VOLUME 9 NETWORK - TRAFFIC CONTROL AND COMMUNICATIONS

SECTION 3 DESIGN AND IMPLEMENTATION (OVERVIEW)

PART 1

TA 71/97

MOTORWAYS. OVERVIEW

SUMMARY

This advice note provides an overview to the design and implementation of motorway communication schemes.

INSTRUCTIONS FOR USE

This is a new document to be inserted into the Manual.

1. Insert TA 71/97 into Volume 9 Section 3.

2. 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.

THE HIGHWAYS AGENCY

THE SCOTTISH OFFICE DEVELOPMENT DEPARTMENT

THE WELSH OFFICE
Y SWYDDFA GYMREIG

THE DEPARTMENT OF THE ENVIRONMENT FOR NORTHERN IRELAND

Design and Implementation (Overview)

Summary: This advice note provides an overview to the design and implementation of motorway communication schemes.

REGISTRATION OF AMENDMENTS

Amend No	Page No	Signature & Date of incorporation of amendments	Amend No	Page No	Signature & Date of incorporation of amendments

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MOTORWAYS. OVERVIEW

Contents

Chapter

1. INTRODUCTION

General

1. This Advice Note provides an overview to the design and implementation of motorway communications schemes.

Scope

1. This Advice Note is applicable to the understanding of the design and implementation of motorway communication schemes.

2. The specific requirements for each Overseeing Organisation are contained in the relevant Annex to this Advice Note, they are as follows:

Annex A for England.

Annex B for Scotland.

Annex C for Wales.

Annex D for Northern Ireland.

3. This Advice Note is intended to be used by Overseeing Organisation staff, their consultants, Agents and maintenance contractors.

Related Standards and Advice Notes

1. The following Technical Directives are of relevance:

TD 33: The Use of Variable Message Signs on All Purpose and Motorway Trunk Road

TD 45: Motorway Incident Detection and Automatic Signalling (MIDAS)

TD 46: Motorway Signalling

TD 47: Motorway Loop Detectors

TD 48: Motorway Closed Circuit Television System

2. The following Advice Notes are of relevance:

TA 70: Introduction

TA 72: National Motorway Communications Systems (NMCS)

TA 73: Motorway Emergency Telephones

TA 74 Motorway Signalling

TA 75: Motorway Transmission

TA 76: Motorway Control Office

TA 77: Motorway Infrastructure Design

Implementation

1. This Advice Note is for information only.

2. REFERENCES

1. Design Manual for Roads and Bridges (DMRB): Stationery Office Ltd

TD 33: The Use of Variable Message Signs on All Purpose and Motorway Trunk Road (DMRB 8.2)

TD 45: Motorway Incident Detection and Automatic Signalling (MIDAS) (DMRB 9.1.2)

TD 46: Motorway Signalling (DMRB 9.1.1)

TD 47: Motorway Loop Detectors (DMRB 9.1.3)

TD 48: Motorway Closed Circuit Television System (DMRB 9.1.5)

TA 70: Introduction (DMRB 9.2.1)

TA 72: National Motorway Communications Systems (NMCS) (DMRB 9.4.1)

TA 73: Motorway Emergency Telephones (DMRB 9.4.2)

TA 74 Motorway Signalling (DMRB 9.4.3)

TA 75: Motorway Transmission (DMRB 9.4.4)

TA 76: Motorway Control Office (DMRB 9.4.5).

TA 77: Motorway Infrastructure Design (DMRB 9.5.1)

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VOLUME 9 NETWORK - TRAFFIC CONTROL AND COMMUNICATIONS

SECTION 3 DESIGN AND IMPLEMENTATION (OVERVIEW)

PART 1

TA 71/97 Annex A (England only)

MOTORWAYS. OVERVIEW

Contents

A1. INTRODUCTION

A1.1 General

1. This Annex is for the specific requirement of motorway communications in England.

DMRB Structure

2. Section 1 of Volume 9 of the Design Manual for Roads and Bridges (DMRB) contains Technical Directives (TD) which detail the Standards of Provision.

3. Section 2 onwards contains Technical Advice (TA) Notes which reflect current practice in the field of motorway communications and control.

Design Loop

4. Figure A1.1a shows the 'Design Loop' illustrating the general sequence in the iterative design process which starts with the design for emergency telephones and signals followed by transmission and control office designs. Last in the cycle is the design of the infrastructure that will be required to support all communications equipment and systems.

Glossary

5. A Glossary of Terms is given in Chapter A8.

Standard Drawings and Specifications

6. Standard MCX and MCY drawings and MCH and TR specifications are issued by the Highways Agency (HA).

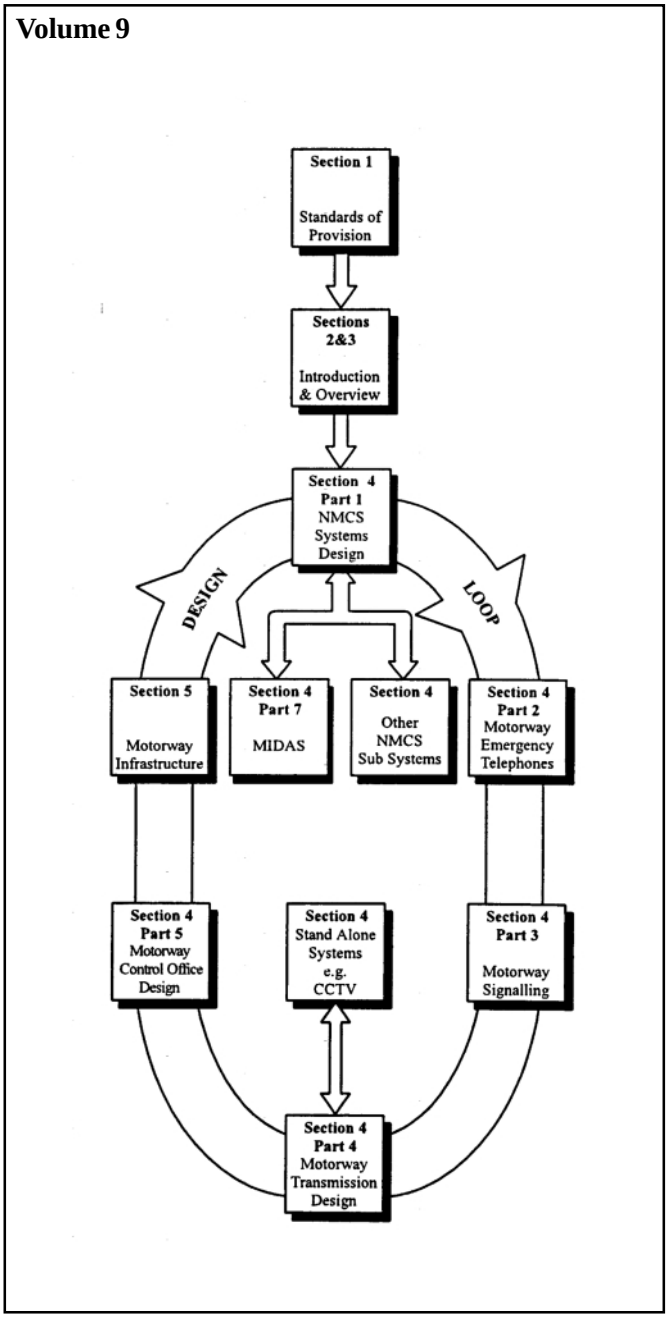

Figure A1.1a Structure of Volume 9 of the Design Manual for Roads and Bridges

A2. PROJECT MANAGEMENT

A2.1 Introduction

1. The motorway communications system is an essential and integral component of the motorway network. It is vital for the safe and efficient operation and management of the network.

2. The design, installation and commissioning of the motorway communications system is therefore an integral part of any motorway construction or improvement scheme and it is necessary to incorporate its requirements into the planning process of the scheme.

3. The Highways Agency utilise a standard model for the development of all motorway construction projects - the New National Network (NNN). The NNN comprises the tasks and milestones which together form the standard scheme development process. The NNN is mounted on standard software and is fully documented in the Project Management Manual.

4. The responsibilities for planning and coordinating motorway communications schemes and the motorway communications elements of motorway construction schemes are contained in the Highways Manual.

A3. BULK PURCHASE

A3.1 Introduction

General

1. Standard items of motorway communications equipment are purchased by the Highways Agency (HA). This ensures that equipment conforms to the relevant specification and that equipment from different sources is compatible.

2. Bulk purchased equipment is normally stored at the HA's store.

3. Bulk purchased equipment is collected from store by the scheme contractor, or delivered to site.

Procedure for Ordering Equipment

4. Two documents are available for identifying the bulk purchase requirements of a scheme:

i. MCH 1286 is used for communications schemes;

ii. MCH 1288 is used for road construction schemes which require bulk purchase equipment;

5. MCH 1286 list all equipment currently available through bulk purchase. It also includes a delivery profile for each item of equipment which is used to indicate the quantity required per quarter over a three year period. The delivery profile allows the HA to place accurate orders for equipment.

6. It is essential that Project Managers update MCH 1286 as soon as changes to quantities or dates occur.

A3.2 Replacement of Bulk Purchase Equipment

1. Bulk purchase equipment which is damaged during installation should be replaced with equipment fully meeting the relevant specifications by the Contractor who caused the damage, at his own cost. Where the HA has adequate supplies of the equipment to be replaced it may be possible to arrange for equipment, from store, to be loaned to the Contractor. This arrangement will only be permitted where the Contractor has ordered replacement equipment and at the HA's discretion.

A4. DOCUMENTATION STANDARDS

A4.1 Design Documentation

General

1. Design documentation will comprise a number of reports and sets of associated drawings which will result in the production of tender documents. Following construction a set of as-installed records will be produced which should accurately record the details of what has been provided.

2. The actual requirements for documentation will depend on the details of the particular scheme and the Design Agent's brief. However the following general principles should apply to most situations. It is useful to consider documentation in relation to the stages of a scheme: Preliminary Design, Detailed Design, Implementation and Completion. These stages are detailed in the New National Network.

Preliminary Design

3. Preliminary design should include an assessment of any existing system. This is particularly relevant when additions or alterations are to be made to an NMCS2 system. An Existing System Report should be produced which draws together all relevant information. This will provide a clear base point from which design can proceed.

4. Designers will find that photographic and video surveys of the scheme area will be valuable as they will help to avoid the need for excessive site visits. Where existing power and communications are to be used, actual cable terminations should be documented and then checked against any available as-installed information.

5. A Preliminary Design Report which includes an assessment of what is required should be produced. It should provide sufficient information for bulk purchase equipment to be ordered. The report will give an indication of the scale of work required to implement the scheme.

6. Schematic and geographic drawings should be produced at this stage which identify locations of key equipment such as Signals, Telephones, Transponders and Responders. Geographic drawings should be based on 1:10000 scale location maps.

Detailed Design

7. For road construction schemes, the Technical Appraisal Report (TAR) will include motorway communications requirements. Detailed design takes the scheme to the production of tender drawings and documents. MCX installation drawings and all relevant specifications should be referred to in the tender documentation.

8. Schedules of bulk purchase cable and equipment, power and communication cable terminations, signal addressing and telephone system addressing will be produced during detailed design and included within the tender documentation.

Implementation and Completion

9. This is the site work necessary to install and commission the scheme. The documentation produced for the contract will be used as the basis for the production of comprehensive as-installed information. Particular attention should be paid to producing documentation which will meet the handover into maintenance requirements as detailed in MCH 1349.

A4.2 Scheme Drawings

1. Geographic and schematic drawings are required for motorway communications. These drawings should be produced, probably using CAD, to the standard required by the Highways Agency (HA). Geographic drawings indicate the location of equipment in relation to the motorway whilst schematic drawings show all items of equipment and their interconnecting cables.

2. Typical schematic details and the schedule of symbols to be used are included in the MCX installation drawings. The symbols used on the schematic drawing should also be used for geographic drawings.

3. Drawings should be produced at A1 size.

4. The presentation of scheme drawings follows one of two styles:

i. Separate geographic and schematic drawings, with geographic drawings at 1:2500 scale; or,

ii. Combined drawings with a geographic drawing at 1:2500 scale occupying the upper section of the drawing and the corresponding schematic below. This is the style required by MCH 1635.

5. It will also be necessary to produce drawings which show site specific details such as retaining walls, cabinet hardstandings and safety fencing.

A4.3 As-Installed Drawings

1. As-installed drawings are compiled from design drawings which have been amended to record changes made during construction. The HA is responsible for holding and maintaining as-installed records.

2. As-installed drawings are essential documents for the effective maintenance of the NMCS. They are also required by consultants and contractors who are planning or undertaking work on existing motorways. It is therefore essential that as-installed records are accurate and up to date. Any discrepancies or errors will hinder the effective performance of the specialist Regional Maintenance Contractor (RMC) and may result in cables being damaged by contractors subsequently working on the motorway.

3. Generally, as-installed records for recently completed schemes are of a reasonably high standard. However, standards tend to reduce dramatically as the age of the scheme increases.

4. It is generally the contractor who is responsible for producing these records on cable upgrading contracts. Experience has shown that a low priority has often been given to the production of these records and they are invariably issued late. Given the maintenance significance of these records, they should be available for issue to the specialist RMC at handover. It is therefore advisable for the Engineer to be responsible for their production.

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

i. Cable test certificates.

ii. Electrical certification in accordance with the requirements of the current regulations.

iii. As-built information for structures including records on the structures database.

6. It is advisable that all as-installed records, cable test certificates and electrical certification, are collated in a handover record.

A5. CONTRACTS

A5.1 Construction and Installation Contracts

1. Schemes other than Design and Build (DB) or Design, Build, Finance and Operate (DBFO) which involve the provision of motorway communications can be divided into three broad categories each having its own type of contractual arrangement - Road Construction (construction, improvement, major maintenance), Cable Upgrading and Systems Contracts.

2. When planning road construction and cable upgrading schemes, consideration should be given to the most appropriate contractual arrangements which will allow signals and telephones to be commissioned and handed over to the police when the road opens to traffic. Generally, these schemes will take place within or adjacent to sections of motorway which have operational signals and telephones. In these instances, the scheme will affect the communications network outside the contract boundaries. Consideration should then be given to the interface between the new and existing network and the tests required between relevant transmission stations. Bypass arrangements may be needed to keep systems operational on either side of the scheme.

Road Construction Contracts

3. These are large civil engineering schemes and consequently the main contractor will be a civil engineering contractor usually employed under the Institution of Civil Engineers (ICE) conditions of contract. A specialist sub-contractor would usually be employed by the main contractor for the installation of the communications infrastructure including the termination and testing of cables. The installation and commissioning of signals and telephones would be undertaken by a separate 'electronics' contractor employed by the Highways Agency (HA). Alternatively the 'electronics' contractor may be a nominated sub-contractor in the main construction contract.

Cable Upgrading Contracts

4. These contracts will generally involve the installation of duct and cable networks. The main contractor will therefore be a civil engineering contractor employed using ICE conditions of contract. Cabling works may be sub contracted.

5. Where cables are to be installed in an existing duct network the main contractor will be a cable installation contractor employed using the Institution of Electrical Engineers/Institution of Mechanical Engineers (IEE/IMechE) Model Form of Contract.

6. Where a short section of armoured cable is to be replaced or where minor additions are made to an existing armoured cable network the ICE Conditions of Contract are the most appropriate form of contract. This is due to the risks involved with excavations in the motorway verge and the need for variations to deal with unforeseen conditions.

7. The arrangements for the 'electronics' contractor are the same as for a road construction contract.

Systems Contracts

8. These cover a wide range of contracts including NMCS Subsystems, CCTV systems and trials of new motorway equipment. Contracts can include the manufacture, supply, installation and commissioning of such systems. Contracts are let by the HA generally using IEE/IMechE Conditions of Contract. Any work which involves operational equipment should be undertaken by the HA's specialist Regional Maintenance Contractor (RMC). The RMC will also be involved where equipment supplied by the contractor is to be taken into maintenance.

Design and Build (DB)/Design, Build, Finance and Operate (DBFO) Contract

9. For DB and DBFO contracts, the design, installation and commissioning of motorway communications works are the responsibility of the DB/DBFO contractor. The DBFO contractor is also responsible for all maintenance work throughout the duration of the concession period.

10. All design, installation, commissioning and maintenance of motorway communications systems on such contracts should comply with current HA standards.

A5.2 Supply of Equipment

1. The main items of communications equipment will be bulk purchased by the HA, and supplied to the Contractor.

2. MCH 1286 list the equipment available as bulk purchase items from the HA. Where other items of equipment specific to a scheme, such as duct or larger cable sizes are required, they should be supplied by the Contractor.

A5.3 Installation

1. The activities described in the following paragraphs should be regarded as typical; detailed arrangements may vary considerably between schemes.

Infrastructure Contract

2. The following work will usually be included within the infrastructure (ie Road Construction or Cable Upgrading) contract(s):

i. Provision and installation of duct network.

ii. Provision of foundations and the installation of cabinets and signal posts.

iii. Installation of telephone posts and housings.

iv. Provision of hardstanding at telephones and cabinets.

v. Provision or modification of safety fences and guard rails.

vi. Provision of access steps and bridges over drainage ditches.

vii. Provision or modification of access to equipment through noise barriers.

viii. Installation of cables and Cable Joint Enclosures.

ix. Installation and/or modification of gantries in preparation for the installation of gantry signals and their associated equipment.

x. Other structural works as required.

xi. Provision of power supply facilities.

xii. Labelling of chambers, cabinets, posts and cables.

xiii. Testing and certification of cable.

xiv. Testing of safety fencing.

xv. Traffic management.

This work may be split into two contracts - a civils contract to provide the duct network and other civils infrastructure, and a contract for the installation, termination and testing of cable.

Systems Contract

3. The following work will usually be carried out by the systems contractor:

i. Acceptance testing of infrastructure.

ii. Remedial work in relation to cable termination.

Note: When testing or inspection reveals the need to replace a cable or correct work, it will normally be carried out by the infrastructure contractor.

iii. Installation of all signals, telephones, power and communications distribution and control equipment.

iv. Installation of Transponders and Telephone Responders.

v. System testing.

vi. Testing communication between roadside telephones and Responders, signals and Transponders.

vii. Fitting and removing signal and telephone covers as required.

viii. All necessary test certification including:

Site Acceptance Tests
MCH 1472 - Telephone Responder;
MCH 1476 - Standard Transponder;
MCH 1258 - NMCS1 Responder.

ix. Traffic management (if required).

A6. MAINTENANCE

A6.1 Introduction

1. The Highways Agency (HA) is responsible for the reliable and effective operation of the National Motorway Communications System (NMCS). The HA sets standards for maintenance and operation which ensures that systems and equipment of a consistent, high standard are provided without excessive maintenance liabilities.

2. Maintenance work is carried out by contractors employed by the HA:

(i) maintenance of the NMCS within a Region is undertaken by the specialist Regional Maintenance Contractor (RMC); and,

(ii) maintenance of the transmission network is undertaken by the Transmission Works Contractor and the National Carrier Maintenance Contractor (NCMC).

A6.2 Specialist Regional Maintenance Contractor (RMC)

1. The RMC provides a high priority maintenance cover for all motorway communications and other systems operated by the police where down time should be kept to a minimum. The RMC operates under a dedicated team arrangement where an agreed level of staffing is available 24 hours a day, 365 days a year.

2. The RMC may also be required to perform additional duties outside the dedicated team arrangement; either to repair or maintain systems and equipment not covered by the contract or to provide disconnections/connections to operational systems and equipment for other contractors.

A6.3 Transmission Contractors

Transmission Works Contractor

1. The Transmission Works Contractor is appointed and managed by the Highways Agency. This contractor is responsible for the provision, installation and commissioning of National carrier circuits and fibre optic Pulse Code Modulation (PCM).

National Carrier Maintenance Contractor (NCMC)

2. The NCMC is appointed and managed by the Highways Agency. This contractor is responsible for the maintenance of National carrier equipment and circuits, fibre optic PCM equipment and circuits and all fibre optic repairs.

A6.4 Maintenance Requirements

System and Equipment Requirements

1. It is essential that all systems and equipment installed within the NMCS can be operated and maintained to the required standards of operation detailed in MCH 1349. This document specifies the requirements for installation standards, spares, documentation, routine maintenance schedules, specialist test equipment, handover into maintenance and warranty.

2. It is the responsibility of the HA's Project Manager to ensure that the requirements of MCH 1349 are met and that full maintenance cover is in place when new systems or equipment are brought into service. Only equipment which complies with MCH 1349 can be guaranteed operation support.

3. MCH 1349 includes a useful checklist which Project Managers should follow in order to ensure compliance with current standards.

4. There are three categories of maintenance cover for system and equipment which range from Operational to Custodian. MCH 1349 should be consulted for further details.

Changes to Equipment Quantities

5. The RMC is issued with a full list of equipment which is to be maintained. Therefore where schemes add or remove equipment a variation to the RMC's contract will be necessary. All such changes should therefore be communicated to the HA to allow the necessary changes to the RMC's contract to be made. Project Managers are responsible for informing the HA's Transmission Branch of all changes using MCH 1399.

Changes to Infrastructure

6. The national transmission network will be affected by any schemes which amend or add to the motorway network such as new motorways and motorway widening. Other schemes such as upgrading contracts and the installation of additional or removal of redundant systems will also affect the national network.

7. The Project Manager is responsible for informing the HA's Transmission Branch of all proposed changes using the appropriate form from MCH 1593. This will allow the HA to schedule the provision of the necessary transmission equipment and labour.

Changes to System Data

8. The procedure to be followed to implement changes to System Data is described in MCH 1596.

Changes to Systems in Service

9. Changes to systems whilst in service will be subject to operational change controls operated by the HA and the impact should be assessed at an early stage through the appropriate Operational Change Board, if one exists.

A6.5 Maintenance of Design, Build, Finance and Operate Roads

1. The maintenance of roads operated by Design, Build, Finance and Operate Contractors (DBFO Co) is the responsibility of the DBFO Co. The standards of maintenance required will be detailed in the contract and will be similar to those required on motorways operated by the HA.

A7. SCHEMES

A7.1 Overview

General

1. The level of equipment, design constraints and installation will vary depending upon the type of scheme. Various types of scheme are listed in this Chapter together with the design considerations, constraints and special requirements associated with each type.

A7.2 New Motorways

General

1. The motorway communications system is an integral part of a new motorway.

Cable Infrastructure

2. A ducted cable infrastructure capable of supporting NMCS2 is required, see TA 77: Motorway Infrastructure Design.

Telephones

3. Telephones as detailed in TA 73: Motorway Emergency Telephones will be required.

Signals

4. Signals should be provided in accordance with TD 46: Motorway Signalling.

MIDAS

5. MIDAS Loop Detectors are to be installed on new motorways in accordance with TD 47: Motorway Loop Detectors. MIDAS infrastructure should be provided where the criteria listed in TD 45: Motorway Incident Detection and Automatic Signalling are met.

6. Where MIDAS Loop Detectors are to be installed on motorways constructed using porous asphalt, advice from the Highways Agency should be sought at an early stage. The material used to seal the slots into which loops are installed will introduce an impervious barrier into the porous asphalt layer.

CCTV

7. TD 48: Motorway CCTV lists the criteria to be met before a CCTV system can be provided.

Meteorological System

8. This is not a standard provision and advice from the Highways Agency (HA) should be sought if fog is perceived to be a problem.

Variable Message Signs (VMS)

9. This is not a standard provision, the agreement of the HA for the use of VMS should be obtained. Design standards for the use of VMS are given in TD 33: The Use of Variable Message Signs on All Purpose and Motorway Trunk Road.

Control Offices

10. The new motorway is likely to be built within the area of an existing operational Control Office (CO). The scheme will generate changes to the mimic diagram and Operator Interface (OIF) maps and database. In addition, extra equipment may be required especially when CCTV is provided. An enhanced link from motorway to CO may also be required. For more information see TA 76: Motorway Control Office.

Transmission Stations

11. Where required by the provisions of TA 75: Motorway Transmission, new Transmission Stations should be provided.

Power

12. Power supplies from the relevant Electricity Supply Company will be required. For more information see TA 77: Motorway Infrastructure Design.

Maintenance Considerations

13. Before the motorway communications system is handed over into maintenance the requirements of MCH 1349 should be satisfied.

A7.3 Recabling and Upgrading

General

1. This section addresses the considerations necessary for developing designs for re-cabling and/or installing new equipment on existing motorways.

2. Schemes taking place on existing motorways may involve the installation of a new system such as CCTV or the upgrading of a system from NMCS1 to NMCS2.

Ducted Cable Network

3. A ducted cable network capable of supporting NMCS2 is required. For more information see TA 77: Motorway Infrastructure Design.

Traffic Management

4. When working on existing motorways work will be taking place in close proximity to fast moving traffic. Traffic management measures in accordance with Chapter 8 of the Traffic Signs Manual will need to be effected to provide a safe working environment and to safeguard the travelling public. The level of traffic management required will place constraints upon the contractor's method of working and his timing and this should be taken into account when planning and designing works on existing motorways.

5. The traffic management required for the construction of the scheme may necessitate the installation of a temporary CCTV system to monitor the works. Temporary VMS may also be desirable. Early advice from the HA should be sought.

Existing Services/Cables

6. The verges of existing motorways contain numerous drains and cables. Accurate as-installed information is therefore essential, however this is often not available. Special consideration, as detailed in TA 72: National Motorway Communications Systems during the planning stages is required to reduce the risk of damage to existing services and cables.

Access to Cabinets

7. Generally, existing motorway cutting and embankment slopes will be landscaped with mature trees and shrubs which may prevent access to cabinets. Liaison with the HA's Regional Landscape Architect will be required to arrange for the removal of trees/ shrubs to provide access to cabinets. For more information see TA 75: Motorway Transmission.

Transverse Ducts

8. The standard of provision for cross carriageway ducts is for a set of 4 ducts of 100mm diameter every 500m along the motorway. Existing, empty ducts are, generally, extremely difficult, if not impossible, to locate as marker posts and blocks were rarely provided or maintained. A survey of existing ducts should be undertaken during the design stage. New cross carriageway ducts may be installed by trenchless techniques as detailed in TA 77: Motorway Infrastructure Design.

Maintaining the Existing System

9. It is essential that the existing motorway communications system remains operational at all times during the contract. It should be remembered that the longitudinal cable will be part of the national carrier network in addition to its function of carrying local data from signals/telephones, etc.

10. Any disconnections/connections to operational systems should be made by the specialist Regional Maintenance Contractor (RMC).

11. Details of how the existing system may be maintained are given in TA 75: Motorway Transmission.

Telephones

12. Recabling contracts should include the upgrading of emergency telephones to the standards detailed in TA 73: Motorway Emergency Telephones.

Signals

13. Recabling contracts should include the upgrading of signals to the standards detailed in TA 74: Motorway Signalling.

Maintenance Considerations

14. Before the scheme is handed over into maintenance the requirements of MCH 1349 should be satisfied.

Variable Message Signs (VMS)

15. This is not a standard provision, the agreement of the HA for the use of VMS should be obtained. The design standards for the use of VMS are given in TD 33: The Use of Variable Message Signs on All Purpose and Motorway Trunk Roads.

Control Offices

16. Modifications to the relevant Control Office will usually be required. These will include modifications to Mimic diagrams and NMCS1/2 OIF maps and database and may also include the provision of additional equipment (especially when CCTV is installed). For more information on Control Offices see TA 76: Motorway Control Office.

Transmission Stations

17. These schemes will rarely require additional Transmission Stations but an existing building may need to be moved or replaced. Further information on transmission stations can be found in TA 75: Motorway Transmission.

Power

18. Power supplies from the relevant electricity supply company will be required. For more information see TA 77: Motorway Infrastructure Design.

A7.4 Widening and Reconstruction

General

1. The widening of existing motorways to increase traffic capacity can be undertaken in many different ways, for example: parallel, symmetrical or asymmetrical. The effect on the existing motorway communications system will depend on the details of the individual scheme. However, the guidance given in this section is of a general nature and should be tailored to suit the requirements of individual schemes.

2. The effects of the works on traffic will dictate the phasing of the works and the level of traffic management required. It is essential that motorway communications implications are taken into account during the design of traffic management systems to ensure the integrity of the national network is not compromised.

3. This section describes the problems involved and the procedures to be adopted for excavation or reconstruction work on motorway verges, central reservations and carriageways. In addition the level of provision for motorway communications equipment is detailed.

Maintaining the Existing System

4. The existing motorway communications system outside the contract area should remain operational at all times. It should be remembered that the longitudinal cable will be part of the national carrier network in addition to its function of carrying local data from signals and telephones. Consideration should be given to 'patching across' the contract area by Third Party circuits, interrupter cables or microwave radio.

5. The Design Agent should produce an Existing Communications Report which should identify those circuits which are required to maintain existing national communications. Any disconnections/connections to operational systems should be made by the RMC.

6. Details of the special precautions required to protect existing cables are given in TA 72: National Motorway Communications System 2. Details of how the existing system may be maintained are given in TA 75: Motorway Transmission.

Contract Boundaries

7. The boundaries of a widening reconstruction contract will rarely coincide with the location of Transmission Stations. Therefore a length of longitudinal cable will be installed, terminated and tested within an existing transmission length. Arrangements should be made for connection into the existing network and test between relevant Transmission Stations. This will have to be undertaken by the RMC.

Physical Constraints

8. Many widening schemes will involve the provision of additional traffic lanes within existing land take. The implications which this will have on the motorway communications infrastructure are described in TA 77: Motorway Infrastructure Design.

Cable Infrastructure

9. A cable infrastructure capable of supporting NMCS2 is required. For more information see TA 77: Motorway Infrastructure Design.

Telephones

10. Telephones as detailed in TA 73: Motorway Emergency Telephones will be required.

11. Particular care should be given to the provision of telephones and access facilities at locations with discontinuous hardshoulders.

Signals

12. Signals should be provided in accordance with TA 74: Motorway Signalling.

13. Careful consideration should be given to the provision of signals and their address coding at junctions where a lane is lost.

MIDAS

14. MIDAS Loops are to be installed on widened motorways and existing motorways during major maintenance in accordance with TD 47: Motorway Loop Detectors. MIDAS infrastructure should be provided when the criteria listed in TD 45: Motorway Incident Detection and Automatic Signalling are met.

15. Where MIDAS Loop Detectors are to be installed on motorways constructed using porous asphalt, advice from the HA Should be south at an early stage. The material used to seal the slots into which loops are installed will introduce an impervious barrier into the porous asphalt layer.

CCTV

16. TD 48: Motorway CCTV lists the criteria to be met before a CCTV system can be provided.

Meteorological System

17. This is not a standard provision and advice from the HA should be sought if fog is perceived to be a problem.

A7.5 Non-Trunk Motorways

General

1. Unlike trunk road motorways which are the responsibility of the HA, non-trunk road motorways (often called “principal road” motorways) are owned and maintained by the Highway Authority.

Communications Systems

2. Where non-trunk road motorways form spurs from, or extensions to the main trunk road motorway network, the telephone and signal systems are normally provided as extensions to the NMCS.

3. Isolated or self-contained non-trunk road motorways may be equipped with non-standard communications systems provided and maintained by the Highway Authority.

System Standards

4. Where non-trunk road motorways have NMCS systems, they are provided and maintained by the HA acting as the Highway Authority’s agent. Before accepting involvement with such a scheme, the Highways Agency will wish to satisfy itself that the system is consistent with its own standard trunk road motorways as specified in this manual.

Cable Infrastructure

5. A Cable Infrastructure capable of supporting NMCS2 is required; see TA 77: Motorway Infrastructure Design.

Telephones

6. Emergency Telephones should be provided in accordance with TA 73: Motorway Emergency Telephones.

Signals

7. Signals should be provided in accordance with TA 74: Motorway Signalling.

MIDAS

8. MIDAS Loop detectors and MIDAS infrastructure should be provided when the criteria laid down in TD 47: Motorway Loop Detectors and TD 45: Motorway Incident Detection and Automatic Signalling respectively are met.

9. Where MIDAS Loop Detectors are to be installed on motorways constructed using porous asphalt, advice from the HA Should be sought at an early stage. The material used to seal the slots into which loops are installed will introduce an impervious barrier into the porous asphalt layer.

CCTV

10. TD 48: Motorway CCTV lists the criteria to be met before a CCTV system can be provided.

Transmission Stations

11. When required by the provisions of TA **/**: All Purpose Trunk Road Emergency Telephones, Transmission Stations should be built.

Control Offices

12. It is likely that this road will be within the area of an operational Control Office (CO). Additional signals and telephones will generate changes to equipment in the CO including the mimic diagram, OIF maps and database.

Meterological System

13. This is not provided as standard, and advice from the HA should be sought where fog is perceived to be a problem.

Finance

14. Since the HA's role as agent for the communications system will be the reverse of that normally applying to civil works on trunk roads the HA will expect to be paid an agency fee calculated in the same manner as that normally paid by them to the Highway Authority.

Maintenance

15. The maintenance of the motorway communications system on non-trunk motorways will be undertaken by the RMC. Arrangements will have to be made, with the HA, to extend the RMC's area, and to agree fees.

A7.6 Major Maintenance

General

1. Major maintenance schemes may involve the resurfacing or reconstruction of the existing carriageway or major strengthening or reconstruction of bridges and other structures. This will often have a significant impact on the existing motorway communications infrastructure, the extent of this impact will depend on the scope of the civil engineering works.

Existing Services/Cables

2. Communications equipment, particularly buried cables, are vulnerable to damage during any of the following operations:

i. Tree planting.

ii. Provision of noise barrier fencing.

iii. Reconstruction of carriageways.

iv. Resurfacing to a greater thickness "overlay".

v. Recabling contracts.

vi. Drainage alterations.

vii. Provision of safety fencing.

3. Special consideration, as detailed in TA 77: Motorway Infrastructure Design, should be given during the planning stages to avoid the possibility of damage to existing services and cables.

Maintaining the Existing System

4. The existing motorway communications system should remain operational at all times during the contract. It should be remembered that the longitudinal cable will be part of the national carrier network in addition to its function of carrying local data from signals/telephones etc.

5. Any disconnections/connections to operational systems should be made by the specialist RMC.

6. Details of how the existing system may be maintained are given in TA 75: Motorway Transmission.

MIDAS

7. MIDAS Loop detectors are to be installed on existing motorways during Major Maintenance in accordance with TD 47: Motorway Loop Detectors.

8. Where MIDAS Loop Detectors are to be installed on motorways constructed using porous asphalt, advice from the HA Should be sought at an early stage. The material used to seal the slots into which loops are installed will introduce an impervious barrier into the porous asphalt layer.

Traffic Management

9. The traffic management required for the construction of the scheme may necessitate the installation of a temporary CCTV system to monitor the works. Temporary VMS may also be desirable. Early advice from the HA should be sought.

A7.7 Link Roads (Collector-Distributors)

General

1. The use of Link Roads (formerly termed 'Collector-Distributors') has been very limited so far, however as the motorway widening programme progresses their use may increase. The safety implications for link roads require special considerations when designing communications schemes.

Motorway Communications Considerations

2. It is important that emergency signalling requirements are fully considered at an early stage as they may critically affect the geometry and dimensions of the proposed layout. A comprehensive signalling system integrated with the static signing of the carriageway should be planned as a fundamental part of the scheme design.

3. The number and location of gantries is influenced by the number of lanes, road markings, static signing, and the position of structures. Generally, if lane signalling is required it will be necessary to install gantries in advance of each lane gain or drop. There should be sufficient gantries to enable unambiguous lane signalling to be set under worst case conditions. Spacing should allow adequate distance for weaving between adjacent gantries under emergency conditions when distractions are greater. Gantry spacings of less than 500m should be avoided if standard lane signalling facilities are to be provided. Particular attention needs to be given to transfer roads and the distances between adjacent merges and diverges where confusing signals could arise if distances are too short.

4. The scheme design should also make adequate provision for the accommodation of roadside equipment and allow for safe installation and maintenance access.

Address Coding

5. Special consideration should be given to the provisional siting of signals and also address coding. Advice and agreement from the HA should be sought at an early stage.

Site Data

6. Schemes involving Link Roads are likely to have a significant impact on site data. Advice and agreement from the HA should be sought at an early stage.

A7.8 All Purpose Trunk Roads

General

1. All purpose trunk roads are owned and maintained by the HA and provide a lower level of service than motorways. The major difference with regard to motorway communications is that there is no requirement for the provision of signals or emergency telephones. However, many are equipped with a basic telephone facility and the A3 on the approaches to the M25 has been equipped with cantilever mounted signals as part of the M25 trial.

2. A major constraint on trunk roads is the lack of a soft verge, the proximity of footways and the presence of a large number of existing services. These factors combine to produce a situation where it is often impossible to install cable in trench. A major cabling scheme is currently proposed for the North Circular Road (A406) where cables are to be installed in ducts placed under the inside traffic lane.

3. Consideration should be given to the security of equipment installed at the roadside, such as locking of cabinets, where access by the public is freely available.

A7.9 NMCS1 to NMCS2 Upgrading

General

1. This section should be read in conjunction with TA 72: National Motorway Communications Systems.

2. The most likely scenario for the implementation of NMCS2 is as a replacement for an NMCS1 system. The exception is where there is no existing NMCS1 system, ie where a new motorway is constructed or where an existing trunk road is upgraded to motorway standards. Even in these cases the NMCS2 infrastructure may have to operate within an NMCS1 CO area.

3. Completing the installation of the NMCS2 Control Office Base System (COBS) is the final step to successful conversion from NMCS1 to NMCS2. Cable and equipment can be installed well in advance of the installation of a COBS. This section highlights the main events within an NMCS1 to NMCS2 upgrading scheme. Specific design information is provided in TA 72: National Motorway Communications Systems.

Maintaining the Existing System

4. The existing motorway communications system should remain fully operational at all times until NMCS2 is commissioned and handed over to the police. This will involve careful planning by the Design Agent as dual running of both NMCS1 and 2 systems and transmission networks will be necessary during the commissioning phase of the works.

5. Any disconnections/connections to operational systems should be made by the RMC.

Cable Infrastructure

6. A cable infrastructure capable of supporting NMCS2 is required in advance of NMCS2 installation. Refer to TA 77: Motorway Infrastructure Design.

Telephones

7. Telephone sites should be upgraded to NMCS2 standards in accordance with TA 73: Motorway Emergency Telephones.

Signals

8. Signal sites should be upgraded to NMCS2 equipment standards in accordance with TA 72: National Motorway Communications Systems. This may also require the provision of 21-bit Transponder equipment as detailed in TA 72: National Motorway Communications Systems.

Transmission Stations

9. The existing NMCS1 Transmission System will require enhancement or refurbishment and this may also require the provision of new Transmission Stations or the replacement of existing Cabinets Type 617 with Transmission Station buildings. Temporary transmission circuits may also be necessary during the commissioning period. Refer to TA 75: Motorway Transmission.

Control Offices (CO)

10. The requirements for an NMCS2 CO are detailed in TA 76: Motorway Control Office.

NMCS2

11. The system design requirements for NMCS2 are detailed in TA 72: National Motorway Communications Systems.

A7.10 Phase 1 Telephones to NMCS2 Upgrading

General

1. The infrastructure to support any existing Phase 1 telephone system is unlikely to be suitable for NMCS2. Therefore, a completely new infrastructure capable of supporting NMCS2 is usually required.

2. For further information on NMCS2 Infrastructure see TA 77: Motorway Infrastructure Design.

3. The exception is when Phase 1 telephones have been installed as a temporary measure before NMCS2 is available. In this case, the Phase 1 Telephone Bridging Units (TBUs) will usually be replaced by one or more Telephone Responders. The provisions for this changeover should be made when planning the temporary Phase 1 system.

4. For further information on Phase 1 Systems see TA 72: National Motorway Communications Systems.

NMCS2

5. For further information on NMCS2 see TA 72: National Motorway Communications Systems.

Telephones

6. Telephone sites should be upgraded to NMCS2 standards in accordance with TA 72: Motorway Emergency Telephones.

A7.11 Design and Build

1. The level of equipment, design constraints and installation standards required on Design and Build schemes are the same as those required for schemes designed and built separately.

2. Refer to the relevant paragraphs above for the requirements for a particular type of scheme.

A7.12 Design, Build, Finance and Operate

1. The level of equipment, design constraints and installation standards required on Design, Build, Finance and Operate (DBFO) schemes are similar to those required for schemes designed and built separately. In addition, the DBFO Contractor (DBFO Co) is responsible for operating and maintaining the motorway communications network on the Project Road.

2. Refer to the relevant paragraphs above for the requirements for a particular type of scheme.

3. At the end of the concession period, the DBFO Co will be required to hand over a motorway communications system which conforms to the HA's standards in operation at that time.

A8. GLOSSARY

Address Coding
Addresses are codes by which emergency telephones and signals can be identified. The code takes the form:

1234A1 where the first four digits are derived from the local marker post number and motorway identifier, the letter denotes the carriageway along which the equipment is sited, and the final digit denotes the carriageway lane, if applicable.

The Address Codes are also called geographic addresses, as opposed to Electronic Addresses.

Armoured Cable
A cable which incorporates a layer of steel wire wrapped helically around the cable to provide mechanical protection from damage. The armour wire is protected from moisture by a polyethylene sheath. The sheath is coated with graphite - this graphite coating is used when testing the integrity of the sheath.

Cabinet Type 617
Standard motorway cabinet, for use on motorway verges, to house transmission equipment.

Cable Joint Enclosure
Environmentally sealed enclosure housed in underground chambers used to contain cable terminations, and in some cases, loading coils. CJE are available in the following types:

Type 15	Use	No of Cables to be Accommodated	Comments
1	Longitudinal 40 pair joint	3 x 40 pair	Unloaded.
2	Longitudinal 40 pair joint	3 x 40 pair	As 15-1, with additional module providing 22 circuits loaded at 22mH.
3	Longitudinal 40 pair joint	3 x 40 pair	As 15-1, with additional module providing 6 circuits loaded at 88mH.
4	Longitudinal 40 pair joint	3 x 40 pair	As 15-1, with additional module providing 28 circuits loaded at 22mH.
L	Local distribution	3 x 40 pair and 6 x quad	
RSI	Rural signal interface	4 x quad	
HFC	High frequency carrier joint	4 x carrier quad	
F	Optical Fibre Cables	3 x 24 fibre	

Note: Type RSI are housed in Cabinets Type 609

Cantilever
An overhead structure which extends from the verge. It has only one leg which is located in the verge. Used to support Enhanced Message Signs (EMS) and Enhanced Matrix Indicators (EMI).

Carrier Network
Two types of network are installed each using a different type of carrier system:

(a) Copper cable networks use frequency division multiplex (FDM) to transmit the standard carrier of 12 analogue channels. A mini-carrier of six analogue channels is provided as an option;
(b) Optical fibre networks use time division multiplex (TDM) to transmit 30 digital Pulse Code Modulation (PCM) channels.

Chamber
Underground structures of a standard size used to house cable joints and to facilitate cable installation.

Type	Plan Size (mm)	Use
A	1300 x 750	To house cable joints.
B	600 x 600	Cable installation at changes of direction; access to Transverse ducts.
C	450 x 450	Cable distribution at cabinet sites.

Chambers may be constructed from brick, plastic or concrete.

Closed Circuit Television (CCTV)
A system using remotely controlled television cameras to monitor traffic patterns at sites susceptible to traffic congestion such as tunnels junctions and interchanges. The images are transmitted from the camera to the Control Office (CO) over the fibre optic cable infrastructure.

Control Office (CO)
The Control Office (CO) is the location from where the Highways Agency's motorway communications equipment, for the motorways in a given Police Force Area, are controlled. The CO is used by the Police Authority for day-to-day control of motorway traffic. More than thirty Police Authorities are involved in operating the national system, each Police Authority being issued with a code of practice approved by the Association of Chief Police Officers, in order to standardise the use of motorway signals for each region.

Control Office Base System (COBS)
That part of the instation which performs those functions which are common to all NMCS2 systems. Includes the Operator Interfaces (OI).

Design and Build (DB)
A contract where a single contractor is appointed to design and build a scheme. An outline design may be prepared by the client. The DB Contractor will generally utilise sub-contractors for various elements of the work.

Design, Build, Finance and Operate (DBFO)
A contract where a company takes full responsibility for a section of road for a defined concession period, generally 30 years. The DBFO company will be required to undertake certain capital works such as widening an existing road or construction of a new road. During the concession period the DBFO company will be paid according to traffic usage using a tolling system.

Duct
A plastic pipe buried in the ground.

Ducted Cable Network
A sealed network of buried ducts in the motorway verge, with connections crossing beneath the carriageway. The ducted network is used for the installation of motorway communications cables. Cables are jointed in sealed joints which are housed in underground chambers.

Gantry
An overhead structure which spans a carriageway. Used to support signals and/or signs.

Highways Manual
An internal Highways Agency manual which documents internal procedures.

Interrupter Cable
Cable used as a temporary replacement of the permanent cable to bypass a section of the existing motorway cable from the live circuits when major works are being undertaken on that section of motorway. Also used as a temporary replacement for damaged cable.

Link Road
A road which runs parallel to a motorway and forms a link between adjacent junctions. It allows local traffic to travel between junctions without interrupting the flow on the motorway. Link roads were formerly known as Collector-Distributors.

Longitudinal Cable
The 40 pair copper and 24 fibre cables (two separate cables) running parallel to the motorway in the duct network, each pair and fibre is dedicated to a specific purpose. Historically 20 pair NMCS1 and 30 pair NMCS2 cables were direct buried. The 20/30 pair copper cables may be augmented by composite copper/ optical fibre cables dedicated to CCTV or carrier circuits.

Maintenance
Maintenance of equipment comprises the activities undertaken to repair an item of failed equipment and the activities undertaken to prevent items of equipment from failing (preventative maintenance).

Major Maintenance
A civil engineering contract involving works on an existing motorway including resurfacing, reconstruction of the carriageway or bridge works.

Mimic Diagram
A large diagram which schematically represents the Control Office Area (COA) and indicates the status of the devices and systems in the COA.

Motorway Incident Detection and Automatic Signalling (MIDAS)
A Control Office Base System (COBS) Subsystem which monitors traffic flow conditions and interacts with signal subsystems to automatically set signals without operator intervention. Signals are set when a queuing traffic is detected.

Motorway Emergency Telephone
A telephone provided by the Highways Agency in the verge of motorways and all-purpose roads for use in the event of an incident or vehicle breakdown. Emergency telephones are linked, via the NMCS, to police Control Offices.

Motorway Transmission
Telecommunications equipment and systems provided for the motorway network.

National Carrier Maintenance Contractor (NCMC)
The Contractor responsible for the maintenance of the Carrier Network throughout the motorway network.

National Motorway Communications System (NMCS)
The motorway traffic control and emergency telephone network adopted to serve the motorways of England.

National Motorway Communications System 1 (NMCS1)
A combined signalling and telephone system controlled from Regional and National central processors, installed up to 1988.

National Motorway Communications System 2 (NMCS2)
A system using locally based distributed processing to control telephones and signals, installed from 1988.

New National Network
The standard project management network for highways schemes.

Operational Change Board
A body which oversees an Operational Change Control.

Operational Change Control
The procedures set in place by the Highways Agency to allow the effect of changes to working systems to be assessed and implemented in a controlled manner.

Operator Interface (OIF)
The OIF provides a means of controlling the systems and can consist of an operator's control panel, a QWERTY keyboard and a visual display unit.

Patching Across
Removing a section of motorway from the communications circuit when a cable is damaged or there are long term major works occurring within that section.

Phase 1 Telephone System
A system of emergency telephones originally devised by the the General Post Office (GPO) at the request of the, then, DTp, and sited along a motorway verge connected to a police control centre but not to the public telephone network. The Phase 1 system is completely independent of the NMCS.

Project Management Manual
A Highways Agency manual which documents the New National Network.

Public Switched Telephone Network (PSTN)
PSTN is provided by a Public Telecommunications Operator (eg. British Telecommunications Ltd, Mercury Communications Limited), ie a telephone connection accessed by the user dialling numbers.

Public Telecommunications Operator (PTO)
A licensed provider of Public accessible telecommunications services (eg. British Telecommunications Ltd, Mercury Communications Limited).

Pulse Code Modulation
Pulse Code Modulation is a process of converting an analogue signal into a digital signal. A sample of the analogue signal is taken and equated to the nearest digital level. Each digital level is associated with a binary code. This code is transmitted instead of the analogue signal. This process operates on an individual signal and does not create additional capacity. The analogue signals are sampled at 8KHz and produce 8-bit codes. This gives a single channel with a bit rate of 64,000 bits per second or 64Kbit/s.
PCM is commonly used to describe multi channel digital transmission systems. This is not totally correct as PCM is not a transmission system. PCM is generally used with Time Division Multiplexing (TDM) transmission systems.

Regional Maintenance Contractor (RMC)
A Contractor responsible for the day to day maintenance of instation and outstation equipment. Also has first line responsibilities for the transmission equipment in their region.

Responder
An NMCS1 outstation which controls telephones and signals.

Site Data
The Control Office Base System data that identifies all of the outstation devices within the Control Office Area and defines the device's operational characteristics. Site Data also encompasses Signal Sequencing Data which describes the road layout, signal positions and traffic engineering consideration to the Central Processor/ Database Processor/Control Office Base System.

Subsystems
A group of commands, communications messages and types of Motorway Devices which together implement a primary function of the system, eg. Fog, Signals.

The subsystem provides the format, sequence and information for the use of its facilities in NMCS2. Examples are as follows:-

SIG Signals
MSS Message Signs Subsystem
FOG Fog Detection
MIDAS Motorway Incident Detection and Automatic Signalling
MET Meteorological Monitoring (ie. wind speed and direction, ice, etc)
LTG Lighting Control

21-bit Transponder
This item of equipment is a derivative of the Standard Transponder (ST), modified to allow communication with an NMCS1 Central Processor, to enable control of NMCS2 signals in a NMCS1 Control Office (CO) Area. The 21-bit Transponder translates and interprets messages received from NMCS1 and controls the signal accordingly. The term 21-bit is derived from the NMCS1 21 bit word length.

Standard Transponder
Standard Transponder is at the lowest hierarchical level within the Control Office Area. It interfaces to Local Communications Controller/HDLC links and provides a star point on the RS485 local links. It also provides some of the signal sub-system functions and a post box service to other sub-systems. It controls up to 120 motorway devices.

Telephone Bridging Unit (TBU)
The TBU is the outstation part of a temporary telephone system used on opened motorways before commissioning an NMCS1 or 2 system.

Telephone Responder
A motorway based mini telephone exchange controlling the connection of telephones with an NMCS2 Control Office.

Third Party Circuit
A circuit provided by a Public Telecommunications Operator.

Transmission
Telecommunications terminology for the sending and receiving of signals.

Transmission Network
A network of cable and equipment which allows the sending and receiving of signals between devices and control offices.

Transmission Station
A Transmission station is an outstation unit provided to house telecommunication equipment require to allow successful communications between the Instation and Outstation Services. The TS are either buildings or cabinets Type 617 and are spaced at approximately 20km intervals within a Control Office area.

Variable Message Sign (VMS)
A sign which can display a number of defined legends or messages.

A9. REFERENCES

MCH 1258 - NMCS1 Responder

MCH 1286 - Request for Financial Approval

MCH 1288 - Request for Financial Approval for Bulk Purchase Equipment Only

MCH 1349 - Maintenance and Operational Requirements for New Systems & Equipment

MCH 1399 - Maintenance Instruction Notification of a Change in Equipment

MCH 1472 - NMCS2 Site Acceptance Certificate - Telephone Responder

MCH 1476 - NMCS2 Site Acceptance Certificate - Signal Transponder

MCH 1593 - Maintenance Instruction Changes to Communication Infrastructure

MCH 1594 - MCP Number Allocation and Bulk Purchase Equipment Requirements

MCH 1596 - NMCS Site Data Procedures

MCH 1635 - Motorway Communications Record Drawings Produced Using CAD

MCX Drawings

TD 33: The Use of Variable Message Signs on All Purpose and Motorway Trunk Road (DMRB 8.2)

TD 45: Motorway Incident Detection and Automatic Signalling (DMRB 9.1.2)

TD 46: Motorway Signalling (DMRB 9.1.1)

TD 47: Motorway Loop Detectors (DMRB 9.1.3)

TD 48: Motorway CCTV (DMRB 9.1.5)

TA 72: National Motorway Communications Systems (DMRB 9.4.1)

TA 73: Motorway Emergency Telephones (DMRB 9.4.2)

TA 74: Motorway Signalling (DMRB 9.4.3)

TA 75: Motorway Transmission (DMRB 9.4.4)

TA 76: Motorway Control Office (DMRB 9.4.5).

TA 77: Motorway Infrastructure Design (DMRB 9.5.1)