

TECHNICAL SPECIFICATION
FOR
TRACK TO TRAIN CLOSED CIRCUIT TELEVISION SYSTEM FOR
NORTHERN LINE

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1.0 INTRODUCTION

The Train shall be controlled by a single Train Operator in the leading cab. It is essential that the Train Operator is provided with a clear view of the entire length of the station platform to check that all Passengers have safely entered or alighted from the Train prior to closing the doors and moving off. The Contractor shall supply a closed circuit television system to facilitate this as specified. Schedule 6 - Part B covers the design, supply and installation, of fixed colour CCTV equipment at every station on the Northern Line and colour CCTV Trainborne Equipment to be installed in the Trains.

References within the Schedule 6 - Part B to CCIR and CCITT relate to recommendations published by the International Telecommunications Union. Now designated as ITU-R and ITU-T, respectively.

2.0 SCOPE OF WORKS

A total of 50 stations, of which 36 are in deep tube tunnel, shall be equipped between Morden, Edgware and High Barnet including the branch and loop lines. Pre-service testing facilities shall be provided to permit functional testing of the CCTV Trainborne Equipment before Train handover for service running or stock move.

The Trackside Equipment shall comprise a minimum of two colour CCTV cameras per platform per station, picture combining and transmission equipment, and a radiating cable network for transmitting the pictures to the Train using low power RF carrier techniques with angle modulation. Figure 1, appended to Schedule 6, Part B, sets out a system schematic for a CCTV system used in a similar application on the Company's railway.

Each Train cab shall be provided with receiving equipment and colour monitor(s) for displaying the platform camera pictures.

Figure 4, appended to Schedule 6, Part B, sets out estimated equipment and cable details, this is provided for information only.

The Contractor shall carry out a detailed Site survey of all stations in order to ascertain quantities of equipment, materials, cable routes, trunking, secure equipment mounting requirements and locations. Drawings and other documents for all aspects shall be produced by the Contractor during the survey to form a survey report which shall be submitted to the Project Manager.

The survey shall include measurements of ambient light levels and at above ground stations the precautions to be taken to avoid cameras looking into the sun directly, particularly sunrise and sunset or being masked by existing fixed infrastructure.

The Contractor shall be responsible for ensuring DTI type approval and obtaining this approval prior to the factory acceptance testing of the equipment.

The Contractor shall also be required to comply with any conditions stipulated by the Department of Trade and Industry Radio Communications Division concerning the low power RF carrier transmission design including type approval procedures, and to assist the Company in their application for a frequency allocation for the system.

The system shall be designed such that the radiating medium is located under the platform nosing, or low on tunnel walls where this is agreed with the Project Manager.

3.0 GENERAL TECHNICAL REQUIREMENTS

3.1 DESIGN OBJECTIVES

The following objectives shall be met by the Contractor:-

- i) achievement of high reliability and availability that is consistent with meeting the specified Train delivery,
- ii) the provision of video images meeting the quality levels specified,
- iii) ensuring that an optimum radiated RF power is used that has good electro-magnetic immunity and minimises the spillage of RF within and outside Company's premises.

3.2 AVAILABILITY OF VIDEO IMAGES IN CABS

A continuous display of pictures from the platform located cameras shall be available in the controlling cab when the Train is within the Stopping Zone and on departure such that the last Passenger door may still be viewed for the complete length of the platform.

This availability of video images shall be provided at all Sites to provide bi-directional working.

4.0 PLATFORM COVERAGE

In Schedule 6 - Part B a "platform" shall be defined as the area of a station facing a railway track which the Trains utilise for station stops under normal service conditions. Consequently, an island platform served by Trains on both sides shall be considered as two platforms.

Sufficient colour CCTV cameras shall be provided on each platform of each station on the Northern Line to give an unobstructed view, in sharp focus, of any Passenger on the platform over the entire platform length.

The cameras shall be located such that the minimum lateral field of view shall comprise an area 4.0 m wide including the 3.0 m of platform width nearest the platform edge and 1.0 m beyond the platform edge. Figures 2 and 3, appended to Schedule 6, Part B, are included for information and show the typical arrangement used by the Company. The inclusion of other areas of the Train or periphery of the actual platform floor area within the field of view shall be minimised.

The camera positions shall be optimised in order to minimise the number of cameras required for each platform.

The cameras shall compensate for changes in ambient lighting levels such that the resolution and colour balance shall be maintained under lighting conditions in the range 5 lux to 100,000 lux.

Normal tunnel station platform illumination is expected to be in the region of 20 to 90 lux.

At surface stations the cameras will be exposed to bright sunlight with illumination levels up to 100,000 lux.

At surface and underground stations usable pictures shall be provided under conditions of lighting failure with minimum illumination levels of 5 lux.

All illumination levels refer to measurements made on the ground plane.

Outputs from each platform installation to allow connection to a future Northern Line Main Control Room line CCTV surveillance system shall be provided as described in section 11.8.3.1.

5.0 PICTURE TRANSMISSION

The transmission quality shall be unaffected by the motion of the Train up to the limits of its performance and when negotiating worst case track and infrastructure geometry's.

At some stations alternative routes exist on the approach and departure sides of station platforms and platforms may be used by Trains running in either direction. At some stations, single tracks have platforms on either side of them and at some through stations Trains terminate and reverse directions. The correct platform pictures shall be transmitted to each Train under any combination of the above circumstances.

The relationship of the platform to the track is set out in general terms on Contract Drawing SK12363.

6.0 PICTURE DISPLAY

The CCTV system shall prohibit the display of pictures to a Train from any other platform other than the platform at which the Train is stopping, stopped or leaving.

A split screen technique shall be used for electronically providing multiple pictures on the cab monitor(s) such that the video pictures are displayed side by side on the monitor with Train/platform orientation on the display as defined in Figure 5, appended to Schedule 6, Part B,.

It shall be possible to adjust the brightness of the monitor display both manually and automatically to optimise display clarity under varying ambient lighting conditions within the cab.

The displayed picture shall be stable, with accurate colour reproduction, and shall be free of noise, interference, ghosting and pulsing effects. In stations with more complex layouts where more than one Train may be receiving pictures of their appropriate platforms simultaneously, there shall be no mutual interference effect on the monitor display as a result of pickup from another energised parallel radiating cable or from any other cause.

Outside the specified zone of operation of the CCTV system, the cab monitor display shall be automatically blanked.

7.0 SYSTEM TECHNICAL PERFORMANCE

7.1 GENERAL

The CCTV system shall utilise standard CCIR composite video signals with PAL colour encoding. The station CCTV Trackside Equipment bandwidth shall be sufficient to ensure that the overall CCTV system bandwidth is as specified.

The overall video system shall conform to the following requirements:-

- (a) CCIR 1.0 V peak-to-peak composite video signals with PAL colour encoding,
- (b) scanning system based on 625 lines with a 2:1 interlace at 25 frames per second,
- (c) picture aspect ratio of 4:3,
- (d) minimum system video bandwidth of 5.0 MHz. The video switch shall have a minimum bandwidth of 5.5 MHz.

7.2 VIDEO TRANSMISSION LINK

Figure 1, appended to Schedule 6, Part B, shows the configuration of the video transmission system.

At all Sites, the overall video link transmission performance from the camera input on the station power feed unit to the output of the Trainborne Equipment receiver shall be measured with the Train passing through the specified CCTV system zone of operation and shall comply with the following minimum performance requirements:-

- (a) K factor rating of 5% using a 2.0 T pulse,
- (b) luminance non linearity 20%,
- (c) signal to noise ratio of 45 dB over 5.0 MHz band width.

The above performance shall be achieved under all combinations of temperature, humidity, vibration, EMC and power supply variations specified herein, to the satisfaction of the Project Manager within the specified lighting range and with a maximum co-axial cable length from the transmitter to the input to the radiating medium of 350.0 m, a radiating medium length of 150.0 m and a camera cable length of 350.0 m.

8.0 MONITORING AND SELF TEST FACILITIES

The station Trackside Equipment shall also include self-monitoring facilities with alarm outputs to a remote monitoring point, the requirements for these facilities are set out in section 11.9.

9.0 CCTV SYSTEM LIFE

The functionality of the CCTV system shall be maintained throughout the Contract Duration.

10.0 PARTICULAR REQUIREMENTS: TRAINBORNE EQUIPMENT

Each Train shall be supplied with fully integrated CCTV Trainborne Equipment. The CCTV Trainborne Equipment shall be a set of self-contained modules with minimal interconnecting cabling.

10.1 SUMMARY OF FACILITIES

The CCTV Trainborne Equipment shall provide the reception and display of a colour video signal transmitted from platform surveillance CCTV cameras to the Train. The CCTV Trainborne Equipment shall have comprehensive testing and diagnostic facilities which shall be fully integrated with the Trains' control and monitoring system, this system is specified in Schedule 6 - Part A (section 15 (sub-section 155) refers).

The received CCTV pictures from the fixed cameras on station platforms shall be displayed on a high resolution LCD colour monitor integrated into the cab control console, refer to Schedule 6 - Part A for the details of where the monitor and its various controls are to be placed in the cabs of the Trains.

Each cab is provided with a high resolution colour monitor for displaying diagnostic information generated by the Trains' control and monitoring system. To provide a standby capability in the event of a failure of either the control and monitoring system or CCTV monitors, a video switch shall permit video signals from either the control and monitoring system or CCTV system to be re-routed to the serviceable monitor.

10.2 GENERAL TECHNICAL REQUIREMENTS

10.2.1 The CCTV Trainborne Equipment shall be supplied to the same standards and requirements as the Train, its equipment and systems as specified in Schedule 6 - Part A.

10.3 FUNCTIONAL REQUIREMENTS

10.3.1 The CCTV Trainborne Equipment shall only be enabled in the Controlling Position cab.

10.3.2 The CCTV Trainborne Equipment shall derive its power supply from the Trains' Control Supply.

Each cab CCTV Trainborne Equipment shall be protected by a suitably rated MCB.

10.3.3 Test facilities for the CCTV Trainborne Equipment shall be provided on the Trains such that a Trainborne transmitter and colour video signal generator can inject a signal into the receiver antenna. The test signal shall be switched on and off by the Train Operator as required.

10.3.4 The CCTV Trainborne Equipment shall be self monitoring and any faults detected shall be reported to the Trains' control and monitoring system, the information must include:-

- (a) operational status,
- (b) alarm indications,
- (c) fault diagnostics.

10.3.5 The CCTV Trainborne Equipment shall be provided with a diagnostic interface with the control and monitoring system for reporting the status of the CCTV system. The data shall include information to enable Train Operators to rectify a fault by means of text messages to be displayed on the cab information monitor (Schedule 6 - Part A (section 13 (sub-section 133.1)) refers).

10.4 TECHNICAL REQUIREMENTS

10.4.1 General

The CCTV Trainborne Equipment shall utilise standard CCIR composite video signals with PAL colour encoding. The bandwidth of the CCTV Trainborne Equipment shall be sufficient to ensure that the overall CCTV system bandwidth is as specified.

10.4.2 Antennae

Antennae, to be located on both sides of the Train and as close as possible to the cab, shall be configured to optimise the reception of the RF signal from the CCTV system radiating medium mounted under the platform nosing while minimising the reception of unwanted signals from other sources.

The antenna shall be of an extremely rugged design that shall withstand the effects of carriage washing plants and other physical hazards typical of an underground mass transit railway environment

The mass and physical dimensions of the antenna shall be minimised to simplify the physical mounting arrangements.

The antenna design and installation shall take account of the varying vertical and horizontal offset that will occur between the Trainborne antenna and radiating medium due to track curvatures.

The Contractor shall accommodate for any constraints regarding the mounting arrangements of the proposed antenna, such as the proximity of other equipment on the carbody and the dimensions of the free space envelope required.

The Contractor shall submit a plot of the antenna polar response and the proposed position and mounting arrangement on the carbody to the Project Manager for review.

Where the antennae and receivers are positioned both at the front and rear of the Train to achieve the specified zone of operation of the CCTV system the Contractor shall provide adequate means of selecting the appropriate antennae, this selection shall not be via the correct side door enable signal provided by the system specified in Schedule 6 - Part D.

10.4.3 Receiver

10.4.3.1 General

The receiver shall demodulate the received RF carrier signal into a 1.0 V, peak-to-peak, CCIR colour composite video signal. The minimum video bandwidth after demodulation shall be 5.0 MHz. The carrier will be in the 50.5 to 52.0 MHz band.

10.4.3.2 Specific Technical Requirements

The receiver shall comply with the following:-

- (a) number of channels : 1,
- (b) modulation type : frequency,
- (c) RF input impedance : 75.0 ohms,
- (d) picture blanking : outside the specified zone of operation of the CCTV system and in the event of a failure the video output shall be switched to black level.
- (e) video output level : 1.0 V peak-to-peak into 75.0 ohms,

10.4.4 Monitor

10.4.4.1 Specific Requirements

The monitors shall be a high resolution, LCD, colour model with a 8.6" diagonal display size and 4:3 aspect ratio. Their pixel resolution shall be vertically 456 lines and horizontally 960 lines. The scanning system shall provide a 2:1 interlace at 50 fields/second. The monitor's input impedance shall be 75.0 ohms. The monitor input shall be fed from the video switch. Interfacing shall be at CCIR composite video signal level, 1.0 V peak-to-peak.

The monitors shall be flush mounted in the cab. The mounting arrangements shall provide shock absorbency compliant with Standard BRB/LUL/RIA 20.

The monitor shall incorporate a power "on/off" visual indication.

The location of the cab monitors are specified in Schedule 6 - Part A section 13 (sub-sections 133.1.2 and 132.4.6.10)}.

10.4.4.2 Monitor Controls

10.4.4.2.1 Brightness and Contrast

The brightness of the CCTV monitor display shall be controllable to optimise the clarity of the display under the varying ambient lighting levels within the cab. The brightness control shall have both manual and automatic switching modes. The manual range of adjustment shall be limited to ensure that a clear, well contrasted

picture is always displayed. The controls shall be supplied as part of the monitor unit.

10.4.4.2.2 Monitor Swap Control

The video feed to the CCTV monitor shall be switchable by means of a video switch, the 'monitor swap control', to either the received picture from the CCTV system or the text display output from the Trains' control and monitoring system.

11.0 FIXED EQUIPMENT

11.1 INTRODUCTION

The station CCTV Trackside Equipment consists of platform surveillance cameras, picture combiners, RF transmitters and a distribution network comprising connecting non-radiating coaxial cable and a radiating medium and cables within communication equipment rooms. At platforms with an obstructed view, additional cameras may be required which shall also entail the provision of video multiplexers to combine all the necessary pictures from platform cameras to be transmitted.

11.2 SUMMARY OF FACILITIES

The station CCTV Trackside Equipment shall be installed at the specified stations. The size of the installation at each station is dependent on several factors:

- (a) the number of platforms,
- (b) the operational configuration of the platforms (i.e. bi-directional working),
- (c) the presence of visual obstructions on platforms.

CCD colour cameras with fixed focal length lenses mounted in permanent pre-set positions shall monitor the station platforms. They shall be powered through their video coaxial cable to minimise platform cabling. The video cabling shall connect the camera with the transmission equipment in the station equipment room. The camera cabling shall terminate in the power feed units.

Video distribution amplifiers shall be provided in order that both individual camera feeds and the transmission feed for each platform is available for connection to the station CCTV surveillance system.

A video jackfield shall be used to provide ready access to the inputs and outputs of all video equipment and VDAs. Video cabling between the jackfield and station CCTV surveillance system will be provided by others.

The video signal shall be frequency modulated onto an RF carrier in the transmitter and then fed to the radiating medium of trackside level.

The radiating mediums are to be connected to the equipment room by means of non radiating coaxial cable. At all stations the Contractor shall provide all necessary wall penetrations, trunking, conduit or ducting (as defined in Schedule 6 - Part F) for all connecting cables. Local connections to each camera shall be via cable conduit.

The CCTV Trackside Equipment shall include mains isolation switches within the central equipment to isolate each of the incoming mains supplies.

The CCTV Trackside Equipment shall be provided with visual indications to indicate operational status and alarm conditions. Also, changeover, volt free contacts are to be provided for each alarm indication. Equipment and systems shall incorporate protection against lightning and inadvertent high voltage pulses.

The station CCTV Trackside Equipment shall include buffered CCIR composite video outputs from each platform camera and from each platform combined picture for connection by others into a future Company centralised CCTV surveillance system. This facility will eventually be used to transmit the pictures generated by the track-to-Train CCTV system back to the Northern Line Main Control Centre.

11.3 STATION EQUIPMENT GENERAL TECHNICAL REQUIREMENTS

The CCTV system station based control equipment supplied shall be housed within the communication equipment room at each location and contained in lockable cabinets.

All racks, shelves, units, and internal and external cabling shall be clearly labelled to enable rapid location of a particular unit or circuit.

Standardised racking shall be used.

11.3.1 Cubicles, Panels and Boxes

All cabinets, termination and junction boxes necessary for the accommodation and termination of all electrical apparatus and equipment, cabling and wiring provided under this Contract shall be of sound construction and uniform appearance and shall be manufactured from steel sheet no less than 1.5 mm in thickness. They shall be fully proofed against vermin, and insects. The degree of protection shall be to BS EN 60529; IP 52 for internal equipment and IP65 for external equipment, except where specified otherwise.

Each internal equipment cabinet at all Sites shall be floor mounted and suitable for top and bottom cable access with nominal dimensions 600.0 mm (width) x 600.0 mm (depth) x 2000.0 mm (height) inclusive of 100.0 mm high plinth.

Internal equipment cabinets shall be provided with a mains voltage 13.0 A socket for the use of engineers test equipment. The socket is to be mounted in an accessible position in the lowest level panel of the rack.

Access to panels and cabinets shall be from the front and rear. Access doors shall give unrestricted access to the interior, and shall be provided where necessary with integral locks. The equipment enclosure design shall be such that access doors required to be opened or removed during maintenance or repairs whilst the equipment is still operational shall not constitute elements of any electromagnetic screening measures necessary. Each enclosure supplied shall be furnished with

gland plates sufficient in quantity, strength and size to accommodate all cables entering and terminating in the enclosure.

All cable glands and connectors shall be overlaid with a heat-shrinking sleeve.

11.3.2 Plugs and Sockets

All plugs and sockets shall comply with a standard acceptable to the Project Manager.

Plugs shall be positively retained in their respective sockets and it shall not be possible to insert a plug in an incorrect orientation. Where similar plugs are situated adjacent to each other it shall be arranged that a plug cannot be inserted into the wrong socket.

Plugs and sockets carrying "Band 1" and "Band 2" voltages as defined in IEC 449 shall be segregated.

11.3.3 Fuses, Links and Terminals

Power supply fuses and links shall be mounted in a readily accessible position within the cabinet, and to facilitate identification shall be grouped, spaced, cabled and labelled according to their function.

The fuses shall conform to BS EN 60127 or as otherwise agreed with the Project Manager and be readily removable from the front of the apparatus. Approved symbols shall be used on diagrams and on fuse and link labels.

All live incoming power supply circuits in which the voltage exceeds 50.0 V (DC or AC) shall pass through insulated fuses or links, the supplies being connected to the bottom terminal, which shall be shrouded. The contacts of the fixed portion of the fuse or link shall be shrouded in order that accidental contact with live metal cannot be made when the moving portion is withdrawn.

All terminals to which 240.0 V AC wiring is connected, where they are not housed in individual terminal boxes, shall be provided with a transparent insulated cover which, in addition to any other form of identification shall be labelled as specified.

Warning notices or labels shall be applied to any items of equipment where voltages higher than 50.0 V (DC or AC) are used.

11.3.4 Cabling and Wiring

All cabling shall be neatly run and fitted in or upon such cable trays, trenches, ducts or conduits as may be appropriate to the layout and equipment. The Contractor shall provide and install all trays, supporting brackets, clamps and other fixings

necessary for the support of cables supplied and any steel item shall be fully galvanised (see Schedule 6 Part F).

The Contractor shall be responsible for:-

- (a) provision and installation of approved non-ferrous glands, grommets, and connectors at all cable entries to the equipment,
- (b) provision and fitting of identification ferrules as necessary and termination of individual cores in an approved manner.

The Contractor shall provide, install and terminate all internal wiring within cabinets, panels, kiosks, termination and junction boxes or other enclosures supplied.

All internal wiring shall be neatly run and securely fixed in non-rusting cleats in such a manner that, wherever practicable, wiring can be checked against diagrams without removal of cleats. Cleats shall be of an approved moulded insulating material and preferably of the limited compression type.

All wires between the terminal of two items of equipment shall be given unique wire identifications according to a system approved by the Project Manager. A wire number shall not change solely by virtue of passing through, say, a termination box.

Crimped terminations shall be in accordance with Standard BS 5G 178 unless agreed otherwise by the Project Manager.

Flexible cable tails shall be provided to route the radio feeder cables within the equipment cabinets. The associated connector shall be installed external to the cabinet in an accessible position within the cable trunking.

11.4 MATERIALS

All materials shall conform to the Company's Code of Practice for Safety of Materials Used in the Underground.

All materials used shall be of a fire retardant, low smoke, non-halogenated type. The Contractor shall produce a Materials Inventory for all materials used in the equipment and this shall be forwarded to the Project Manager for approval. The general requirements for this Materials Inventory are specified in Schedule 6 - Part A section 4 (sub-section 4.10.1.2.7). All cables and materials used at Sites where Section 12 of the Fire Precautions Regulations are in force and within communication equipment rooms at surface Sites shall be approved by the Company.

The Project Manager may grant dispensation in accordance with the Contract variation procedure for any materials that are not compliant. In such cases manufacturer's data and 3.0 m length of cable, or other agreed material samples,

shall be submitted to the Project Manager for his consideration and acceptance prior to the production of equipment.

Pressure formed laminates shall conform to Company Standard SE970.

Materials used in cables at the following stations where Section 12 of the Fire Precautions Regulations are not in force may be of standard PVC construction and must be resistant to UV radiation:-

Edgware, Burnt Oak, Colindale, Hendon Central, Brent Cross, Golders Green, High Barnet, Totteridge & Whetstone, Woodside Park, West Finchley, Finchley Central, East Finchley, Morden, Mill Hill East.

Guidance on cable construction can be obtained from the following Company Standards and specifications:-

EME-SP-14-027	2, 3 & 4-core SWA Cable - Low Voltage Limited Fire Hazard (LSNH) 2.5 sq mm to 300 sq mm.
EME-ST-03-006 -Part 1	Low Voltage Cables, Limited Fire Hazard (LSNH): General Requirements
EME-ST-03-006 - Part 2	Low Voltage Cables, Limited Fire Hazard (LSNH): Testing Methods
SE667:	19/0.25 mm Flexible Equipment Wire - Low Smoke Non Halogen
SE886:	1/0.8 mm Equipment Wire - Low Smoke Non Halogen
SE968:	Multicore Low Smoke Zero Halogen Cables for Electricity Supply.
SE1000A:	Standard Tests and Requirements for Materials
SEDP0601:	Procedure for Approval of Cables.

Printed circuit boards shall be of a flame retardant woven glass epoxy resin impregnated laminate in accordance with BS 4584, section 102.5.

All power transformers shall conform to BS 171.

All electric components used shall conform to the following Company Standard SE819A.

The Project Manager may grant dispensation if any components are unable to comply with the above, providing details are submitted for written approval and acceptance is granted prior to the production of equipment.

11.5 EQUIPMENT REQUIREMENTS IN RESPECT OF HEALTH AND SAFETY

All equipment shall be designed to take into account the provisions of the Health & Safety at Work Act 1974, Company Standard SCS-ST-0027 and BS 7671 (IEE Wiring Regulations).

All metal enclosures shall be provided with an earthing terminal to enable a 7/1.04 mm (6.0 mm² cross sectional area) cable to be terminated to provide a separate earth to that of the 240.0 V AC power supply cabling. The terminal shall include a 'stud' to take lugged cable.

No equipment shall contain any material which will constitute a health hazard to staff or Passengers at any time.

The Contractor shall label equipment according to a system approved by the Project Manager.

11.6 ENVIRONMENT

The Trackside Equipment shall operate in the following defined environments and any possible combinations thereof.

The approval of the Company shall be obtained if forced heating/cooling is utilised to enable correct system operation under these conditions. In such cases where forced heating/cooling has been utilised, precautions shall be taken, such that on failure of the forced heating/cooling system, there shall be no resultant damage to the equipment, or fire risk

The Contractor shall take note of the requirements in Company Standard SE1015 regarding solar radiation and the use of anti-condensation heaters.

11.6.1 Temperature

The station CCTV Trackside Equipment shall operate correctly and continuously within the limits of ambient temperature detailed in section 3.0 of Company Standard SE1015. The ambient temperature shall be that surrounding the equipment external to the equipment cabinet or equipment enclosure

All other external equipment and cables will be installed either in tube tunnels, sub surface or surface locations.

11.6.2 Humidity

The station CCTV Trackside Equipment shall operate continuously and correctly with an environment where humidity levels are as defined in Company Standard SE1015, sections 4.1 and 4.2.

11.7 SOFTWARE

All computer programmes, flow charts and specifications that are specifically written for the CCTV system shall be prepared and presented in accordance with the British Computer Society Code of Good Practice and shall be in accordance with BS 4058.

11.8 FIXED EQUIPMENT SPECIFIC TECHNICAL REQUIREMENTS

11.8.1 General

The camera power feed units, picture combiners, picture multiplexers (for platforms with more than 2 cameras) and transmitters shall be mounted in standard 19" racking and accommodated in the station equipment.

All video connections shall be via standard 75.0 ohm BNC connectors.

11.8.2 Cameras

11.8.2.1 General

The camera shall be a high resolution, high sensitivity colour CCD model of compact dimensions and light weight. It shall be a rugged design suitable for internal or external use.

The camera shall have excellent long term stability with minimal colour drift. The tolerances for the colour balance on each individual camera shall be such that when the outputs of two cameras at a given station are combined on a split image display there shall be a negligible subjective difference between the colour balance of each picture.

The camera system shall be designed for power feeding via a composite video/power cable to minimise the cabling installation requirements and facilitate a simple and fast exchange of camera units. A junction box is to be provided adjacent to each camera with a short cable tail to the camera.

The camera shall have a combination of auto-iris and AGC ranges permitting it to be used in the specified range of lighting conditions. The camera shall be tolerant to scenes containing large variations in luminance and shall generate satisfactory shadow and highlight detail. The maximum ratio of illuminances that the camera can accommodate in meeting this performance requirement shall be advised by the Contractor.

11.8.2.2 Electrical Performance

(a) Scanning System

625 lines with 2:1 interlace at 25 frames per second.

(b) Output Signal

CCIR composite video with PAL colour encoding, 1.0 V peak-to-peak into 75.0 ohms unbalanced load.

(c) Image Sensor Resolution

CCD sensor with pixel matrix and image processing to provide minimum resolution of 320(V) lines at a minimum 20% luminance modulation using EIA (RETMA) resolution chart (or equivalent).

(d) Sensitivity

20 lux for a picture signal to noise ratio of 50 dB or better (see also section 11.8.2.3(b)).

(e) Controls

Automatic iris drive. AGC with peak/average controls. Auto/manual white balance.

11.8.2.3 Optical Performance

(a) Angle of view: $8^{\circ} \pm 0.5^{\circ}$ (vertical) with 4:3 picture format.

(b) Depth of focus/sensitivity: camera sensitivity shall be sufficient to permit a lens aperture providing a depth of focus of 20.0 m to 85.0 m at a luminance of 20.0 lux.

11.8.2.4 Mechanical Requirements

Cameras shall be supplied with adjustable manually pre-set cradles. The cradles shall be adjustable in both the horizontal and vertical planes with a facility for locking the cradle once adjusted.

The camera shall be housed in a lockable, dustproof and waterproof housing IP65 of BS EN 60529 that shall be suitable for both indoor and external use.

The camera housing shall be provided with any heating facilities necessary to ensure screen demisting and de-icing under the specified environmental conditions. The

housing shall incorporate a hood to prevent driving rain from entering the screen when the camera is positioned horizontally. All cabling to the housing shall be within flexible metal conduit.

The Contractor is to provide camera shades at all locations where problems are likely to be encountered from sunlight and platform lighting installations.

Cable routing from the platform structure to the cameras shall provide an aesthetically pleasing arrangement with the cables preferably routed within the camera support brackets as is appropriate to the Site.

11.8.2.5 Camera Mounting Arrangements

The camera shall be mounted to provide the specified field of view. Each Site installation proposal shall be subject to the Project Manager's approval.

In tube tunnel stations and at surface stations where the camera position is under a station canopy, the camera shall be suspended from the roof structure. A suitable support bracket providing ease of camera maintenance shall be provided to ensure that the camera is correctly positioned in its cradle over the platform (supports are to be bolted to the tunnel rings and not to the infill).

In surface stations where the camera position is on an open platform, a cantilevered mast shall be provided such that the base of the mast is a minimum of 3.0 m from the platform edge away from the running line and the minimum vertical clearance between the cantilevered section of mast and the platform surface is 3.0 m.

The following requirements apply to the mounting brackets and masts:-

- (a) all steelwork shall be hot dip galvanised to BS 729 and finished in a durable paint finish of a colour to be approved by the Project Manager,
- (b) the rigidity of the assembly shall be such that with the camera fixed in position, in a wind gusting to 80 km/h, the camera mounting shall have a torsional displacement in both vertical and horizontal axes of less than 30 minutes of arc,
- (c) the complete assembly with camera fixed in position shall withstand a wind gusting to 160 km/h without any damage or permanent displacement.

11.8.3 PICTURE COMBINER AND TRANSMITTER

11.8.3.1 General

The picture combiner and transmitter shall convert the outputs from the platform cameras into a combined split screen image which shall then be modulated with an RF carrier and transmitted into the radiating medium network via the distribution control unit.

Additional outputs from the CCTV Trackside Equipment (within the communications equipment rooms) shall be provided; these shall include video outputs from each platform camera and the video output from the picture combiner. These additional outputs shall be CCIR composite video at 1.0 V peak to peak.

11.8.3.2 Picture Combiner

The picture combiner shall electronically combine the composite video outputs of two cameras into a single split image picture. The picture images shall be split at a vertical interface line and the position of the split shall be horizontally adjustable to give from 10% to 90% width for each picture. The split position shall normally be adjusted to provide two half width pictures.

The picture combiner shall introduce negligible picture degradation with static or moving scenes and the combiner display shall have a clear edge to each picture along their joint boundary, with no evidence of "tearing" or other visible detractor.

The split screen display arrangement shall be in accordance with figure 5.

11.8.3.3 Picture Multiplexer

At stations where additional cameras are required to monitor the entire platform length, an electronic picture multiplexer shall be provided to enable all the camera images of the platform to be displayed onto one monitor screen. Each camera image shall be full size and not subject to the picture combiner as defined in section 11.8.3.2. The picture multiplexer shall introduce negligible picture degradation to static or moving scenes, negligible instability, negligible 'stroboscopic' effect and negligible real time delay. No noise, picture roll or other detrimental effect shall be visible as a result of the multiplexing.

The stations where a picture multiplexer is required are as identified in figure 4, however the Contractor shall confirm these requirements by Site survey. The display of the camera images on the monitor shall be in accordance with figure 5.

11.8.3.4 Transmitter

The transmitter shall translate the CCIR composite video signal from the picture combiner and optional picture multiplexer onto frequency modulated radio frequency carrier. The RF signal shall be amplified and buffered as necessary for transmission into the radiating medium. Transmission shall be via a distribution unit for more complex station layouts.

The modulator shall have a deviation and output level sufficient to satisfy the overall CCTV system noise and bandwidth requirements while complying with any

requirements stipulated by DTI. The complete transmitter shall be DTI type approved.

The transmitter output shall be fully protected against short and open circuit loads and the effects of pickup fed back from the radiating feeder network into the transmitter output.

11.8.4 Common Mode Failure

The system reliability performance shall avoid a common mode failure occurring which will affect simultaneously the output transmitted by each platform CCTV system.

This shall include picture combiners, distribution amplifiers, transmitters and power supply units serving both the central equipment cabinet and cameras installed externally.

Within the central equipment cabinet each platform CCTV system shall be fed by a separate power supply cable independently fused at the local power distribution board within the communications equipment room.

11.8.5 CABLING

11.8.5.1 RF Non-radiating Cable

Non-radiating coaxial cables shall be utilised for connecting each radiating medium feeder section with the RF distribution unit. The most complex station layouts typically have up to four discrete sections of radiating medium that all require independent feeding from the distribution unit. Connection lengths of 350.0 m are involved for worst case cable runs. The output power of the transmitter is to be adjustable to be able to provide correct signals levels using a 350.0 m non-radiating cable.

The system design shall take account of the variation in connecting cable lengths and losses and ensure that the overall system performance is uniform and unaffected by the feeder section length.

The non-radiating coaxial cable shall be unarmoured but shall be protected by non-conducting conduit whenever the cable branches out of an existing or new cable route onto the track formation to the radiating medium connection.

11.8.5.2 Radiating Medium

The radiating medium shall be mechanically robust with characteristics that minimise the adverse effects of the hostile electrical environment within which the CCTV system shall operate. The radiating medium shall be provided throughout its

length with a non-conductive and weather proof outer sheath or covering. The installation arrangements are detailed in section 11.8.5.3 and the medium characteristics shall take account of the following factors:-

- (a) proximity to running rail causing distortion of radiated field and phase shift between inner and outer cable conductors,
- (b) proximity to other power and signalling cable radiating interference that could be picked up by the radiating medium,
- (c) prohibition of any earth connection, whether DC or AC, to the radiating medium meeting the requirements of BS 7671.
- (d) medium expansion or contraction due to temperature changes. The radiating medium shall have a serviceable life of at least 25 years under the environmental conditions specified. It shall not suffer from any of the following degenerative effects during its serviceable life:-
 - I) ingress of moisture when continually exposed to moisture,
 - II) decomposition of outer sheath due to:
 - i) temperature cycling,
 - ii) contact with oil or grease,
 - iii) exposure to direct sunlight.
- (e) the distant end of the radiating medium is to be fitted with a precision 75.0 ohm load. The voltage standing wave ratio (VSWR) on the radiating medium and of the distribution cable is not to exceed 1.3:1 in the RF channel used.

The Contractor shall include VSWR measurements in its test procedure for each installed radiating medium section.

The design of the medium shall be selected to optimise the coupling and transmission losses for this specific system application while minimising interference pickup.

11.8.5.3 Radiating Medium Fixings

The radiating medium shall be mounted on the underside of the platform nosing, or low on tunnel walls where approved by the Project Manager, and shall not infringe on the kinetic profile defined in Contract Drawing 88155 .

The mounting arrangement proposed by the Contractor shall provide secondary retention of the medium and shall be subject to the approval of the Project Manager.

Mechanical support sufficient to prevent medium sag and distortion shall be incorporated and shall be provided and shall be at discrete intervals for the full length of the radiating medium.

Tests shall be carried out to Standard BRB/LUL/RIA 20 on a complete section of radiating medium and support system to ensure that the assembly is immune to vibration.

The radiating medium terminating impedance and the connection to the non-radiating coaxial cable shall both be housed in waterproof and dustproof terminating boxes to protection standard IP65 of BS EN 60529 providing test points for the cabling and rugged physical protection.

11.9 SYSTEM MONITORING AND ALARMS

Monitoring facilities shall be included for composite video signal level and RF transmit power level at appropriate stages of the signal chain.

A status module shall be provided which monitors the condition of other critical modules within the equipment. On failure of an equipment unit a common failure LED shall be lit and a volt free contact operate. Failure of any of the equipment units shall result in the common failure volt free, earth free changeover contact operating.

Separate changeover contacts shall also be provided for each failure condition for external alarm monitoring. Connection to and supply of telemetry equipment to implement the remote monitoring of the volt free contact shall be provided by others.

11.10 POWER SUPPLIES

11.10.1 All Trackside Equipment provided by the Contractor shall operate continuously from an input mains 240 V, single phase, 50 Hz, AC supply as specified in section 8.0 of Company Standard SE 1015.

11.10.2 The Company will provide within the communication equipment room of each Site a local power distribution board (PDB) to feed the mains supply to the Contractor equipment cabinets and to any equipment units installed external to the communication equipment room.

11.10.3 The Contractor shall be responsible for supplying:-

- (a) All power conversion equipment which may be necessary to operate the equipment installed within the communication equipment room and at external locations.
- (b) Power supply cables from the PDB to his equipment within the communication equipment room and externally.
- (c) Residual Current Circuit Breakers (RCCBs) within the PDB to protect each power feed cable as described in (b) above and associated equipment.

The protector device shall be compatible with a Crabtree C50 type, combined MCB/RCCB with 30.0 mA sensitivity.

- 11.10.4 The power distribution from the PDB shall be arranged with dual input mains supplies. On failure of a single power supply, the remaining supply shall operate all platform equipment.

Each supply shall be fed from a separate power outlet on the power distribution board.

- 11.10.5 To restart the equipment on power failure of any duration or extent, no external intervention (manual or from other equipment) or reset shall be required (other than fuse replacement) and the equipment shall automatically restore to full correct operation within 10.0 s of restoration of the power supply.

11.11 IDENTIFICATION AND LABELLING

All equipment and cables shall be identified and, where appropriate safety/hazard warning labels shall be installed on and within the equipment to comply with the appropriate UK standards such as BS 7671 and BS 5378: Part 1 and to the appropriate parts of the equipment as required by the Safety Sign Regulations 1980 and in accordance with EC Directive 92/58/EEC.

The type and form of labels to be used shall comply with appropriate national or international standards and shall be subject to the approval of the Project Manager.

Cables shall be identified by their circuit reference designations by an approved heat shrinkable sleeve. Each cable shall be sleeved with its identity at both ends and as close to the point of termination as possible and at intermediate lengths of 50.0 m.

Equipment cables and where appropriate module equipment shall be marked with their tag numbers using layered traffolyte to give white alpha/numerics on black background.

Labels shall be firmly attached to the equipment where practical - bolting or adhesive techniques being acceptable. For equipment such as cameras the tag label shall be embossed stainless steel fixed to the equipment with a stainless steel, fine, wire and a crimped lead or other soft metal seal.

12.0 LIST OF DRAWINGS AND REFERENCED DOCUMENTS

12.1 General

The issue status of the drawings and documents referenced below are defined in Schedule 6 - Document J.

12.2 DRAWINGS

12.2.1 Reference figures

Figure 1	Track-to-Train CCTV System Schematic
Figure 2	Typical Tube Station: Overall Camera Arrangement
Figure 3	Typical Station: Individual Camera Arrangement
Figure 4	Schedule of Materials (Sheets 1 to 4 inclusive) (for information)
Figure 5	Image Display for Cab Monitor

12.2.2 Contract Drawings

88155	Kinematic Profile
90-901	Geographic Track Diagram
SK12363	Relationship between Platform and Track

12.3 Company Specifications/Standards

SE819A	Electronic Apparatus - wiring and soldering
EME-SP-14-027	2, 3 & 4-core SWA Cable - Low Voltage Limited Fire Hazard (LSNH) 2.5 sq mm to 300 sq mm.
EME-ST-03-006 - Part 1	Low Voltage Cables, Limited Fire Hazard (LSNH): General Requirements
EME-ST-03-006 - Part 2	Low Voltage Cables, Limited Fire Hazard (LSNH): Testing Methods
SE667:	19/0.25 mm Flexible Equipment Wire - Low Smoke Non Halogen
SE886:	1/0.8 mm Equipment Wire - Low Smoke Non Halogen
SE968:	Multicore Low Smoke Zero Halogen Cables for Electricity Supply.
SE1000A:	Standard Tests and Requirements for Materials
SEDP0601:	Procedure for Approval of Cables.

12.4 National and International Standards

BS EN 60529	Degrees of Protection
BS EN 60127	Miniature Fuses
BS 4584	Metal-clad base materials for printed circuit boards
BS 729	Hot dip galvanised coatings on iron and steel articles
BS 171	Power Transformers
BS 7671	IEE Wiring Regulations - 16th Edition