

Briefing Note

CEJ 0m09½ch, (Cardiff) : Structural Collapse – Bridge Spandrel Wall, 9th August 2012
Formal Investigation Recommendation A5.2

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Network Rail to consider developing a mechanism to improve cross-discipline communication, specifically with regard to renewal items, to allow greater awareness of the potential to affect vulnerable assets and their rate of deterioration.

Intention:

To ensure that the potential impact of other disciplines work on structures assets are understood over both the long and short term.



Figure 1: Structural Collapse of bridge spandrel wall at CEJ 0m09 1/2ch, Cardiff

In August 2012, a masonry spandrel wall located at 0 miles 0209 yards on the Cardiff East Junction (CEJ) failed, collapsing on the line below.

This briefing note has been prepared in response to the Network Rail Formal Investigation Recommendation A5.2. SMIS Ref. QWA/2012/AUG/44.

The purpose of this document is to raise awareness of Network Rail standards and processes which currently facilitate cross-discipline communication.

Causes contributing to the failure

The formal investigation report recorded the following underlying causes to the failure:

- A lack of bond strength between the masonry blocks, due to gradual deterioration and breakdown of the ashlar mortar.
- The handrailing, which was fixed to the top of the spandrel wall, caused what would have been a local failure at the low mileage end, into a global failure as the handrailing pulled a larger proportion of the wall down than would otherwise have occurred.

- A failure to tie in the spandrel wall, with the brickwork retention, during a 1960s installation of a signal gantry during which a section of the original spandrel wall was taken down to accommodate the gantry installation.
- Track renewal undertaken in January 2010 included a minor track lift that increased lateral forces on the structure.
- There was a failure to relate deterioration and failures in other parts of the asset with the section of wall at 0 m 9½ ch to invoke an appropriate enhanced examination regime.
- There was no evidence to indicate that the examination regime takes cognisance of failures along other sections of the structure or potential risks of changes made to it to more accurately identify or add weighting to the potential risks.

Recommendation rationale

The investigation team believed that the spandrel wall rotated about the external edge of the arch face rings, causing the centre of gravity to shift forward prompting the upper section to fail, destabilising lower sections.

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The investigation team found that the erection of the signal gantry during the 1960s required the modification to part of the spandrel wall and connection into the adjacent Hope Street under bridge. The portal legs of the gantry are recessed into the masonry and necessitated the removal of the masonry wall and the end of the arch barrel. A brickwork wall has been built behind the portal to retain the fill material. This remained intact following the collapse and indicated that there was no continuity provided between these structures.



Figure 2: Modification of the spandrel wall to accommodate the signalling gantry

The installation of the gantry had compromised the integrity of the spandrel wall and weakened its capability to resist loads. The structure's evident material defects have also contributed to reducing its capacity.

The track renewal works carried out in January 2010 involved a deep-dig and an increase in ballast depth, resulting in amplified lateral forces on the structure

What has changed since the incident in 2012?

Following a review of the current standards and processes in regard to cross discipline communication, it was found that, since the time of the incident, Network Rail has introduced processes at each stage of the project life to ensure that any renewal works integrate correctly with the existing infrastructure and other discipline designs.

The relevant existing standards listed below have been revised since the incident to strengthen the statements of responsibility for safety in design and for management of interfaces and interoperability between project outputs and the railway system.

Legislation

- The Construction (Design and Management)

Regulations 2015

Network Rail Documents

- Sponsors' Handbook Version 2, January 2014
- NR/PSE/GUD/0231 Issue 01, November 2013, Requirements Engineering Fundamentals

Network Rail Standards

- NR/L2/OHS/0047 Application of the Construction (Design and Management) Regulations to Network Rail Construction Projects, June 2015
- NR/L2/INI/02009 Issue 6, September 2015, Engineering Management of Projects
- NR/L2/INI/02009/01, September 2015, Module 1 Roles, Responsibilities and Accountabilities
- NR/L2/INI/02009/02, September 2015, Module 2 Authority to Work (AtW) Competence Requirements

Other related documents already in existence prior to incident

- Network Rail Engineering Requirements
 - ✓ NR/L2/CIV/003 Issue 4, June 2012 Engineering Assurance of Building and Civil Engineering Works
 - ✓ NR/L2/ELP/27311 Issue 4, June 2011 Engineering Assurance Requirements for Design and Implementation of Electrical Power Engineering Infrastructure Projects
 - ✓ NR/L2/SIG/30003 Issue 1, June 2011 Engineering Assurance Arrangements for Signalling Engineering Schemes and Services
 - ✓ NR/L2/TEL/30022 Issue 7, June 2011 Engineering Assurance Arrangements for Communications Engineering Schemes and services
 - ✓ NR/L2/TRK/2500 Issue 3, June 2011 Engineering Assurance Arrangements for Track Engineering Projects
 - ✓ NR/L2/ERG/24020 Issue 3, June 2011 Engineering assurance requirements for Ergonomics within design and development projects
- IP6000, v3 April 2016 GRIP4Track Project Management Plan. Plain Line and High Output

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Existing Documents and Standards Review

NR/L2/OHS/0047 Application of the Construction (Design and Management) Regulations to Network Rail Construction Projects, June 2015

The CDM Regulations 2015 place obligations upon Network Rail to design, build and maintain the railway infrastructure so that risk to health and safety for the workforce, passengers and the public are not affected by the work activities. This includes cross-discipline risks. It applies to all construction and maintenance works carried out on the infrastructure.

Network Rail standard NR/L2/OHS/0047 is the primary document that defines the requirements and accountabilities for Network Rail with regards to the CDM Regulations 2015. It is supported by specific CDM Management Procedures defined by each Route, Function, Region and Major Programme.

The standard stipulates the requirements on management of CDM interfaces and clearly defines the duties of the Clients representatives.

NR/L2/OHS/0047 CL.8 CDM Interface

cl.8.2 Early GRIP Planning Stages

Client Representatives shall plan projects to minimise construction interfaces.

cl. 8.3 Coordination between Projects

...the Client's representatives shall identify the relevant parties and require them to adapt their plans to take into account each other's interface arrangements.

The process of Design Reviews provides means of co-ordination between relevant supply chain partners, operators, maintainers as well as the Client's representative. The intent of the Design Reviews is to coordinate the works with others and optimise the health and safety benefits when considering the buildability, usability and maintainability of an asset. The Design Reviews are initiated by the Principle Designer at the design stage and any significant risks and interdependencies are recorded within the Pre-construction Information Pack (Form NR/L2/OHS/0047/F0002) and the CDM Plan for the Project (Form NR/L2/OHS/0047/F0052).

Sponsors' Handbook Version 2 and NR/PSE/GUD/0231 Issue 1

The Sponsors' Handbook focuses on the processes required to develop capital projects (renewals and enhancements).

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As of April 2014, the Project Requirements Specification (PRS) was replaced with a new suite of requirements documents, referred to as the Client Requirements Document (CRD), Route Requirements Document (RRD) and Detailed Route Requirement Document (DRRD). The Sponsors' Handbook and NR/PSE/GUD/0231 stipulate the requirements for delivering these products.

The new requirements management process stipulates the need for cross-discipline communication through the need to engage with stakeholder management and identify project interdependencies. Stakeholder identification is required from the outset of a project. Their needs are captured and verified in the Clients Requirements Document (CRD). This document is also used to record any interdependencies, and requires the consequences of the proposed works to be realised.

The management of the requirements is a concurrent process that ensures that requirements are fully negotiated, defined and prioritised between stakeholders and mapped between client, route and deliverer.

As illustrated in Figure 4, the CRD is developed at the Early Development Phase, driven by customers, stakeholders, strategy and business objectives. The RRD is then developed throughout the Plan and Develop Phase (GRIP 1 to 3), satisfying the CRD. The DRRD is produced during the Deliver Phase (GRIP 4) and is driven by the Detailed Design Solution. All requirements are captured in the Contract Requirements document.

NR/L2/INI/02009 Issue 6 Engineering Management of Projects

This standard applies to all projects and the organisations working on projects that change, renew, enhance or remove Network Rail infrastructure assets except the following works undertaken by Network Operations:

INI/02009 CL.2.2 Exclusions

- a) the works do not physically replace existing assets and do not alter the configuration of assets;
- b) the works are limited to the direct replacement of individual components, and those items are physically and functionally directly compatible with the items being replaced;
- c) the works are limited to the "efficient recovery of redundant assets" (ERORA) and the changes have been authorised by the Route Asset Manager (RAM) [Signalling].

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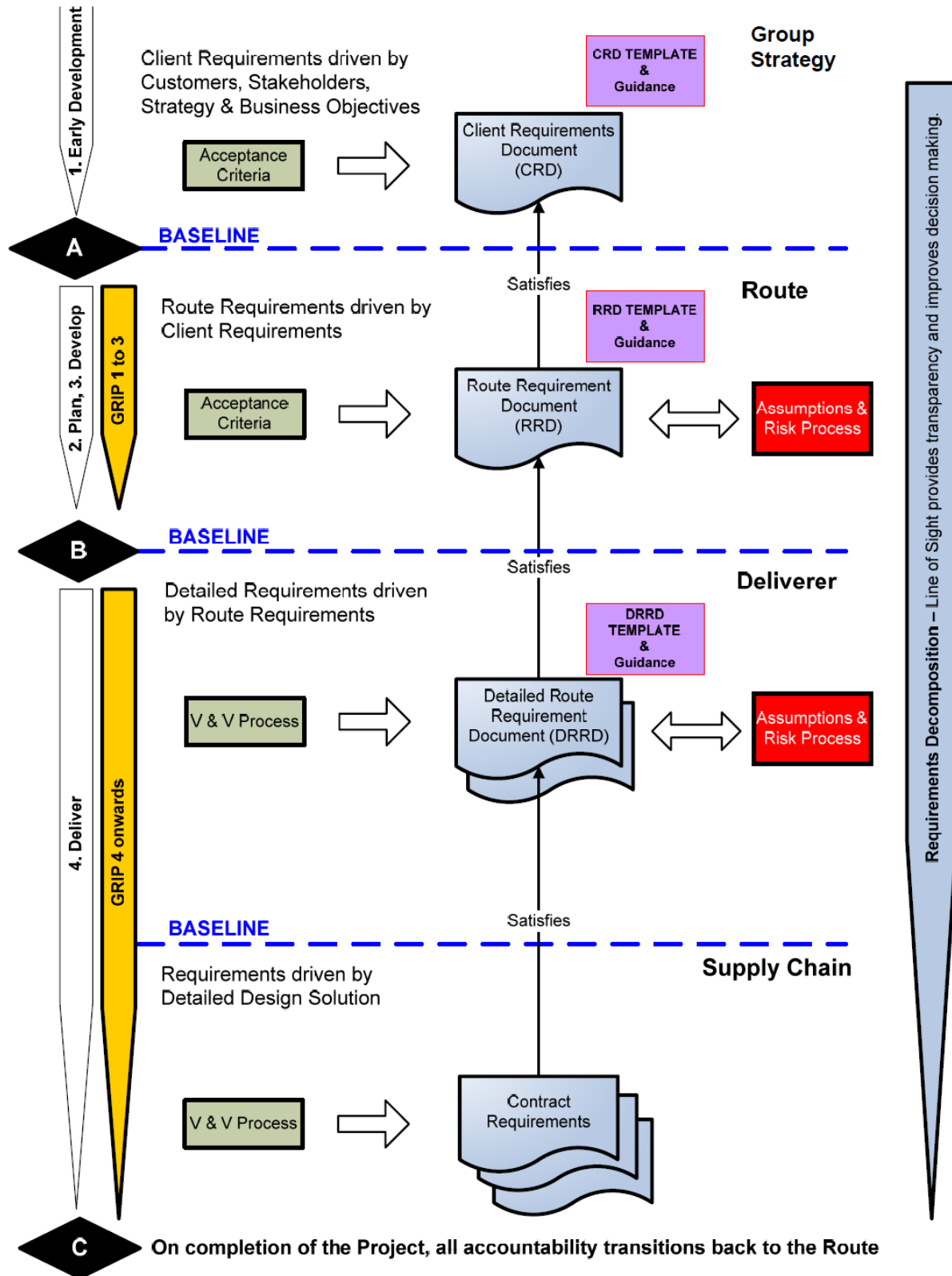


Figure 4: Requirements Hierarchy and Decomposition, Sponsor's Handbook v2

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INI/02009 defines the requirements for the management of engineering interfaces. It specifies that checks and reviews are required to certify that the design integrates effectively with other engineering disciplines and the possible effects on existing infrastructure are managed. Key parts of the integration process are the Interdisciplinary Checks (IDC) and Interdisciplinary Review (IDR).

INI/02009 Cl.3 Definitions

IDC *An assessment undertaken by the Design Organisation to confirm that the information included in the design is compatible and conforms to the requirements of all other designs with which the design is expected to interface*

IDR *A review undertaken by the DPE to confirm that the information included in the design submitted for Acceptance appears to be compatible and conform to the requirements of all other designs with which the design is expected to interface*

The roles and responsibilities for key project appointments are stated in this standard. The Designated Project Engineer (DPE) and Contractor's Engineering Manager (CEM) roles are safety critical to safety, integrity and interoperability of project outcomes, which includes those related to multi-disciplinary activities.

INI/02009 CL.4.2 Role and Responsibility

CEM *Person within every design and/or construction organisation contracted to Network Rail, (or to a party other than Network Rail where agreed with Network Rail) with overall accountability for all engineering activities applicable to that specific Contract including those undertaken by subcontracted organisations.*

DPE *Person appointed by Network Rail accountable for the coordination and integration of technical and engineering aspects of a specific project particularly where the project includes multi-disciplinary activities.*

The process of undertaking the IDC and IDR, and the responsibility of the key appointments, has been outlined in the clauses below.

INI/02009 Cl. 7.4 Interdisciplinary Checks

7.4.1 *The CEM shall be responsible for making sure that IDCs have been carried out on each of their design packages prior to their formal submission to Network Rail for review, including where a joint IDC/IDR is conducted.*

7.4.5. *At the conclusion of the IDC process, all discipline CREs shall sign an IDC certificate.*

7.5.1 *The CEM shall make sure that all engineering deliverables are accompanied by a signed IDC certificate.*

INI/02009 Cl. 7.6 Interdisciplinary Reviews

7.6.3 *The DPE shall be responsible for planning and conducting all IDRs, recording the results and managing the close out of the issues that arise. The output of the IDR shall be held in a register "IDR Actions Tracker" or equivalent. Interdisciplinary issues shall be resolved within the design/engineering team before IDR close-out.*

The reporting lines and information exchange between the roles have been mapped (Figure 5). It shows that the appointed organisation for the management of the design is accountable for coordination between different discipline designs for the project. The CEM is accountable for the implementation of the IDC process. The DPE supports that process and verifies that the coordination and integration take place. The CEM and all CREs retain full responsibility for their design including its capability to interface correctly with other designs. The number of disciplines for each project may vary according to the multidiscipline nature of the project.

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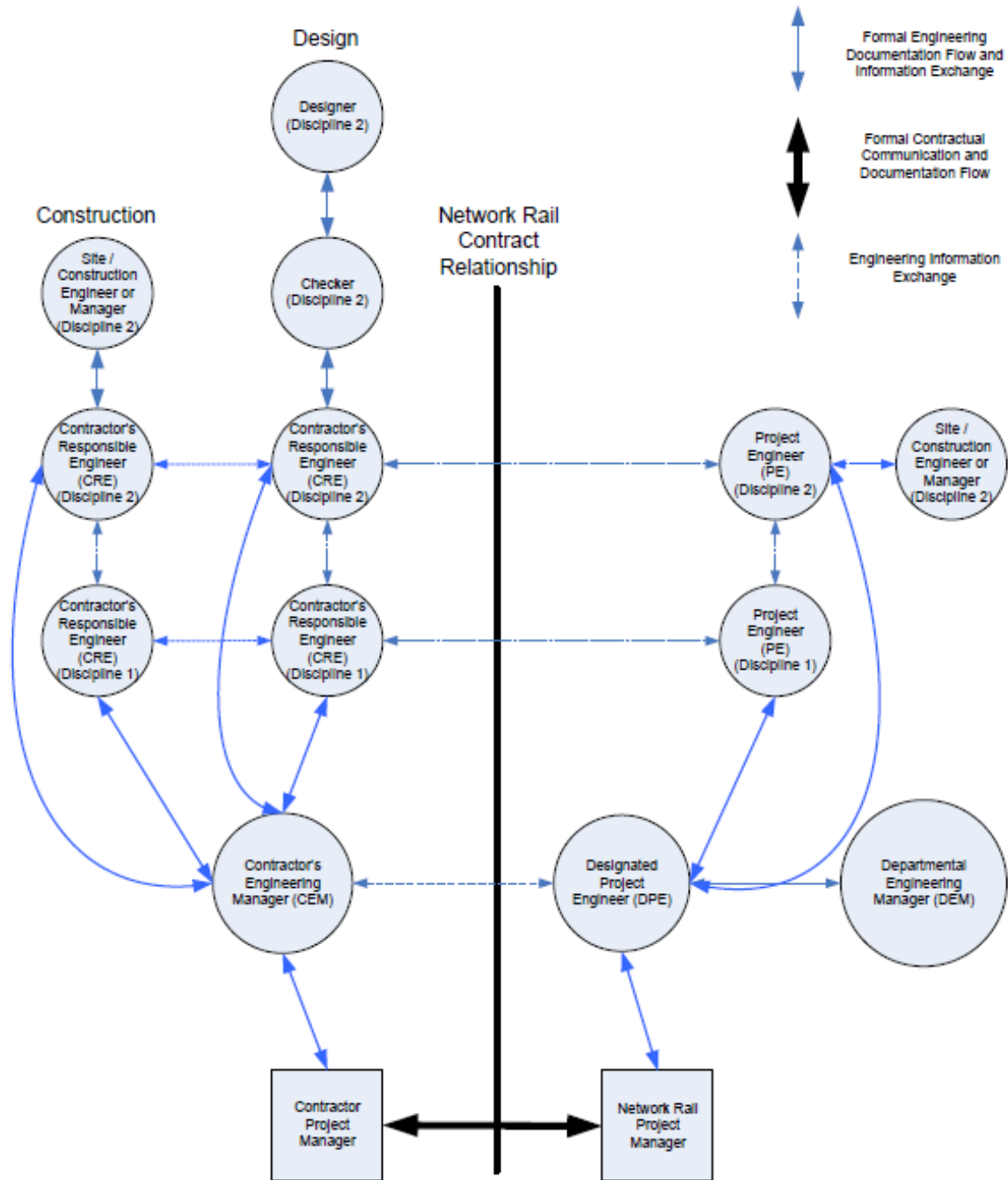


Figure 5 Engineering Team Relationships, NR/L2/INI/02009 Issue 6

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Works undertaken by Third Parties and Outside Parties

When works or activities by Third Parties and Outside Parties potentially impacts on the railway infrastructure, Network Rail has an asset protection activity in place that manages these interfaces.

Sponsors' Handbook Cl.27.0 ASPRO

The majority of smaller interface projects are normally carried out by an ASPRO team, and involves entering into an agreement with the party carrying out the works, and monitoring compliance with that agreement.

The Works Agreement (e.g. BAPA, APA etc.) covers the design, construction and maintenance of all works and requires compliance with current standards and processes, as identified above, in regard to cross discipline communication.

Relevant documents for management of Outside and Third Party works is provided for reference below:

- NR/L2/INI/CP0043, Issue 3, March 2009 Management of Third Party Works on Network Rail Infrastructure
- Asset Protection Outside Parties, Guidance Document Requirements for Construction Works on or near Railway Operational Land by Outside Parties

Related ongoing projects within Network Rail

A brief summary of ongoing projects within the company is provided below which are considered to enhance further the existing cross discipline communication mechanisms.

➤ **Engineering Project iELC (integrated Engineering Lifecycle)**

The iELC project is 1 of 16 P3M3 Projects ('Portfolio, Programme and Project Management Maturity Model') led by IP Team. It aims to address the following risks:

Risk	Cause
Project outputs may not satisfy project requirements	Inadequate requirements management, clarity regarding accountabilities, governance and scalable end to end Engineering process
A Systems Engineering approach may not be applied to network change	Lack of an integrated engineering approach and systems engineering expertise / awareness within Network Rail

Outcome of the project is the introduction of a phased lifecycle that sits alongside the GRIP stages. Each phase details potential engineering activities and ends with an Engineering Gate. Engineering Gate questions and templates will ensure that technical aspects are included and will support the GRIP stage gate reviews. The iELC project will start its roll out across the Regions and major Programmes in November 2016 as a non-mandatory process.

➤ **CDM Management Procedures; Network Operations; 'Route Template' Asset Protection**

This document has been produced as a draft and is under discussion with the relevant parties. It is to act as a means of control for the discharge of Network Rail's duty to comply with the CDM Regulations 2015. This is intended to be a live document and will provide compliance authority through Network Rail standard NR/L2/OHS/0047 Application of the Construction (Design and Management) Regulations to Network Rail Construction Projects. It will be superseded by the 'CDM Management Arrangements' which are to be put in place by each Route Managing Director.

The target date for implementation of these CDM Management Arrangements was June 2016.

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Key findings from the review of the existing Network Rail processes related to renewal works:

- ✓ Stakeholder identification and involvement
 - The Stakeholders should be identified from the outset of a project and their requirements captured and prioritised in CRD, RRD and DRRD as specified in the Sponsors' Handbook.
 - The list of stakeholders will grow and change through the lifecycle of the project. They should continue to be consulted until the project is finished
- ✓ The management of the engineering interfaces during the project phases should be achieved through the IDC and IDR process in accordance with NR/L2/INI/02009.
- ✓ Network Rail duties for the coordination of the design works and the management of the construction interfaces with regards to CDM Regulations 2015 are outlined in NR/L2/OHS/0047.

Conclusion

The review of current Network Rail standards identified that the control in respect of cross discipline communication is achieved through the acceptance of the CRD, DDR and DRRD in the early stages of the projects and through the IDC and IDR process during the design stage.

These processes have been stipulated in the company standards for each discipline (i.e. Buildings & Civils, Electrical Power, Signalling, Track, Telecommunications and Ergonomics) and confirmed to be complied with from different parts of the organisation (i.e. IP Buildings & Civils, IP Track and ASPRO team).

It is evident that the existing processes regarding cross-discipline communication, specifically in respect to renewal works, have been improved significantly since the incident in 2012.

Network Rail can conclude that the controls that are in place with regards to cross-discipline communication are satisfactory and therefore no changes to the existing standards are deemed necessary

To aid project delivery this briefing note will be passed onto the project delivery teams. This is to emphasise the importance of cross-discipline communication through the different phases of each project and to provide a reference to the relevant standards.