

MCH 1540
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Specification for the Installation of Detector Loops on Motorways and All-Purpose Trunk Roads

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REGISTRATION OF AMENDMENTS

Amend No	Page No	Signature & Date of Incorporation of Amendments	Amend No	Page No	Signature & Date of Incorporation of Amendments
Issue A		December 1990			
Issue B		March 1992			
Issue C		January 1997			
Issue D		September 2003 Comprehensive review			
Issue E		February 2005 Requirement to install hard shoulder loops deleted, section on loop array repairs added and other minor changes			
Issue F		September 2006 - An alternative single loop repair methodology added in Chapter 4. - Number of twists per metre for loop tails increased. - Reference to sector scheme requirements added.			



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MCH 1540F

**SPECIFICATION FOR THE INSTALLATION
OF DETECTOR LOOPS ON MOTORWAYS
AND ALL-PURPOSE TRUNK ROADS**

Contents

Chapter

- 1 Introduction
- 2 Detector Loops
- 3 Detector Feeders
- 4 Loop Array Repairs
- 5 Loop Testing
- 6 Detector Housings
- 7 Glossary
- 8 References
- 9 History

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1 INTRODUCTION

General

1.1 Whilst this document is issued as a specification, it contains a range of information. Some sections are specific technical requirements. Other sections are included to indicate what is desirable or considered to be good practice, or just for information.

1.2 Mandatory requirements are denoted by the word 'shall'. These requirements must be met in full. They represent the minimum necessary subset of the requirements that, if not fulfilled, would make it very difficult to meet the system's performance objectives. They have the same status as a Specification for Highways Works Clause.

1.3 Desirable requirements are denoted by the wording 'should' or 'may'. These are less crucial, and need not be met on a specific installation. However, they are considered good practice, and as such, every effort should be made to meet them. This will help to ensure reliability and a high standard of work.

1.4 Some sections contain 'information only' statements. They are intended to explain or provide additional advice, or information for clarification purposes. They do not constitute a requirement.

1.5 To indicate 'information only' statements, they are denoted by x.xx (I) where x.xx is the unique section number.

1.6 This document shall be read in conjunction with the Specification for Highways Works (SHW) and the Notes for Guidance (NG) on the SHW, and Highway Construction Details (HCD), and Bills of Quantity for Highways Works. These documents are contained in the Manual of Contract Documents for Highway Works (MCHW).

Sector Schemes

1.7 As a measure of quality management and installation staff competency, it is recommended that where an appropriate Sector Scheme exists, it should be specified in contracts. If thus specified, the appropriate sector scheme shall be implemented during installation and testing

Scope

1.8 This specification relates to the installation of inductive vehicle detector loops on the Highways Agency's road network. It may also be used by other highway authorities for roads under their control.

1.9 This specification does not cover core census sites, which have different requirements.

1.10 Guidance for designers on the siting of loop installations for the different applications can be found as follows:

- On Motorways	MCH 1589
- For MOVA	MCH 1542
- For SCOOT	MCH 1352

1.11 Siting of loops for detection and speed measurements at signalised junctions and pedestrian crossings is specified in MCE 0108.

Implementation

1.12 This document supersedes MCH 1540 Issue E.

1.13 Detector loops installed against MCH 1540 Issue D shall remain valid. Retrospective action against MCH 1540 Issue D shall not be necessary.

1.14 As directed by Clause 1218 (MCHW 1.1200) this document shall be used for contracts for installation, improvement or maintenance of vehicle detector loops, on the Highways Agency road network and other roads designated by other Overseeing Organisations.

1.15 Variations to the requirements and procedures in this document shall only be made with the approval of the Overseeing Organisation.

1.16 Any comments or enquiries relating to this document should be addressed to:

Highways Agency
Safety and Information Division
c/o Plans Registry
Temple Quay House
2 The Square
Temple Quay
Bristol
BS1 6HA

Email: tss_plans_registry@highways.gsi.gov.uk

2 DETECTOR LOOPS

General

2.1 (I) The layout and installation details of detector loops are as detailed in Drawings G1 to G32 of the Highway Construction Details (HCD) (MCHW Vol. 3).

2.2 The detector cables shall comply with specification TR 2029.

2.3 The Design Organisation shall ensure that the location and type of loop configuration is shown on the relevant drawings, to be used as the Contract Drawings. These shall be used as 'as-built' drawings, if all the requirements of 2.15 are met.

2.4 The position of the loops shall be given with a reference distance to the leading edges of the loops from a permanent piece of street furniture, or a marker post number.

2.5 Great care shall be taken to ensure that the construction standard for roads is known. Motorways may be of conventional 'flexible', 'reinforced concrete', or Continuous Reinforced Concrete Pavement (CRCP), or 'composite' construction. Therefore, the correct depth of slot shall be selected accordingly.

2.6 Consideration shall be given to the effect of any slab reinforcement in concrete roads.

2.7 The Design Organisation shall include sufficient ducts in the Contract to accommodate the number of feeder cables required at a particular location.

2.8 Subject to the scheme manager's approval, for flexible construction, where no cross-carriageway ducting exists, consideration may be given to slot cutting across the carriageway. HCD Drawings G11 to G16 give guidance on layouts when using such transverse cutting.

2.9 The Overseeing Organisation shall determine the exact location of each loop before the commencement of any associated work.

2.10 The final loop position shall be one metre clear of any street furniture, steel covers, gratings, or any temporary surface reinstatement or damaged area.

2.11 Loops shall have a minimum clearance of 50mm above any road reinforcement.

2.12 Loop tail slots shall have at least 1 metre horizontal separation from any ferrous objects such as grids, chamber covers, etc.

2.13 (I) Separation from any ferrous objects is necessary to avoid a reduction in loop sensitivity, leading to poor detection performance and the occurrence of false detection signals.

2.14 The Contractor shall be responsible for setting out and marking all loop slot configurations and other loop associated work.

2.15 At the end of the installation works, the Contractor shall submit, to the Overseeing Organisation, a full set of 'as-built' drawings for each loop, or set of loops. These shall be delivered within one calendar month of the issue of the appropriate completion certificate or as stipulated in the Contract. The drawings shall be a plan to a scale of 1:500 with detailed insets of 1:200 for each loop. The drawings shall each show:

- i) North point, road layout and names where applicable;
- ii) Ducts, cable runs and type of cable in each run,
- iii) Position of all chambers; and
- iv) Dimensions of loops and number of turns in each loop

2.16 Upon completion of the installations, 'as-built' drawings shall be added to master records held for both scheme drawings and system schematics.

2.17 (I) The nominated agent for the Highways Agency motorways is the Regional Maintenance Contractors Managing Consultant (RMCMC), or TechMAC as appropriate. The nominated agent for the Highways Agency trunk roads is the Managing Agents, or TechMAC as appropriate.

Installation

2.18 Slot cutting shall not be conducted if the air temperature falls below 2°C.

2.19 (I) The widths and depths of the loop and loop tail slots to be used in concrete, porous and bitumen road surfaces shall be as shown in HCD Drawings G1, G2, G3 and G4.

2.20 After cutting, all slots shall be thoroughly cleared of silt and debris, and dried to no wetter than damp dry, (i.e. no standing water visible in the slots) immediately before installing the cables and backfilling.

2.21 All internal corners shall be crosscut to the appropriate depth, in accordance with HCD Drawing G5.

2.22 (I) This is to ensure that road pavement movement does not overstress the cable at these points. This is a known cause of loop cable failure.

2.23 Each loop shall be formed on site and comprise a single length of continuous, unjointed cable.

2.24 The loop shall comprise three turns unless stated otherwise in the contract.

2.25 (I) A loop with an incorrect number of turns will have a different detection point to a correctly installed loop, resulting in an error in the vehicle length/speed calculations on which many systems depend.

2.26 The cable for each loop shall be dry before installation and shall be laid evenly in the slots without kinking. It shall be lightly tamped into position (using a suitable blunt instrument) with the layers of cable in contact and at the required depth below the road surface, in accordance with the appropriate HCD Series G Drawing for the type of road construction.

2.27 During loop installations, it is recommended that, the Contractor should test each loop circuit before and again after backfilling the slots. This will identify any emerging cable problems, which would be disruptive and costly to repair once covered with encapsulant and topped off with bitumen. See Chapter 5 for details of testing.

2.28 Where loop tails share a common slot, each pair shall be twisted between 10 and 15 twists per metre in order to reduce the potential for cross-talk between loops and also to ensure that loop tails stay together throughout their length.

2.29 Sufficient length of tail shall be left neatly coiled within the roadside chamber to permit loop/feeder jointing to take place outside the chamber. However this tail length should not be excessive, which can lead to cross-talk between loops. Tails within a roadside chamber shall also be twisted between 10 and 15 twists per metre.

2.30 Any tails left un-terminated shall be identified and sealed to prevent the ingress of water.

2.31 Slots shall be backfilled with a suitable compound to encapsulate the cables as shown in HCD Drawings G1 and G2.

2.32 (I) The encapsulant fixes the cable in place permanently, and gives protection to the cable from the hot pour bitumen used to finally fill the slot.

Encapsulate Requirements

2.33 The encapsulant used shall have the following properties when prepared for application to cables installed in the slots:

- i) A pouring temperature as recommended by the product manufacturer but not exceeding 85°C;
- ii) A pouring viscosity not greater than 50 Poise, which shall be achieved within 10 to 30 minutes after mixing;
- iii) When prepared and poured in accordance with the manufacturer's instructions and the requirements in this document, the encapsulant shall bond to the substrate walls, whether concrete, asphalt, pitch or bituminous composition, without allowing the formation of voids; and
- iv) A pot life of up to 90 minutes and, once poured shall allow the addition of hot pour bitumen to the slot within 45 minutes.

2.34 The encapsulant used shall have the following properties when fully cured in the slot:

- i) Shore-A hardness rating between 50 and 90;
- ii) Tensile strength @ 20°C not less than 1.5 MPa in asphalt, and not less than 4.0 MPa in concrete;

- iii) Compressive strength not less than 1.5 MPa in asphalt at 20°C and not less than 40.0 MPa in concrete;
- iv) Stiffness Modulus at 20°C of 1.0 to 3.0 GPa in asphalt, and 20.0 to 30.0 GPa in concrete;
- v) Bond strength at 20°C shall be not less than 1.0 MPa in asphalt, and not less than 4.0 MPa in concrete; and
- vi) When covered as in 2.36, the encapsulant shall remain fit for purpose for at least 15 years.

2.35 The remainder of the slot shall be filled with hot pour oxidised grade bitumen compound to BS EN 13304 heated to 180°C and having a viscosity not greater than 80 Poise. The hot pour compound shall totally fill the slot and any shrinkage as a result of curing is to be topped up, especially on crosscut corners.

2.36 The loop tails are to be marked as soon as they are laid to indicate the identity of the loop in accordance with clause 3.28. This marking shall be by means of permanent labels in accordance with clause 3.28 before testing to section 5 is carried out.

Concrete Roads

2.37 In addition to the foregoing general requirements, the following shall be taken into account for concrete roads.

2.38 For concrete road surfaces, slots shall not be cut closer than 1.5 metres from transverse joints between adjacent concrete sections.

2.39 Where the loop cable is laid through an expansion joint in a concrete pavement, suitable dowels or wedges shall be inserted to enable the cable turns to maintain the shape indicated in HCD Drawings G3 and G4. At the boundary of each crossing area, a suitable mastic or similar material shall be pressed into the slot and so form a temporary dam to contain the flexible sealant to the specified area of the slot. When the dam is in position the dowels or wedges maintaining the cable position shall be removed, and a flexible sealant applied. This is to allow for small movements in the carriageway surfaces.

Porous Road Surfaces

2.40 In addition to the foregoing general requirements, the following shall be taken into account for porous road surfaces.

2.41 The installation of loops into porous road surfaces requires a modified loop slot profile, and use of a porous backfill in order to retain porosity of the road surfaces.

2.42 (I) Porous road surfaces enable the rapid draining of the road surface during and after heavy rain by allowing rainwater to drain through the porous surface to drainage channels at the road verge. Standard loop installation practice would prevent the free draining of the road and cause a 'pond' of standing water within each loop perimeter. This would partly defeat the purpose of installing porous surfaces in the first place and would also present a potential hazard from spray, and in the event of freezing, from ice.

2.43 Loops shall be cut with a modified slot profile as shown in HCD Drawing G2.

2.44 The slot shall be cut such that the shelf is on the outside of the loop slot. This avoids the loop cable riding up onto the shelf during winding.

2.45 Loops shall be wound into the 10mm wide lower slot, which shall be below the level of the porous road surface.

2.46 Loops and loop tails shall be encapsulated as shown in HCD Drawing G2.

2.47 The porous backfill shall consist of a nominally single-sized dry aggregate (minimum size 6mm, maximum size 14mm) bound by a pre-mixed proprietary thixotropic epoxy resin or equivalent adhesive binder, mixed to ensure that the aggregate is completely coated and with a void content after compaction between 15 to 25%.

2.48 The slots shall be half filled with porous backfill and firmly tamped. Then filled to the road surface with backfill and again firmly tamped down to achieve a final level between 2mm and 5mm below the road surface level. Finally the slot shall be topped up to road level with the same thixotropic epoxy resin or equivalent adhesive binder as used to bind the aggregate, taking care to ensure that the backfill below remains porous.

Damage to Road Construction

2.49 If during slot cutting, the saw breaks through into a hardcore bed, any other road base or reinforcing material, the cutting work shall cease immediately and the Overseeing Organisation shall be notified.

3 DETECTOR FEEDERS

General

3.1 Loops are connected to detector units housed in a cabinet by means of feeder cables. These feeder cables shall comply with specification TR 2031. If cable ducts are used between the loop joint chamber and detector housing, un-armoured feeder cables may be used. Otherwise, armoured feeders shall always be used.

3.2 The installed feeder cable shall not exceed 200 metres in length from the detector housing to the most distant loop connected to it

3.3 Feeder cables shall be run in the verge, or where applicable on all-purpose trunk roads, in the footway.

3.4 Where 3.3 cannot be complied with; feeder cables shall be run along the central reservation or, exceptionally, the carriageway. HCD Drawings G22 and G23 give details.

3.5 All cables which are installed and which are not immediately terminated shall be sealed to prevent the ingress of water.

3.6 Each feeder shall be labelled at its point of entry to the detector housing. The system of identification shall be agreed with the Overseeing Organisation. The cable marker reference, each detector function and the physical position of each detector module inside the housing shall be shown on a drawing to be fixed to the inside of the equipment housing. The drawing shall be in the form of a self-adhesive label and conforming to BS 4781. Alternatively, the label may also be laminated or encapsulated and attached inside the cabinet by a cable tie. In either case, it is important that the information in this drawing shall remain legible over the expected life of the installation even if the equipment housing is opened in wet or freezing weather.

Cable Joints

3.7 There shall be no joints along the length of any feeder cable, except where cross-motorway cutting is deployed. Refer to 3.25.

3.8 Cable joints shall not be encapsulated in epoxy resin type materials.

3.9 On HA road network, the loop/feeder cable joints shall always be enclosed in a re-enterable joint enclosure.

3.10 The re-enterable joint enclosures shall be to BS EN 60529:1992 sub-clauses 13.1, 13.2, 13.3, 13.4, 14.1, 14.2, 14.2.8 and 14.3. They relate to an IP 68 rating against the ingress of dust and water.

3.11 Connections between feeder cable and loop tails shall be made wherever possible by using protected re-enterable terminal blocks suitable for 2.5mm² cables. Where this is impractical then one of the following methods shall be used according to site conditions:

- a ratchet type crimping system
- solder sleeves, provided that lead free solder is used.
- solder on the cables directly, which is then insulated, provided that lead free solder is used.

Whichever method is used care shall be taken to ensure that the joint is made correctly, using the correct tools and following manufacturers instructions.

Loop Joint Chambers

3.12 On the Highways Agency road network, loop joint chambers shall be provided to house all joints between loop tails and feeders. They shall be sited off the carriageway.

3.13 Wherever possible, loop joint chambers shall be located where they have the protection of safety barriers and shall not be positioned where lid removal and access could be hindered by later addition of a new safety barrier.

3.14 Loop joint chambers shall be capable of withstanding vehicle overrun.

3.15 Prefabricated loop joint chambers may be used provided they meet the requirements of 3.14.

3.16 (I) HCD Drawings G7, G8, G9, G10, G25 and G26 show details of typical loop joint chamber installations. Where cross-carriageway cutting is used, the near side chamber inlets need to be modified to cater for all the feeders and loop tails to be accommodated.

3.17 Sufficient loop and feeder cable length shall be left in the chamber to allow for convenient re-jointing to take place. However this shall not be taken to excess as surplus cable length may lead to cross-talk, and congestion within the chamber, both of which must be avoided.

3.18 To avoid problems with water ingress and connection reliability, care shall be taken that the cable entry into any joint shall be kept as straight as possible. This shall be especially during the jointing process and the replacement of the completed joint into the chamber. Care shall also be taken during subsequent chamber activities to avoid undue strain on the joints.

All-Purpose Trunk Roads

3.19 In addition to the foregoing general requirements for cable joints and loop joint chambers, the following shall be taken into account for Highways Agency all-purpose trunk roads.

3.20 It is permissible to run two feeder cables in one slot provided that the minimum depth of cover is maintained, as specified in the relevant HCD drawings.

3.21 Loop tails laid in a footway from the kerb to the loop joint chamber, or feeders laid in the footway, or verge, shall be laid in accordance with Clause 1217 (MCHW 1.1200).

3.22 Where cables cross kerb lines from the carriageway to the footway one of the two arrangements shown in HCD Drawing G24 shall be used.

Motorways

3.23 In addition to the foregoing general requirements for cable joints and loop joint chambers, the following shall be taken into account for motorways.

3.24 Feeders from the far carriageway shall be routed via cross-motorway ducts where those exist and the other requirements of this document can be complied with. Where such ducts do not exist, consideration may be given to slot cutting across both carriageways. The Overseeing Organisation shall be consulted to ensure that any such cutting does not compromise the road structure.

3.25 Where cross-motorway cutting is deployed, and loop tails are taken off the carriageway on the far side, the crossing shall be made with armoured feeder cable which may be jointed on the near carriageway, using joint enclosures suitably configured for feeder-to-feeder joints, and using the same joint chamber employed for the near carriageway loops. Refer to HCD Drawings G14, G15, and G16.

3.26 In the event that cross-motorway cutting is carried out, feeder cables may be routed via a joint chamber in the central reserve, where this is possible. A 1m loop of feeder cable shall be left in this chamber to allow future jointing. Feeder cables shall not be jointed in this chamber on initial installation.

3.27 **(I) The** purpose of this central reserve chamber is to enable reinstatement of the feeder if, at some future date, only one side of the carriageway is resurfaced and loops are lost.

3.28 **(I) Consideration** should be given to modifying the near carriageway chamber inlet to accommodate two 100mm inlets, to allow easier installation of all the cables required to enter the chamber.

3.29 All loop tails and feeder cable ends in the loop access pits and the termination cabinets shall be fitted with cable identifiers to clearly identify the loops. The cables shall be identified as detailed below:

Lane	Loop Identity	
1 (nearside)	1P	1S
2	2P	2S
3	3P	3S
etc;		

where P is the primary (first to be crossed by traffic) and S is the secondary loop of a pair.

4 LOOP ARRAY REPAIRS

Note: These guidelines only apply to maintenance repairs of MIDAS inductive loop arrays.

4.1 When one or more loops fail within an array, the recommended method of repair is to replace all of that type of loop, (primary or secondary) as described in Option 1.

4.2 Alternatively, the Traffic Operations Project Sponsor, in consultation with the maintaining authority may, after completing a risk assessment, traffic flow and traffic management impact analysis and a relative cost analysis, authorise single lane loop repairs to be carried out as described in Option 2.

4.3 If loops have failed in both the primary and secondary sub-arrays then the whole array shall be re-cut.

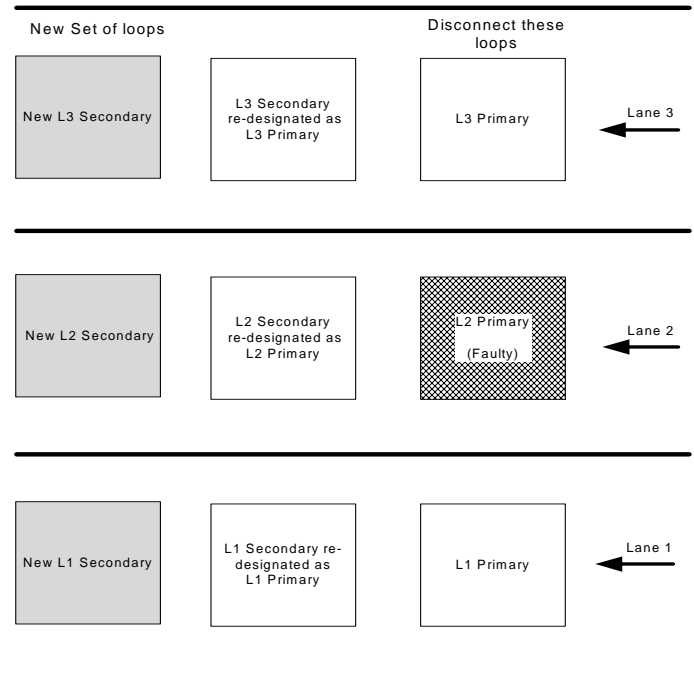
4.4 Care shall be taken to ensure that the effective new position of the array does not exceed the 500 metre +/- limits as specified in the DMRB Vol 9 Section 3 HD 20/92 "Loop Detectors for Motorways" This is especially important if multiple fault / re-cuts have occurred at this site. If the effective new position does break the site data limits, then the whole array shall be re-cut within MIDAS specified limits and the site data amended accordingly.

Option 1

4.5 If any of the primary loops have failed then:

- (i) Disconnect all primary loops;
- (ii) Cut a new set of loops downstream of the array and connect them as secondaries; and
- (iii) Re-designate the original secondary loops as primaries.

For example: (drawing not to scale)

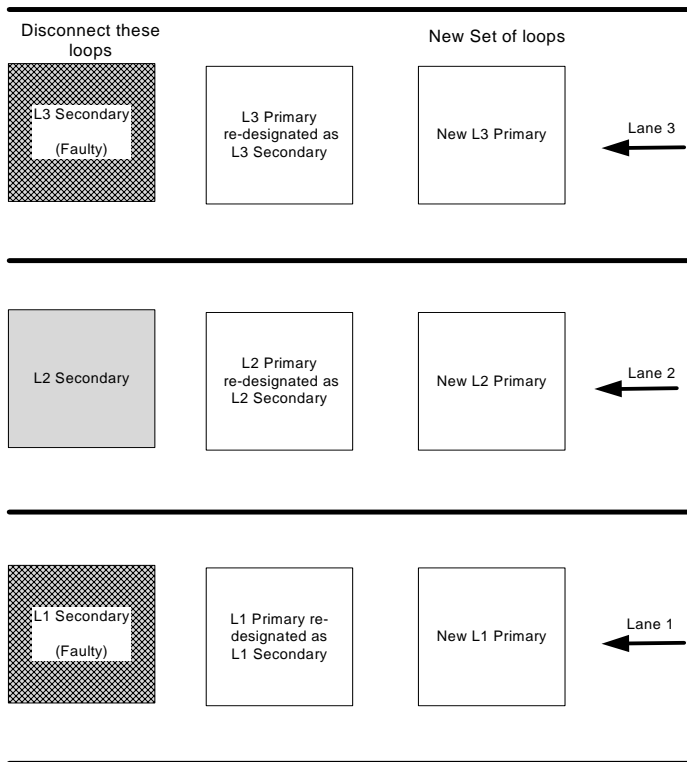


**Option 1: Method of Repair for
Primary loop failures**

4.6 If any of the secondary loops have failed then:

- (i) Disconnect all secondary loops;
- (ii) Cut a new set of loops upstream of the array and connect them as primaries; and
- (iii) Re-designate the original primary loops as secondaries.

For example: (drawing not to scale)



Option 1: Method of Repair for Secondary loop failures

Option 2

4.7 Following an instruction from the Traffic Operations Project Sponsor, a repair in accordance with Option 2 may be undertaken.

4.8 For a primary loop failure:

- (i) Disconnect the failed primary loop;
- (ii) Cut a new loop in the relevant lane downstream of the array and connect it as the secondary; and
- (iii) Re-designate the original secondary loop in the relevant lane as the primary.

For example: (drawing not to scale)

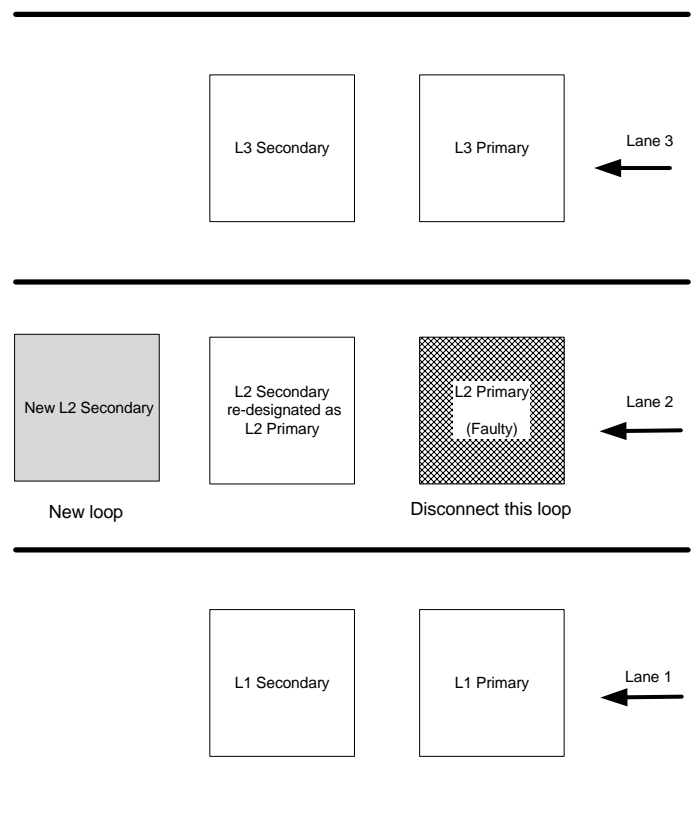
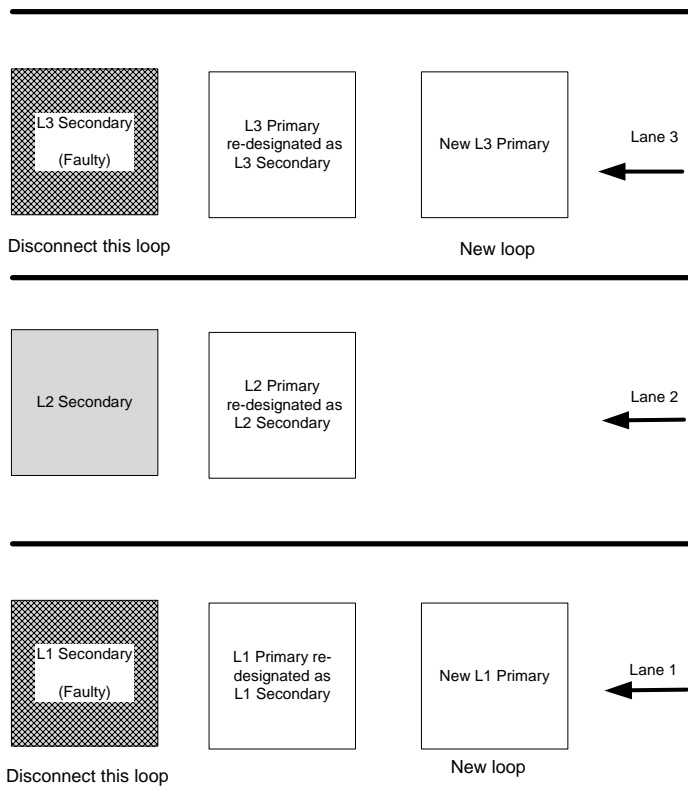


Figure 4-3 Option 2: Faulty Primary Loop

4.9 For secondary loop failures:

- (i) Disconnect the failed secondary loop;
- (ii) Cut a new loop in the relevant lane(s) upstream of the array and connect it as the primary; and
- (iii) Re-designate the original primary loop in the relevant lane as the secondary.

For example: (drawing not to scale)



4.10 Hard shoulder loops shall no longer be installed or used. If an existing hard-shoulder loop fails, then the procedures to change the site data shall be initiated as soon as possible to remove both the primary and secondary hard-shoulder loops from the data. The existing hard-shoulder loops shall be disconnected and 100µH inductors fitted on the detector terminals in place of the loops. It should be noted that this will produce a fault condition until new site data is installed.

4.11 Note that correct spacing between the primary and secondary sub-arrays shall be maintained in any loop re-cutting.

4.12 Any loop tails that have been disconnected shall be cut short, the ends of the tails insulated to prevent inadvertent short circuits with other cables and the tails clearly marked with a water-proof label as being disconnected.

Figure 4-4 Option 2 Faulty Secondary Loop

5 LOOP TESTING

5.1 Two distinct types of final loop testing shall be carried out. These are outlined as follows:

- (i) Tests to be carried out in the loop joint chamber, without feeder cables fitted. On some occasions, when loops are not to be commissioned until a later date, these are the only tests carried out. This set of circumstances arises principally on motorways and some all-purpose trunk roads where MIDAS is under consideration. The loops may be installed as part of resurfacing, or new build, but the detection system may be installed and commissioned at a later date. These tests shall be known as 'Loop Tests', and
- (ii) Tests to be carried out during installation and commissioning. This is a final check on the detector loop, joint, and feeder cable installation as part of the commissioning process for a traffic control, vehicle survey, or MIDAS system. Tests shall be carried out in the detector housing, without the feeders connected to the detectors. These tests shall be known as 'Complete Circuit Tests'.

5.2 Further to the above mandatory requirements, the loop installation contractor is strongly advised to carry out two further stages of testing as follows;

- (i) After loop cable installation; and
- (ii) After backfilling.

5.3 It is not a requirement to formally record the above interim tests. However, once the loop is correctly installed, and the loop tails are in the loop joint chamber, then it is strongly advised that the contractor proceed to have the loop formally accepted by the Overseeing Organisation.

5.4 **(I)** The initial testing after loop cable installation is to check the integrity of the loop before backfilling. After backfilling, the tests shall be carried out from the loop tails before the feeder is connected. These tests are intended to show if any damage has been caused to the loop cabling during installation in the carriageway. Testing shall also show if the loop has the correct number of turns. If there is a problem, then remedial action at this stage, when traffic management is still on the road, will be quicker and cheaper.

5.5 Test results shall be submitted to the Overseeing Organisation. They shall be recorded and approved, on the installation test certificate shown in HCD Drawing G6.

5.6 The Installation Test Certificates are the property of the Overseeing Organisation. They shall be forwarded to the Overseeing Organisation within the time stipulated in the Contract.

5.7 If the Contract for works is for loop installation only, the Overseeing Organisation shall inspect and accept as for Loop Tests as in 5.1 (i). The results of tests 5.18, 5.23, and 5.30 shall be recorded. Any loop tails left un-terminated at this stage shall be sealed to prevent the ingress of water.

5.8 If the Contract of works is for loop installation and commissioning, the Overseeing Organisation shall inspect and accept as for 5.7 above, plus the Complete Circuit Tests as in 5.1 (ii). The results of tests 5.18, 5.19, 5.21, 5.23, 5.25, and 5.31 shall be recorded.

5.9 If there is a considerable delay between installing loops, and a new contract for installing feeders and commissioning, then the Loop Tests shall be repeated, before feeders are connected to the loop tails.

5.10 The Contractor shall, correct or replace, any loop, and/or feeder, that fail the tests specified.

5.11 Loops forming a MIDAS array shall display similar characteristic readings when compared with other loops in the scheme with similar physical attributes. For example, primary and secondary loops in any lane should exhibit near identical readings. Adjacent arrays in the same lane should exhibit similar readings, assuming loop tails are of a similar length. It is necessary to note the readings of each loop so that a history of loop readings is built up as installation proceeds. In this way, discrepancies between readings will be more noticeable, and any potential problems will be detected earlier.

5.12 Particular attention shall be given to inductance readings where a wide variation in reading for loops in adjacent arrays in the same lane may be indicative of an incorrect number of turns, which must be investigated before backfilling.

5.13 Any pair of loops for vehicle counting, identification, speed measurement, etc. shall display near identical readings. Other single traffic control loops shall be checked very carefully against calculated values, as there are no nearby comparisons.

5.14 Once accepted by the Overseeing Organisation, a copy of the loop and complete circuit test results shall be lodged with the Overseeing Organisation within the time stipulated in the contract.

Conductors Resistance

5.15 **(I)** The purpose of this measurement is to ensure that any joints are electrically sound and that the cable is continuous.

5.16 The maximum permitted resistance of loop cable to TR 2029 is 13.7 ohms per kilometre.

5.17 The maximum permitted resistance of feeder cable to TR 2031 is 12.1 ohms per kilometre.

5.18 The series resistance of a loop measured between the two conductors in the loop joint chamber shall not exceed 12.1 ohms per kilometre when corrected to 20°C.

5.19 The series resistance of a complete circuit, comprising loop and feeder cable, measured between the two conductors of a feeder cable at the equipment housing, shall not exceed 13.7 ohms per kilometre when corrected to 20°C.

5.20 **(I)** A value of approximately 5 ohms may be expected for a two metre square loop with an average feeder length, which may increase to 8 ohms for feeders up to 300 metres. These figures are only a rough guide and readings for loops in similar positions shall be compared and any significant variations investigated.

5.21 If armoured feeder cable is used, it is only earthed at one point. This is normally at the detector housing. The resistance of the armoured sheath to earth shall be less than 0.5 ohms.

Insulation Resistance

5.22 **(I)** The purpose of this measurement is to ensure that the insulation is undamaged and that joints are physically sound and not leaking to earth due to water ingress.

5.23 With the two conductors of a loop tail, or complete circuit (comprising a loop and feeder) connected together, the insulation resistance between the cable conductors and a good earth point shall be >100 M Ohms measured at 500Vd.c. Any failures must be investigated and rectified.

5.24 Care shall be taken to ensure that the cable insulation is clean and dry at the test connection point to ensure that dampness or dirt does not give a false reading.

5.25 If armoured feeder cable is used, before the earth connection is made, the resistance of the armoured sheath to earth shall be measured. It shall be greater than 100 M Ohms. If this test fails, then it indicates damage to the feeder cable. This shall be investigated and remedial action taken.

Inductance

5.26 **(I)** The purpose of this measurement is to give confidence that a loop has been installed correctly.

5.27 The required measurements shall be made with no vehicles on or traversing the loop.

5.28 For roads where high levels of traffic are expected, it is advisable whenever possible to carry out these tests before the road/carriageway is opened.

5.29 The loop inductance shall be measured and the value compared with the theoretical value of inductance obtained using the formula in 5.33.

5.30 The inductance of every loop shall be measured using a calibrated inductance meter (accuracy $\pm 2\%$), connected directly onto the two conductors comprising the loop circuit.

5.31 Measured loop inductance shall not differ from the calculated value by more than 20%. An inductance value outside this range indicates an incorrect number of loop turns. This shall be investigated and remedial action taken. All loops shall have the same number of turns and shall be re-checked whenever possible before backfilling.

5.32 The measured loop inductances for pairs of loops in the same lane shall be within 10%. An inductance value outside this range indicates an incorrect number of loop turns.

5.33 (I) Loop inductance shall be calculated as follows:

Loop inductance, L_l

$$A_{ll} = 0.2 \times P \times N^2 \times \ln(D/a) \mu\text{H}$$

Where: P = perimeter of loop in metres

N = number of turns

ln = naperian or natural log.

D = distance between the longest sides of loop in metres.

a = effective loop wire RADIUS in metres:

For: 1 turn a = 0.7 mm (0.0007 m.)

2 turns a = 2.5 mm (0.0025 m.)

3 turns a = 3.0 mm (0.0030 m.)

4 turns a = 3.5 mm (0.0035 m.)

Example Calculation

To calculate the inductance of a 3 turn, 2 metre square loop with an 11 metre tail and 50 metres of feeder:

$$L_{\text{loop}} = 0.2 \times P \times N^2 \times \ln(D/a) \mu\text{H}$$

$$= 0.2 \times 8 \times 9 \times \ln(2/0.003) \mu\text{H}$$

$$= 14.4 \times \ln(666) \mu\text{H}$$

$$= 14.4 \times 6.5 \mu\text{H}$$

$$= \mathbf{93.6 \mu\text{H}}$$

$$L_{\text{tail}} = 11 \text{ metres} \times 0.64 \mu\text{H/metre} = \mathbf{7.0 \mu\text{H}}$$

$$L_{\text{feeder}} = 50 \text{ metres} \times 0.79 \mu\text{H/metre} = \mathbf{39.5 \mu\text{H}}$$

$$\text{Total inductance} = \mathbf{93.6 + 7.0 + 39.5 = \underline{\underline{140 \mu\text{H}}}}$$

Loop tail inductance, L_t

Loop cable has an inductance of 0.64 $\mu\text{H/metre}$. Note that this is for a twisted pair of cables.

$$L_t = (\text{length in metres}) \times (0.64) \mu\text{H}$$

Loop feeder inductance, L_f

Two pair armoured feeder cable has an inductance of 0.79 $\mu\text{H/metre}$ of feeder cable (as cut).

$$L_f = (\text{length in metres}) \times (0.79) \mu\text{H}$$

Total inductance, L = $(L_l + L_t + L_f) \mu\text{H}$

6 DETECTOR HOUSINGS

6.1 Detector housings shall be positioned so that they do not obstruct the sightlines of road users, and/or pedestrians. They shall not obscure any legal road signs or markings. Consideration shall also be given to access for maintenance, and the safety of personnel carrying out the work.

6.2 Detector housings shall be positioned so as to reduce the possibility of damage in the event of a road traffic accident, and wherever possible reduce their visual impact.

6.3 On motorways, if a Cabinet 600 equipped for loop detectors is used, then it shall be installed in accordance with Clause 1508 (MCHW 1.1500). In addition to Clause 1508, a trickle vent shall be designed into the cabinet to reduce the risk of condensation forming. Alternative approved housings may be used with the agreement of the Overseeing Organisation.

6.4 The power supply cable shall be terminated as described in Appendix 15/1 (for motorways), or Appendix 12/5 (for all-purpose roads (MCHW 2.1500)).

6.5 The loop feeders shall be terminated in terminal blocks complying with Clause 1514 (MCHW 1.1500), secured to the equipment frame.

6.6 Each feeder shall be terminated with approximately 1 metre of slack cable to allow future repair and reconnection.

6.7 Each feeder cable in the detector housing shall be identified by means of a label.

6.8 Detector housings shall be sited as near as possible to an existing electrical supply. This may be a power supply point for the communications system. If this is not possible, an independent supply shall be arranged with a local electricity supplier.

7 GLOSSARY

Definitions

For the purpose of this Specification the following definitions shall apply:

Overseeing Organisation: The term Overseeing Organisation means the Highways Agency, the Scottish Executive, Welsh Assembly Government, or the Department for Regional Development (Northern Ireland), depending on who is responsible for the Contract.

Nominated agent: An organisation or nominated person approved by the Overseeing Organisation to supervise contracts for design, installation, and maintenance of roads controlled by the Overseeing Organisation. The nominated agent for the Highways Agency's motorways is the Regional Maintenance Contractors Managing Consultant (RMCMC). The nominated agent for the Highways Agency's trunk roads is the Managing Agents. Other Overseeing Organisations will have different procedures.

Contractor: The organisation contracted to carry out the work.

Project Sponsor: The Person who manages the Highways Agency's interest in a project.

Regional Electrical Support Teams: Regionally based Highways Agency electrical engineers dealing with signs, safety and electrical matters on Highways Agency roads including Traffic Signals, Street Lighting, Enforcement Cameras and Communication Systems.

Far Carriageway: For a particular detector installation on a dual carriageway, the carriageway furthest from the location of the detector housing.

Near Carriageway: For a particular detector installation on a dual carriageway, the carriageway nearest the location of the detector housing.

Nearside (lane, etc): Relating to the side of a road or carriageway furthest from the centre of the road.

Loop: One or more turns of insulated conductor installed on or below the carriageway and which acts as a transducer in order to detect the presence of vehicles.

Loop Tails: The two ends of the loop laid together from the loop to the point of connection to the loop feeder.

Loop Feeder Cable: The cable connecting the loop or loop tails to the vehicle detector.

Loop Pair: The primary and secondary consecutive loops that lie in a single lane.

Primary Loop: The upstream loop of a pair and the first to be crossed by a vehicle moving in the correct manner.

Secondary Loop: The downstream loop of a loop pair.

Substrate: One of the layers of material forming a pavement construction below the wearing course.

8 REFERENCES

- 8.1 MCHW Manual of Contract Documents for Highway Works,
Volume 1 - Specification for Highways Works
Volume 2 -Notes for Guidance on the Specification for Highways Works
Volume 3 - Highway Construction Details
Volume 4 - Bills of Quantity for Highways Works.
- 8.2 Design Manual For Roads and Bridges (DMRB)
- 8.3 MCH 1542 Installation Guide for MOVA
- 8.4 MCH 1352 Technical Guide to SCOOT Loop siting
- 8.5 MCE 0108 Siting of Inductive Loops for Vehicle Detecting Equipments at Permanent Road Traffic Signal Installations
- 8.6 TR 2029 NMCS Inductive Loop Detector Cable
- 8.7 TR 2031 NMCS Feeder Cable for Inductive Loop Detectors
- 8.8 BS EN 60529 Specification for degrees of protection provided by enclosures (IP code)
- 8.9 BS EN 124 Gully tops and manhole tops for vehicular and pedestrian areas – Design requirements, type testing, marking, quality control
- 8.10 BS 4781 Specification for pressure-sensitive adhesive plastics labels for permanent use
- 8.11 HD 20/92 Loop Detectors For Motorways
- 8.12 MCH 1589 Guide to the siting of Inductive Loop Detectors on Motorways

9 HISTORY

Issue A	December 1990
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