TECHNICAL DESCRIPTION
of
STUDIO CAMERA CHANNEL
TYPE 10678B. 405 LINES
TYPE 10678C. 625 LINES

BROADCAST EQUIPMENT DIVISION

E·M·I ELECTRONICS
LIMITED
HAYES • MIDDLESEX • ENGLAND

P.S. 3078 T.P.

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STUDIO CAMERA CHANNEL
TYPE 10678B,405 LINES
TYPE 10678C,625 LINES

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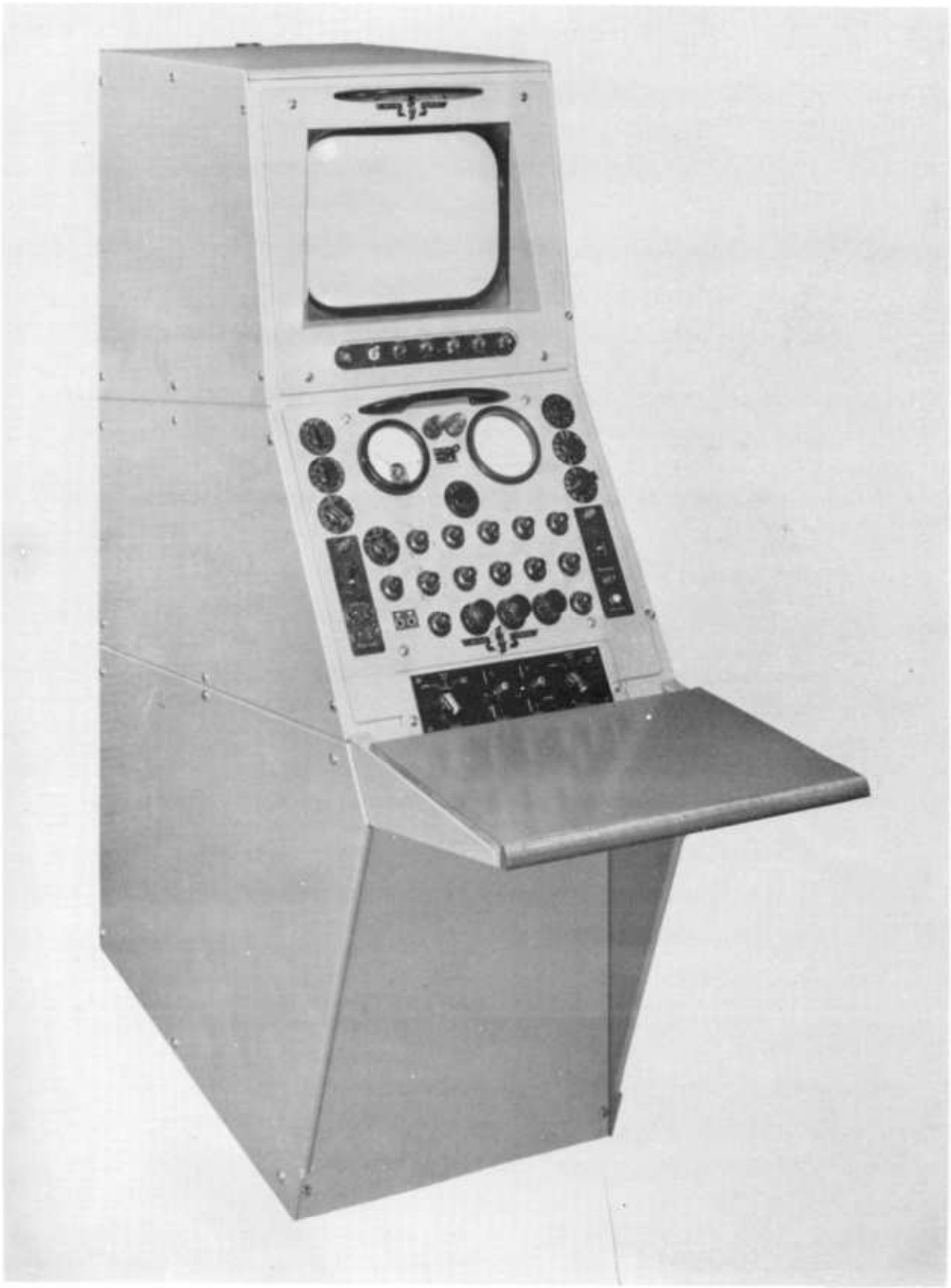
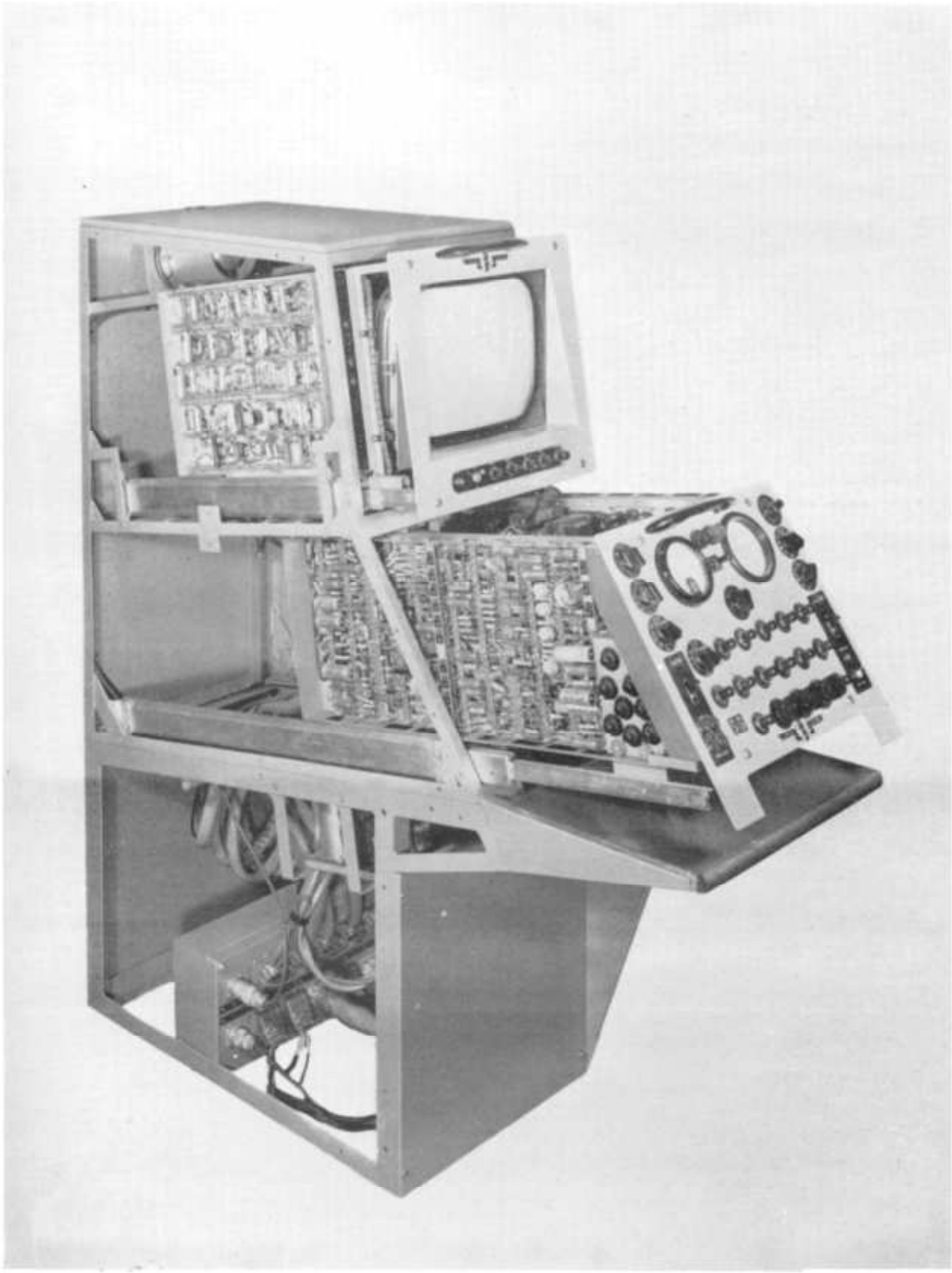
STUDIO CAMERA CHANNEL TYPE 10678.

Emitron Camera complete with viewfinder.



STUDIO CAMERA CHANNEL TYPE 10678.

Camera Control and Power supply Console.



STUDIO CAMERA CHANNEL TYPE 10678.

Camera Control and Power Supply Console,
showing the accessibility of the separate units.

1.0 CAMERA.

1.1 Pick-up Tube.

The Camera is designed for studio use, and accommodates a new Emitron Type 10764. This tube is similar to the well-known Emitron Type 5954, which has been in regular service at B.B.C. studios for some years, but it incorporates modifications which enable an appreciably larger range of input light to be handled without loss of definition, and it is completely stable under all conditions of incident light. It is entirely free from shading or other spurious signals and does not exhibit halo effect. No warming up period is necessary, and a static picture may be transmitted for an indefinite period without burn-on. Absolute black level is established when the scanning beam is cut off, and the colour response is such that no colour filter is required when incandescent tungsten lamp illumination is employed.

1.2 Lenses.

The Camera carries a turret capable of holding four lenses. The lenses normally supplied are :-

Focal Length.	Total Horizontal Angle.	Maximum Aperture.
3"	33°	f 1.9
4"	25°	f 1.9
8"	13°	f 4.5
12"	8°	f 4.5

All lenses are by Dallmeyer, and other lenses than those quoted above can be supplied. The length of the diagonal of the optical image is 56mm. A combination, internal-mask-diaphragm type lens hood suitable for the lens group is supplied. The maximum focal length of lens which can be accommodated in the turret without obstructing the 3" lens is 10" in the case of adjacent lenses, and 12" in the case of diagonally opposite lenses.

1.3 Mechanical Features.

The Camera is built of light alloy pressings. Carrying handles are built in at the top, and may be used for slinging. The panning head fitting is a standard dove-tail slide. The electronic viewfinder is a detachable sub-unit carried centrally in the top of the camera, its axis being approximately 10" above the camera axis. The view finder may be tilted about + 30° relative to the camera axis, to ease the stance of the operator when taking high or low angle shots. The overall dimensions, including turret and viewfinder but exclusive of lenses, are as follows :-

Length	27"	Height	21"
Width	15"	Weight (without lenses)	160 lb.

Focus control is effected by means of a handle fitted for left hand operation. Motion is non-linear with rotation, to give finer control with short focus lenses, and is of fixed ratio, independent of the lens in use. The maximum available travel requires approximately 90° movement of the handle, and is more than adequate to fill the screen with an object 16" x 12" when using the 10" lens. The mechanism can be locked in any position. During focussing both turret and camera tube move, the masses being roughly balanced to ease operation on high or low angle shots.

Lens selection is by direct turret drive from the rear of the camera.

Iris control on the lens in use is by a drive from the rear of the camera. A meter giving an indication of the aperture setting is visible beside the picture display, inside the viewfinder. The setting of the iris is used as a means of controlling the depth of focus only.

Light control is effected by the positioning of an annular optical wedge, which is servo driven from the Camera Control Unit and used as a gain control. A signal indicator is included on the C.C.U. in the form of a Waveform Monitor.

For test purposes, an optical projector can be supplied as an extra. This device fits on to the 3" lens, obviating any necessity to remove lens or hood, and accommodates standard 3.1/4" lantern slides. Supply for the lamp is obtained from a service outlet on the camera. A recommended set of slides suitable for the setting up and testing of channel can be supplied.

1.4 Electrical features.

The electrical circuitry is contained in sub-units which are readily removable from the camera for servicing.

The sub-units comprise :-

Head Amplifier
Scan Unit
Viewfinder
Light Control Servo Amplifier

The Head Amplifier incorporates the special E.M.I. low noise input valve, Type R. 5559 (R_n = 100 ohms) and delivers an output of 1/4 V to the camera cable with a flat output volts/input current frequency characteristic.

The Scan Unit provides the line scanning waveform and blackout pulses. It also generates a check sawtooth for testing and setting-up purposes.

The Viewfinder incorporates a Mullard C.R.T. with

an aluminium-backed white screen of 5" diameter. This operates at 10 kV and provides a large bright picture.

All interconnections between sub-units are completed in a detachable internal filter box, which carries a meter and selector switch for checking important potentials and currents.

Provision is made for reserving both line and field scan. Three transmission indication lamps are carried on the camera.

A two-way speech circuit is provided between the camera and the C.C.U. and the camera carries a calling push-button.

2.0 CAMERA CONTROL AND POWER SUPPLY EQUIPMENT.

2.1 General.

A single camera channel comprises, in addition to the Camera, a Control Unit and Signal Routing Panel, a Picture Monitor, and certain power supply units. The Control Unit and the Picture Monitor, together with the Shift Supply Unit (which provides L.T. D.C. to the camera scanning coils for centering purposes) are housed in a console. The consoles associated with a number of cameras may be assembled as a fixed suite. The remaining equipment consists of units providing stabilised positive and negative H.T. supplies for the Camera and the Control Unit, with appropriate switching and metering units. This equipment occupies space in a standard cubicle, one cubicle sufficing to house the Power Supply Units for two camera channels together with a common meter panel.

The dimensions of the console and cubicle are as follows :-

	Console.	Cubicle.
Depth ...	51" (inc. 12" Desk)	21"
Width ...	19"	21"
Height ...	57"	88"
Weight (with all units in position)	300 lb.	700 lb. (2 Channels)

The camera cable plugs into a socket on a connector panel fitted at the foot of the console. Interconnections between the console and the power cubicle are effected by means of cables supplied with the equipment. All external circuits terminate on the Console Connector Panel. These

circuits are as follows :-

Inputs. (a) A.C. mains, 240 V, 50 c/s 2 kVA.

(b) D.C. control volts, 50V, 0.6A., (or 24V, 1.3A)

(c) Standard pulse waveforms, viz:

Line Timing
Field Timing
Mixed Suppression
Mixed Sync.

(d) Standard video waveform from external source (e.g. test signal).

Outputs.(a) Transmission line (standard video waveform).

(b) Pre-view line (standard video waveform).

Provision is also made for production cueing and talkback circuits

2.2 Camera Control Unit and Signal Routing Panel.

The C.C.U. is mounted immediately above the console desk, at a convenient height for a seated operator. It carries on its front panel all the controls necessary for the operation of the channel and for setting up purposes. The principal controls are :-

Line Scan Amplitude and Shift.

Field Scan Amplitude and Shift.

Beam Alignment.

Beam Current.

Beam Focus.

Cable Length Correction (up to 1000 ft.)

Gain (Light Control)

Lift.

Contrast Law (Gamma).

Power supplies for this unit and for the Camera are derived from the incoming mains and from rectifier units in the power cubicle. A built-in meter is provided for checking important potentials and currents. L.T. D.C. supplies for injection into the camera scanning coils for centering purposes are derived from the Shift Supply Unit housed within the console.

Timing pulses are derived from the Waveform Generator,

which also supplies the suppression and synchronising pulses. The pulses are added to the picture signal in the signal amplifier to produce the standard video waveform.

The circuitry associated with the signal amplifier incorporated in the C.C.U. provides for aperture correction, cable loss equalisation, line-by-line clamping of signal level, and the adjustment of picture black with reference to the absolute black datum provided by the Emitron during beam cut-off periods. The gamma control circuit is designed so as to maintain black and peak white levels constant and independently of the setting of the control. Provision is made for optional phase reversal of the output signal.

Two video outputs of 1 V overall amplitude and 75 ohms impedance are provided, designated "Main" and "Preview". The "Main" output is intended to supply the transmission line. In normal operation the Channel Picture Monitor (mounted in the console immediately above the Control Unit) is bridged across the "Main" output, so that the feed cannot fail without the operator's knowledge. This bridging is controlled by a switch on the Signal Routing Panel, which permits of the alternative connection of the Picture Monitor to an external source (e.g. a test signal), or to a combination of the channel output and an external source. The "Preview" output normally supplies the Producer's Preview Monitor. A third output is used internally to supply the camera viewfinder. A further switch on the Signal Routing Panel permits of the routing of alternative signals to the viewfinder, in a similar way to the Picture Monitor. The Signal Routing Panel also carries the transmission On/Off key.

The Control Unit also contains a built-in waveform monitor. This displays the outgoing waveform on a $3\frac{1}{2}$" diameter tube at line, half line, field, or half field frequency. An electronic marker may be superimposed at will to indicate peak white. When the unit is withdrawn for servicing, the waveform monitor may be disconnected from the output and used for fault tracing.

Testing and setting-up of the Control Unit, or the Camera and Control Unit together, is carried out with the aid of the check sawtooth generated in the Camera Scan Unit. The necessary switching is effected at the Filter Box in the Camera.

Provision is made for two-way speech communication between the C.C.U. and camera operators. Each is provided with a head and breast telephone, the necessary circuits being carried through the camera cable.

2.3 Channel Picture Monitor.

This unit is situated immediately above the Control

Unit. It incorporates a 14" diagonal aluminium-backed white screen display tube working at 13 kV, giving a good brightness range and fine focus. It is a self-contained unit operating directly from the supply mains. The video amplifier and scanning circuits are built on a common chassis and the power unit is on a separate chassis. A built-in meter is provided for checking valve feeds and H.T. voltages.

The video amplifier incorporates a D.C. restoration circuit which operates off the tips of sync. pulses. This permits the recognition of faults which would be masked by a system of black level clamping.

A contrast control is provided. Focus and shift are pre-set.

2.4 Power Cubicle.

The apparatus housed in the power cubicle to feed one camera and control unit comprises :-

(a) One Switch Panel.

This panel carries switches, fuses, and indicator lamps, together with a thermal relay, which delays the switching of the A.C. supply to the H.T. transformers in the thermionic rectifiers, until the warming-up period for the heaters has elapsed.

(b) Two 450 V Rectifiers.

These are thermionic, and a choke input smoothing circuit is incorporated.

(c) Two 300 V Stabilisers.

These stabilise the output from the 250 V rectifiers and are designed to cater for mains variations of ± 5%. They provide a positive H.T. supply at 300 V and the maximum load (per unit) is 750 mA.

(d) One 150 V Rectifier and Stabiliser.

This is a thermionic rectifier and stabiliser catering for mains voltage variations of ± 5%. It provides a negative H.T.supply at 150 V, the maximum load being 500 mA.

(e) One Meter Panel for measuring valve feeds and H.T. potentials in the thermionic units.

3.0 PERFORMANCE.

(a) Frequency Response.

The frequency response of vision amplifiers is within the range 0 to -1dB of the value at 100 kc/s over a frequency spectrum of 50 c/s to 5.5 Mc/s.

(b) Phase Characteristic.

The response of the equipment to equal mark-space ratio square wave signals of frequency between 50 and 5000 c/s is such that the error in output signal due to slope of the tops and bottoms of the pulses is less than 2% of the peak to peak output of the pulses.

A test object comprising either a black rectangle of 3/4 the image area on a white ground, or a similar white object on a black ground, is reproduced on the picture monitor (in normal adjustment) without visible shading of the object or the background.

The high frequency phase response is such that no "rings" or overshots at black to white, or white to black edges are visible on the picture monitor (in normal adjustment) at a viewing distance of 4 times the picture height.

(c) Circuit Impedance.

Units of equipment are designed to work from and into unbalanced circuits of 75 ohms impedance.

Input impedances are 75 ohms $\pm$ 2% at low frequency, and are not adjustable. The equivalent resistance is within $\pm$ 2% of its L.F. value at all frequencies up to 5.5 Mc/s, and at this frequency the effective series reactance does not exceed 12 ohms.

75 ohms characteristic co-axial cables with suitable connectors are used for unit interconnections.

(d) Impedance of Bridging Amplifiers.

Where used (i.e., picture monitor input), bridging connections will cause no visible disturbance to the circuit to which they are connected.

(e) Standard Signal Level.

The standard composite signal level is 0.7 V for picture (white positive) and 0.3 V for synchronising signals.

Standard levels for synchronising signals are 2 volts or 4 volts.

(f) Unwanted Signals.

The peak to peak signal due to electrical pick-up at mains or twice mains frequency is less than 1% of the peak to peak composite signal. Spurious signals of electrical origin at any other low frequency are negligible.

High frequency unwanted signals (noise) are dealt with in paragraph (h).

The Emitron Type 10764 is completely free from optical burn in, halo effect due to electron redistribution, shading, or any other spurious signal effects.

(g) Resolution.

In the absence of aperture correction, and with normal peak white output from the Emitron, modulation at maximum transmitted picture frequency compared with low frequency is as follows :-

	405 line. 3 Mc/s.	625 line. 5.5 Mc /s.
Picture centre ...	-3dB	-4dB
Middle of top, bottom or sides	-4dB	-5dB
Corners	-5dB	-6dB

Removable aperture correction units, appropriate to the bandwidth in use, may be inserted to produce full modulation over the greater part of the picture area.

(h) Signal/Noise Ratio.

The Emitron and its associated circuits produce an approximation to a "triangular" noise spectrum, i.e. the noise amplitude is proportional to frequency. This noise is agreed to be less objectionable, power for power, than flat spectrum noise. The weighting factor in favour of triangular noise is accepted by the C.C.I.R. as approximately 8 dB for 405 line systems, and may be assumed to be at least 10 dB for 625 line systems, although no figure has as yet been universally accepted.

The Emitron is a linear transducer and is normally worked with a gamma correction exponent of about 0.5. This worsens the noise content by about 3 dB.

Allowing for these factors, normal studio conditions.

(using gamma and aperture correction) should result in pictures with an equivalent signal/noise ratio of 35 - 38 dB for 625 line systems, and 43 - 40 dB for 405 line systems.

(i) Contrast Range.

A Contrast range of greater than 50:1 can be accommodated with no appreciable loss of resolution or grey scale. Highlights giving a range in excess of 250:1 can be reproduced with some loss. There is no formation of spurious signals by highlights.

Good pictures can also be produced with low contrast ranges (less than 10:1) and ranges as low as 3:1 will produce quite reasonable pictures.

The contrast law is identical from tube to tube. Gamma control is used solely for matching shots from different angles, and can be adjusted on transmission. good grey rendition is also a feature of the tube.

(j) Sensitivity.

The signal/noise ratio specified in (h) can be obtained with an average tube using 80 ft lamberts in highlight with a lens stop of f5.6.

(k) General.

The tubes are immediately changeable, no warming-up period beyond that required for the gun being needed. The cameras will operate in an ambient temperature of up to 85°F.

4.0 RECOMMENDED SCHEDULE.

LIST OF EQUIPMENT.

Unit	Quantity per Camera Channel	
Emitron Camera (with 4 lenses)	1	
Camera Cable with connectors	2 x 100 ft.	
Camera Control Console containing :-	1	
Picture Monitor	1	
Camera Control Unit	1	
Signal Routing Panel	1	
Shift Supply Unit	1	
Connector Panel	1	
Head and Breast Telephone Set	2	
Power Cubicle containing :-	1	*
Switch Panel	1	
Positive H.T. Rectifier	2	
Positive H.T. Stabiliser	2	
Negative H.T. Rectifier and Stabiliser	1	
Meter Panel	1	*
Connector Panel	1	*

* The cubicle will accommodate two sets of camera channel power supply equipment, and cubicles are therefore supplied on the basis of one per two channels. The meter panel and the connector panel are common to the two sets of power units.

MSRA/CVH.
Feb.1958.