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TII Publications

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For all documents that existed within the NRA DMRB or the NRA MCDRW prior to the launch of TII Publications, the NRA document reference used previously is listed above under 'historical reference'. The TII Publication Number also shown above now supersedes this historical reference. All historical references within this document are deemed to be replaced by the TII Publication Number. For the equivalent TII Publication Number for all other historical references contained within this document, please refer to the TII Publications website.

TRAFFIC CONTROL AND COMMUNICATIONS

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TRAFFIC CONTROL AND COMMUNICATIONS

1501 Introduction

- 1 Motorway communications installations shall comply with this Series.

1502 General Requirements

- 1 The Contractor shall:
 - i. unless otherwise described in Appendix 15/1, supply, deliver, store and install communications cables including fibre optic cables, power cables, detector loop and feeder cables; and
 - ii. supply, deliver, store and install cabinets and ancillary items as listed in Appendix 15/1, unless otherwise described therein; and
 - iii. supply, deliver, store and install all associated cable fittings, as described in Appendix 15/1, terminate cables in compliance with Clauses 1515 and 1516 and test the installations in compliance with Clauses 1515 and 1518.
- 2 All operations shall be arranged so that the communications installation is completed, tested and the test results approved by the Employer's Representative at least 8 weeks before the date for completion of the Works and, where required in Appendix 15/1, to allow time for the Employer's Representative to commission the system. The Contractor shall allow sufficient time in their programme for any repairs and retesting which may be required to be completed satisfactorily before the aforementioned 8 week commissioning periods.
- 3 The Contractor shall provide facilities for the electricity supplier for service connections and for the Employer's Representative for commissioning of the system.
- 4 The Contractor shall demonstrate, in advance of commencing cable installation work, competency to undertake the necessary cable termination and testing requirements detailed in Clauses 1511, 1513, 1515, 1516 and 1518, to the satisfaction of the Employer's Representative. The Contractor shall allow sufficient time in their programme to achieve compliance; 14 days' notice, in writing, to the Employer's Representative is required. The written consent of the Employer's Representative shall be obtained before cable installation commences.
- 5 The Contractor shall provide the Employer's Representative with full details of all personnel whom they propose to employ on the testing and terminating of cables. Such details shall be provided in writing, 14 days prior to the commencement of cable termination. The written approval of the Employer's Representative shall be obtained prior to the commencement of such work

1503 Materials Equipment and Workmanship

- 1 The electrical installation associated with the Motorway Communication systems, including materials and equipment supplied by the Contractor, shall comply with the most recent version of ET101, 'National Rules for Electrical Installations' by the Electro-Technical Council of Ireland and the regulations, codes of practice and guidelines of ESB Networks.
- 2 All such equipment shall be sufficiently compact for satisfactory installation and operation in the accommodation provided for it.

- 3 The Contractor shall ensure that enclosures, following the drilling cutting or removal of cable entry knockouts, maintain the manufacturer's quoted IP Classification ratings and are cleaned of all waste and surplus material prior to any further work being undertaken.
- 4 All equipment supplied or employed to complete the installation shall comply with the appropriate European Standard published as I.S. EN or CENELEC Harmonisation Document or the equivalent Irish Standard or, in the absence thereof, with the appropriate Irish Standard. Equipment for which none of these standards exist shall comply with the appropriate IEC, ISO or BSI standard.
- 5 All equipment supplied or employed to complete the installation shall be clearly CE marked and shall conform to the requirements of all relevant EU Directives.

1504 Site Records

- 1 The Contractor shall keep a daily record in duplicate in a clear and legible form, on drawings, of all work carried out as it proceeds. One copy shall be kept available for the use of the Employer's Representative during the Contract and shall, at completion certificate stage of the contract, be handed to the Employer's Representative for record purposes. (Handover during maintenance period is not acceptable). The following information shall be recorded on the drawings:
 - i. Cable routes, including cable lengths. Additionally, within a ducted network, the number and type of cable allocated to each duct and the length of each cable.
 - ii. Cable size, type and drum number;
 - iii. Cabinet positions, type and internal electrical layout; Power supply interfaces and associated electrical load; Telecom and other interfaces;
 - iv. Cable chamber locations including type, depth, incoming and outgoing ducts, type of chamber cover and details of cable joints within.
 - v. Devices;
 - vi. Telephones;
 - vii. Joint and sheath repair positions;
 - viii. Duct locations including depth, number of ducts, duct material and the number and type of cable in each duct ;
 - ix. Cabinet and cable chamber references.
 - x. Any additional requirements stated in Appendix 15/1.
- 2 The drawings shall be subject to the approval of the Employer's Representative at weekly intervals during the Contract. Electrical schematic of installation including circuit protective device arrangement and rating;
- 3 Locational measurements shall be taken of the underground equipment to the nearest 100 mm from the nearest edge of the carriageway or fence line. Offsets to the cables shall be recorded at 20 m intervals and at every change of direction along the line of the cable unless otherwise directed by the Employer's Representative. Offsets shall be defined longitudinally by distance from a permanent road feature, a marker post or other point agreed with the Employer's Representative.
- 4 The Contractor shall keep a daily record of the work in sufficient detail including type and drum number of underground cables to enable site records to be completed. A copy of the daily record shall be provided by the Contractor on the next working day for retention and use by the Employer's Representative.

- 5 The Contractor shall keep record sheets for ducts and chambers which shall indicate details of all cables, Cable Joint Enclosures (CJE), Above Ground Joints (AGJ), ironwork, and plugs installed and tests undertaken.

1505 Cabinets and Ancillary Items

- 1 Cabinets and ancillary items shall include cabinet bases, cabinet fittings, equipment mounting posts, and other similar items.
- 2 The Contractor shall be responsible for safe storage of the equipment including the provision of a dry heated store as described in Appendix 15/1. All equipment shall be secured by means of master keys, of which 2 originals of each shall be supplied to the Employer's Representative on the completion of the Works
- 3 The Contractor shall maintain an up to date record of all equipment, including cable. The record shall include details of the number and type of equipment and serial numbers (drum numbers for cable).

1506 Cables

- 1 Communications cable shall consist of one or more of the following as required in Appendix 15/1:
 - i. armoured multi-pair cable to the Specification given in Appendix 15/1;
 - ii. armoured fibre optic cable to the Specification given in Appendix 15/1.
 - iii. non-armoured copper communications cable to the Specification given in Appendix 15/1;
 - iv. non-armoured optical fibre communications cable to the Specification given in Appendix 15/1;
 - v. non-armoured coaxial communications cable to the Specification given in Appendix 15/1;
 - vi. armoured copper communications cable to the Specification given in Appendix 15/1;
 - vii. armoured composite copper/fibre optic cable to the Specification given in Appendix 15/1;
 - viii. armoured coaxial communications cable to the Specification given in Appendix 15/1;
 - ix. armoured feeder cable for inductive loop detectors to the Specification given in Appendix 15/1;
 - x. inductive loop detector cable to the Specification given in Appendix 15/1;
 - xi. Any other cable specified in Appendix 15/1 or may be required as part of a Contactor proposed solution.
- 2 Power supply cable for communication systems shall be armoured, typically be of type XLPE/SWA/PVC and comply with BS 5467. Power cables shall be as per the Specification given in Appendix 15/1.
- 3 All conductors for power supply cables shall be stranded copper regardless of the conductor size and have PVC bedding and sheaths, unless agreed otherwise with the Employer's Representative. Cable sheaths shall be flame retardant.
- 4 The approximate positions of cables to be installed and their terminating cabinets are described in Appendix 15/1. The exact location shall be agreed with the Employer's Representative before

the commencement of any associated ground work. At this time the Contractor shall also provide the Employer's Representative with a schedule of cable lengths and their locations, after checking the lengths of cable routes on the Site.

- 5 Each drum of cable delivered to the Site shall be accompanied by duplicate copies of test certificates bearing the cable description and the name of the manufacturer. No cable length shall be laid until its manufacturer's test certificate has been accepted by the Employer's Representative and the Contractor has tested and accepted the integrity of the sheath in accordance with the cable test specification. The results of the Contractor's tests shall be notified to the Employer's Representative. The location in the ground of cable lengths by reference to their drum numbers shall be kept with the daily records.
- 6 The location of direct buried cables shall be detected, confirmed and protected in accordance with the Conditions of Contract, "Special Requirements in Relation to Motorway Communications Systems" and any additional requirements determined by the design.
- 7 The Contractor shall be responsible for the safe and secure storage of all cable. The Contractor shall keep and maintain a register of all cable drums; the register shall for each cable drum include the cable drum number, cable size and length(s) of cable removed. Both ends of each cable are to be sealed as protection from the ingress of moisture.
- 8 The system of colour coding of conductors throughout the installation shall be as per the European harmonised core colour code. Conductors of each type (phase, neutral & protective) shall not be converted (e.g. by sleeving) for use as any other type of conductor than that specified.
- 9 Glands for armoured cables shall be IS EN 50262 and sized to suit the cable being terminated. Where SWA cables are glanded to clearance holes, the gland shall be secured using a brass lockout and brass earth tag. All glands shall be fitted with shrouds.

1507 Cable Laying

- 1 Motorway Communication ducts shall comply with Appendix 15/1 and be installed in accordance with Clauses 1530 and 1531.
- 2 Cables shall be laid in accordance with any particular requirements in Appendix 15/1, including, if required, additional protection and support
- 3 Cable covers for protection of underground cables shall be installed as described in Appendix 15/1. When cable covers are installed marker tapes are not required.
- 4 Cable trenches shall be excavated to the lines described in Appendix 15/1 and in accordance with Clause 602. The depth of excavation shall be such that cables laid under verges, footways or open ground shall have a minimum cover of 600 mm and under carriageways of 750 mm, or 300 mm below formation, whichever is the greater depth
- 5 Where agreed by the Employer's Representative cable may be installed using a purpose built cable laying machine.
- 6 Cables shall be laid without sharp bends and kinks and in accordance with any particular requirements in Appendix 15/1. If required, additional protection and support shall be provided as described in Appendix 15/1 or as directed by the Employer's Representative. Communication cables shall be installed without mechanical pulling.
- 7 Where cables are laid across or within 500 mm of filter drains they shall be contained within a duct. The ducts shall be surrounded with 150 mm of mix ST2 concrete in compliance with Clause

2602. In the event that a cable route coincides with the line of a filter drain the Contractor shall inform the Employer's Representative prior to continuing the trenching operation; an alternative trench line shall be agreed. Any damage caused by the Contractor to any drain shall be repaired and reinstated to the satisfaction of the Employer's Representative at no cost to the Employer.

- 8 Communications cables following the same route shall, unless otherwise described in Appendix 15/1, occupy the same trench with a clearance of 50 mm between the outer sheaths of the cables. Communication cables shall have a clearance of 150 mm between them and the outer sheath of associated power cables. Non associated power cables and other services shall be given a clearance of 300 mm, unless otherwise described in Appendix 15/1.
- 9 Cables shall be installed in accordance with the cable manufacturer's specifications. Cables shall only be laid when the ambient temperature is above 0°C, and the cable has been stored at a temperature greater than 0°C for the previous 24 hours.
- 10 Cables shall not be bent to an internal radius of less than 12 times the external diameter of the cable or less than the radius recommended by the manufacturer, whichever is greater.
- 11 Sufficient length of cable shall be allowed for its correct termination. When termination does not proceed immediately following the installation of the cable, its end shall be sealed against the ingress of moisture. An additional loop of cable, of sufficient length to allow for termination in the cabinet, shall be allowed for at cabinet sites to enable future re-termination to be carried out.
- 12 When duct or trough alignments differ from those of the trench the transition from one to the other shall not exceed 1:30 horizontally or vertically.
- 13 Unless otherwise directed by the Employer's Representative, cables laid in trenches shall be both bedded on and covered by a 75 mm thickness of sand passing a 2 mm sieve to BS 410. Class 1C material complying with Table 6/1 and compacted to the requirements therein shall be deposited to a thickness of 175 mm prior to further backfilling to comply with sub-Clause 15 of this Clause.
- 14 Cable marker tape complying with Clause 1531 shall be laid approximately 250 mm above all communications and power cables. Where several cables are laid in one trench one line of marker tape shall be installed for each 600 mm of trench width. The wording on the tape shall be "Electricity Cables" where power supply cables and communication cables are laid in one trench, and the tape shall be yellow.
- 15 When cables are required to be laid in ducts the Contractor shall swab through the duct prior to drawing in the cables and a further draw rope. On completion of cabling and prior to backfilling, ducts shall be left with a draw rope in place and then re-sealed with mechanical duct plugs installed in compliance with sub-Clause 1530.8, or suitable alternative material, to adequately seal the ducts against the ingress of foreign matter.
- 16 The cables shall be looped around the cable support ironwork as detailed on RCD Drawing Number RCD/1500/016 and secured to the ironwork.

Where cables are laid in troughs they shall be covered with sand passing a 2 mm sieve to BS 410 or equivalent material up to the level of the cover.

- 17 Cables shall be lubricated during installation using a suitable water based, biodegradable lubricant.
- 18 The draw rope shall not be used for cable installation. The Contractor shall use the draw rope to pull through a purpose made cable pulling rope which shall then be used for cable installation. The cable pulling rope shall be attached to the cable by means of a pulling eye fitted to a stocking

- (copper and power cable) or a pulling eye attached to the central strength member (fibre cable). In all cases the Contractor shall attach a swivel between the cable pulling rope and the pulling eye.
- 19** Backfilling to trenches shall not take place until they have been inspected and approved by the Employer's Representative. Backfilling shall be in accordance with Clause 602 with material Class 1 or 2 complying with Table 6/1 and compacted to the requirements therein. The material shall be spread and compacted evenly without dislodging, disturbing or damaging cables, ducts or troughs. Power hammers shall not be used within 300 mm of cables, ducts or troughs. The surface shall be reinstated as described in Appendix 15/1.
 - 20** As unburied or exposed cable is liable to theft and/or vandalism, no cable shall be left exposed at the end of any work period. Any cable stolen and/or vandalised as a result of the Contractor's non-compliance with this requirement shall be replaced by a length equal to the original unbroken total length of cable involved (i.e. straight through joint's will not be accepted), at the Contractor's own cost which also includes the cost of the replacement cable.
 - 21** Where directed by the Employer's Representative, any cable trenches, or excavations left open overnight or between the finish of one work period and the start of the next work period shall be covered by steel plates. The steel plates shall be strong enough to withstand the passage of any vehicles permitted to drive on the roadway, without the possibility of collapse or dislodgement.
 - 22** Between adjacent, longitudinal cabinets a drum length of cable shall be laid in one operation, unless otherwise directed by the Employer's Representative.
 - 23** Longitudinal cables shall generally be run parallel to the fence line or edge of the hard shoulder. Transverse cables shall run at right angles to the carriageway. Transverse cables installed diagonally with respect to the carriageway shall not be accepted unless being laid in existing ducts.
 - 24** The Contractor shall remove and replace over its full length any damaged cable or cable which proves unsatisfactory
 - 25** All longitudinal fibre-optic and 30-pair cables and those fibre-optic, 20-pair and 2-pair transverse cables exceeding 50 metres in length shall be provided with buried loops. These loops shall be installed at each end of the cable immediately adjacent to the entry and exit ducts at cabinet locations. The loop shall be made of a minimum of 3 metres of cable.
 - 26** In the event of any protective insulation or armouring being stripped or damaged whilst cables are being installed, the whole of the particular length of cable concerned shall be replaced and re-connected at the Contractor's expense prior to the handover date.
 - 27** Immediately on completion of laying, cables shall be temporarily marked to ensure their unambiguous identification
 - 28** The Contractor shall satisfy himself that ducts are suitable for cable installation prior to the drawing in of cable. The Contractor shall ensure that, on completion of the cable installation works, a draw rope is secured in each duct, in compliance with 1530.8.
 - 29** Power cables shall not share the same duct as longitudinal communications cables.
 - 30** Purpose made bellmouths shall be fitted to the exit and entry of every duct, including all intermediate points, prior to the commencement of cable installation. A purpose made cable chute shall be used at the cable entry point to the network. Cable guides shall be used to support the cable in all intermediate chambers.

- 31 Where intermediate chambers exist on a cable route the cables shall, where practical, be installed through these chambers in one operation; the Contractor shall ensure that an operative is present at every such chamber to ensure the safe installation without damage to the cable. Where cables pass through intermediate chambers, the Contractor shall, immediately after installation, label each cable with the destination of the cable (joint chamber or equipment reference as appropriate) 150 mm from the entry and exit points of the chamber. The type of labelling to be used shall comply with RCD Drawing Number RCD/1500/019.
- 32 Optical fibre cables shall additionally be marked at intervals of 500 mm along their length inside chambers; the marking shall be 25 mm wide, yellow PVC adhesive tape or alternative fit for the purpose.
- 33 Cable management in chambers shall be as shown on RCD Drawing Number RCD/1500/020. The cabling Contractor shall secure the cables to the chamber walls using appropriate fixings.
- 34 All non-armoured cables installed on gantries shall be protected from mechanical damage by being installed within a covered cable tray.
- 35 Once a cable has been drawn off the drum, it shall immediately be laid in position in trenches or ducts. No cable shall be left lying on the surface after removal from the drum for more than the minimum practicable time.

1508 Installation of Cabinets and Signal Posts

- 1 The Contractor shall construct paved areas and foundations incorporating plinths for cabinets and signal posts as described in Appendix 15/1. The cabinets and signal posts shall be mounted on the plinths using holding down bolts. Paved areas shall be either constructed level or with a gentle fall away from cabinets as directed by the Employer's Representative; cabinet doors shall be capable of opening and closing without being fouled by the paved area.
- 2 The bases of cabinets shall be sealed, after the completion of terminations and testing.
- 3 The Contractor shall keep the interior of cabinets free from moisture and dirt. The Contractor shall ensure that the doors of each cabinet are closed and properly secured after the installation of equipment in the cabinet and after the completion of any other work.
- 4 Entry/exit ducts to cabinets shall be sealed using purpose made mechanical plugs in compliance with sub-Clause 1530.14 to prevent the ingress of soil, gravel etc. On a direct buried network entry/exit ducts shall be sealed using suitable plugs or expanding foam.

1509 Gantries for Motorway Signals

- 1 The structural steelwork and foundation arrangements for fabricated steel portal gantries for signs/signals shall comply with Series 1800 of this Specification and all associated Road Construction Details (RCDs) contained in Volume 4 of the NRA MCDRW. Details of traffic signs including variable message signs and matrix signals on gantries are given in Appendix 12/1. Details of electrical equipment are given in Appendix 14/5.

1510 Installation of Emergency Telephones

- 1 The Contractor shall construct paved areas and set the telephone post vertically in concrete foundations as described in Appendix 15/1.
- 2 Telephone housings and instruments shall be mounted on the posts and orientated so that the back of the housing faces oncoming traffic unless otherwise described in Appendix 15/1.
- 3 Where telephones are installed on existing motorways they shall be covered with “Not in Use” bags until they have been commissioned and are available for use by the public

1511 Cable Joints

- 1 Cable joints shall not be permitted in communication cables without the prior approval of the Road Authority.
- 2 Cable joints in power supply cables shall be as described in Appendix 15/1. The approval of the Employer’s Representative is required for the provision of additional joints. Approval will not be given for cable joints situated in a duct or trough. Heat-shrink type joints shall not be used.
- 3 Cable joints in detector loop systems shall comply with Clause 1523.
- 4 Joints shall be made using a suitable jointing system in which all components are mutually compatible and adequate for the type of cables to be jointed. Joints shall be installed in accordance with the manufacturer's instructions. Unless agreed by the Employer’s Representative, the Contractor shall submit records to the Employer’s Representative to enable cable joints to be identified with the jointer responsible for the work.
- 5 The Contractor shall notify the Employer’s Representative before jointing commences so that they may have the opportunity of inspecting the whole of the jointing operations. Jointing shall only be carried out when all materials to be used in the jointing are free from visible signs of moisture and joints shall be left protected from the weather during the curing period. Joints shall be adequately supported at all times. Backfilling shall not take place until the completed joint is in a fit condition to withstand any stresses which may be imposed on it and has been approved by the Employer’s Representative.
- 6 Where described in Appendix 15/1, a cable joint marker block, consisting of a 300 mm square and 225mm deep precast concrete block or buried active joint marker shall be placed over the cable joint. The block shall have a mark indented into its top surface as described in Appendix 15/1 and shall be recorded on the site records.

1512 Installation of Ancillary Items

- 1 Boxes shall be mounted on to the baseboards of Cabinets, the knockouts for cable access removed as necessary and holes bushed, all as described in Appendix 15/1. Terminators shall be fitted within the Boxes where appropriate.
- 2 Distributors shall be mounted on to the baseboards of Posts and Distributors shall be mounted on gantries as described in Appendix 15/1.
- 3 Distributive and protective devices shall be installed in power supply cabinets as described in Appendix 15/1.
- 4 The Contractor shall supply and install enclosures, termination equipment and all fixings as described in Appendix 15/1.

1513 Termination of Armoured Multi-pair Communication Cables

- 1 The armour and sheaths shall be removed from the ends of the communication cable to reveal the pairs of insulated conductors. All surplus jelly shall be removed by the use of a clean dry cloth taking care not to stretch the insulation, and any fluid substance to aid the cleaning process shall have the prior approval of the cable manufacturer and the Employer's Representative. Such approval will not be unreasonably withheld provided that the substance has been shown to have no detrimental effect on the cable or, if applicable, the jointing system. Heat shall not be applied to any part of the cable. The cable crutch shall be fitted with a sleeve and the cable ends shall be glanded or cleated and sleeved. Glands, cleats and earth tags shall be of aluminium.
- 2 The pairs of insulated conductors shall be twisted together and laced neatly to form a loom passing from the cable gland position to the termination position. All conductors shall be long enough for several subsequent terminations and each pair of conductors shall be identified by means of a numbered plastic sleeve or collar. 30-pair looms are not to be laced together in a common loom but are to be physically separate and installed individually.
- 3 Unless otherwise described in Appendix 15/1, communication cables shall be terminated in terminal blocks complying with Clause 1514. The conductors shall be secured by tightening the screws with a torque screwdriver to within the range 0.4 to 0.6 Nm.
- 4 Links shall be installed and connected within Cabinets and Boxes and jumper leads shall be installed between Boxes wherever two are installed within one Cabinet; using as appropriate the insulated conductors of multi-pair/0.9 mm cable with its outer sheath, armour and inner sheath removed. The leads shall be of sufficient length to facilitate routine maintenance and allow for several subsequent re-terminations and shall not obstruct any accessory in the box. The Contractor shall maintain multi-pair colour coding so that colour code duplication does not occur. Care shall be taken at all times to maintain correct pairing. In the 'mainside' box the links shall be tied back and left unconnected.
- 5 In adverse weather conditions, terminations shall be carried out beneath a purpose made tent.
- 6 Where the Contractor is required to terminate cables into cabinet equipment containing operational circuitry; the Contractor shall notify the Employer's Representative sufficiently in advance so that they may arrange for Specialists to attend the site to supervise or undertake all work within the cabinet for which the Contractor is responsible. This shall not compromise the operational system(s).

1514 Cable Connectors

- 1 The Manufacturer of terminal blocks proposed by the Contractor shall be subject to approval by the Employer's Representative. Approval will not be unreasonably withheld provided the Contractor can demonstrate that their adopted terminal block is in all respects physically compatible with the design and that it has satisfactory electrical performance characteristics.

1515 Termination of Fibre Optic Communication Cables

General

- 1 The Contractor shall be responsible for the safe disposal of any fibre waste.

Non-Armoured Cables

- 2 Unless otherwise stated in Appendix 15/1, cables shall be terminated in CJE. The manufacturer's instructions shall be followed. The fibres shall be fusion spliced and protected from mechanical strain.

Armoured Cables

- 3 Cables shall be terminated in an approved hermetically sealed box containing silica gel to prevent damage due to the occurrence of moisture. The fibres shall be fusion spliced and protected from mechanical strain.
- 4 Copper conductors shall be secured by tightening the screws with a torque screwdriver to within the range 0.4 to 0.6 Nm.

1516 Termination and Jointing of Power Supply Cables for Communications

- 1 Power supply cables for communications shall be terminated with compression lugs or bootlace ferules, as appropriate, and correctly crimped as described in Appendix 15/1. Compression lugs up to and including 4mm² shall be pre-insulated and the clearance hole in the lug shall match the stud size to which it is fitted.
- 2 Compression lugs of 6mm² and above shall be standard tubular cable lugs manufactured from tin plated annealed electrolytic copper to EN 13600. Lugs shall have a single hole and shall have a suitable current handling capacity for the cable core. Bolts of dissimilar metals shall not be used to connect the lugs. Crimped connections shall be suitably supported to reduce any pressure on the connection.
- 3 Cable joints in power cables shall be made where described in Appendix 15/1. Additional joints shall not be permitted to overcome inaccuracies in measurement, or cable damage. Cable joints shall not be situated in a duct or trough. Heat-shrink type joints shall not be used.
- 4 Joints shall be made using a suitable jointing system in which all components are mutually compatible and adequate for the type of cables to be jointed. Joints shall be installed in accordance with the manufacturer's instructions. Prior to cable laying the Contractor shall provide the Employer's Representative with the names of the jointers proposed and evidence of the proposed jointers' competence in the use of the cable joint kit to be used. Jointers shall not commence any jointing until the written approval of the Road Authority has been received. A record shall be kept to enable cable joints to be identified with the jointer responsible for the work.
- 5 Jointing shall only be carried out when all the materials used in the joint are free from visible signs of moisture. Joints must be left protected from water, frost, direct sunlight and extremes of temperature during the curing period. Joints shall be adequately supported at all times.

Backfilling shall not take place until the joint is completely cured and able to withstand any stresses which may be imposed on it.

- 6 Where a new power supply is being provided to existing equipment which will result in a disruption to or the loss of existing facilities (signals, CCTV etc.) the Contractor shall obtain written authority from the Road Authority who will advise the Road Authority's Maintenance Contractor of the anticipated duration, so that the effects of the power supply disruption can be assessed.

- 7 The Contractor shall provide at least two weeks' notice in writing to the Road Authority of all planned disruptions. The Contractor shall undertake all necessary preparatory work to ensure that the period of disruption is minimised.
- 8 Where power supply cables are to be terminated into existing cabinets which contain operational equipment, the Contractor shall, through the Road Authority, arrange for the Road Authority's Maintenance Contractor to attend each site to witness cable termination work undertaken by the Contractor. The Contractor shall give at least two weeks' written notice.
- 9 At each existing gantry the Contractor shall carry out suitable tests to confirm that the lighting supply and the communications power supply are fed from the same phase. Where tests show the two supplies are not in phase the Contractor shall isolate the communications energy supply, at the energy isolation cabinet, from the mains supply and carry out the necessary remedial works.
- 10 Where described in Appendix 15/1, a cable joint marker block, consisting of a 300 mm square and 225 mm deep precast concrete block or buried active joint marker shall be placed over the cable joint. The block shall have a mark indented into its top surface as described in Appendix 15/1, and its position shall be recorded on the site records.

1517 Earthing and Bonding

- 1 The entire installation shall be properly and effectively earthed and bonded, with protective earthing and main supplementary equipotential bonding provided, as required, throughout.
- 2 The earthing and bonding of the whole installation shall comply with the most recent version of ET101, 'National Rules for Electrical Installations' by the Electro-Technical Council of Ireland. It shall also be in compliance with clause 1420 and as specified in Appendix 15/1.
- 3 The area of gland plates or boxes which will come in contact with a cable gland shall be cleaned of all paint and corrosion before a cable gland is fitted. Once the gland is fitted, exposed metalwork of gland plates or boxes shall be suitably treated to protect against corrosion.
- 4 All connections to bolted fixtures shall be made through crimped type lugs.
- 5 Adjacent cabinets less than 2 metres distant shall be effectively earth bonded together.
- 6 Tests on the earthing system shall be made and recorded in accordance with the ETCI Regulations. Resistance tests shall be carried out on each section of the earthing system and on the complete system at the completion of the works.

1518 Cable Testing

- 1 As soon as is practicable after completion of the installation, the Contractor shall undertake tests on cables as detailed within this series and Appendix 1/5.
- 2 Cables shall be tested at the manufacturer's works to ensure compliance with the specifications and the tests shall be witnessed by the Employer's Representative.
- 3 When installed, cables shall be tested by the Contractor in accordance with the Specifications and the Employer's Representative shall arrange for the tests to be witnessed by a specialist if they so require.
- 4 Three copies of all cable test results shall be supplied to the Employer's Representative on the completion of each test.

- 5 The Contractor shall, after testing, locate and expose any damaged outer sheath whether caused by himself or not and shall report all such damage to the Employer's Representative. The Employer's Representative shall be informed prior to the commencement of any operation to expose damaged cable and shall be allowed to be in attendance during the operation.
- 6 The Contractor shall provide and display warning notices, barriers etc. when testing cables.
- 7 All test instruments requiring calibration shall have a current calibration certificate, the Contractor shall provide the Employer's Representative with copies of all such certificates prior to the commencement of testing.
- 8 The Contractor shall give at least two weeks' notice, in writing, to the Employer's Representative of their intention to test any cable.
- 9 No tests shall be carried out until the cable trench has been backfilled and the ground above the cable reinstated and the cable ends have been installed (terminated) in the respective termination cabinets.
- 10 The Contractor shall carry out the tests described below on power cables, together with such other tests and measurements to prove compliance with this specification, relevant standards and with the requirements the most recent version of ET101:
 - a) An insulation resistance test to measure the insulation resistance between each conductor and the remaining conductors and between each conductor and the metallic sheath (if any) and armouring.
 - b) An earth continuity test to verify that the cable armouring and metal sheath, if any, have been properly bonded to earth.
 - c) Phase-rotation and phase-correspondence tests to prove that the cables have been correctly connected.

1519 Labelling and Numbering

- 1 Gantries, cabinets, signal posts and telephones shall be numbered and cables shall be labelled, in accordance with details described in Appendix 15/1.
- 2 With the exception of the cable labels and any earthing labels required in Appendix 15/1 all labels shall be of the engraved colour laminated type. In addition all engraved labels shall be secured into position using stainless steel nuts, bolts and washers or stainless steel screws as appropriate.
- 3 The Contractor shall not leave cables unlabelled at any time and shall provide temporary labelling accordingly to facilitate testing and termination prior to the implementation of permanent labelling.
- 4 All Cabinets containing power distribution and control equipment shall be provided with a laminated circuit chart, indicating the source of supply, destination, circuit arrangements, equipment rating in accordance with Appendix 15/1 and the most recent version of ET101, the 'National Rules for Electrical Installations' by the Electro-Technical Council of Ireland.
- 5 Where the Contractor carries out modification work to existing cabinets, new labels and cabinet circuit charts shall be fitted where appropriate and in accordance with Appendix 15/1.

- 6 Each end of every cable shall be fitted with an identification tag adjacent to the gland shroud bearing the cable number. All cables run underground shall be fitted with identification tags at all entries to ducts and at all cable chambers.
- 7 Cable identification tags shall be pre-marked type, fitted on suitable carrier strips. Text shall be indelible and shall be black on a yellow background. Tags shall be securely fastened using polypropylene cable ties. Self-adhesive embossed plastic labels shall not be accepted as permanent means of identification.
- 8 The Contractor shall submit to the Employer's Representative a proposed identification system prior to installing any labelling. This shall include a system of identification and information on the types and manufacture of tags.

1520 Loading

- 1 The longitudinal communications cable shall be loaded in accordance with Appendix 15/1.

1521 Removal and Resiting of Existing Equipment

- 1 Existing communications equipment shall be removed or resited where required in the Works, as detailed in Appendix 15/1. No equipment shall be removed or cables disconnected or cut until approved by the Employer's Representative.
- 2 Existing redundant cabinets, telephone posts, housing and handsets, signal equipment, etc., as detailed in Appendix 15/1 shall be carefully removed to store. The location of the store shall be notified by the Employer's Representative at the commencement of the Works.
- 3 Where required in Appendix 15/1 redundant electronic or signalling equipment shall be removed by the Contractor under the supervision of the Employer's Representative. At least 1 week notice shall be given by the Contractor to the Employer's Representative of their intention to remove such equipment.
- 4 Conductors shall be disconnected from the equipment in which they are terminated, the terminal screws and glands shall be re-tightened and the cable withdrawn clear of the equipment.
- 5 Items of equipment to be resited shall be unbolted from their plinths or supports together with their holding down bolts, stored, and resited as described in Appendix 15/1. Plinths and concrete foundations shall be broken out and disposed of in compliance with Clause 201.
- 6 Buried cables to be removed shall be located and pegged throughout their routes; the Contractor shall also excavate trial holes to expose these cables at the pre-determined locations. Where instructed by the Employer's Representative, the Contractor shall excavate that part of the cable route carefully by hand. Where the cable to be removed is sharing a trench with other existing cables, on completion of removal, all stones and contaminated material shall be removed from the cable trench, clean sand and warning tape shall be provided and installed and the cable trench shall then be reinstated in compliance with Clause 201; the Contractor shall then remove and dispose of all unsuitable and surplus material. Cable in ducts shall be carefully withdrawn, the Contractor shall also fulfil the requirements for removal of duct seal, re-sealing and re-roping. Cables in troughs shall be carefully segregated and lifted out, the Contractor shall also remove all trough lids, all debris from troughs and all sand from troughs. On completion the Contractor shall provide and install clean sand, reinstate all trough lids, and provide and install new trough lids to replace any breakages caused during the preceding operation. Redundant cables shall be coiled onto drums at the time of removal and transferred to the site storage area. At a convenient time, to be identified by the Employer's Representative, the Contractor shall remove the redundant cable from the drums and dispose of it.

- 7 Cables on signal gantries shall be isolated, disconnected and taken down, the Contractor shall also transport these to the site storage area and dispose of these at a time to be advised by the Employer's Representative. The Contractor shall provide and install new cable clips, where required, for retaining existing cables on the gantry structure and cable tray.
- 8 The cables shall be removed in compliance with Clause 201.
- 9 The sites of cabinets, plinths and cable trenches shall be reinstated to the level of the surrounding ground unless otherwise described in Appendix 15/1.

1523 Loop Detectors

- 1 Cabinets for loop detector use shall be installed in accordance with Clause 1508,
- 2 The power supply cable shall be terminated as described in Appendix 15/1. The loop feeders shall be terminated in terminal blocks complying with Clause 1514, secured to the equipment frame. Terminal screw tightness shall be within the range 0.4 to 0.6 Nm. Each feeder shall have 500mm of cable coiled in the bottom of the cabinet to allow subsequent re-terminations.
- 3 Each feeder cable shall be individually identified by means of a label.
- 4 Where loops are to be installed on existing motorways shall be the responsibility of the Contractor to devise and obtain approval for and provide the traffic management systems necessary for the safe installation of the loops. Traffic management shall comply with the requirements of Clause 117.

General

- 5 The layout and installation details of detector loops shall be as detailed in Drawings RCD/1500/025 to RCD/1500/047 of the Road Construction Details (RCD).
- 6 The Employer's Representative shall ensure that the location and type of loop configuration is shown on the relevant drawings, to be used as the Contract Drawings.
- 7 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.
- 8 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.
- 9 Consideration shall be given to the effect of any slab reinforcement in concrete roads.
- 10 Subject to approval, for flexible construction, where no cross-carriageway ducting exists, consideration should be given to slot cutting across the carriageway.
- 11 The final loop position shall be 1 metre clear of any street furniture, steel covers, gratings, or any temporary surface reinstatement or damaged area.
- 12 Loops shall have a minimum clearance of 50mm above any road reinforcement. For loop installations on existing reinforced concrete roads, the Contractor shall determine the depth of the reinforcement at proposed loop locations before loops are cut. Loops shall not be installed in locations where the minimum clearance is not achievable. Refer to Clause 1008 when siting loops for new road schemes comprising reinforced concrete road

- 13 The installation of loops on bridge structures should be avoided as far as possible.
- 14 Loop tail slots shall have at least 1 metre horizontal separation from any ferrous objects such as grids, chamber covers, etc.
- 15 The Contractor shall be responsible for setting out and marking all loop slot configurations and other loop associated work.
- 16 At the end of the installation works, the Contractor shall submit, to the Employer's Representative, 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
- 17 Upon completion of the installations, 'as-built' drawings shall be added to master records held for both scheme drawings and system schematics.

Installation

- 18 Slot cutting shall be undertaken utilising a mechanically propelled road saw.
- 19 Slot cutting shall not be conducted if the air temperature falls below 2°C.
- 20 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 Drawings RCD/1500/025, 026 027, and 028.
- 21 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.
- 22 All internal corners shall be crosscut to the appropriate depth, in accordance with RCD/1500/029.
- 23 Each loop slot shall be cut to ensure that the loop cable shall exit the pavement at a depth of 150mm.
- 24 Each loop shall be formed on site and comprise a single length of continuous, unjointed cable.
- 25 The loop shall comprise three turns unless stated otherwise in the contract.
- 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 Road Construction Drawing for the type of road construction.
- 27 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.

- 28 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.
- 29 Any tails left un-terminated shall be indented and sealed to prevent the ingress of water.
- 30 Slots shall be backfilled with a suitable compound to encapsulate the cables as shown in Drawings RCD/1500/025, 026 and 038.

Encapsulate Requirements

- 31 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.
- 32 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 the encapsulant shall remain fit for purpose for at least 15 years.
- 33 The remainder of the slot shall be filled with hot pour oxidised grade bitumen compound to IS 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.
- 34 The loop tails are to be marked as soon as they are laid to indicate the identity of the loop. This marking shall be by means of permanent labels.

Concrete Roads

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

- 36** For concrete road surfaces, slots shall not be cut closer than 1.5 metres from transverse joints between adjacent concrete sections.
- 37** 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. 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

- 38** In addition to the foregoing general requirements, the following shall be taken into account for porous road surfaces.
- 39** 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.
- 40** Loops shall be cut with a modified slot profile as shown in Drawing RCD/1500/026.
- 41** 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.
- 42** Loops shall be wound into the 10mm wide lower slot, which shall be below the level of the porous road surface.
- 43** 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%.
- 44** The slots shall be half filled with porous backfill and firmly tamped. The slots shall then be 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

- 45** 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 Employers Representative shall be notified.

Loop Testing

- 46** 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. These tests shall be known as ‘Loop Tests’, and
 - ii. Installation as part of the commissioning process for a traffic control, vehicle survey, or automatic incident detection 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'. Tests to be carried out during installation and commissioning. This is a final check on the detector loop, joint, and feeder cable

- 47 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.
 - iii. 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 Employers Representative.
- 48 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.
- 49 Test results shall be submitted to the NRA. They shall be recorded and approved, on the installation test certificate shown in Drawing RCD/1500/030.
- 50 The Installation Test Certificates are the property of the Employers Representative. They shall be forwarded to the Employers Representative within the time stipulated in the Appendix 15/1.
- 51 If the Contract for works is for loop installation only, the Employers Representative shall inspect and accept Loop Tests and the results shall be recorded. Any loop tails left un-terminated at this stage shall be sealed to prevent the ingress of water.
- 52 If the Contract of works is for loop installation and commissioning, the Employers Representative shall inspect and accept Loop Tests, plus the Complete Circuit Tests. The results of tests shall be recorded.
- 53 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.
- 54 The Contractor shall, correct or replace, any loop, and/or feeder, that fail the tests specified.
- 55 Loops forming an automatic incident detection 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 that the Contractor shall 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.
- 56 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.
- 57 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.

- 58** Once accepted by the Employers Representative, a copy of the loop and complete circuit test results shall be lodged with the Employers Representative within the time stipulated in the contract.

Conductors Resistance

- 59** The maximum permitted d.c. resistance of the loop cable conductor when corrected to 20°C in accordance with IEC 60228 shall not exceed 13.7 ohms per kilometre of cable.
- 60** The maximum permitted d.c. resistance of each feeder cable conductor shall be measured in accordance with IEC 60189, and when corrected to 20°C by the appropriate factor specified in IEC 60228 shall not exceed 12.1 ohms per kilometre of cable. 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.
- 61** 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.
- 62** If armoured feeder cable is used, it shall 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

- 63** 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.
- 64** 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.
- 65** 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

- 66** The required measurements shall be made with no vehicles on or traversing the loop.
- 67** 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.
- 68** The loop inductance shall be measured and the value compared with the theoretical value of inductance obtained using the formula in 1523.69.
- 69** 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.
- 70** 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.
- 71** 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.

72 Loop inductance shall be calculated as follows:

Loop inductance, L_1

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

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.)

Loop tail inductance, L_{tail}

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

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

Loop feeder inductance, L_{feeder}

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

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

Total inductance, $L = (L_1 + L_t + L_f) \mu\text{H}$

Example Calculation

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

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

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

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

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

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

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

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

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

1524 Trial Pits

- 1 Trial pits shall be excavated as described in Appendix 15/1.

1525 Maintaining the Existing Motorway Communications Network

- 1 The motorway communications network forms part of the Motorway Communications System and consequently any damage to equipment/infrastructure within the works area can have severe consequences to the system as a whole. The Contractor shall maintain the integrity of the existing motorway communications system by one or any combination of the following methods:
 - i. Protection and use of existing network and equipment.
 - ii. Provision of a temporary network.
 - iii. Use of the new network.
- 1 The method(s) shall be identified in the Contractor's programme and agreed with the Employer's Representative.
- 2 The Contractor shall give at least three weeks' written notice of the proposed change to the network, which must have been identified in advance in the Contractor's programme. Any such proposal shall be subject to the agreement of the Road Authority. The alternative network shall be installed, tested and accepted by the Road Authority at least 5 days before the proposed date of change of network. The Contractor shall allow adequate time in their programme to ensure that the revised network is accepted.
- 3 The Contractor must allow the Road Authority's Specialist Maintenance Contractor access to all equipment within the Works which has been identified as operational.

1526 The Inspection and Testing of Electrical Installations

- 4 The Contractor shall carry out the Inspection and Testing of Electrical Installations in accordance with ET101 'National Rules for Electrical Installations, Fourth Edition'. The Contractor shall provide Inspection and Completion Certificates to the Employer's Representative in accordance with ET101.
- 5 Where the Inspection/Tests show that existing cabinets or the earthing arrangements within existing cabinets do not meet with the requirements of ET101, the Contractor shall immediately notify the Employer's Representative giving full details of non-compliance. The Contractor shall not undertake any work on such a cabinet until written instructions have been issued by the Road Authority.
- 6 For the purposes of carrying out the Tests the Contractor shall use instruments which shall be tested and calibrated at six monthly intervals. Copies of the test/calibration certificates shall be forwarded to the Employer's Representative with the first certificate dated within three months of the Contract start date. The Line to Earth Loop Impedance testing instrument shall be of the

digital display type and shall operate from zero to 19.99 ohms (Accuracy $\pm 1\%$ F.S. $\pm 1.5\%$ Reading) with 0.01 ohm Resolution. Where Alternating Current measurements are required, Ammeter testing instruments shall be of the digital display type and shall be capable of operation from 0-200 mA in 2 mA, 20 mA and 200 mA ranges with accuracy of $\pm 1\%$.

1527 Cable Installation at Buildings

- 1 Cables shall be installed into and terminated within Buildings as described in Appendix 15/1
- 2 Work shall not be undertaken in Buildings by the Contractor unless the building's operator is in attendance. The work shall be identified in the Contractor's programme and agreed with the Road Authority. The Contractor shall provide at least two weeks' notice in writing to obtain authority to undertake the work. The Contractor shall request the attendance of the building's operator, who will witness the Contractor's work. The Contractor must ensure that they do not disrupt any live systems.

1528 Modifications to Existing Cabinets

- 1 The Contractor shall carry out modifications to existing cabinets as described in Appendix 15/1.
- 2 The Contractor shall, prior to laying any cable to the cabinets, locate, by electronic means, the position of all cabling; expose all cables by careful hand excavation and identify the type, size and designation of each cable.
- 3 Where necessary the Contractor shall remove, retain for re-use, and replace the cabinet base pea gravel; remove and relay any hardstanding; excavate to expose cable remake loop, excavate cable routes; reroute cable to gain sufficient lengths for the proposed modification; reinstate cable trenches; break open and re-seal resin filled base; disconnect and reconnect, undo existing gland and re-gland, including the provision of new gland assemblies and cable termination ancillaries where required; withdraw and reinstall cables at cabinet base.
- 4 Any work required to operational circuitry shall be undertaken under the supervision of the Road Authority's Maintenance Contractor. The Contractor shall give at least two week's written notice of the need for such work.

1529 Temporary Emergency Telephones

- 1 Temporary Emergency Telephones shall be installed for use by the public when it would be necessary to cross either a live traffic lane or the Works to use the nearest working Emergency Telephone. When not in use Temporary Emergency Telephones shall either be removed or covered up. The direction of Temporary Emergency Telephones shall be indicated in a manner approved by the Road Authority at 100 metre intervals. The location and orientation of Temporary Emergency Telephones shall be agreed with the Road Authority.
- 2 Temporary Emergency Telephone Instruments shall be of a type compatible with the Road Authority's Emergency Telephone answering system.
- 3 Connections and disconnections from the live communications network shall be carried out by the Road Authority's Specialist Maintenance Contractor(s). The Contractor shall give at least two week's written notice of the need for such work. The need for this work shall be identified in advance in the Contractor's programme and agreed with the Road Authority
- 4 The Contractor shall install, place in position, maintain, cover up, uncover, reposition, recable and remove Temporary Emergency Telephones and associated work as necessitated by the progress of the Works.

1530 Cable Ducts

- 1 The term cable duct is used in this Series to describe the ducts or conduits used for installing the motorway communications cable network. The ducts shall comply with this Series and any other requirements described in Appendix 15/1. The Contractor shall be responsible for ensuring that all components used within the duct are compatible with each other and with existing ducts.
- 2 With the exception of ducts in transverse crossings installed using trenchless installation techniques, cable ducts shall comply with the general requirements of IS EN 50086-1 and the particular requirements of IS EN 50086-2-4. The ducts shall have a current Irish Agrément Board Roads and Bridges Certificate or equivalent in accordance with Clause 104. With the exception of ducts in transverse crossings installed using trenchless installation techniques, ducts shall be manufactured from thermoplastic material. The bore shall be smooth and even. The external surface shall be even or corrugated in the longitudinal section.
- 3 With the exception of ducts in transverse crossings installed using trenchless installation techniques, ducts shall be solid, twin or multi-walled. Non homogeneous ducts with honeycomb or foam filled construction between the inner and outer surfaces will not be permitted.
- 4 The IS EN 50086-2-4 classifications shall be “Normal duty”. Ducts shall have an IS EN 60529 IP Code of IP47.
- 5 With the exception of ducts in transverse crossings installed using trenchless installation techniques and unless otherwise described in Appendix 15/1 the sizes of the ducts shall be as shown on the Drawings. These internal diameter sizes are 150 mm, 100 mm and 50 mm and correspond to IS EN 50086-2-4 nominal external diameter sizes of 200 mm, 125 mm and 63 mm respectively. The corresponding minimum internal diameters shall not be less than the preferred minimum inside diameters of 150 mm, 94 mm and 47 mm respectively contained in IS EN 50086-2-4, Table 101.
- 6 Ducts of 200 mm and 125 mm nominal size shall be non-coilable and supplied in straight lengths. Ducts of 63 mm nominal size should be supplied in straight lengths, on reels or coiled. Ducts shall meet the requirements of Table 5/10 for Static friction coefficient and Resistance to point loads. With the exception of ducts in transverse crossings installed using trenchless installation techniques, the external wall of the ducts shall be self-coloured purple in accordance with National Joint Utilities Group publication “Guidelines on the positioning and colour coding of utilities’ apparatus”. The ducts shall comply with any additional requirements described in Appendix 15/1.
- 7 The materials from which the duct and fittings are made shall be treated so that they are protected from the deleterious effects of short term exposure to ultra violet light and shall be resistant to degradation by acids, alkalis, common chemicals, bacteria, fungi and moulds occurring in soils. The Contractor shall protect the duct and fittings on site in accordance with the suppliers’ recommendations.
- 8 Each duct shall be fitted with a pigmented, stranded polypropylene or equivalent rot-proof material draw rope of 5kN breaking load and having a design life of not less than 20 years, the ends of which shall be made fast within the chambers to which the duct is terminated. Draw ropes shall be secured to the duct plugs. Draw ropes shall not be knotted within ducts; where a joint is required it shall be a spliced joint.

Ducts in Transverse Crossings

- 9 Ducts in transverse crossings installed without a sleeve using directional drilling techniques, conforming to the requirements of Series 8000 of UK Highways Agency’s MCHW 5.8.2, shall consist of four 110 mm nominal size Medium Density Polyethylene (PE 80) pipes conforming to

the relevant provisions of either BS EN 12201-2 or BS EN 13244-2 and any other requirements described in Appendix 15/1. The pipe bores shall be smooth and even.

- 10 The pipes shall be securely bundled together and installed under the crossing with a minimum cover above the duct of eight times the reamed diameter of the bored hole. Each pipe shall be tested after installation in accordance with the requirements of Clause 1533. Lengths of pipe not installed in the bored hole shall be self-coloured purple on the external wall or sleeved with a duct that is self-coloured purple.
- 11 The ducts shall have a current Irish Agrément Board Roads and Bridges Certificate or equivalent in accordance with Clause 104.

Non-Armoured Cable Network

- 12 The duct network shall be protected against the ingress of water, gas and air. This shall be achieved by the ducts having suitable joints and also plugs at the entry to all chambers. The degree of protection shall be IP47
- 13 Ducts containing motorway communications cables or power cables for motorway communications systems installed on roads other than motorways shall be clearly and permanently marked with the legend "MOTORWAY COMMUNICATIONS/POWER" in two, diametrically opposite, planes. The ducts shall be installed such that the legend is uppermost. The method of marking shall not affect the integrity of the duct. This marking is in addition to the markings required in the BS EN 50086 series. The method of marking and the durability test shall comply with the BS EN 50086 series.
- 14 The Contractor shall provide and install in the end of every duct at every point of entry to chambers purpose made mechanical duct plugs in accordance with RCD Drawing Number RCD/1500/014. The Contractor shall provide inserts which fit into the cable ports to allow combination of cables to be installed as detailed in Appendix 15/1. Duct ends at cabinets shall be fitted with open grommets to prevent cable chaffing.
- 15 Ducts shall be supplied with purpose made spacers and strapping as indicated on RCD Drawing Number RCD/1500/013. The strapping shall bind the ducts tightly in the specified formation during installation, backfilling and for the whole life of the duct. The spacing of the strapping shall be such that the ducts shall not separate by more than 50 mm, this spacing would typically be 1 m. The contact area between spacer and duct shall be large enough to ensure that the spacer cannot pierce the walls of the duct. The Contractor shall provide the Employer's Representative with details of the proposed strapping and spacer arrangement for approval at least 2 weeks prior to the installation of any ducts.

1531 Installation of Ducts

General

- 1 Ducts shall be laid at the level and offset shown on the Drawings and schedules. Longitudinal ducts shall generally be run parallel to the edge of the hardshoulder. Transverse ducts shall run at right angles to the carriageway. The exact location of the ducts shall be agreed on site before the commencement of any associated groundworks. Excavations shall comply with Clauses 502 and 602. Immediately following the excavation of the trench, the ducts shall be jointed and laid on the bedding material. The deviation in level from that specified at and point shall not exceed 50 mm.
- 2 Ducts and fittings shall be examined for damage and the joint surfaces and components shall be cleaned immediately before laying. Measures shall be taken to prevent soil or other material from entering ducts, and to anchor each duct to prevent movement before the work is complete.

Non-Armoured Cable Network

- 3** Duct joints shall have the following characteristics:
 - i. The joint and duct shall be free from burrs and other irregularities that may cause damage to cables when they are drawn through the duct.
 - ii. The joint shall hold and maintain the ducts in axial alignment during installation and afterwards when subjected to reasonably foreseeable ground movement.
 - iii. The joint shall not compromise the duct network protection of IP47.
- 4** Cable duct configurations, bedding, haunching and surround shall be as shown on RCD Drawing Number RCD/1500/010, 011 and 012.
- 5** Backfilling shall be undertaken immediately after the required operations preceding it have been completed.
- 6** Trenches for the cable ducts shall be backfilled with Class 8 lower trench fill material, as described in Table 6/1 and in compliance with the 600 Series, which shall be placed above the surround material. The Class 8 material shall extend to within 150 mm of ground level. The material shall be spread and compacted evenly without dislodging, disturbing or damaging the ducts. Power hammers shall not be used within 300 mm of the ducts.
- 7** For ducts shown on RCD Drawing Number RCD/1500/010, 011 and 012 topsoiling, grass seeding and/or turfing, as described in Clauses 618, shall be placed in the top 150 mm of the cable duct trench unless otherwise specified in Appendix 15/1.
- 8** For ducts shown on RCD Drawing Number RCD/1500/010, 011 marker tape shall be laid within the trench excavation at a depth of 150 mm or at the Class A/topsoil interface whichever is the greater. The marker tape shall comply with Clause 1530.

Armoured Cable Network

- 9** Ducts shall be provided for cables that are laid across or within 500 mm of filter drains. The ducts shall be surrounded with 150 mm of ST2 concrete in compliance with Clause 2602. In the event that a cable route coincides with the line of a filter drain an alternative trench line shall be determined. Any damage caused by the Contractor to any drain shall be satisfactorily repaired and reinstated at no cost to the Employer.

Marker Tape

- 10** All cables and ducts installed underground shall have their position indicated by the use of detectable marker tape. Marker tape, as described below, shall be buried in the trench above the cable/duct.
- 11** Marker tape shall be manufactured from self-coloured thermoplastic material not less than 150 mm wide; it shall have a metallic insert or backing which will allow detection by electronic route tracing equipment. The detectable metallic component and the form of tape construction shall be either:
 - i. Stainless steel wire or wires with a minimum total cross sectional area of 0.30 mm² laid in a sinusoidal wave form or stainless steel strip with minimum dimensions of 10 mm wide and 100 micron thick. The stainless steel wire or strip shall be sandwiched in between two layers of thermoplastic tape with a combined minimum tape thickness of

- 150 micron or bonded to one layer of thermoplastic tape with a minimum thickness of 150 micron.
- ii. Aluminium foil with minimum dimensions of 50 mm wide and 9 micron thick totally enclosed in between two layers of thermoplastic tape. The combined thickness of the two tape layers shall be a minimum of 400 micron.
- 12** Joints between successive lengths of tape shall be made using crimps or clamps such that the electrical continuity and tensile strength of the tape is maintained. The joint shall be protected from corrosion and attack from ground chemicals.
- 13** The wording on the marker tape shall read “CAUTION COMMUNICATIONS/ POWER CABLES BELOW”. The wording shall occur at intervals up to a maximum of 1 m apart. The letters of the wording shall be a minimum of 30 mm high with a minimum of 5 mm line thickness.
- 14** Marker tape shall be yellow in colour, with wording in black.

1532 Chambers for Motorway Communications Cables

- 1** Chambers shall be Type COMMS I, COMMS II or COMMS III as shown on RCD Drawing Number RCD/1500/015, 017 and 018. These chambers are rectangular in plan and have a standard plan size. Where designated as Joint Chambers, chambers Type COMMS I shall be fitted out with cable supports as detailed on RCD Drawing Number RCD/1500/016. Chambers shall be as detailed in the schedule in Appendix 15/1. Chambers shall be constructed so that their covers are flush the level of the adjacent ground.
- 2** Chambers shall be used solely for motorway communications cables.
- 3** The exact location of these chambers shall be agreed with the Employer’s Representative on site prior to the commencement of any excavation works. Failure to do so may result in abortive work.
- 4** Foundations to chambers shall be of ST4 concrete in accordance with Clause 2602.
- 5** Brickwork shall comply with the 2400 Series and be built with mortar designation (i) in English bond. The joints of brickwork where exposed shall be finished as specified for unpointed joints in Clause 2412. The ends of all ducts shall be neatly built into the brickwork and finished flush with mortar designation (i).
- 6** Precast concrete chambers shall comply with BS 5911-3 and IS EN 1917. Cast in situ chambers shall be constructed of ST4 concrete complying with Clause 2602 unless otherwise described in Appendix 15/1.
- 7** Chambers not exceeding 1.3 metres in depth to invert, may be constructed from complete plastic units or other units in equivalent material. Where the units do not meet the loading requirements of BS 5911-3 and IS EN 1917, they shall be surrounded by 150 mm of ST4 concrete.
- 8** Where the depth of invert of chambers exceeds 900 mm below the finished surface of the carriageway or the adjacent ground, manhole steps shall be built in as specified in IS EN 1917. Steelwork fittings shall comply with EN 10088 and be galvanised in compliance with Clause 1909 after fabrication. Threaded components shall be galvanised in compliance with Clause 1909.
- 9** Excavation around chambers, shall be backfilled with general fill materials as described in Table 6/1 and compacted in compliance with Clause 612. Where mechanical compaction is impracticable, the excavation shall be backfilled with ST2 concrete complying with Clause 2602.

Where there are precast concrete access shafts to precast concrete chambers, the shafts shall be surrounded by a minimum thickness of 150 mm of ST4 concrete, and the remaining excavation backfilled with general fill material as described in Table 6/1 compacted in compliance with Clause 612.

- 10 Chamber covers, gratings and frames shall be as described in Appendix 15/1 and shall comply with IS EN 124. Triangular covers shall be hinged. Requirements for special duty covers for use in carriageways shall be as described in Appendix 15/1.
- 11 Two sets of lifting keys as described in Appendix 15/1 shall be delivered to the Employer's Representative for each type of cover supplied. Additionally, a suitable cover lifter shall be delivered to the Employer's Representative where the mass of an individual cover exceeds the value in Appendix 15/1.
- 12 Frames for chamber covers gratings shall be set in cement mortar designation (i) complying with Clause 2404 or a suitable proprietary quick setting mortar of equivalent strength.
- 13 Chambers shall be constructed with a sump as shown on RCD Drawing Number RCD/1500/015 and 017. Chambers shall be constructed with a soakaway or connected to the highway drainage network where detailed in Appendix 15/1.
- 14 Chambers shall be clearly identified by the legend "MOTORWAY COMMUNICATIONS", the lettering shall be 25 mm high and shall be embossed into each cover. Where covers have a concrete infill a plate manufactured from a non-corrodible metal or steel, galvanised in accordance with Clause 1909, shall be cast into the concrete flush with the concrete surface.
- 15 The marker post reference of the chamber (e.g. 1234A) and the chamber reference number shall be stamped, in letters 50 mm high, in a concrete block cast immediately adjacent to the cover or cast and raised in aluminium riveted to the chamber cover. The concrete shall have a steel float finish applied prior to the stamping. Except for communication jointing chambers, chambers that are within 5 metres of cabinets do not require this referencing. This dimension shall be measured from the chamber cover frame to the nearest cabinet. Communication jointing chambers shall always be referenced.

1533 Proving and Testing of Ducts

- 1 Longitudinal and cross carriageway cable ducts shall be proved by drawing a wooden or plastic mandrel through as the ducts are laid. Local ducts from chambers to cabinets shall be proved by drawing through each completed length of duct a spherical mandrel of a diameter 10% less than the nominal bore of the duct. On the successful completion of each pull the Contractor shall certify compliance of the duct and immediately plug the duct in accordance with sub-Clause 1530.8.
- 2 Longitudinal and cross carriageway cable ducts shall be tested in chamber-to-chamber sections by means of the air test described in sub-Clause 3 of this Clause. On the successful completion of each test the Contractor shall certify compliance of the duct and immediately plug the duct in accordance with sub- Clause 1530.8.
- 3 To undertake the test, air shall be pumped in by suitable means until a stable pressure of 100 mm head of water is indicated in a U-tube connected to the system. The air pressure shall not fall to less than 75 mm head of water during a period of 5 minutes without further pumping, after an initial period to allow for stabilization.
- 4 A register of mandrel and air test certificates shall be maintained by the Contractor and handed to the Employer's Representative on the successful completion of the ducting work.

1534 Closed Circuit Television

- 1 Closed Circuit Television (CCTV) shall be as described in Appendix 15/1.

1535 Cable Trays

- 1 A cable tray shall be installed on the walkway of steel portal gantries as detailed in RCD Drawings Number RCD/1800/017 and 021 and shall be as described in Appendix 15/1.
- 2 The cable tray shall be manufactured from high quality sheet steel to EN 10130 and hot dipped galvanised after manufacture to EN ISO 1461.
- 3 The cable tray shall be aligned with the cable duct in the portal gantry structure and shall be securely fixed to the walkway using galvanised self-tapping screws. The cable tray shall be positioned to allow seamless continuation of the cable run between the cable duct in the portal gantry structure and the cable tray on the walkway.
- 4 Cable trays shall be heavy duty, perforated with a returned pattern 50mm flange.

1536 Poles for Lightweight ITS Equipment

- 1 Lightweight ITS equipment includes detection equipment, cameras, solar panels for ITS equipment and motorway entry signals.
- 2 Lightweight ITS equipment which requires power and/or communications cables shall be installed on poles with access doors. Where multiple poles are required, at least one pole shall have an access door. This pole shall be connected to the cabinet by a 100mm diameter local duct as per RCD.
- 3 Where required, plinths for lightweight ITS equipment shall make provision for cabinets and ancillary items, ducts, retention sockets, mini pillars and chambers as per Clause 1505 and detailed on RCD Drawing Numbers RCD/1500/0069 - 070. The plinth layout for pole installations without cabinets and ancillary items shall be as per RCD Drawing RCD/1500/071.
- 4 For roads with a mandatory speed limit of 80 kmph or more the distance of poles from the carriageway shall be determined in accordance with NRA TD 19. Detection equipment poles not located within the clear zone shall be passively safe. Passively safe poles shall comply with the performance types in I.S. EN 12767. The structural performance shall be clearly marked on the post. Passively safe poles shall have a 30 year design life and the design shall have a signed manufacturer's warranty against material failure for 10 years.
- 5 Lightweight motorway signs shall be installed on multiple poles and shall be located behind safety barrier. The safety barrier shall be provided in accordance with NRA TD19.
- 6 Motorway entry signal plinth shall be installed at an angle relative to the carriageway to achieve optimal visibility of the sign. VMS display elements shall be aligned correctly with the road as per the manufacturer's recommendations.
- 7 Lightweight motorway entry signals shall be installed with a vertical clearance of between 1.2m and 1.5m from the finished level of the plinth.
- 8 Motorway entry signal plinth shall be installed at an angle relative to the carriageway to achieve optimal visibility of the signal. VMS display elements shall be aligned correctly with the road as per the manufacturer's recommendations.

- 9 Lightweight motorway entry signals shall be installed with a vertical clearance of between 1.2m and 1.5m from the finished level of the plinth.
- 10 The height of the poles will be dependent on the type of the equipment being installed and should be determined by the performance requirements of the equipment and should be in accordance with the manufacturer's recommendations. Holes for power and/or communications cables shall be pre-drilled.
- 11 The minimum mounting height for Cameras used for traffic monitoring and vehicle detection shall be 4m above finished ground level. Poles with these types of equipment should be positioned away from parapets and street furniture to limit access by unauthorised persons
- 12 The detection equipment poles shall be located at an off-set from a carriageway in accordance with the performance requirements of the equipment and should be in accordance with the manufacturer's recommendations.
- 13 All ITS equipment shall be accompanied by a maintenance vehicle layby area as per RCD Drawing Number RCD/1500/024. In locations where safety barrier is not required, the maintenance vehicle layby area shall be provided immediately adjacent to the ITS equipment.
- 14 Sites for detection equipment shall be selected clear from vegetation and shall, as far as possible, be installed on straight section of road. The sites for detection equipment shall be identified in locations with sufficient area for the maintenance vehicle lay-by area.
- 15 Standard steel poles may be used in locations where detection equipment poles are installed behind existing safety barrier. Standard steel poles shall comply with Series 1200. The working width of the existing safety barrier shall be verified prior to the siting of poles for detection equipment. Any amendments or alterations to the existing safety barrier resulting from the presence of the detection equipment pole shall be in accordance with NRA TD 19.
- 16 The poles shall be installed in retention sockets as per Clause 1205. The retention sockets shall be installed in a mass concrete foundation within a plinth as per RCD Drawing Numbers RCD/1500/069 - 071. Poles carrying power and/or communications cables shall be installed in retention sockets with a duck foot bend and shall be connected with the cabinet by local 100mm diameter duct. Where multiple poles are installed, flat base retention sockets shall be used for any additional poles.
- 17 Passively safe columns with power and/or communications cables shall be fitted with a suitable electrical disconnect system as per NA.8 of the National Annex to EN 12767. The electrical disconnect system shall ensure that power cables entering the column shall be disconnected upon impact, isolate the power supply to the impacted object and minimise the possibility of an exposed live cable end. The type of electric disconnect system proposed by the Contractor shall ensure that the electrical installation remains compliant with the 'National Rules for Electrical Installations' by the Electro Technical Council of Ireland (ETCI) and shall be subject to approval by the Employer's Representative
- 18 The concrete surround of retention sockets shall be cast as a single foundation where the separation between multiple poles is less than 800mm. The concrete for the foundation shall be in accordance with I.S. EN 206-1:2002 and shall comply with the following:

- i. Minimum concrete strength class: C30/37
- ii. Minimum slump class: S2
- iii. Maximum water/cement ratio: 0.50
- iv. Minimum cement content: 320 kg/m³
- v. Cement type: sulphate-resisting cement
- vi. Maximum aggressive chemical environment: XA2. For installations in a more chemical aggressive environment, refer to I.S.EN 206-1:2002 for additional requirements.

Table 15/1 contains details of typical pole sizes, planting depths and design requirements for poles manufactured from different material types. Table 15/1 shall be read in conjunction with RCD Drawing Numbers RCD/1500/069 – 071. The suitability of pole sizes shall be verified for each individual site location and shall comply with BD94 and I.S. EN 40.

Equipment Type	Design Criteria	Material Type		
		Steel#	Aluminium*	Other Materials**
Detection Equipment	Pole Height: H: 6.1m H1: 5.3m H2: 0.8m	CHS 168X4	CHS 200X4	Stiffness for bending, EI: 1429 kNm ² Stiffness for torsion, GIu: 440 kNm ² Bending moment, Mu: 5 kNm Moment for torsion, Tu: 0.5 kNm Shear capacity, V: 1 kN
	Pole Height: H: 8.0m H1: 7.0m H2: 1.0m	CHS 219X4.5	CHS 250X4	Stiffness for bending, EI: 2069 kNm ² Stiffness for torsion, GIu: 637 kNm ² Bending moment, Mu: 11 kNm Moment for torsion, Tu: 0.5 kNm Shear capacity, V: 2 kN
Motorway Sign***	Sign face Area: A: 1.8 m ² Planting Depth: H2: 0.7m	2 CHS 114X4	2 CHS 165X3.3	Stiffness for bending, EI: 433 kNm ² Stiffness for torsion, GIu: 134 kNm ² Bending moment, Mu: 5 kNm Moment for torsion, Tu: 0 kNm Shear capacity, V: 2 kN
	Sign face Area: A: 2.7 m ² Planting Depth: H2: 0.8m	2 CHS 114X6	2 CHS 200X3.3	Stiffness for bending, EI: 615 kNm ² Stiffness for torsion, GIu: 190 kNm ² Bending moment, Mu: 7 kNm Moment for torsion, Tu: 0 kNm Shear capacity, V: 3 kN
	Sign face Area: A: 3.6 m ² Planting Depth: H2: 0.9m	2 CHS 140X5	2 CHS 226X4	Stiffness for bending, EI: 987 kNm ² Stiffness for torsion, GIu: 304 kNm ² Bending moment, Mu: 11 kNm Moment for torsion, Tu: 0 kNm Shear capacity, V: 4 kN
<p>NOTE:</p> <p># THE STEEL SECTION SIZES ARE CALCULATED BASED ON GRADE S275. THE ALUMINUM SECTION SIZES ARE CALCULATED BASED ON FOLLOWING VALUES: ELASTIC MODULUS: 69.5 kN/mm²; SHEAR MODULUS: 26.1 kN/mm²; POISSON'S RATIO: 0.33.</p> <p>** THE VALUES IN THIS COLUMN ARE FOR ONE POLE ONLY.</p> <p>** Mu & Tu & V (MIN CAPACITY VALUE) IN THIS COLUMN ARE THE CALCULATED VALUES.</p> <p>*** VERTICAL CLEARANCE BETWEEN UNDERSIDE OF SIGN AND FINISHED GROUND LEVEL BETWEEN 1.2m AND 1.5m.</p>				

Table 15/1 Pole Sizes and Performance Requirements



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