

---

**VOLUME 9 NETWORK - TRAFFIC  
CONTROL AND  
COMMUNICATIONS  
SECTION 4 SYSTEMS DESIGN**

---

**PART 1**

**TA 72/97**

**NATIONAL MOTORWAY  
COMMUNICATIONS SYSTEMS (NMCS)**

**SUMMARY**

This advice note describes the National Motorways Communications Systems (NMCS). It contains the information necessary for the design of an NMCS, and provides a reference to the NMCS document set.

**INSTRUCTIONS FOR USE**

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

1. Insert TA 72/97 into Volume 9 Section 4.
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**

# **National Motorway Communications Systems**

Summary: This advice note describes the National Motorways Communications Systems (NMCS). It contains the information necessary for the design of an NMCS, and provides a reference to the NMCS document set.

**REGISTRATION OF AMENDMENTS**

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

**REGISTRATION OF AMENDMENTS**

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

---

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

**SECTION 4    SYSTEMS DESIGN**

---

**PART 1**

**TA 72/97**

**NATIONAL MOTORWAY  
COMMUNICATIONS SYSTEMS (NMCS)**

**Contents**

Chapter

1. Introduction
2. References
3. Enquiries

# 1. INTRODUCTION

## General

1. This Advice Note describes the National Motorway Communications Systems (NMCS). It contains the information necessary for the design of an NMCS, and provides a reference to the NMCS Documentation set.

## Scope

1. This Advice Note is applicable to NMCS schemes. It is for use for the design of NMCS within motorway communications, motorway construction and improvement 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. There are no Technical Directives related to the design of NMCS systems. References for the standard of provision applicable to each Overseeing Organisation is given in the appropriate Annex.

2. The following Advice Notes are of relevance:

TA 70: Introduction

TA 71: Design and Implementation (Overview)

TA 73: Motorway Emergency Telephones

TA 74: Motorway Signalling

TA 75: Motorway Transmission

TA 76: Motorway Control Office

TA 77: Motorway Infrastructure

## Implementation

1. The appropriate Annex should be used forthwith on all motorway communications, motorway construction and improvement schemes currently being prepared provided that, in the opinion of the Overseeing Organisation, this would not result in significant additional expense or delay progress. Design Agents should confirm its application to particular schemes with the Overseeing Organisation.

## 2. REFERENCES

TA 70: Introduction (DMRB 9.2.1)

TA 71: Design and Implementation (Overview)(DMRB 9.3.1)

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)

### 3. ENQUIRIES

Approval of this document for publication is given by the undersigned:

Director of Traffic Systems and Signing Division  
Highways Agency  
Tollgate House  
Houlton Street  
Bristol  
BS2 9DJ

R EASTMAN  
Director of Traffic Systems and  
Signing Division

The Deputy Chief Engineer  
Roads Directorate  
The Scottish Office Industry Department  
New St Andrew's House  
Edinburgh  
EH1 3TG

J INNES  
Deputy Chief Engineer

The Director of Highways  
Welsh Office  
Y Swyddfa Gymreig  
Crown Buildings  
Cathays Park  
Cardiff CF1 3NQ

K THOMAS  
Director of Highways

Assistant Technical Director  
Department of the Environment for  
Northern Ireland  
Roads Service  
Clarence Court  
10-18 Adelaide Street  
Belfast BT2 8GB

D O'HAGAN  
Assistant Technical Director

All technical enquiries or comments on this document should be sent in writing as appropriate to the above.

---

**VOLUME 9 NETWORK - TRAFFIC  
CONTROL AND  
COMMUNICATIONS**  
**SECTION 4 SYSTEMS DESIGN**

---

**PART 1**

**TA 72/97 Annex A (England Only)**

**NATIONAL MOTORWAY  
COMMUNICATIONS SYSTEMS (NMCS)**

**Contents**

Chapter

- 1 Introduction
- 2 National Motorway Communications Systems
- 3 NMCS2 System Description
- 4 NMCS2 System Design
- 5 NMCS2 Instation Design
- 6 Phase 3 Telephone System Design (NMCS2)
- 7 NMCS2 Data System Design
- 8 Regional Communications Controller (NMCS2)
- 9 NMCS2 System Data
- 10 NMCS1 to NMCS2 Changeover
- 11 NMCS2 Subsystems
- 12 NMCS1
- 13 Glossary
- 14 References

# 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 A11. Standard Drawings and Specifications

6. Standard MCX and MCY drawings and MCH and TR specifications are issued by Network Control Division (NCD) of the Highways Agency (HA).

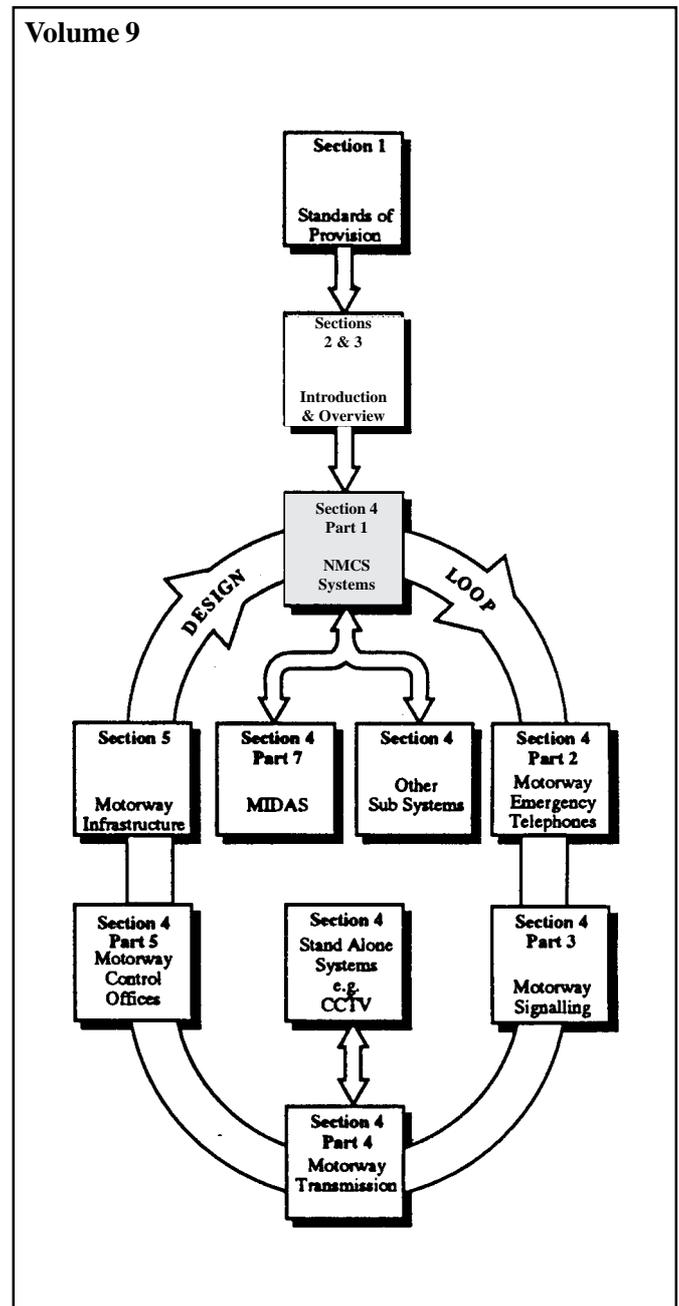


Figure A1.1a Structure of Volume 9 of the Design Manual for Roads and Bridges

## **A2. NATIONAL MOTORWAY COMMUNICATIONS SYSTEMS**

### **A2.1 Introduction**

1. Motorway equipment such as telephones and signals is connected by transmission networks to computers and control equipment located in Control Offices. There are two systems currently in use in England - National Motorway Communications System, first generation (NMCS1) and second generation (NMCS2).
2. Current Highways Agency policy is to implement NMCS2 nationally and therefore to phase out NMCS1 systems.
3. This Annex describes both NMCS1 and NMCS2 and provides information for scheme design and the implementation of these systems.
4. NMCS equipment and system specifications are produced by the Highways Agency and are referred to in this Annex.

### **A2.2 Programmable Electronic Systems (PES)**

1. Motorway communications systems come into the category of Programmable Electronic Systems (PES) used in safety related applications. The integrity of the system with regard to safety and the risk and consequence of failure should, therefore, be assessed and the results acted upon. This is a matter for the NMCS2 equipment and system specifications and will be reflected within those documents.
2. This Annex explains how the components of the systems can be combined in the most efficient way to provide a standard NMCS on a section of motorway. It does not, therefore, deal with the integrity of the NMCS.

## A3. NMCS2 SYSTEM DESCRIPTION

### A3.1 NMCS2 Overview

1. NMCS2 is the second generation of National Motorway Communications System. It provides facilities for the Police in the Control Office (CO) to operate motorway devices, and to answer calls made on the emergency telephones.
2. NMCS2 is a communications system consisting of an instation at the CO linked to a telephone system (Phase 3 Telephone System) and a data system. These two systems form independent networks. The data system allows various instation Subsystems to communicate with motorway devices such as signals, message signs and meteorological equipment.
3. In contrast to its predecessor, NMCS1, all processing in an NMCS2 System is carried out within the CO area, either at the computer instation or at intelligent roadside outstation equipment. Connection to the national network via a Regional Communications Controller (RCC) is retained, to support communication between COs and central logging.
4. The Phase 3 Telephone System connects the Operator Interface (OIF), at the CO to the emergency telephones. Each telephone is connected to a roadside telephone exchange known as a Telephone Responder. Up to 6 telephone circuits run throughout the CO Area. They are switched back to the CO as necessary by items of equipment known as Sector Interfaces or Block Interfaces, depending on their position in the switching hierarchy.
5. The data system is distributed through the CO Area via a Local Communications Controller (LCC) to devices known as Standard Transponders (ST). Each ST acts as the monitoring and control point for all motorway devices in its area. The abbreviation TPR is used for Standard Transponders in the NMCS2 Documentation Set.
6. All motorway devices are controlled via the NMCS2 data system by NMCS2 Subsystems. Typical Subsystems are those controlling Signalling, Lighting and Message Signs.

7. A Management Overview of the operation of NMCS2 is contained in MCH 1617, and a more detailed technical overview is given in MCH 1618.

### A3.2 NMCS2 Development

#### Initial NMCS2 Systems

1. NMCS2 was initially installed in four M25 CO's in 1988: Welwyn, Heston, Chigwell, and Godstone.
2. The M25 systems provided a basis for the specification of systems for Manchester and Birmingham (Perry Bar). Further systems were supplied for East London and the Dartford River Crossing.

#### Control Office Base System (COBS)

3. In 1992, the specifications for the further refinement of NMCS2 to a Control Office Base System (COBS) using a Local Area Network (LAN) for connection of all Subsystems were published.
4. Management and technical overviews of the operation of the COBS type NMCS2 are contained in MCH 1617 and MCH 1618 respectively.

## A4. NMCS2 SYSTEM DESIGN

### A4.1 Design Process

1. This Annex is intended to assist designers with the design and implementation of NMCS2.
2. Each Chapter of this Annex which deals with NMCS2 is structured in the same way:
  - (i) An overview of what is to be achieved.
  - (ii) The components of the design.
  - (iii) How these components work together.
  - (iv) Design.
  - (v) Addressing, data changes required to achieve the task.

### A4.2 NMCS2 Design Documentation

#### System Documentation

1. MCH 1616 provides a guide to NMCS2 documentation. This gives details of the appropriate technical specifications for both NMCS2 telephone and data systems. Designers should use this document as a base point for understanding the operation of NMCS2 references and in which specifications further details can be found.

#### Phase 3 Telephone System Guide

2. MCH 1331 provides a guide to the Phase 3 Telephone System. It outlines the reasoning behind the operation and provision of the Phase 3 system, and gives useful background information for designers.

#### Obsolete Documentation

3. MCH 1539A, NMCS2 Installation Design Guide, is superseded by this Design Guide. It was produced in April 1990 and described pre-COBS (Control Office Base System) NMCS2 system design, installation and commissioning. MCH 1539A is available as an historical document.

### A4.3 Scheme Design Information

#### Scheme Reports

1. The documentation that is usually required as part of scheme design will generally range between Design Reports in which the Design Agent will explain aspects of the scheme proposals through to Contract Documentation and “as-installed” drawings. With the exception of Design Reports, NMCS2 design is recorded on drawings and standard schedules.

#### Preliminary Design Drawings

2. These are typically 1:10000 scale geographic drawings produced at an early stage in a large scheme design (such as NMCS1 to NMCS2 changeover). They identify to the nearest marker post the locations of Motorway Emergency Telephones, Motorway Devices, Standard Transponders, Responders, Transmission Stations, Sector and Block Interfaces and Local Communications Controllers. The cable infrastructure and associated cabinets are not shown.

#### Geographic Drawings

3. At the detailed design stage geographic drawings, typically at 1:2500 scale are produced. They identify cabinet locations, cable routes, equipment locations, etc. These drawings will be the main scheme drawings and also provide the basis for “as-installed” information.

#### Schematic Drawings

4. The schematic drawings indicate all the cable connections made to the data system, the telephone system and also power cable. Each drawing should cover the range of a Standard Transponder or Telephone Responder.
5. It should be noted by designers that there is a requirement to produce or modify as-installed drawings, relating to each Standard Transponder and each Responder, for the specialist Regional Maintenance Contractor (RMC) maintenance records.

**MCH 1420/1421**

6. These are documents to be completed by Design Agents to record the proposed connections to and configurations of each Standard Transponder and Responder respectively. In existing NMCS2 Control Office (CO) Areas a unique drawing number in the MCY series will have been allocated by the Highways Agency (HA) for installed operational equipment. They will be required to be updated as part of the “as-installed” information process.

**OIF Map Drawings**

7. There will be a requirement for new, or modified, OIF maps to be generated. The HA will define the format.

**Control Office Layout Drawings**

8. Equipment layouts in Control Rooms and Equipment Rooms will need to be produced by designers working within a CO. The minimum requirement is to record the positions and interconnections of motorway communications equipment. There is a need to liaise closely with the Police Building Services and Communications Managers to ensure that the police operational requirements are also met.

**System Data**

9. Data describing the configuration of motorway devices and the scheme-specific characteristics of the Subsystems is downloaded from the COBS on initialisation as Site and Configuration Data. The designers will need to specify all this data for conversion to electronic format by the HA who manage and issue all system data.

## A5. NMCS2 INSTATION DESIGN

### A5.1 Overview

1. The NMCS2 instation consists of the Control Office Base System (COBS), Subsystems and Communication Interfaces. The COBS includes Operator Interfaces (OIF). With the exception of the OIFs, which are installed within the Control Office (CO) Control Room, all other NMCS2 instation equipment is located within the CO Equipment Room.
2. A full technical description of the NMCS2 instation architecture is given in MCH 1618 NMCS2 Technical Overview.

### A5.2 System Components

#### Control Office Base System (COBS)

1. The COBS consists of a central processor and the OIFs. Subsystems are separate processors, which are connected to the COBS via an instation Local Area Network (LAN).
2. The COBS equipment comprises hardware and software necessary to:
  - i. interface with operators via up to six OIFs.
  - ii. provide processing facilities to carry out common processing functions.
  - iii. interface with Subsystems via an instation LAN interface.
  - iv. interface with outstation equipment via up to three High-level Data Link Control (HDLC) Point to Point links.
  - v. interface with other COs and the Central Logging Facility via a Regional Communications Controller (RCC) network.
  - vi. interface with maintenance engineers terminals via Datel.
  - vii. interface with an engineer via an Engineer's Console.
  - viii. interface with a Write Once Read Many (WORM) memory device.

3. All NMCS2 systems have a Signals Subsystem. Other Subsystems, for Message Signs, Motorway Incident Detection and Automatic Signalling (MIDAS) or Lighting Control, for example, may also be provided.
4. The COBS acts as a central repository for data including Subsystem fault and operational information for maintenance and other purposes. Subsystems will contribute data regarding their own status and that of their devices to the Logs.
5. System Data is provided to the COBS such that it can ascertain both the system configuration and the motorway devices and outstation equipment applicable to the system. Map information for display purposes is included within the scope of Configuration Data.
6. The operation of the COBS is defined in TR 2132 Control Office Base System.

#### Local Area Network

7. The NMCS2 instation LAN is only used for connecting the COBS with the Subsystems.
8. The LAN is an Ethernet Open Systems Interconnection (OSI) LAN that conforms to the UK Government OSI Profile (UK GOSIP) Version 4.0.
9. Further information is available in TR 2133 Instation LAN Transmission.

#### Operator Interface (OIF)

10. One OIF is normally provided for each operator position. It consists of an Operators Control Panel (OCP) and a visual display unit (VDU).
11. Each OIF provides the human interface to the NMCS2 COBS and Subsystems for the control of motorway devices. When used for controlling devices, the OIF displays are driven by the Subsystems; when used for housekeeping they are driven by the COBS directly.

12. An Operator's Control Panel is the main operator input device. It has a set of function keys that enable the operator to access the menus, cursor control keys, and a set of alpha-numeric keys for the input of motorway addresses. In addition, it has a two-line LCD display and a set of indicators. It also has a connector to allow a full qwerty keyboard to be connected for the input of text.

## A6. PHASE 3 TELEPHONE SYSTEM DESIGN (NMCS2)

### A6.1 Overview

#### General Description

1. The Phase 3 emergency telephone system within NMCS2 allows up to six operators in the Control Office (CO) to handle calls from emergency telephones. The system broadly breaks down into two parts: the 'Instation' equipment in the CO, and the 'Outstation' equipment that is normally at the roadside.

2. For further detailed information see MCH 1331. Instation

3. The telephone instation equipment has three components:

- i. Operator Control Panel (OCP), which allows the operator to control telephone operation to make and receive calls, hold calls, transfer calls etc. The OCP usually forms part of the Operator Interface (OIF) for the Control Office Base System (COBS).
- ii. Telephone Line Controller (TLC), which interprets the operator commands via the OCP. Each TLC has total control over one motorway telephone circuit, giving it access to every telephone on the system.
- iii. Inter-Panel Link Unit (IPLU), which connects the TLCs, allowing telephone calls to be transferred between TLCs and providing a fault logging facility and connection to COBS;

#### Outstation

4. The telephone outstation equipment has three components:

- i. The telephones (see TA 73: Motorway Emergency Telephones for further information).
- ii. Telephone Responders which are controlled by the TLC and connected to the telephones. The abbreviation RES is used for Telephone Responders in the NMCS2 Documentation Set.

- iii. Sectoring Equipment to regulate the speech signal paths and isolate the various parts of the circuits. A set of Sector Switches, one per circuit, is grouped together to form a "Sector Interface" or a "Block Interface" depending on its position in the network.

#### Configuration

5. Depending upon the actual installation, equipment may be configured in any of three configurations:

- i. The normal Phase 3 Telephone System instation consists of two or more TLCs with their OIFs and an IPLU;
- ii. It is also possible to configure the equipment in a minimal system, consisting of two TLCs with their OCPs and without an IPLU.
- iii. The third configuration supplements the normal Phase 3 Telephone System with a Phase 2 Telephone System interface to facilitate the transition from old to new generations of equipment. This configuration is required when Phase 2 telephones will form part of the Phase 3 Telephone System installation.

### A6.2 System Components - Instation

#### Description

1. The instation equipment consists of up to 6 TLCs each with an associated OCP. Each TLC is connected to one telephone circuit, and controls the switching of telephones over that circuit, providing the connection point for the operator's telephone handset. Each OCP includes a small LCD display and a set of function keys allowing control of the TLC with a buzzer, a set of light emitting diode (LED) alarm lights. The buzzer and indicator lights draw the operator's attention to new calls and to problems that occur in the system.

2. Each OIF includes a visual display unit (VDU), which augments the display on the OCP and provides maps of the CO Area. It also allows operators to control NMCS2 functions using the OCP. An IPLU connects the TLCs within a CO, coordinating the information and allowing the transfer of calls between TLCs. Neither VDUs nor the IPLU are essential for the control of the telephone system.

### **Telephone Line Controller**

3. As implied by the name, each TLC controls the switching of a telephone circuit. It allows the operator to speak to particular telephones, and to hold and disconnect callers as required.

4. The TLC communicates with Responders over the telephone circuits, interrogating them to find their status, reporting new calls and other changes in status to the OCP. Under the control of the OCP, the TLC instructs Responders to switch telephones to its line, to hold calls or to disconnect them from its line.

5. The interface between the TLC and the operator or maintainer is provided by the OCP and OIF, as prompts and operator keystrokes.

### **Operator Control Panel**

6. The OCP supports the telephone system and provides facilities that can be used to control the NMCS2 data system. If the data system fails, the design allows the OCP to continue to control the telephone system.

7. The OCP interfaces directly with the TLC to control telephones. When the NMCS2 data system is available, the OCP also interfaces with the COBS to provide the input mechanism for the data system function.

8. The OCP provides function keys that control the operation of the telephone system, with a small LCD display to show various telephone system parameters and messages. A buzzer is provided to draw the operator's attention to new telephone calls and system alarms and a set of indicator lights shows the type of event.

### **VDU**

9. The main purpose of the VDU is the display of maps and other information for the NMCS2 data system. However, when the telephone system is being

controlled, the VDU provides an additional means for the operator to see what is happening, thus supplementing the OCP display.

### **Inter Panel Link Unit**

10. The IPLU provides an interface between the individual TLCs in a CO. It disseminates information about telephones to all of the TLCs, thus ensuring that all operators are aware of a new call when the first TLC has detected it. It provides facilities for transferring calls between TLCs.

11. The IPLU receives information about changed telephone statuses from the individual TLCs, and passes the information to other TLCs. Additionally, the IPLU provides a channel for communication between TLCs where a call is to be transferred, allowing the synchronisation of disconnection and connection commands.

12. Where Phase 2 telephones form part of the system, the IPLU also communicates with the Phase 2 Adapter that allows telephones to be connected to the NMCS2 system.

13. The IPLU has a control panel and display that support testing and maintenance of the system.

14. For further detailed information on telephone installation requirements see TR 1331.

## **A6.3 System Components - Outstation**

### **NMCS2 Telephone Circuit**

1. Within NMCS2 a telephone circuit is used to connect each TLC via Sector Switches to the Telephone Responders which control the telephone instruments.

2. Both data (control data between the TLC and the Telephone Responder) and speech are transmitted over the telephone circuits. The two signals are separated by use of a notch filter, allowing them to be transmitted simultaneously. Data is transmitted at 50 baud in a frequency range of 2600±400 Hz, speech uses the remainder of the frequency band 250 to 3400Hz. Further information is contained in TR 1329.

### **Telephone Responder**

3. A Telephone Responder is a telephone exchange that handles the switching of motorway telephone calls. It communicates with the telephone installation over

several circuits and switches telephones to and from the circuits. The equipment is located at the roadside and is usually housed in a Cabinet Type 600. In terms of the communications path, it resides between a Sector or Block Interface and the roadside telephone equipment.

4. A Telephone Responder controls up to six telephones per address. A maximum of three addresses per Telephone Responder site are allowed. However, cable pair allocation dictates that in standard circumstances there is a limit of 12 telephones (2 addresses) per Telephone Responder. The 18 telephone Responder is usually installed for special applications where a higher level of provision of telephones is required, for example in tunnels.

5. In general Telephone Responders allow all TLCs access to all telephones, but in certain special installations the Highways Agency may specify that not all Telephone Responders are connected to all lines. The Telephone Responder connects telephones to telephone circuits, holds calls and arbitrates conflicting requests from TLCs requesting action on the same phone.

6. Unlike the NMCS1 Responder the NMCS2 Phase 3 Responder is a dedicated telephone-only device.

7. The Telephone Responder is able to provide a similar service to that of a Phase 1 TBU when it is configured to work over one line.

8. Telephone Responders can be configured to 2 or 4 wire working between responders and instation, but not between responders and telephones.

9. Further information on the Telephone Responder is available in TR 1330.

### Sector Interface Equipment

10. The Sector Interface equipment is located at the point where a telephone circuit from the CO splits to serve different branches of the motorway system. In terms of the communications path a Sector Interface resides between the TLC and the Telephone Responder.

11. Sector Interface equipment can be located in COs, Transmission Stations or mounted in Cabinets Type 600 (preferably with other equipment such as Telephone Responders).

12. The Sector Interface equipment comprises up to six Sector Switches, two Power Supply Units, a back-up battery unit and all cable connectors and interconnecting

cables. One Sector Switch will be required for each telephone circuit the equipment serves. Sector Switches have independent speech/data paths from other Sector Switches within the Sector Interface.

13. Sectoring equipment may be connected:

- i. directly to a TLC
- ii. to an output port of another Sector Interface, to switch sectors.
- iii. as a Block Switch, to an output port of another Sector Interface, to switch blocks.

14. For further information on Sector Interface equipment refer to TR 1334.

## A6.4 Outstation Design - Telephone Responder Siting

### 5km Responder Rule

1. One of the philosophies of NMCS2 is the concept of 'Complete CO Area Coverage'. It should be possible anywhere on the network to add extra equipment with the minimum additional infrastructure. For the Phase 3 Telephone System this gives rise to the '5km Responder Rule'.

2. To ensure that there is no break in the NMCS2 telephone network, on present or future schemes, Telephone Responders should be placed at a maximum electrical distance of 5km of longitudinal cable apart.

3. This provides a fail-safe method of placing Telephone Responders in such a way as to provide a Phase 3 telephone network with continuous coverage.

4. The rule is based on the following:

- i. A Telephone Responder is able to drive a telephone over a cable length of 3.2km.
- ii. A Telephone Responder is usually sited within 50m of a longitudinal cable joint.
- iii. Telephones are connected to the nearest cable joint.

5. The rule is formulated on the assumption that if cable joints are spaced 500m of cable length apart, and a

Responder feeds five cable joints in each direction from the cabinet it is connected to, there should be a distance of 2.5km to the outermost cable joints. Local quad telephone cabling may have to cross carriageways using ducts that are not always in the ideal place. Bearing this in mind, it should be possible to keep within the 2km transmission limitation using the 'budget' of a maximum 700m cable run from the last cable joint to a telephone. Hence a Responder every 5km should satisfy the local transmission requirements.

### **Telephone Responder Positions**

6. In CO Areas containing motorway-motorway interchanges start by placing a Telephone Responder on each arm of the interchange. Then fill in the rest of the network as described below.
7. In CO Areas where there are no motorway-motorway interchanges, start by placing a Telephone Responder at a point 2km from the CO boundary, or 2km from the start of a motorway. Fill in the rest of the network by placing a Telephone Responder every 5km. Place a Telephone Responder in any sections of less than 5km length that remain.
8. Determine the likely telephone loading of each Telephone Responder. If there are any with 10 or more telephones, refine the design by adding extra Responders, so reducing the spacing. This will allow for future expansion and cater for further refinements during the design process.
9. Try to combine ST and Telephone Responder sites wherever possible.
10. Telephone Responders require a power supply; telephones do not. On existing motorways, examine the present Electricity Supply Company Interface (EI) provision. Cost savings can be made by installing new equipment near existing EI sites although this may appear to be uneconomical in equipment terms. This can be especially true in rural situations where the cost of providing a new supply may be high.
11. Bearing in mind the design refinements made for existing EIs, look at moving or adding Telephone Responders near to new EIs proposed to cater for signalling or lighting.
12. Finally check over the revised design to ensure that where the separation between Telephone Responders

is greater than 5km, the transmission limitations can be satisfied. Also, ensure that there are no superfluous Responders.

13. When the design has reached this point the preliminary allocation of sectors, blocks and Responder electronic addresses can be made.

## **A6.5 Outstation Design - Terminations and Connections**

### **Local Connections (Responder to Telephone)**

1. The longitudinal 40 pair cable has 8 pairs allocated to remote (ie more than 500m away from the Responder) telephone connections (Pairs 17, 18, 19, 20, 27, 28, 29 and 30).
2. Typical local arrangements are shown in Figure A6.5a.
3. Telephone Responders can have a 2 or 4-wire capability, this is set at the factory and should be defined at the time of ordering.
4. Telephone Responder will be provided equipped for six lines. The 6 line system requires six 88mH loaded pairs for two wire working or 12 22mH loaded pairs for four wire working.
5. Telephone Responders are designed to be mounted within a Cabinet Type 600. It is normally supplied with an emergency battery power supply on a battery shelf. The Cabinet Type 600 housing the Telephone Responder may contain space for an ST and a Telephone Responder. If this is the situation, a special type of battery shelf is required. A Telephone Responder is supplied with flying leads for connection to the mains supply and longitudinal cable.
6. In 6 and 12 Telephone Responders, the shelf/chassis space required is identical. The Responder address(es) required are set up on site.

### **Sectoring**

7. Sectoring is used to spread the switching of telephone circuits efficiently around the network to minimise the limitation of 2 wire circuit by reducing the chance of mismatch and side tone.

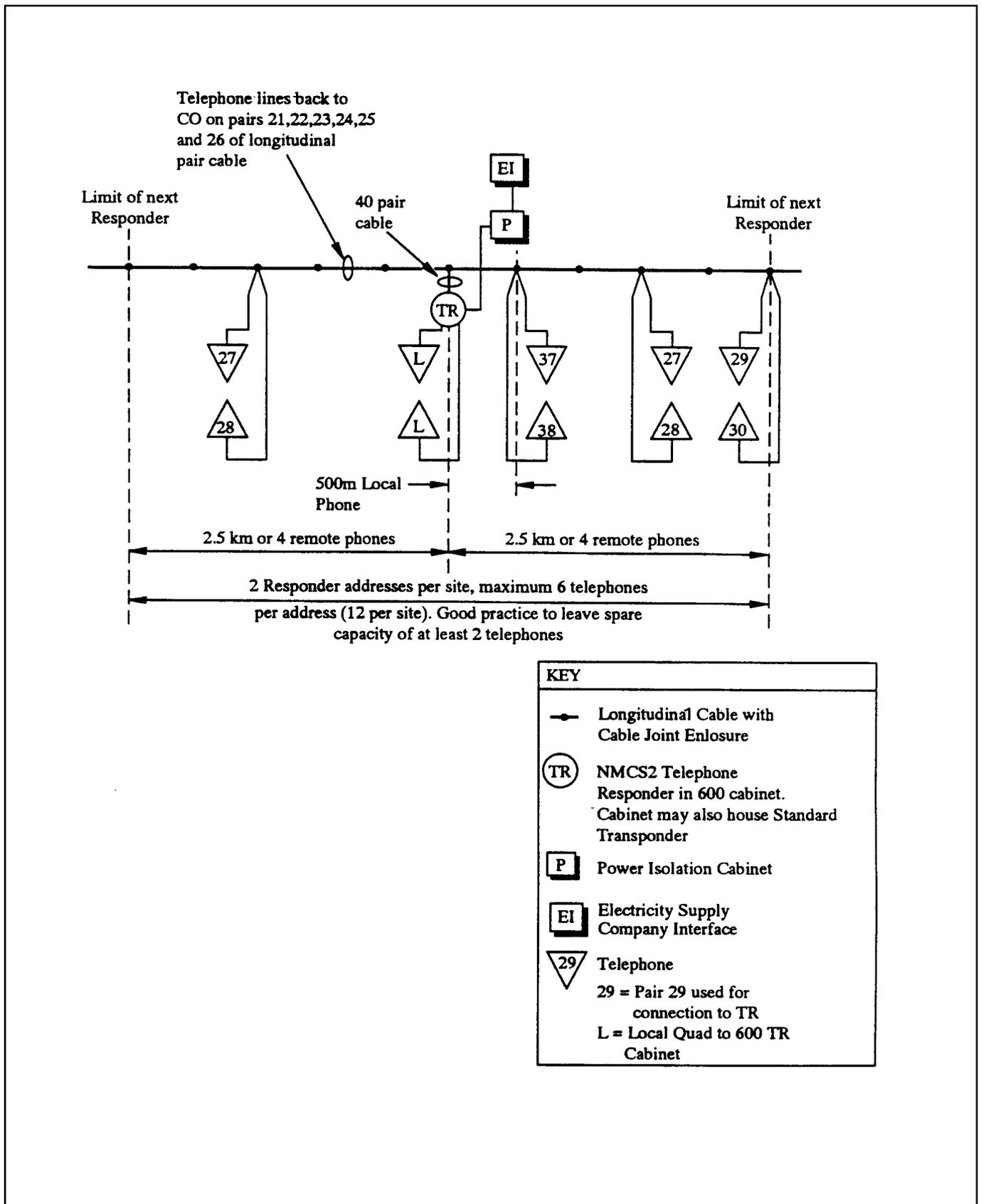


Figure A6.5a Telephone Responder Requirements (2 wire)

8. This switching is achieved through Sector Interfaces and Block Interfaces. These devices are identical in operation and construction, though in the network hierarchy a Sector Interface should always come between a Block Interface and the CO. Each has four ports through which the telephone circuits are switched. Each circuit will have a dedicated Sector Switch to switch it to the appropriate port.

9. The Sector Switch is a relatively simple device that allows one input to be switched to one of four outputs. The switching decision is made by the TLC.

**Network Design Rules**

10. The following network design rules should be followed:

- i. CO Areas can be divided into up to 8 sectors.
- ii. Each sector can be divided into up to 8 blocks. Blocks can only exist within sectors.
- iii. Each block can contain up to 8 Responder addresses. If a sector is subdivided into blocks it can contain up to 8 x 8 or 64 Responder addresses.
- iv. Each Responder address can support 6 telephones.
- v. There are usually 2 Responder addresses at each site.

**A6.6 Outstation Design - Telephone Network**

**General**

- 1. Normal provision is for 6 telephone circuits throughout the CO Network. However, for smaller CO Areas fewer circuits may suffice.
- 2. Switching between lines is achieved following an operator instruction at the CO.
- 3. In a small installation this can be done directly. However, most CO Areas require a telephone transmission network that is broken down into Sectors, some of which are further sub-divided into Blocks of Responders.

**Number of Telephone Circuits**

4. MCH 1331 details the methodology by which the desirable maximum number of telephones per Phase 3 telephone circuit (to give effective call handling facilities at the CO) can be calculated. The calculations assume the usual 1.5km spacing of telephones and the 'remote hold' facility of the Phase 3 Responder. Table A6.6a details the results.

No. of Telephone Circuits	Desirable Maximum No. of Telephones
1	3
2	30
3	90
4	174
5	271
6	379

**Table A6.6a**

- 5. This information could also be useful if it were necessary to run NMCS2 on 20 pair NMCS1 cable that only has 4 pairs available for telephone lines.
- 6. Designers should bear in mind the following:
  - i. It is desirable to keep the number of Sector Interfaces and Block Interfaces low, but not at the minimum, as this might cause problems when catering for expansion.
  - ii. It is not necessary to use all sectors.
  - iii. It is not necessary to use all blocks.
  - iv. It is possible to have a mixture of sectors that have been divided into blocks and 'non-divided' sectors.
- 7. Block Interfaces should always come after Sector Interfaces in the communications path. Before Block Switching is employed, consultation with the Highways Agency is required to define a suitable 4 wire transmission network.
- 8. Typical telephone transmission network design is shown in Figures A6.6a and A6.6b overleaf.

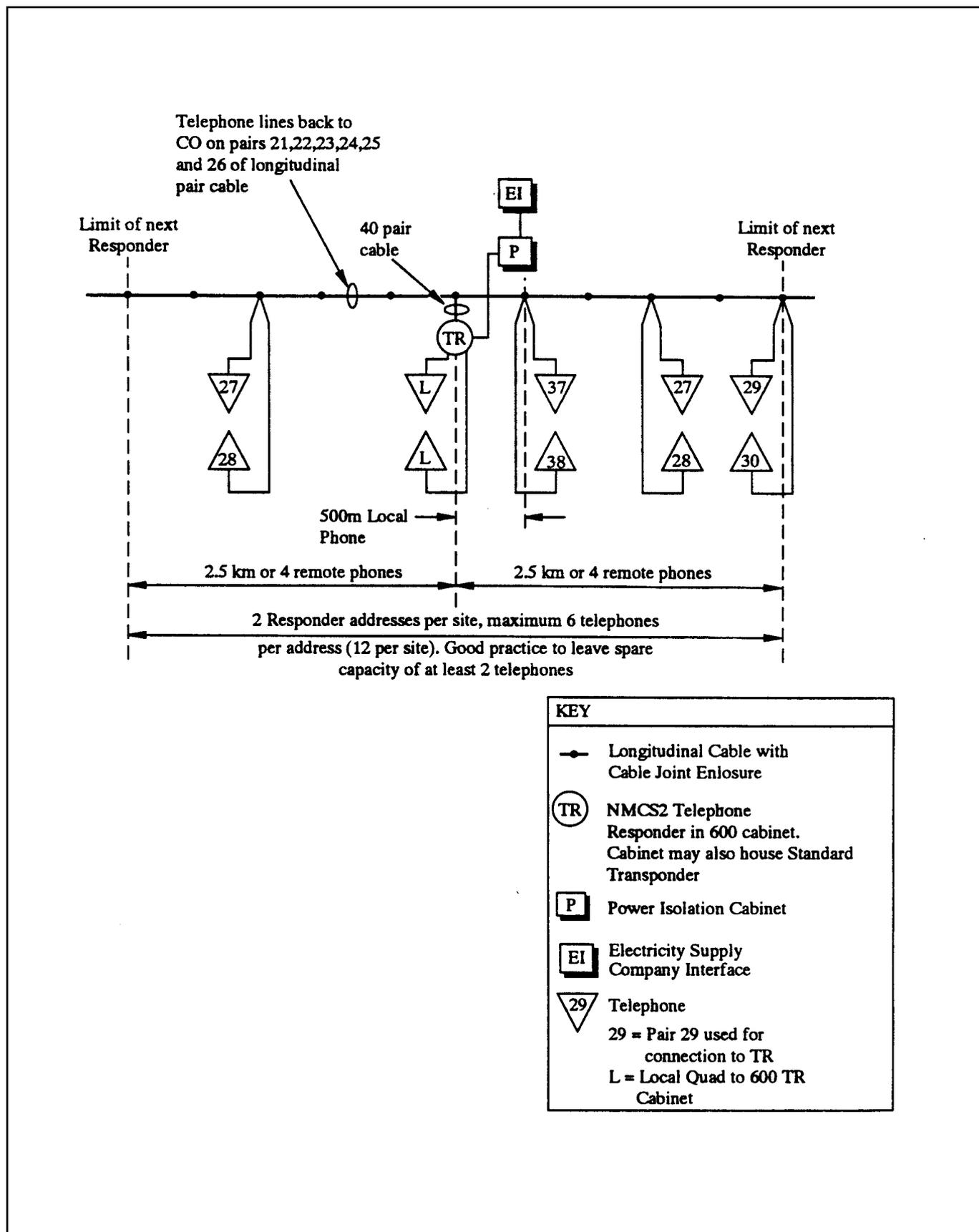


Figure A6.6a Typical Control Office Area split into sectors

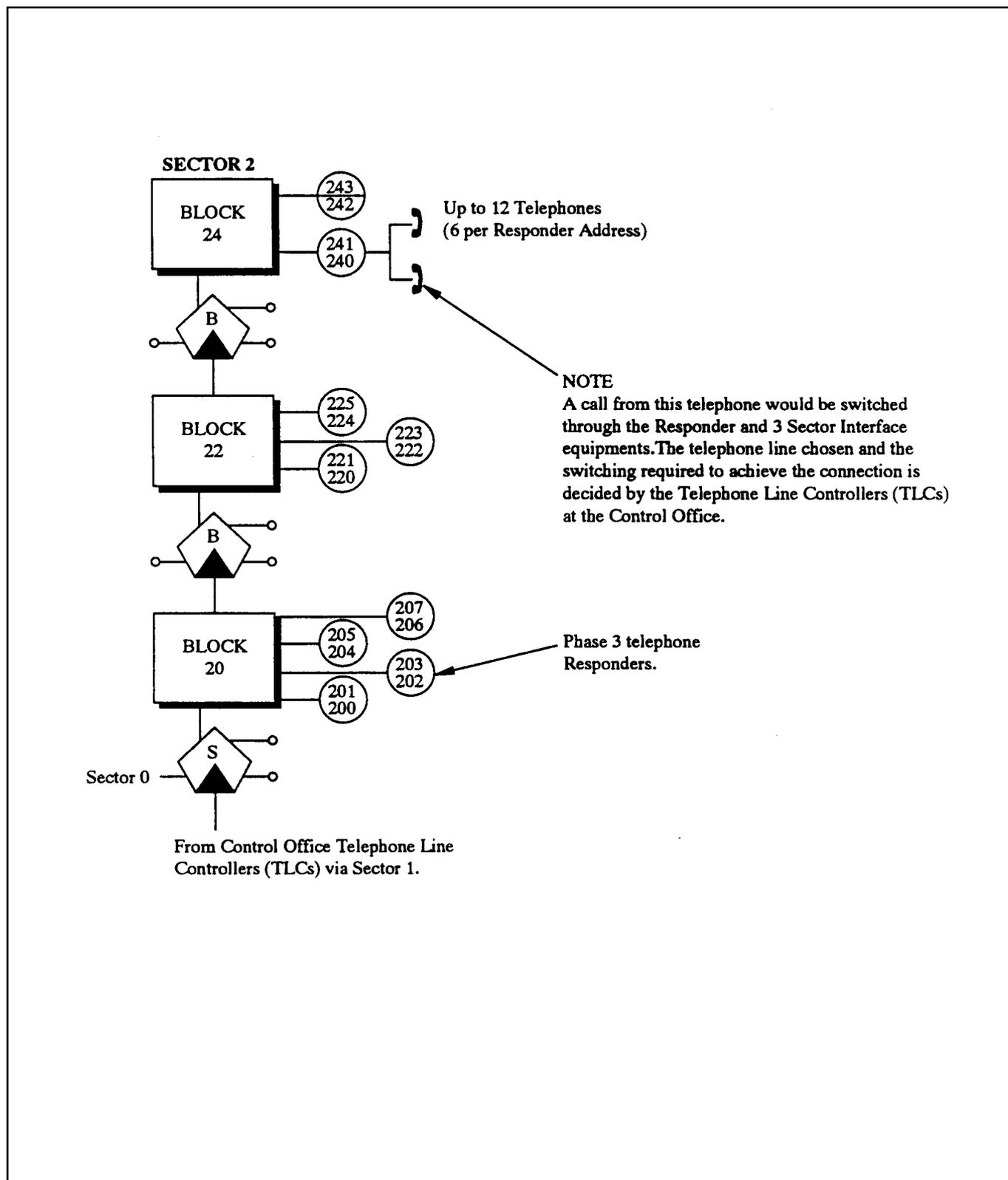


Figure A6.6b Typical Sector split into Blocks

## A6.7 Addressing

### General

1. There are two types of addressing, geographic and electronic. Geographic Addressing is dealt with in TA 77: Motorways. This sub-chapter deals with electronic addressing in an NMCS2 telephone network.
2. The limits of sectoring are allied to the electronic addressing of devices on the telephone transmission network. This addressing allocates octal references to telephones, Responders, Sectors and Blocks. There is no connection with the geographic address of the equipment.

### Telephones

3. Telephones have Electronic Addresses within the NMCS2 System architecture as well as Motorway Addresses. The Electronic Address is converted to the Motorway Address at the TLC within the CO. Details of Motorway Addresses are contained in TA 77/95: Motorways.
4. Telephones are numbered 1 to 6 at each Responder address.
5. Telephones have 4 figure octal addresses. An address 7452 identifies a telephone on the fifth responder in block 4 of sector 7.

### Telephone Responders

6. Responders have 3 figure octal addresses. Address 632 identifies the second Responder on block 3 of sector 6.
7. The address 000 is reserved.
8. A Responder should have sequential addresses within the same block and sector. For example 010, 011, 012 would be acceptable for an 18 telephone Telephone Responder but 007, 010, 011 or 127, 130, 131 would not.

### Blocks and Sectors

9. Two figure octal references are used to identify blocks, and single figures for sectors.

### Addressing System

10. From the Network Design Rules in A6.6 it can be seen that the maximum number of Responder addresses in the CO Area is 512 comprising 8 SECTORS of 8 BLOCKS of 8 RESPONDERS.
11. With one of these addresses, 000, being reserved, the maximum number of telephones per CO is 3066. The calculation is:  $(512 - 1) \times 6 = 3066$  Telephones.
12. The addressing system is shown in Figure A6.7a.

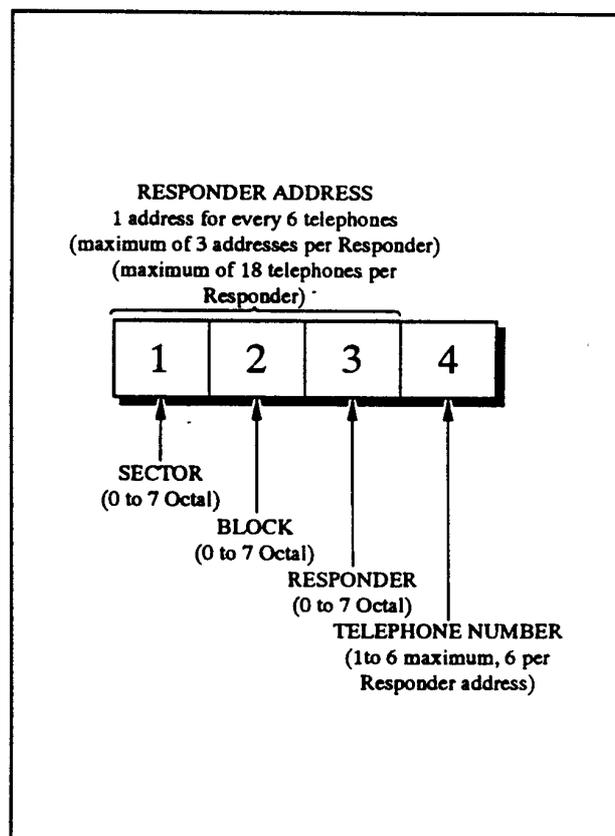


Figure A6.7a Addressing

13. Only the numbering of telephones is required to be continuous, ie, if four telephones are connected to a Responder they should be numbered 1 to 4. For Responders, Blocks and Sectors the addressing system allows gaps. This is particularly useful when planning for future expansion.
14. For more details, see MCH 1539 Installation Design Guide.

## **A6.8 MCH 1421**

1. This is a standard form on which the details of telephone addressing are recorded. When operational, it is normal for all the MCH 1421 forms for a CO Area to be given an MCY drawing reference by the Highways Agency (HA).
2. CO Area schematic diagrams of the telephone system are usually kept by the HA.

## A7. NMCS2 DATA SYSTEM DESIGN

### A7.1 Overview

1. The NMCS2 Data System is used to monitor and control motorway devices. These devices may be primarily output devices such as signals or message signs, or primarily input devices such as fog detectors or incident detection loops.

2. The data system installation consists of the Control Office Base System (COBS) and the various Subsystems that monitor and control the motorway devices via the data system. The Operator Interfaces (OIF) allow operator interaction with the Subsystems.

3. The data system outstation equipment consists of the Local Communications Controller (LCC), the Standard Transponder (ST) and the site equipment. The Data Transmission network required is summarised in Figure A7.1a.

4. In NMCS2 there are two types of communications paths:

- i. a telephone data path (used solely by the telephones system to control telephones)
- ii. a data communication path, of which there are three instances:
  - a. The NMCS2 COBS to the Regional Communications Controller (RCC) data path supports NMCS2 over boundary communications, and NMCS2 central logging.
  - b. The COBS to motorway devices data path provides control of motorway devices by all Subsystems.
  - c. The COBS to remote maintenance terminal data path provides external maintenance access to the system.

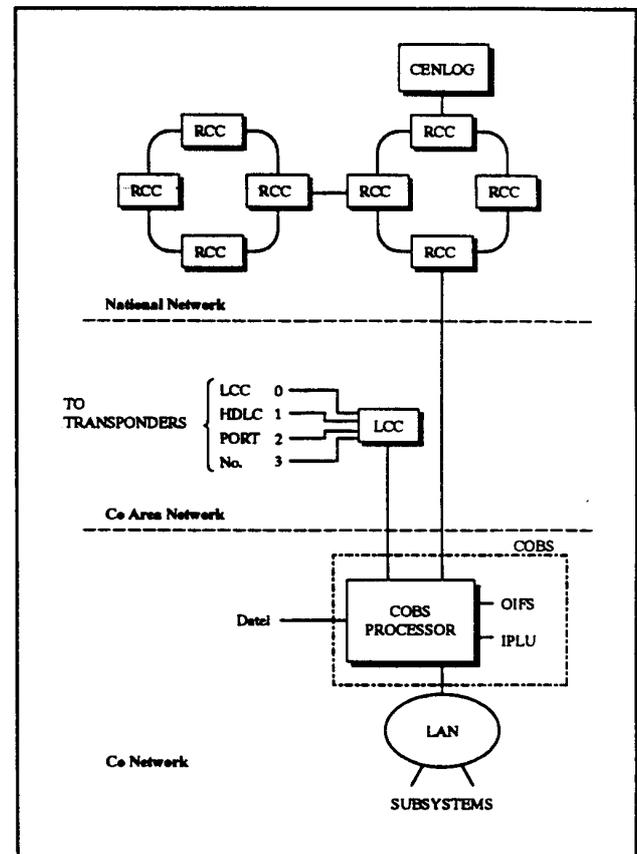


Figure A7.1a NMCS2 Data Transmission Network Overview

## A7.2 System Components

### Local Communications Controller (LCC)

1. The LCC comprises hardware and software necessary to interface with the COBS via a High-level Data Link Control (HDLC) Point to Point link and to Standard Transponders via up to four HDLC Multidrop links. The equipment includes a back-up power supply. Within the LCC's site data are details of all active Standard Transponders on its HDLC links.

2. The LCC performs two primary functions. Firstly, it acts as a communications node, routing messages through to their destination without interpretation. Secondly, the LCC maintains the status of all Transponders on its HDLC Multidrop links and reports faults and changes as necessary.

3. Further information on the LCC is available in TR 2046.

### Standard Transponder

4. The Standard Transponder (ST) is a local communications node within the data communications path of NMCS2. It enables the COBS to control the motorway devices and communications with the devices via RS485 communications links. The ST equipment is located next to the motorway. In terms of the data communications path, it resides between an LCC and the motorway devices.

5. The ST equipment comprises hardware and software necessary to interface with an LCC via an HDLC Multidrop link and to motorway devices via up to four RS485 links. Details of all the motorway devices attached to its RS485 links are provided to the ST as site data from the COBS. The equipment includes a back-up power supply.

6. The ST performs different functions depending upon the types of motorway device attached to its RS485 links. For each output type motorway device (except signals) the ST passes on messages received via the HDLC Multidrop link, to control the motorway devices. The ST performs further functions for signals. The ST maintains the status of all motorway devices (whatever their type) and reports changes as necessary.

7. Further information on the ST is available in TR 2045.

### Other Transponders

8. As NMCS2 Subsystems are developed it is envisaged that there may be a need for other types of Transponder, such as the MIDAS Transponder which is under development, that will perform tasks specific to a particular Subsystem.

### 21-bit Transponder

9. This device allows NMCS2 Signal Site Equipment to operate within an NMCS1 CO Area. For further information see TA 72: National Motorway Communications Systems and TR 2077.

### Signal Driver

10. The Signal Driver forms part of the Signals Subsystem of NMCS2. The equipment is located at the motorway either on a post in the central reservation or on a gantry. It is integral on a cantilever mounted EMS or MS2. In terms of the data system hierarchy it resides between a Standard Transponder and the Indicator(s).

## A7.3 Data Transmission Network

### Overview

1. The NMCS2 Data Transmission Network has four different types of link, and uses three different protocols for communication. These are summarised in Table A7.3a.

Link	Protocol	Use	Limitation
National Network Wide Area Network (WAN)	X.25 Level 3	RCC to RCC/COBS to RCC/COBS to Central log	Up to 20 COBS per RCC
HDLC Point to Point	X.25 Level 2	COBS to LCC link	3 links per COBS
HDLC Multidrop	X.25 Level 2	LCC to Transponder link	4 links of up to 58 slave stations (transponders)
RS485 Multidrop	RS485	Transponder to Device links	4 links of up to 30 devices

**Table A7.3a NMCS2 Data Links**

2. It can be seen, therefore, that if the COBS requires a motorway device to perform an action it will involve the transmission of messages over three successive links: the HDLC Point to Point, the HDLC Multidrop and the RS485. This is illustrated in Figure A7.3b.
3. TR 2070 gives details of the data system message control.

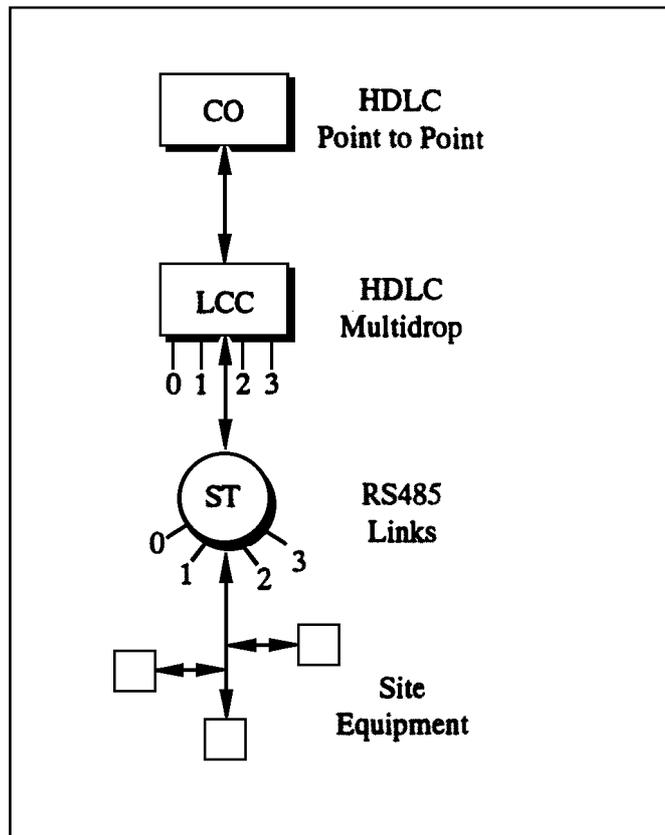


Figure A7.3b NMCS2 Data Transmission Network Overview

#### HDLC Point to Point Link

4. Within NMCS2, HDLC Point to Point interfaces are used to connect the COBS, located at the Control Office (CO), to LCCs, located at a CO Area communications interchange. Up to three links may be present in each system, however, cable pair limitations will normally limit the number of links used.
5. Physically, each link comprises two nodes, the COBS and the LCC connected by a 4-wire circuit.
6. The link utilises V29 Synchronous Modems operating at 9.6 kbit/s.

7. The HDLC Point to Point specification is TR 2049.

#### HDLC Multidrop Link

8. Within NMCS2 an HDLC Multidrop link is used to connect an LCC, located at the CO Area major communications interchange, to the Standard Transponders located at the roadside.
9. Physically the link comprises a master station, the LCC, and up to 58 slave stations, each consisting of a Standard Transponder, connected by a 4-wire circuit.
10. The LCC provides HDLC links in 4 directions. A problem arises when one of the links needs to be split, for example where a short motorway spur occurs along a length of motorway. A hybrid transformer, located at the TS can be used to perform the split; this will create an unloaded spur. Where the use of unloaded spurs is considered early advice should be sought from the Highways Agency.

11. The HDLC Multidrop specification is TR 2066.

#### RS485 Links

12. Within NMCS2 an RS485 link is used to connect Standard Transponders to motorway devices.
13. Physically, the link comprises a master device, ie the Standard Transponder, and up to 30 slave devices, each of which is of one RS485 unit load and may be one of several types of motorway device. Each motorway device comprises of a transceiver port and a 2-wire circuit.
14. The RS485 technical specification is TR 2067.
15. The RS485 link operates asynchronously, half-duplex at 2400 bit/s.

### A7.4 Outstation Design - Data Network

#### Local Communications Controller

1. The LCC provides the means of communication between the COBS and Standard Transponders. This enables the instation to control the motorway devices via the Transponder's RS485 communication links.
2. Normally there will be one LCC, however, up to 3, subject to cable pair limitations, may be provided if required. The COBS communicates to an LCC using an HDLC Point to Point link.

3. The LCC fits into a single 19" racking unit, 6U high.
4. The LCC has four ports through which HDLC Multidrop data communication paths pass to the Standard Transponders. The ports are numbered 0 to 3. Each port can support up to 58 STs.
5. The LCC is located at the CO Area major communications interchange. This would usually be either at a centrally positioned Transmission Station (TS), or the TS where the connection back to the CO is made, or at the CO itself.
6. Once the Transponder and CO Data Transmission Design has been completed, Transponders along lengths of motorway can be assigned to ports on the LCC. As long as there is no obvious overloading of ports the LCC can be situated in the most convenient place on the network. If advice is required on the transmission design or allocation of LCC ports it should be sought from the Highways Agency.
7. The LCC specification is TR 2046.

## A7.5 Outstation Design - Transponders

### 7km Transponder Rule

1. One of the philosophies of NMCS2 is the concept of 'complete CO Area Coverage'. It should be possible anywhere on the network to add extra equipment with the minimum additional infrastructure.
2. The design criteria for Standard Transponder (ST) siting are:
  - i. The maximum length of an RS485 link is 4km of cable.
  - ii. STs are sited within 50m of a joint on the longitudinal cable.
  - iii. Except for signals local to an ST, RS485 connections are made to the nearest joint on the longitudinal cable.
  - iv. A maximum of 30 devices may be connected to a Transponder port.

3. To ensure that an RS485 connection to the NMCS2 Data Transmission network can be made at any point on that network, on present or future schemes, Standard Transponders should be placed a maximum electrical distance of 7km of longitudinal cable apart.
4. This provides a fail-safe method of placing STs to provide continuous RS485 availability throughout the NMCS2 CO Area transmission network. It is also important to note that Transponders may well be less than 7km apart. This is especially true in areas of dense signalling such as interchanges.
5. There should be a maximum cable length of 3.5km + 50m from the Transponder to the last cable joint. Even in the worst case when the spur cable between ST and cable joint is 50m, there would still be a budget of 450m of cable for connection to motorway devices.

### Initial Transponder Positioning

6. An ST should be placed to cover each spur of any motorway - motorway interchange. An ST should be placed 3km from each CO boundary and start of motorway. The network should then be filled by placing an ST every 7km.

### Port Allocation

7. The loadings of the Transponder ports need to be assessed. Every signal indicator, fog detector, etc, is a device. A transponder port has the capacity to drive 30 devices. However, on new installations it is good practice to limit the number of devices per port to around 20, to allow for future expansion.
8. At Standard Transponder sites, RS485 lines to site equipment are standardised in their allocation as follows:
  - i. Port 0 is connected to unit 1, pair 3 (in the longitudinal cable) in the direction of increasing marker posts;
  - ii. Port 1 is connected to unit 1, pair 3 (in the longitudinal cable) in the direction of decreasing marker posts;
  - iii. Port 2 is not normally connected into the longitudinal cable but is used for local connections (ie, site equipment cabled directly to the Transponder site and not requiring remote connection through the longitudinal cable);

- iv. Port 3 is normally left free for future use but may be employed for other RS485 duties if cable pair availability and if circumstances warrant this.
- 9. There are no requirements to 'balance' the number of devices on each port.
- 10. The typical NMCS2 ST requirements are shown in Figure A7.5a.

### **Refined Transponder Positioning**

- 11. Following the exercise to determine port loadings it may be necessary to insert additional STs and move equipment to maintain sensible spacing.
- 12. When the telephone system design is complete, combining ST and Telephone Responder sites will save on power cable and cabinet provision.
- 13. Designers should not forget that STs and devices require power. On existing motorways the possibility of placing the ST near to an existing EI should be examined. Many NMCS1 rural installations consisted of a Responder, an EI and a pair of signals at the same site. Use of existing EIs may be more economical than the provision of an extra Transponder in some situations.
- 14. The possibility of using new EIs installed for lighting or for enhanced signalling installations should also be kept in mind when positioning STs.

### **Network Connection**

- 15. The ST is connected to the longitudinal cable network by a 40 pair spur cable. The MCX 0800 series refers.

### **Infrastructure**

- 16. For provision of cable and cabinets, refer to TA 77: Motorways.

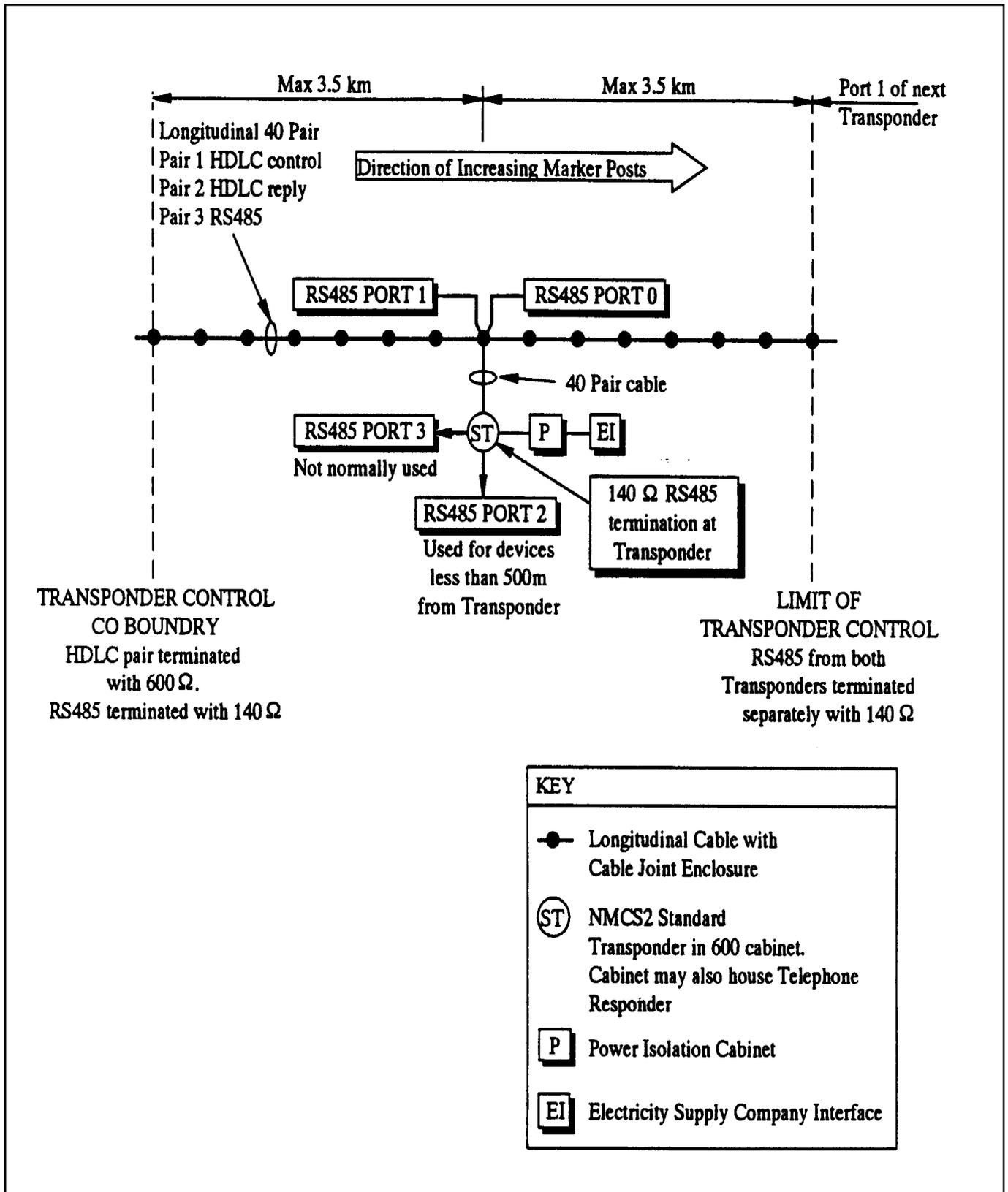


Figure A7.5a Standard Transponder Requirements

## A7.6 Outstation Design - Terminations

### General

1. The general requirements for NMCS2 terminations are summarised below. The design detail should be recorded on the system schematic drawings.

### HDLC Multidrop Link

2. HDLC control and reply signals appear on pairs 1 and 2 of the longitudinal 40 pair cable throughout the CO Area. The HDLC is linked to Transponders via pairs 1 and 2 of the local cable which are terminated in Cable Joint Enclosures (CJE). At the HDLC Transmission boundaries each pair should be terminated with a 600 Ω resistor. The exact position of the end of line termination is dependent on the loading of the cable and is determined by the Highways Agency and installed by its Transmission Works Contractor.

### RS485 Link

3. RS485 links require to be terminated in 140 Ω resistors. For ports 0 and 1, unit 1 on pair 3 of the longitudinal cable, the resistors are placed at the furthest CJE from the ST. For Port 2, the local port, the 140 Ω termination is made at the ST.

### Local Cabling

4. All signal cabling requirements are dealt with in TA 74: Motorway Signalling.

## A7.7 Addressing

### General

1. There are two types of addressing, geographic and electronic. Geographic Addressing is dealt with in TA 77/95: Motorways Infrastructure Design. This sub-chapter deals with electronic addressing in the NMCS2 data transmission network.

### Transponder Addresses

2. Transponder addresses should relate to their 'slave station' addresses on the HDLC multidrop link. This can take the form of a three figure octal address. The first figure should be in the range 0 to 3 to reflect the four ports of the LCC. The second two figures should be in the range 05 to 76. Addresses 00 to 04 are reserved (01 for COBS, 02 to 04 for LCC) and 77 is used for an 'all stations broadcast'. This gives a total of 58 device addresses available for each LCC port.

### Device Addressing

3. Site equipment is also numbered in octal. The allocated number is prefixed by the Transponder Port number of the RS485 link to which it is connected. This provides a 3 (octal) digit number that should be unique to that Transponder. Standards for site equipment addressing may be summarised as follows:

- i. sites are numbered progressively working outwards from the Transponder.
- ii. the first item of site equipment is numbered (after the RS485 Port number of the Transponder) commencing with 01, the next 02, etc. The maximum is 36 (30 devices).
- iii. site equipment that is common to both carriageways (eg, a double headed signal post) has the 'A' carriageway equipment numbered before the 'B' carriageway equipment.
- iv. gantry indicators are numbered from near-side (Lane 1) to off-side (Lane 2, Lane 3, etc).
- v. gantry signals spanning a main carriageway and a merging or diverging slip/link road have the main carriageway indicators numbered before the link/slip road indicators.
- vi. Motorway Signals Mark 2 (MS2) consist of two components, the Enhanced Message Sign (EMS) and the Enhanced Matrix Indicator (EMI); both require a device address.

## **A8. REGIONAL COMMUNICATIONS CONTROLLER (NMCS2)**

### **A8.1 Overview**

1. The Regional Communications Controller (RCC) is provided to link NMCS2 COs to the central logging centre at Coleshill and to other NMCS2 COs for cross boundary communications.

### **A8.2 Components**

1. The RCC Network is a National Wide Area Network (WAN) and comprises of a number of X.25 packet switches located at key locations on the network. The network manager is located in Coleshill Computer Centre; there is also a connection to Tollgate House in Bristol.

### **A8.3 Operation**

1. RCC communication links to Control Office Base Systems (COBS) use the X.25 level 3 protocol. The motorway communications cable network or Public Telecommunications Operator (PTO) is used to provide these links.

### **A8.4 Design**

1. MCH 1627A - RCC Network Implementation, Naming, Addressing and Routing in the RCC Network gives further details.
2. RCCs are sited in Transmission Station buildings.
3. It is recommended that discussion should take place with the Highways Agency (HA) to achieve efficient and programmed connection into the RCC Network when new NMCS2 COs (including changeover from NMCS1) are being planned. The connection of new equipment to the RCC requires the involvement of the HA for port addressing changes and provision of V29 modems.

## A9. NMCS2 SYSTEM DATA

### A9.1 Overview

1. Each NMCS2 installation will differ from others in several ways. These include the:
  - i. number and types of Operator Interfaces (OIF)
  - ii. number and locations of outstations
  - iii. number and types of motorway devices
  - iv. number of telephone circuits
  - v. Subsystems installed
  - vi. maps, menus, and other information to be displayed on OIF's
  - vii. peripherals (eg printers) installed.
2. Also, with a given system, standard types of equipment such as Standard Transponders need to operate differently depending on the number and configuration of the devices connected to it. This variable information is down-loaded to the Transponder from the instation, In this way, re-configuration and the adding or removing of devices can be carried out simply and without extensive re-programming.
3. System data is divided into two categories:
  - i. Configuration Data, which defines the installation-specific information in the first paragraphs above;
  - ii. Site Data, which includes the information downloaded to outstations (the latter paragraph above), and information to inform Subsystems about the devices they control.
4. All system data is held centrally, on the Control Office Base System (COBS), from which it is loaded to outstations and Subsystems as appropriate. System data is maintained by the Highways Agency.

### A9.2 System Data Changes

1. The procedures to be followed when planning and implementing changes to System Data are detailed in MCH 1596.

### A9.3 MCH 1420 and MCH 1421

1. These proformas are completed by design agents to detail Transponder and Responder electronic addressing. Within an existing Control Office area they will have MCY drawing numbers unique to that area. They should form the base point for preparing a data change.

## A10. NMCS1 TO NMCS2 CHANGEOVER

### A10.1 Overview

1. The upgrading of motorway communications from NMCS1 to NMCS2 usually involves the concurrent operation of both systems and their equipment. The following items are available to aid the process:

- i. NMCS1 Telephone Only Responder,
- ii. NMCS2 21-bit Transponder.

2. A suggested changeover method is shown in Figure A10.1a. This will, however, require modification to suit site-specific requirements.

### A10.2 NMCS1 to NMCS2 Upgrading

#### Overview

1. The most likely scenario for the implementation of NMCS2 is as a replacement for an NMCS1 system. Only where new motorway is constructed, or where existing trunk road is upgraded to motorway standards, is it likely that NMCS2 will not be installed as a replacement for an existing NMCS1 system. Even in these cases the NMCS2 infrastructure may have to operate within an NMCS1 Control Office (CO) Area.

2. Completing the installation of the NMCS2 COBS installation is the key to successful conversion from NMCS1 to NMCS2. Cable and equipment should be installed well in advance of Control Office Base System (COBS) installation. This section highlights the main events within an NMCS1 to NMCS2 upgrading scheme.

#### Infrastructure

3. All cable upgrading contracts or new motorway works should provide infrastructure capable of supporting NMCS2. The NMCS1 to NMCS2 upgrading Design Agent should identify all areas where this is required.

4. Where equipment renewal is being undertaken the following works are required:

- i. Installation of 21-bit Transponders to replace existing NMCS1 Responder signalling capability.
- ii. Installation of NMCS2 infrastructure at signal sites connected to 21-bit Transponders.
- iii. The installation of Cabinet Type 600 to house NMCS2 Phase 3 Telephone Responders.
- iv. The retention of existing NMCS1 Responders and/or the installation of NMCS1 Telephone-Only Responders until changeover from Phase 2 to Phase 3 Telephone Systems.
- v. Cabling of telephones to Cable Joint Enclosures, not to NMCS1 Responders.
- vi. Sufficient power supplies to cater for all proposed equipment.

5. NMCS2 infrastructure on each separate scheme contract should extend to the limit of the scheme, or to meet the limit of existing NMCS2 infrastructure. There should not be any possibility of any gaps in NMCS2 coverage when the conversion process is completed.

#### Conversion

6. There are several possible stages in the conversion from NMCS1 to NMCS2 once the NMCS2 COBS has been commissioned.

- i. NMCS1:  
Existing system with NMCS1 Responders driving NMCS1 signalling equipment and Phase 2 telephone system.
- ii. NMCS1 with 21-bit Transponders:  
Existing system except that 21-bit Transponders drive NMCS2 signalling equipment. Phase 2 Telephone System driven by NMCS1 Telephone Only Responders.

- iii. NMCS2 with Phase 2 and Phase 3 Telephones: Full NMCS2 signalling and Phase 3 telephones. These are commissioned on a sector by sector basis as available telephone lines on the longitudinal cable are transferred from Phase 2 operation.
- iv. NMCS2: Full NMCS2 signalling and Phase 3 Telephone System.

When the conversion is complete, all items of NMCS1 equipment are recovered and considered for refurbishment and cables are removed and scrapped where appropriate. Any power supplies no longer required are made safe.

### **Alternative Conversion Strategies**

- 7. Telephone conversion can be undertaken before, or at the same time as Transponder conversion. It is, however, normal practice to treat telephone and signal conversion as separate exercises.
- 8. In some CO Areas, such as those covering M25, NMCS2 and NMCS1 systems have been in concurrent operation on different parts of the motorway network, supported by different infrastructure.
- 9. There have also been conversions where Phase 2 and Phase 3 telephone systems have shared telephone pair allocations.
- 10. Where a civil scheme is of such magnitude that the existing communications infrastructure should be removed and the scheme is close to a CO boundary, it may be useful to temporarily change that boundary to the scheme limit.

### **NMCS1 During Conversion**

- 11. 21-bit Transponders cannot share NMCS1 Telephone Only Responder addresses. This may lead to the non-availability of sufficient Responder addresses within the NMCS1 Responder groups and necessitate the provision of an additional Responder group.
- 12. All stages during the upgrading will have some effect on both the local and national networks. It is important that the Highways Agency's Transmission Branch is consulted. They will have to co-ordinate work for the National Carrier Maintenance Contractor (NCMC) and the National Transmission Works Contractor.

- 13. Similarly it is important that the specialist Regional Maintenance Contractor (RMC) is kept fully aware of all changes within his area of responsibility.

### **A10.3 NMCS1 Telephone Only Responder**

- 1. These devices are purchased by the Highways Agency and supplied to contracts for use in CO Areas where the use of 21-bit Transponders has become widespread. They are able to drive a maximum of 8 Phase 2 telephones from 2 NMCS1 Responder addresses.
- 2. They have the advantage that they can be mounted in cabinets that are being provided to house Phase 3 Telephone Responders. Space should be left in these cabinets between the Telephone Only Responder and the battery to allow for the installation of a Phase 3 Telephone Responder.
- 3. A further advantage of the Telephone Only Responder is that it can drive telephones up to 3.2km away from it, similar to the Phase 3 Telephone Responder. This contrasts with the 2.5km maximum distance of the normal NMCS1 responders.

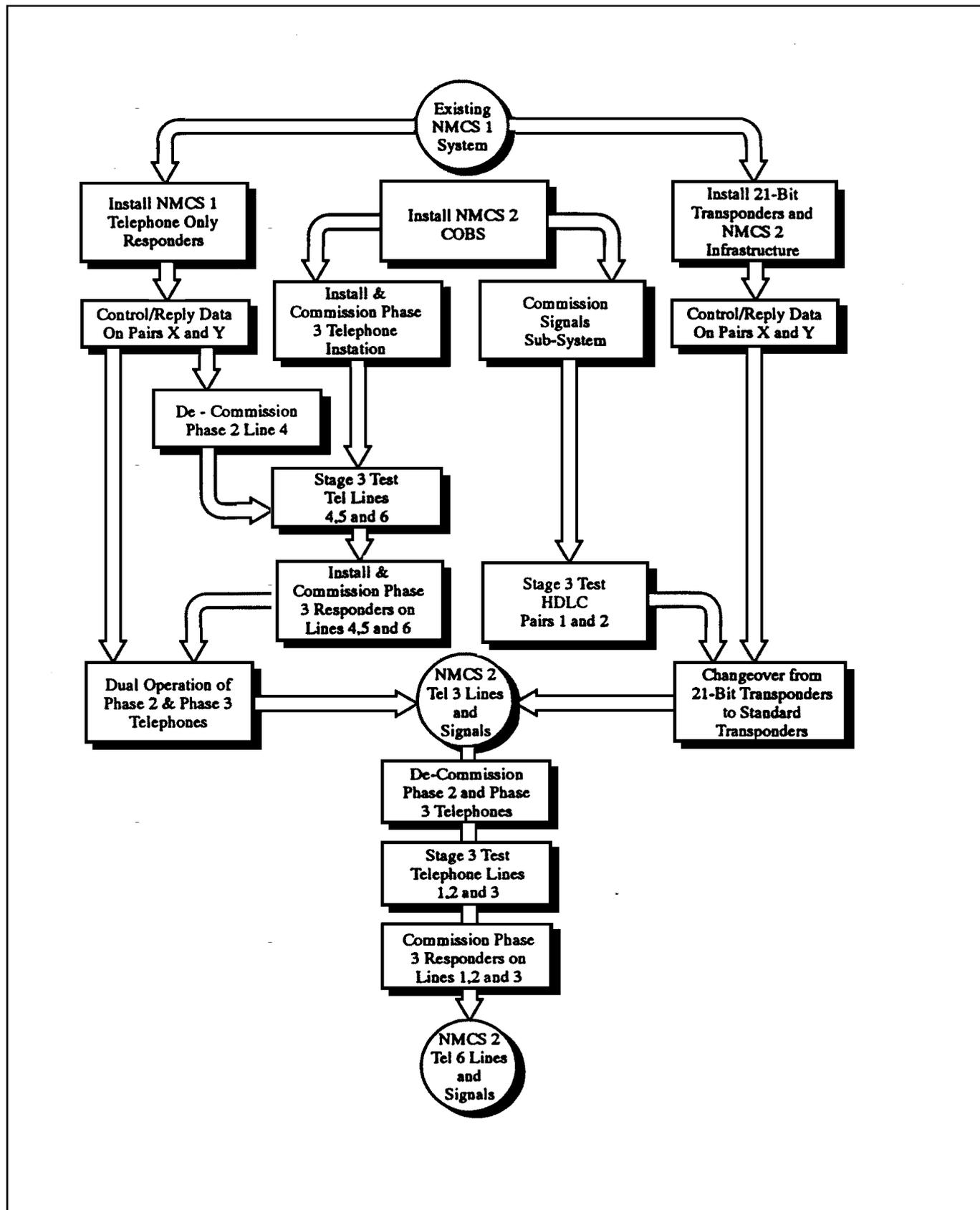


Figure A10.1a Typical Stages of NMCS1 to NMCS2 Changeover

## A10.4 Phase 1 to Phase 3 Telephone Conversion

1. A simple and quick upgrade path allows a minimum Phase 3 system to be implemented. Phase 1 outstations (Telephone Bridging Units) are replaced with Phase 3 Responders that may often be restricted for operation with a single longitudinal circuit in a direct emulation of a Phase 1 system. The Phase 1 Telephone Answering Units (TAUs) are replaced with Telephone Line Controllers (TLC). A TLC may be substituted for a TAU; the number of TLCs provided being defined by the number of operators required to have access to the system via Operator Control Panels (OCP). Telephone instruments and signal distribution components remain unchanged.

## A10.5 Phase 2 to Phase 3 Telephone Conversion

### Method

1. Telephone lines within the longitudinal cable are shared between Phase 2 and Phase 3 systems. This means that the police are required to operate two different systems.
2. Typically, a 3 line/3 line or 2 line/4 line arrangement will exist. Interrupter cable is used wherever necessary to maintain service. The actual changeover program will depend on the CO Area geography.
3. Figure A10.1a shows a general method for the changeover from Phase 2 telephones to Phase 3 telephones.

## A10.6 NMCS1 to NMCS2 Signalling Conversion

### 21-bit Schemes

1. A variant of the NMCS2 Standard Transponder, the 21-bit Transponder, exists to allow the installation of NMCS2 signals within an NMCS1 CO Area.
2. The 21-bit Transponder is a Standard Transponder modified to enable it to communicate with an NMCS1 Central Processor instead of an NMCS2 Local Communications Controller (LCC). It also enables an NMCS1 Central Processor to control NMCS2 matrix indicators (but not other motorway devices) for traffic management. This is achieved via the

RS485 communications links of the Transponder. The 21-bit Transponder equipment is located next to the motorway and housed in a Cabinet Type 600.

3. Later changeover to NMCS2 operation is achieved by completely replacing the 21-bit Transponder with a Standard Transponder.
4. The 21-bit Transponder can hold up to 15 addresses within the NMCS1 Responder Group, eight signals per Responder address. They can be mixed with ordinary 700 series NMCS1 responders.
5. Site Data contains translation tables for the data used by the NMCS1 Central Processor and that used by the 21-bit Transponder for the control of its RS485 links. Site Data is loaded into the non-volatile memory of the 21-bit Transponder. This data is copied to intermediate working memory (for commissioning purposes) at run-time and may be modified using an Engineer's Terminal. The 21-bit Transponder equipment includes a back-up power supply.
6. The Signal site equipment connected to a 21-bit Transponder is always of the NMCS2 type.
7. For further information on the 21-bit Transponder see TR 2077.

### NMCS1 Data Changes

8. When proposing the use of 21-bit Transponders, Design Agents should bear in mind the increase in size of NMCS1 Responder Groups. There may even be a requirement to provide an extra Responder Group. In this case, the Highways Agency's Transmission Branch should be consulted as early as possible during the design process.

## A11. NMCS2 SUBSYSTEMS

### A11.1 Overview

1. As well as the standard functions provided by the Control Office Base System (COBS), all NMCS2 systems contain one or more Subsystems which control specific types of motorway devices. A Subsystem is implemented on a separate processor, connected to the COBS via the Local Area Network (LAN).

2. All NMCS2 systems have a Signals Subsystem, which controls the signalling equipment.

3. Subsystems currently planned include:

- i. Message Signs (MCH 1655);
- ii. Lighting Control (MCH 1660);
- iii. Motorway Incident Detection and Automatic Signalling (MIDAS);
- iv. Wall Mimic Control (WMC);
- v. Tunnels;

against sequencing algorithms, and responding to operator requests with commands to indicators.

4. Details of the motorway devices for which the Signals Subsystem is responsible are provided by the COBS in Site Data. So that the Subsystem can effect control of current and yet to be defined indicators, it receives indicator type tables from the COBS. The indicator type tables describe the Aspects and control data for all available Indicators.

5. For further information refer to TR 2072.

### A11.2 Signals Subsystem

1. The Signals Subsystem is responsible for controlling all the indicators within the boundary of the Control Office (CO) Area and for requesting appropriate settings of indicators next to the CO Area. Indicators within the CO Area are controlled by sending messages on the High-level Data Link Control (HDLC) network. Cross-Boundary indicators are controlled by sending requests to other CO NMCS2 systems over the Regional Communications Controller (RCC) network.

2. The Signals Subsystem equipment comprises of hardware and software necessary to interface with a COBS and other Subsystems via a LAN interface. Physically the Signals Subsystem equipment resides in a 19" rack within a cabinet located in the CO Equipment Room.

3. Functionally the Signals Subsystem provides operators with facilities to control the setting and obtain the status of indicators. This is achieved by presenting menus and displays at the Operator Interface (OIF) and Engineer's Console, processing operator setting requests

## A12. NMCS1

### A12.1 NMCS1 Overview

1. NMCS1 was conceived as a National Transmission System. Its philosophy of central, rather than distributed, processing supported by a suitable transmission network is indicative of the technology available when it was designed in the 1970s. Subsequent upgrades, add-ons and software developments have enhanced its performance. The system has now been superseded by NMCS2, though NMCS1 will remain in place in parts of England for some years to come, until NMCS2 conversions are complete.
2. NMCS1 is an analogue transmission system. The equipment connected to this system has been designed to interface with it. This contrasts with NMCS2, which uses standard protocols within a digital environment, which allows a far greater variety of types of equipment to connect with it.
3. Detailed technical information on NMCS1 transmission and a description of the national network is contained in TA 75/95: Motorway Transmission.
4. This Chapter reflects designs that have long since been installed and operational. It explains how NMCS1 functions and is connected together. It is only intended as a design guide for minor additions to existing systems, in the light of the fact that no new NMCS1 systems are envisaged. It also provides important background information on standards that have previously been employed. This will be useful to NMCS2 conversion designers by giving an appreciation of how the system was configured for NMCS1.
5. NMCS1 has three main components:
  - i. Central Processors
  - ii. Control Offices
  - iii. Motorway equipment (Responders, telephones and signals).
6. The components are linked together by a national and a local transmission network. The telephone system and the signalling system cannot be supplied, or operate, separately. Figure A12.1a shows how the components are linked together.

### A12.2 NMCS1 National Network

#### Overview

1. The National Transmission Network provides communications between Control Offices (COs), Central Processors (CPs) and the local network to the roadside equipment (Responders).
2. The National Transmission Network uses a Frequency Division Multiplex (FDM) 12+12 channel system to relay information. This system is also known as the High Frequency Carrier (HFC) Network. This uses dedicated pairs in the 20 or 30 pair cable laid alongside the motorway. The basic network in England forms a national 'figure of 8' centred on Coleshill. This allows dual routing from anywhere on the network in the case of a cable break.
3. The figure of 8 network runs along sections of M1, M4, M5, M6, M18, M25, M42, M61 and M62. It is supplemented by various sub loops, such as M25 and the North West loop. Spurs along other motorways connect all COs to the National Network. Often when the CO is distant from the motorway, the final link is made by Private Wires from a suitable Transmission Station.
4. Designers should note that the availability of spare carrier channels may be a constraint on temporary expansion of an NMCS1 CO before conversion to NMCS2.

#### Network Fault Monitoring

5. A Transmission Integrity Tone is sent out by the CP and detected by the CO's, it should be present on all longitudinal cables. If it is not detected at intervening Transmission Stations, or at the CO, there is a break in the national network. The CO will then raise a transmission fault known as TA1.
6. If the CP does not receive replies from Responders/signals/telephones when it makes its regular polls of these devices, it will assume a break in the network; resulting in a TA1.

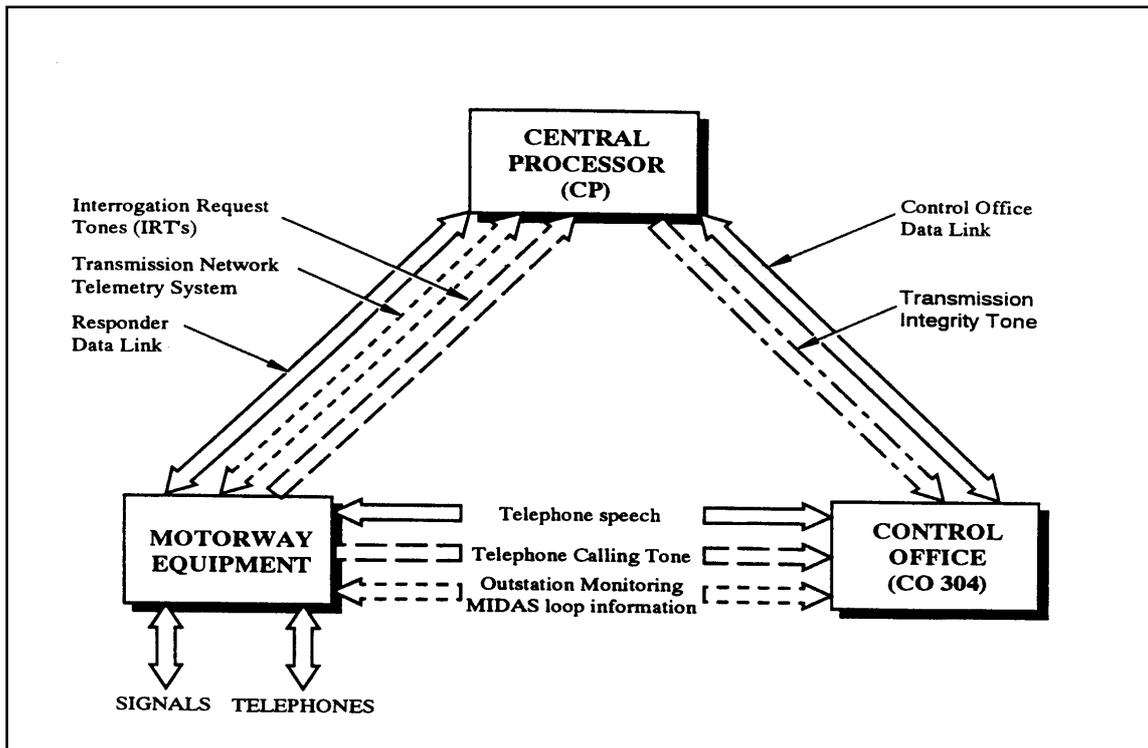


Figure A12.1a NMCS1 Operational Network

7. A transmission network Telemetry System can locate cable breaks to sections between Transmission Stations. The system also allows maintenance personnel to access fault logs kept at the CPs for anywhere in the country. This can be done from any transmission station, or via the Public Switched Telephone Network (PSTN), using a Remote Engineers Terminal (RET).

#### Network Maintenance

8. The National Network is maintained by the National Carrier Maintenance Contractor (NCCMC). The local network is maintained by the specialist Regional Maintenance Contractor (RMC). Both should be informed, via the HA and involved in any work or modification to the NMCS1 Network.

#### Further Information

9. Further information on the NMCS1 National Network is contained in TA 75: Motorway Transmission.

### A12.3 Local Network

1. Each CO area has a local transmission network that carries the Responder data link between the CP and the motorway equipment. This is the link through which signals are set on site, telephone calls are identified and faults are reported.
2. Telephone transmission capacity problems are overcome by using carrier equipment similar to that on the HF Carrier Network. Usually a 6+6 channel system is used. This is known as mini carrier and is maintained by the RMC. Fibre Optic Pulse Code Modulation (PCM) is also used.
3. The only direct links between the motorway equipment and each CO are:
  - i. the telephone speech circuit
  - ii. the telephone calling tone which allows the request for connection to be detected.

In some CO areas links providing information from outstation monitoring equipment are also present.

4. Also present on at least part of the local transmission network, is the CO Data Link. This is the path along which the CP and the CO 304 processor at the CO communicate.

### A12.4 Central Processors

1. There are two NMCS1 CPs. The CP303 is at Coleshill near the M6/M42 interchange in the West Midlands, and controls CO areas in the South of England. The CP305 is at Westhoughton at M61 Junction 6 in Greater Manchester and controls the North of England.

2. At each centre there are two computers. One is constantly on standby for the other. A regular change over between processors takes place at 10am every day.

3. CPs contain the following information for their region:

- i. Responder groups
- ii. Responder addresses
- iii. Signal addresses
- iv. Signal sequencing information
- v. Telephone addresses
- vi. CO addressing

4. CPs also act as activity logging centres. The results of all Responder group checks (which take place approximately every 5 minutes), fault reports, signal setting activity, telephone activity, and entries made by operators at COs are all recorded.

5. The CP regards the CO as its control equipment. Only very limited telephone facilities are available at the CO in the event of a failure of the NMCS1 National Network linking the two. The Phase 2 telephone system reverts to "fall-back" or "Line 1" working which is a simple system in which all calls share a single party line without call identification.

6. The CP can be interrogated by maintenance engineers via telex, Remote or the NMCS Telemetry System. The telemetry system is based at the Coleshill centre.

## A12.5 NMCS1 Responder

### NMCS1 Type 700A Responder

1. The NMCS1 specification for Type 700A Responders allowed for equipment operating up to 8 signals and 8 telephones. Responder types are identified as 7xy where x is the number of signal interface cards fitted, and y is the number of telephones to be provided for.

2. Responders usually have a capability for 6 signal interface cards to be fitted. 8 signal capability was wired up as a special requirement on manufacture, though some manufacturer's equipment can easily be modified. Designers should check with the RMC and the HA's Transmission Branch if 8 signal capability is required, as it may be more prudent in the long term to fit an NMCS2 21-bit Transponder, NMCS2 local cable arrangements and NMCS2 type site equipment.

3. Responders are normally placed in parallel across the main transmission path with connection via 20 or 30-pair cable to the nearest longitudinal Cabinet Type 609. Connections to telephones are via quad cable (previously known as 2 pair cable).

4. There may be compatibility problems in re-arranging or moving Responders to create a mix of types and manufacture within a group. All such NMCS 1 alterations should be referred via the Highways Agency to the RMC for advice.

5. Responders are housed in Cabinets Type 600.

6. Signals can be placed a maximum of 1km cable length away from an NMCS1 Responder.

7. Telephones can be placed up to 2.5km cable length away from the Responder.

8. Following the introduction of NMCS2, Type 700A Responders are no longer manufactured. The HA may be able to supply Responders recovered from COs that have undergone NMCS2 conversion. Telephone only Responders and NMCS2 21-bit Transponders should be used to expand an NMCS1 CO network. NMCS1 Telephone Only Responder

9. This is used in conjunction with NMCS2 21-bit Transponders, usually as part of an NMCS2 changeover. It can be placed where an NMCS2

Telephone Responder is proposed, or can be used to increase telephone capability in an NMCS1 CO area.

10. Telephones can be placed up to 3.2km cable length away from the Responder. It is however suggested that the NMCS2 “5km Responder Rule” is employed.

### NMCS2 21-bit Transponder

11. This allows NMCS2 signal equipment to be used in an NMCS1 CO area.

12. The RMC will need to be trained on the use of the 21-bit Transponder, the RS485 protocol and signal equipment, if used.

### A12.6 Phase 2 Telephone System

1. The NMCS1 telephone system is also known as the Phase 2 Telephone System.
2. It is important to make the distinction between the capacity of NMCS1 Responders to control up to 4 or up to 8 telephones, and 4-line or 8-line working within a CO.
  - i. There is no correlation between the identity of a telephone on a Responder (T1, T2, T3, T4) and the line on which the telephone call is answered.
  - ii. An 8 telephone Responder actually has two NMCS1 Responder addresses. Therefore to the CP, it is regarded as two separate 4 telephone responders
  - iii. 8-line systems are essentially two 4-line systems each within its own Responder group covering different parts of the CO area, Lines 1 to 4 for one part and Lines 5-8 for the other.
3. The standard Type 352 telephone in a Type 611 housing is used for both NMCS1 and NMCS2.
4. Further details on telephones can be found in TA 73/95: Motorway Emergency Telephones.

### A12.7 Signals

1. The standard 400 series indicators are used for both NMCS1 and NMCS2.
2. The signal distributors, controllers and switches are unique to NMCS1. However, where 21-bit Transponders are used NMCS2 signal site equipment should be used.

3. Further information on signals and signal siting can be found in TA 74/95: Motorway Signalling.

### A12.8 2456 Common Interface Unit

1. The 2456 Common Interface Unit allows limited connection of devices other than signals to NMCS1. It requires mounting within a Cabinet Type 600, cabling details are shown on MCX 0337.
2. Each unit takes up one Responder signal mode. Each adjustable aspect on a Type 407 signal can be converted by the interface into a suitable control code to drive the device.
3. For further information regarding availability and system design, contact the Highways Agency.

### A12.9 Control Office

#### Control Room

1. There is the facility for up to four telephone answering panels within the Control Room. Depending on the size of the CO Area, they may be 4 or 8-line panels.
2. There is the facility for up to 4 signal setting terminals. These take the form of a VDU and qwerty keyboard. Signals can be set by using a function key driven menu system combined with a schematic map displayed on the VDU, or by typing in a proposal longhand. This terminal is known as the CO306 or CO308 depending on the system fitted.
3. A hard copy printout of signal setting and fault reports is provided by a “Trend” printer. This is usually located in the Control Room, but may be in an adjacent room. Before CO306/CO308s were installed the Trend was used to type in signal setting proposals.

#### Equipment Room

4. There can be up to three cabinets:
  - i. NMCS1 CO304
  - ii. NMCS1 CO306 or CO308
  - iii. Transmission rack

In many COs the transmission equipment is contained within the CO304 rack. Refer also to TA 75/95: Motorway Transmission.

## A12.10 Operational Description

### Signal Setting

1. The operator types in a proposal on the CO306/CO308 terminal at the CO. This is communicated to the CP via the CO Data Link. The CP first asks the operator several questions to avoid accidental setting and to log the reasons why the request is being made. The CP also applies the signal sequence rules to the request to determine any signals that will automatically be set because of the proposal. If the operator requests that the setting is to be activated, the CP responds via the Responder Data Link to set the signal(s). The signal(s) will reply to their Responder with details of the aspect(s) set or adapted to. The details will be relayed back to the CO via the CP.

2. A hard copy of the signal setting activity is generated on the Trend printer at the CO. The CP also records this information in its logs. The relevant lamp for the signal(s) will be illuminated on the active mimic.

### Telephone Call

3. When a handset of a motorway emergency telephone is lifted off the cradle, it is detected by the Responder. The Responder then sends out an Interrogation Request Tone (IRT) (either 540Hz or 660Hz). This is detected at a Transmission Station which passes it on to the CP and switches off the 780Hz Telephone Calling Tone (TCT). At this moment, the telephone call is on Line 1 (or Line 5), and is not identified, but can be heard at the CO. When it detects the IRT, the CP initiates a search for the address of the telephone via the Responder Data Link. Then, via the CO Data Link, it prepares the CO304 to accept the call on the next available private telephone line. When the telephone is identified the CP switches the telephone speech to the appropriate line and identifies both line and telephone address on the operators answering panel. The CP then monitors that the handset is still lifted to allow subsequent calls to be switched to free line. A 'Telephone off Hook' alarm is raised if the receiver is not replaced within 10 minutes after cancellation by operator.

4. The operator can call a telephone by entering the address on the answering panel and sending it via the CO Data Link to the CP. The CP then searches via the Responder Data Link for the Responder to which that telephone is connected, and then sets up the call on the next available free line.

5. It is important that the NMCS telephone system should continue to function in the event of power supply or equipment failures. The standby telephone system is provided for this purpose. This simple system uses only Line 1 of the four telephone speech circuits (ie, it does not switch the telephones onto Lines 2 to 4 in the normal manner). Therefore, all calls share the party line. It does not identify the calling telephone or check that the handset has been replaced properly.

6. The CO is equipped with batteries so that the standby telephone system will continue to operate in the event of a mains supply failure. A mains-operated battery charger maintains the batteries fully charged under normal operating circumstances.

7. The standby telephone system is a fail-safe system. It detects a calling telephone by the absence of the TCT. The telephone speech circuits are routed directly to the CO from the motorway. So, even in the event of a catastrophic failure of the CO, with the call detection equipment inoperative, the standby telephone system will still function. This will permit speech between the motorway and the CO. However, in these circumstances it is necessary for the operator to maintain a listening watch to detect new telephone calls. A loudspeaker unit known as a Line 1 Monitor is temporarily fitted in many COs for this purpose.

## A12.11 Design - General

1. The basic networks for all NMCS1 CO areas were installed before 1990 using MCH 1301, 1302 and 1306 as their basis for design.

2. It is the Highways Agency's intention not to install any more systems. Any additions to present systems are to be achieved by the following methods:

- i. Simple addition to, or minor rearrangement of, the existing network. This may involve the swapping of NMCS1 Responders to provide extra capacity at a site, or the fitting of expansion kits to existing Responders. Such alterations should be undertaken by the specialist Regional Maintenance Contractor.
- ii. The re-use of NMCS1 equipment recovered from CO areas converted to NMCS2.
- iii. The use of NMCS2 21-bit Transponders which operate signals using local NMCS2 infrastructure within an NMCS1 CO area.

- iv. The use of NMCS1 Telephone Only Responders available from the Highways Agency.
3. Options iii and iv will require an installation to NMCS2 standards. When the NMCS2 changeover is undertaken for that CO area the 21-bit Transponder can be replaced by an NMCS2 Standard Transponder and the Telephone Only Responder can be replaced by a Phase 3 Telephone Responder.

### A12.12 Design - Responder Siting

1. It should be remembered that NMCS1 Responders were never intended to provide complete CO Area coverage. The basic rural outstation design is to provide for two local signals, two local telephones and two remote telephones. Consequently all local connections, including power may be made to the Responder Cabinet Type 600.
2. A number of simple design rules exist for NMCS1 Responder Siting:
  - i. A Responder can drive up to eight signals.
  - ii. The maximum cable length between any signal and its controlling Responder is 1km.
  - iii. Nearby signals should share a Responder. Sharing is usually preferable because this can be expected to reduce fault liability and there are software advantages in using the minimum practical number of Responders.
  - iv. For commissioning and maintenance reasons, it is preferable to site Responders opposite their dependent signals.
  - v. Responders can control up to four or eight telephones depending on type. Conversion kits are available for converting some Responders from four to eight telephone capacity. A four telephone Responder requires one address within the Responder Group, and an eight telephone Responder requires two addresses.
  - vi. The maximum permissible loop resistance for the cable between a telephone and its Responder is 150 Ω. This is equivalent to a maximum cable length of 2.5 km.

- vii. Where, on an interchange, a Responder is not near the main longitudinal cable, several Responders may share a common spur cable. However, the Highways Agency should be consulted about any proposals involving spur cables exceeding 1km in length.

### A12.13 Design - Cabling

1. The information given below refers to the design of existing NMCS1 installations. The equipment and cables used are obsolescent and may no longer be available. These installations use armoured cable directly buried in the motorway verge and are incompatible with a ducted cable network.

#### Longitudinal

2. Longitudinal cabling is in 500m cable lengths between Cabinets Type 609. Termination frames type 11 and 12 are used for 20 and 30 pair cables respectively. Replacement of frames should be by using types 13 and 14 suitable for NMCS2.

#### Responders

3. Responders are spurred off the main longitudinal cables when required using a 20 pair cable.

#### Signals

4. All signal installations require a 20 pair cable between the signal and the responder, or Cabinet Type 609 it is spurred off. The exception is a 3 signal gantry which requires a 30 pair cable.
5. Nine cable pairs are required to make each signal connection between the responder or Cabinet Type 609 and the signal. Standard 20 or 30 pair cable is used for the spur cable as appropriate.
6. Responder Cabinet Type 600 wiring details are shown on MCX 0337 Sheet 1.

#### Telephones

7. Each telephone is connected to the cable network by an individual quad cable. Remote telephones normally use pairs 17 and 18 in a longitudinal 20 or 30 pair cable. This should be checked with the Highways Agency before any work commences.
8. Telephones are directly connected to adjacent Responders or to the nearest longitudinal Cabinet Type 609. Within interchanges there may be a Cabinet Type

600 to which telephone and signal cables are terminated before being taken back to the responder. As-installed records should show these details.

### **Power**

9. Early installations sometimes took power supplies from nearby lighting columns. Power to Responders and signals was taken directly from the Electricity Supply Company Interface. Power to signals adjacent to Responders was usually taken from the distribution board within the Responder Cabinet Type 600.

10. Later installations used power cabling from discrete power cabinets.

11. Any design to replace NMCS1 power design should bring the installation up to the requirements of BS 7671.

### **Schematic Detail**

12. A typical NMCS1 outstation schematic diagram is shown in Figure A12.13a. For the key to the symbols refer to MCX 0131.

### **Further Information**

13. Where additions to, or replacements of, existing NMCS1 installations are planned early advice from the Highways Agency should be sought.

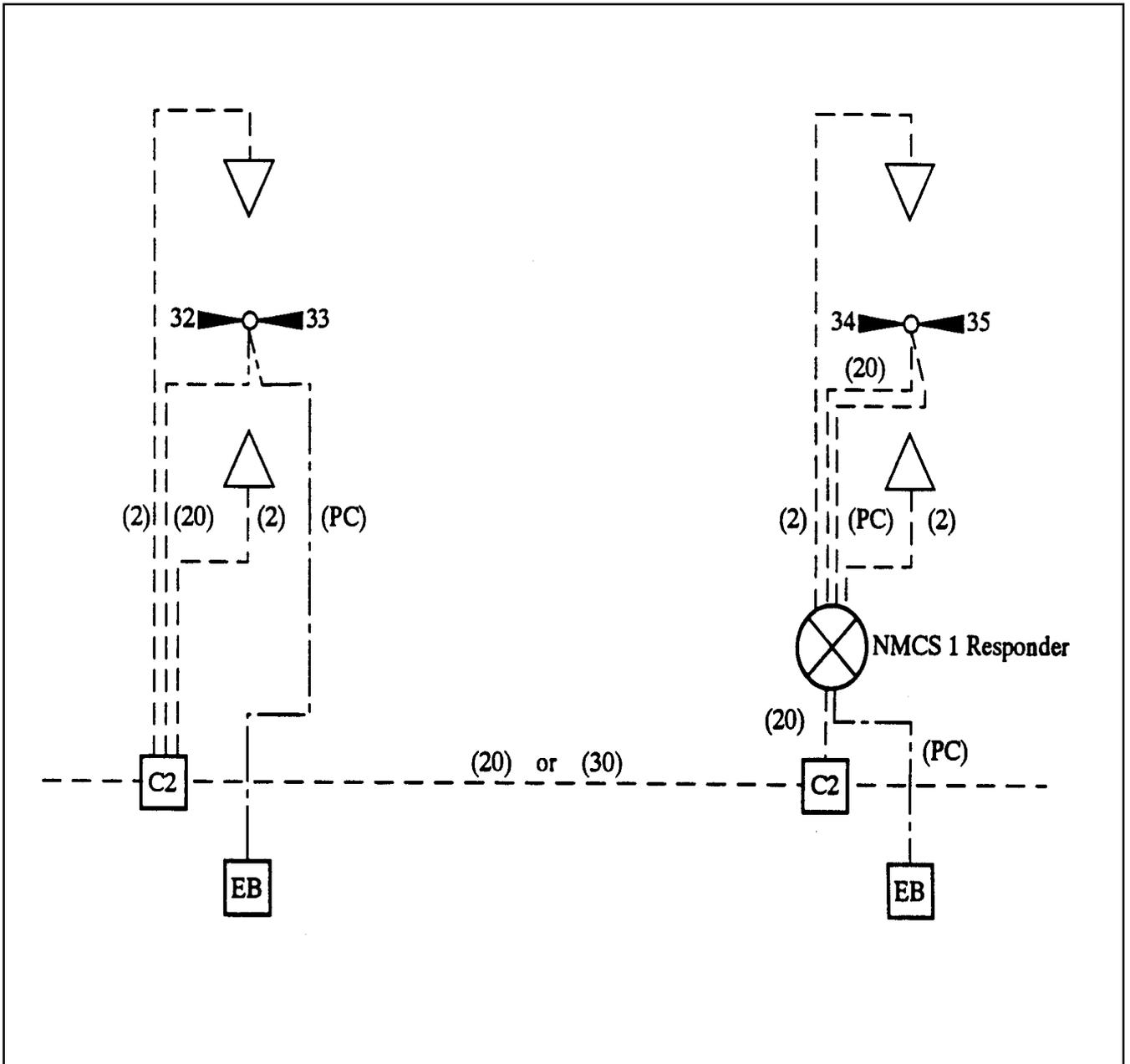


Figure A12.13a Typical NMCS1 Outstation Schematic

## A12.14 Responder Addressing

### Overview

1. Coleshill CP303 and Westhoughton CP305 each have the potential capability to communicate with up to 40 Control Offices (CO) / 80 Responder groups each of up to 55 Responders in two sub-groups.
2. The hierarchy that the NMCS1 transmission system creates is shown in Figure A12.14a and explained below.

### Responder Groups

3. Responder Groups exist as part of the device addressing hierarchy between CO/Central Processor (CP), signals and telephones. The number of Responder groups in a CO area depends on the number of Responders in the CO area. This is dependent on the number of signals, telephones and types of Responder installed. Before NMCS2 conversions were required, the highest number of Responder groups in a CO area was two. However, the following have led to the use of third Responder groups where unavoidable:

- i. NMCS 21-bit Transponders,
- ii. operation of NMCS1 Telephone Only Responders,
- iii. free cable pairs on the transmission network.

4. Advice should be sought from the Highways Agency before embarking on the creation of a third Responder Group. Responders with 21-bit interfaces driving signals cannot simultaneously drive telephones using the same octal address and this has group loading implications.

5. A Responder Group is made up of a maximum of 55 Responders with octal addresses between 01 and 67. Responder addresses 00 and 70 to 77 are used for test purposes only.

6. The Responder Group is split into two sub-groups, those with an Interrogation Request Tone (IRT) of 1 and those with an IRT of 0.

7. Transmission considerations determine the IRT. It is usual that 'legs' of the local transmission network from nodal Transmission Stations have the same IRT.

Ideally a Responder Group would have a balance between IRT's, but this is not often achievable in practice. There is a limit of 35 Responders on a single IRT per Responder group. The Highways Agency will advise on any modification options to the transmission network necessary to accomplish an even IRT split.

### Responder Addresses

8. It is quite usual for some of the Responder Addresses in a Responder group not to be taken up. Often gaps have been left in the addressing to cater for future expansion. It is also quite easy to change a Responder address by combining a Data Change with work on site.

9. It is imperative that "Dual Address" responders have consecutive octal addresses within the same Responder Group.

### Signal Interface Cards

10. Signal interface cards are connected to "modes" of the Responder. The modes have octal addresses and are used in descending order from 35 to 26.

11. A 'dual address' Responder is used to provide 8 telephones. The signal modes will only be on one of the addresses.

### Telephones

12. There is a maximum of 4 telephones per Responder address. These are known as T1, T2, T3 and T4.

13. At a "dual address" Responder, therefore, there is the possibility of 4 telephones per Responder address. Slots on the lower numbered Responder address should be used up first.

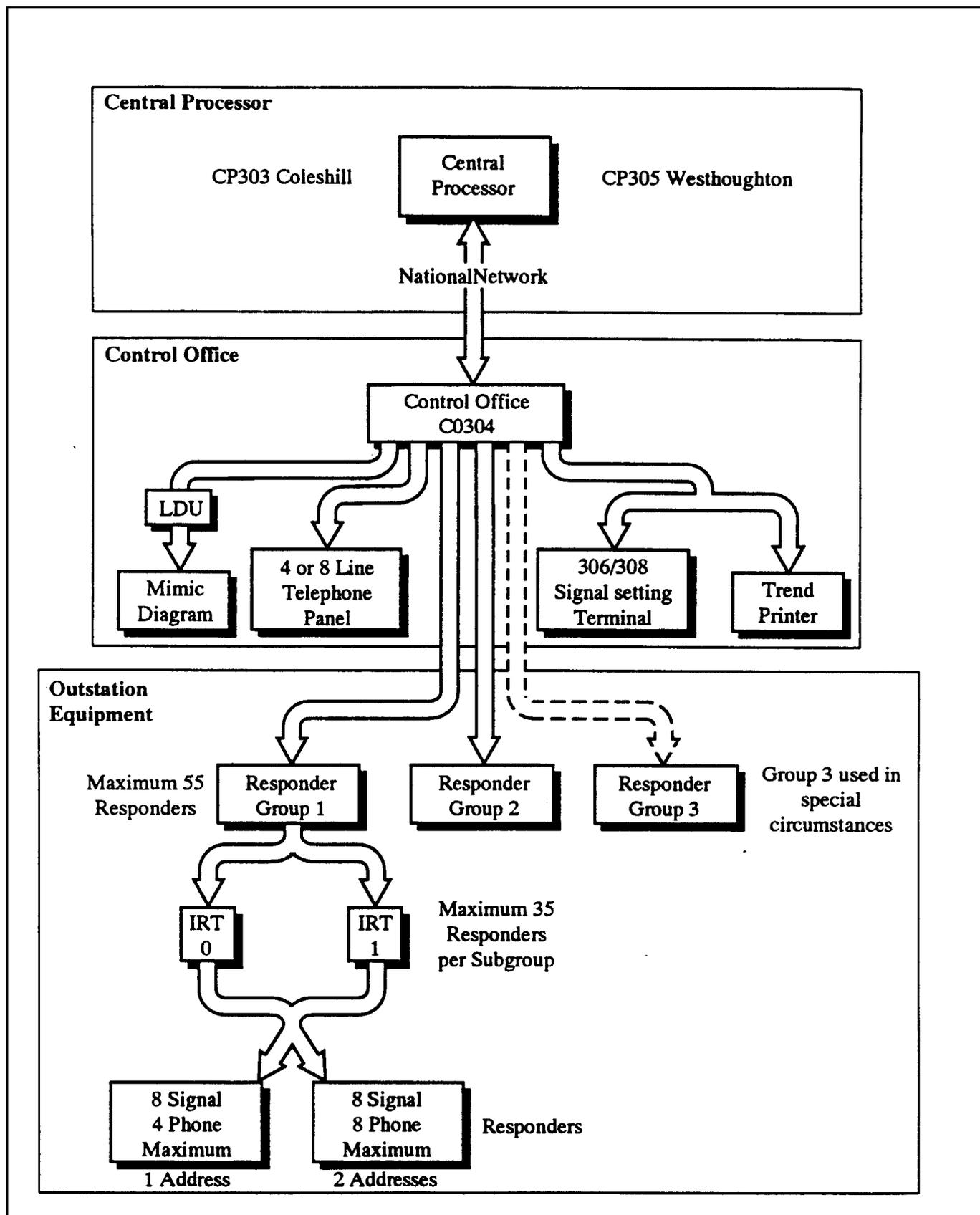


Figure A12.14a NMCS1 Hierarchy in a CO Area

## A12.15 Site Data

### CP Data

1. Central Processors (CP) at Coleshill and Westhoughton contain all the operational data for NMCS1 outstation equipment. To alter this information a CP Data Change is required. These are arranged by the Highways Agency on a monthly basis. A minimum of 8 weeks notice is required to complete an NMCS1 Data Change.
2. Data Changes may involve the addition of a signal or telephone, or change in signal sequencing. MCH 1596 details the process that should be followed.
3. The Data is printed out in two forms:
  - i. Short form listing which lists:
    - (a) Control Office Number
    - (b) Motorway the responder is on
    - (b) Responder Group Number
    - (c) Responder Number
    - (d) Carriageway the responder is on
    - (e) IRT of the responder
    - (d) Telephone connected to each responder
    - (e) Signals connected to each responder

It also contains the Mimic Diagram Lamp Display Unit Allocations

- ii. Long form Listing  
This lists the signal sequencing for the CO Area.  
It is usually on a limited circulation.

### CO306/CO308 Data

4. When an NMCS1 CP data change is done for a CO area there may be a requirement to change the map details on the CO306 or CO308. This can take longer than 8 weeks. MCH 1365 details the process that should be followed.

### CO304 Data

5. This is the program that runs the CO304 minicomputer at the CO. It is kept on a permanently loaded Electronically Programmable Read Only Memory (EPROM). Any changes are undertaken by the RMC on behalf of the Highways Agency. It is not affected by any changes in outstation design.

## A13. GLOSSARY

### **Aspect**

The legend displayed on a matrix signal.

#### **Analogue Transmission**

In analogue transmission the whole of the analogue signal is transmitted using an appropriate carrier.

### **Block**

A section of carriageway between two Geographic addresses. If there could be multiple routes between the two addresses (eg. clockwise and counter-clockwise on a circular route), a third Geographic Address is specified to identify a unique route.

### **Block Interface**

An item of equipment within the Phase 3 Telephone system which connects up to eight telephone responders to a sector interface. Electronically, it is the same equipment as a sector interface, but it performs a different function.

### **Block Switching**

NMCS2 telephone system term, block switching is used to connect responders to sector switches.

### **Cabinet Type 600**

Standard motorway equipment cabinet, for use on motorway verges, to house equipment such as Standard Transponders, MIDAS Transponders, Responders, Sector Interfaces and Sector Blocks. Also used as a Marshalling Cabinet.

### **Cabinet Type 609**

Standard motorway cable connection cabinet, for use on motorway verges, to house connection boxes for data, and also used to house (separately) electrical power supply distribution and isolation equipment.

### **Cable Joint Enclosure (CJE)**

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).

### **Central Logging**

Collecting and processing of log information from a number of Control Offices (CO) throughout the NMCS at a central location.

### **Central Logging Facility (CENLOG)**

An operational centre within the National Motorway Network which is connected to all compatible Control Offices via the Regional Communications Controller (RCC) network. Its purpose is to collect log information relating to the use and availability of NMCS equipment for centralised processing and analysis.

### **Central Processor (CP)**

The main computer used in the Computer Centre, used to control, via the Control Offices, the motorway telephone and signals a number of COs. CPs in current use are:

**CP303** (Ferranti Argus) at Coleshill

**CP305** (Ferranti Argus) at Westhoughton

The CP is the central component in an NMCS1 system.

***Configuration Data***

Control Office Base System (COBS) data relating to the operation of subsystems, subsystem equipment and the inter-relationships between subsystems and between the subsystems and COBS. Operator Interface (OIF) data such as map and menu data is also referred to as Configuration Data.

***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 Area (COA)***

The area of influence and interest within a Control Office as defined by motorway devices with which it can communicate via the Local Communications Controller.

***Control Office Base System (COBS)***

That part of the installation which performs those functions which are common to all NMCS2 systems. Includes the Operator Interfaces (OI).

***Control Room***

The part of the Control Office where the operators answer telephone calls, set signals and, where available, monitor CCTV and operate other equipment. Sometimes shared with other Police Operations and equipment.

***Digital Signal***

A digital signal has discrete levels within its limits and these levels may be independent of preceding and succeeding levels.

***Electricity Supply Company Interface (EI)***

An electrical power supply provided by an Electricity Supply Company at the motorway boundary.

***Electronic Address***

All sites on the National Motorway Communications System (NMCS) have an Electronic Address. The electronic address allows data to be routed via the communications network to the relevant piece of roadside equipment.

***Engineer's Console***

A means of engineer's access to the database and the system at large. Access will be used to retrieve system performance/status data. Except for control of motorway devices, all facilities at the Operator's Interface (OIF) are available.

***Engineer's Terminal***

A means of engineer's access to the database and the system at large. Access will be used to change nominated sub-system site data and retrieve system performance/status data. Except for control of motorway devices, all facilities at the Operator's Interface (OIF) are available.

***Enhanced Matrix Indicator (EMI)***

A matrix signal which has additional aspects for use on four lane carriageways. EMI are mounted on Cantilevers only. When used in conjunction with an Enhanced Message Sign (EMS), it forms a Motorway Signal Mark 2 (MS2).

***Enhanced Message Sign (EMS)***

A sign which is used to display a variety of legends or messages. The legend or message is controlled from the installation. EMS has 2 rows of 12 characters. Can be mounted on a gantry or cantilever.

***Equipment Room***

The part of the Control Office (CO) that houses the electronic equipment required to interface with the outstation devices and the operator interfaces within the Control Room.

***Ethernet***

An international communications standard for Local Area Networks.

***Frequency Division Multiplex (FDM)***

An analogue transmission system where individual signals are multiplexed with a high frequency carrier to allow several signals to share a transmission circuit.

***Gantry***

An overhead structure which spans a carriageway having a leg in the verge and a leg in the central reserve (may span more than one carriageway and have more than 2 legs). Used to support signals and/or signs.

### ***Geographic Address***

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.

### ***High Frequency Carrier (HFC)***

The High Frequency Carrier system is an analogue transmission system where individual 4KHz bandwidth signals are multiplexed with a higher frequency signal, the carrier, to allow the signals to share the transmission circuit.

### ***High-level Data Link Control (HDLC)***

A protocol, at link level, which forms the basis of all inter-station communications on the NMCS2 data system, Closed Circuit Television (CCTV) system and the Regional Communications Controller (RCC) network. When each station communications link is set up, point to point or multidrop, the delivery, security and integrity of each frame of data is assured.

HDLC is the basis of a family of protocols which form the main data highway(s) for communication between Data Base Processor, Local Communications Controller, Regional Communications Controller and Transponders providing the packet message handling network.

### ***Instation***

Those parts of the National Motorway Communications System (NMCS) which are normally located within the Control Office. See also Outstation. Often referred to as the building which contains the control office and provides an office type environment for equipment sited at the instation.

### ***Inter-Panel Link Unit (IPLU)***

An NMCS2 telephone instation unit used to co-ordinate the activities of the Telephone Link Controllers (TLC), such as call transfer and keeping each TLC aware of all other TLC relevant activity. It is the generator of the telephone logs.

### ***Interrogation Request Tone (IRT)***

A signal switched on at an NMCS1 Responder when a telephone handset is lifted off the hook. This signal is used by the central processor to initiate the handling of a telephone call. The tone is allocated channels CH101 (420 Hz), CH102 (540 Hz) or CH103 (660 Hz).

### ***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.

### ***Lighting Control***

A Control Office Base System (COBS) Subsystem which controls motorway lighting.

### ***Local Area Network (LAN)***

Telecommunications terminology for a data communications network used to interconnect personal computers and equipment over a limited area.

### ***Local Communications Controller (LCC)***

An NMCS2 data system message switching unit, the most significant CO area data system communications node. Sited at the most strategic point on the motorway network, it provides the downside on the Database Processor (DBP) - LCC level 2 link and the master on the four LCC-Transponder HDLC links.

### ***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.

### ***Matrix Signal***

A signal used for displaying traffic control legends to motorists. The legend (Aspect) is constructed from a matrix of lights. Each MS can display a predefined set of aspects only, such as 'Fog', 'End', speed restrictions, and lane restrictions using 'wickets'.

### ***Message Sign***

A generic term for signs which can display messages; this includes EMS, MS2 and FTMS.

***MIDAS Transponder***

A Transponder dedicated to MIDAS and not used by other devices or subsystems.

***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 Device***

Any outstation that interacts with its environment, serves as a source of information to be instation and/or is under the control of the instation.

***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 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 Signal Mark 2 (MS2)***

A motorway signal comprising an Enhanced Matrix indicator (EMI) and an Enhanced Message Sign (EMS) mounted on a cantilever structure.

***Multidrop Link***

A transmission channel that allows a master device to communicate with several devices over the same channel.

***National Carrier Maintenance Contractor (NCMC)***

The Contractor responsible for the maintenance of the Carrier Network throughout the motorway network.

***National Motorway Communications System 1 (NMCSI)***

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.

***National Transmission Works Contractor***

The Contractor responsible for bringing transmission systems into service.

***NMCS2 Documentation Set***

The documents which describe the NMCS2 system, produced by the Highways Agency.

***Operator Control Panel (OCP)***

An NMCS2 unit, designed primarily for the telephone system to provide indicators, message display and keyed input to and from the operator. It also provides a means of input from the operator to the data system, in conjunction with the Operator Interface (OIF), using function keys to drive the menus and cursor keys to manipulate maps and text. Thirdly, it can provide a full text input when a QWERTY keyboard is plugged into the OCP.

***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.

***Outstation***

Site installations outside computer centres and control offices, set up at convenient positions along the motorway to house communications equipment such as Responders, distributors, signal controllers, signal switches, connectors, terminal panels, and power supply units.

***Packet Switch***

Data network that divides messages into easily handled packages for transmission. Destination information is added to each package. The national transmission network linked by the Regional Communications Controllers (RCC) is a packet switched network.

***Phase 2 Adapter***

An NMCS telephone instation unit that allows the NMCS2 instation equipment to interface with NMCS1 phase 2 telephone system.

### ***Phase 2 Telephone System***

The system of telephones installed along motorways as part of the first generation National Motorways Communications System, controlled by the Central Processor for call identification and switching.

### ***Phase 3 Telephone System***

The system of telephones installed along motorways as part of the second generation National Motorways Communications System (NMCS2).

### ***Port***

Telecommunications terminology for a physical interface or connection between equipment or between equipment and cables. A standard transponder has one High Level Data Link Connection (HDLC) port to the Local Communications Controller (LCC) and four RS485 ports.

### ***Private Wire***

A dedicated permanent circuit provided by a Public Telecommunications Operator between two locations.

### ***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 (PCM)***

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.

### ***Quad Cable***

A 4 wire cable in which all the wires are twisted (laid) together, rather than in 2 pairs. This reduces cross pair interference where the pairs are used as the same channel.

### ***Regional Communications Controller (RCC)***

An NMCS message switching unit, and the national network communications network. The RCC is an NMCS item of equipment which provides the facility of linking a Control Office, to other communication centres and Control Offices.

### ***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.

### ***19" Racking Unit***

A standard physical arrangement for electronic equipment. Originally an American Standard but later adopted as BS5954. The term is derived from the width of the equipment shelf that fits into the 19" Racking Unit. The height of a rack is often given in "U" (units) or number of shelves that can be stacked within the rack, 1U is approximately equal to 50mm.

### ***Remote***

Data link over the Public Switched Telephone Network (PSTN) allowing full duplex communications, allows automatic fault reporting to the specialist Regional Maintenance Contractor (RMC) and remote interrogation by the RMC.

### ***Remote Engineers Terminal (RET)***

A terminal allowing remote access to the NMCS1 Central Processor for maintenance purposes.

### ***Responder***

An NMCS1 outstation which controls telephones and signals.

### ***Responder Address***

The electronic address that identifies a particular responder to the Central Processor/Database Processor/Control Office Base System.

**Responder Group**

A number of responders, up to a maximum of 55, controlled by the NMCS1 central processor. The responder group can be further divided into 2 sub-groups (each group having a maximum of 35 responders) for new telephone call monitoring.

**RS485**

A data protocol (EIA RS485) and practice adopted for use by NMCS2 between the Standard Transponder and motorway devices.

The RS485 Multidrop Link is the lowest hierarchical level of transmission in an NMCS2 data system and provides the means, parameters and protocol of communication between Transponders and motorway devices. It allows the Transponder to control several devices at once or individual devices. However, individual devices can only transmit to the Transponder. Transmission is half duplex, ie transmission in only one direction at once. Each link caters for up to 30 motorway devices. Each message comprises 5 characters of 8 data, 1 parity, 1 start and 1 stop bits. The characters represent address, command, data byte 1, data byte 2 and longitudinal parity.

**Sector**

An NMCS2 telephone system term, see Sector Switch and Sector Interface.

**Sectoring**

An NMCS2 telephone term for dividing the network into sectors.

**Sector Interface**

An NMCS2 telephone system unit. Sited at the most strategic point in the motorway, the SI is the most significant telephone node in the Control Office area network. The SI provides, for the telephone system, the transmission system facility for common speech and data circuits. It comprises 4 ports which are themselves comprised of Sector Switches needing one Sector switch for each Telephone Line Controller the port serves. It provides an interface between the Telephone Line Controller and the lower order telephone switching stations.

**Sector Switch**

An NMCS2 telephone system unit, the next most significant telephone node after the Sector Interface. Sector Switches are the units that make up a sector interface. There is one sector switch for each telephone circuit. The Sector Switch, when used as a station in its own right, performs as an intermediate level between the Sector Interface and Responders.

**Signal Address**

Addresses are codes by which 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.

**Signal Driver**

An outstation dedicated to controlling a matrix signal.

**Signal Sequencing**

The setting of a number of signals in addition to that requested directly by an operator or Subsystem in order to achieve safe traffic management.

**Signal Subsystem**

A Control Office Base System (COBS) Subsystem which controls motorway signals. The Signal Subsystem is always present in a Control Office area.

**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.

**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.

### ***Subsystem***

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

### ***Telemetry System***

Telecommunications terminology for the remote monitoring and control of equipment, devices and systems.

### ***Telephone Bridging Unit***

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

### ***Telephone Calling Tone (TCT)***

A signal initiated at a transmission station and transmitted to the control office on channel CH104 at 780 Hz, used to check for normal telephone operation. The signal is turned off by an Interrogation Request Tone from a Responder.

### ***Telephone Line Controller (TLC)***

An NMCS2 telephone system instation unit. The TLC links an Operator's Interface to the Inter Panel Link Unit and controls the outstation telephone status and switching on one of a set of parallel circuits serving all, or a selection of, responders within a Control Office Area.

### ***Telephone Responder***

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

### ***Telephone Only Responder***

A device used in conjunction with 21-bit Transponders. It can drive up to 8 Phase 2 telephones from 2 NMCS1 Responder addresses.

### ***Transmission***

Telecommunications terminology for the sending and receiving of signals.

### ***Transmission Integrity Tone***

A test signal used to check transmission lines. It is initiated in the central processor and transmitted to the control office on channel 103 at 660 Hz. The absence of a received signal causes a TA1 fault.

### ***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.

### ***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.

### ***U***

The number of standard height 19" shelves that fit into a racking unit, 1U is approximately 50mm, (19") is an international standard for the physical size of electronic equipment, originally an American standard but later adopted as BS 5954.

### ***UK Government OSI Profile (UK GOSIP)***

OSI - Open System Interconnection - is the International Standards Organisation 7 layer protocol, reference model, the concept of which provides standards for interconnections between equipment. An OSI profile is a subset of the protocols chosen for use on a particular network. UK GOSIP is that profile used by the UK Government for the procurement of systems.

### ***V29 Modem***

Modulator/Demodulator complying with ITU-T standard V29 for 4.8 Kbit/s or 9.6 Kbit/s operation over Private Wire.

***Visual Display Unit (VDU)***

A VDU comprises a colour monitor for the presentation of active data system and telephone information superimposed on road layouts. It may be a component of the Operator's Interface provided for each control office operator position.

***Wall Mimic Control***

An NMCS2 Subsystem that controls mimic diagrams.

***Wide Area Network (WAN)***

A data network that covers a large area and requires specialist transmission equipment to cater for all its interconnections.

***2 Wire***

A circuit which uses 2 conductors, a single pair for both transmitting and receiving.

***4 Wire***

A circuit which uses 4 conductors, 2 wires for transmitting and the other 2 wires for receiving. The cable may be constructed in pairs or as a quad cable.

***Write Once Read Many (WORM)***

A data storage device which allows large amounts of data storage to be readily accessed.

***X.25***

ITU-T standard protocol for Packet Switched Data Networks.

## A14. REFERENCES

MCH 1301-MCH 1306 - Historical

MCH 1331 - Guide to Phase 3 Telephone System

MCH 1365 - Instructions for Site Data Changes for Control Office Connected to CP303/305

MCH 1420 - Schedule of Outstation Equipment in NMCS2 Signal Transponder

MCH 1421 - Schedule of Outstation Equipment in NMCS2 Telephone Responder

MCH 1539A - Historical

MCH 1596 - NMCS Site Data Procedures

MCH 1616 - Guide to NMCS2 Documentation

MCH 1617 - NMCS2 Management Overview

MCH 1618 - NMCS2 Technical Overview

MCH 1627A - RCC Network Implementation. Naming, Addressing and Renting in the RCC Network

MCH 1655 - Overview of the NMCS2 Message Signs Subsystem

MCH 1660 - NMCS2 Lighting Control Overview

MCX Drawings

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 Offices (DMRB 9.4.5)

TA 77: Motorways (DMRB 9.5.1)

TR 1329 - NMCS2 Phase 3 Telephone Data Transmission

TR 1330 - NMCS2 Telephone Responder for Phase 3 Telephone System

TR 1331 - NMCS2 Telephone Instation

TR 1334 - NMCS2 Sector Interface for Phase 3 Telephone System

- TR 2045 - NMCS2 Standard Transponder
- TR 2046 - NMCS2 Local Communications Controller
- TR 2049 - NMCS2 HDLC Point to Point Communications
- TR 2066 - NMCS2 HDLC Multi-Drop Communications
- TR 2067 - NMCS2 RS485 Communications
- TR 2070 - NMCS2 Message Control
- TR 2072 - NMCS2 Signals Subsystem
- TR 2077 - NMCS2 21-bit Transponder
- TR 2132 - Control Office Base System
- TR 2133 - Instation LAN Transmission