TECHNICAL SPECIFICATION

FOR

NORTHERN LINE RADIO SYSTEM

NORTHERN LINE RADIO SYSTEM

CONTENTS

1.0 INTRODUCTION

1.1 Schedule 6, Part C, covers both the provision of a new radio system, the Final UHF Trunked Radio system, and the upgrading of the Existing VHF Radio system under the terms of this Contract.

1.2 The Contractor shall initially overhaul and enhance the Existing VHF Train Radio system to reliably provide the necessary functions for OPO (T) of the Trains as they are brought in to Passenger service whilst maintaining the existing facilities for the Existing Trains with improved reliability and coverage. Before commencement of this work the Contractor shall assume responsibility for maintenance of the Existing VHF Train Radio system, and shall retain this responsibility until the recovery of the equipment after it is taken out of service. The Contractor shall supply the Trains with VHF radios compatible with the overhauled and Enhanced Existing VHF Train Radio system. The existing functionality shall not be adversely affected by the enhancements and must continue to operate throughout to ensure no disruption to the service and other running of Existing Trains on the Northern Line. It is the Contractor's responsibility to ensure that it is fully aware of the functionality and operational usage of the Existing VHF Train Radio system to ensure this requirement is met.

The design of the Train installation shall be such as to minimise the work required to change to the Final UHF Trunked Radio system.

1.3 The Contractor shall provide a Final UHF Trunked Radio system conforming with sections 3 to 6 of Schedule 6, part C.

1.4 For each system the Contractor shall prepare a functional design specification (FDS) in collaboration with the Company and shall obtain the Company's approval of this prior to undertaking detailed design.

1.5 The Contractor shall comply with applicable Company Standards in respect of the UHF Trunked Radio systems, the particular Company Standards to apply shall be determined in the generation of the FDS as set out in paragraph 1.4 of this Schedule 6, Part C.

2.0 EXISTING AND ENHANCED EXISTING VHF TRAIN RADIO SYSTEM

2.1 CURRENT SYSTEM ARCHITECTURE

2.1.1 Line System

2.1.1.1 Control

The existing control system is based on a Storno RA7575 control system, utilising DC signalling.

2.1.1.2 Base Equipment

The base equipment consists of Storno CQF614D base stations with external high stability oscillators operating in quasi-synchronous mode.

2.1.1.3 Infrastructure

Control Rooms: The Existing VHF Radio System has its control interfaces at the Northern Line Main Control Centre. At the Northern Line Main Control Centre location are the main radio and signalling control equipments and the Northern Line control room. The Northern Line Emergency Control Centre has only interface controls connected to Northern Line Main Control Centre.

Propagation: The means of propagation is predominantly a VHF high band leaky feeder cable with uni-directional repeater amplifiers, utilising DC power feeding arrangements over the leaky feeder. The power supplies are co-located with the base equipment.

Land Lines: The land lines are provided over the Company's own cabling infrastructure. Due to the nature of the signalling between base and control they must remain DC continuous, unless special conversion arrangements are made.

Power Supplies: In tunnel areas the AC feeding is from dual supplies via a changeover contactor.

2.1.1.4 Channel Change

At the entrances and exits to Golders Green and Morden Depots and at Colliers Wood channel change beacons are installed. These continuously transmit a signal to change the radio channel of passing trains. Confirmation beacons are located some distance after the change beacons in some instances.

Each beacon comprises a transmitter mounted in a trackside equipment case and an antenna mounted on the sleepers.

2.1.2 Depot System

At Morden and Golders Green Depots, a modern 3 channel VHF radio system utilising Philips M87 control equipment exists. The channel utilisation is as follows:

Channel1 Depot management use for day to day Depot running,
Channel2 Permanent talk through for train shunting movements,
Channel3 Intended train control channel.

Channel 3 is not yet in operation (and the service is provided via a system of similar vintage to the line system), but it is fully equipped and ready for change-over.

2.2 ENHANCEMENTS REQUIRED

The following list the enhancements required to the Existing VHF Radio System and the additional equipment necessary to bring the system up to OPO (T) standard.

2.2.1 System Enhancements

2.2.1.1 Control System and Base Stations

These require re-calibration to ensure that the audio levels and delays across the system are equalised and the base station set up is correct to manufacturers specification. This will entail an end to end test.

2.2.1.2 Propagation Infrastructure

This will require re-alignment to ensure that the drive levels to, and output levels from, the repeater amplifier system are at the correct levels.

2.2.1.3 Land-lines

The land-lines can either be diverted via leased line for increased integrity (however note 2.1.1.3), or the existing circuits verified and tagged.

2.2.2 New Provisions

2.2.2.1 The system must be converted to give the functionality required for OPO(T). The minimum additional functions required between the Northern Line Main Control Centres and Northern Line Emergency Control Centres and the Trains are:-

a) incoming call to the Northern Line Main Control Centre or Northern Line Emergency Control Centre shall display train running number and base station location,
b) if the incoming call is an OPO(T) alarm this shall be clearly indicated
c) the Line Controller shall have the facility to make a public address announcement to a Train which has originated on OPO(T) alarm,
d) an OPO(T) alarm call shall be identified even when a call is active in another base station section,
e) when a Train is being prepared for Passenger service it shall be possible to perform a comprehensive semi-automatic self-test of the functions.

Section 2.3 details how the above requirements are achieved on another Company railway line. It is not necessary to retain the same coding arrangements other than

maintaining the method of calling Existing Trains and the functionality identified therein.

2.2.2.2 Line System

The control system must have installed a parallel decoding arrangement to handle the new coding arrangement for OPO(T). The control position at the Northern Line Main Control Centre and Northern Line Emergency Control Centre may be changed to give the Operators a common method of managing standard calls as of today and the new OPO(T) arrangements.

Three or five additional control points shall be installed on the senior signal operators' desks and the Northern Line Main Control Centre and Northern Line Emergency Control Centre, to initiate calls only. It is envisaged that these would consist of a handset and a busy indication lamp only.

2.2.2.3 Power Supplies

Those line base stations which have only a single power supply shall be provided with a UPS of sufficient capacity to sustain operation for 4 hours with 50% of continuous operation in transmit and receive mode.

The following Sites may require a UPS to be provided, however the Contractor shall verify the requirements as part of its Site survey:-

i) High Barnet,
ii) Finchley Central,
iii) Highgate,
iv) Edgware,
v) Hendon Central,
vi) Golders Green,
vii) Belsize Park,
viii) Tooting Bec,
ix) Colliers Wood.

2.2.2.4 Depot System

The third channel on the existing Depot system is to be brought on line and a method of system testing is to be added.

2.2.2.5 Trainborne Equipment

Every Train delivered to the Company prior to the Final UHF Trunked Radio system being accepted for traffic service shall be fitted with radio units compatible with the Enhanced Existing VHF Radio system. The design of the Radio Trainborne Equipment shall minimise the conversion work that will be required to permit the Radio Trainborne Equipment to be compatible with the Final UHF Trunked Radio system. The Radio Trainborne Equipment shall be fully integrated into the Train

and shall comply with the relevant requirements of Schedule 6, Part A. The Radio Trainborne Equipment may operate in semi-duplex, subject to Project Manager's approval.

2.3 OPERATION OF OPO(T) ON ANOTHER LINE

The control system shall operate in one of four modes:-

1. Monitor,
2. System Test,
3. Alarm Test,
4. Alarm.

Full details concerning the operation of the control equipment are given in Company Standard SE869.

2.3.1 Monitor

The system shall power up into MONITOR mode, this being the "normal" mode of operation. The "MONITOR" mode shall monitor all incoming land lines (up to a maximum of 20). When an ALARM TEST code is detected the control unit shall enter ALARM TEST mode. When an ALARM code is detected the control unit shall enter ALARM mode. When the SYSTEM TEST key switch on the OPO(T) panel is pressed, the control unit shall enter SYSTEM TEST mode.

2.3.2 System Test (refer to figure 1)

2.3.2.1 When SYSTEM TEST is selected (the SYSTEM TEST key switch is pressed) on the OPO(T) panel, the control unit shall cycle through a series of internal test procedures, to verify that the trackside equipment is functioning correctly. The internal test procedures performed shall include the following:-

i) full control panel functions,
   - indicators,
   - sounder,
   - LED display,

ii) internal memory tests to prove that all of the memory is usable.

2.3.2.2 The "SYSTEM TEST" mode shall take less than 20 s to complete.

2.3.2.3 During a SYSTEM TEST the TEST STATUS indicator shall become illuminated (white aspect). The results of the SYSTEM TEST once complete, are indicated by the condition of the TEST STATUS indicator.

2.3.2.4 The indicator shall be extinguished only if the test is successful, and the VERIFY REQUEST indicator (present within the TEST VERIFY key switch) shall be illuminated.

2.3.2.5 The system shall then wait until the TEST VERIFY key switch is depressed before the VERIFY REQUEST indicator is extinguished, and the system returns to the MONITOR mode.

2.3.2.6 The TEST STATUS indicator shall remain illuminated and the audible sounder activated if the SYSTEM TEST fails. The VERIFY REQUEST indicator shall then illuminate.

2.3.2.7 The system shall then wait until the TEST VERIFY key switch is pressed before the VERIFY REQUEST indicator is extinguished and the audible sounder is silenced.

2.3.2.8 The system shall then return to the MONITOR mode (with the TEST STATUS indicator illuminated).

2.3.2.9 After completion of a SYSTEM TEST the printer is to print a message corresponding to the status of the test as outlined in paragraph 2.3.5.

2.3.3 Alarm Test

2.3.3.1 An alarm acknowledge code shall be transmitted 1.5 s +/- 10 ms after the detection of a valid alarm test code.

2.3.3.2 After transmission has taken place the control unit shall open a window for 4 s ± 500 ms to wait for the ALARM TEST confirmation code.

2.3.3.3 If a L12abc code is received the result is a pass. If a L3abc code is received the result is a fail. If neither a L2abc nor a L3abc code are received the result is a NO RESPONSE, see appendix 3 for printer output formats (message types 4, 5 and 6 respectively).

2.3.3.4 On completion of printer output message the control unit shall return to the MONITOR mode.

2.3.3.5 Should the system be busy or unable to reply to a requesting Train printer message type 11 is to be printed.

2.3.4 Deadman Alarm (refer to Figure 1)

2.3.4.1 If the Deadman Device is released at the Controlling Position, a timing device waits 60 s. If after that, the Deadman Device is still released, an alarm is sounded in the cab. If the Deadman Device remains released for a further 30 s an alarm signal (L0 abc), the Deadman Alarm, is sent to control.

2.3.4.2 Upon detection, the Deadman Device RELEASED ALARM RECEIVED light shall flash, an audible warning shall be sounded, the Train running number shall be displayed and a printer message type 14 shall be printed.

2.3.4.3 The system shall then wait for the Deadman Device RELEASED ALARM ACKNOWLEDGE to be sent, (00abc). When this switch is pressed, the ALARM RECEIVED indicator shall be extinguished, the alarm audible warning shall be silenced and the acknowledge signal shall be sent.

2.3.4.4 The control system then waits to see if the alarm codes are still being sent. (The Train may have been sending during the alarm acknowledge period and not received the acknowledge.) If the codes are still being detected, the ALARM RECEIVED light shall re-illuminate, indicating the ALARM ACKNOWLEDGE cycle needs repeating.

2.3.4.5 When the alarm has stopped, the Line Controller shall call the Train to ascertain if it is a genuine alarm. (L7 grg, or L7 abc). If it is a false alarm, the Train Operator will make a call to the Line Controller to confirm the false alarm. If it is a true alarm, the Line Controller continues as in section 2.3.4.9.

2.3.4.6 If no further alarms are received, the RESET ENABLE indicator shall illuminate and allow the SYSTEM RESET to take place, providing the following two conditions have been met: -

a) the handset is correctly stowed;
b) Radio communication has taken place between the Line Controller and the alarm Train.

2.3.4.7 When these two conditions have been met, and the SYSTEM RESET switch is pressed, the RESET ENABLE light is extinguished and the control unit shall return to the MONITOR MODE.

2.3.4.8 If further alarms are received, the system reverts to the ALARM DETECTED state, and repeats from paragraph 2.3.4.2.

2.3.4.9 At paragraph 2.3.4.5, if the alarm is a true emergency, then the Line Controller activates the public address switch which sends a PA OPEN code, (01abc) to open the public address on the alarm Train. The PA OPEN indicator is illuminated when the PA OPEN confirmation code, (01abc) is received from the alarm Train. If no confirmation is received, printer message type 8 is printed.

2.3.4.10 The PA switch is then held down and the PA message is passed to the Train. If the message is longer than 50 s, a PA OPEN (Refresh) code, 01abc, is sent automatically. After the transmission of each PA OPEN code, a 2 s +/-200ms window is opened to detect the PA OPEN confirmation code. If no confirmation is received, the PA OPEN indicator is extinguished and message type 12 is printed out.

2.3.4.11 When the PA switch is released, the PA OPEN indicator is extinguished and a PA CLOSE code, 02abc, is sent. Message type 13 is then printed.

2.3.4.12 The control unit shall continue to monitor for further Train alarm codes, which if detected shall be stored in a stack. The second Train alarm indicator is then illuminated.

2.3.5 Printer Messages

Messages will conform to the style and content shown below, where:

DD/MM/YY	represents day/month/year
HH/MM/SS	represents hours (24 hour clock)/minutes/seconds
?12345	represents a non-system 5 tone sequence
JUpqr	= junction unit serial number
Train abc	= manually set up Train number

	DATE	TIME	FUNCTION
Type 1	DD/MM/YY	HH/MM/SS ?12345	Call sign out of range
Type 2	DD/MM/YY	HH/MM/SS JU pqr	Test initiation telegram corrupt
Type 3	DD/MM/YY	HH/MM/SS	Control unit initialised
Type 4	DD/MM/YY	HH/MM/SS Train abc	Deadman Alarm test successful
Type 5	DD/MM/YY	HH/MM/SS Train abc	Deadman Alarm test failed (JU pqr problem reported)
Type 6	DD/MM/YY	HH/MM/SS Train abc	Deadman Alarm test failed. JU pqr (no response)
Type 7	DD/MM/YY	HH/MM/YY	Change date
Type 8	DD/MM/YY	HH/MM/SS	Train PA open confirmation not abc received
Type 11	DD/MM/YY	HH/MM/SS Train abc	Test initiation request JU pqr received but system busy
Type 12	DD/MM/YY	HH/MM/SS Train abc	PA announcement - no abc contact
Type 13	DD/MM/YY	HH/MM/SS Train abc	PA announcement - completion
Type 14	DD/MM/YY	HH/MM/SS Train abc	Deadman Alarm received
Type 15	DD/MM/YY	HH/MM/SS JUpqr	Train number incorrect. Nr out of range

2.3.6 5 Tone Selective Call - Tone Frequencies

DIGIT	ACTUAL USED FREQUENCY (H_Z)	STANDARD CCIR FREQUENCY (H_Z)
1	1121	1124
2	1200.5	1197
3	1278	1275
4	1357	1358
5	1444	1446
6	1541	1540
7	1638	1640
8	1747	1747
9	1856.3	1860
0	1983	1981
R (Repeat)	2110	2113
G (Group & All Call)	1022	------

3.0 UHF TRUNKED RADIO SYSTEM

3.1 PRINCIPAL DESIGN OBJECTIVES

The Company has a requirement for a UHF Company wide trunked radio system for which Schedule 6, Part C defines the Northern Line portion.

The Contractor shall ensure that the Final UHF Trunked Radio system fulfils the following design objectives ranked in order of importance:-

a) achievement of specified performance and functionality,
b) achievement of the specified service availability, reliability and maintainability,
c) use of proven technology.

3.2 OUTLINE OF THE FINAL UHF TRUNKED RADIO SYSTEM

3.2.1 The Final UHF Trunked Radio system shall be installed on the Northern Line which is defined on Contract Drawing 6235 11 00 N001 000 00 DRG 90-901.

The Final UHF Trunked Radio system shall be available at all stations and Depots on the Northern Line and shall provide facilities for numerous users groups and simultaneous usage.

The existing propagation infrastructure consisting of repeatered leaky feeder cable situated at trackside being suitable for propagation only of VHF signals is to be replaced by a UHF (up to 500 MHz) capable propagation infrastructure. Existing station radio leaky systems were designed for the propagation of UHF signals may be incorporated.

3.2.2 The Northern Line operates an intensive service with train frequencies down to 2 to 3 minute intervals over substantial periods of its 20 hour running day.

The Final UHF Trunked Radio system must be designed with the consequences of any failure taken into account. The failure of the OPO(T) Deadman Alarm, will require the withdrawal of affected Trains from service or double manning. The failure of Radio Trackside Equipment will require double manning of Trains or the supervision of the service

3.2.3 The Final UHF Trunked Radio system is replacing one with limited capabilities. Even apart from the OPO(T) Deadman Alarm function already referred to, it has an importance to the running of the railway both at an organisational level and a safety level which makes its availability imperative.

The Final UHF Trunked Radio system shall provide communications for a number of user groups at present having no effective tunnel communications (e.g. track and signal engineers) therefore it is required to be engineered and installed to a standard that justifies the dependence that its users will place upon it.

3.2.4 The Contractor shall replicate in respect of both trackside and Trainborne aspects, the functionality of the Enhanced Existing VHF Train Radio system that includes, but is not limited to the OPO(T) Deadman Alarm, the OPO(T) Depot test facility, testing of cab/saloon audio paths and switching by automatic test announcement, etc.

3.2.5 A number of interface issues within the Final UHF Trunked Radio system are required of these, the most significant are the linking of existing emergency service base station transceivers along with the trunked channel transceivers into the new trackside propagation infrastructure (and of the trunked channel transceivers and any additional emergency service base station transceivers into the station radio leaky feeder systems). It is important to note that although the specified system is described as a "UHF trunked radio system" the propagation infrastructure which forms a major part of the requirement is to carry a number of emergency services comprising conventional UHF, VHF high-band and possibly VHF low-band for which hand-portables, base transceivers and control/MMI (where applicable) is not directly in the Company's control. There may also be a requirement to carry channels within Band III for signalling data.

3.2.6 The interfacing of the Final UHF Trunked Radio system externally requires that the design shall take full account of the implications on co-existence and inter-working, of:-

a) situations where lines or sections of the same line run close to one another
b) interchange stations in anticipation of the equipping of other Company lines with similar trunked radio systems.

It is a requirement that the design of the Final UHF Trunked Radio system shall be such as to gain positive function advantage for itself and other lines, as it expands across the Company infrastructure.

4.0 FINAL UHF TRUNKED RADIO OPERATIONAL REQUIREMENTS

4.1 GENERAL SYSTEM

The Final UHF Trunked Radio system shall provide radio coverage over the Northern Line, its Depots, Outstations, sidings and stations. A trunked radio system is required not only because of the efficient use that can be made of the 10 channels available to the Company, but also because of the versatile connectivity it offers.

The Final UHF Trunked Radio system is required to provide communications within, and in certain cases between, a number of user groups whose mobile members may be:-

a) lone workers (e.g. permanent way patrol man walking tunnels at night, signal technician repairing fault),
b) paired workers (e.g. travelling ticket inspectors working on a Train or Existing Train),
c) groups of workers, working together or with a degree of separation depending on the task (e.g. signal workers during testing),
d) groups of workers permanently at the same location (e.g. station staff at medium and large stations, also Depot staff),
e) station groups, where a number of stations are semi-permenantly grouped together as part of security initiatives, potentially under control of nominated station.

A number of other combinations of staff grouping / distribution exists or are likely to exist. Versatility is required of the system at two levels - firstly in respect of the communications call destinations available to any suitably equipped mobile user and secondly in respect of groups and who is actually (technically) permitted to talk to who.

As well as needing to accommodate the needs of short or medium term user groups, the system is required to accommodate changes to communication path requirements resulting from organisational or structural changes during the long term evolution of the Company.

Further information about the required connectivity's is given in section 4.2, but the Contractor is required to provide a system in which all mobile users and fixed control points (terminals) can communicate. This potential total versatility in access is then required to be limited to suit the needs of the Company, as at that time defined, by:-

i) the use of radio mobiles offering, for example, no keypad and simple one-button communications to their own control point only for some users,

ii) the software of the switching controller(s).

It should be noted that not all user groups are to have a fixed control point (terminal): in certain cases the members of the group are all mobile. In some case even where there is a fixed control point, much of the radio traffic may simply be between mobiles and not involve the control point. Conversely, for reasons associated with working practices, some user groups are required not to permit mobile to mobile calls within the groups except under special permissive conditions. Train radio is such a group.

The Contractor shall provide a system which makes special provision for Train radio, the operational requirements for which are distinguished from those of the other user groups in three main ways.

Firstly, whereas the other user groups shall provide communications on the basis of:-

a)	one-to-one (secure),		
b)	sub-group (user configurable)	-	within overall user group,
c)	all-call (Broadcast)	-	".

Train radio shall overlay upon the above non-geographically defined capability, a zonal address / reception capability. This shall allow calls from and to up to 14 defined sections or zones of line to be dealt with by a senior signal operator having operational responsibility for that section. Again, a flexible arrangement enabling any of the 14 line control room radio terminals at which the senior signal operators are seated to form the control point (terminal) for any section / zone and moreover for more than one section to be allocated to any one terminal. This is to deal with conditions where manning of all terminals cannot be justified by traffic levels and in the limit display of all sections at any one terminal is required. It is in this latter point of the Train user group having multiple co-sited terminals (for the senior signal operators and an "oversee" position for the Line Controller) that the second important difference from the other user groups is found: In the case of the other user groups which do have fixed control points some may have dual non co-sited terminals but In these cases not only the presentation / functionality but also the application remains largely the same. The Train user group differs lastly in the requirements for an installed mobile transceiver of which more details are given in section 6.0.

4.1.1 Call Set-Up Times

A number of the users of the system have only the limited capability of calling one or two destinations i.e. either the control point terminal of their user group or perhaps all other hand-portables of their user group. For these users the versatility of connectivity offered by the trunked system will not be apparent. It is therefore important that their simple requirements for radio communications are not made unacceptably difficult in use, especially when in some cases their requirement

would have been met by a simple press-to-talk (PTT) on a hand-portable in a back-to-back arrangement.

It is thus desirable that the call set-up time should not exceed 500 ms and except for reasons of channel unavailability shall never exceed 1 s. Ruthless pre-emption for emergency calls shall be used, with the option to remove low priority groups during a major incident.

4.1.2 Redundancy

The following shall be supplied as a minimum to ensure that no single failure causes loss of system functionality, and multiple failures cause loss of system capacity only. A "single failure" may extend to complete loss of the equipment at one site.

a) Back up of processors in switch equipment shall be automatic.
b) Frequency agile bases for re-allocation of control channels and dynamic frequency allocation.
c) Back up transmission systems shall be employed for tie-lines.

4.1.3 Fall-Back Modes

a) The mode for MSC / LSC link loss shall allow each LSC to operate as a separate switch.
b) The mode for base / LSC link loss (if applicable) shall allow each base station to operate in local talk-through.
c) There shall be Indication of the current mode to users. i.e. audible / visual alert of system status

4.2 INDIVIDUAL USER GROUP REQUIREMENTS

4.2.1 Trainborne Radio

The Line Controllers / senior signal operators shall have "full facility" terminals allowing them to talk to any user on the Line, as well as to make the more normal calls to Trains. Broadcast and group calls from the Line Controller shall be directed to all group members on the line. Broadcast and group calls from a senior signal operator shall be directed to all group members in the area currently being controlled by that senior signal operator.

Calls from a Train addressed to the senior signal operator shall be directed to the senior signal operator who is currently controlling the location from which the call originated.

The principal controls on the Train shall permit selection of "call Line Controller", "call senior signal operator" or "call Depot" and the subsidiary control system shall

permit calling of any other location as defined in Schedule 6, Part A section 154.4.4.3.1.

The full facility terminals required for the Line Controller / senior signal operators are distinguished from the simple radio terminals sought for other control points of the system (e.g. station radio) in providing:

a) call requests from Trains must be identified on the Line Controller's or senior signal operator's call stack by the following, as a minimum:-
   i) Train running number (if set),
   ii) Car number (derived from the Train),
   iii) location (derived via the Train from the signalling system),
   iv) Radio serial number (this can be in lieu of Train or Car number, where neither is available),
   v) flags to indicate the Train or call status, e.g. restricted manual operation,
   vi) OPO (T) Deadman Alarm call,
   vii) mayday emergency call,
   viii) radio base station location
b) differentiation by colour, size, flashing or other means, of emergency calls.
c) indication of zone(s) / section(s) selected for acceptance on the particular terminal, and thus the calling mobile location.
d) means of constructing or calling from a memory short-form, data messages and despatching them to Trains or hand portables.
e) means of determining to which zone(s) / section(s) group and all-calls within the Train user group should be transmitted.

4.2.2 Station Radio

A simple terminal is required for station radio systems. Operationally, although the majority of the communications from it will be to individual, groups or all station staff, the terminal shall provide means of calling other users by ID or (in the case of a Train) running number. It shall also display to the user the identity and user group of incoming calls and their status , i.e. emergency or routine.

At each station one or two users, usually the supervisors, when away from the office and terminal require their hand-portables to provide communications to other user groups as well as to other station staff on a one-to-one or group basis. Most station staff however require only to call the local terminal.

Station staff hand-portables shall provide emergency call facility to their terminal and in the case of the hand-portables with the ability to call beyond their user group also send emergency calls to, for example, the Line Controller.

4.2.3 Depot Radio

The system shall enable the duty depot manager and shunter to call Depot staff with hand-portables individually or as a group from terminals in the Depot office or similar control locations. They shall also have the ability to call and receive calls from Trains as individuals or a group, although because Trains, when in the Depot, do not carry a meaningful running number they also may need to be addressed (in the case of an individual call) by Car number. The Depots, although having a control point for radio which is local may be largely considered as an additional two zones / sections on the running line.

Most of the hand-portables supplied for the Depot staff are required only to provide communications to Trains, and within their own user group (operationally there will be one or two user sub-groups within each Depot). One or two hand-portables will be required to provide communications to destinations outside the Depot user groups, for example to the line controller. All hand-portables shall provide emergency call facility to whatever destinations they are able to address.

4.2.4 Engineers Radio

Engineers radio encompasses a number of sub-groups requiring communications within their own group, between sub-groups, to a signal operations manager's terminal in the Northern Line Main Control Centre, to the Line Controller or to any senior signal operator. A requirement for additional terminals at different locations is likely to exist in the future.

Most hand-portable users will require to communicate with all other hand-portable users within the sub-groups as a group or their control. A limited number of hand-portables with the capability of calling other hand-portable holders in the other engineering sub-groups in addition to other user groups shall be provided. All hand-portables shall be capable of sending emergency status calls to their control point, and on the higher specification hand-portables, emergency calls to the line controller if operationally necessary.

The Contractor shall provide a system capable of meeting the needs of engineers who may work in up to four geographically separated groups, each of which may split down further. The concept broadly being of four working parties, working on up to four separate tasks, reporting back to the engineering works controller at a common co-ordination point. The communications requirement is thus seen to be mainly within the groups. Groups may sometimes work in the same location and conversely members of a given group may on occasions need to work geographically separated from the rest of their groups.

4.2.5 Revenue Control Radio

A small number of revenue control staff communications via mobiles on the Trains and in stations. They require to talk to each other on an individual basis or their

control centre which would be equipped with a "simple" terminal. This shall be capable of displaying the identity of incoming calls, and user group although it is not expected that the revenue control centre will receive calls from outside its user group (own hand-portables) often. The terminal shall also be capable of differentiating emergency call status incoming by flashing of display and audible warning or other agreed method, and shall also provide means of inputting selection for individual calling (by number) or direct selection by hand-portable holder name. This is operationally practical only because of the small number of users in this group. The control terminal is required also to provide means of group calling.

4.2.6 Line Management

This group of users consists of passenger services department officials who working from bases at various stations move about the line as required to deal with problems and regulate the train service. They require no fixed control point radio terminal / control as such but require their hand-portable to communicate with a number of control points. The principal ones of these are:

a)	senior signal operators	-	Northern Line Main Control Centre
b)	Line Controller	-	Northern Line Main Control Centre
c)	stations or station groups	-	
d)	Depots	-	
e)	duty operations manager	-	Northern Line Main Control Centre

Additionally they require to call Train Operators (usually on an individual basis, by running number) and to call each other on a group or individual basis.

In the event that the station-based senior signal operators positions are manned (in an emergency) the section / zones of Train radio communications are to be devolved from the line control room to local "line-side" positions which will be staffed only for the situation. They also will represent another destination for calls from Northern Line management hand-portables.

Note: Where the required location for one of these station-based senior signal operators coincides with a station radio terminal one device may serve both functions. Where it does not a separate terminal having full facilities will be required.

4.2.7 Emergency Services

4.2.7.1 British Transport Police (BTP) No. 8 Area

Currently, the base stations, common control equipment and control terminals for this user group, which will be propagated with the trunked channels but outside the trunk in respect of signalling and switching, are already provided and working though only into the station leaky feeder systems.

The Contractor shall extend coverage of this VHF high band channel beyond the stations and into the running tunnels. Coverage of the running lines beyond the tunnel sections is not required as the police have a separate aerial propagated channel serving the open areas through which the Northern Line passes. The extension of coverage into the tunnels shall be undertaken - and this affects principally the design of the propagation infrastructure to be supplied by the Contractor - in such a way that certain operational features that police currently have are not undermined. Their system consists of in excess of a hundred station based radio base stations operating with physical isolation between their zones (the stations). The Contractor in providing contiguous coverage through the tunnels is by definition asked to undermine this isolation. This shall be done in such a manner as:-

a) minimises any overlap problems (the base stations are not equipped with high stability oscillators)

b) does not destroy the call (geographically) source information produced by the association of the received signal with a particular base station that allows a display of the railway station that a hand-portable is calling from.

The Contractor shall extend this but in such a way as allows the staff in the Police Control Room to continue to see the location of their officers within reasonably defined and controlled limits (e.g. perhaps station and half way to the next station(s) in all directions)

4.2.7.2 London Fire & Civil Defence Authority (LFCDA)

Like the police, this service currently has station only coverage of stations where Section 12 of the Fire Precautions Regulations are in force with their conventional UHF channel. A base station at each station similarly feeds into a combiner / splitter and hence the station leaky feeder system.

Unlike the police, the LFCDA base stations are not landlined back to a control room but function as independent free-standing, carrier controlled talk-through base stations. They provide communications between hand-portables carried by the firemen into the station and others at the station entrance when the need arises.

The Contractor shall extend the coverage of the LFCDA channel through all the running tunnels of the Northern Line. The LFCDA have special requirements for the operation and functionality of their system once it ceases to be a set of independent isolated base station areas. The Contractor shall extend in effect the coverage of each station system to a point half-way to the next station. At some stations a limited extension of the station radio system into the tunnels does exist, principally for the extension of the coverage of the station staff channel to cover points and signals. These so called "tunnel extension loops" do not destroy the UHF isolation which currently exists between stations and the LFCDA base stations are not therefore of a stability suitable for quasi-synchronous operation.

The base stations are Storno CQF9000 and due to modification with self-test circuits unsuitable for internal addition of high stability oscillators.

The LFCDA, apart from requiring that coverage throughout the tunnels should not be impaired by beats between non-quasi synchronised base stations, have further requirements concerning the linking and interworking of these base stations. As a result the Contractor is required to provide means whereby the base stations can be coupled into expandable talk-through groups which may themselves be merged into larger groups or left separate according to the emergent commonality or lack of it in the incident the LFCDA are attending.

The Contractor is required to agree with the Company a jointly satisfactory solution which meets the LFCDA's requirements within the limits imposed by the technology of their hand-portables.

5.0 RELIABILITY, AVAILABILITY, MAINTAINABILITY AND SAFETY (RAMS) REQUIREMENTS

The Contractor shall supply a Final UHF Trunked Radio system shall that meets the reliability, availability, maintainability and safety requirements set out in Schedule 4.

6.0 FINAL UHF TRUNKED RADIO SYSTEM PARTICULAR TECHNICAL REQUIREMENTS

6.1 GENERAL

The Contractor shall comply with the requirements of Schedule 4, section 2.2 in the design of the Final UHF Trunked Radio system. The Contractor also shall produce a functional design specification (FDS), following a comprehensive study of Schedule 6, Part C.

The FDS shall be a description of the system that the Contractor would supply in response to Schedule 6, Part C. It will explain how that system will meet the operational and technical requirement. By means of text, drawings and diagrams it will convey sufficient design information to allow the Project Manager to review the suitability and competence of the solution proposed. In general the information given shall be of a design to system component level and of its intended placement and distribution about the railway.

The Contractor shall ensure the following areas of concern are addressed within the FDS:-

a) expansion and up-grade paths to include expansion of the system to other lines,
b) seamless coverage and hand-over arrangements,
c) geographically-based receive zones for Trains,
d) interface with existing ((especially and proposed (multi-functional control panel)) Trainborne Equipment (OPO(T),

e) suitable terminal displays,
f) input to the propagation infrastructure of emergency service base stations,
g) stated field strengths,
h) connection of logging recorder to the total trunked system.

In order to facilitate evaluation, the Contractor shall as far as is practicable present an FDS with the same structure as Schedule 6, Part C.

It is the responsibility of the Contractor to carry out surveys in all areas to form the basis of their design. This shall include cable routing throughout track and station as well as locations for housing equipment. The Contractor shall be responsible for the seeking of approvals from the Company for use of any equipment rooms and environmental/architectural approval of any installation works within public view.

6.2 MAIN SYSTEM CONTROL

This shall have initial capacity for the Northern Line with potential capacity for all lines. There will be 10 channels available to cover all lines. Four of these are currently in use for station radio systems, the remaining six are the subject of a provisional offer by the radio agency, and the proposed frequency / channel implementation plan shall take account of this.

The MSC may be centrally located at one or more of the Company's main telephone exchanges (i.e. Baker Street or Embankment) or communication equipment rooms at Euston and Embankment. Its principal function is to provide switching and routing for LSCs and local terminals, channel allocation, system maintenance and management.

6.2.1 Operator Interfaces

All terminals shall have the ability of displaying all screen presentations used on the system. The appropriate screen giving emphasis to his particular function shall be selectable by the operator.

Interfaces shall be provided for the following users. It is anticipated that each will be provided with :-

a) a colour VDU and "mouse" or a colour touch screen, and a keyboard are required to enable the operator to log on and take control of the required sections/zones onto the particular terminal. Secondly, they allow select and reply to calls and the assembly of short data messages (SDM) for dispatch.
b) It is anticipated that a personal computer will form the base of each operator position, however there is no obligation intended for the contractor to provide personal computer based terminal equipment.
c) a desk-top microphone and loudspeaker, plug-in headset with boom microphone or plug-in handset will be required to receive and reply to calls.

The interface between the Northern Line Main Control Centre and Northern Line Emergency Control Centre terminals and the system shall be such that the functionality of the terminals can be emulated by a Northern Line Main Control Centre and Northern Line Emergency Control Centre communications system in the future.

6.2.1.1 Senior Signal Operators Terminals

The Operators require a VDU presentation with a clear uncluttered layout tailored to the railway requirements and operating practices. The operator interface shall utilise keyboard, mouse, touchscreen or a combination of these. When the display screen normally associated with one operators position is diverted to another, the receiving screen shall by splitting or partial superimposition be capable of showing the two sets of information. The senior signal operators screens although capable of showing emergency calls will not need to invite the senior signal operator to reply since these calls will be dealt with by the Line Controller.

The senior signal operators' terminals shall be configurable so as to accept 1/C calls from any selection of base stations, when a Train selects "call senior signal operator". This configuration must be simply achieved from the Line Controller's or senior signal operator's terminal, or via a data link from another system.

The system shall permit a variable number of senior signal operators to be logged on to the system but it shall ensure that all areas are always covered. This configuration will similarly define the area covered by a call to "all Trains or Existing Trains" or similar.

6.2.1.2 Line Controllers Terminals

As for 6.2.1.1 but calls and alarms directed to the Line Controller only, except when senior signal operators terminals are unmanned or diverted to Line Controller. This terminal shall be able to select and display over and above its usual function, any one (or more, within the limits of reasonable legibility) of the senior signal operators screens.

6.2.1.3 Network Management

This shall be a VDU to allow set-up of talk groups, logging facility, storm plans (pre-programmed reconfigurations of talk groups for use during incidents or emergencies etc.). It shall be configured to allow call logging to a disk drive or printer. This terminal shall also facilitate the collection of statistical data for traffic level analysis and prediction.

6.2.1.4 Maintenance Terminal

This shall monitor the condition of all bases, LSC, MSC and the associated transmission, including power supply units. Alarms shall indicate the status of the failure i.e. urgent, non-urgent etc. Where 'urgent' is defined as a fault which reduces the capacity or affects the operation of the system, and 'non-urgent' indicates failure of a back-up or standby. Monitoring of the RF infrastructure shall also be provided without recourse to tunnel-based active equipment.

6.2.1.5 Emergency (Evacuation) Remote Terminals

In certain circumstances there will be a need to evacuate the Northern Line Main Control Centre at which the Line Controller and senior signal operators are located. In this event replication of the Northern Line Main Control Centre Radio facilities are required at the remote location, this shall take the form of several terminals displaying all calls including those of an emergency nature.

This facility must not depend upon the integrity or existence of the Northern Line Main Control Centre. It must be able to take control autonomously.

6.2.2 Ancillary Equipment & Interfaces

6.2.2.1 PABX Interconnect

This shall be achieved across the Company's MD110 exchange switches and between the MSC and LSCs in such a way as to provide maximum redundancy by distribution. The number of lines required shall be determined from projected traffic levels and user requirements. The contractor shall provide the means to restrict access to the PABX in a structured way for certain users. For example; no access, internal calls only, national, international etc. It shall be possible for access levels to be configured over the air-interface.

6.2.2.2 Data Logger

This shall record all call requests, set-ups and clear-downs, and other system events, including sufficient data as to enable ready access to the relevant voice recording.

6.2.2.3 Logging Audio Recorder

To monitor all traffic on the trunk with easy recall by time and callsign, tapes or disks shall require changing no more than once in every 36 hours, alarms shall be displayed on relevant terminals prior to expiry of the tapes / disks. There shall be one recording/replay device located in or adjacent to the Northern Line Main Control Centre.

6.2.2.4 Simulator

This shall enable training to be carried out for Line Controllers, senior signal operators, and others. It is to be independent from the trunk but simulate functions of both Line Controllers and mobile displays on a personal computer. This shall be separate from the cab simulator which is specified elsewhere.

6.2.3 Uninterruptable Power Supply (UPS)

All equipment including MSC and terminals shall be backed by UPS to provide for 4 hour standby supply, indication of general failure shall be to the Line Controller, with specific fault information(e.g. mains loss, battery high/low etc.) being sent to the maintenance terminal.

6.3 LOCAL SYSTEM CONTROLLER (LSC)

These shall provide switching and routing of calls, base station control, some PABX interface etc., at a level between the infrastructure and the MSC.

6.3.1 Operator Interfaces

At this level Operator interfaces are required in the control rooms of the following users.

6.3.1.1 Station Supervisors Terminal

A simple terminal of suitable durability with facility to display identity of incoming callers is required, except at designated stations, see 6.3.1.3.

6.3.1.2 Depot Managers Terminal

A full facilities terminal is required.

6.3.1.3 Station-Based (Emergency) Senior Signal Operators Terminal

A full facilities terminal providing the same type of screen presentation as for the senior signal operators is required at up to 18 locations along the whole line. Where this is located in a station supervisors office, it shall replace the supervisors simple terminal.

6.3.1.4 Revenue Controllers Terminal

A simple terminal of suitable durability with facility to display identity of incoming callers is required.

6.3.1.5 Engineers Controllers Terminal

These shall be simple terminals with facilities to display the identity of incoming callers . These shall be located at the line service centre (for Traffic Hours use) and the engineering works control centre (Engineering Hours use).

6.3.2 Uninterruptable Power Supply (UPS)

All equipment including the local system controller and the terminals in 6.3.1 are to be backed to provide for 4 hours standby. Indication of general failure shall be presented to the relevant controller, with specific fault information to the maintenance terminal.

6.4 FIXED-SITE BASE STATIONS

The Contractor shall supply the items listed below which shall be of a rugged construction suitable for use in communication equipment rooms which may or may not be protected against dust and water ingress. They shall be protected to IP54 rating of BS EN 60529 as a minimum and if required further protected against the environment.

These shall be installed in a number of communications equipment rooms depending on the design of the propagation infrastructure. All these rooms are at stations though some are to be installed at platform level and others at the top (booking hall) level of the station. Surface stations may not have equipment rooms, and those that do will not be of the standard of sub-surface stations.

6.4.1 Transceivers

A number (depending upon the anticipated traffic levels) will be mounted together in a common rack at each base station site. The technical characteristics are not specified here as they are considered to be determined by the overall system performance requirements.

6.4.2 Combining / Splitting

Because of the requirement for frequency agile transceivers, hybrid combining/splitting shall be provided for the total number of trunked channels used at any one location. A combination of hybrid for trunked bases and cavities for the emergency services should be considered to ensure minimum power loss. It is desirable that the combining equipment be rack mounted and ideally accommodated within the same enclosure as the transceivers.

6.4.3 Emergency Services Interface

The combining and splitting arrangements at all base station sites shall provide separate TX and RX ports for connection to emergency service transceivers

(provided or to be provided by others) for the services listed under 4.2.7. It should be noted that the emergency services transceivers that are already installed have an RF power output limited to 6 W. Handportables used by the LFCDA are of the intrinsically safe type, and therefore have a power output of 1W.

6.4.4 Uninterruptable Power Supply (UPS)

The Contractor shall provide a UPS delivering an appropriate DC supply for 4 hours to (principally) transceivers and any other co-sited peripherals, in the event of a mains failure. The output or mains fail alarm, with specific fault information, from this UPS shall be taken for display at the maintenance terminal (6.2.1.4) and a general alarm to the station supervisors terminal.

6.5 PROPAGATION INFRASTRUCTURE

An infrastructure capable of propagating bands used by all private mobile radio and emergency services up to 500 MHz shall be provided over the entire line using leaky feeder/radiating cable. The leaky feeder or radiating cable shall not be installed in any way that may cause its long or short term performance to be affected. It is current practise, to avoid cables becoming screened, buried, or immersed in water, to install cable on stand-off LSNH clips. Particular attention should be paid to the security of these fixings in respect of the retention of the cable. The infrastructure shall employ no tunnel-based active equipment. Irrespective of the level of the sub-division in the propagation infrastructure (e.g. were every station to be a base station site); the movement of mobiles across the RF boundaries at full line speed shall cause no disruption to the continuity of radio calls requested or then in progress. The Contractor shall consider any potential difficulties of handover associated with the trunked systems and use appropriate techniques to achieve a solution.

6.5.1 Running Line

All parts of the running line, tube (tunnel) and open (above ground) and its sidings and crossover shall be served by leaky feeder/ radiating cable producing a signal level of 35 dBuV/m at 500 MHz with the objective of ensuring a call "success rate" in excess of 99.9%, assuming a random distribution of mobiles (Trains and hand-portables). A "successful" call being defined as one wherein a signal to noise ration of 12 db SINAD is established to or from the mobile for a period of 10 s.

6.5.2 Stations

All the sub-surface stations on the line of which coverage by this system is required are currently equipped with leaky feeder networks. It is required that these networks are re-utilised for this system and the necessary connection from the base station sites (6.4) or other suitable parts of the infrastructure be provided. The Contractor shall be responsible for ascertaining the integrity of the existing station leaky feeder network and the correction of any short-comings in that

network. To reciprocate the minimum talk-back power from a handportable, the networks have been designed so that an RF input of 1W will achieve a minimum field strength throughout all the station of 25 dBuV/m at 450 MHz.

6.5.3 Disused Stations, Shafts etc.

The new cable network shall be extended to cover all areas of all disused stations, shafts, passages and tunnels which are accessible from the running tunnels, to the same standards as are applied to stations.

6.5.4 Depots

Coverage shall be achieved by an aerial so mounted and of such type as to provide satisfactory coverage throughout the Depot and its carriage sidings but with coverage beyond the perimeter reduced to a technical minimum. This technique has been successfully used for the Depots' existing VHF systems. It is suggested that the trunked system aerial should be located adjacent to this existing VHF aerial.

6.6 INTERCONNECTION

This part of Schedule 6, Part C describes the transmission paths either required , or in some cases existing, between various non co-sited elements of the Final UHF Trunked Radio system.

6.6.1 MSC / LSC "Tie-Lines"

Intercommunication between elements of the system will be implemented by the Contractor. Up to twelve fibres within any cable in the optical fibre cable network being supplied under this Contract may be utilised for this purpose.

6.6.2 MSC Local Audio Interconnect

It is anticipated that the MSC will be co-located at or adjacent to one of the Company's telephone exchanges. Local audio interconnect shall be undertaken by the Contractor and entail connection into the Company's Ericsson MD 110 exchanges through which connections to the terminals (operator interface) will be achieved.

6.6.3 LSC / Fixed-Site Base Stations "Tie-Lines"

In the event that the LSC is not co-located with the base station, the fixed path to the base station sites (and in any case beyond the local exchange) shall be provided by the Contractor.

6.6.4 LSC Local Audio Interconnect

It is anticipated that these paths from the LSC to local terminals (6.3.1) can be provided by the Company's own transmission system. However, to enable this to be verified the Contractor shall indicate the requirements.

6.6.5 Fixed-Site Base Station to Propagation Infrastructure RF Interconnect

Appropriate runs of low-loss coaxial feeder shall be provided at all base station sites (to link combining equipment to trackside leaky feeder), and all sub-surface stations (to link trackside leaky feeder to and from station systems).Special consideration should be given to connection of existing emergency services base stations. The Contractor shall provide suitable low loss solid screened RF co-axial cables for this purpose. The cable shall meet the Company's requirements as referred to in 6.5.

6.7 MOBILES

Mobiles shall be provided in the form of fixed installations for the Trains, handportables, and transportables for other Company users.

6.7.1 Trainborne Equipment

A set of Radio Trainborne Equipment comprising the following shall be provided for each of the cabs of the Train as specified in Schedule 6, Part A. The Contractor shall be responsible for the installation of this equipment in agreed location(s). The Radio Trainborne Equipment shall be designed, constructed, tested and installed in compliance to the requirements for Trainborne Equipment as specified in Schedule 6, Part A.

6.7.1.1 Transceiver

A UHF trunked transceiver capable of operating in full or semi-duplex mode shall be provided.

6.7.1.2 Control Head

The functions of a control head shall be provided by the cab controls specified in Schedule 6, Part A section 15 (sub-section 154).

6.7.1.3 Aerial

A UHF aerial of a type and form to be determined by the system requirements shall be provided. Within these constraints the Contractor is required to investigate the optimum location and aerial type to achieve the best and consistent coupling to the trackside leaky feeder/radiating cable.

6.7.1.4 External Interfaces

The transceiver shall have provision for interfacing to various Train functions, normally demanding dry closures, such as OPO(T) Deadman Alarm trigger, emergency address enable etc.

6.7.1.5 Power Supply

The Radio Trainborne Equipment shall be powered from the Trains' Control Supply.

6.7.2 Hand-Portables & Transportables

A quantity of UHF trunked hand portables and transportables and accessories as follows shall be provided. The Contractor shall make available, at an appropriate time, examples of suitable radios for appraisal by the end user.

6.7.2.1 Hand Portables

Two types of hand portables shall be supplied by the Contractor; a basic type without keypad enabling the user to call one or two pre-assigned destinations, and a full-facilities version with keypad. An emergency call facility shall be provided on both types. The hand portable shall have sufficient bandwidth to permit their use on any channel within the Company allocation.

It is highly desirable that they shall be able to switch to a direct mode of operation on a simplex channel which may fall anywhere within the UHF private mobile radio allocation. There shall be the facility to call the portable back into the trunk should this be required.

The hand-portables should be programmable via the air interface.

6.7.2.2 Transportables

The transportables to be supplied by the Contractor shall be equipped with full facilities as the second type of hand portable described above and direct mode (with call back see 6.7.2.1).

6.7.2.3 Chargers

The Contractor shall supply single and multi-way chargers for the handportable batteries in a quantity to be agreed with the Project Manager. The transportables shall be provided with integral batteries and chargers thus enabling mains operation.

6.7.2.4 Batteries

The Contractor shall supply one battery and a single spare each hand portable and a spare battery with each transportable.

6.7.2.3 Lapel Microphones/Aerials/Carrying Cases

The Contractor shall provide lapel microphones, aerials and carrying cases with the hand portables and transportables in quantities to be agreed with the Project Manager.

6.8 SYSTEM CAPACITY

6.8.1 The traffic capacity for which the system is to be designed shall be agreed between the Company and the Contractor during development of the FDS. It shall be based upon measured and predicted traffic and any relevant experience.

6.8.2 The management system shall measure the actual traffic in such a way as to facilitate confirmation of the adequacy of the system capacity.

6.8.3 The system shall be designed and constructed so as to facilitate expansion of capacity in any area if it becomes necessary.

6.9 SCADA & DIAGNOSTIC REQUIREMENTS

The Final UHF Trunked Radio system and sub systems employed shall have their own diagnostic system built into their control computer system.

Any loss of communications facilities shall be indicated in general terms to the operator's position to which they apply and to the engineering controller position. Further, more detailed information about the equipment failures shall be presented to the engineering controller and system's technician.

The self diagnostic system shall provide the engineering controller with an audio alarm and a visual warning on the control VDU, detailing the fault and after acknowledgement, provide a hard copy printout of the fault, without interference to the systems operation.

The control system shall also be capable of monitoring the condition/state of trackside cable infrastructure and station housed radio equipment and systems, landlines, and all control equipment, gathering diagnostic data for fault location and maintenance purposes and shall allow searches of the data according to varying criteria. All critical system operating criteria shall be monitored.

Failure of the diagnostic system shall not result in the failure of the Final UHF Trunked Radio system to continue to operate.

6.10 FIBRE OPTIC TRANSMISSION OF FINAL UHF TRUNKED RADIO SYSTEM DATA

6.10.1 Introduction

a) The Contractor shall ensure that the Final UHF Trunked Radio system is fully integrated in to the optical fibre system specified in Schedule 6, Part F to relay between Final UHF Trunked Radio system Sites the audio, data and RF channels which are required to operate the Final UHF Trunked Radio system.

b) The Contractor shall supply the transmission equipment necessary to utilise the fibre optic network allocation of a maximum of 12 fibres. The transmission equipment shall be housed within the Final UHF Trunked Radio system cabinets and shall be interfaced to the optical fibre cable network via the fibre distribution panel/cabinet installed within each Site communication equipment room.

c) The Final UHF Trunked Radio transmission system shall be configured to provide very high circuit availability and to limit to a minimum the effects of common mode equipment and cable failure on overall system operation.

d) The Contractor shall provide within each Site communications equipment room and the Northern Line Main Control Centre and Northern Line Emergency Control Centre all equipment, cables and materials necessary to complete the works to achieve overall system operation.

6.10.2 Network Configuration

The transmission network shall be configured in a ring topology using equipment and fibre route redundancy, as appropriate to fulfil the following failure criteria:-

a) the system shall automatically reconfigure and remain in operation on single optical fibre cable failure, failure of the associated terminating equipment or associated power supply system,
b) if a complete Site fails all other Sites shall remain in operation,
c) if the Northern Line Main Control Centre fails all other Sites shall remain in operation in conjunction with the Emergency Control Centres,
d) if dual main optical fibre cables fail all services shall be maintained to all Sites except those directly served by the failed cable section,
e) the system shall be designed to avoid common mode failure resulting in catastrophic loss of communications circuits at any Site.

6.10.3 Channel Performance

The Contractor shall ensure that:-

a) the error performance of each end to end data channel shall exceed the requirements of ITU-T recommendation G-821 with the error allocation apportioned to the appropriate section length in accordance with G921

such that a maximum BER (Bit Error Ratio) of $1:10^{-9}$ is not exceeded over a 1 month period,

b) each end to end speech channel shall have a noise performance to meet the requirements of ITU-T, G712.

6.10.4 Channel Interfaces

The Contractor shall ensure that:-

a) the characteristics and interfaces for each speech and data channel shall conform with the appropriate ITU-T recommendations,

b) The Contractor shall ensure that suitable electrical interfaces are provided to operate over the cable lengths from communication equipment rooms to other equipment room areas.

6.10.5 Expansion

The transmission equipment at each Site shall be capable of 100% expansion of the installed audio and data channels within the rack space and back plane wiring provided within the equipment cabinet.

6.10.6 Channel Terminations

All channels shall be terminated within a mini distribution frame installed in the transmission equipment cabinet with all terminations readily accessible for maintenance access.

Interface connections for speech circuits shall be arranged via line and equipment side terminals of the insulation displacement type. Data channels shall be interfaced via polarised plug and socket connectors.

6.10.7 Network Management

The Contractor shall ensure that:-

a) a comprehensive fault monitoring and alarm diagnostic system shall be provided for the complete transmission network which includes all equipment and associated fibre optic cables.

b) the network management system shall be integrated with the alarm diagnostic system appropriate to the Final UHF Trunked Radio system and shall include for the transmission network all applicable functions detailed in 'supervisory alarm monitoring and diagnostic system' in Schedule 6, Part C, section 6.9.

c) the network management facility shall be menu driven and shall also provide:-

   i) circuit availability data and bit error ratio statistics for each individual channel at 2Mbit/s.

ii) access to all control and set-up parameters which are available to the user for network configuration, testing, equipment interfaces and system operation.

iii) database facilities which shall provide to the user access to all appropriate drawings, documents and system data which is required for system maintenance and operation.

6.10.8 Engineering Order Wire

a) The Contractor shall supply an engineering order wire telephone facility which shall interlink each communication equipment room location to provide a telephone channel via the transmission system for the purpose of equipment set up and maintenance operations,

b) The engineering order wire shall be configured with the following facilities:-

i) it shall operate as a service channel which shall be configured so that the communication circuit is maintained irrespective of which transmission path is in operation,

ii) the engineering order wire omnibus circuit shall provide individual outstations with the facility to selectively call other communication equipment room locations and the group call of all outstations simultaneously,

iii) the engineering order wire facility shall be capable of being expanded to a total of 100 locations with station calling established by 2 digit push button, DTMF dialling,

iv) a telephone handset shall be positioned at a suitable working height on the rack and recessed into the face of the equipment cabinet. The handset shall be provided with a retaining cradle,

v) in addition to the engineering order wire telephone installed in the equipment cabinets within each communication equipment room, an engineering order wire telephone shall be installed at the network management workstation within the Northern Line Main Control Centre and Northern Line Emergency Control Centre,

vi) the idle channel noise shall not exceed -50 dBm0p for the worst end to end circuit,

vii) the ringing tone level at each Site shall be adjustable and shall be fully audible within the communication equipment room with the doors of the engineering order wire equipment cabinet closed.

6.10.9 BABT Approval

The transmission equipment shall be approved by BABT (British Approvals Board for Telecommunications) in accordance with the requirements of OFTEL (Office of Telecommunications).

6.10.10 Power Supply

The Final UHF Trunked Radio system's optic fibre transmission equipment at each Site shall derive its power supply from the Final Trunked Radio system's UPS as specified in sections 6.2, 6.3 and 6.4.

6.11 INTEGRATION INTO EXISTING COMPANY SYSTEMS

6.11.1 Installation

This section specifies the connection of the Final UHF Trunked Radio system to the Company's existing systems.

6.11.1.1 PABX Interconnect

The Contractor shall ensure that the MSC and LSCs readily interface with the Company's Ericsson MD110 telephone exchanges. The Final UHF Trunked Radio system controllers shall take account of the Company's internal telephone networks numbering scheme. The means of access between the telephone network and Final UHF Trunked Radio system is to be discussed.

6.11.1.2 Station Radio Infrastructure

The Final UHF Trunked Radio system shall utilise the existing leaky feeder network to provide coverage throughout the sub-surface (only) stations. At surface stations the Contractor shall, if necessary, augment the coverage provided by the trackside leaky feeder (of the trunked system) by the addition of aerials to suit local requirements.

6.11.1.3 LFCDA Base Station

Connection shall be made such that the existing coverage is maintained and extended into full coverage of the running tunnels at sub-surface stations.

6.11.1.4 BT Police Base Station

Connection shall be made such that the existing coverage is maintained and extended into full coverage of the running tunnels at sub-surface stations.

6.12 REMOVALS

6.12.1 The Contractor shall remove all parts of the redundant Enhanced Existing VHF Radio system including tunnel based equipment. It shall then be transferred to a place of storage or disposed as directed at the time by the Project Manager. Any equipment disposed of shall be dealt with in accordance with the relevant local authority and COSHH regulations. Removal of redundant equipment shall not

jeopardise or interfere with any operational system, unless previously agreed and authorised in writing by the Project Manager.

6.12.2 Where Company equipment is to be removed from Sites with restricted access, then the Contractor shall obtain the Project Manager's approval for disposal before commencing work.

7.0 LIST OF DRAWINGS OF REFERENCED DOCUMENTS

7.1 Contract Drawings and documentation are defined in Part J.

Table 7.1.1 a) Contract Drawings

Drawing Number	Title
2-9756/T23615	Commissioning Test Record (1988)
2-9754-T24080	Coburg Street Cable Terminations for RA 7570
2-9364-T23935	Coburg Street Extension Cables Schematic
2-9364-T23937	Coburg Street extension cables allocation
2-9364-T23936	Coburg Street Equipment Layout
2-9364-T19563	Coburg Street Control System Schematic
2-9756-T19565	Coburg St RA7570/02 Interface Rack
2-9756-T19559	Coburg Street Fuse Bay TR1
2-9756-T235 79	High Barnet 7/26 Base Station Fuse Bay
2-9756-T235 80	Coburg Street Base Station Fuse Bay
2-9756-T235 76	Coburg Street Base Station Fuse Bay
2-9756-T235 77	Morden 7/13 Base Station Fuse Bay
2-9756-T235 78	Edgware 7/23 Base Station Fuse Bay
2-9756-T235 81	Finchley Central 7/25 Base Station Fuse Bay
2-9756-T235 83	Euston Charing Cross 7/19 Base Station Fuse Bay
2-9756-T235 84	Charing Cross 7/18 Base Station Fuse Bay
2-9756-T235 85	Stockwell 7/17 Base Station Fuse Bay
2-9756-T235 86	Tooting Bec 7/14 Base Station Fuse Bay
2-9756-T235 87	Elephant & Castle 7/15 Base Station Fuse Bay
2-9756-T235 88	Old Street 7/16 Base Station Fuse Bay
2-9756-T235 89	Euston (City) 7/20 Base Station Fuse Bay
2-9756-T235 90	Belsize Park 7/33 Base Station Fuse Bay
2-9756-T235 91	Golders Green 7/21 Base Station Fuse Bay
2-9756-T235 92	Hendon Central 7/22 Base Station Fuse Bay
2-9756-T23724	Highgate Depot 8/01 Base Station Fuse Bay
CT16847C	Golders Green Channel Change Beacon Location
3-9756-T 21098	Collier Wood Channel Change Beacon Location
3-9756-T 24052	Brent Cross Channel Change Beacon Location
3-9756-T 24053	Hampstead Channel Change Beacon Location
3-9756-T 24062	Tooting Broadway Channel Change Beacon Location
3-9756-T 24063	South Wimbledon Channel Change Beacon Location

3.9756.T18644	Kennington to Morden
2.3256.T18898	Kennington to Mornington Crescent
2.9756.T19160	Morden Base Station (B/S)
2.9756.T24228	Colliers Wood B/S
2.9756.T19159	Tooting Bec B/S
2.9756.T19158	Stockwell B/S
2.9756.T18615	Elephant and Castle B/S
CT18616	Old Street B/S
CT18618	Euston City B/S
2.9756.T18617	Charing Cross B/S
2.9756.T18619	Euston (CX) B/S
2.9756.T19364	Belsize Park B/S
2.9756.T19155	Golders Green B/S
2.9756.T23731	Highgate Depot B/S
CT18594	Kennington to Camden (City)
CT15858	Chalk Farm to Mornington Crescent
CT19153	Archway B/S
2.9756.T19156	Hendon Central B/S
2.9756.T19157	Edgware B/S
2.9756.T18646	Belsize Park to Edgware
2.9756.T19151	High Barnet B/S
2.9756.T19152	Finchley Central B/S
2.9756.T18645	Camden to High Barnet
6235 11 00 N001 000 00	Drg 90-901

Table 7.1.1 b) Documentation -

LUL, Philips or Storno Ref No.	Title	Equipment
6176-SP-102464-2	Technical Specification	Storno RA7570 Control System and Base Station Set Up Procedure
617-SP-102464		Control Rack Audio Block Diagram Figs 1 & 2
6176-SP-102863-1	Set Up	for Type 79 Repeater Amplifier System
	Operator Manual	Campus Radio (Philips Depôt radio)
	System Manual	Campus Radio (Philips Depôt radio)
COS 93248	Contents List & Index	LUL Campus Radio
3513 538 0311	Document Index	COS 93248 London Underground Ltd
3513 538 0311	Block Schematic	Campus Radio System
3513 537 0221	Rack Layout	Campus Radio Station
3513 537 0221	Block Schematic	Campus Radio Station
CT44062/000-999	Circuit Diagram	DC Power Distribution

CT44063/00-99	Assembly Drawing	240v a.c. Access Panel
CT44063/00-99	Circuit Diagram	240v a.c. Access Panel
CT60180/050-990	Circuit Diagram	DC Power Cable
3513 534 0045	Circuit Diagram	Standby Battery Housing
3513 534 0045	Assembly Drawing	Standby Battery Housing
3513 539 6031	Circuit Diagram	Standby Battery Cable
3513 537 4405	Circuit Diagram	Mod to M87 Remote Controller AC Mains Fail Alarm
3513 537 3403	Circuit Diagram	Modification to SPCX 1000 (LUL)
3513 537 3403	Assembly Drawing	Modification to SPCX 1000 (LUL)
3513 568 1058	Mod. Instruction	FX5000 with Tx Slave Relay 2 sheets
CT72199/19	Circuit Diagram	Mod to QT12 Plan Shelf CT57553
CT72179/41 Sht 1.1	Assembly Drawing	Mod to M87 Ops. Audio Board (AT28736) to disable mute circuit.
Sht 1.2		
AT28827	Assembly Drawing	Operator's RS232C Interface PCB Assy
	Descriptions	Section 3
3513 538 0311	System Description	Campus Radio System 23 sheets
	Test Procedures	Section 4
3513 538 0311	Campus Radio System	Test Procedures 27 sheets
	"Volume I"	Storno CCIR Tone signalling system and unit drawings
CT15747	Assembly for Line Interface Rack RA7570F/00	Train Radio Equipment
CT15748	Rear View of Control and Interface Racks	Train Radio Equipment
3-9765-T22758c	Confidence Tone and Auto-Acknowledge Generator	Train Radio - Control Rack Equipment
7570-1-1	Circuit Diagram	7570M/00
7570-1-19	Control Panel CP681	7570/00 Remote Control Equipment
	Table total qty per line	Base Stn, power feeds, repeaters etc.
7570-4-1	AF Routing Plan	CAF680-7570
D110 092	Layout Service Panel	MP681
D109 711	Service Panel	MP681

D109 094/2	Layout DC functions Service Panel	MP681
X401.041	Diversity Unit parts list	DV682
D400.921/3	Diversity Unit circuit	DV682
	District Line	Table of unit locations
	Piccadilly Line	Table of unit locations
	Bakerloo Line	Table of unit locations
	Central Line	Table of unit locations
	Jubilee Line	Table of unit locations
	Metropolitan Line	Table of unit locations
	Northern Line	Table of unit locations
7570-2-2	Assembly for RA7570/01a	
7570-11-25	System Description	CAF680-7570 LTE Trackside Control System (11 sheets)
750/029/4	Trim Reinforcing Plate	Videmech Ltd.
7570-3-1	Trackside Radio Control Scheme	CAF680-7570
7570-3-2	Commissioning Instructions	CAF680-7570 LTE Trackside Control System (11 sheets)
7570-11-32	Operating Instructions	CAF680-7570 (3 sheets)
7570-3-1	Parts List	System Layout CAF680-7570
7570-2-2	Parts List	Assembly RA7570/01a CAF680-7570
7570-7-12	Wiring Schedule for:	JP/01a on RA/01a 16 sheets
7570-7-14	Allocation of connectors to Junction Panels	RA7570/01
7570-7-10	Wiring Diagram	RA7570/01a
7570-2-14	Parts List	Assembly JP7570F/01
7570-7-8	Wiring Diagram	PS7570F/00
7570-2-11	Assembly	PS7570F/00
7570-2-11	Parts List	Assembly PS7570F/00 2 sheets
7570-6-18	Component Assembly	DP680-7570/00
7570-6-18	Parts List	Component Assembly DP680-7570/00
7570-11-26	Unit Description	Main System Controller TE7570F/01 3 sheets
7570-7-2	Wiring Diagram	TE7570F/01
7570-2-5	Parts List	Assembly TE7570F/01 2 Sheets
7570-1-4	Circuit Diagram	AA 7570M/03a & 04a
7570-6-11	Component Assembly	AA 7570M/03a & 04a

7570-11-7	Unit Description	Audio Mixer AA7570M/03a & 04a
7570-6-11	Parts List	Component Assembly AA7570M/03a & 04a 2 sheets
7570-1-28	Circuit Diagram	LC 7570M/01 & 02
7570-6-17	Component Assembly	LC 7570M/01 & 02
7570-11-23	Description and Specification	Audio Mute Unit LC 7570M/01 2 sheets
7570-6-17	Parts List	Component Assembly LC 7570M/01 & 02 3 sheets
7570-1-25	Circuit Diagram	VC 7570M/00
7570-6-30	Component Assembly	VC 7570M/00
7570-11-1	Technical Description	VOX Unit VC 7570M/00 3 sheets
7570-6-30	Parts List	Component Assembly VC 7570M/00 3 sheets
7570-1-18	Circuit Diagram	TP 7570M/00 & 01
7570-6-24	Component Assembly	TP 7570M/00 & 01
7570-6-24	Parts List	Component Assembly TP 7570M/00 & 01 2 sheets
7570-6-1	Component Assembly	RP 7570M/00
7570-11-1	Technical Description	Line Termination Unit RP 7570M/00
7570-6-1	Parts List	Component Assembly RP 7570M/00 2 sheets
7570-11-9	Technical Description	Multi-function Control Logic Card CF 7570F/00 2 sheets
7570-1-10	Circuit Diagram	CF 7570F/00
7570-6-6	Component Assembly	AA 7570M/00
7570-6-5	Parts List	Component Assembly CF7570M/00 2 sheets
7570-11-5	Technical Description	4 Watt Monitor Amplifier AA 7570M/00
7570-1-5	Circuit Diagram	AA 7570M/00 Audio Power Amplifier
7570-6-6	Parts List	Component Assembly AA 7570M/00 2 sheets
7570-1-17	Circuit Diagram	ST 7570M/00
7570-6-8	Component Assembly	ST 7570M/00
7570-11-19	Technical Description	5-tone Tone Encoder ST 7570M/00
7570-6-8	Parts List	Component Assembly ST 7570M/00 3 sheets
7570-1-13	Circuit Diagram	SU7570M/00

7570-6-7	Component Assembly	SU7570M/00
7570-11-12	Technical Description	BCD 5 digit Select Logic Card (for 5-tone)
7570-6-7	Parts List	Component Assembly SU7570M/00 2 sheets
7570-1-3	Circuit Diagram	SU7570M/01
7570-6-4	Component Assembly	SU7570M/01
7570-11-4	Technical Description	BCD 5 digit Binary Logic Encoder Card (for 5-tone) SU7570M/01
7570-1-7	Circuit Diagram	SU7570M/10, 11, 12
7570-6-6	Component Assembly	SU7570M/00
7570-6-6	Parts List	Component Assembly SU7570M/10/11/12 2 sheets
7570-7-6	Wiring Diagram	TE 7570/02
7570-11-27	Technical Description	2/4wire convertor and exchange line connect unit TE 7570F/02 2 sheets
7570-2-6	Parts List	Component Assembly TE 7570F/02 2 sheets
7570-1-12	Circuit Diagram	CF7570M/01
7570-6-17	Component Assembly	CF7570M/01
7570-11-11	Technical Description	Exchange Line Holding Card CF7570M/01
7570-6-17	Parts List	Component Assembly CF7570M/01 2 sheets
7570-1-3	Circuit Diagram	HU7570M/00
7570-6-7	Component Assembly	HU7570M/00
7570-11-12	Technical Description	2/4wire Hybrid Card HU7570M/00
7570-6-7	Parts List	Component Assembly HU7570M/01 2 sheets
7570-6-15	Component Assembly	LA7570M/01, 02, 03
7570-6-15	Parts List	Component Assembly LA7570M/01/02/03 4 sheets
7570-1-5	Circuit Diagram	AA7570M/02
7570-6-10	Component Assembly	AA7570M/02
7570-11-14	Technical Description	AVC Amplifier Card AA7570M/02 3 sheets
7570-6-10	Parts List	Component Assembly AA7570M/02 3 sheets
7570-1-7	Circuit Diagram	SU7570M/10, 11, 12
7570-6-6	Component Assembly	SU7570M/10-12

7570-6-10	Parts List	Component Assembly SU7570M/10/11/12 3 sheets
	"Volume II"	Storno CCIR Tone signalling system and unit drawings
	District Line	Table of unit locations
	Piccadilly Line	Table of unit locations
	Bakerloo Line	Table of unit locations
	Central Line	Table of unit locations
	Jubilee Line	Table of unit locations
	Metropolitan Line	Table of unit locations
	Northern Line	Table of unit locations
	Table, total qty per line	Base Stn, power feeds, repeaters etc.
7570-7-5	Circuit Diagram	Diversity Terminal TE7570/05
7570-11-28	Technical Description	20 channel diversity voting unit TE7570F/05 1 sheet
7570-2-7	Parts List	Assembly TE7570F/05 2 sheets
7570-1-15	Circuit Diagram	Diversity Unit DV7570M/00
7570-6-3	Component Assembly	DV7570M/00
7570-11-4	Technical Description	Diversity Comparitor DV7570M/00 2 sheets
7570-6-3	Parts List	Component Assembly DV7570M/00 2 sheets
7570-1-14	Circuit Diagram	Squelch Level Control LC7570M/00
7570-6-8	Component Assembly	LC7570M/00
7570-11-5	Technical Description	Squelch Level Control LC7570M/00
7570-6-8	Parts List	Component Assembly LC7570M/00 3 sheets
7570-1-16	Circuit Diagram	SU7570M/03
7570-6-12	Component Assembly	SU7570M/03
7570-11-8	Technical Description	Diversity Voted Indicator SU7570M/03
7570-6-12	Parts List	Component Assembly SU7570M/03 2 sheets
7570-1-8	Circuit Diagram	SU7570M/13/14/15
7570-6-13	Component Assembly	SU7570M/13/14/15
7570-6-13	Parts List	Component Assembly SU7570M/13/14/15 2 sheets
7570-1-2	Circuit Diagram	Mixer Amplifier AA7570M/00a/01a
7570-6-2	Component Assembly	AA7570M/00 & /01a
7570-11-6	Technical Description	Audio Mixer AA7570M/00/01

7570-6-2	Parts List	Component Assembly AA7570M/00/01 2 sheets
7570-1-6	Circuit Diagram	RP7570M/00 & 01
7570-6-9	Component Assembly	RP7570M/00 & 01
7570-6-9	Parts List	Component Assembly RP7570M/00 & /01 2 sheets
7570-7-7	Wiring Diagram	TE7570/07 2 sheets
7570-11-29	Technical Description	5-tone CCIR decoder TE7570F/07 5 sheets
7570-2-8	Parts List	Component Assembly TE7570F/07 2 sheets
7570-1-7	Circuit Diagram	PS7570M/00
7570-6-13	Component Assembly	PS7570M/00
7570-11-35	Technical Description	Power supply +24v to +5v, +12v & -12v PS7570M/00
7570-6-13	Parts List	Component Assembly PS7570M/00
7432-1-1	Circuit Diagram	DE7432M/00 & 01
7432-6-1	Component Assembly	DE7432M/01 2 sheets
7432-11-1	Technical Description	8085 uProcessor DE7432M/01 3 sheets
7432-6-1	Parts List	Component Assembly DE7432M/00 3 sheets
7432-1-10	Circuit Diagram	Tone Decoder SR7432M/01
7432-6-4	Component Assembly	SR7432M/01
7432-11-20	Technical Description	CCIR 5-tone decoder SR7432M/01 2 sheets
7432-6-4	Parts List	Component Assembly SR7432M/00/01 3 sheets
7570-1-8	Circuit Diagram	ID7570M/00
7570-6-14	Component Assembly	ID7570M/00 2 sheets
7570-11-10	Technical Description	CCIR 5-tone decoder ID7570M/00
7570-6-14	Parts List	Component Assembly ID7570M/00 2 sheets
7570-1-22	Circuit Diagram	SU7570M/06
7570-6-20	Component Assembly	SU7570M/06
7570-6-20	Parts List	Component Assembly SU7570M/06 2 sheets
7570-1-14	Circuit Diagram	CF7570M/02a
7570-6-15	Component Assembly	CF7570M/02a
7570-11-13	Technical Description	CCIR 5-tone decoder CF7570M/02a

7570-6-15	Parts List	Component Assembly CF7570M/02a 2 sheets
7570-1-16	Circuit Diagram	SU7570M/04
7570-6-16	Component Assembly	SU7570M/04
7570-11-14	Technical Description	2 digit binary encoder SU7570M/04
7570-6-16	Parts List	Component Assembly SU7570M/04 2 sheets
7570-1-6	Circuit Diagram	SU7570M/01/02/04
7570-6-6	Component Assembly	SU7570M/01/02/04
7570-6-6	Parts List	Component Assembly SU7570M/01/02/04 2 sheets
7570-1-20	Circuit Diagram	SU7570M/05
7570-6-19	Component Assembly	SU7570M/05
7570-11-34	Technical Description	RS232 interface card SU7570M/05
7570-6-19	Parts List	Component Assembly SU7570M/05
7570-11-30	Technical Description	Local Engineers Control Card MP7570M/00 2 sheets
7570-7-4	Wiring Diagram	MP7570F/00
7570-2-9	Parts List	Assembly MP7570F/00
7570-1-2	Circuit Diagram	SU7570M/03
7570-6-2	Component Assembly	SU7570M/03
7570-11-2	Technical Description	General purpose multi-function card SU7570M/03
7570-6-2	Parts List	Component Assembly SU7570M/03 2 sheets
7570-1-6	Circuit Diagram	IU7570M/00
7570-6-9	Component Assembly	IU7570M/00
7570-11-6	Technical Description	Multi-function interface card (engineer's audio) IU7570M/00
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7458-1-32	Circuit Diagram	Audio Power Amplifier CP7458M/06
7458-6-34	Component Assembly	CP7458M/06 2 sheets
7458-11-11	Technical Description	Audio Amplifier CP7458M/06 2 sheets
7458-6-34	Parts List	Component Assembly CP7458M/06 3 sheets
7570-1-11	Circuit Diagram	DU7570M/01
7570-6-10	Component Assembly	DU7570M/01

7570-11-8	Technical Description	Multi-function interface card (engineer's audio) DU7570M/01
7570-6-10	Parts List	Component Assembly DU7570M/01
7570-1-15	Circuit Diagram	SU7570M/02
7570-6-12	Component Assembly	SU7570M/02
7570-11-15	Technical Description	Tx Key lockout card SU7570M/02
7570-6-12	Parts List	Component Assembly SU7570M/02
7570-1-9	Circuit Diagram	DU7570M/00
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7570-11-7	Technical Description	Tx Key lockout card DU7570M/00
7570-6-11	Parts List	Component Assembly DU7570M/00 2 sheets
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7570-7-15	Circuit Diagram	SG7570F/00
7570-11-36	Technical Description	CCIR tone encoder SG7570F/00 3 sheets
7570-6-11	Parts List	Component Assembly SG7570F/00 2 sheets
7500-1-30	Circuit Diagram	IU7500M/01
7500-6-40	Component Assembly	IU7500M/01
7500-11-24	Technical Description	Memory Extension Card for 8085 uProcessor IU7500M/01
7500-1-52	Circuit Diagram	DE7500M/00
7500-11-28	Technical Description	8085 uProcessor DE7500M/01
7458-1-36	Circuit Diagram	Interface Unit for uProcessor I/O ports IU7458M/00
7458-6-24	Component Assembly	IU7458M/00
7458-11-75	Technical Description	Interface Unit for uProcessor I/O ports IU7458M/00
7458-6-24	Parts List	Component Assembly IU7458M/00 2 sheets
7458-1-8	Circuit Diagram	Address Decoder and Data Latch SU7458M/06
7458-6-9	Component Assembly	SU7458M/06
7458-11-80	Technical Description	Address Decoder and Data Latch SU7458M/06 2 sheets
7458-6-9	Parts List	Component Assembly SU7458M/06 2 sheets
7458-1-9	Circuit Diagram	Address Decoder for Diversity Panel SU7458M/07

7458-6-10	Component Assembly	SU7458M/07
7458-11-81	Technical Description	Address Decoder for Diversity Panel SU7458M/07
7458-6-10	Parts List	Component Assembly SU7458M/07 2 sheets
7432-1-3	Circuit Diagram	ID7432M/00
7458-11-3	Technical Description	5 digit display module with drivers ID7432M/00
7458-1-23	Circuit Diagram	SU7458M/09
7458-11-78	Technical Description	5-tone call encoder with display SU7458M/09
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7570-11-19	Technical Description	5-tone call encoder with display ST7570M/00
7570-1-23	Circuit Diagram	16 button keyboard KB7570M/00
7570-6-21	Component Assembly	KB7570M/00 2 Sheets
7570-6-21	Parts List	Component Assembly KB7570M/00 2 sheets
7500-1-13	Circuit Diagram	TT7500M/00/01
7500-11-3	Technical Description	ZVEI 2-tone transmitter TT7500M/00
7500-1-34	Circuit Diagram	DP7500M/01
7500-23-1	Technical Description	Storno Systems Monitor SP7500/00 16 sheets
7570-7-9	Wiring Diagram	TE7570F/00
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7570-11-38	Parts List	Mod. Kit to modify RA7570/01 for deversity timeout indication and cleardown.
7570-1-4	Circuit Diagram	TU7570M/00a
7570-6-3	Component Assembly	TU7570M/00a
7570-11-3	Technical Description	Diversity Channel Timer Card TU7570/00a 2 sheets
7570-6-3	Parts List	Component Assembly TU7570/00a 3 sheets
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7570-2-1	Assembly for	RA7570/00
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7570-2-1	Parts List	Component Assembly RA7570/00
7570-2-3	Parts List	Component Assembly RA7570/02
7570-7-13	Allocation of Junction Panels for:	RA7570/00
7570-7-11	Wiring Schedule	JP7570/00 on RA7570/00 6 sheets
7570-2-13	Parts List	Assembly JP7570/00

7570-11-33	Technical Description	Rack Mounted Line Interface Unit TE7570F/00
7570-2-4	Parts List	Assembly TE7570F/00 2 sheets
7570-1-1	Circuit Diagram	RP7570M/00
7570-6-1	Component Assembly	RP7570M/00
7570-11-1	Technical Description	4 wire DC line interface card RP7570M/00
7570-6-1	Parts List	Component Assembly RP7570M/00 2 sheets
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7500-1-17	Circuit Diagram	DU7500M/00
7500-6-16	Component Assembly	DU7500M/00
7500-12-2	Test Procedure	DU7500M/00 2 sheets
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7570-11-17	Modification Instructions	CP681-7197/1 to Spec. 7570
7570-11-17	Parts List	CP681-7570/00
7570-11-38	Modification Instructions	To modify RA7570/01 for Diversity Timeout indication and Rx code cleardown. 2 sheets
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	Storno Drawings List	CAF680-7570 Vol. 1, 10 sheets un-numbered
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CAF7570	OPOT Modification	Storno Trackside Alarm Control Unit
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7570-7-18	Wiring Diagram	TE7570F/10
7570-11-47	Description	TE7570F/10 Tone shelf
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7570-7-19	Wiring Diagram	TE7570F/11
7570-11-48	Description	TE7570F/11 uProcessor Shelf 2 sheets
7500-6-97	Component Assembly	Standard TE Backplane (with slow-bus)
7500-2-25	Drawing	Std Backplane TE Assy
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7500-6-205	Component Assembly	IU7500M/13
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7500-6-196	Component Assembly	PS7500M/07
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7500-1-46	Circuit Diagram	SB7500M/03
7500-11-116	Technical Description	Addressable interface for slow-bus SB7500M/03 2 sheets
	Index	Sub-Section 3.9 Duplicates 3.8 with incorrect drawing number in heading.
7500-6-54	Component Assembly	SB7500M/03
7500-1-46	Circuit Diagram	SB7500M/03
7500-11-116	Technical Description	Addressable interface for slow-bus SB7500M/03 2 sheets
	Index	Sub-Section 3.10
7570-6-30	Component Assembly	SU7570M/08
7570-1-29	Circuit Diagram	SU7570M/08
7570-12-3	Test Specification	SU7570M/08 4 sheets
7570-11-49	Technical Description	Switching unit for jingles and function inputs. SU7570M/08 2 sheets
	Index	Sub-Section 3.11
7570-6-31	Component Assembly	SU7570M/09
7570-1-30	Circuit Diagram	SU7570M/09
7570-12-4	Test Specification	SU7570M/09 3 sheets
7570-11-50	Technical Description	Two tone chime, and Key & AF Mute lines control card. SU7570M/09 1 sheet
	Index	Sub-Section 3.12
7500-2-46	Component Assembly	TQ7500M/00/01/02
7500-1-116	Circuit Diagram	TQ7500M/00/01/02
7500-12-49	Test Specification	TQ7500M/00/01/02 2 sheets
7500-11-65	Technical Description	Two tone chime, and Key & AF Mute lines control card. TQ7500M/00/01/02 11 sheets
7500--6-167	Component Assembly	Display Board
7500-6-172	Component Assembly	Interface Board
7500-1-115	Circuit Diagram	Interface Board
7500-12-54	Test Specification	Interface Board or IU7500/08a 2 sheets
7500-6-166	Component Assembly	TQ984-7500/00/01/02
7500-1-113	Circuit Diagram	TQ984-7500/00/01/02
	Index	Sub-Section 3.13
7500-6-152	Component Assembly	TU7500M/02

7500-1-102	Circuit Diagram	TU7500M/02
7500-11-158	Technical Description	Storno Slowbus clock card. TU7500M/02 3 sheets
	Index	Sub-Section 3.14
7500-6-203	Component Assembly	WD7500M/01
7500-1-145	Circuit Diagram	WD7500M/01
7500-11-156	Technical Description	Processor watchdog card. WD7500M/02 1 sheet
	Index	Sub-Section 3.15
7696-6-38	Component Assembly	IU7696M/02a
7500-11-82	Technical Description	Interface unit. 37 way D type to 25 way D type. WD7500M/02 1 sheet
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7673-6-1	Component Assembly	ID7673M/00 3 sheets
7673-1-2	Circuit Diagram	ID7673M/00
7673-11-2	Technical Description	Purpose clock card for Slowbus. ID7673M/00 1 sheet
7673-12-2	Test Specification	ID7673M/00 3 sheets
	Index	Section 4
7570-2-19	ASM	CB680-7570/10
7570-1-27	Circuit Diagram	CB680-7570/10
7570-11-45	Technical Description	Opto-isolated control panel - Train Location Indicator CB680-7570/10
7570-6-28	Component Assembly	CB680-7570/10
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7570-2-20	ASM	CB680-7570/11
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7570-11-46	Technical Description	Opto-isolated control panel - Train Number Indicator CB680-7570/11
7570-6-29	Component Assembly	CB680-7570/11
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	Index	Section 6
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7570-7-20	ASM	CC7570/10
7570-7-21	ASM	CC7570/11
7570-7-21	Wiring Schedule	CC5750/11 2 sheets, sheet 1 missing
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7570-24-1	Fitting Instructions	SP7570/00
	Parts Lists Issue 3	CAF7570/00 50 sheets, un-numbered

7570-9-1	Functional Specification	LUL Trackside Alarm Control Unit 11 sheets

FIGURE 1 : SYSTEM TEST SEQUENCE