
**VOLUME 9 NETWORK – TRAFFIC
CONTROL AND
COMMUNICATIONS**

**SECTION 3 TRANSMISSION
INFRASTRUCTURE**

PART 1

TD 72/17

TRANSMISSION INFRASTRUCTURE

SUMMARY

This document describes the telecommunication services and associated infrastructure required to support a highway communication system, with design process requirements and factors that should be taken into account. It supersedes TA 72/97, TA 75/97 and TA 77/97 – the purpose being to provide designers with information required when developing, in conjunction with the telecommunications service provider, contract specific requirements for telecommunications services, with necessary supporting infrastructure.

INSTRUCTIONS FOR USE

This standard is to be incorporated into the manual.

1. This document supersedes TA72/97, TA75/97 and TA77/97
2. Remove content pages for Volume 9 dated November 2016
3. Insert new content pages for Volume 9 dated February 2017
4. Remove TA 72/97 from Volume 9, Section 4, Part 1
5. Remove TA 75/97 from Volume 9, Section 4, Part 4
6. Remove TA 77/97 from Volume 9, Section 5, Part 1
7. Insert TD 72/17 into Volume 9, Section 3, Part 1
8. Archive this sheet as appropriate.

Note: A quarterly index with a full set of volume contents pages is available separately from The Stationery Office Ltd.



HIGHWAYS ENGLAND

TD 72/17



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TRANSMISSION INFRASTRUCTURE

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REGISTRATION OF AMENDMENTS

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1. INTRODUCTION

1.1. Background

- 1.1.1. The Overseeing Organisation procures telecommunication services and associated infrastructure for highways under the National Roads Telecommunications Services (NRTS) project from a Telecommunications Service Provider (TSP). The telecommunications services support signals, Emergency Roadside Telephones (ERTs), cameras, detection systems and other roadside technology that in turn support safe and reliable journeys and ensure drivers are informed of traffic conditions ahead.
- 1.1.2. Under the NRTS project, the Overseeing Organisation's TSP has end-to-end responsibility for transmission services, while the actual roadside technology devices and Regional Control Centres (RCCs) applications remain the responsibility of the Overseeing Organisation.
- 1.1.3. The TSP is responsible for the design, provision and maintenance of the telecommunications services. The TSP is also responsible for monitoring and reporting the performance of the telecommunications services and for providing resilient and reliable telecommunications services.

1.2. Scope and Purpose

- 1.2.1. This document describes the requirements for the provision of telecommunications services and associated roadside infrastructure on the highways in England. The transmission services and the associated infrastructure are used to support the use of technology on the highway by providing a means to transmit data (including digital Closed Circuit Television (CCTV) and Voice over Internet Protocol (VoIP)) between RCC systems and traffic technology devices. These requirements permit those parties involved with the design of a road scheme ("the designer") to complete their designs, which since the introduction of the NRTS project has significant involvement of the TSP.
- 1.2.2. This document should be read in conjunction with TD 71 *Technology Overview and General Requirements*.
- 1.2.3. The purpose of this document is to provide the designer with the information that they require in order to develop, in conjunction with the TSP, the contract specific requirements for telecommunications services and the infrastructure necessary to support the telecommunications services. It provides advice and standards to be followed by both the designer and the TSP's designer.
- 1.2.4. Where this document contains design requirements, it must be read in conjunction with the general requirements in GD 01, GD 2, GD 04 and with all other DMRB documents relevant to the design of the particular works to be undertaken.
- 1.2.5. Where this document contains technology requirements that fall within the scope of the TSS Plans Registry, it shall be read in conjunction with the general requirements in TR 1000, TR 1100, TR 2130 and with all other Traffic Systems and Signing (TSS) Plans Registry documents relevant the particular works to be undertaken.

1.3. Definitions, Acronyms and Abbreviations

- 1.3.1. A list of abbreviations used in this document is given overleaf.

Table 1.3.1 Abbreviations used in this document.

APTR	All Purpose Trunk Road
ALM	Ambient Light Monitor
AMI	Advanced Motorway Indicators
BIM	Building Information Modelling
CCI	Camera Control Interface
CHARM	Common Highways Agency Rijkswaterstaat Model
CRP	Capture Requirements and Plan
CCTV	Closed Circuit Television
CCD	Cross-Carriageway Duct
DBFO	Design, Build, Finance and Operate
DBFO Co	Design, Build, Finance and Operate Contractor
DSR	Design Strategy Record
DNO	Distribution Network Operator
DTS	Ducts Through a Structure
EI	Electricity Interface
ERT	Emergency Roadside Telephone
GSM	Global System for Mobile Communications
HDLC	High-Level Data Link Control
HATMS	Highways Agency Traffic Management System
HSE	Health and Safety Executive
IP	Internet Protocol
IPT	IP Translator
LCC	Local Communications Controller
MD	MIDAS Detector
MSP	Maintenance Service Provider
MET	Meteorological Subsystem
MIDAS	Motorway Incident Detection and Automatic Signalling
NMCS2	National Motorway Communications System, Second Generation
NRSWA	New Roads and Street Works Act
NRTS	National Roads Telecommunication Services
OAL	Outstation Auxiliary Link
PGRU	Pair Gain Remote Unit
POTS	Plain Old Telephone Service
PME	Protective Multiple Earthing
PSTN	Public Switched Telephone Network
PTZ	Pan Tilt Zoom
RMC	Ramp Metering Controller
RCC	Regional Control Centre
RCU	Roadside Controller Unit
SCI	Service Control Interface
SDP	Service Delivery Point

SHW	Specification for Highway Works
SPC	Service Provision Capability
STI	Service Type Instance
TSP	Telecommunications Service Provider
TVBS	Television Base Station
TVOS	Television Outstation
TC	Transmission Cabinet
TCP/IP	Transmission Control Protocol/Internet Protocol
TMS	Technology Management Systems
TPMS	Technology Performance Management Service
TS	Transmission Station
TSS	Traffic Systems and Signing
UMS	Unmetered Electricity Supply
UMSO	Unmetered Supplies Operator
VRS	Vehicular Restraint System
VIH	Video Information Highway
VoIP	Voice over Internet Protocol

1.4. Mutual Recognition

- 1.4.1. Where there is a requirement in this document for compliance with any part of a 'British Standard', technical specification or quality mark, that requirement can be met by compliance with GD 01.
- 1.4.2. Throughout the document there is reference to - design, installation and maintenance work being carried out (for example, clause 4.1.3); assessment of risk for maintenance work (for example, clause 4.2.9); specification of works (for example, clause 4.3.17); construction work being carried out (for example, clause 4.3.30); and installation activities being carried out (for example, clause 5.1.1).
- 1.4.3. Where designs or specifications are being prepared for construction; where risk assessments are being carried out for maintenance work; and where construction or installation works are being carried out the Construction (Design and Management) Regulations 2015 must apply. In these circumstances it must be made clear to all parties involved who the client is and as a minimum a construction phase plan will be required for all construction works. For works involving more than one contractor the client must appoint a principal designer and principal contractor.
- 1.4.4. For further details refer to the HSE (Health and Safety Executive) publication Managing Health and Safety in Construction (Design and Management) Regulations 2015 document reference L153.

1.5. Implementation

- 1.5.1. This standard shall be used forthwith on all projects for the assessment, design, construction, operation and maintenance of transmission services on the highways in England.
- 1.5.2. All projects that require the use of transmission services shall involve the TSP from the outset and throughout the life of the project.
- 1.5.3. Telecommunications services will be delivered by the TSP who is contracted to provide, operate and maintain the telecommunications services. In each case the Overseeing Organisation will provide the details of the relevant TSP that will provide the telecommunications services to the designer.

1.6. Application in Devolved Administrations

- 1.6.1. Contract-specific additional requirements and substitute requirements can be included for contracts where the Overseeing Organisation is not Highways England (or its successor). Where required, these will be issued by:

Scotland:

Transport Scotland, 8th Floor, Buchanan House, 58 Port Dundas Road, Glasgow, G4 0HF.

Wales:

The Welsh Government, Transport Department, Cathays Park, Cardiff, CF10 3NQ.

Northern Ireland:

Director of Engineering, Department for Infrastructure, Transport NI, Clarence Court,
10 – 18 Adelaide Street, Belfast BT2 8GB.

- 1.6.2. Also, the Overseeing Organisation has the option to issue an initial list of alternative requirements/ departures.

1.7. Feedback and Enquiries

- 1.7.1. Users of this document are encouraged to raise any enquiries or provide feedback on its content and usage to the dedicated Highways England team. The email address for all enquiries and feedback is:
DMRB_Enquiries@highwaysengland.co.uk

2. BACKGROUND OF TRANSMISSION NETWORK

2.1. NRTS Background

- 2.1.1. Since the late 1980's traffic technology deployed on motorways and All Purpose Trunk Roads (APTRs) has adopted a communications architecture known as the National Motorway Communications System, Second Generation (NMCS2). This is a hierarchical architecture to route messages between RCCs and roadside technology devices. NMCS2 employs communications protocols and transmission techniques that are bespoke to the Overseeing Organisation. All roadside technology deployed at the start of the NRTS project used NMCS2 bespoke protocols and transmission techniques.
- 2.1.2. The NRTS project was conceived to provide a single, national approach to the future development of the telecommunications network and the provision of telecommunications services. Under this arrangement, the Overseeing Organisation contracted out the responsibilities associated for the renewal of roadside infrastructure, transmission equipment and cabling, plus the performance of the telecommunications services to the TSP.
- 2.1.3. Telecommunications services are specified in terms of 'services', that is, the interface at either end of the connection and the performance between the interfaces rather than in terms of the infrastructure (ducts, cables, transmission equipment etc.) required to deliver the services. The services support the devices and systems used by the Overseeing Organisation.
- 2.1.4. Under the NRTS project there is a clear division of responsibilities between the Overseeing Organisation and the TSP. The TSP has end-to-end responsibility for telecommunications services, while the roadside technology devices and RCC applications remain with the Overseeing Organisation.
- 2.1.5. The TSP is responsible for monitoring the performance of the telecommunications services, for providing a resilient and reliable service and for providing additional local connections to support additional roadside devices.
- 2.1.6. The TSP has responsibility for transmission services across the highways in England. There are only a few exceptions where at present the TSP does not provide services, for example the M6 toll road.
- 2.1.7. From the Overseeing Organisation's perspective, the TSP provides a 'service capability' for conveying voice, video and data signals that link roadside devices to RCCs, conveying video data signals between RCCs, and RCCs to third party operational stakeholders. The 'capability' can be represented by a cloud because it is the TSP's responsibility to determine how the transmission service is delivered across the cloud.

2.2. TSP's Transmission Architecture

- 2.2.1. The TSP provides, operates and maintains a national network along all motorways in England and some APTRs for the Overseeing Organisation. The network is largely transparent to the user of the services and comprises cables, copper or optical fibre, laid along the length of the road network, jointed at regular intervals.
- 2.2.2. The TSP provides all of the transmission equipment and components of the transmission network. The core network comprises an optical network with connected equipment that uses industry standard Internet Protocols (IPs) to form an "IP network". Where the optical network is not available, the IP network uses a copper cable network. The term "core network" is used to describe the cable network that links RCCs with Transmission Stations (TSs) (small brick or pre-fabricated buildings or of modular construction) and

Transmission Cabinets (TCs). It consists of the transmission network, power and network management systems that monitor the network.

- 2.2.3. The TSP's, TSs and TCs are provided at regular intervals along the road network and at other major node points, such as motorway to motorway intersections. TSs and TCs house electronic transmission equipment that aggregates all the roadside devices onto the high bandwidth core network.
- 2.2.4. The IP-based architecture provides a resilient and flexible solution and is based on commercial off the shelf equipment, rather than one which is bespoke to the Overseeing Organisation.
- 2.2.5. Message signs, signals, Motorway Incident Detection and Automatic Signalling (MIDAS) detectors and other roadside technology are now procured with IP interfaces that allow them to be served by generic services (see 2.3.2 for a definition of generic services) instead of requiring bespoke services.
- 2.2.6. Where message signs, signals and MIDAS detectors with an RS485 *Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems* (that is non-IP) interface remain in service, the TSP operates services that utilise an intermediate transmission device, known as an IP Translator (IPT) to connect these devices to the core network. This permits the continued use of these legacy assets to be realised while benefiting from the improved resilience of the generic services and an IP based transmission network.
- 2.2.7. The IPT is intended for use only in support of existing legacy roadside technology. IP-enabled roadside devices shall be deployed for all new-build or upgraded schemes and such new devices will be supported by generic services.
- 2.2.8. Generic services support the switched distribution of CCTV camera images from roadside cameras to RCCs, or via portal interfaces to web-based viewing applications. Where analogue video signals from the roadside cameras exist, they are encoded by the TSP into digital data for routing across the IP network to the viewing destination (typically an RCC), where the data can be decoded back into analogue video signals for viewing on monitor displays.
- 2.2.9. The TSP's network supports the Overseeing Organisation's deployment of ERTs that uses a combination of analogue subscriber lines and line extenders coupled to a VoIP transmission solution. This permits the routing of both speech and text from ERTs to RCCs or other central call-handling centres.

2.3. TSP's Transmission Services

- 2.3.1. The TSP operates nationally and offers a range of telecommunications services based upon a particular geographic location or, where longitudinal communications cables exist, the type (copper or fibre) and capacity of these cables. The TSP operates and maintains all services between roadside technology devices, RCCs and other locations.
- 2.3.2. The TSP delivers a range of telecommunications services that support legacy NMCS2 protocol and transmission requirements, these are known as bespoke services (that is, bespoke to Highways England legacy NMCS applications). The TSP also delivers a range of telecommunications services that are capable of supporting both Highways England and non-Highways England applications that use open communications standards, these are known as generic services.
- 2.3.3. Within each of the bespoke services and generic services offerings of the TSP there are a number of 'service categories' that have been defined. Service category definitions embody the definition of performance associated with the services as well as any limitations and constraints applied to their application. For bespoke services and some generic services, service categories have an association with

the attributes of specific groups of roadside technology. Prior to performing any design work, the designer shall consult with the TSP for details of current service categories that are to be deployed and any associated deployment rules for the services that support different types of roadside technology.

2.3.4. Service categories are used by the TSP to group related service types. The 'unit' of the transmission service is the Service Type Instance (STI), a complete end-to-end transmission link of a specified service type. The service type designates what the electrical and, where relevant, network characteristics of the service are (for example whether it is an IP link or a CCTV link) and its performance specification along with the physical interface that appears at each end of the service.

2.3.5. Each physical end of an STI terminates at a Service Delivery Point (SDP). The SDP is the interface between the TSP's network and the Overseeing Organisation or third-party equipment and is also the demarcation point for maintenance responsibility.

2.3.6. At any given location, the ability of the TSP to provide an STI of a specific service type, or the choice of service type deployed to fulfil an STI requirement, is dependent upon the Service Provision Capability (SPC). The SPC is determined by the geographic location and underlying infrastructure at the location. For example, the type of infrastructure present (copper or fibre) and the transmission bandwidth that the SPC provides at the location shall be capable of supporting the services.

2.3.7. The TSP shall be consulted at the outset and throughout the life of any scheme.

2.3.8. In order to accommodate the services required by the scheme, the TSP will undertake a network capacity check to identify further infrastructure (enablers) that are required to support the new STIs. The TSP and the Overseeing Organisation will review the requirement for any enablers associated with the scheme, that is, items within the TSP's transmission network that require upgrade in order to accommodate new TSP's services.

2.3.9. Telecommunications services shall be ordered through the TSP. In some cases, the TSP is required to undertake enabling works that are common to the delivery of many services (for example increasing the capacity of a telecommunications node on the network). These works are defined as 'enablers' and a set of rules determine when an enabler is required to be ordered from the TSP. Enablers provide the capability for the TSP to deliver and operate the services. The TSP is responsible for determining the quantity and type of transmission equipment required to support their services and any enablers.

2.4. Bespoke Transmission Services

2.4.1. Bespoke services are particular to the Overseeing Organisation applications they support. These applications are those defined by the Overseeing Organisation as 'legacy'. Legacy applications are those supported by the current catalogue of services, but are not intended for wider deployment beyond the number of bespoke services that are required to operate with legacy roadside technology equipment (except in exceptional circumstances and with the prior agreement of the Overseeing Organisation).

2.4.2. The use of bespoke services will decrease as numbers of legacy roadside technologies requiring bespoke services diminish because for all new or upgraded schemes, only Transmission Control Protocol/Internet Protocol (TCP/IP) enabled roadside technology is permitted under 2.4.5 below.

2.4.3. The only bespoke services still in active use are used to communicate with legacy signals, message signs, traffic and queue detection and meteorological systems using an IPT (see 2.2.6).

2.4.4. Legacy roadside technology systems that require bespoke services and examples of where these are deployed are listed in table 2.4.4.

Table 2.4.4 Bespoke Services

	Roadside technology	Examples of where deployed
Bespoke service	Legacy signalling and monitoring	Legacy devices that still use RS485 <i>Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems</i> transmission standard but are controlled by an IPT: Message signs Signals Fog detectors Common interface units
	Legacy MIDAS	Legacy MIDAS outstations which still use the RS485 transmission standard but are controlled by an IPT. Ramp Metering.

RULES FOR USE OF GENERIC SERVICES TO REPLACE BESPOKE SERVICES

2.4.5. Unless agreed otherwise by the Overseeing Organisation, generic services employing TCP/IP shall be used for all new roadside technology equipment including maintenance upgrades. This requirement does not apply to the repair and replacement of individual items of equipment.

2.4.6. With exception of specific instances agreed in advance with the Overseeing Organisation, retained existing technology shall be upgraded to use IP-generic services. Replacement technology shall be compatible with the IP protocol implemented as part of the scheme.

2.5. Generic Transmission Services

2.5.1. Generic services are not intended to be particular to any Overseeing Organisation application. A summary of generic services descriptions and examples of where they are deployed are listed in table 2.5.1.

Table 2.5.1 Generic Services

	Service category description	Examples of where deployed
Generic service	Analogue circuits or direct connection	Copper multi-pair connections. Connecting adjacent roadside equipment. Ramp Metering Outstation Auxiliary Link (OAL).
	IP service	All new applications and devices with a need for data transmission. Roadside IP services (centre to roadside). RCC IP services (centre to centre).
	Switched video services	Networked CCTV transmission links at defined picture quality levels with network switching and recording provided as part of the service.
	Switched ERT	ERT transmission links between roadside telephones and RCCs based on a combination of standard analogue subscriber interfaces (Plain Old Telephone Service – POTS) and VoIP technology. Voice traffic concentration and network switching is provided as part of the service.

2.5.2. Leased telecommunications services are used to connect end devices or applications in locations where roadside infrastructure and the TSP's cabling is not provided or the TSP does not have the coverage or capacity to provide the required telecommunications services. The TSP provides leased telecommunications services from a third-party (for example, public telecommunications operators or mobile network operator). The TSP manages the operational delivery of these third-party telecommunications services on behalf of the Overseeing Organisation. The provision of leased telecommunications services by the TSP includes localised roadside infrastructure and cabling and transmission equipment as required to support the services needed by the technology deployed.

2.6. Service Delivery Point

2.6.1. SDPs can be thought of as the end of the pipe, where the actual output of a transmission service STI is delivered to defined performance characteristics. SDPs also define the telecommunications maintenance boundary between the TSP and the Overseeing Organisation. Under certain conditions, a single SDP will present more than one STI (for example, for a single connection to a number of signals on a gantry).

2.6.2. The SDPs are located either at the roadside or in an RCC. The physical properties and location of the SDP are determined by the service type, which in turn will be determined by the TSP to meet the transmission service requirements of the designer. The details, layout and physical form of SDP presentation (for example terminals, connectors, optical presentation etc.) shall be obtained from the TSP.

2.6.3. SDPs shall not be located within tunnel bores, they shall be installed within equipment rooms or cabinets. In each case the Overseeing Organisation shall be responsible for the design, installation and maintenance of communications cables beyond the SDPs.

2.6.4. The TSP is responsible for the provision, installation, cable termination and testing of its own transmission equipment and cabling up to the SDP.

2.6.5. Cables beyond the SDP that connect to the Overseeing Organisation's systems or roadside technology equipment, including any cables that interconnect these systems that are beyond the SDP, including those within equipment cabinets shall be the responsibility of the Overseeing Organisation.

2.7. Service Provisioning Capability (SPC)

2.7.1. The TSP has assigned a SPC to every highway. The specific provision and configuration of copper and fibre optic cables for a given section of road determines the SPC. It is possible to change the SPC from one class to another through what is termed as a 'regrade' (a re-grading of the SPC). The presence of infrastructure (as set out in 2.7.2 below) influences the SPC. Designers shall consult with the TSP to determine the SPC relating to their scheme and to obtain details of the current service categories and service types supported by the SPC.

2.7.2. The SPC applicable to a location is primarily influenced by the following:

- Longitudinal copper cabling.
- Longitudinal copper and fibre cabling.
- Longitudinal fibre cabling.
- No longitudinal cabling.

2.8. Future Applications

2.8.1. New technology applications required to interface with the TSP's network shall be developed through consultation with the Overseeing Organisation and the TSP.

2.8.2. New systems shall be designed to utilise the existing generic service categories and comply with MCH 1514 *Code of Connection*.

SUPERSEDED

3. TRANSMISSION NETWORK

3.1. Overseeing Organisation NMCS2 Transmission Architecture

3.1.1. The following section describes the hardware elements that interface with the TSP's services at the SDPs.

3.1.2. MCH 1616 *NMCS2 Guide to Documentation* provides a guide to highway technology systems documentation. This gives details of the appropriate technical specifications for both highway technology telephone and data systems. MCH 1616 describes the basic operation of the NMCS2 system.

3.2. Traffic Management System

3.2.1. Currently the Highways Agency Traffic Management System (HATMS) is used to monitor and control traffic technology devices. These devices are primarily output devices (such as signals or message signs), or input devices (such as fog detectors or incident detection loops).

3.2.2. Each RCC is equipped with an HATMS instation that uses the NMCS2 architecture via an IP transmission network provided by the TSP to interconnect various types of equipment.

3.2.3. The HATMS functionality is distributed across a number of sub-systems located in the RCC:

- Signals
- Message signs
- MIDAS
- MET

Further information on the above can be found in TD 71 *Technology Overview and General Requirements*.

3.2.4. Each sub-system communicates with one or more Local Communications Controllers (LCC), also located in the RCC, which in turn communicate with the roadside devices.

3.2.5. CHARM (Common Highways Agency Rijkswaterstaat Model) is being deployed as a replacement for HATMS.

3.3. Signalling Local Communications Controller

3.3.1. Each RCC is equipped with up to four standard LCCs through which the HATMS instation communicates with the roadside message signs, signalling and meteorological equipment located in that RCC's area. Each LCC communicates across the TSP's network with a number of roadside devices. The allocation of roadside devices to LCCs is defined in the site data configuration for each RCC.

3.3.2. LCCs have output ports that support both legacy and IP based communications. Since the introduction of the IPT, roadside technology devices connect via generic services to the LCC's IP interfaces. Through this IP interface, each LCC communicates with all the message signs, signals or meteorological devices allocated to it. The LCC's legacy High Level Data Link Control (HDLC) communications interfaces are no longer used. This does not apply to tunnels that need to retain legacy equipment to meet existing safety cases.

3.3.3. Further information on the LCC is available in TR 2046 *NMCS2 Standard Local Communications Controller (IP-LCC)*.

3.4. Signals

3.4.1. Signals are roadside technology devices located on:

- Overhead gantries to provide lane-based signalling
- Posts in the central reservation to provide carriageway-based signalling
- Roads to manage traffic entering the motorway network
- Link roads to manage traffic transitioning between connected motorways

3.4.2. At each roadside location one SDP is typically provided by the TSP, to which all the signal STIs at that location are connected. Where groups of signals, such as Advanced Motorway Indicators (AMI), are controlled by a separate roadside controller, it is the roadside controller that shall connect to the SDP.

3.4.3. Where a signal is one element of a larger sign enclosure that also incorporates a message sign element, such as an MS3 or MS4, only one SDP shall be required for both STIs.

3.4.4. IP-enabled signals are connected to the TSP's network via a generic service through which they communicate with their LCC at the RCC. The particular service type that is provided is dependent upon the provisioning capability of the TSP infrastructure at the signal location as determined by the TSP.

3.4.5. Existing signals with legacy interfaces are connected to the TSP network using a service type that employs an upstream IPT device (as described in 2.2.6). It is the IPT that facilitates the communication by the legacy signal across the TSP's IP network with the LCC in the RCC. Such IPT-derived generic services represent the TSP's universal service provision for all legacy signalling device connections. The use of legacy signals and IPTs shall not be considered for new installations unless otherwise approved by the Overseeing Organisation (for example, with regard to legacy tunnel equipment as outlined in 2.2.6 above).

3.4.6. IP-enabled Ambient Light Monitors (ALMs), where required in support of AMI, connect to the TSP's network via generic service through which they communicate with their LCC at the RCC. ALMs with legacy interfaces directly connect to a roadside controller, so require no dedicated service provision (see 3.4.2).

3.5. Message Signs

3.5.1. Message signs are roadside technology devices, located on overhead gantries or verge-mounted cantilever structures, which display text and pictogram messages. These messages can be of a strategic nature, providing route and travel information, or of a tactical nature, providing advisory warnings of incidents or road conditions ahead.

3.5.2. One roadside SDP is provided by the TSP for each message sign. If the message sign utilises a separate roadside controller, it is the roadside controller that connects to the TSP SDP.

3.5.3. Where a message sign is one element of a larger sign enclosure that also incorporates a signal element, only one SDP is required for both STIs as the enclosure will have only one physical interface.

3.5.4. The service types provided for IP-enabled or legacy message signs are the same as those described for signals in 3.4.4 and 3.4.5 above.

3.6. MIDAS Local Communications Controller

3.6.1. Each RCC is equipped with up to two MIDAS Local Communications Controllers (MIDAS LCC) through which the HATMS instation communicates with the MIDAS outstation equipment located in that RCC

area. Each LCC communicates across the TSP's network with a number of MIDAS outstations. The allocation of MIDAS outstations to LCCs is defined in the site data configuration for each RCC.

- 3.6.2. MIDAS LCCs operate in 'IP LCC mode' (see TR 2167 *NMCS2 MIDAS LCC Specification* and TR 2192 *NMCS2 MIDAS TCP/IP Link Specification* for further details). Each LCC interfaces with the TSP's transmission network via a single generic service IP connection in the RCC. Through this single IP interface, each LCC communicates with all the MIDAS detector outstations allocated to it.

3.7. MIDAS Outstations

- 3.7.1. MIDAS outstations are roadside devices used for the monitoring of traffic flow. One SDP for each outstation is provided by the TSP, through which the MIDAS outstation communicates with a MIDAS LCC at the RCC.
- 3.7.2. Each MIDAS outstation is connected to downstream detector equipment, capable of monitoring up to ten lanes of traffic using traffic sensors. The inductive loop is the most common form of traffic sensor on the motorway and trunk roads, with two loops installed in each lane to enable the measurement of vehicle speed, flow, headway and occupancy. Alternative traffic sensor technologies are available, including verge-mounted radar devices and in-carriageway magnetic vehicle sensors. The choice of detector technology does not influence the choice of service type required for the MIDAS outstation, which is a standard provision in all instances. However, more centralised systems employing remote detectors (for example verge-mounted radar devices) that transmit raw data to remote data processing and aggregation points will have an impact on the service type required to support such roadside technology devices.
- 3.7.3. IP-enabled MIDAS outstations are connected to the TSP's transmission network via a generic service. The particular service type that is provided is dependent upon the provisioning capability of the TSP's infrastructure at the outstation location and will be determined by the TSP.
- 3.7.4. Existing MIDAS outstations with legacy interfaces are connected to the TSP's network via a service type that employs an upstream IPT device (as described in 2.2.6). It is the IPT that facilitates the communication by the legacy outstation across the TSP's IP network with the LCC in the RCC. Unless otherwise approved by the Overseeing Organisation the use of legacy MIDAS outstations and IPTs shall not be considered for new installations.
- 3.7.5. All legacy MIDAS outstation connections use the TSP's universal service provision, which is the IPT-derived generic services described in 3.7.4 above.
- 3.7.6. In addition to the upstream LCC connection, each MIDAS detector (MD) has an Outstation Auxiliary Link (OAL), which is typically used in Ramp Metering applications. Where an MD is required to provide traffic flow information to an adjacent or near-by Ramp Metering Controller (RMC) the MD's OAL is connected to the RMC using an analogue directly connected generic service type. This connection is provided via local copper cable infrastructure using RS485 *Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems* interfaces and does not traverse the TSP's core or local access layer networks.
- 3.7.7. Further information on the MD is available in TR 2169 *MIDAS Outstation Specification*.

3.8. Closed Circuit Television (CCTV)

- 3.8.1. The Overseeing Organisation's CCTV system is used to select, receive, control and display video streams from roadside cameras. A CCTV instation, known as a Television Base Station (TVBS), is located in each RCC and acts as a communications node for the control of CCTV outstations. These outstations, known

- as Television Outstation (TVOS), are located at the roadside and each comprise one camera and its control electronics.
- 3.8.2. Each TVOS is logically connected across the TSP's transmission network to the corresponding TVBS for the region in which the TVOS is located; however, video images can be viewed and camera control can be initiated from any TVBS for any TVOS connected to the TSP's network.
 - 3.8.3. Each TVBS has a generic service IP interface with the TSP's network at the RCC through which it sends control messages to TVOSs and receives status messages from TVOSs in response. This interface is known as the Camera Control Interface (CCI) and typically provides control of the Pan Tilt Zoom (PTZ) functions of the camera.
 - 3.8.4. Each TVBS has a Service Control Interface (SCI) with the TSP's network at the RCC through which it sends video switching requests to the TSP's video encoder and decoder equipment located at nodes on the TSP's transmission network to route video streams from the selected roadside camera to the selected video monitor located at an RCC.
 - 3.8.5. Each TVOS is connected to the TSP's transmission network via two separate interfaces; one for video transmission and the other for control data (telemetry) transmission. The video stream from the camera connects to a generic SDP (1 volt peak to peak composite video interface), from where the video signal is encoded by the TSP into an IP data stream for onward transmission. The TVOS connects to the TSP's network via a generic service SD connection for the purposes of camera control and outstation status monitoring. The particular service type for PTZ control is a standard service type for all TVOSs. The method of implementing generic IP services to support the TVOS will be determined by the TSP on a per-site or per-scheme basis. It will also be influenced by the proximity of the TVOS to local TSP's transmission equipment elements and the SPC of the TSP's infrastructure at that location. However, regardless of the method of implementation, the network functionality provided is identical in every case.
 - 3.8.6. TSPs roadside CCTV services shall not be requested or specified without a generic service for PTZ and related camera control provision. This allows standardisation of the TSP's equipment and provides a telemetry capability that could be used for future applications (such as wiper controls) for no additional cost at the time of design and installation.
 - 3.8.7. The CCTV system and TSP's network provide facilities for controlling cameras remotely (such as at other RCCs and via web based services). These facilities and the ability to distribute images are provided by the Video Information Highway (VIH). Remote users intending to view or control TVOSs shall communicate via the TVBS. Further information is included in MCH 1960 *CCTV Second Generation Management Overview* and MCH 1970 *Highways Agency CCTV Notes for Guidance*.
 - 3.8.8. The TSP's transmission network supports the switched distribution of CCTV camera images from roadside cameras to a central location such as an RCC, or via portal interfaces to web-based viewing applications. Analogue video signals from the roadside cameras are encoded by TSPs into digital data for routing across the IP network to the viewing destination (typically an RCC), where the data is decoded back into video signals for viewing on monitor displays.
 - 3.8.9. Where an analogue CCTV camera is connected remotely to the TSP's SDP using coaxial cable, the length of coaxial cable shall be no greater than 100 metres.
 - 3.8.10. CCTV cameras and outstations are currently specified with an option for both video and control signals to communicate using a single IP generic service. Video signals are encoded within the camera and therefore a separate analogue video connection is not required. The application and use of IP CCTV cameras is limited by the compatibility of video switching, recording and display technologies used elsewhere within

the overall CCTV system. Designers shall therefore consult the Overseeing Organisation and TSP to determine the feasibility of the application of IP CCTV within their designs.

CCTV WITH NO HIGHWAYS ENGLAND COMMUNICATIONS SERVICE CONNECTION

- 3.8.11. In areas where the provision of CCTV is required, but no Highways England communications service connections are available, this is achieved using third party communications links, the most common being the use of wireless communications technology. CCTV using wireless communications allows the Overseeing Organisation to provide CCTV quickly to areas where standard CCTV has not been cost effective to deploy, that is, in locations not currently serviced by the core network (see 2.2). Further guidance can be found in MCH 2544 *Providing CCTV Coverage away from the NRTS Network*.
- 3.8.12. When the provision of CCTV using wireless communications is being considered, the advice of the Overseeing Organisation shall be sought.

3.9. Emergency Roadside Telephone (ERT) Systems

- 3.9.1. The Overseeing Organisation ERT system is based on industry standard analogue and digital transmission technologies. On the highway, a generic service is employed that uses analogue subscriber interfaces and line extenders connected to a VoIP core. RCC operators access ERTs through the Overseeing Organisation's Integrated Command and Control System (ICCS). The TSP contractor provides the analogue subscriber interfaces, line extenders and VoIP core. ERT's calls received from users are routed via VoIP gateways located in TSs to RCCs and other key locations where the generic service presents SDPs containing an aggregation of ERT calls.
- 3.9.2. The Type 354 ERTs are located at the roadside interface with the VoIP network via standard subscriber line interfaces that emanate from Pair Gain Remote Units (PGRUs). PGRUs are used to increase the capacity of longitudinal copper cable networks, they are provided by the TSP and are located in roadside cabinets or TSs. Each PGRU can support up to 12 ERTs, which are connected to the PGRU via the TSP's local cabling. The SDP for each ERT is located in the ERT column, to which the ERT connects directly.
- 3.9.3. On an APTR that has no cabled TSP network infrastructure, wireless Global System for Mobile Communications (GSM) or cabled Public Switched Telephone Network (PSTN) ERT variants are deployed that utilise leased telecommunications services provided by mobile and fixed network operators.
- 3.9.4. The TSP's transmission network supports the Overseeing Organisation's deployment of ERTs with a VoIP transmission solution that permits the routing of both speech and text from roadside telephones, across the TSP's IP transmission network, to RCCs or other central call-handling centres.

3.10. Ramp Metering Controller

- 3.10.1. The RMC is remotely accessed for maintenance and data gathering purposes via a generic service. This service is provided by the TSP and is typically implemented using an IP generic service, depending upon the requirements of the scheme and the RMC equipment deployed.

3.11. Meteorological and Other Devices

- 3.11.1. Meteorological devices are connected as roadside input devices to a Meteorological Subsystem (MET) located in an RCC.
- 3.11.2. Meteorological devices are connected to the TSP's network via generic services through which they communicate to an IP interface on a LCC at the RCC. The service type that is provided will be dependent

upon the provisioning capability of the TSP's infrastructure at the device location and will be determined by the TSP.

- 3.11.3. Meteorological devices with legacy interfaces are connected to the TSP's transmission network via a service type that employs an upstream IPT device (as described in 2.2.6). It is the IPT that facilitates the communication by the legacy device across the TSP's IP network with the LCC in the RCC. This IPT-derived service type is the TSP's universal provision for all legacy meteorological device connections.

SUPERSEDED

4. TRANSMISSION INFRASTRUCTURE DESIGN

4.1. Overview

- 4.1.1. Infrastructure required to support telecommunications services is termed 'roadside infrastructure'. In this context roadside infrastructure comprises the brick-built TSs or slabs for modular TSs, generator bunds, ducts, sub-ducts, chambers, cabinet bases, fencing and gates, associated retaining structures, access infrastructure and protection infrastructure required to support the provision of the telecommunications services. The exact level of roadside infrastructure provision will vary, depending upon the existing infrastructure and the telecommunications service requirements.
- 4.1.2. The following key items enable the provision of the services:
- Cable network
 - Duct network
 - Cabinets
 - Roadside electronic equipment
 - Power supplies
 - Telecommunications interfaces
 - RCCs
- 4.1.3. The design process is iterative and involves the designer, the Overseeing Organisation, the TSP and the Maintenance Service Provider (MSP). The TSP performs design, installation and maintenance activities in accordance with the TSP's documented procedures and associated requirements.
- 4.1.4. The collaborative production of transmission infrastructure designs shall accommodate the requirements of Building Information Modelling (BIM) as specified in IAN184. The design process flow shall support the implementation of transmission infrastructure in addition to post implementation maintenance functions identified within section 5, specifically, the capturing of as-installed records and drawings in accordance with the requirements of section 5.4.
- 4.1.5. The designer shall obtain an up-to-date set of the TSP's documented procedures and associated requirements prior to undertaking any new design. The designer shall also consult with the TSP in respect to the current service types that are available from the TSP.
- 4.1.6. Prior to the outline design stage, one of the key design decisions to be made is the responsibility for designing and installing communications infrastructure. There are two possible options:
- **Procured without roadside infrastructure:**
 - The TSP will, in consultation with the designer, produce the top-level schematic cable route design which will be passed back to the designers.
 - The designer shall complete the design and arrange for the communications infrastructure to be provided prior to TSP arriving on site to install, terminate and test cables and equipment required to provide the services.
 - Before the TSP installs any cabling, it will undertake an acceptance process for the installation of large power cables etc.
 - Cables 'beyond the SDP' and typically those affixed to structures or located in areas subject to restricted conditions will be installed by the Overseeing Organisation's contractor.
 - **Procured with roadside infrastructure:**
 - The TSP will design and provide the communications infrastructure, longitudinal cable and TSP local cabling (with the exception of cables fixed to structures).
 - Upon the completion of cable installation and termination, the TSP will test the installation.

- The TSP will return elements of the roadside infrastructure to the scheme that are not to be maintained by the TSP.
- 4.1.7. All items of roadside equipment and cable joints will have their ideal locations. However, the best design balances ideal locations with physical constraints, environmental requirements and cost. For instance, duct, cable or equipment savings can be achieved by minor adjustments to locations.
- 4.1.8. *Specification for Highway Works (SHW) series 1500* Notes for Guidance (and associated templates for *Appendices 15/1, 15/2 and 15/3*) contain details in respect to the compilation and content of appropriate design outputs required by the scope of the scheme and the procurement of telecommunications services and infrastructure.
- 4.1.9. The TSP operates a Capture Requirements and Plan (CRP) process to provide advance warning of changes affecting the TSP and Overseeing Organisation services. The TSP utilises a forward programme to record all future works requirements and maintain records of past works.
- 4.1.10. As part of the engagement with the TSP under the TSP's CRP process, the designer shall develop and agree with the TSP a programme that reflects the TSP's periods for completing the TSP's outline and detailed designs (including telecommunications bypasses) and incorporates as a minimum the notice periods applicable to the implementation of telecommunications bypasses, regrading, service provisioning and any associated enablement activities.
- 4.1.11. Scheme roadside infrastructure design shall not include the design of the longitudinal or local communication cable networks (other than cables beyond the SDP and the exceptions in section 5.3). The provision of the longitudinal cable network and local communication cables will be the responsibility of the TSP.
- 4.1.12. Where the detailed design of roadside infrastructure is prepared by the TSP, the TSP will be responsible for the installation of the roadside infrastructure to the extent of the TSP's responsibilities that are recorded in *Appendices 15/1, 15/2 and 15/3*. Where the roadside infrastructure is designed by the Overseeing Organisation, the Overseeing Organisation will be responsible for the installation of the roadside infrastructure.
- 4.1.13. The TSP produces an outline design as part of the CRP process and this forms the basis for a task authorisation to commence the installation design task. The output from the installation design task is a detailed design (in the form of a planning instruction including task authorisations for completion as the activity progresses).
- 4.1.14. The Overseeing Organisation retains the maintenance responsibility for items of roadside infrastructure comprising Cross-Carriageway Ducts (CCDs), Ducts Through Structures (DTSSs), ducts for cables beyond the SDP, Cable Over Gantry (COG) solutions, access infrastructure and protection infrastructure. The TSP retains maintenance responsibility for longitudinal and local ducts, including power ducts for communications power cables and all chambers that directly interface with the TSP's ducts.
- 4.1.15. In respect of the installation of ducts, including CCDs and the excavation of trenches for the installation of buried cables, the designer shall ensure that the reporting, risk management and design procedures set out in HD22 *Managing Geotechnical Risk* are implemented for each scheme.

4.2. Design Overview

- 4.2.1. MCH 1652 describes asset record requirements for the design of the power, telecommunications and ducting networks and other associated equipment. As a minimum, the locations of cables, equipment, SDPs, chambers, physical constraints and cabinets shall be recorded.
- 4.2.2. The location of TSs and TCs will be finalised by the TSP before starting the schematic design as this has a fundamental effect on the design of the cable network.
- 4.2.3. Where the scheme boundary does not coincide with a TS or TC, the cable infrastructure adjacent to the scheme boundary shall be taken into account.
- 4.2.4. Interface cabinets shall be provided where a ducted network interfaces with an existing direct buried network or there is a change in the SPC. The type and location of the interface shall be developed through consultation with the TSP.
- 4.2.5. An assessment, in accordance with TD 19 *Requirement for Road Restraint Systems*, shall be undertaken to determine whether the roadside equipment has been sited safely and whether a Vehicular Restraint System (VRS) shall be required for the protection of road users, technology equipment and maintenance personnel.
- 4.2.6. An assessment, in accordance with the Overseeing Organisation's metal theft risk assessment and toolkit, shall be undertaken to ensure measures are put in place to provide adequate protection to the transmission infrastructure against the risk of theft or damage.
- 4.2.7. Where noise fences or environmental barriers are installed between a cabinet and the carriageway, access provision shall be made to the cabinet whilst maintaining an effective noise or environmental barrier in accordance with HA 65 *Design For Environmental Barriers* and HA 66 *Environmental Barriers: Technical Requirements*.
- 4.2.8. Paved areas shall be constructed between access steps, cabinet hard standings and the hard shoulder or a suitable refuge in order to provide continuous safe access.
- 4.2.9. The distance that maintenance operatives are expected to walk must be minimised. Any task, the equipment required, and the distance travelled must be risk assessed by the designer in accordance with the *Manual Handling Operations Regulations*.
- 4.2.10. The design shall meet the Overseeing Organisation's maintenance requirements.
- 4.2.11. Where legacy services are to be maintained, the location of longitudinal cable joints shall be within 30 metres of existing IPT locations.
- 4.2.12. Public telecommunications and Distribution Network Operator (DNO) interface cabinets shall be constructed in the line of the highway boundary fence, with any set-back designed to ensure that the whole of its foundation lies within land belonging to the Overseeing Organisation.
- 4.2.13. The design shall minimise the risk of theft or damage to equipment, and protect against vandalism to maintain the integrity of the installation. The design shall also include an assessment of risks to operational and maintenance staff, and minimise risks of injury and threats to their personal safety. Where this is not possible, the design shall include appropriate mitigation.
- 4.2.14. A Design Strategy Record (DSR) shall be developed as the design progresses to demonstrate and record strategic and design constraints and decisions, with supporting evidence, in an auditable manner.

4.2.15. The existing transmission infrastructure, longitudinal cables and ducts, shall be used wherever practicable. The philosophy adopted for the design of the transmission system shall be logged in the DSR.

4.3. Cable Network

4.3.1. The specifications for roadside cables shall be in accordance with the *SHW series 1500*. The TSP will either adopt the Overseeing Organisation's specifications or the TSP's own cable specifications.

4.3.2. Power cables installed on highways (excluding motorways) shall have sufficient mechanical protection as excavation of the road on the highway is more common and less controlled than on the motorway.

4.3.3. Mechanical protection shall be required where non-armoured cables are installed on gantries.

4.3.4. The TSP's cable network comprises optical fibre and copper cables installed longitudinally in the verges of the highway. Historically, armoured cables were buried directly in the ground. Current installation practice requires the use of non-armoured cables to be installed in a fully sealed ducted network. Cable jointing and termination is within environmentally sealed above or below ground enclosures.

4.3.5. The design of the longitudinal network will be undertaken by the TSP.

4.3.6. Optical fibre cables are used to carry generic low (typically data from signs, signals and MIDAS) and high-bandwidth (typically CCTV) generic services core network transmission circuits that link transmission nodes. The number of longitudinal optical fibres needed to support the TSP's services will be greater where a high density of CCTV cameras will be required, and correspondingly lesser to support fewer CCTV cameras. Optical fibre cables containing 48 or 96 fibres are common for most new installations. In low-density environments, the use of 24-fibre cable is likely to provide sufficient capacity for TSP's transmission needs. The fibre count needed to support a scheme will be determined by the TSP, based upon the designer's end device requirements.

4.3.7. Copper cables are used to carry low-bandwidth IP (typically 2Mbps or less), ERT generic services and elements of the TSP's core network between transmission nodes where optical fibre cables are not installed. Historically, copper cables containing up to 40 pairs were commonly installed longitudinally. However, the reducing requirement for copper transmission circuits allows the TSP to recommend lower pair-count cables for new schemes, with 10-pair or 20-pair cables, typically providing sufficient capacity for TSP's transmission needs.

4.3.8. Local cables can also form part of the TSP's cable network, but only where these deliver TSP's STIs from connections with the longitudinal network or TSP's transmission equipment to remote SDPs. These local cables will typically be:

- 2-pair (quad) or 10-pair copper cables
- 4-fibre optical cables
- Cat5 Ethernet cables

4.3.9. The TSP's cable requirements for regrades, renewals and new installations will be determined by the TSP, based upon the type and quantity of transmission services required at the roadside.

4.3.10. The Overseeing Organisation is responsible for local cables beyond the SDP, that is, from the SDP to the actual technology device.

4.3.11. Armoured cable shall not be used for new longitudinal cabling except through the consent of the Overseeing Organisation and the TSP.

- 4.3.12. Armoured cable shall only be used to replace short sections of the existing armoured cable network and longitudinal infrastructure on the APTR (confirmed by the TSP on a case by case basis) (see 4.3.2).
- 4.3.13. Where longer lengths of armoured cable are to be installed by the TSP that would otherwise require long cable trenches to be open for extended periods then sacrificial ducting shall be installed between intermediate cable draw pits in accordance with the *SHW series 1500*.
- 4.3.14. During the design stage, the existing cable network and the effect that the scheme design will have upon it shall be identified so that cost saving measures such as the co-location of cabinets, roadside furniture and end devices can be considered wherever possible.

LONGITUDINAL CABLE JOINTS

- 4.3.15. Cable joints are used to join adjacent lengths of the TSP's longitudinal cable together, and to join local TSP cables to longitudinal cables wherever STIs are delivered to roadside equipment. Cable joints are environmentally sealed re-enterable units that are housed in below-ground chambers or in above-ground cabinets.
- 4.3.16. As loaded transmission circuits are no longer used within the TSP's network, there is no requirement to space longitudinal copper cable joints at fixed intervals to incorporate cable pair loading. This allows for a more optimal alignment of longitudinal cable joints with roadside equipment locations to minimise the extent of the TSP's local cabling needed to place TSP SDPs close to roadside devices.
- 4.3.17. The TSP is responsible for the specification of longitudinal cable joints.
- 4.3.18. The use of below-ground or above-ground joints will be determined by the TSP with regard to different SPCs or new installations. The location of the TSP's cable joints on the longitudinal cabling will be determined by the TSP as part of the transmission design, in collaboration with the designer.

PROTECTION OF EXISTING CABLES

- 4.3.19. When planning work on existing roads, special consideration shall be given to the protection of the existing roadside, power and communications infrastructure during any construction works. In addition to its function of carrying local data and video services, the longitudinal cable forms part of the TSP's core national network. Any damage to the existing infrastructure will therefore cause disruption to operations over a wide area. The existing technology system outside the works area shall remain operational at all times.
- 4.3.20. An existing technology report shall be produced by the designer to inform the Overseeing Organisation and TSP and to assist in the agreement of measures to be incorporated within the design. The existing technology report shall be produced following consultation with the TSP and shall include a risk-based assessment of how the scheme might affect the existing TSP's core network and local services (including any construction phasing). The report shall identify a set of temporary or permanent arrangements (for example service de-activation or removal) and mitigation measures necessary to maintain the integrity of the network and services, for example the installation of a telecommunications bypass. Where it is impossible to avoid interruption of the core network, the core network shall be maintained with the minimum of interruption, using the telecommunications bypass.
- 4.3.21. Within the existing technology report consideration shall be given to maintaining local services, including the use of temporary cabling, where this is both important to the Overseeing Organisation and practical to do so, given the vulnerability of any temporary cabling, access arrangements and the continuity of power

supplies to the roadside technology equipment and the TSP's transmission equipment providing the local services during the period of the works.

- 4.3.22. Where it is not possible to avoid the TSP's live cables, the telecommunications bypass will be installed by the TSP. This is typically achieved through the installation of interrupter cables. It is notable that when the interrupter cables need to connect to the nearest longitudinal cable joints, the length of the interrupter cables extends beyond the boundaries of the scheme construction work. The interrupter cables used to provide a telecommunications bypass shall be protected from damage in accordance with the requirements of the *SHW Series 1500* and any specific requirements of the TSP. This installation and protection of the telecommunications bypass is the responsibility of the scheme.
- 4.3.23. All cable damage shall be reported immediately to the TSP, and the Overseeing Organisation shall be informed as soon as practicable. In the event that the cable is not the responsibility of the TSP, the TSP will contact the Overseeing Organisation for resolution. Fully detailed drawings shall be provided to the TSP, indicating the following information:
- The preferred safe route for any interrupter cables that the TSP is required to install.
 - Any areas where special protection measures are to be employed for the protection of the bypass, bearing in mind it is the scheme's responsibility to protect the interrupter cable and any intermediate joints.
 - The optimum location(s) at which the TSP can safely install interrupter cable joints, such that they will not be damaged during the scheme works.
- 4.3.24. The design shall be such that the TSP is provided with safe 24-hour access to the bypass location for the duration of the works, or offered suitable safe alternative means of access (for example traffic management).
- 4.3.25. The TSP will design, install, maintain and remove communications bypass arrangements and shall provide, where practicable, temporary connections to roadside devices that are required to remain in service that would otherwise have their TSP's services isolated by the communications bypasses.
- 4.3.26. The location of all cable and equipment shall be determined and an assessment made of the risk of damage in accordance with the requirements of the Overseeing Organisation's metal theft toolkit (see 4.2.6).
- 4.3.27. The impact of scheme works on the nearby infrastructure shall be assessed and, as result, the type and duration of the works planned accordingly. The cable protection and other mitigation measures required will depend on many factors including the risk of damage and the type of cable infrastructure. The TSP shall be consulted on a site-specific basis and its specific requirements complied with.
- 4.3.28. Where work is undertaken in close proximity to existing cables or ducts, the exact location of the cables and ducts shall be marked clearly prior to the commencement of any works. In the case of the infrastructure forming part of the TSP's network, the contractor shall request the TSP to locate, identify and mark its assets. During the works, and where construction works are performed in close proximity (where close proximity working is defined by the requirements of the TSP) to the TSP's buried cabling or other assets, no works shall be performed without either a representative of the TSP being present to monitor the works, or following the submission by the contractor of a method statement, written permission is received from the TSP that the contractor can proceed with the works without the TSP being present. The responsibilities, process and interaction between parties is defined in the TSP's interface agreement produced and supported by the scheme contractor under clause 1502.2 of the *SHW 1500 series*. The requirement on the scheme contractor in respect of close proximity working is specified in clause 1502.4(i) and Appendix 15/3 of the *SHW 1500 series*.

RE-USE OF EXISTING CABLE

4.3.29. Scheme designers shall consider, in consultation with the TSP, if the re-use of existing infrastructure by new schemes is possible and would result in overall project cost savings to the Overseeing Organisation. In such circumstances, the existing infrastructure will need to be protected from damage whilst those works are in progress and remain fit for purpose thereafter.

4.3.30. Where the works include activities that include the re-location or replacement of a cabinet or the interruption of an existing duct network (for example), the designer shall consult with the TSP and comply with any special requirements of the TSP regarding the disconnection and the pulling back of existing cables prior to the re-installation and termination of the existing cables. Such activities shall consider, on a site-by-site basis, the handling and accommodation requirements associated with any cables that are pulled back.

4.4. Duct Network

4.4.1. Installation requirements shall be in accordance with the *SHW series 1500*. This permits the selection of either the Overseeing Organisation's ducting standards or the TSP's duct standards on a scheme, providing the respective standards are consistently applied.

4.4.2. The term cable duct is used in this document to describe the ducts, sub-ducts or conduits used for installing the highway communications cable network comprising communications and power cables.

4.4.3. All ducts shall be laid within the highway boundary.

4.4.4. Longitudinal ducts shall be located to the rear of all other services and equipment including safety fences, drainage and lighting columns, with the exception of roads where the latest *New Roads and Street Works Act (NRSWA)* applies. The offset from the edge of the carriageway to the duct trench shall be determined following an assessment of the potential impact on the stability of adjacent earthworks slopes, carried out in accordance with *HD 22 Managing Geotechnical Risk*. Where the HD22 assessment identifies no risk to the stability of earthworks then the cable duct offset shall be 2 metres. The optimum location for cable ducts is within a flat verge. Ducts shall be located within a flat verge in the early stages of design where practicable and additional verge width shall be provided where feasible.

4.4.5. Ducts shall be laid in straight lines from one chamber to the next with smooth, long radius bends. Ducts shall be laid in a manner that will avoid forming pinch points or including sharp discontinuities within the direction of the duct that mean that ducts or cables suffer damage during cable installation. The use of 'flexible' ducts (ducts of a construction that are designed to be coiled to a small radius) shall not be used for longitudinal ducts. TA 77/97 A3.4 (ii) indicates a maximum distance of 500m spacing between chambers.

4.4.6. Existing ducts can be sleeved or sub-ducted where the existing duct has discontinuities or internal sharp edges or roughness that would otherwise damage cables during their installation. This provides one or more continuous smooth ducts.

4.4.7. Where there is limited verge width or non-existent conventional verges, such as in areas of retained cutting or where access pathways are provided, the ducts shall be located under the hardened verge. In these cases the ducts are considered to have 'hard re-instatement' and are not classified as DTSS.

4.4.8. Ducts can be located either in the centre of the wheel-track zone in the hard shoulder or within the hardened verge. In this instance, the nature of the fill provided to the ducts shall be in accordance with the requirements of the *SHW series 1500*.

- 4.4.9. Where it is necessary to install ducts beneath heavily trafficked existing ground, consideration shall be given to the installation technique to ensure that the existing ground surface is not disturbed.
- 4.4.10. Maintenance of the completed system shall be considered during the design phase, including subsequent requirements for traffic management. The duct route shall be located to facilitate safe access. Additional requirements regarding maintenance can be found in section 5 and *SHW series 1500* respectively.
- 4.4.11. Where bases for roadside technology such as CCTV cameras, gantries or large signs coincide with the longitudinal duct route, these bases shall be designed to allow ducts to be built in. Such ducts, where the structural foundations within which the duct route passes are not considered to be DTSs to the extent that they require transition chambers to be installed at either end of a DTS. Typically, one chamber is provided to provide local duct connections to the roadside technology.
- 4.4.12. All un-armoured longitudinal communications cables, local communications cables and power cables shall be installed in cable ducts or sub-ducts provided specifically for this purpose as detailed in the *SHW series 1500*. Communications cables and power cables shall be installed in separate ducts.
- 4.4.13. A longitudinal and local duct design of suitable capacity shall be produced to carry all TSP communications and power cables (as required by the Overseeing Organisation or the TSP) through the extent of the scheme. This will be subject to the approval of the TSP, which will specify the capacity and interfacing requirements of the duct design. The duct design shall support the TSP's services needed locally by the scheme and the infrastructure needs of the national network that is carried through the scheme works area.
- 4.4.14. New or existing ducts can be sub-ducted to provide managed cable installation and to increase the integrity of the duct network. This shall be done in accordance with the requirements of the *SHW series 1500* and any specific requirements of the TSP. Sub-ducts shall be either drawn into ducts between chambers or be part of a modular construction where the sub-ducts are either pre-installed or are moulded into an outer duct.
- 4.4.15. The TSP is responsible for the allocation of space within all ducts.
- 4.4.16. The longitudinal duct route shall be chosen to minimise the number of CCD crossings required, for example to access TSs.
- 4.4.17. For designs of new longitudinal infrastructure where overhead power lines, electric rail supplies or other power supply circuits run alongside a particular verge, the design of the longitudinal cable route shall be in the opposite verge, where practical. Any route using the same verge as one of the above circuits will be reviewed and approved by the TSP prior to the commencement by the TSP of any detailed design (that is design activities that are tasked by the Overseeing Organisation upon the TSP and paid for by the Overseeing Organisation).
- 4.4.18. The location of the duct network shall facilitate safe access for the purpose of maintenance. Access to the duct network that requires temporary traffic management shall be minimised.

LOCAL DUCTS

- 4.4.19. Local ducts are used to connect equipment to the longitudinal and CCD network.
- 4.4.20. Except where permitted under the *SHW series 1500*, separate ducts for communications and power cables shall be provided.

- 4.4.21. Local ducts shall be provided for all local TSP cables, typically where services extend from a longitudinal cable joint to a roadside cabinet or SDP location. Where a TSP SDP is not co-located with a longitudinal cable joint, local TSP ducts shall be provided from the designated longitudinal chamber to the roadside cabinet or SDP location.
- 4.4.22. Where cabinets or SDP locations are in the same verge and adjacent to the longitudinal cable route, local ducts shall be laid in the same trench, parallel to the longitudinal duct route up to a maximum length nominated by the TSP. If the local duct exceeds this nominated maximum length, an intermediate chamber shall be provided on the longitudinal duct route adjacent to the cabinet or SDP location. The longitudinal duct allocated to local cables shall be broken out in this intermediate chamber and the local TSP duct run directly to the roadside cabinet or SDP.
- 4.4.23. Limited use of flexible ducts for local ducts is only permitted for short lengths within local duct networks, typically to overcome the presence of unforeseen obstacles at site, its use shall not be specified within a new design.
- 4.4.24. Under no circumstances shall a scheme contractor break into, or install cables in, ducts that are the responsibility of the TSP, without the agreement of the TSP.

DUCTS THROUGH STRUCTURES (DTSs)

- 4.4.25. Where the TSP's cable infrastructure passes through a structure (for example bridge decks or foundations), the cable shall be contained within ducts. These ducts are designated as DTSs in order to differentiate them from ducts otherwise located within a hardened (for example shallow encasement in concrete or hard pavement) or soft verge.
- 4.4.26. Where there are ducts through structures, it is notable that some structures installed prior to the year 2000 contain asbestos and this shall be considered. If work on ducts within structures installed prior to 2000 is planned then the *Control of Asbestos Regulations 2012* applies. The regulations require that asbestos must be presumed to be present unless it can be confirmed otherwise. For further information refer to the HSE publication – *Managing and working with asbestos – Control of Asbestos Regulations 2012 Approved code of practice and guidance reference L143*; The HSE publication *Asbestos the Survey Guide reference HSG264*; and the Overseeing Organisation's published documents on asbestos management.
- 4.4.27. Unless specifically tasked under an ad-hoc agreement, the design and maintenance of DTSs is not the responsibility of the TSP. DTSs are integral elements of the structure in which they are located and they will be handed over to the Overseeing Organisation.
- 4.4.28. DTSs shall be designed to connect to ducts, via chambers as necessary, such that a continuous duct route is formed. The physical transition between ducts in the soft verge and DTSs shall be implemented such that cables can be safely installed through the DTSs without damage to the cables or the ducts, and the cables can be adequately accessed and maintained thereafter. Refer to section 4.6 below for further guidance on the use of chambers when a duct route is required to transition between soft verge and DTSs.
- 4.4.29. Where separate viaducts are constructed for each carriageway, provision for cabling between the structures shall be required.

CROSS-CARRIAGEWAY DUCTS

- 4.4.30. CCDs provide the means by which cables can cross carriageways from one verge to the other, from verge to central reserve and from one side of a slip road to the other.

4.4.31. The depth of CCDs is dictated by the following factors:

- The pavement construction depth.
- The method of duct installation to be used.
- The need to ensure that adequate protection to the duct is achieved, both during construction and under long term vehicular loading.
- The location of drains.
- Whether the road is new or existing.

4.4.32. The design and maintenance of CCDs is not a responsibility of the TSP; CCDs are an integral element of the carriageway under which they are located. Following construction, they will be handed over to the Overseeing Organisation for the purpose of maintenance.

4.4.33. CCDs shall be connected to ducts via chambers, such that a continuous duct route is formed. The physical transition between ducts and CCDs is implemented such that cables can be safely installed through the CCDs without damage to the cables or the ducts, and the cables can be adequately accessed and maintained thereafter.

4.4.34. Where the TSP's longitudinal cable route crosses between verges, the crossing shall be implemented using a CCD or DTS.

4.4.35. Where the longitudinal network runs along one carriageway, and TSP's SDPs are required on the opposite carriageway, CCDs or DTSs shall be provided for the local TSP cables needed to span the carriageway. The cable requirement will be advised by the TSP and the designer shall ensure adequate CCD provision shall be made for these cables in the design.

4.4.36. All new CCDs provided for use by the TSP are continuous between verges. If a scheme design requires access to the central reserve, then this can be agreed with the TSP, but the design shall provide for at least two continuous ducts between verges for use by the TSP. Provision of any ducting from the longitudinal network to the centre reserve is subject to the TSP's consent; there is no requirement upon the TSP to provide chambers in the centre reserve to serve matrix signals or other equipment.

4.4.37. When considering the placement of CCDs, the following factors shall be taken into account:

- The requirement for pairs of telephones (A and B carriageway) to be sited opposite each other.
- Where legacy devices are deployed, the maximum cable length between the TSP's IPTs and their dependent devices.

4.4.38. Where existing CCDs are to be used to provide a cable route that includes TSP cables, the condition and capacity of the existing ducts for the proposed new cables shall be proved.

4.4.39. Where existing CCDs are available, and proving of the duct shows that the condition of the existing ducts is acceptable and there is sufficient capacity for new cables, then this route shall be utilised. However, where the condition of existing ducts is unacceptable or there is insufficient capacity, then the following options are available:

- Sleeve or sub-duct the CCDs.
- Use of an alternative existing CCD that is viable and that can be made available, subject to agreement of the Overseeing Organisation.
- Provision of a new CCD crossing by the Overseeing Organisation.

4.4.40. Any consideration to the provision of sub-ducting, duct lining, or other refurbishment of existing ducts shall be subject to the prior consent obtained by the designer from the TSP.

DUCTS OVER GANTRIES

4.4.41. As an alternative to the use of CCDs for the routing of TSP's SDPs to the opposite verge from the longitudinal infrastructure, local TSP cables can be installed in cross-gantry cable ducts.

4.4.42. The term 'cross-gantry cable duct' is used to describe the provision of an overhead ducted cable route between two underground chambers located on opposite carriageways, associated with an instance of a single-span gantry, the duct route being overhead via the gantry rather than via buried CCDs. The cross-gantry cable duct shall comprise both buried ducts between the chambers and the gantry bases, and above-ground ducts routed up and over the gantry with access points at ground level to facilitate the pulling of cables without the need for any access equipment.

4.4.43. The design of any duct-over-gantry infrastructure is the responsibility of the designer. The design shall be subject to consent by the TSP and the Overseeing Organisation, which is required for each new or substantially changed design. The design shall be demonstrated and tested in an off-road environment prior to implementation. This shall prove that the design is suitable for the installation of the TSP's cables and their maintenance thereafter. Previously consented designs (or those with minor modifications) can be re-used without the need to demonstrate or test the design, subject to the consent of the TSP.

4.4.44. The overall duct route across the gantry from chamber to chamber shall be suitable for the installation of all types of TSP cabling. The TSP will advise on the duct over gantry design criteria and the test criteria that shall be met to ensure the design can be accepted.

4.4.45. The duct design shall include a spare duct of the same size and type as those used for cable installation, fully roped, only for TSP's future use (for example to install a replacement cable in the spare duct, whilst maintaining operational service through the existing cable and duct).

4.4.46. On completion of cabling, the 'spare' duct shall be devoid of cables. Duct space utilisation of all ducts shall be designed so as not to exceed 70% of the overall internal cross-sectional area of a duct, taking into account the cross-sectional area of the pulling arrangement.

4.4.47. Ducts and their fixing arrangements over a gantry are considered a permanent part of the gantry structure and are handed over to the Overseeing Organisation's maintainer responsible for maintaining the gantry structure.

NON-DUCTED NETWORK

4.4.48. In areas where a duct network is not present, armoured cables buried in trenches can be installed, taking account of the limitations in their use and requirements as specified in the *SHW series 1500*.

4.4.49. Trench routes shall be located at a suitable distance from the hard shoulder and parallel to the boundary fence, and shall be subject to the designer's risk assessment and Geotechnical Risk Assessment under *HD 22 Managing Geotechnical Risk*.

DIRECT BURIAL OF CABLES

4.4.50. Direct burial is no longer standard practice for the installation of communication cables. However, it is appropriate in exceptional circumstances, such as the replacement of short lengths of existing direct buried cable. Where lengths of TSP's armoured cables are installed in the TSP's sacrificial ducting with

intermediate cable pulling pits, these shall be provided in accordance with the *SHW series 1500* and requirements of the TSP.

- 4.4.51. Composite OF-copper cable shall not be provided for future installation, however it can be provided for repair or replacement of existing cables, or for the provision of a new SDP in an area of armoured cable.

CABLE TROUGH

- 4.4.52. The use of new trough units for communications cables is not standard practice; however, there are sections of the existing network located in cable trough. Early advice from the Overseeing Organisation and the TSP shall be sought where the utilisation of existing trough is considered.
- 4.4.53. Where cable is to be installed within a cable trough, either armoured cable or sub-ducted non-armoured cable shall be used.
- 4.4.54. The requirements for the installation of cables in troughs are provided in the *SHW series 1500*.
- 4.4.55. Where a cable is laid at shallow depths, the designer shall ensure that the cable is protected at the transition between the trough and the duct or trench (see 4.2.6).

CHAMBERS

- 4.4.56. Ducted cable infrastructure requires the provision of below-ground access to allow the Overseeing Organisation's and TSP's power and communication cables to be installed in the ducts and to accommodate below ground cable joints and power cable reduction joints. They also act as the longitudinal intersection point from which local ducts go out to roadside cabinets and SDPs.
- 4.4.57. Chambers shall be designed and constructed in accordance with the requirements of *SHW series 1500*.
- 4.4.58. The designer shall select the grade of chamber lids and the construction details for each chamber as appropriate to the location of the chamber.
- 4.4.59. Chambers shall be constructed to dimensions that are sufficiently large to accommodate both the duct and cable infrastructure that they shall contain, and the safe access of installation and maintenance operatives.
- 4.4.60. The designer shall consult with the TSP regarding the dimensions and optimal placement of the chambers needed to accommodate the TSP's cable infrastructure requirements through the scheme works area.
- 4.4.61. Chambers with hinged lids shall be located such that the hinged lid can be opened fully and is not impeded by any object or is within any deflection zone of a vehicle restraint system.
- 4.4.62. Chambers shall include sufficient space and hardstanding around a chamber for the safe insertion or removal of chamber covers or the operation of hinged lids. Access to the sides of chambers where cable pulling activities are undertaken shall incorporate sufficient unimpeded space to allow either manual or machine cable pulling operations as determined by the length and size of the cables being installed, and for operatives to walk around and access the sides of chambers. The designer shall consult with the TSP for details concerning the method of installing cables and the space requirements to accommodate these cable pulling operations.
- 4.4.63. The requirement of internal steps, bearers for cables and joints in chambers shall be dependent upon the depth of the chamber and cable jointing practice.

- 4.4.64. The design shall consider the requirement for the installation of power and communications cables through the ducted system. The design of chambers shall allow for the bending radius of power cables and the containment of reduction joints at cabinet sites.
- 4.4.65. Power cable joints for the jointing of cables of an overall cross-section greater than 50mm² shall not be permitted within telecommunications chambers that house longitudinal below ground cable joints. Power cable joints for cables of a conductor size of greater than 50mm² shall be housed in separate, and in some cases additional chambers.
- 4.4.66. Power cables shall be supported and routed in a manner that does not impede access to the telecommunications infrastructure nor create a hazard when using the access steps (where present). Power cables through joints shall be placed in separate chambers.
- 4.4.67. Chambers shall be installed at both ends of every CCD.
- 4.4.68. The finished level of chambers shall match that of the surrounding ground. The finished level of chambers shall not result in the chamber being above the surrounding ground because the raised chamber creates a hazard to an errant vehicle. Equally, if the finished level of the chamber be below that of the surrounding ground, the resulting depression creates a hazard to an errant vehicle and encourages the pooling of water. In both instances, an assessment in accordance with TD19 *Requirements for Road Restraint Systems* shall be undertaken. If a retaining feature or re-profiling is needed, their details shall be determined in accordance with HD22 *Managing Geotechnical Risk* and where necessary BD2 *Technical Approval of Highway Structures*.
- 4.4.69. Other than on flat verges, if retaining walls or local surface re-profiling are required at chamber locations, they shall be designed to suit the specific topographical and geotechnical conditions. Consideration shall be given, where appropriate, to adjust the level of the top of the chamber in order to overcome the need for a retaining wall.
- 4.4.70. If existing chambers are located under in-running lanes or existing hard shoulders, they shall be removed or relocated away from the carriageway and hard shoulder. New chambers shall not be located under in-running lanes or exiting hard shoulders.
- 4.4.71. Chambers shall be labelled in accordance with the requirements of the *SHW series 1500*.

CHAMBERS IN STRUCTURES

- 4.4.72. Where ducts are installed in structures, it is likely that they will be located at a different depth and offset to the main longitudinal duct run. This is due to the physical constraints of the structure. At all such locations, a transition chamber shall be provided at each end of the structure to allow cables to be installed through the structure. The required transition chamber dimensions shall be agreed with the TSP.
- 4.4.73. Some existing structures contain ducts that are smaller in diameter than standard longitudinal ducts. These ducts are often truncated at the edge of the structure. Sub-ducts will in many cases be able to bridge these interfaces and allow a continuous run between interface chambers either side of the structure.
- 4.4.74. Chambers at each end of a structure can be used to accommodate changes in offset over a short distance under certain circumstances. This applies, for example, when there is a difference in horizontal offset and vertical alignment between the ducts in the structure and the soft verge at either side. One chamber is used to accommodate the transition of ducts from the structure and one to accommodate the offset to the line of the longitudinal ducts.

- 4.4.75. The dimensions and spacing of chambers on structures shall be subject to approval by the TSP.
- 4.4.76. Chambers on structures shall be installed either side of any expansion joint to allow the termination of the flexible or other ductwork arrangement to accommodate the expansion of the structure and, where necessary for the correct operation, the retention of cables either side of the expansion joint.
- 4.4.77. Chambers and ducts shall remain free from water at all times. The designer shall specify suitable drainage for all chambers and ducts.

4.5. Telecommunications Bypasses

- 4.5.1. The existing technology system outside the works area shall remain operational at all times. Longitudinal cables inside the works that are part of the core network and necessary for the continued operation of existing technology systems and local services outside the works shall remain operational at all times, or provision shall be made to provide temporary alternatives to ensure continuation of service.
- 4.5.2. Upon the completion of the existing technology report (see 4.3.20) the recommendations of the report shall be agreed with the Overseeing Organisation prior to the scheduling of any telecommunications bypass and the implementation of temporary cables to maintain local services. Following confirmation of the need to install a telecommunications bypass, the designer shall obtain and confirm the relevant requirements from the TSP.
- 4.5.3. The TSP will design, install, maintain and remove communications bypass arrangements and will provide, where practicable, temporary connections to roadside devices that are required to maintain local services that would be isolated by the implementation of a communications bypass.
- 4.5.4. An emergency cable repair service will be provided by the TSP for the interrupter cable in the event of any interrupter cable or other temporary cable sustaining damage. To ensure swift repair, safe means of access to the cable shall be determined at the pre-installation design stage by liaison with the scheme contractor.
- 4.5.5. If the design specifies the re-installment of the original longitudinal cables (that is, the sole reason for the interruption was to guarantee continuity of service by mitigating a measured risk to the existing cables presented by the proximity of the works) then the existing cables will be retested by the TSP to prove the cable integrity both before and after the scheme works. The scheme contractor shall be invited to witness these tests. Any cables found to be damaged shall be replaced at the contractor's expense.

4.6. Cabinets

EQUIPMENT CABINETS

- 4.6.1. The TSP's transmission equipment located at the roadside shall be housed in weatherproof cabinets, designed for the housing of electronic equipment. The responsibility for the provision, installation and use of each equipment cabinet shall be determined with information where necessary obtained from the TSP.
- 4.6.2. A means of local isolation of the equipment cabinet shall be provided, within view and readily accessible, unless equipment cabinets have a separate internal and physically segregated means of isolation prior to the main distribution board. The route to access the cabinet containing the local power isolation shall be safe to readily access (that is, not across a carriageway or slip road).
- 4.6.3. Cabinets shall be designed and specified to ensure that the internal environmental conditions necessary for proper operation of all of the equipment housed within it.

- 4.6.4. Where cabinets are to be provided by a scheme, the TSP will advise the scheme of any requirements for housing of the TSP's transmission equipment including the environmental conditions that the cabinet shall provide, the amount of internal cabinet space required and the power supply and distribution requirements.
- 4.6.5. It is permitted to co-locate the Overseeing Organisation's and TSP's equipment in shared cabinets. The use of such shared cabinets will require the approval of the TSP and the Overseeing Organisation. The designer shall consult with the Overseeing Organisation and the TSP during the design period to ensure that adequate space, power, ventilation and access is provided for the TSP's equipment and for the connections that will be made to the TSP's equipment within the cabinet.
- 4.6.6. Each equipment cabinet shall accommodate cable termination, SDP presentation and space for the labelling of SDPs and STIs in accordance with the requirements of the TSP. Equipment layouts shall accommodate the potentially conflicting requirements to house termination frames and to accommodate cabling and connectors and to preserve access to the rear of equipment. Equipment layout plans shall include details of power distribution and cable interlinking between equipment and SDPs.
- 4.6.7. To facilitate the calculation of power and ventilation requirements for cabinet enclosures, the designer shall request that the TSP provide the power consumption (peak and average power consumption), ratings for power distribution protective devices and heat dissipation figures for the TSP's equipment.
- 4.6.8. The designer shall ensure that the space requirements around equipment within cabinets to ensure adequate ventilation are preserved and the total heat dissipation is kept below limits provided by the TSP. Following consultation with the TSP, the designer shall produce a layout plan for each unique type of cabinet configuration and obtain the TSP's consent for the layout plan. Tests to characterise the heat dissipation performance of a cabinet design or internal equipment layout shall be required as required by the TSP prior to completion of the design. Such tests shall be performed where appropriate in conjunction with the TSP and paid for by the Overseeing Organisation. Tests will be considered for a variety of reasons, including:
- Where a new type or design of cabinet is being considered.
 - Where new combinations of equipment are proposed and these have a total heat dissipation near to or just higher than the recommendations of the TSP or current known operational conditions that have proven to be satisfactory.
 - Where the design calls for particularly compact layouts and previously considered requirements for air gaps are removed.
- 4.6.9. The TSP will advise when equipment cabinets containing the TSP's transmission equipment require the fitting of thermostatically controlled heaters.
- 4.6.10. Equipment cabinets that require air conditioning to maintain the internal environmental conditions or rely on fans and filters to provide external air into an equipment cabinet shall not be used without prior agreement of the Overseeing Organisation.
- 4.6.11. Where equipment cabinets use internal fans to aid the circulation of internal air during periods of high ambient temperatures, the operation of such fans shall be thermostatically controlled.
- 4.6.12. The location of cabinets housing TSP equipment and SDPs in relation to the TSP's longitudinal cabling, cable joints and the associated roadside devices shall be agreed with the Overseeing Organisation and the TSP.
- 4.6.13. Cabinets shall be located in areas which are safe both for maintenance personnel and road users. The choice of cabinet location shall have due regard for cost, environmental considerations and for aesthetics.

On a ducted network, end device equipment cabinets shall be co-located at the main and joint chamber sites to minimise the number of intermediate chambers required, and the length of local ducts.

- 4.6.14. The siting of all cabinets shall allow for maintenance access. The requirement is that access shall be readily and easily available from a vehicle parked on the hard shoulder in the case of motorways or a suitable refuge, which allows maintenance vehicles to park clear of the carriageway, such as a layby in the case of APTRs. This shall require the provision of a safe means of access and egress for vehicles.
- 4.6.15. When cabinets and devices that are sited remotely from the carriageway require the provision of access steps, they shall be provided in accordance with *Series 1100*. Clause 1104 provides additional requirements for steps.

4.7. Locating Roadside Equipment

- 4.7.1. When siting telephones, signals and other equipment on existing roads, their locations shall be planned such that the number of new transverse duct crossings is minimised and new cabinets are grouped with existing cabinets.
- 4.7.2. If a potential cabinet site is determined to be at risk from flooding, the cabinet shall be sited well above any likely flood level.
- 4.7.3. Where the road is sited in a cutting or on an embankment, the cabinets shall not cause visual intrusion for local residents or users of adjacent land, and shall be consistent with current legislation, policy and the long-term route management strategy.
- 4.7.4. Where cabinets are to be located at the top of 'drop-offs', such as retaining walls, safe access shall be provided. Additional protection between the cabinet and the drop off shall be provided as required.
- 4.7.5. Proposed or existing landscaping and planting shall not cause access or maintenance problems for staff from either the Overseeing Organisation or the TSP. The problems might include: overgrowth of cabinets and access routes, damage through the penetration of ducts or cabinets by roots, or the obscuration of cabinets in future years. Liaison with the Overseeing Organisation during the planning stage is therefore necessary to coordinate the location of communications infrastructure and tree planting. When planning works on existing roads, liaison with the Overseeing Organisation shall be necessary in order to arrange for the removal of trees and shrubs.
- 4.7.6. Equipment shall not be placed such that the location presents a risk to the safety or security of staff, or would facilitate theft or damage to cabinets or equipment. Security shall be considered and an assessment undertaken to identify risks to personal safety and the risk of damage or theft of cabinets or equipment when positioning roadside equipment, including the DNO supplies. The location of equipment in concealed or secluded areas shall be avoided. Where equipment cannot be sited to avoid secluded or concealed areas, measures shall be taken to mitigate any risks and this shall be approved by the Overseeing Organisation.
- 4.7.7. Where a gantry spans both carriageways, all the signals shall be controlled from cabinet-mounted equipment located on the same side of the highway as the transmission system cabling. Roadside Controller Units (RCUs), interface equipment and TSP-supplied equipment can be mounted in the roadside cabinets.

ABOVE-GROUND JOINT CABINETS

- 4.7.8. The TSP's above-ground communications cable joints and longitudinal cable sections shall be jointed and housed in weatherproof cabinets.

- 4.7.9. When the above-ground joint cabinets are being provided by the TSP, the details of cabinet bases, sizes and quantity of ducts required to connect cabinet bases with the duct network will be determined by the TSP.

THIRD-PARTY COMMUNICATIONS INTERFACE CABINETS

- 4.7.10. Where the TSP's communications network design requires the use of third-party communications services at the roadside, the physical interface between the third-party provider's cable infrastructure and the TSP's cable infrastructure shall be housed in a weatherproof cabinet. The TSP will advise on the cabinet requirements, such that the enclosure, access and maintenance needs of the third-party provider and the TSP are both satisfactorily accommodated.
- 4.7.11. Roadside infrastructure shall be provided as necessary to facilitate the installation of the TSP's local cabling between a fence-line communications cabinet provided by the TSP and the roadside device or equipment cabinet that contains the TSP's SDP. Designers shall liaise with the TSP to ensure that the TSP's requirements are included as part of the design.

TRANSMISSION STATIONS

- 4.7.12. TSs have traditionally been of brick or pre-fabricated construction. New TSs are provided by the TSP and are of modular construction that can be assembled off-site and lowered as a near completed unit onto a pre-prepared base. The rules for the provision of a TS, for the requirements to provide a TS and for the construction of the associated infrastructure are provided by the TSP.

TRANSMISSION CABINETS

- 4.7.13. TCs are used to house the TSP's transmission equipment. It is a weatherproof and environmentally controlled cabinet that accommodates a variety of equipment, including termination frames, a power distribution unit, air conditioning, standby power provision in the form of batteries and a generator socket.
- 4.7.14. TCs will typically be provided by the TSP. However, designers shall liaise with the TSP to ensure that the TSP's requirements for supporting scheme infrastructure are fully understood, including the option for the scheme contractor to install bases for TCs to details provided by the TSP.

REMOVAL AND RE-LOCATION OF TRANSMISSION CABINETS AND TRANSMISSION STATIONS

- 4.7.15. The designer shall consult with the TSP and examine all practical alternatives before considering the removal and re-location of TCs and in particular TSs. The removal and re-location of these items can be complex and expensive and can only be performed in a number of stages that requires consultation with the Overseeing Organisation as services that wholly rely on the TC or TS will be affected.
- 4.7.16. Where the removal and re-location of a TC or TS is necessary, the scheme designer shall consult with the TSP to obtain the technical requirements and to determine a programme to reflect the number of stages required to complete the required activities within the scheme's overall programme.

HARDSTANDINGS AND STEPS

- 4.7.17. The standard of provision for hardstandings at cabinet and signal sites shall be as detailed in the *SHW series 1500*. A hardstanding shall be provided at every cabinet door. Where two or more cabinets occur at one site, they shall be linked by a paved area.
- 4.7.18. Where cabinets are situated on cutting or embankment slopes or unprotected edges, consideration shall be given to the provision of handrailing to protect maintenance personnel from the risk of falling.

4.7.19. Access steps for cabinets are detailed in the *SHW series 1100* and where provided, they shall be linked to cabinet sites by a path or paved area.

GEOTECHNICAL CONSIDERATIONS

4.7.20. In the majority of cases, the ducts and chambers will be located within the earthworks slopes. The excavating of trenches in these slopes can lead to problems with slope stability. The geotechnical implications of this shall be checked for each scheme. The excavation of trenches shall be checked with HD22 *Managing Geotechnical Risk*.

4.7.21. In the early stages of design, a geotechnical desk study shall be undertaken in consultation with the Overseeing Organisation. Additional information shall be provided as required (for example, from trial pits). Further information on the processes are described in HD 22.

4.7.22. Where retaining walls and foundations are required for cabinets, they shall be designed in accordance with HD 22 and when applicable BD 2 *Technical Approval of Highway Structures*.

4.8. Transmission Power Supply Design

4.8.1. 230 volt (+10%, -6%) single phase AC mains power supplies shall be used where possible as the primary energy source for roadside technology, the TSP's transmission equipment and RCC equipment.

4.8.2. Power supplies are obtained from the DNO. Where existing supplies need to be updated (for example, on existing roads), the DNO applications shall be considered at the earliest stage to reduce the risk of delay associated with obtaining such supplies.

4.8.3. The Overseeing Organisation prefers unmetered (UMS) exit points. A National Measurement Office Recommendation on Unmetered Supplies states that DNO's should take a more pragmatic approach about allowing UMS connections. So, if either of the following points apply, then discussions with the UMISO at the DNO should commence as early as possible in the design stage:

- a) The requested supply capacity at the exit point is less than 5.0 kVA;
- b) All the equipment to be connected via the exit point has been allocated a Charge Code by the UMISUG.

Qualification of unmetered supplies shall follow BS CP 520:

- Equipment connected to an Unmetered Electricity Supply (UMS) exit point shall possess a valid charge code. Information about applications for charge codes and which types of equipment that are permitted to be connected to roadside UMS exit points can be obtained from the Overseeing Organisation.
- Under the Electricity (Unmetered Supplies) Regulations (SI 2001/3263), which is governed by the National Measurements Office, the unmetered supplies operator (UMISO) at the DNO is empowered to make the final decision about which assets are permitted to be connected to UMS exit points.
- For electricity billing purposes, assets connected to UMS exit points will be declared in the Overseeing Organisations' Technology Equipment Asset database, currently the Technology Performance Management Service (TPMS). Information about adding new assets into TPMS can be obtained from the Overseeing Organisation.

4.8.4. If DNOs provide a 3-phase supply, the designer shall ensure that the loads are balanced and the supply is terminated as three single phase exit points.

- 4.8.5. Designers shall consider, in consultation with the Overseeing Organisation, the local DNO interpretations of the National Earthing Regulations - Engineering Recommendation G12/3. The Overseeing Organisation prefer a TN-C-S (PME) termination with a dedicated customer earth terminal. If the DNO offers a TT termination with no customer earth terminal, discussions should be sought with the DNO's Network Service/Compliance Manager to ascertain which particular DNO regulation/specification has been applied. Ways should be investigated to modify the roadside cabinet infrastructure layout to allay the DNO's implied public safety risk for high touch voltages on EI cabinets in the event of a DNO network fault. The Overseeing Organisation can offer support, guidance and anecdotal evidence for the safe provision of TN-C-S (PME) terminations.
- 4.8.6. Power distribution networks for the highway shall be radial networks centred on Electricity Interfaces (EIs) housed in the relevant cabinet or enclosure. A cabinet or enclosure housing the power isolation shall be within view and readily accessible of the equipment and the other communications cabinets it serves. This route to access the cabinet containing the local power isolation shall be safe to readily access (that is, not across a carriageway or slip road). For local isolation purposes, the local isolation can be provided at the EI cabinet. This applies, for example, where an EI is situated within view and is readily accessible to equipment.
- 4.8.7. For protected highways, EI cabinets shall be located such that they are accessible both from within and outside the Overseeing Organisation's boundary. The foundations of EI cabinets shall be located within the Overseeing Organisation's boundary. For APTRs and unprotected highways, EI cabinets shall be located such that there is safe access to the cabinet.
- 4.8.8. Shared power supplies where the Overseeing Organisation provides power to the TSP shall conform to the current arrangements for the Overseeing Organisation to provide power to the TSP and the TSP's requirements for the connection and operation of shared power supplies. The designer shall consult with the TSP regarding the sharing of power supplies, this shall include the exchange of detailed requirements, as a minimum in respect of:
- The source characteristics of the power supply and how this is impacted by the Overseeing Organisation's day to day operations.
 - Isolation of power supplies.
 - The supply characteristic at the point of connection of the TSP's equipment or sub-distribution components.
 - The number of circuit ways and the ratings of protection devices.
 - The peak and average load presented for each circuit way by the TSP's load and the details of the electrical load in a form to meet the requirements of BS CP 520 in the case of unmetered supplies.
 - Earthing requirements.
 - Cables and sub-distribution components to be installed by the TSP downstream of the point of sharing power supplies.
 - Labelling.
- 4.8.9. Equipment power connections within cabinets can comprise outlet sockets to IEC 60320 part 2-2 sheet F.
- 4.8.10. Multi-bay cabinets incorporating an internal and physically segregated means of isolation of the incoming power supply prior to the main distribution board do not require a local 609P to be installed within view.
- 4.8.11. The design of the power distribution networks shall take account of the load requirements for equipment sites.

- 4.8.12. Cable sizes shall be calculated based on the equipment loads and earthing requirements. The design load shall be assessed based on data obtained from the TSP and the Overseeing Organisation equipment manufacturer, and shall also make an allowance for reasonable future addition to the load.
- 4.8.13. The Overseeing Organisation shall seek advice from the TSP on the power requirements of TSP equipment located in shared cabinets.
- 4.8.14. Luminaires on gantries are required to be divided equally into two separate circuits where each circuit is connected to the common gantry isolation arrangement and cabinet distribution unit.
- 4.8.15. Each type of electrical equipment (such as CCTV, matrix signals, enforcement equipment, VMS and sign lighting) on a gantry shall be capable of being isolated independently from all other electrical circuits for maintenance purposes.
- 4.8.16. Super-span portal gantries shall be capable of being isolated from either carriageway.
- 4.8.17. The latest data supplied by the Overseeing Organisation shall be utilised when undertaking detailed power design calculations. 2.0 kVA spare capacity shall be allowed at all signal gantry structures provided this does not result in the total load exceeding the maximum capacity on a single phase that will be supplied by the DNO.

4.9. Renewable Energy

- 4.9.1. Where it is economical to use renewable energy sources, roadside technology and the TSP's transmission equipment shall do so. This is subject to feasibility analysis, including consideration that the design of the equipment allows it and that any limitations regarding the use and availability of renewable energy sources are taken into account within the design.

4.10. Site Data

- 4.10.1. For the Overseeing Organisation's Technology Management Systems (TMS), site data shall be designed in accordance with MCH 1596 *HATMS Site Data Change Procedure*. Geographic and electronic addressing conventions are described in MCH 1700 *Compiling Site Data for HATMS*.
- 4.10.2. The designer shall coordinate with the TSP to ensure site data requirements have been captured.
- 4.10.3. CCTV site data shall be designed in accordance with MCH 1885 *Second Generation CCTV Site Data Change Process for New Video Inputs*.
- 4.10.4. ERT site data shall be designed in accordance with MCH 2543 *Site Data Change Process for Emergency Roadside Telephones (ERTs)*.
- 4.10.5. Designers shall consult with the Overseeing Organisation's software maintenance contractors for the TMS at the outset to ensure site data changes can be planned and scheduled.

5. INSTALLATION AND MAINTENANCE

5.0.1. Installation and maintenance requirements can be found in *SHW series 1500* and general guidelines can be found in TD 71 *Technology Overview and General Requirements*.

5.1. Installation

5.1.1. The installation activities described in the following list are those undertaken in a typical scheme (however detailed arrangements vary):

- Provision and installation of duct network.
- Provision of foundations and the installation of cabinets and signal posts.
- Installation of telephone posts and housings.
- Provision of hardstanding at telephone and cabinet sites.
- Provision or modification of safety fences and guard rails.
- Provision of access steps and bridges over drainage ditches.
- Provision or modification of access to equipment through noise barriers.
- Installation of cables, and the location of power and communications cable joints (including the TSP's cable joints).
- Installation or modification of gantries in preparation for the installation of gantry signals and their associated equipment.
- Other structural works as required.
- Provision of power supply facilities.
- Labelling of chambers, cabinets, posts and cables.
- Testing and certification of cable.
- Testing of safety fencing.
- Traffic management.

5.1.2. The level of traffic management required will place constraints upon the method of working and timing, and this shall be taken into account when planning and designing works.

5.1.3. The following work will usually be carried out by the Overseeing Organisation in conjunction with the TSP:

- Acceptance testing of infrastructure.
- Remedial work in relation to cable termination.
- Installation of all signals, telephones, power and communications distribution and control equipment.
- Installation of transponders and telephone responders.
- System testing including local testing of roadside technology and end-to-end testing back to RCCs.
- Testing communication between roadside telephones and responders, signals and transponders.
- Fitting and removing signal and telephone covers as required.
- All necessary test certification including:
 - Site acceptance tests.
 - Electrical installations.
 - Traffic management.

5.2. Acceptance

5.2.1. Where the Overseeing Organisation is providing the civil roadside infrastructure, it will undertake all acceptance tests that the TSP would ordinarily perform to self-certify the installation.

- 5.2.2. These acceptance tests will be performed and documented in accordance with the TSP's requirements and where stated by the TSP, specific tests will be made available to be witnessed by the TSP.
- 5.2.3. MCH 1980 *Process for Commissioning and Handover of Technology Schemes* shall be used to define the scheme process and the activities necessary for successful scheme implementation. It shall also define the required notice periods for scheme activities and the deliverables needed to complete each stage.
- 5.2.4. The TSP will self-certify the performance of the requested services and the TSP will provide evidence of any tests and performance attributes of the services directly to the Overseeing Organisation.

5.3. Maintenance

- 5.3.1. Once the scheme is ready to be handed over into maintenance (including any sectional completion), the requirements of MCH 1349 *Maintenance and Operational Requirements for New Systems & Equipment*, the relevant acceptance criteria and as-installed records shall satisfy the maintaining agent's and TSP's requirements.

EXCEPTIONS FOR PROVISION AND MAINTENANCE

- 5.3.2. The Overseeing Organisation and the TSP will agree, record and label the demarcation points for the change in responsibilities. Typically, this demarcation point is the nearest joint to the structure. However, the TSP remains responsible for transmission up to the service delivery point.
- 5.3.3. Cables permanently fixed to structures (that is, not in ducts) and / or located in areas subject to restricted conditions (for example at height, confined spaces, over water or within the operational railway environment) shall be designed, provided, installed and maintained by the Overseeing Organisation. The TSP is responsible for the termination, allocation of pairs and fibres and the definition of the performance characteristics, type and capacity of the cable but not the procurement of the cable. The responsibilities of the Overseeing Organisation include the seeking of acceptance from the TSP for the design, provision, installation and maintenance of these cables. As part of the cable installation activities, the scheme shall undertake cable testing in accordance with the *SHW series 1500* and the scheme shall ensure that these tests are witnessed by the TSP.
- 5.3.4. The designer shall provide designs to accommodate cables routed through structures and areas subject to exceptions to the provision of maintenance as notified to the designer by the Overseeing Organisation. The following shall apply:
- The responsibilities of the designer include the seeking of acceptance from the TSP for the design of suitable ducts through the structure to permit the installation of the TSP's cables.
 - Where cross-carriageway cable routes for the TSP's local communications cables use ducts attached to a gantry structure, the cable installation methodology shall not require any access to the structure at height. The designer shall closely liaise with the TSP and seek approvals in accordance with the TSP's approvals process for all designs. Designs that are already proven will not be subject to any re-testing in accordance with this approvals process. Designs that are already proven in this context are designs that have been successfully proven in accordance with the TSP's approvals process, or are based upon these designs and meet the following requirements:
 - The duct size, material, grade and coefficient of friction are the same or offer superior performance in respect of their environmental conditions and the installation of cables.
 - The bend radius of ducts is no less than a previously proven design using a duct of the same or lower coefficient of friction.
 - The clamps that clamp the ducts to the structure are more frequent, or arranged for superior clamping performance and they are of the same or superior type.

- Once the cable route, duct design and installation methodology are proven, the TSP will become responsible for the procurement of the cable, installation, termination, allocation of pairs and fibres and the definition of the performance characteristics, type and capacity of the cable.

MAINTENANCE OF DESIGN, BUILD, FINANCE AND OPERATE ROADS

5.3.5. The maintenance of roads operated by Design, Build, Finance and Operate Contractor (DBFO Co) will be the responsibility of the DBFO Co.

5.4. Documentation Standards

5.4.1. Following construction, a set of as-installed records shall be produced which accurately records the details of what has been provided. The actual requirements for documentation will depend on the details of the particular scheme. Further information can be found in TD 71 *Technology Overview and General Requirements*.

AS-INSTALLED RECORDS AND DRAWINGS

5.4.2. The TSP is responsible for holding and maintaining as-installed records for the transmission network. It shall therefore be necessary to liaise with the TSP to include details of the existing cable infrastructure and associated cabinets.

5.4.3. The as-installed drawings are compiled from design drawings which have been amended to record changes made during construction and are essential for effective maintenance and for planning or undertaking work on existing roads.

5.4.4. In addition to as-installed drawings, a number of other record documents are required for maintenance purposes. These include:

- Cable test certificates.
- Electrical certification in accordance with the requirements of the current regulations.
- As-installed information for structures including records on the structures database.

SUPERSEDED

6. REFERENCES

6.1. Normative References

The following normative references are included in this document:

SHW series 1500 Notes for Guidance
Manual Handling Operations Regulations
MCH 1349 Maintenance and Operational Requirements for New Systems
MCH 1514 Code of Connection
MCH 1596 HATMS Site Data Change Procedure
MCH 1885 Second Generation CCTV Site Data Change Process for New Video Inputs
MCH 1980 Process for Commissioning and Handover of Technology Schemes
MCH 2543 Site Data Change Process for Emergency Roadside Telephones (ERTs)
HD 22 Managing Geotechnical Risk
BD 2 Technical Approval of Highway Structures
Manual of Contract Documents for Highway Works: Volume 1 - Specification for Highway Works – Series 1500 Highway Communications
Manual of Contract Documents for Highway Works: Volume 1 - Specification for Highway Works – Series 1100 Kerbs, Footways and Paved Areas
BS CP 520 BSC PROCEDURE Unmetered Supplies Registered in SMRS
TD 19 Requirements for Road Restraint Systems
HA 65 Design For Environmental Barriers
HA 66 Environmental Barriers: Technical Requirements
The Electricity (Unmetered Supplies) Regulations, 2001 (SI 2001/3263)
TR 1000 Introduction to the Traffic Systems and Signing Registry
TR 1100 General Technical Requirements for Motorway Communications Equipment
TR 2130 Environmental Tests for Communications Equipment and Portable and Permanent Road Traffic Control Equipment for use on Trunk Roads
New Roads and Street Works Act (NRSWA)

6.2. Informative References

The following informative references are included in this document:

GD 01 Introduction to the Design Manual for Roads and Bridges (DMRB)
GD 2 Quality Management Systems for Highways Design
GD 04 Standard for Safety Risk Assessment on the Strategic Road Network
TA 77 Motorways
TD 71 Technology Overview and General Requirements
RS485 Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems
MCX 0153 Installation Drawing Layout of Communications Cabinets, Post, Ducts and Hardstanding Sheet 1
MCX 0146 Installation Drawing NMCS Cab. 609/620 Set in Standard Motorway Fence
TR 2046 NMCS2 Standard Local Communications Controller (IP-LCC)
TR 2167 NMCS2 MIDAS LCC Specification
TR 2169 MIDAS Outstation Specification
TR 2192 NMCS2 MIDAS TCP/IP Link Specification
MCH 1616 NMCS2 Guide to Documentation
MCH 1652 Communications Records Drawings - Computer Aided Drawings Requirements
MCH 1700 – Compiling Site Data for HATMS

MCH 1960 CCTV Second Generation Management Overview
MCH 1970 Highways Agency CCTV Notes for Guidance
MCH 2544 Providing CCTV Coverage away from the NRTS Network
IEC 60320 Part 2-2 sheet F
Managing and working with asbestos - Control of Asbestos Regulations 2012 Approved code of practice and guidance
HSE Asbestos the Survey Guide
Interim Advice Note 63/05: Asbestos Management Applicable to the Strategic Road Network
National Earthing Regulations - Engineering Recommendation G12/3
BS CP 520 Unmetered Supplies Procedure

SUPERSEDED

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