MCR21 rebuild history and deviations from original

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Note **This document is a work in progress, and will be added to from time to time.**

BBC - Principal equipment originally installed

Pye Mk6 Image Orthicon Camera channels x 4, info at TVcameramuseum
Pye 20 channel sound mixer
BBC designed 10 channel vision mixer type MX1/501
Production desk,
Engineering managers desk.
Pye 14 inch picture monitors x 6
Pye 17 inch transmission monitor
BBC Waveform Monitor type MN6/501 & MN6/510 x 6
Peto Scott 8.5 inch picture monitor
Tektronix 515A oscilloscope x 2
Ferguson SPG x 2 and change over unit. These SPGs could operate on 405, 525 or 625 lines.
Vision Matrix by Pye.
BBC vision DAs and test signal generators.
BBC Audio Line Identification Unit type RP4/1
Philips twin track Tape Recorder type EL3503 in custom housing.
Eddystone radio microphone receivers type S890, BBC HR20A/7 x 2
Claude Lyons Automatic Voltage regulators x 3
Gresham Lyons Pulse and Bar Generator 405/625 lines

BBC - Service

The BBC accepted MCR21 from Pye and it was first taxed and registered on the 12th November 1963. It started programme work in 1964 and with the local unit number of LO1[i]. It covered the whole gamut of programmes[ii] both minor and major.
MCR21 was kept up to date and was converted to colour in June 1969 in time for the Investiture of HRH the Prince of Wales at Caernarfon. This was with two Philips PC60s cameras[iii] (Badged Peto Scot?) and MCR21 was given the new local unit number of LO21.
Around 1972 MCR21 was re-equipped again this time with two EMI 2001 cameras, the same as the cameras used on the rest of the London OB fleet. MCR21 remained in BBC service till late 1976 or early 1977. It was then sent to the BBC redundant plant department to be sold.

Amateur Service

In 1979 MCR21 was purchased by television enthusiast BS. MCR21 was in a sorry state by this time, much of the original equipment was missing and it was in dire need of a respray. It was fortunate that the original vision mixer BBC type MX/501 was present and over a period of time the Pye sound mixer and other suitable equipment was acquired. This section of MCR21, production control desk, was original and remained in place with only a few modifications which were easily removed for the final restoration back to original.

Back in 1979 the idea was to re-equip it with what cameras could be obtained at an affordable price, An EMI 203 and a Pye Mk7 were used in the first refit along with some DA's, SPGs Monitors and all the other “Glue” that was needed to make a functional OB van. As the BBC paintwork was in poor condition it was decided to give it a new livery, Blue was chosen.

The next re-fit was with a pair of EMI 2001 cameras, recently demobbed form broadcast service, along with new SPG, a Matrix, DA's and a Rank Bush Murphy colour transmission monitor. The EMIs were used for several years, going to number of amateur radio shows.

One of the problems of TV at this time was how to record your cameras. As a rule of thumb, if you could afford it the results were unsatisfactory, and if it made good recordings, you could not afford it. I chose an IVC 851 monochrome 1 inch recorder. When it worked it replayed good pictures in monochrome, but as it was a wide bandwidth recorder (to 5Mhz.) replaying though a time base corrector would stabilise the signal and restore the colour. It was a well made machine if somewhat unreliable.
In the middle 1980s some Marconi MkVIII colour cameras from Belfast became available and there of these were installed in MCR21 in it's third refit. Having the experience from the earlier work a much better job was done in the installation of these cameras with the correct operators control panels, colour monitors, waveform monitors, another matrix, a pair of Marconi SPGs with a change over unit. During all these refits the original BBC sound and vision desks were supported and maintained in their original form.

As a matter of policy it was decided that no commercial work would be undertaken, It being the view that there was no money to be made, only a treadmill of debt and constant need for work to pay off the debt. At this time there was no requirement for Vintage OB vans to appear in historic programs.

Preparation for restoration

After our Trust had been formed and our plans had been formulated and the Heritage Lottery Fund grant had be approved we started to remove all the equipment from MCR21 as it was felt that it would be best if it went to WJ empty to save any damage to the items we planned to reinstall.

We are fortunate to have a number of photographs, taken by Pye of MCR28, the last of the line but substantially the same as MCR21 along with some original construction drawings and the original technical handbooks, so a lot of information is available.

Professional work

Work at Ward Jones Ltd.

MCR21 was transported to Ward Jones Ltd. (WJ), just to the north of High Wycombe, by a low loader on the 16th October 2019. MCR21 was towed out from it's parking space by a Discovery SUV and then it was winched onto the back of the slide-back low-loader. The journey to WJ was uneventful and MCR21 was parked up in their yard.

There was some considerable delay before work started in early 2020. Work started on the under-body and the front substructure framework was replaced using timber. The original substructure was in steel and partly the Commer framework, this had completely rotted away. The lower parts of the rear quarter panels were also rebuilt in steel as original.

The brakes and wheels were also refurbished and 6 new tyres fitted to the resprayed wheel drums. Attention to the cooling system pipework and radiator. At this time the petrol tank was sent off for specialist repair.

By July work was continuing on the bodywork, doors removed and the skirt lockers bottoms repaired or replaced. The rear climbing steps were sent off for re-chroming. Rubbing down of the paintwork commenced.

By August some respraying of the bodywork with primer had commenced, as a function of this most of the windows and all the doors had been removed so that the paint would continue under the widow rubbers.

Rear double glazed windows

A problem arose with the 4 rear windows. These are double glazed and had a rising shutter to keep the sound and light out. With some difficulty one of the 4 windows was removed by WJ and it was discovered that the special double glazing rubber was unobtainable. It was decided that the other 3 windows should stay in place. The 4th window was eventually replaced as single glazing[iv] and the interior wall cladding was later replaced by one of our volunteers after MCR21 had been handed back to us. (1st June 2021)

At some future time all 4 rear windows will have to be refitted using the correct rubber glazing strip which may have to be made to our requirements. The 3 original window's rubber glazing strip is showing signs of decay.

Fuel System

By September the refurbished fuel tank had arrived and it needed a new fuel gauge sender unit. The original sender unit had disintegrated and it's resistance was not known. A replacement was obtained that fitted the hole and this was installed. It later became apparent the the resistance range was unsuitable for the gauge so an electrical adaptor will have to be made.

The original engine driven lift pump was faulty and WJ installed a temporary electric pump. This will be removed and the mechanical lift pump reinstated at some future point. When MCR21 left WJ it was driven to Nick Kerner's garage (NK) and one of the experienced staff did some work on the carburettor, this improved the engine running somewhat.

The original mechanical fuel lift pump has been serviced and re-installed along with the serviced carburettor.

Painting starts

WJ had a contractor in to do this and a problem arose over the paint colour not matching the specified BS381C 223, despite what it said on their tin! They had sprayed the rear section! A compromise was made over the colour, due to time pressure with the contractor. A section of old paintwork that had not been exposed to the elements was used as a sample and paint was made up to match this. It is very very nearly correct!

Finances

By July 2020 MCR21 had been with WJ almost a year and we were over halfway though out HLF grant period and we, the Trust, were concerned about the slow progress.

By late October, we were becoming concerned about WJ having used up our HLF budget and the amount of work remaining to be done. A meeting was held to sort out what had to be done and what could be omitted. It was agreed that WJ would complete the work needed to get MCR21 watertight and mechanically OK for the road. We (the BTTT) agreed to do some of the work our-selves. We provided the following items & work at WJ:-

The fuel gauge sender unit.
The perspex curved windows.
The restored headlight units. (by one of our volunteers)
Dual Lucas horns.
The side, rear lights & turn indicators.
Restoration of the original number plates.
We did all the vehicle wiring to the lights etc.
We refitted the window screen wiper motor and arms.
We agreed to do the following work later:-

refit the roof rack framework and decking
have the bumpers restored and re-chromed.

Perspex quadrant front windows

A pair of these were needed to replace the original ones which had become badly crazed and opaque. These were made by a specialist firm near Watford. The were refitted by WJ's contract glazier.

Work at NK

We arranged for NK to drive and escort MCR21 back from WJ to the garage near Warfield, MCR21 suffered from loss of power on journey and was towed part of the way. NK's mechanic worked on the ignition system and the carburettor which improved performance and the next journey to NK's storage unit was uneventful.

Sign-writing

A professional sign-writer was employed to do the BBC lettering and the door texts. (14th June 2021) The three BBC crests were recreated in a modern vinyl format instead of the supposed original transfers. Care was taken to use the crests from the correct period.

Volunteer Work

Volunteer work in storage

During the period MCR21 was in KN's storage unit we cleaned and tidied the interior, performing some preliminary work:-
Three holes in the floor of zone one were repaired.
The windscreen washer pipe was repaired.
Trim around the inside of the windscreen.
The rear climbing steps to the roof rack were installed.
Work was done on the locker doors.

MCR21 left NK's on 7th May 2021.

Roof Rack

MCR21 had an extensive roof rack decking and scaffold rigging rails on both sides. Access to the roof was by a set of “fold out” foot steps and the rear of MCR21. The decking was arranged around a single and a twin extractor fan units. The original fans were long lost when MCR21 left BBC service and I was told that is was very easy to loose them to low branches. In 1980 three ex-military fans were obtained and fitted in the original positions. These had the advantage of substantial metal cowls which have proved to be satisfactory in use.

We assembled and painted the replacement wood framework using the “Meranti” timber WJ had ordered at an earlier stage for this job. Rubber pads were glued to the underside of the framework before it was placed on the roof. This framework is attached to the roof by six curved metal brackets on each side. These also bolted to the two scaffold poles.

We decided to keep and refit the original Teak decking planks. These were in poor condition and needed much filling of the damaged areas, sanding and painting in the original green colour the same as the body colour. They were attached with two stainless steel screws to replace original the three steel ones in each location.

Bumpers

The front and rear bumpers were in a poor state and we took them away to deal with ourselves. We searched for a firm who could do this and one was located near Eversley. They decided the only was to deal with them was to cut the middle section out and weld the curved corners back on to a new middle section. This worked reasonably well, but there was a misunderstanding over the chroming work. They said they had only quoted for the metal work and not the chroming which they could not do. Eventually we located a firm near Bristol who had a tank large enough to accommodate the bumpers and they were re-chromed. All of this went well over budget but fortunately one of our supporters stepped in and made a donation to cover the extra cost of the chroming. We re-fitted them mid 2021 in time for the Goodwood Revival Show.

Radiator Grille

WJ replaced the radiator grille surround but we refitted the radiator grille after repainting it in the original black colour. (17th May & 6th June 2021). The aperture in the grille surround had to be enlarged before the grille would fit.

Front Shock Absorbers

After the return from MCR21's first public display it was noticed that the rubber bushes on the nearside shock absorber had failed. On removal it was clear that the whole unit had seized up. Both NS and OS units were sent off for specialist repair and have been refitted.

Starting Handle

The original one was lost a long time ago, A replacement is needed. A first unsatisfactory one has been made.

Interior general

Drivers Cab Early work

In one of the early refits (c. 1990) the front of the cab was rebuilt with better access and a new instrument binnacle was made with additional controls and instruments. A set of lighting switches was fitted to the steering column, these controlled the side/headlights/turn indicators and the hooter. The original foot operated dip switch was abandoned. This work could be further improved with a better finish nearer the original style.

Cab Seating

The original drivers and passenger seats are present, the drivers seat is somewhat the worse for wear, but serviceable. They both retain the original vinyl covering with patches.

Operational seating

An original bench seat is at the rear. Three of the four production seats are present, these are the correct type, but have been repainted and re-upholstered. The engineers seats are present. The frames have been repainted and the vinyl is original with some restoration. The fold down lighting engineers seat and table are present and original.

Underfloor ducting

The underfloor ducting was repaired with patches to cover unwanted holes and painted black. (1st June 2021) Care was taken not to disturb the original electrical services in conduits that joined the ducting. These cables were re-wrapped in new insulating tape and their destinations identified. Plenty of time was allowed for the paint to be fully dry before new cables were laid.

Ventilation

Three Ventaxia roof extractor fans were originally fitted, They are thought to be the standard industrial roof model with a Bakelite dome.[v] These were missing on acquisition and 3 robust ex military Ventaxia fans were installed. Additionally two smaller ones in each of the front mudguards, to draw air into the front zone 1 section, are on some of the original drawings. At some point in the BBC service these were removed. They have not been refitted. It is not clear how they might have been wired into the system. Three ex military 240v fans are now installed and working with the correct control units.

Technical installation

Zone 1

Zone 1 is the front area behind the drivers cab and in front of the middle gangway.

This is the principle area for the installed equipment:-

SPG

Two original Fergusson WG61 SPG's are installed. These can operate on 405, 525 or 625 lines. A sync pulse change-over unit has been made and installed in the original place. A sync comparator unit, that changes the selected mixer channel from non-sync to sync when the phasing is correct is to be made. Fits underneath.

Test signal box

A BBC unit fitted for sawtooth and PLUGE outputs., The original unit was for 405/625 operation. This has been rebuilt with one Pluge generator and a suitable sawtooth generator and are installed in a 10 slot box. This may need further improvement.

Distribution amplifier box,

A BBC 10 slot crate with 8 DA's, and 6 gain controls has been built in the correct style.

Radio microphone receivers,

The original ones were by Eddystone and have been replaced by two BBC units type RC4/1 as these would have been changed in service.

Pye Mk6 CCUs

The camera control units, CCUs, 4 would have been originally installed with provision for a 5th one. One CCU is currently fitted with provision for guest cameras to the side.

Pulse and Bar generator

Made by Gresham Lions, it is hoped that a correct unit can be found, BBC type GE4/504. Failing this a Marconi unit might be fitted.

Vision Preview Matrix.

This unit has been constructed and is functionally the same as the original, which was made by Pye. The case would originally be the same as the Pye CCU but the rebuilt one has a similar frame to the Fergusson SPGs.

Video Jackfield.

Two correct frames BBC type JF3/502 have been fitted and the layout of the Musa connectors has been updated in line with the modifications in service as suggested by the crew of MCR19.

Tektronix Oscilloscope

A type 515A, the correct type is fitted and, due to its provenance, it may have been one of the ones originally used in the OB fleet.

Preview vision monitor

Made by Peto Scott. Correct type fitted, provenance unknown.

Mains master power distribution panel, & workbench

Three original type extractor fan speed controls installed

A maintenance bench lamp, a close match to the original type has been installed

To the rear and accessible from the cab:-

Trans-Rehearse switch unit, original restored and installed.

Talkback Junction box, replicated and installed

Zone 2

Zone 2 is the area behind the middle gangway and the front fascia of the monitor stack including the engineers desks. This area is known as the "Monitor Stack"

Equipment:-

Four camera PSUs power supply units, with provision for a fifth one. These mount on cross members at the bottom of the section. None are currently fitted Sept 2023.

Manual mains voltage regulator. Not fitted

Four underfloor "night" heaters. Yet to be fitted

Six waveform monitors BBC type MN6/501 replaced later by MN6/510[vi]

Six 14" and one 17" picture monitors Pye type 842843. These are not the correct original type which were type 842822 alas these are not obtainable.

Off air TV tuner for 405 & 625 transmissions. A Fergusson model replaces the original Pye unit.

Optical PPM BBC type PRM/1

Transmission Rehearse indicator unit.

Monitor selection indicator unit, two fitted, one to be found.

Monitor UMD & Cue indicator x 7

7 LCD monitors to show the demo programs and the Pi computer unit to drive them.

Clock

A small but essential part of an OB is the time. I believe the original clock in MCR21 was a synchronous electric one, the only other, less likely, choice was clockwork and it is well before battery clocks were available. So we have found a suitable clock and in is now installed. It is mounted on a small swing out flap so that the clock rear can be accessed from the front of the monitor stack and the Del (direct line phone) is within reach.
The original clock was illuminated by a couple of 6.3V bulbs, these may have been set into the translucent clock face. Ours has a metal faceplate so this won't work! Could it be that it can be illuminated from the front by two bulbs on some sort of a stalk arrangement?? Suggestions?

Picture Monitors

Six of the 14inch size and one 17inch size have been installed, there is a certain amount of unreliably but it is hope that they will improve with use. We have spare 14inch ones.

As a matter of preservation we have decided to use them as little as possible so to preserve the tube tube life as replacements or re-gunning is very difficult. To show MCR21 in operational mode a set if LCD monitors have been installed in front of the CRT monitors for normal use. These are easily removed and the CRT monitors can be slid to the forward position.

Off Air TV Tuner

The original unit by Pye, a special early model for bands 1, 3, 4 & 5 is unavailable so a slightly later but otherwise similar unit by Fergusson has been installed.

Vision Engineers control desk 1

This has been rebuilt to the original pattern, two original OCPs Operational Control Panels, A switching and communications panel, and a forth panel with a set of matrix selector control buttons for the engineers preview monitor ans some additional switches for the remote source genlock selection.

Vision Engineers control desk 2

The frame for this has been rebuilt to the original pattern. The two original OCPs that would have been fitted are unavailable. A set of matrix selector control buttons for the cameras external viewfinder inputs is fitted. This panel has talkback controls.

Vision Engineers Tektronix 514A Oscilloscope

This fits in the space between the two vision engineers desks. We have the scope but the mounting frame needs to be made.

Zone 3

Zone 3 is the rear section, the production desk, battery charger.

Audio auxiliary unit

As part of this work we have had some ongoing problems with the Audio Mixer reserve power supply change over system. Sometime it would not work and at others the reserve PSU was slow coming into use. This was not a fault in the PSUs but something it the rather complex relay logic and switching circuits. There are three, hard to get at, large C/O relays in the bottom of the Audio Auxiliary Unit. I was not looking forward to accessing these. But there were also two smaller plastic relays that detected the availability of the PSUs. It turned out that one of these had, not just contact problem's, but the moving centre contact had fractured and was hanging loose inside the plastic case!, Not seen this before! Easy fix!
The normal sequence for the Audio Mixer 16v amplifier supply is PSU 1, then PSU 2, then failing to the 18v 100Ah battery.

Audio Mixer desk

Twenty inputs in groups of, ten, four and six. With a master output, three group outputs, and selected inputs switched to the PA outputs. It has comprehensive monitoring facilities.

The mixer is in quite good condition with cleaning and minor repairs. The electronics have the age related problems of switches, contacts and component failures in the amplifier modules. Work is underway to service/repair these problems. Some of the twenty channels are currently working.

Vision Mixer desk

Ten input channels, four may be switched to synchronous or non-synchronous operation with mixing or wipes between the A and B banks. Caption insertion is also an option.

The vision mixer is in good condition and is awaiting electronic restoration.

Production Secretary's desk

This is the position at the left end of the production desk and it has controls for talkback, commentators feeds, and the GPO telephone.

In good condition and partly working

Battery Charger

This rather large unit made by "Heayberd" has 3 transformer/rectifier sections with two sections for the 24V batteries and one section having dual 12v/18v outputs. Each section has a 6A meter and a switch to set the current. It is fitted in the rear bench seat, accessed by a door with a ventilation chimney above with an external vent. The mains input can be switched to either the normal supply or the "night supply"
Original Battery compliment:-
Lighting 24v 100Ah, Communications 24V 100Ah, Sound desk 18V 100Ah, Vehicle 12v 100Ah.

Outside lockers:-

All the external lockers were fitted with a square key budget lock and a key operated Yale lock. Most of these Yale locks are yet to be restored. Most have clips to hold the door in the open position.

Nearside rear, AVRs

The 3 AVRs (Automatic Voltage Regulators) are mounted on a pull-out tray, each is connected to the mains input panel were they can be switched in or out of circuit. They are each rated at 30A and have an input voltage range of 190-260V. A three transistor servo amplifier detects the voltage error and drives a "Parvolux" DC motor coupled to a Variac which is connected to a Buck-Boost transformer with the secondary in series with the output. A heavy unit at approx 50Kg.

The Locker interior was painted, the original wood floor was retained and the DC locker light re-installed.

Nearside mid, spare wheel

The spare wheel mounting frame/brackets are missing, to be reinstated at some future time. The starting handle and wheel brace also located there.

Nearside front, storage

Spare water, oil, & Jack.

Nearside technical services locker

All the camera, communication, sound and vision connectors are here. The panels and connectors have been restored to a high standard, close to the original specification with the correct original style connectors apart from the 3 "multi-mic connectors".

Camera:-

4 BICC MK4b bulkhead camera connectors. One of these has been installed. Three more are yet to be installed. There is a problem with the length of these cables making installation difficult. Shorter cables sought.

Vision:-

Various inputs and outputs can be connected to the 16 PL259 connectors.
Two additional PL259 connectors are for the radio microphone receiver aerials. Two "C" connectors are installed for the Check Receiver. Originally they were 75Ω but 50Ω have been installed. For VHF & UHF

Sound:-

30 XLR connectors for communications, Talkback, mixer outputs.
20 XLR connectors for sound mixer inputs.
A further 20 XLRs are installed below the mixer inputs. These would have connected to the 3 F&E EA "multi-mic connectors" which we have not yet found/installed.
At the bottom of the main panel are 15 more XLR connectors each with three binding posts to allow direct connection of wires. These 15 connectors are wired back the the Engineering Managers desk jack sockets as part of the telephone-communications system.
At the top of the panel is an original "Eurovision" F&E EA connector for talkback. Next to it is the XLR for the GPO telephone connection.[vii]

note this section formatted as hanging indent

The locker has DC Lighting with a timer switch and provision to connect a 24V extension lead lamp.

Offside rear, battery compartment

In service the two 24V DC 100Ah batteries, for the sound communications and lighting standby service. Each battery has an isolating switch. An original inverter for the lighting standby has been reinstalled here. It is planned that smaller batteries will be used and the 18V one installed in this locker too.

The interior was painted and new wood flooring installed by WJ. The DC locker light with timer switch has been re-installed.

Offside middle, battery compartment

In service the 18V DC sound mixer standby battery was installed here. It is planned that this battery will be in the in the rear compartment with the other batteries.

The steel locker floor has been replaced and covered with wooden surface. The locker is currently used for cable storage.

Offside front

The original use for this locker is not clear? it may have been part of the manual voltage regulator.

The floor has been replaced and new removable rear panels, to give access to the vacuum brake servo, are yet to be installed.

Rear air-conditioning locker

This locker gave access to the air-conditioning/heating unit which conditioned and circulated the air in the rear production area. 10% of new air was added to the return air. It drew cooling air for the condenser through a filter from underneath the rear of the vehicle and discharged this air under the vehicle to the middle. This had an additional large fan and a nylon canvas discharge sock which collapsed during travel to prevent the entry of road dirt. The original unit would have used the "R12" gas which is now prohibited.

All of this equipment has gone and awaits a suitable replacement.

Rear technical power locker

All the power inputs and outputs are here with switching and monitoring. The panels and connectors have been restored to a high standard, close to the original specification.

Inputs:-	240V AC at 60-80A.	BICC[viii] Main and standby connectors
	240V AC at 15A.	Niphan night supply.
	240V or 6.3V AC 5A	Niphan locking reference.
Outputs:-	240V regulated 5A	Niphan for commentator one.
	240V regulated 5A	Niphan for commentator two.
	240V regulated 5A	Niphan GP Circuit A
	240V regulated 5A	Niphan GP Circuit B
	240V regulated 15A	Niphan GP Circuit C
	240V unregulated 15A	Niphan GP Circuit x 2
	240V switched artists cue,	Niphan 5A.

The locker has DC Lighting with a timer switch and provision to connect a 24V extension lead lamp.

Notes: The upper door requires a Yale lock fitting and the lower door requires repairs to the budget square key lock.

Glossary

Ah	Ampere Hour	(a measure of battery capacity)
AVR	Automatic Voltage Regulators	
BICC	British Insulated Calendar Cables Ltd.	
CCU	Camera Control Unit	
C/O	Change Over	
CRT	Cathode Ray Tube	(the picture tube or Kinescope)
DA	Distribution Amplifier	(video)
DC	Direct Current	
EA	Type number of connector	
F&E	Films and Equipments	(manufacturer)
GPO	General Post Office	(UK)
LCD	Liquid Crystal Display	
MCR	Mobile Control Room	
PA	Public Address	
PSU	Power Supply Unit	
OCP	Operational Control Panel	
SPG	Sync Pulse Generator	

i The BBC had different numbering schemes, the MCR (Mobile Control Room) number in this case 21, and a local unit number which related to the base (London) and it's position it the scheme (numbers 1 to 6 for London at this time).

ii See http://mcr21.org.uk/programs/ for programme list.

iii See http://www.tvcameramuseum.org/norelco/pc60/pc60p1.htm

iv The second glass pane, which was not re-fitted, is in store. At some future point it is hoped that new double pane glazing strips can be made to allow refitting to all 4 windows.

v There is a story, recollected by the original crew, that the Bakelite Ventaxia fans domes did not survive well the contact with low tree branches!

vi Waveform Monitor BBC type MN6/510/145. Repair work Replaced:-Both PSU bridge rectifier diodes replaced by eight type BYX22.The Originals had corroded badly due in part to the rubber Hellerman overall sleeves. Tantalum capacitor C29 in horizontal deflection circuit found to be short circuit and replaced with an electrolytic.. The CRT has reasonable emission.

vii At the time MCR21 was built, the GPO was VERY protective of the telephone network and only GPO engineers could work on it.

viii BICC = British Insulated Calendar Cables