

Information for users

The following document:

NR/L3/CIV/020
Issue 1

has had changes made to it, most recently, with effect from **7 August 2015**.

Instructions for use

It is essential that you first read and understand each letter of instruction pertaining to the standard before proceeding to use the standard. You must then apply the requirements of each letter to the standard.

NR/BS/LI/331	Issue 2	07 August 2015	Proceed to letter ►
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Compliance date	4 th June 2011

Level 3

Design of Bridges

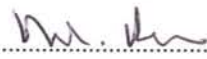
Endorsement and Authorisation

Endorsed by:



K. Brady, Senior Policy Development Specialist (Civil Engineering)

Authorised by:



N Ricketts, Professional Head (Buildings and Civils)

Accepted for issue by:



M. McManus, National Standards Manager

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Published and issued by Network Rail Kings Place, 90 York Way London N19AG



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Publication date	5 th March 2011
Compliance date	4 th June 2011

Issue record

Issue	Date	Comments
1	March 2011	New standard, incorporating RT/CE/S/007 : <i>Design loading for accommodation and occupation overbridges.</i>

Compliance

This Network Rail standard shall be complied with by Network Rail and its Contractors from 4th June 2011.

When this standard is implemented, it is permissible for all projects that have formally completed GRIP Stage 3 (Option Selection) to continue to comply with the issue of any relevant Network Rail standards current when GRIP Stage 3 was completed and not to comply with requirements contained herein, unless stipulated otherwise in the scope of this standard.

Reference documentation

Statutory regulations

The Construction (Design and Management) Regulations 2007 (SI No. 320)

The Railways (Interoperability) Regulations 2006 (SI No. 397)

The Railways (Interoperability) (Amendment) Regulations 2007 (SI No. 3386)

Railway Interoperability Directive 2008/57/EC

Health and Safety at Work Act 1974

Building Regulations 2000 (SI No 2531)

Traffic Signs (Amendment) Regulations and General Directions 2010

Railway Group Standards

GC/RT5033	Terminal tracks - requirements for buffer stops, arresting devices and end impact walls
GC/RT5212	Requirements for defining and maintaining clearances
GE/RT8006	Assessment of compatibility of rail vehicle weights and underline bridges
GE/RT8073	Requirements for the application of standard vehicle gauges
GE/RT8025	Electrical protective provisions for electrified lines
GE/RT8029	Management of clearances and gauging [superseded]
GI/RT7016	Interface between station platforms, track and trains
GL/RT1253	Mitigation of d.c. stray current effects
GM/RT2149	Requirements for defining and maintaining the size of railway vehicles
GO/RT3413	Provision of information and signs for access on the railway
GE/GN8573	Guidance on gauging.

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Network Rail standards

NR/GN/CIV/001	Waterproofing of underline Bridge decks
NR/GN/CIV/002	The use of protective coatings and sealants
NR/GN/CIV/025	The structural Assessment of underbridges
NR/GN/CIV/202	Management of the risk of Bridge strikes
NR/L3/CIV/003	Technical Approval of design, construction and maintenance of Civil Engineering Infrastructure
NR/L1/AMG/1010	Policy on working safely in the vicinity of buried services
NR/L2/AMG/1020	Buried services data provision
NR/L2/AMG/1030	Working safely in the vicinity of buried services
NR/L2/AMG/1040	Buried services data feedback
NR/L3/CIV/005	Railway drainage systems manual
NR/L3/CIV/006	Handbook for the examination of structures
NR/L3/CIV/037	Managing the risk arising from mineral extraction and landfill operations
NR/L3/CIV/038	Managing the potential effects of coal mining subsidence
NR/L3/CIV/039	Specification for the assessment and certification of protective coatings and sealants
NR/L3/CIV/040	Specification for the use of protective coating systems
NR/L3/CIV/041	Waterproofing systems for underline Bridge decks
NR/L3/CIV/071	Geotechnical design
NR/L3/CIV/076	Management of Bridge strikes from road vehicles and waterborne vessels
NR/L3/CIV/140	Model Clauses for Civil Engineering works
NR/L3/CIV/151	Technical Approval of Standard Details and Designs for Civil Engineering works
NR/L3/MTC/089	Asset management plan
NR/SP/ELP/21085	Design of earthing and bonding systems for 25 kV a.c. electrified lines
NR/L2/INI/CP0047	Application of the Construction (Design and Management) Regulations to Network Rail construction works
NR/SP/OHS/069	Lineside facilities for personal safety
NR/L1/TRK/05200	Vegetation
NR/L2/TRK/2049	Track Design handbook
NR/L2/TRK/2102	Design and construction of track
NR/L2/TRK/2500	Technical Approval in the design of track infrastructure
NR/L2/TRK/5100	Management of Fencing and Other Boundary Measures
NR/L2/TRK/038	Longitudinal timbers - design, installation and maintenance

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RT/CE/C/015 The Assessment of underbridge capacity

RT/CE/S/035 Assessment of structures

British Standards

- BS 5395-1 Stairs, ladders and walkways. Part 1: Stairs. Code of practice for the design of stairs with straight flights and winders (2010)
- BS 6799 Highway parapets for bridges and other structures
Part 2: Specification for vehicle containment parapets of concrete construction (1991)
Part 4: Specification for parapets of reinforced and unreinforced masonry construction (1999)
- BS 7818 Specification for pedestrian restraint systems in metal (1995)
- BS 8300 Design of buildings and their approaches to meet the needs of disabled people. Code of Practice (2009)
- BS EN 1317-2 Road restraint systems. Performance classes, impact test acceptance criteria and test methods for safety barriers (1998)
- BS EN 15528 Railway applications. Live categories for managing the interface between load limits of vehicles and infrastructure (2008)
- BS EN 50122 Railway applications - Fixed installations
Part 1: Protective provisions relating to electrical safety and earthing (1998)
Part 2: Protective provisions against the effects of stray currents caused by d.c. traction systems (1999)
- BS EN ISO 12944-3 Paints and varnishes. Part 3: Design considerations (1988)
- BS EN ISO 14122-2 Safety of machinery. Permanent means of access to machinery. Working platforms and walkways (2001)
- PD 6688-1-7 Recommendations for the design of structures to BS EN 1991-1-7 (2009)

Structural Eurocodes

- BS EN 1990 Eurocode: Basis of structural design (2002) + A1 (2005)
Annex A2: Application for bridges (2002)
NA to BS EN 1990. UK National Annex to Eurocode. Basis of structural design (2002) + A1 (2005)
- BS EN 1991 Eurocode 1. Actions on structures (2003)
BS EN 1991-1-4. General actions. Wind actions (2005)
BS EN 1991-1-6. General actions - Actions during execution (2005)
BS EN 1991-1-7. Accidental actions (2006)
BS EN 1991-2. Traffic loads on bridges (2003)

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NA to BS EN 1991-1-1. UK National Annex to Eurocode 1. Actions on structures. General actions. Densities, self-weight, imposed loads for buildings (2002)

NA to BS EN 1991-1-6. UK National Annex to Eurocode 1. Actions on structures. General actions - Actions during execution (2008)

NA to BS EN 1991-1-7. UK National Annex to Eurocode 1. Actions on structures. Accidental actions (2006)

NA to BS EN 1991-2. UK National Annex to Eurocode 1. Actions on structures. Traffic loads on bridges (2003)

BS EN 1992 Eurocode 2. Design of concrete structures (2004)

BS EN 1992-2: Concrete bridges - design and detailing rules (2005)

BS EN 1993 Eurocode 3. Design of steel structures (2005)

BS EN 1994 Eurocode 4. Design of composite steel and concrete structures (2004)

BS EN 1995 Eurocode 5. Design of timber structures (2004)

BS EN 1996 Eurocode 6. Design of masonry structures (2005)

BS EN 1997 Eurocode 7. Geotechnical design (2004)

BS EN 1998 Eurocode 8. Design of structures for earthquake resistance (2004)

BS EN 1999 Eurocode 9. Design of aluminium structures (2007)

Highways Agency standards

BD 29/04 Design criteria for footbridges

BD 30/87 Backfilled retaining walls and bridge abutments

BD 42/00 Design of embedded retaining walls and bridge abutments

BD 65/97 Design criteria for collision protection beams

BD 74/00 Foundations

TD 19/06 Requirements for road restraint systems

Department for Transport (DfT)

Managing the accidental obstruction of the railway by road vehicles (2005)

Accessible train station design for disabled people: A code of practice (2010)

International Union of Railways

UIC 719-R Earthworks and track bed construction for railway lines

UIC 774-3R Track-Bridge interaction. Recommendations for calculations

UIC 777-2R Structures built over railway lines. Construction requirements in the track zone

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Other publications

Burland and Kalra: *Geotechnical aspects*. Proc. Instn Civ. Engrs, Part 1, 1986, 80, Dec., 1479-1503

CIRIA: Culvert design and operation guide. C689. (2010)

Traffic Signs Manual (11 June 2004) London: TSO for DfT, the Scottish Executive, the Welsh Assembly Government and the Department for Regional Development NI

Disclaimer

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1 Purpose

The purpose of this standard is to define the requirements for the structural Design of Bridges and Bridge-like structures.

2 Scope

2.1 Ownership and management

This standard is applicable to the Design of temporary and permanent Bridges and Bridge-like structures.

2.2 Types of structure

This standard is applicable to the structural Design of Bridges and to Bridge-like structures such as;

- Culverts,
- subways,
- structures that support buildings over operational railway lines,
- cut and cover structures,
- elevated vehicle forecourts and ramps,
- avalanche shelters.

This standard is not applicable to the Design of;

- Equipment support structures - such as gantries for signals or overhead line electrification (OLE),
- Earthworks (but see **17** for the design of earth retaining walls),
- cable bridges,
- pipe bridges (but see **10.20**),
- pipes,
- buildings and other structures that are supported by a Bridge.

2.3 Extent of structures

For the types of structure within its scope, this standard applies to all structural parts (such as decks and abutments) and elements (such as beams, columns and ballast plates) and permanent access facilities (such as walkways) that are integral with the structure. However, this standard is not applicable to the design of Longitudinal timbers - this is covered by [NR/L2/TRK/038](#): *Longitudinal timbers - design, installation and maintenance*.

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2.4 Categories of work

This standard applies to the Design of;

- repair works,
- alterations,
- strengthening works,
- renewed/replaced structural elements,
- renewed/replaced parts,
- new structures.

This standard also applies to;

- all stages where permanent works and temporary works are taken into operational use in stages, see [NR/L3/MTC/089: Asset Management Plan](#),
- temporary works provided for the execution of the structure.

2.5 Types of rail traffic

This standard is applicable to structures carrying conventional railway traffic at conventional speeds; that is;

- passenger rail traffic with a maximum permitted speed not exceeding 125 mph (200 km/h),
- freight traffic with a maximum axle weight of 25 tons and maximum permitted speed not exceeding 60 mph (100 km/h),
- freight traffic with a maximum axle weight of 22.5 tons and maximum permitted speed not exceeding 75 mph (120 km/h).

Instruction and guidance on the Design of structures that are intended to carry rail traffic travelling in excess of these speeds can be sought from Network Rail's Professional Head (Buildings and Civils).

3 Roles, responsibilities and competencies

Those appointing persons to positions with responsibilities to deliver the requirements of this standard shall check that appointees are competent and that they understand their responsibilities. Appointments, responsibilities and duties shall be documented.

The skill, expertise, training and experience of those employed on a Design shall be appropriate to the nature and complexity of the structure being designed. This competency shall be assessed by the person making the appointment.

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The aims of *The Construction (Design and Management) Regulations 2007* are delivered, in the main, through five key roles: Client; CDM Co-ordinator; Designer; Principal Contractor; and Contractor. Network Rail undertakes all these roles, according to circumstance, on construction projects and [NR/L2/INI/CP0047: Application of the Construction \(Design and Management\) Regulations to Network Rail construction works](#) defines for Network Rail employees (a) the competence requirements for undertaking these roles, and (b) how these roles are to be fulfilled.

The roles, responsibilities and competencies of those involved in the producing and checking a Design are specified in [NR/L3/CIV/003: Technical Approval of design, construction and maintenance of Civil Engineering Infrastructure](#).

The responsibilities of Network Rail's Infrastructure Liability Manager are described in **9.7**.

4 Definitions and abbreviations

The non-capitalised definitions are derived from, and follow the practice of, the Structural Eurocodes.

Accommodation Bridge

A Bridge provided to maintain access to lands that were severed by the construction of the railway and which can only legally be used by the successor to the original landowner whose land was severed; however, subsequent public footpath and bridle rights may have been acquired by other users.

AIP: Approval in Principle

Assessment

The determination or confirmation of the stability or safe-load bearing capacity of a structure.

Authorised Walking Route

A designated route providing pedestrian access to and egress from places of work (including booking-on points and stabling points) and which is suitable for use by persons not certificated in Personal Track Safety.

Bridge

A structure of one or more spans greater than or equal to 1.8 metres whose prime purpose is usually to carry traffic or services over an obstruction or gap.

Cess Walkway

A designated walkway along the cess where persons certificated as competent in Personal Track Safety may walk safely while trains pass.

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Containment Level

The capacity of road restraint systems to restrain road vehicles.

Culvert

A structure with a span or diameter greater than 0.45 metres but less than 1.8 metres whose prime purpose is usually to permit water or services to pass under or adjacent to a railway, road or other Network Rail infrastructure.

Design

Information in the form of drawings, diagrams, calculations and/or specifications (performance, materials and workmanship) which together describe in detail what is to be constructed and, where applicable, how it is to be constructed. The term is also used to describe the process by which such information is produced, including the undertaking of structural calculations.

Designer

The person responsible for the Design who is authorised to sign the AIP submission and/or the Design certificate on behalf of the Design organisation.

design value

The value of a variable used in the calculation of the dimensions, forces on or in the structure being designed.

design working life

Assumed period for which a structure or part of it is to be used for its intended purpose with anticipated maintenance but without major repair being necessary.

Earthwork

An Embankment, Cutting (soil or rock) or Natural Slope (soil or rock), or nailed or reinforced soil structure whose face angle is less than 70 degrees to the horizontal.

execution

All activities carried out for the physical completion of the work including procurement, the inspection and documentation thereof.

form of structure

Arrangement of structural members.

Hidden Critical Elements

A primary structural member that cannot be observed from at least one side throughout its extent and it is not protected by a material which is known to preserve the condition of the part.

Immediate Access

The place immediately adjacent to the track and at a level that is not more than 500 mm above or below the top of the adjacent sleepers.

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Interworking

The ability of the structure to be compatible with current and foreseeable rail traffic - including traffic diverted from other routes, emergency rail traffic, and the cascade of rail vehicles from one route to another. It includes the Design of the structure meeting interoperability requirements.

limit states

States beyond which the structure no longer fulfils the relevant design criteria.

serviceability limit states

States that correspond to conditions beyond which specified service requirements for a structure or structural member are no longer met.

ultimate limit states

States associated with collapse or with other similar forms of structural failure.

method of construction

Manner in which the execution will be carried out.

Occupation Bridge

A Bridge carrying a private road which generally pre-existed the railway and which can only be used by authorised users - typically the successors of the original users of the road and their invitees, although subsequent public footpath and bridleway rights may have been acquired by other users.

Outside Party

A person or organisation, other than Network Rail, that is an infrastructure owner or developer, or is a user or occupier of Network Rail's infrastructure. The term includes Highway Authorities, Roads Authorities, Passenger Transport Executives, public or private developers, and Train Operating Companies.

Overline Bridge

A Bridge which passes over the railway.

Position of Safety

A place with Immediate Access from the track for persons to move to and stand in safely while trains pass.

RA: Route Availability

Real Trains

The axle loads and axle spacings of particular trains and/or railway vehicles, and the combinations of such trains/vehicles. The axle loads correspond to the design mass under exceptional payload conditions in accordance with [GE/RT8006](#): *Assessment of compatibility of rail vehicle weights and underline bridges* and [BS EN 15528](#): *Railway applications. Live categories for managing the interface between load limits of vehicles and infrastructure*.

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Refuge

A specially constructed recess providing a discrete Position of Safety.

Remit

The formal document issued by Network Rail which describes the purpose, scope and objectives for a project, an outline of the service required, key responsibilities, and the outputs to be delivered at completion of the project phases.

Shared structures

A structure for which the ownership and/or management is shared between Network Rail and an Outside Party.

structure

Organised combination of connected parts, including fill placed during execution of the construction works, designed to carry loads and provide adequate rigidity.

Track support system

The structure that provides immediate support to the track; it includes the formation, capping layers, blanketing, ballast, geosynthetics that are integral with the system, and Longitudinal Timbers.

Underline Bridge

A Bridge which carries one or more railway tracks.

5 Applicability of this standard

This standard shall be applied to the Design of temporary and permanent Bridges and Bridge-like structures that are owned or managed (solely or Shared) by Network Rail.

This standard shall be applied to the Design of all Underline Bridges and Bridge-like structures.

Best endeavours shall be used so that the Design of Outside Party Overline Bridges, footbridges and Bridge-like structures complies with the requirements of this standard. Where the requirements are not met, relevant details shall be recorded and the appropriate authorities notified: Network Rail's Professional Head (Buildings and Civils) shall be notified where the safety of train operations or Interworking might be affected.

The general term 'structure' is used in this standard to cover all types of Bridges and Bridge-like structures. However, for convenience and convention, the text also refers to Underline Bridges (for example), but the requirements given for Bridges shall also be applied, where applicable, to Bridge-like structures.

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6 Design objectives

The fundamental objectives of a Design are that the structure will during its execution and design working life (with appropriate degrees of reliability):

- 1 Remain fit for the use required, and sustain all the actions and environmental influences likely to be imposed upon it - within acceptable deformation limits.
- 2 Accommodate existing and foreseeable requirements for users of the structure, equipment, services, and plant.
- 3 Have adequate stability, resistance, stiffness, serviceability and durability.
- 4 Have sufficient resilience, robustness and structural redundancy to;
 - (a) not suffer damage by accidents and events (such as vehicle impact, vandalism, and human error in design and use) that would be disproportionate to the severity of their cause,
 - (b) have a low sensitivity to hazards that it might be subjected to,
 - (c) so far as is reasonably practicable, provide adequate warning of collapse - for example, by showing signs of structural distress or deformation.
- 5 Have adequate clearance between rail traffic and the structure and between trains on adjacent tracks.
- 6 Be economic to construct, use and maintain.
- 7 Be readily accessible for routine examination and maintenance.
- 8 Have no unacceptable effect on;
 - (a) the safe use or performance of existing or proposed railway infrastructure and equipment,
 - (b) other infrastructure and equipment, and
 - (c) the safety of people on or about the structure, and the public at large.
- 9 Cause minimal or no damage to property and the environment.

7 Design approach

7.1 New structures, structural parts and elements

Where applicable, the suite of Structural Eurocodes shall be used to Design new structures, structural parts and elements. However, where it would be inappropriate to use the Eurocodes the designer shall state on

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the AIP submission the basis and justification for adopting alternative standards. (For example, the Eurocodes cannot be applied to the design of structures formed from materials that fall outside their scope, such as fibre reinforced polymers.)

The Eurocodes cannot be applied without amendment or supplement (a) to unusual forms of construction, (b) to structures that have unusual in-service conditions, and (c) where conditions preclude normal checks to be made on construction works or on the maintenance of the structure. In such cases, the necessary amendments and supplements to the Eurocodes shall be stated on the AIP submission.

7.2 Strengthening, alteration and repair works

The Eurocodes should not be used to determine the safe load carrying capacity of an existing structure and, from this, any necessary strengthening, alteration or repair works for that structure. Network Rail standards, and other relevant standards, govern (a) the methods used for undertaking an Assessment, and (b) the means of determining and addressing any shortfall/deficiency in strength from such an Assessment. Such standards may also be used for the design of the required works; however, where applicable, the design of new structural parts/elements shall be based on the Structural Eurocodes.

The Design of strengthening, alteration and repairs to existing elements shall satisfy the requirements of [NR/GN/CIV/025: The structural Assessment of underbridges](#). The Design of strengthening works for structures previously assessed to [RT/CE/C/015: The Assessment of underbridge capacity](#) shall include the provision for the remaining structure to be improved to meet the requirements of [NR/GN/CIV/025](#). The proposed Design approach shall be described in the AIP submission.

Where works are to be undertaken, elements that have been assessed as worse than Assessed Category A2 (in accordance with [RT/CE/S/035: Assessment of structures](#)) shall be strengthened or replaced to comply with the requirements of this standard. Where applicable, the design of new structural parts/elements shall be based on the Structural Eurocodes.

Consideration shall be given to the cost-effectiveness (for managing the structure a whole) of improving the retained parts/elements so that they would comply with the requirements of this standard.

The Design shall consider the interfaces between the changed (strengthened, altered or repaired) and retained parts/elements. A check shall be made that no detrimental effects on the retained

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parts/elements will arise from the installation of the changed ones: the check shall take into account;

- changes in the magnitude of the loads,
- changes in the pattern of the loads,
- the distribution of load effects,
- the stiffness of the changed and the retained parts/elements.

Where the introduction of new elements affects the load distribution or resistance of existing elements, the existing elements shall be assessed in accordance with [NR/GN/CIV/025](#).

The Design of alterations to metallic Bridges shall not introduce poor fatigue details; see [NR/GN/CIV/025](#).

Strengthening and alteration works shall be subject to Technical Approval in accordance with [NR/L3/CIV/003](#): repairs that are not like for like replacements shall be considered as alterations and so shall be subject to Technical Approval.

7.3 Materials and workmanship

The specifications for the construction methods, materials, site tests etc. shall be considered to be part of the Design. Such specifications shall;

- be compatible with the Design assumptions,
- accord with the applicable Design standards,
- be suitable for the local environment of the structure,
- comply with environmental and Health and Safety requirements.

The specifications shall be prepared in accordance with [NR/L3/CIV/140](#): *Model Clauses for Civil Engineering works*. The relevant Clauses shall (a) be revised to take account of changes in the references, and (b) modified and/or supplemented to suit the specific requirements of the works and the Site.

Where it is proposed to fabricate the structural element(s) from a material other than one of those covered in the suite of Eurocodes, the Design of such elements shall be in accordance with recognised international, national, or industry standards; these standards shall be identified in the AIP submission. Where no commonly accepted standards exist (such as for a fibre reinforced polymer) the Design methodology shall be justified and recorded in the AIP submission, and the Design shall be subject to a category III check in accordance with [NR/L3/CIV/003](#).

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To avoid delays in the Design process, novel and/or previously unaccepted construction methods and materials etc. shall be referred to Network Rail's Professional Head (Buildings and Civils) prior to the submission of the AIP.

7.4 Standard Details and Designs

Network Rail has developed Standard Designs and Details (SDDs) for a wide range of commonly undertaken Civil Engineering works. Details of these and their application are provided in [NR/L3/CIV/151](#): *Technical Approval of Standard Details and Designs for Civil Engineering works*.

The designer shall confirm on the AIP submission that consideration has been given to using the SDDs for the works in hand. Further, that where the SDDs are used, the Design has included the necessary requirements for applying them: this shall be stated in the project-specific Certificate of Design and Checking (as given in [NR/L3/CIV/003](#)).

Where it is proposed not to utilise an applicable SDD, the AIP submission shall include a whole life economic justification that takes account of any additional management costs arising from the use of non-standard details.

8 Remit

Network Rail or other relevant Authority (as agreed with Network Rail) shall;

- specify the purpose and intended use of the structure,
- outline the operational and safety requirements for the intended and future use of the structure,
- provide relevant Design information in the Remit, or other documents, to the Designer.

The Remit shall specify all project specific requirements, such as;

- TSI requirements and the means of assessing conformity and verification (see **9.2** and Appendix **C**),
- legal and commercial liability issues (**9.7**),
- the positions of tracks to be supported (**9.9.1**),
- structural gauge and clearances to the railway (**9.9.2**) and to roads/highways (**9.11**),
- design working life (**10.2**),
- road restraint systems (**10.9**), and walkways and Positions of Safety (**10.13**) etc,

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- hydraulic aspects of the Design of Bridges over water and conduits conveying water (**11.5**),
- loads to be supported (including rail/road traffic, equipment, services, and numbers of persons) with consideration given to the likely or reasonably foreseeable future loads (such as given in **11** and **12**),
- speed, tonnage and traffic mix for assessing fatigue (**12.5**),
- particular requirements for passenger comfort for structures on a primary route (**16.1.7**),
- accidental loading requirements (such as given in Appendix **B**),
- loading for an Accommodation or Occupation Bridge,
- planned abnormal use,
- particular security requirements,
- restrictions on load and other limitations in usage - the methods of enforcing these shall be identified and recorded in the AIP submission, and necessary provisions incorporated into the Design.

9 General Design requirements

9.1 Regulations, legislation and standards

The Design shall comply with the requirements of;

- *The Railway (Interoperability) Regulations 2006, + Amendment (2007)*,
- Relevant legislation, such as the *Health and Safety at Work Act 1974*, and *The Construction (Design and Management) Regulations 2007*,
- *Building Regulations*,
- Railway Group Standards,
- Network Rail standards,
- Other standards (generally European ones, but National ones where these are not available) and product specifications etc.

The Design shall also take due regard of good practice guides covering methods of construction (for example) and codes of practice (such as *Accessible train station design for disabled people: A code of practice*).

The Design shall be based on a set of consistent and compatible standards governing, inter alia, loading conditions, structural adequacy, structural performance, construction works and material specifications. Where this is not possible, the AIP submission shall include the studies

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undertaken to demonstrate that the proposed Design requirements are mutually compatible and give the same factor of safety as a conventional Bridge design undertaken to the Structural Eurocodes.

The following shall be stated and justified in the AIP submission:

- 1 Deviations from Railway Group Standards and Network Rail standards and departures from other documents referred to in the Technical Approval Specification of the AIP.
- 2 Incompatibilities in the requirements of the standards used in the Design, and proposals for resolving them.
- 3 Variations from standard industry practice.
- 4 Where the standards allow the Designer a choice, the selection of the method of analysis, design value etc.

9.2 Technical Specifications for Interoperability

The applicability of the Technical Specifications for Interoperability (TSIs) (*high speed and conventional rail*) shall be established for each Bridge and an appendix of the AIP submission shall (a) identify the TSI requirements which apply to the Design, and (b) demonstrate how the Design requirements in the AIP submission comply with those TSI requirements. Appendix C provides an introduction to these particular requirements.

The applicability and requirements of the TSI for Persons with reduced mobility (PRM TSI) is described in *Accessible train station design for disabled people: A code of practice*.

The application of the TSIs is mandatory for works (which fall within the remit of the TSIs) on routes that form part of the Trans-European Network (TEN). Where reasonably practicable, the TSI requirements for structural works (as opposed to procedural actions) shall be applied to works within the scope of the TSIs on other routes.

9.3 Health and Safety and operational safety requirements

The Design shall take into account (a) the requirements and influences which could affect the safety and/or performance of railway operations, and (b) reasonably foreseeable effects of the construction and use of the structure on the health and safety of site operatives, railway passengers, members of the public, and those whose duties take them on or near the line, including;

- safe means of access and egress, including emergencies and for disabled people,

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- fire safety,
- selection and use of materials, components and methods of construction,
- standards of workmanship for execution, planned examination and maintenance,
- maintenance of railway infrastructure,
- operations of other railway infrastructure owners,
- provision of walkways and Positions of Safety alongside the railway (as defined in [NR/SP/OHS/069](#): *Lineside facilities for personal safety*),
- sighting of train control equipment and other lineside signs,
- sighting distances to trains,
- retention of ballast on the approaches to and across Underline Bridges,
- the layout of platforms,
- aerodynamic effects of passing trains,
- potential arcing of electric power equipment,
- induced voltages,
- drainage of ground water and surface run-off where it could affect train control or other safety critical equipment, or the stability of the track,
- avoidance of projections and sharp edges that have potential to cause harm to persons,
- protection against falls from heights in excess of 2 m,
- protection from and deterrence to unauthorised access,
- use of the infrastructure by disabled persons.

The Design shall address accidental design situations, and the following strategy shall be considered:

- avoid - for example, moving Bridge supports away from adjacent tracks,
- protect - for example by providing barriers,
- mitigate - for example, by providing the minimum level of robustness for accidental load effects,
- accommodate - for example, by designing structures to remain stable despite the loss of a column.

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9.4 Construction, maintenance and decommissioning

The structure shall be designed so that;

- there is at least one safe and practicable method by which it can be constructed,
- it can be examined safely and effectively in accordance with [NR/L3/CIV/006](#): *Handbook for the examination of structures*,
- examination by visual observation in accordance with [NR/L3/CIV/006](#) is sufficient for the management of the structure,
- foreseeable maintenance works (for example, the replacement of limited-life components such as bearings, and the reapplication of protective coatings) can be carried out safely and reasonably practicably,
- there is at least one safe and practicable method by which it can be decommissioned; that is, removed or demolished.

The method of construction and the principal stages of construction envisaged by the Designer shall be stated in the AIP submission and/or Design documents. Where necessary, detailed descriptions, drawings, etc. shall be provided.

The Design shall, as far as reasonably practicable, minimise the likely detrimental effects of the construction works on the operational railway.

The interfaces between the structure and the object crossed (such as a road) and the effects and operations of each on the other during the execution, maintenance and de-commissioning of the structure shall be considered in the Design. The envisaged construction works shall avoid unnecessary disruption to interfacing operations.

The envisaged method of decommissioning the structure, and hazards associated with demolition that would not be apparent from an examination of the structure or from its Design or construction records, shall be stated in the AIP submission.

9.5 Structural form

The proposed form and articulation of the structure shall take into account relevant factors and interactions, such as;

- the safe movement of vehicles, people, goods, etc,
- the vertical, lateral and torsional stiffness of the structure - including the potential for such deformations to affect the safe use of the structure,

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- the safety and ease of examining and maintaining the structure,
- the avoidance, so far as is reasonably practicable, of hidden parts/elements (**18.10**),
- the safety and ease of construction,
- the effects of rotation at the bearings, including uplift at the end of the deck behind bearings,
- the need to avoid uplift at bearings (see **10.21**),
- the support provided to the track or carriageway,
- geometric constraints on construction (such as defined in **9.11.2**), and those arising from structure gauge and clearances (**9.9.2**), and electrical protection requirements (**9.9.4**),
- longitudinal and transverse movement, or the effects where such movement is restrained,
- details of joints, drainage systems (**10.4**) and waterproofing (**10.5**),
- restrictions on particular forms of construction (**17.1**).

Consideration shall also be given to the means of examining and maintaining; elements with difficult access; hollow sections; buried parts; and connections to foundations.

Details that could lead to debris and water becoming trapped in joints, crevices etc (and thereby increase the risk of corrosion for example) shall be avoided so far as is reasonably practicable.

Generally, the mode(s) of failure of a structure shall not be catastrophic, and so:

- 1 A structure should be designed so that advanced warning of the onset of the predominant collapse mode(s) of failure is provided (as would be the case, for example, by failure through bending rather than shear): that is, where possible, each ultimate limit state should be preceded by a serviceability limit state.
- 2 The form of construction should provide adequate ductility and/or structural redundancy. Consideration shall be given to incorporating redundancy in the Design so that alternative load paths are available in the event of the unforeseen failure of a structural element.

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A summary of the approach adopted to provide adequate ductility and structural redundancy shall be recorded in the design statement contained in the AIP submission.

9.6 Environmental considerations

The Design shall take account of all reasonably foreseeable effects of the construction and use of the structure on the environment, including;

- the effect on sensitive species,
- the generation and control of noise, vibration and dust,
- the generation, re-use and disposal of waste materials - so far as is reasonably practicable the design shall aim to minimise the amount of disposed material,
- the generation and control of run-off - including contaminated water and the need for separators,
- vegetation - see [NR/L1/TRK/05200: Vegetation](#),
- the carbon footprint of the structure.

9.7 Legal obligation and commercial liability issues

The Design shall take into account Network Rail's liabilities for the structure as established by Network Rail's Infrastructure Liability Negotiations Manager (ILNM) and included in the Remit or otherwise notified to the Designer.

The Design shall satisfy the more onerous of Network Rail's liabilities and the requirements of this standard.

Unless the task has been delegated to the Designer, legal obligation and commercial liability issues shall be addressed by the ILNM: such issues include;

- liabilities,
- easements and wayleaves,
- load-carrying obligations,
- requirements for headroom and carriageway widths etc,
- agreements regarding the maintenance, replacement and renewal of infrastructure and services.

The Designer shall notify the ILNM at an early stage in the Design regarding any such relevant issues, and shall ascertain Network Rail's requirements for those not identified in the Remit.

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9.8 Liaison and planning

The Design shall take into account (a) the requirements of authorities and other interested parties external to Network Rail, and (b) the requirements for the safe and efficient operation of railway infrastructure during the construction works

Liaison with representatives of the relevant organisations shall commence as early in the Design process as is reasonably practicable, and shall continue through the process for as long as is necessary. The arrangements for liaison shall be agreed by Network Rail prior to any contract being made with the representatives of the organisations.

Unless the Designer is delegated to do so, Network Rail will liaise directly with the Office of Rail Regulation (ORR), TSI authorities, the Department for Transport (DfT), Notified Bodies, train/freight/station operating companies, and other leaseholders/tenants of Network Rail.

Provision of access to Network Rail property shall be co-ordinated through Network Rail's Operational Property Service team.

Contact with planning authorities shall be co-ordinated through Network Rail and, unless the Designer is delegated to do so, Network Rail will consult directly with such authorities. Furthermore, without the prior approval of Network Rail's Town Planning team no communication shall be made to parties external to Network Rail regarding permitted development status or planning approval. Where applicable, the following shall be considered in the Design;

- permitted development status,
- planning permission issues - including listed building status,
- materials and finishes,
- aesthetics - including colour schemes,
- landscaping,
- the possible effects of the proposed method of construction and the timetable of the construction works - for example, on road traffic and on those living or working close to the Site.

To avoid abortive Design effort, consultation with the planning authorities should commence as early in the overall Design process as practicable.

The relevant Environmental agencies shall be consulted and, as necessary, agreement for the Design, construction operations, and the specification for materials obtained and documented before finalising the AIP submission. Agreement with the relevant authority shall be reached on the hydraulic design criteria of, for example, Culverts that carry

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watercourses: such criteria dictate the dimensions of (for example) entry and exit sizes.

Network Rail shall, through consultation with the relevant roads/highway authority, private owner and users, agree the requirements for (for example) lateral and vertical clearances, carriageway widths, sight lines and traffic signs (9.11). Such consultations shall take into account existing agreements and legal obligations. Similarly, Network Rail shall consult the relevant authorities, private owner and users, to agree the requirements for waterways for (for example) clearances, lighting and signs (9.12), taking account of existing agreements and legal obligations.

Unless the Designer is delegated to do so, Network Rail will agree, through consultation, the requirements for carrying, protecting, diverting or altering services, Statutory Undertaker's or public utilities' equipment that could be affected by the Design.

Planning and Design issues regarding mineral extraction and landfill shall be dealt with in accordance with [NR/L3/CIV/037](#): *Managing the risk arising from mineral extraction and landfill operations*, and [NR/L3/CIV/038](#): *Managing the potential effects of coal mining subsidence*. Arrangements for liaising with Mine Operators and the Coal Authority, and with Landfill Operators shall be agreed with Network Rail's Principal Mining Engineer prior to consulting these parties.

9.9 Interface with the railway

9.9.1 Track

The positions and number of tracks to be carried or crossed by the structure shall be specified in the Remit or other Design documents.

The position and number of tracks on an Underline Bridge shall not be changed, unless (a) both its superstructure and substructure have been designed and assessed for the change in load effects and (b) any necessary strengthening/alteration works have been completed.

For an Overline Bridge, a change to the number or position of tracks shall not compromise the required clearances.

The form of the proposed structure and its ability to carry the intended loads shall not be unreasonably sensitive to the position of the tracks. Furthermore, the Design shall provide reasonable tolerance (a minimum of ± 50 mm) in the permitted lateral position of the tracks.

The allowable number and tolerable positions of the tracks relative to the structure shall be identified in the AIP submission. Where the

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use or replacement of rail-bearers is not reasonably avoidable, the tolerance in the position of the track shall be identified relative to each rail-bearer.

To minimise track maintenance work arising from a sudden change in the stiffness of the Track support system, a transition zone shall be provided between the ends of a new Underline Bridge and its approach embankments. The provision of such a zone shall also be considered where a Bridge is to be reconstructed. Examples of good practice are given in [UIC 719-R: Earthworks and track bed construction for railway lines](#)

To provide adequate lateral support and to prevent ballast being washed away during flooding, the Design shall include provisions for retaining ballast on the approaches to an Underline Bridge.

Prior to submission of the bridge AIP, the requirements of the track, its support system (including transition zones), track equipment (9.9.3), and track drainage shall be agreed with the appropriate Network Rail Track Engineer.

The Design of the track is defined in [NR/L2/TRK/2102: Design and construction of track](#), and the Design of track infrastructure shall be subject to the approval processes specified in [NR/L2/TRK/2500: Technical Appro in the design of track infrastructure](#).

9.9.2 Structure gauge and clearances

The structure gauge and clearances shall either be (a) established or accepted by the appropriate Network Rail Senior Gauging Engineer and defined in the Remit, or (b) agreed with the Senior Gauging Engineer during the Design process prior to the submission of the AIP. As far as is reasonably practicable, the Design shall provide the Standard Structural Clearance in accordance with [NR/L2/TRK/2049: Track Design Handbook](#).

Horizontal and vertical track alignments shall provide Normal Structural and Passing Clearances (as specified in [GC/RT5212 Requirements for defining and maintaining clearances](#)) for all vehicles currently using the Route and envisaged to operate in the future as specified in the Gauge Capability Database. (However, the requirements given in Appendix 1 of [GC/RT5212](#) shall be modified in accordance with Appendix D of this standard.)

Additional GB-specific TSI requirements are described in Appendix C. Where it would be impracticable to meet these requirements the clearances shall (a) be agreed with the Network Rail Senior

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Gauging Engineer, and (b) be justified and recorded in the AIP submission.

Where the structure supports a platform, the stepping distances for the vehicles likely to stop there shall be as specified in [GI/RT7016](#): *Interface between station platforms, track and trains*.

For all types of works, existing Reduced or Special Reduced clearances and stepping distances shall not be worsened.

In determining clearances, allowance shall be made for;

- track cant,
- end throw,
- permitted/required tolerance in track position,
- proposed track lifting, slewing or realignment schemes,
- the required distance of conductor rails (where present) from the structure,
- electrical clearance and protection requirements (9.9.4),
- the movement of the structure and its foundations under permanent, imposed and transient loads - such as the deformation of an Underline Bridge adjacent to an independently supported platform,
- construction tolerances.

In addition, on ballasted track sufficient space shall be provided between the ends of the sleepers and the adjacent structure to permit track maintenance.

For an Overline Bridge, following the determination of the most onerous position(s) of the track in relation to each critical aspect of clearance then, unless otherwise agreed with Network Rail, the Design shall allow for a further 100 mm lift to cover for any unplanned future track uplift.

Consideration shall be given to the clearance requirements for ballast cleaning machines to pass beside foundations and structural supports. Where applicable, details of any specific arrangements shall be identified in the AIP submission.

9.9.3 Equipment

As required by Network Rail, a structure shall be designed to accommodate service cables and ducts, location cabinets, point motors, rail lubricators, overhead line electrification, and other equipment and equipment support structures. Consideration shall

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be given to the space taken up by such items, the requirements for their maintenance, and connections and power supplies to them - particularly where such items are to be or might be updated.

The loads applied by such items shall be identified in the AIP submission.

9.9.4 Electrical protection, earthing and bonding

The Design of a structure carrying or passing over electrified lines shall comply with the electrical protection and bonding requirements of [GE/RT8025](#): *Electrical protective provisions for electrified lines*.

Bonding that is required exclusively for signalling purposes is outside the scope of this standard.

The Design of earthing and bonding systems for a structure (including its metallic elements and services) shall comply with the requirements of [NR/SP/ELP/21085](#): *Design of earthing and bonding systems for 25 kV a.c. electrified lines*, and meet those of [BS EN 50122-1](#): *Railway applications - Fixed installations. Protective provisions relating to electrical safety and earthing*.

Two of the principal requirements of [NR/SP/ELP/21085](#) are:

- 1 Exposed metal elements and metal services shall be bonded to the traction return rail or earth wire. Concrete reinforcement (including prestressing anchorages) shall be bonded only if it is accessible or electrically connected to accessible metalwork.
- 2 The interconnections and bonding shall, so far as practicable, be arranged such that traction current flow through the Bridge, structural metalwork, and services is avoided.

Note that [NR/SP/ELP/21085](#) only applies to a.c. overhead electrification systems; steel structures should not be bonded to the return rail on d.c electrified routes.

Where railway equipment, railway signal structures, or other equipment support structures attached to the structure are required to be bonded to the traction return rail, the Design of the interface between them shall be such that all the metallic elements form a continuous electrical whole.

Where metal fences are to be attached to a structure, the electrical protection of the structure and fences (including gates) shall be considered as a whole: consideration shall be given to the use of non-conducting fencing.

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Trays or ladders that support electrical cables, and which are to be attached to a structure, shall be earthed to the structure.

Consideration shall be given in Design to maximising the use of metalwork and the reinforcement in substructures for earthing.

Where required by Network Rail, the Design shall include provision for (a) fitting bonding/earthing studs to the structure, and (b) installing remote earth test-points.

Where a structure spans an overhead electrified railway, the Design shall consider the waterproofing of the structure and managing run-off to prevent damage by dripping water causing flash over.

For Outside Party structures, the Design of the earthing and bonding system shall be in accordance with the principles of [NR/SP/ELP/21085](#) and be agreed with the Outside Party.

The Designer shall strive to produce an effective and economic earthing and bonding system that takes due account of the traction power supply system, overhead line equipment, and other electrical components and equipment at the Site. The design documentation for the system shall meet the requirements of [NR/SP/ELP/21085](#) and is subject to acceptance by Network Rail.

9.9.5 Protection from stray currents

Where third rail d.c. electrification is present, the Design shall consider the risk of corrosion generated by stray currents. The process for dealing with such risks is defined in [GL/RT1253](#): *Mitigation of d.c. stray current effects*, and the Designer shall agree with Network Rail, prior to the AIP submission, which of the requirements of that standard are to be incorporated into the Design.

Consideration shall be given to the introduction of measures to mitigate the risk of corrosion - such as electrical isolation of substructure reinforcement cages, electrical screening, sacrificial zinc electrodes, and cathodic/anodic protection. Where applicable, protective provisions shall be in accordance with [BS EN 50122-2](#): *Railway Applications - Fixed Installations. Protective provisions against the effects of stray currents caused by d.c. traction systems*.

9.10 Interface with services

The Design shall make due allowance for services, and their associated equipment, that are to be supported by the structure: loads, alterations and provisions for these shall be identified in the AIP submission.

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The Design shall consider the risks to the superstructure, substructure and associated earthworks arising from the consequential effects of the failure of services and equipment carried by or passing under the structure. Such risks might include the build up of gas in a voided structure, the washout of the support to a bank seat resulting from a burst water main, an electric supply cable coming into contact with metalwork, and the deleterious effects of road de-icing salts (fed through broken or leaky drains) on steelwork.

So far as is reasonably practicable, different types of services shall be segregated. Appropriate facilities shall be provided for maintaining services and equipment, and consideration shall also be given to the means of replacing, renewing and upgrading services and equipment.

Consideration shall be given to providing additional space and ducts to accommodate future services and facilitate access to services with minimal disruption to the railway and the activities of other parties.

9.11 Interface with roads/highways

9.11.1 Acceptance of the Design

Where an existing or proposed road/highway would be affected by the construction and/or use of the structure, the acceptance of the relevant roads/highways authority shall be sought for (a) the relevant parts of the Design, and (b) any mitigation measures. Details and references/confirmation of acceptance shall be included in the AIP submission.

The Design of a Bridge over a non-public road shall comply, as far as is reasonably practicable, with the requirements for the design of a Bridge over a public road/highway; any different criteria shall be identified and justified in the AIP submission.

9.11.2 Headroom

For the Design of new spans over a public road/highway, the headroom from the soffit shall (a) be not less than 5.3 m, and (b) be at least 5.7 m where this can be achieved with reasonable economy. Where it is not reasonably practicable to provide a headroom of 5.7 m (a) the superstructure shall be designed for vehicle collision loads in accordance with [NA BS EN 1991-1-7: UK National Annex to Eurocode 1. Actions on structures. Accidental actions](#) (Table NA.9 and Table NA.10), and (b) details of the arrangements shall be justified and recorded in the AIP submission.

For works on an existing span over a public road/highway, the headroom should not be reduced where it is already less than 5.7 m: indeed, where reasonably practicable, the headroom shall be