fire duct mounted smoke detector	Chainage	Emergency kill button in transformer rooms
62	**Planned Maintenance**																							
63	Manual Handling	Sch1.1																						
64	Heavy object impact with maintainer	Sch1.2				X																		
65	Pointed/sharp object with maintainer	Sch1.3				X																		
66	Exposure to hazardous materials	Sch1.4				X																X		
67	Exposure to hot objects	Sch1.5																						
68	Electrocution	Sch1.6				X													X					X
69	Slips, Trips Falls	Sch2.1																						
70	Contact with overhead lines	Sch2.2				X																		
71	Maintainer struck by train	Sch2.3			X				X															
72	Collision between rail vehicles	Sch2.4							X															
73	Possession interface	Sch2.5							X														X	
74	Lack of communication	Sch3																					X	
75	Inadequate co-ordination of maintenance	Sch3.1																						
76	Loss of data comms	Sch3.2						X																
77	Inadequate Housekeeping	Sch4																						
78	Unauthorised access	Sch5																						
79																								
80	**Plumstead Maintenance Facility**																							
81	Derailment	Pmf1	X																					
82	Collision between rail vehicles	Pmf2	X						X															
83	Collision of rail vehicle with structure	Pmf3	X						X															
84	Impact between train and maintainer	Pmf4	X						X															
85	Slips, trips falls	Pmf5																						
86	Fall from height	Pmf6																						
87	Electrocution	Pmf7																						
88	Fire in facility	Pmf8																			X			
89	Evacuation	Pmf9												X										
90	Trespass & illegal acts	Pmf10																						
91	Unauthorised access	Pmf11																						
92																								
93	**Emergency Modes Of Operation**																							
94	Structural Failure	Emg1.1																						
95	Flood	Emg1.2																						
96	Train Held In Section	Emg2							X															
97	Uncontrolled Evacuation	Emg3			X			X						X	X									
98	Controlled Evacuation	Emg4			X			X						X	X									
99	Emergency Intervention	Emg5																						
100	Emergency Services intervention	Emg5.1																						
101	Train rescue intervention	Emg5.3							X						X									
102																								
103	**Amended Modes Of Operation**																							
104	Speed Restrictions	Amd1	X						X															
105	Reduced Stabling	Amd2																						
106	Reduced Availability of Rolling Stock	Amd3																						
107	High Ambient Air Temperature	Amd4					X																	
108	Consecutive Stations Not Operational	Amd5																						
109																								
110	**Degraded Modes Of Operation**																							
111	ATC lost	Dgd1	X						X															
112	ATC lost on single train	Dgd2	X						X															
113	Single PSD lost at station	Dgd3																						
114	RCC Controlled Evacuation	Dgd4																						
115	Reduced BUCF during RCC failure	Dgd5																						
116																								
117	**Abnormal Modes Of Operation**																							
118	No Smoke Extraction	Abn1																						
119	(180m) Tunnel Walkway Unavailable	Abn2																						
120	RCC Uncontrolled Evacuation	Abn3																						

ISJ: Interim Safety Justifications for Elements

	HAZARDS		1 Railway Systems incl. RCC	2 Non-traction power HV	3 COS Tunnels (and structures)	4 Plumstead Maintenance Facility	5 Plumstead Sidings	6 North Woolwich Portal	7 Pudding Mill Lane Portal	8 Victoria Dock Portal	9 Royal Oak Portal	10 Plumstead Portal	11 Stepney Green Shaft	12 Mile End Shaft	13 Eleanor St Shaft	14 Limmo Peninsula Shaft	15 Fisher St Shaft	16 Liverpool Street station	17 Bond Street Station	18 Tottenham Court Road Station	19 Farringdon Station	20 Whitechapel Station	21 Custom House Station	22 Canary Wharf Station	23 Woolwich Station	24 Paddington Station	26 Old Oak Common Depot	27 Ilford Yard Stablings
			Routeway					Portals					Shafts					LU Stations					RfL Stations				Depots	
62	**Planned Maintenance**																											
63	Manual Handling	Sch1.1																										
64	Heavy object impact with maintainer	Sch1.2																										
65	Pointed/sharp object with maintainer	Sch1.3																										
66	Exposure to hazardous materials	Sch1.4																										
67	Exposure to hot objects	Sch1.5																										
68	Electrocution	Sch1.6		X																								
69	Slips, Trips Falls	Sch2.1																										
70	Contact with overhead lines	Sch2.2																										
71	Maintainer struck by train	Sch2.3																										
72	Collision between rail vehicles	Sch2.4																										
73	Possession interface	Sch2.5																										
74	Lack of communication	Sch3																										
75	Inadequate co-ordination of maintenance	Sch3.1																										
76	Loss of data comms	Sch3.2																										
77	Inadequate Housekeeping	Sch4																										
78	Unauthorised access	Sch5																										
79																												
80	**Plumstead Maintenance Facility**																											
81	Derailment	Pmf1				X																						
82	Collision between rail vehicles	Pmf2				X																						
83	Collision of rail vehicle with structure	Pmf3				X																						
84	Impact between train and maintainer	Pmf4				X																						
85	Slips, trips falls	Pmf5				X																						
86	Fall from height	Pmf6				X																						
87	Electrocution	Pmf7				X																						
88	Fire in facility	Pmf8				X																						
89	Evacuation	Pmf9				X																						
90	Trespass & illegal acts	Pmf10				X																						
91	Unauthorised access	Pmf11				X																						
92																												
93	**Emergency Modes Of Operation**																											
94	Structural Failure	Emg1.1																										
95	Flood	Emg1.2	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
96	Train Held In Section	Emg2	X																									
97	Uncontrolled Evacuation	Emg3	X		X																							
98	Controlled Evacuation	Emg4	X		X			R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	
99	Emergency Intervention	Emg5																										
100	Emergency Services intervention	Emg5.1			X																							
101	Train rescue intervention	Emg5.3																										
102																												
103	**Amended Modes Of Operation**																											
104	Speed Restrictions	Amd1	X																									
105	Reduced Stabling	Amd2																										
106	Reduced Availability of Rolling Stock	Amd3																										
107	High Ambient Air Temperature	Amd4																										
108	Consecutive Stations Not Operational	Amd5																										
109																												
110	**Degraded Modes Of Operation**																											
111	ATC lost	Dgd1	X																									
112	ATC lost on single train	Dgd2	X																									
113	Single PSD lost at station	Dgd3	X																									
114	RCC Controlled Evacuation	Dgd4	X																									
115	Reduced BUCF during RCC failure	Dgd5																										
116																												
117	**Abnormal Modes Of Operation**																											
118	No Smoke Extraction	Abn1																										
119	(180m) Tunnel Walkway Unavailable	Abn2																										
120	RCC Uncontrolled Evacuation	Abn3																										

Systems DESJs/Product Safety Cases

	HAZARDS		Axle Counter	Westrace MkII	LED Signal	MCT Acceptance	TGMT Sub System	ATS Sub System	Points Machine	Tunnel Vent Control System	DESJ: Signalling	DESJ: Comms	DESJ: Traction Power	DESJ: Platform Screen Doors	DESJ: Main Works Track	DESJ: Main Works OHLE	DESJ: Tunnel Vent	DESJ: RCC/BUCF
			Product Safety Cases								DESJs							
62	**Planned Maintenance**																	
63	Manual Handling	Sch1.1																
64	Heavy object impact with maintainer	Sch1.2																
65	Pointed/sharp object with maintainer	Sch1.3																
66	Exposure to hazardous materials	Sch1.4																
67	Exposure to hot objects	Sch1.5																
68	Electrocution	Sch1.6											X			X		
69	Slips, Trips Falls	Sch2.1																
70	Contact with overhead lines	Sch2.2														X		
71	Maintainer struck by train	Sch2.3																
72	Collision between rail vehicles	Sch2.4									X							
73	Possession interface	Sch2.5									X							
74	Lack of communication	Sch3										X						
75	Inadequate co-ordination of maintenance	Sch3.1																
76	Loss of data comms	Sch3.2									X	X						
77	Inadequate Housekeeping	Sch4																
78	Unauthorised access	Sch5																
79																		
80	**Plumstead Maintenance Facility**																	
81	Derailment	Pmf1																
82	Collision between rail vehicles	Pmf2																
83	Collision of rail vehicle with structure	Pmf3																
84	Impact between train and maintainer	Pmf4																
85	Slips, trips falls	Pmf5																
86	Fall from height	Pmf6																
87	Electrocution	Pmf7																
88	Fire in facility	Pmf8																
89	Evacuation	Pmf9																
90	Trespass & illegal acts	Pmf10																
91	Unauthorised access	Pmf11																
92																		
93	**Emergency Modes Of Operation**																	
94	Structural Failure	Emg1.1																
95	Flood	Emg1.2																
96	Train Held In Section	Emg2								X	X		X					
97	Uncontrolled Evacuation	Emg3								X		X						
98	Controlled Evacuation	Emg4								X		X		X				
99	Emergency Intervention	Emg5										X						
100	Emergency Services intervention	Emg5.1										X						
101	Train rescue intervention	Emg5.3																
102																		
103	**Amended Modes Of Operation**																	
104	Speed Restrictions	Amd1					X	X			X							
105	Reduced Stabling	Amd2																
106	Reduced Availability of Rolling Stock	Amd3																
107	High Ambient Air Temperature	Amd4																
108	Consecutive Stations Not Operational	Amd5																
109																		
110	**Degraded Modes Of Operation**																	
111	ATC lost	Dgd1										X						
112	ATC lost on single train	Dgd2																
113	Single PSD lost at station	Dgd3									X							
114	RCC Controlled Evacuation	Dgd4									X							X
115	Reduced BUCF during RCC failure	Dgd5									X	X						
116																		
117	**Abnormal Modes Of Operation**																	
118	No Smoke Extraction	Abn1															X	
119	(180m) Tunnel Walkway Unavailable	Abn2													X			
120	RCC Uncontrolled Evacuation	Abn3																X

Other safety documentation

	HAZARDS		NR Safety Case(s)	NR Interface Safety Justifications	Train Interface with COS (ICA) / Safety Case	RfL/MTR Emergency Response Plans	Operational & Maintenance Procedures	CCEP: Congestion Control & Evacuation Plan	Operational / Maintenance Readiness	Yellow Plant Safety Case
62	**Planned Maintenance**									
63	Manual Handling	Sch1.1					X		X	
64	Heavy object impact with maintainer	Sch1.2					X		X	
65	Pointed/sharp object with maintainer	Sch1.3					X		X	
66	Exposure to hazardous materials	Sch1.4					X		X	
67	Exposure to hot objects	Sch1.5					X		X	
68	Electrocution	Sch1.6					X		X	
69	Slips, Trips Falls	Sch2.1					X		X	
70	Contact with overhead lines	Sch2.2					X		X	
71	Maintainer struck by train	Sch2.3					X		X	
72	Collision between rail vehicles	Sch2.4					X			X
73	Possession interface	Sch2.5					X		X	X
74	Lack of communication	Sch3					X		X	
75	Inadequate co-ordination of maintenance	Sch3.1					X		X	
76	Loss of data comms	Sch3.2					X			
77	Inadequate Housekeeping	Sch4					X		X	
78	Unauthorised access	Sch5					X		X	
79										
80	**Plumstead Maintenance Facility**									
81	Derailment	Pmf1					X			
82	Collision between rail vehicles	Pmf2					X			X
83	Collision of rail vehicle with structure	Pmf3			X		X			X
84	Impact between train and maintainer	Pmf4					X			X
85	Slips, trips falls	Pmf5					X			
86	Fall from height	Pmf6					X			
87	Electrocution	Pmf7					X			
88	Fire in facility	Pmf8					X			
89	Evacuation	Pmf9					X			
90	Trespass & illegal acts	Pmf10					X			
91	Unauthorised access	Pmf11					X			
92										
93	**Emergency Modes Of Operation**									
94	Structural Failure	Emg1.1								
95	Flood	Emg1.2				X				
96	Train Held In Section	Emg2			X	X	X			X
97	Uncontrolled Evacuation	Emg3			X		X	X		
98	Controlled Evacuation	Emg4				X	X	X		
99	Emergency Intervention	Emg5				X				
100	Emergency Services intervention	Emg5.1				X				
101	Train rescue intervention	Emg5.3				X	X			
102										
103	**Amended Modes Of Operation**									
104	Speed Restrictions	Amd1					X			
105	Reduced Stabling	Amd2					X			
106	Reduced Availability of Rolling Stock	Amd3					X			
107	High Ambient Air Temperature	Amd4					X			
108	Consecutive Stations Not Operational	Amd5					X	X		
109										
110	**Degraded Modes Of Operation**									
111	ATC lost	Dgd1			X		X			
112	ATC lost on single train	Dgd2			X		X			
113	Single PSD lost at station	Dgd3					X			
114	RCC Controlled Evacuation	Dgd4				X	X			
115	Reduced BUCF during RCC failure	Dgd5					X			
116										
117	**Abnormal Modes Of Operation**									
118	No Smoke Extraction	Abn1					X			
119	(180m) Tunnel Walkway Unavailable	Abn2					X			
120	RCC Uncontrolled Evacuation	Abn3					X			