SUBCOURSE
SS0600

EDITION
5

TROUBLESHOOT TELEVISION STUDIO EQUIPMENT

THE ARMY INSTITUTE FOR PROFESSIONAL DEVELOPMENT

ARMY CORRESPONDENCE COURSE PROGRAM

IPD

READINESS/ PROFESSIONALISM THRU GROWTH

U.S. ARMY RADIO/TELEVISION SYSTEMS SPECIALIST
MOS 26T SKILL LEVEL 1 COURSE

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TROUBLESHOOT TELEVISION STUDIO SYSTEM EQUIPMENT

SUBCOURSE NO. SS0600-5

U.S. Army Signal School
Fort Gordon, Georgia

TWO CREDIT HOURS

GENERAL

Troubleshoot Television Studio System Equipment is a subcourse which is part of the Radio/Television Systems Specialist, MOS 26T Skill Level 1 Course. It is designed to teach the knowledge necessary for performing tasks related to maintaining and/or troubleshooting television studio system equipment. Information is provided on several tasks which are performed at increasing levels of difficulty at skill levels 1, 2, and 3. The subcourse is presented in six lessons, each lesson corresponding to a terminal objective as indicated below.

Lesson 1: DEFINE TELEVISION CAMERA PRINCIPLES OF IMAGE CONVERSION AND LIGHT PRINCIPLES

TASK: Describe the principles of television camera image conversion and light principles.

CONDITIONS: Given information and illustrations about terms relating to television camera image conversion and light principles.

STANDARDS: Demonstrate competency of the task skills and knowledges by responding to the multiple-choice test covering theory, terminology and principles of the studio television camera and light.

(This objective supports STP tasks listed at the end of this section.)

Lesson 2: DEFINE THE VISIBLE SPECTRUM OF LIGHT AND COLOR PRINCIPLES

TASK: Describe the visible spectrum of light and color principles.

CONDITIONS: Given information and illustrations about terms relating to the visible spectrum of light and color principles.

STANDARDS: Demonstrate competency of the task skills and knowledges by responding to the multiple-choice test covering theory and principles of the visual spectrum of light and color.

(This objective supports STP tasks listed at the end of this section.)

Lesson 3: DEFINE THE MAIN CIRCUITS OF A COLOR TELEVISION CAMERA

TASK: Describe the main circuits of a color television camera.

CONDITIONS: Given information, illustrations and terms relating to main circuits of a color television camera.

STANDARDS: Demonstrate competency of the task skills and knowledges by responding to the multiple-choice test concerning theory terminology and principles of a color television camera's main circuits.

(This objective supports STP tasks listed at the end of this section.)

Lesson 4: DEFINE THE PURPOSE AND USE OF A TELEPROMPTER, PEDESTAL AND CAMERA HEADS

TASK: Describe the purpose and use of a teleprompter, pedestal and camera head.

CONDITIONS: Given information, illustrations and terms relating to a teleprompter, pedestal and camera head.

STANDARDS: Demonstrate competency of the task skills and knowledges by responding to the multiple-choice test covering terms, use, and theory of operation of teleprompter, pedestals and camera heads.

(This objective supports STP tasks listed at the end of this section.)

Lesson 5: DEFINE AUDIO MAINTENANCE PROCEDURES FOR MICROPHONES AND CABLES

TASK: Describe the audio maintenance procedures necessary to ensure proper care and handling of audio equipment (microphones and cables).

CONDITIONS: Given information, illustrations, procedures, and terms for the proper care and handling of audio equipment (microphones and cables.)

STANDARDS: Demonstrate competency of the task skills and knowledges by responding to the multiple-choice test covering terms, use and the proper care and handling of audio equipment (microphones and cables).

(This objective supports STP tasks listed at the end of this section.)

Lesson 6: DEFINE AND EVALUATE PROPER LIGHTING FOR A TELEVISION STUDIO

TASK: Describe what makes good lighting for a television studio and evaluate different lighting illuminations and wavelengths.

CONDITIONS: Given information, illustrations and terms relating to studio lighting requirements, lighting illumination theories, and light wavelengths.

STANDARDS: Demonstrate competency of the task skills and knowledges by responding to the multiple-choice test covering terms, use, and theory of light for proper television studio lighting.

(This objective supports STP tasks listed at the end of this section.)

The objectives for the subcourse support STP tasks:

113-575-2041, Perform Functional Check of a Color Television (TV) Camera System.

113-575-2043, Perform Functional Checks of a Color Television (TV) Studio Camera.

113-575-0043, Troubleshoot a Color Television (TV) Studio Camera.

In addition, the following tasks are referenced from MOS 84F, Soldier's Manual/ Trainer's Guide, which supports information in audio and lighting sections of this subcourse.

113-575-1039, Select a Microphone.

113-577-1044, Set Up Studio Lights for a TV Production.

TABLE OF CONTENTS

Section	Page

Section Page

Whenever pronouns or other references denoting gender appear in this document, they are written to refer to either male or female unless otherwise indicated.

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INTRODUCTION TO TROUBLESHOOTING TELEVISION STUDIO EQUIPMENT

The complexity of today's electronic technology requires that a technician become as knowledgeable and experienced in as many facets of his career field as possible. The purpose of this subcourse is to provide the technician, MOS 26T soldier, with an overall view of some of the equipment used in a television studio, and with some guidelines on how to troubleshoot the equipment: what to look for, how to check it out, and a few procedures to be followed. It is also meant to assist MOS 41E personnel to merge into MOS 26T30, as prescribed by AR 611-201, and to help anyone cross-train into the MOS 26T career field.

LESSON 1
DEFINE TELEVISION CAMERA PRINCIPLES OF IMAGE CONVERSION AND LIGHT PRINCIPLES

TASK

Describe the principles of television camera image conversion and light principles.

CONDITIONS

Given information and illustrations about terms relating to television camera image conversion and light principles.

STANDARDS

Demonstrate competency of the task skills and knowledges by responding to the multiple-choice test covering theory, terminology and principles of the studio television camera and light.

REFERENCES

None

Learning Event 1:
DESCRIBE THE FUNCTION OF ANY CAMERA SYSTEM

1. Image conversion is the principal function of any camera system regard less of media. It involves the theory of light and optical principles and chemical processes for film cameras, and electronic engineering for video cameras. In the following section we will discuss the theory of brightness transfer characteristics, evaluate systems capabilities, and identify the gamma factor.

2. Transfer characteristic: The transfer characteristic, in its simplest terms, is the function which expresses the relationship between the luminance amplitudes of the system output and the system input. However, it must be remembered that each element of the system (the pickup tube, amplifiers, detectors, etc.) has a transfer characteristic. In the final analysis it is the relationship between all these elements that determines the overall transfer characteristic of the system.

Learning Event 2:
DESCRIBE WHAT MAKES UP THE GRAY SCALE OF A TELEVISION SYSTEM

1. The object of a television system is to reproduce a picture or scenes for viewing at some distant location. Most pictures and scenes contain a wide range of total values and colors, which are reproduced by a monochrome television system as gradations of brightness from white through gray to black. These gradations of brightness constitute the gray scale of television system and refer to the relationship between the brightness variations in the original scene and those in the reproduced display.

2. Faithful gray scale reproduction requires that the gray scale of the original scene be reproduced in the same proportion, or ratio, in the display. The actual light levels in the original scene do not need to be reproduced, but the ratio of lightest light to darkest light should be maintained in the displayed picture. This level is called contrast range.

3. For instance, a typical television subject may be lighted so that its highlight brightness is 1000-foot lamberts and its darkest shadows are 10-foot lamberts. The contrast range in this case is 100 to 1.

4. Video display equipment, however, is incapable of yielding light levels as high as 1000-foot lamberts. A video receiver is capable of as much as 100-foot lamberts maximum and 1-foot lambert minimum. The contrast range of the receiver would be the same as that of the original scene (100 to 1) and a faithful reproduction would be obtained.

a. Actually, a 100 to 1 contrast range is practically unobtainable, being limited primarily by the transfer characteristic of the pickup tube, which can provide a nominal contrast range of about 40 to 1.

b. However, excellent contrast can be obtained by matching the contrast ranges of the scene and display, and the lighting of a particular scene to the capabilities of the television system.

5. When the contrast range for a televised scene and the reproduced picture match, the transfer characteristic of such a system is said to be linear or have a gamma of unity (1).

a. While it would seem that a linear transfer characteristic would always be ideal, this is not necessarily the case; however, a television system is generally designed to have an overall linear transfer characteristic.

b. A nonlinear amplifier (gamma corrector) in the camera control unit is generally used to provide control over the system transfer characteristic.

to the overall system.

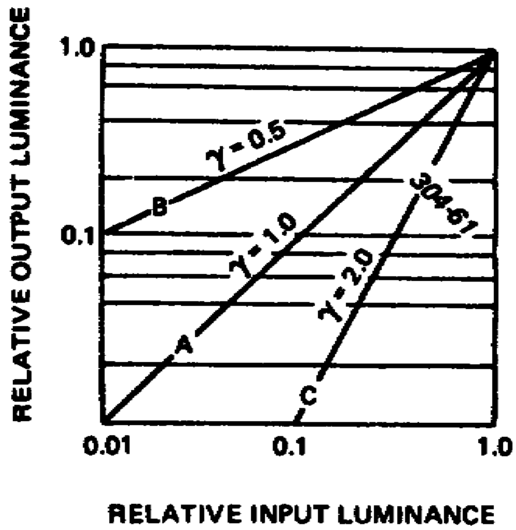


FIGURE 1-1. Theoretical system transfer characteristics

2. To help clarify contrast and the transfer characteristics, the following examples are given to illustrate the use of gamma other than 1.

a. If an unattended monitor camera were placed outdoors where it was subjected to sun reflection and required to monitor the passage of dark and light objects, the contrast range would be far greater than the camera or system could faithfully reproduce. A large amount of picture detail would be lost in the white or black end of the reproduced gray scale.

b. By using a system gamma of less than 1, the wide range of input luminance could be effectively compressed into a narrower range of output luminance, which could be handled by the reproducing kinescope, and the picture detail and relative luminance in the original scene would be faithfully reproduced.

3. Refer to curve b of figure 1-1. This represents the transfer characteristic for a theoretical system with a gamma of 0.5. For such a system, a change of input luminance of 100-1 produces only a 10-1 change in output luminance, which is ideal for the lighting conditions described.

a. On the other hand, where it is necessary to transmit information from a photographic plate or x-ray negative having a narrow contrast range, a system having a gamma greater than 1 would be more useful.

b. Curve c of figure 1-1 represents the transfer characteristic of such a system with a gamma of 2. A 10-1 change in input luminance would be expanded by the system into a 100-1 change in output luminance, resulting in the picture information being more easily discernible.

LESSON 1

PRACTICE EXERCISE

1. What are the gradations of brightness on a television system called?

   a. Gray scale
   b. Brightness balance
   c. Contrast scale
   d. Luminance balance

2. What is the level ratio lightest light to darkest light called?

   a. Brightness range
   b. Contrast range
   c. Illumination range

3. What is it called when the contrast range for a televised and the reproduced picture match?

   a. Gamma of unity
   b. Gamma of 0.5
   c. Gamma of 2

ANSWERS TO PRACTICE EXERCISE

1. a
2. b
3. a

LESSON 2

DEFINE THE VISIBLE SPECTRUM OF LIGHT AND COLOR PRINCIPLES

TASK

Describe the visible spectrum of light and color principles.

CONDITIONS

Given information and illustrations about terms relating to the visible spectrum of light and color principles.

STANDARDS

Demonstrate competency of the task skills and knowledges by responding to the multiple-choice test covering theory and principles of the visible spectrum of light and color.

REFERENCES

None

Learning Event 1:
DESCRIBE THE VISIBLE SPECTRUM OF LIGHT INGREDIENTS

1. The visible spectrum occurs when radiant energy of all wavelengths between 400 and 700 millimicrons is presented to the eye in nearly equal quantities, and the sensation of colorless or white light is perceived (similar to the white light emanating from a black and white television picture tube).

2. The white light can be divided into component radiations by passing a narrow beam of light through a glass prism (see figure 2-1). The resulting band of colored light is called the visible spectrum of light in which the principal colors are red, yellow-green, blue-green and blue.

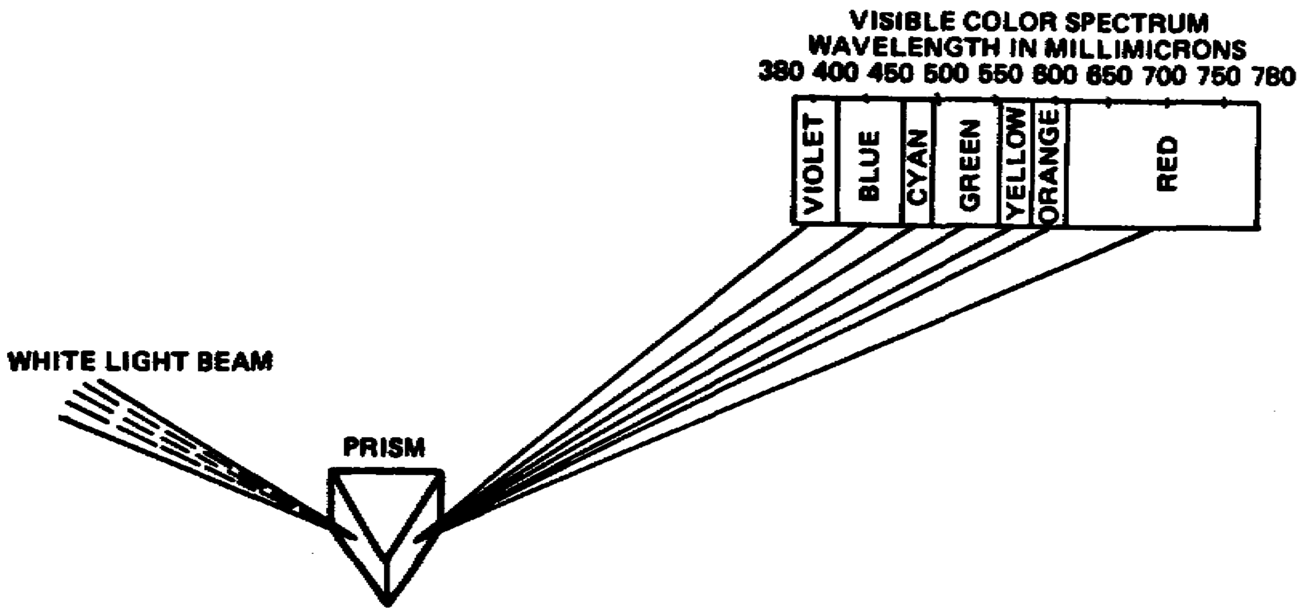


Figure 2-1. Effect of prism on white light

Learning Event 2:
DEFINE LUMINOSITY AND TRICHROMATIC COLOR MIXING

1. A luminosity curve is a graphical representation of the relative brightness to the eye of spectrum colors of a different wavelength. As shown in figure 2-2, the relative brightness of colors viewed under bright light differs from the same colors viewed under dim light. The two curves are similar in shape, but the scotopic curve is displaced about 40 millimicrons to the shorter wavelengths.

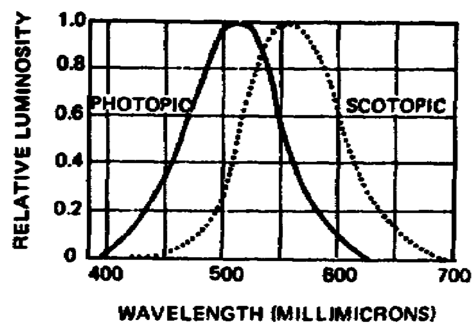


Figure 2-2. Luminosity curves for photopic and scotopic

a. Measurements of luminosity in the photopic range are made under conditions of bright daylight.

b. Measurements of luminosity in the scotopic range are made under conditions of the threshold of vision.

c. Relative luminosity of colors in the region between photopic and scotopic vision varies with intensity level. Generally, the reds tend to become darker in approaching scotopic levels and green and blues tend to become relatively brighter.

2. Trichromatic color mixing: Trichomatic color mixing is based on a theory of color vision which states that the retina of the eye consists of three different types of elements that are responsive to light of wavelengths corresponding to blue, green, and red.

a. These three groups of receptors are connected separately through nerves to the brain, where the sensation of color is derived from an analysis of the relative stimulations from the three receptors.

b. Because of the complexity of this network of nerves and nerve connections, it is easy to understand variations of color vision among individuals. When the system is seriously out of balance, color blindness results.

c. The three colors of blue, green, and red are known as additive primaries. Actually, the three additive color primaries are not necessarily restricted to blue, green, and red lights. Any three colors can be used as primaries as long as not any two of the colors can be mixed to match the third.

d. Blue, green, and red are chosen as primaries in color television because they permit the matching of the greatest range of common colors.

Learning Event 3:
DEFINE THE CHARACTERISTICS OF HUE, SATURATION AND BRIGHTNESS

1. Color characteristics: A study of colors as applied to color television would be relatively simple, if all that had to be considered were the various colors of light obtainable by mixing various intensities of red, green and blue primary lights.

2. These primary colors and their many companions resulting from their mixture (yellow, orange, magenta, cyan, etc.), contribute hue to color sensation, which is only one of three basic characteristics of interest. In addition to hue, two other characteristics of color, saturation and brightness, must be considered.

3. Saturation is a term which describes the amount of white light mixed with hue. The artist calls it "tint." The degree of saturation in a red hue is understood if it is remembered that pink, for example, is fundamentally a red hue diluted or mixed with a considerable amount of white light. A zero saturation of red hue represents white light, while 100 percent or full saturation of red hue is the full and true red with no white light. In other words, the pale or pastel shades of hue are less saturated than the vivid shades of hue.

4. Brightness is a term applied to the basic characteristics of color by means of which colors may be located in a scale ranging from light to dark.

a. Saturation and brightness are somewhat related because saturation reforms to the degree to which a color departs from gray or neutral hue of the same brightness.

b. Figure 2-3 shows the relative spectral sensitivity of the standard lead-oxide tube, the extended red lead oxide tube and two types of vidicon as well as the spectral characteristics of the average human eye. This also shows that the spectral response of the eye is not uniform.

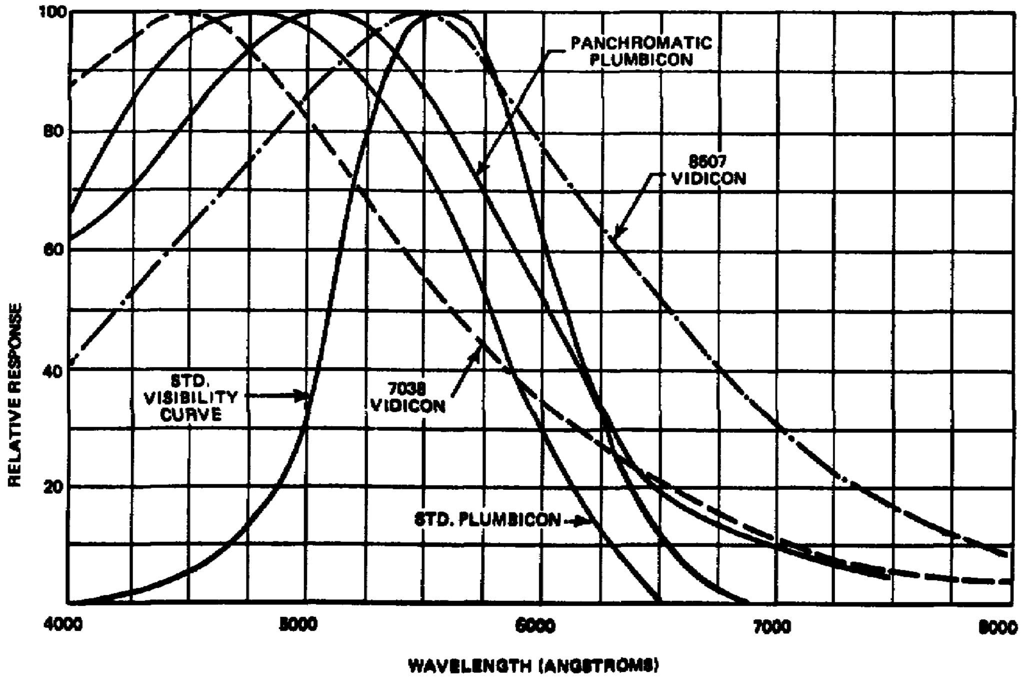


Figure 2-3. Spectral response of typical lead-oxide and vidicon pickup tubes compared to the human eye

c. The response of the eye peaks near the wavelength of yellowish-green. This indicates that a given amount of light energy may appear much brighter at some wavelengths than at others. The curves also show that the response of the various types of pickup tubes do not match.

5. The other two variables of color, hue and saturation, are controlled by the relative spectral distribution of light energy. Hue is determined by radiant purity, or freedom from white light.

a. Figure 2-4 shows a spectral radiation energy curve spread out more or less uniformly over the visible spectrum. When such a condition exists, white is seen as a pale or pastel shade.

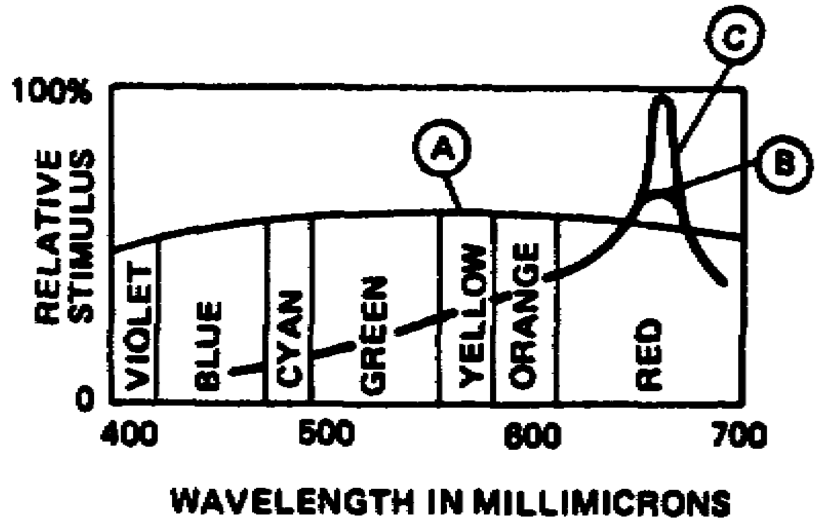


Figure 2-4. Spectral radiation curve of white, pink, and red objects

b. If the spectral radiation curve resembles that of B in the figure, the color is seen as pink; a low saturation of the dominant wavelength hue shows as red.

c. If the curve of special energy is like that shown on line C, the color is seen as a high saturation of dominant hue of red.

Learning Event 4:
DEFINE CHROMATICITY

1. Chromaticity: Chromaticity is that characteristic of a color representing hue and saturation together. The word "chroma" usually refers to the saturation of colors. The color on a color television receiver affects the vividness of the colors in the picture but not their hue.

2. The most commonly used chromaticity diagram is the one shown in figure 2-5 which is based on the color mixture curves shown in figure 2-4. These color mixture curves show the amount of the three primary colors, blue, red, and green, needed to match unit energy at each wavelength in the spectrum.

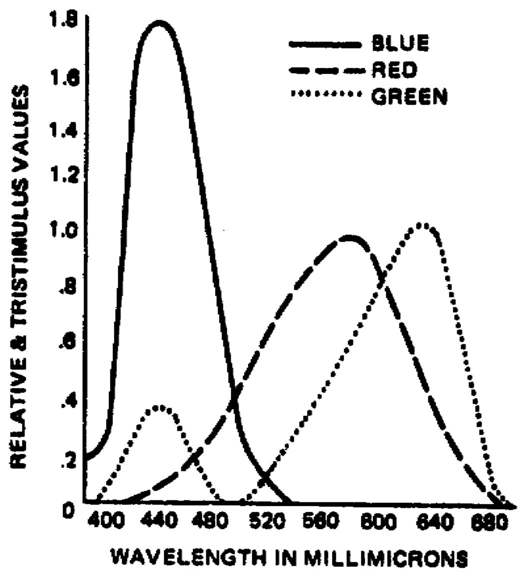


Figure 2-5. Fundamental color mixture curves

a. The derivation of the chromaticity diagram from the color mixture curves is rather complex, and need not be explained in this lesson.

b. The chromaticity diagram of figure 2-6 is a standardized color map for the system of colorimetry used by the International Commission on Illumination.

c. The color television primaries listed in the FCC signal specification are specified in this system of colorimetry and appear as points on the chromaticity diagram.

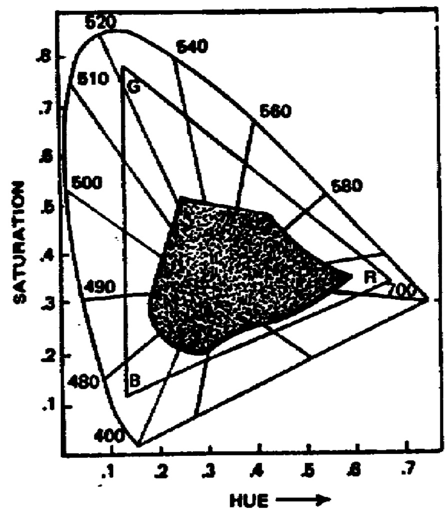


Figure 2-6. Chromaticity diagram

LESSON 2

PRACTICE EXERCISE

1. What is the visible spectrum of light for the human eye?

   a. Between 380-780 millimicrons
   b. Between 400-780 millimicrons
   c. Between 400-700 millimicrons
   d. Between 380-700 millimicrons

2. What is the term which describes the amount of white light mixed with hue?

   a. Brightness
   b. Contrast
   c. Saturation
   d. Light

3. What is determined by radiant purity, or freedom from white light?

   a. Hue
   b. Contrast
   c. Color balance

4. Chromaticity is that characteristic or color representing which of the following:

   a. Hue and saturation
   b. Brightness and saturation
   c. Hue and brightness
   d. None of the above

ANSWERS TO PRACTICE EXERCISE

1. c

2. c

3. a

4. a

LESSON 3
DEFINE THE MAIN CIRCUITS OF A COLOR TELEVISION CAMERA

TASK

Describe the main circuits of a color television camera.

CONDITIONS

Given information, illustrations and terms relating to main circuits of a color television camera.

STANDARDS

Demonstrate competency of the task skills and knowledge by responding to the multiple-choice test covering theory, terminology and principles of a color television camera's main circuits.

REFERENCES

None

Learning Event 1:
DESCRIBE HOW THE COLOR SEPARATION SYSTEM WORKS IN A COLOR CAMERA

1. The block diagram, shown in figure 3-1, shows the major components of the complete color camera chain and their relationship to the units of the camera. Red, green and blue video outputs from the camera are fed through the camera cable to the remote camera control panel and processing amplifier.

a. The processing amplifier and control panel, which can be compared to the camera control in a monochrome system, inserts blanking, shading, and pedestal control for the three tubes, and performs other functions described late in this section. From the processing amplifiers, red, green, and blue video signals are encoded into the composite output color signals.

b. A monitoring console provides both picture tube and waveform displays of various other points in the system which can be selected for display by a switching system. A color monitor provides a composite color picture of the encoded signal.

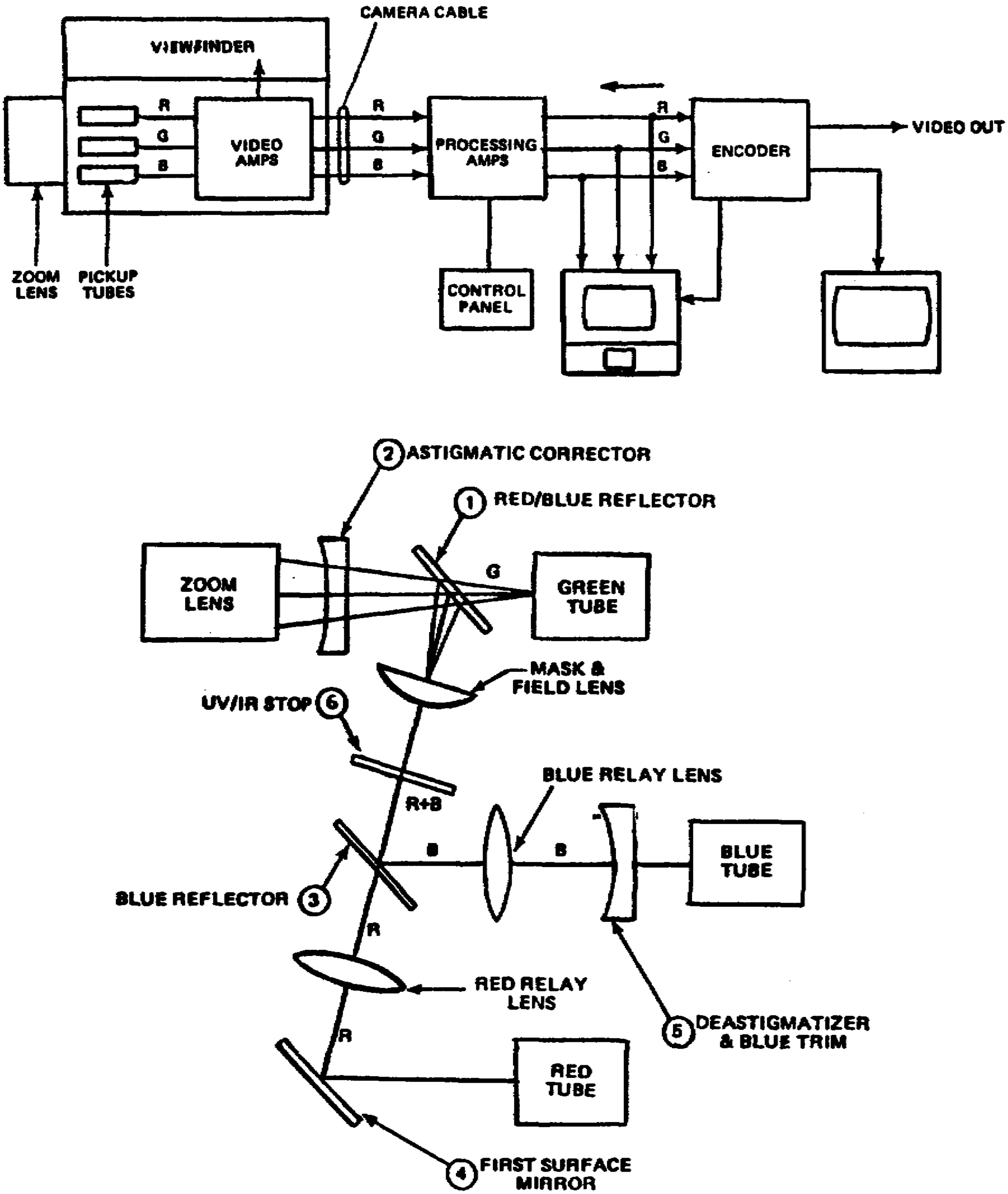


Figure 3-1. Color separation system

2. Optical color separation system. The purpose of the color separation system is to split the incoming image into three colored images as efficiently as possible with minimum image distortion. In this system, as seen in figure 3-1, the primary image from the zoom lens falls directly on the green tube, because the image does not pass through any additional glass. Since the wideband signal is taken entirely from the green tube, the high peaking usually required in video processing is minimized, and signal-to-noise ratio is minimized.

a. The green light passes through the red/blue reflective layer, which is deposited on a 1/6-inch thick glass plate, element 1. The astigmatism introduced by this glass is corrected by element 2, the astigmatic correction.

b. The red and blue light is reflected from the front surface of element 1, and a red and blue image is focused on the mask and field lens assembly. Light passing through this assembly then hits element 6, the ultraviolet/infrared stop. Visible red and blue light passes through this element to the blue reflection, element 3.

(1) The blue light is reflected to the relay lens and imaged on the blue tube. The deastigmatizer, element 5, corrects the astigmatism introduced by the astigmatic corrector, element 2.

(2) The red relay lens forms the red image on the tube via a front surface mirror, element 4.

3. With this system, all of the green light gets to the green tube, all of the blue to the blue tube, and all of the red to the red tube. Thus, the light efficiency is as high as possible commensurate with good colorimetry.

4. The red and blue relay lenses are identical, and each minimizes its image to 0.75 of the green image height and width. Thus the area covered by the red and blue images is about one-half of the green area. This has three very important advantages, as follows:

a. First, the dark current of the red and blue tubes is one-half of what it would be if the full size raster were scanned.

b. Second, minification is equalization of primarily capacitive discharge type lag. This type of lag is proportional to the target voltage swing. Compressing the image onto a smaller scanned area of the tube increases the target voltage swing, and thus reduces lag. The result is minimal differential lag.

c. Third, minification allows normal, zone-3, tube blemishes not to be seen, because that area is not scanned.

d. This optical system allows the use of light baffles because of its distributed layout. This prevents any light outside the field of vision striking the targets.

5. Video flow: For full understanding of video flow, refer to the two foldout block diagrams 3-2 and 3-3 (located at the end of Lesson 3).

a. The color camera system utilizes a filter input FET preamplifier with an improved signal-to-noise ratio, and a 7 mHz bandwidth in the green channel. The red and blue channels have an input stage with a 3.5 MHz bandwidth and approximately twice the gain of the green channel. The optics of the camera are so arranged that the signal current from the green pickup tube is approximately twice that of the red and blue. Consequently, the video signals out of the preamplifiers are approximately equal.

b. This arrangement is used because the green signal makes up a majority of the encoded luminance signal and therefore, requires the best signal-to-noise ratio. In addition, the green channel supplies the high frequency information for the red and blue channels. Limiting resolution in the luminance output is thus determined by the green signal.

(1) In the stages that follow, the FET input section of the video preamps is first amplified, clamped and then blanked before it is sent through the camera cable to the camera compensation module in the camera control unit (CCU).

(2) The cable comp module (A29) consists of three similar circuits that serve to equalize the high-frequency losses that occur in long cable lengths. Its also adds the individual black level setup that is maintained through most of the video path.

(3) From the cable comp module, green video goes to the video sync stripper board (A14), where the internal sync pulse is added to the video in the green video I board (A13). Red and blue video signals are sent directly from the cable comp board to their respective video I boards (A11, A12).

(4) On the video I boards, the video signals are first amplified and then attenuated by the switch master gain resistor. The signal is then white clipped and applied to the automatic gain control (AGC) amplifier, which maintains a fixed video gain throughout the video chain system.

(5) The shading amp that follows the AGC circuit multiplies the video by shading signal from the shading generator board (A3). This is used to compensate for fixed variation in sensitivity that occur in the optics or in the pickup tube.

(6) There are two outputs from the video I board. One is a full bandwidth signal that is only used in the green channel. The other is filtered by a 2.2 MHz, lowpass filter and these outputs feed the masking module (A31).

(7) The masking module consists of three similar circuits that permit the addition or subtraction of one color from another without affecting white balance.

6. The full bandwidth green signal and the low pass green signal also go to the contours separator board (A12), where they are subtracted from one another. This forms a high pass or contours signal which is then applied to a coring amplifier.

a. The coring amplifier strips out the noise by attenuating the low amplitude signals which contain the fine details of the picture. The output of the coring amplifier is applied to an aperture corrector, which boosts the higher frequency portions of the signal. This high-frequency boost compensates for the losses that occur in the pickup tube and lens.

b. From the contour separator, the contours signal is added back into all three video channels on the video II boards (A7, A8, A9). This process restores the green signal to its full bandwidth with an aperture boost. The process also effectively increases the bandwidth of the red and blue channels.

c. Following the addition of contours, a master pedestal signal is added to the video, and it is blanked with composite blanking before being sent to the gamma board.

d. On the gamma module (A30), all of the signals are white clipped and applied to a diode shaping network; this results in a gamma-corrected signal with a gamma of approximately 0.35. The gamma controls allow for continuous adjustment range from 1.0 to 0.35.

e. The gamma-corrected signals are then applied to the line driver board (A6), where the power amplifiers convert them to standard level 75 ohm signals. These are fed to the view finder processor board (A5), the waveform monitor driver board (A4), the encoder section, and the camera control unit back panel red, blue and green outputs.

Learning Event 2:
DESCRIBE HOW THE VIDEO SIGNAL IS PROCESSED FROM THE LENS TO THE FINAL PICTURE

1. Pulse processing: All pulses applied to the camera control unit are buffered by the input buffer board (A26). Composite sync from the buffer board is sent to encoder YIQ matrix board (A23), the bar generator board (A24), and the sync delay board (A25). Delayed composite sync from (A25), is used on the encoder control module (A32) and the viewfinder processor (A5).

a. Composite blanking from the input buffer board is applied to the YIQ matrix board, the bar generator board, the picture and waveform monitor board (A4), and to the three video II boards (A7, A8, A9).

b. Vertical drive from the input buffer board goes directly to the timing generator and pulse advance board (A21). On the timing board, an astable multivibrator is locked to the vertical drive. The output of the multivibrator is converted to a vertical timing pulse and sent to the camera head. Vertical timing pulses go to the camera head as negative pulses, and horizontal timing pulses are sent to the camera head as positive pulses on the same coaxial cable.

c. Horizontal drive from the input buffer board goes to the enhancer modulator board (A19), where it is used to generate timing pulses in the enhancer system. The horizontal drive pulses also go to the timing generator board (A21), where they are used to set the frequency of the astable multivibrator. The output of the latter is used to produce the internal horizontal blanking and the advanced horizontal timing pulses for the camera head. Should horizontal drive to the CCU be intercepted, the astable multivibrator would continue to supply horizontal timing pulses to the camera head.

d. Horizontal timing pulses to the camera head are automatically advanced to compensate for variations in camera cable length. This is done by comparing the pseudo sync returning from the camera head, to the output of the horizontal astable multivibrator. The drive to the camera head is adjusted automatically so that the video returning from the camera head is properly timed.

e. The horizontal blanking from the timing generator board is used on the shading generator board and the sync stripper board. Board (A14) generates the horizontal pulses used throughout the CCU.-These are: The horizontal clamp pulse, that is used on video board I and II, the white pulse is added to the video on the video I board and the white pulse sample on the video II board. The latter two pulses are used in the video AGC.

2. In the camera head the positive horizontal timing pulses and the negative vertical pulses from the CCU are separated on the electrode regulator board.

a. The vertical drive signal is then sent directly to the master sweep board and the individual yoke drivers for the cathode blanking.

b. The horizontal timing pulses are used to generate the horizontal drive for the master sweep board, and produce horizontal clamping and blanking.

c. The sync pulse is sent to the CCU with the green signal, and the test pulse is injected into the preamplifiers.

3. Power distribution: The camera control unit accepts either 115 V AC or 230 V AC at the back panel. This is then converted to unregulated nominal +22 V DC and -22 V DC and +30 V DC. These voltages are used in both the CCU and the camera head.

a. In the CCU, the minimal -22 V and +22 V are regulated to 15 V and used to power most CCU electronics. The +30 V is delayed and used to power the high voltage power supply which produces +900 V DC, +300 V DC, and -100 V DC.

b. The +900 V DC and the +300 V DC are sent directly to the camera head, while the -100 V DC goes to the front panel beam controls.

c. The nominal -22 V is used for generating focus current and supplying the tally from the CCU. A regulator on the sync delay board provides +5 V DC for the digital logic circuits from the + 15 V.

4. In the camera head, the nominal -22 V and the +22 V are regulated down to +12 V DC and -12 V DC to supply most of the electronics in the head. The undelayed 30 V and the -22 V also pass through soft regulators and are converted to +22 V and -10 V. These voltages are used on the yoke driver boards. The delayed +30 V is also used to supply the filament circuit, which is both current and voltage protected.

a. The +300 V supply from the CCU is converted to +43 V for the target supply and +50 V is also filtered and applied to the G-2 electrodes of the three pickup tubes. The +900 V supply is converted to +550 V and +430 V on the electrode regulator board and then applied to the G-4 and G-3 electrodes.

b. The power line voltage supplied to the CCU is also sent to the viewfinder and to the lapsed time meter in the camera head after passing through the power switch.

Learning Event 3:
DEFINE AND DESCRIBE THE ENCODER

1. Encoder: The encoder produces a composite color television signal from the various individual signals originating in a color television system. The complex circuits of the unit perform the following essential functions necessary for transmission of the TV signal according to the FCC specifications:

a. Cross-mixing or matrixing is taking the red, blue, and green video signals from a color TV camera chain, for a color slide camera or from a color bar generator, in proper proportion to produce a luminance signal in the three tube system to produce a two-color difference or chrominance signal.

b. Filter the chrominance signals to maintain their required bandwidth.

c. Compensates for delays in the signals introduced by filtering the chrominance signals.

d. Amplitude and phase modulate the color difference signal.

e. Add E1A sync signals to the video and color information.

f. Produce a burst signal for color synchronization.

g. Shift phase of incoming 3.58 MHz subcarrier through 360 degrees to allow matching of several encoder outputs with respect to subcarriers phase.

h. Maintain carrier balance automatically.

2. The essential circuits of an encoder are basically a matrix and delay, modulator, burst generator, and an adder circuit. In the matrix and filter section, the red, green and blue signals are fed to the unit. There they are transformed to a luminance (Y), and two color-difference (I and Q) signals which are then adjusted with respect to bandwidth and delay.

a. In the modulator section, the two color difference signals are modulated in phase and amplitude to form the chrominance signal. Burst flag is formed and/or processed and used to key the color sync burst into the composite output.

b. In the adder circuit, the operation needed to produce a composite signal from the chrominance, luminance and synchronizing signals is accomplished.

LESSON 3

PRACTICE EXERCISE

1. The image from the zoom lens falls directly onto which tube?

   a. Blue tube
   b. Green tube
   c. Red tube

2. What image is focused on the mask and field assembly?

   a. Red and green
   b. Red and blue
   c. Blue and green

3. What bandwidth is used in the green channel?

   a. 3.5 MHz
   b. 4.2 MHz
   c. 7 MHz
   d. 6 MHz

4. What is the input bandwidth of the color camera's red and blue channels?

   a. 3.5 MHz
   b. 4.2 MHz
   c. 7 MHz
   d. 6 MHz

5. Which input color supplies the high frequency information?

   a. Blue channel
   b. Green channel
   c. Red channel

6. The two video outputs from the video I board that feed the masking module are ___________, and __________.

7. Which board changes your signal to a standard 75 ohm level signal?

   a. Gamma
   b. Video I
   c. Video II
   d. Line driver

8. The astable multivibrator on the timing board is locked to what timing signal?

   a. Horizontal drive
   b. Vertical drive
   c. Sync

ANSWERS TO PRACTICE EXERCISE

1. b

2. b

3. c

4. a

5. b

6. full bandwidth green   low pass green

7. d

8. a

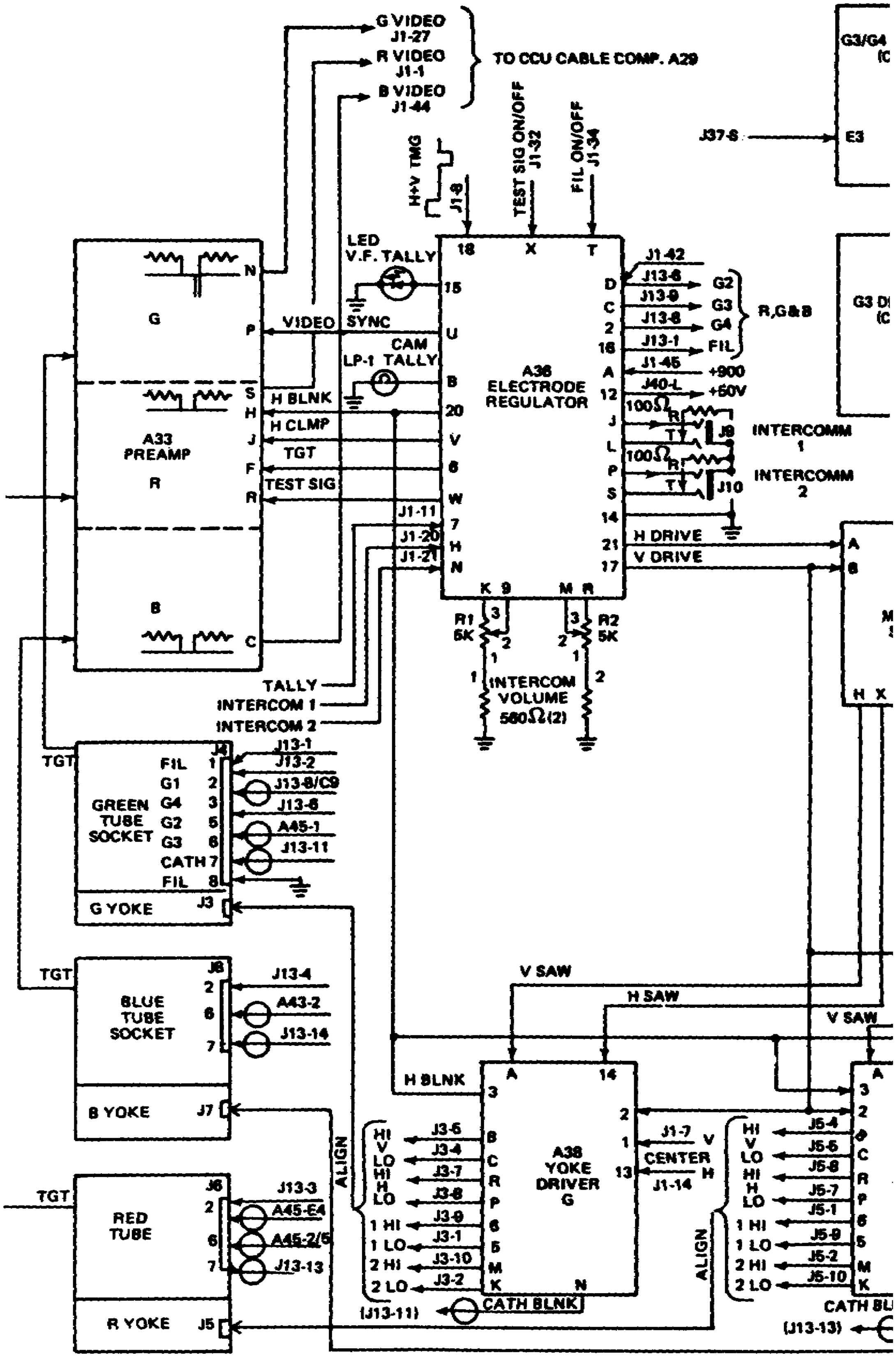


Figure 3-2. Foldout block diagram of camera head

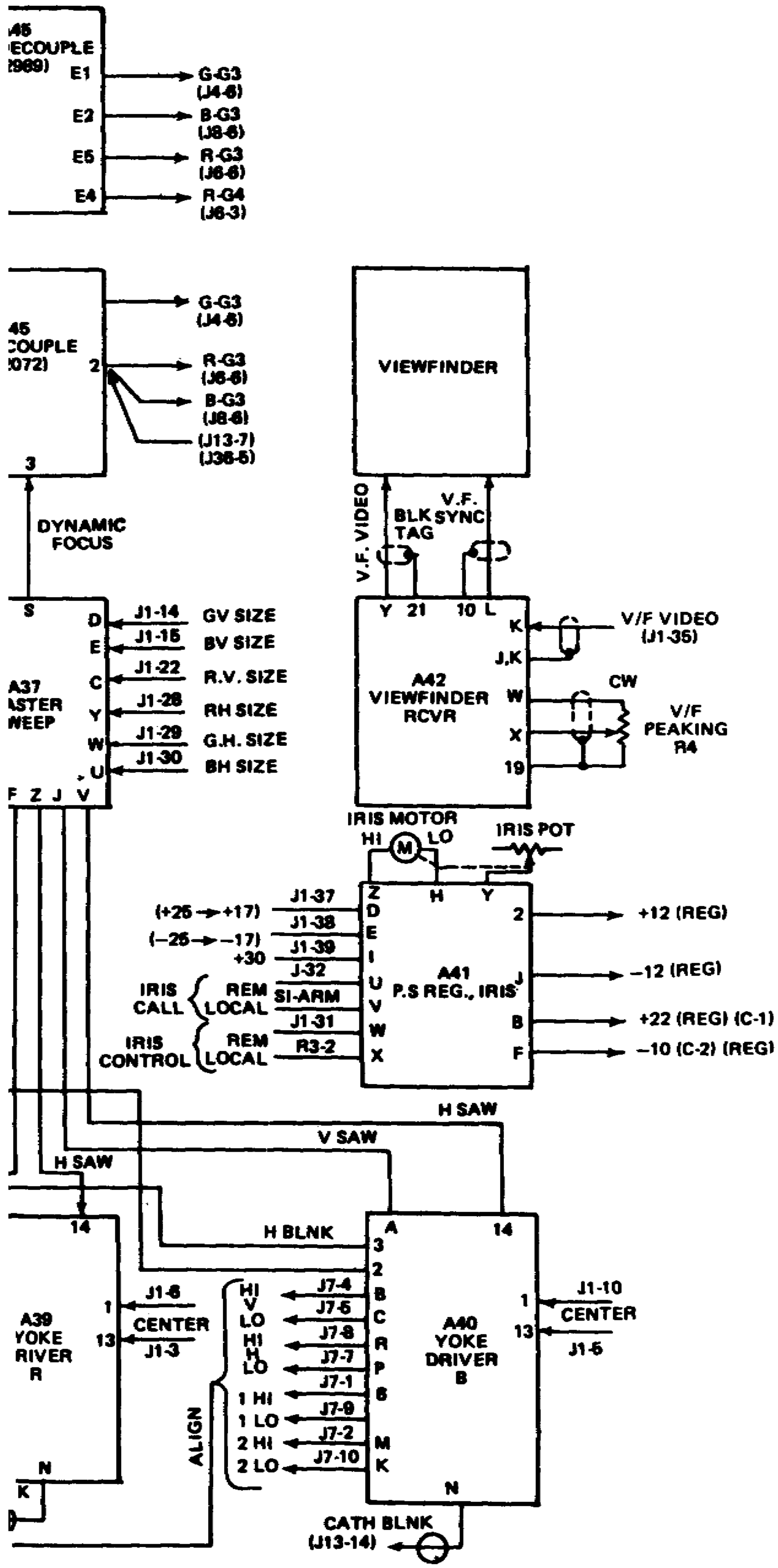
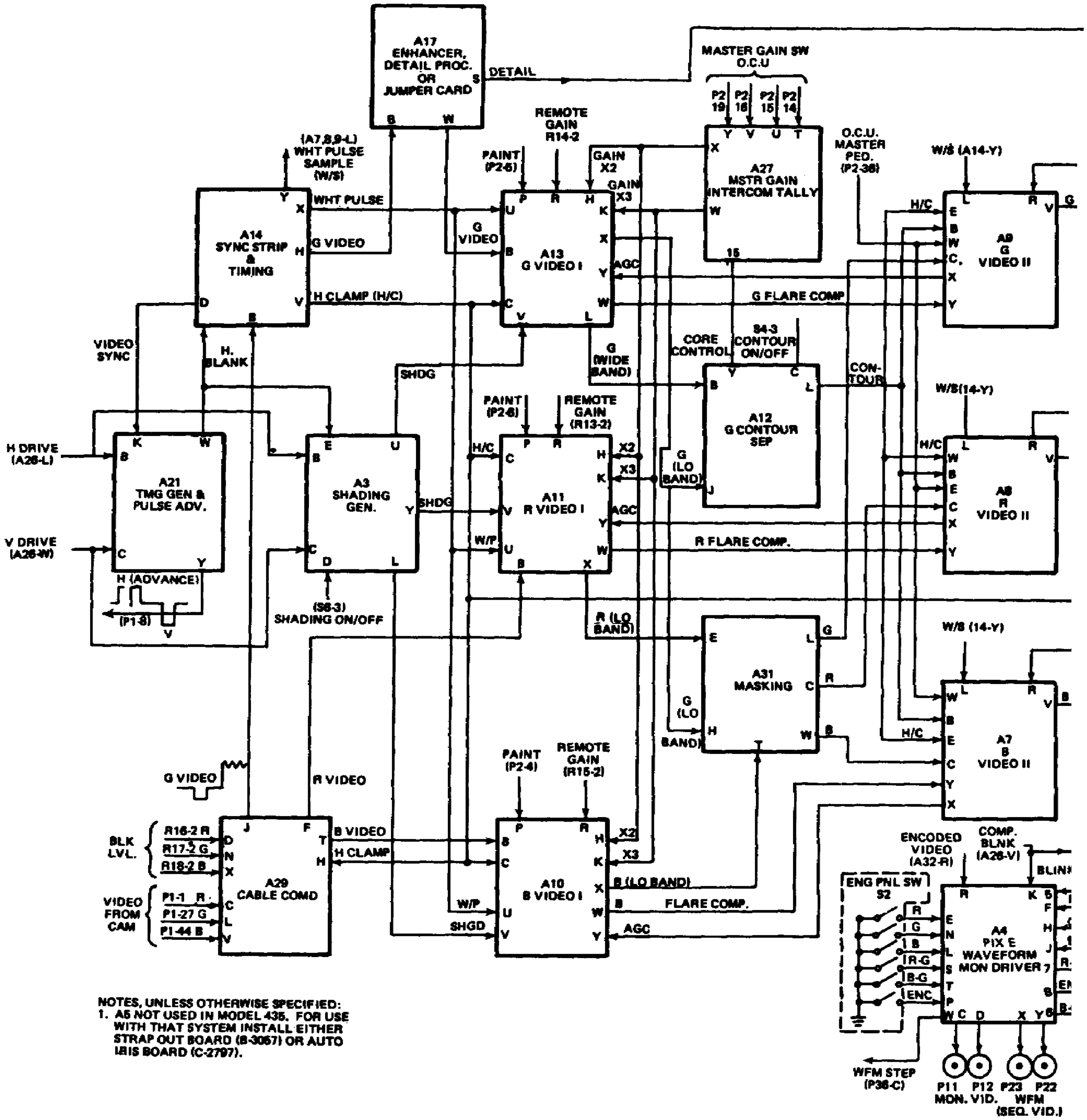


Figure 3-2. Foldout block diagram of camera head, Continued



NOTES, UNLESS OTHERWISE SPECIFIED:
1. A5 NOT USED IN MODEL 435. FOR USE WITH THAT SYSTEM INSTALL EITHER STRAP OUT BOARD (B-3057) OR AUTO IRIS BOARD (C-2797).

Figure 3-3. Foldout block diagram of camera control unit

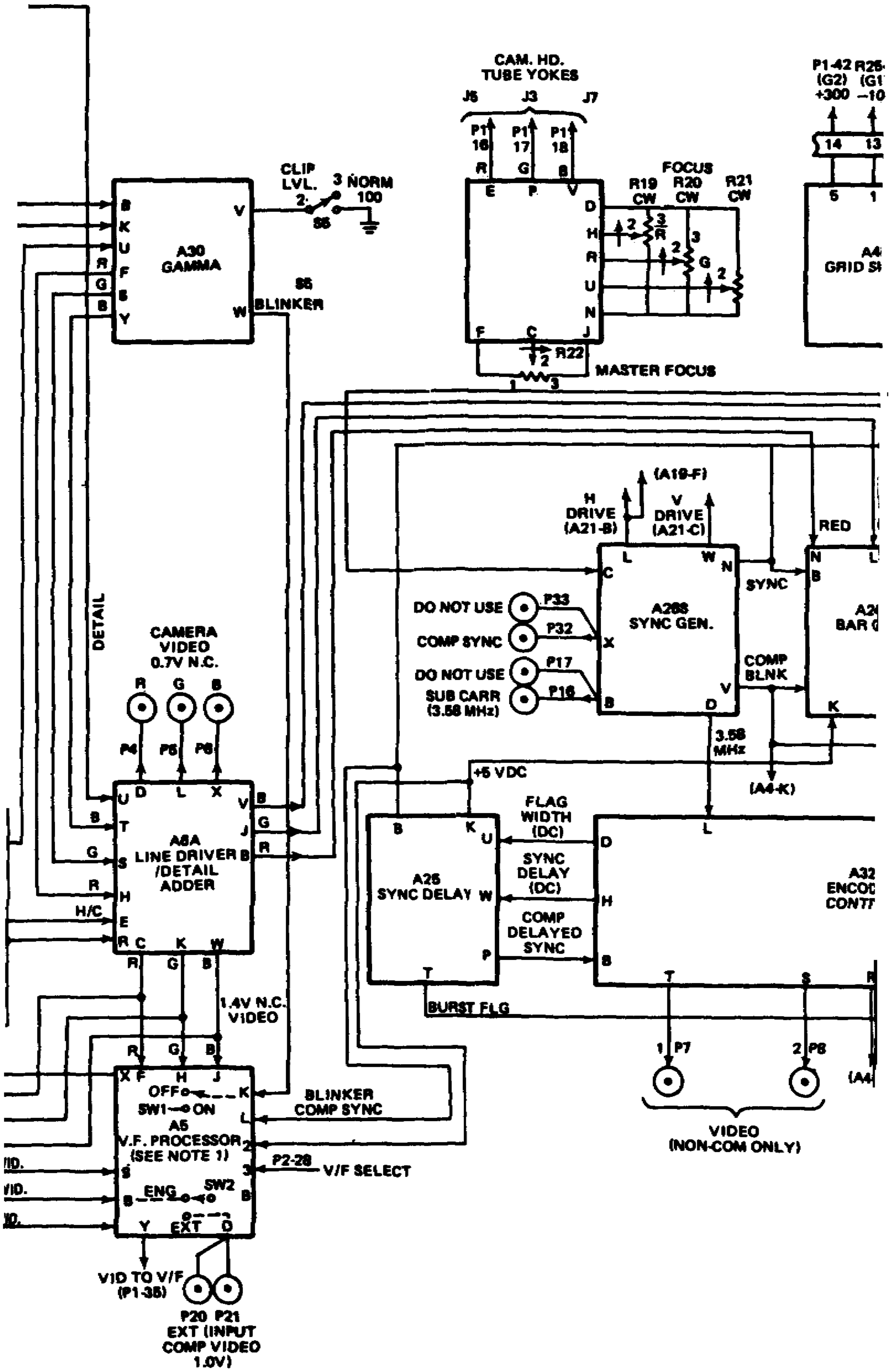


Figure 3-3. Foldout block diagram of camera control unit, Continued

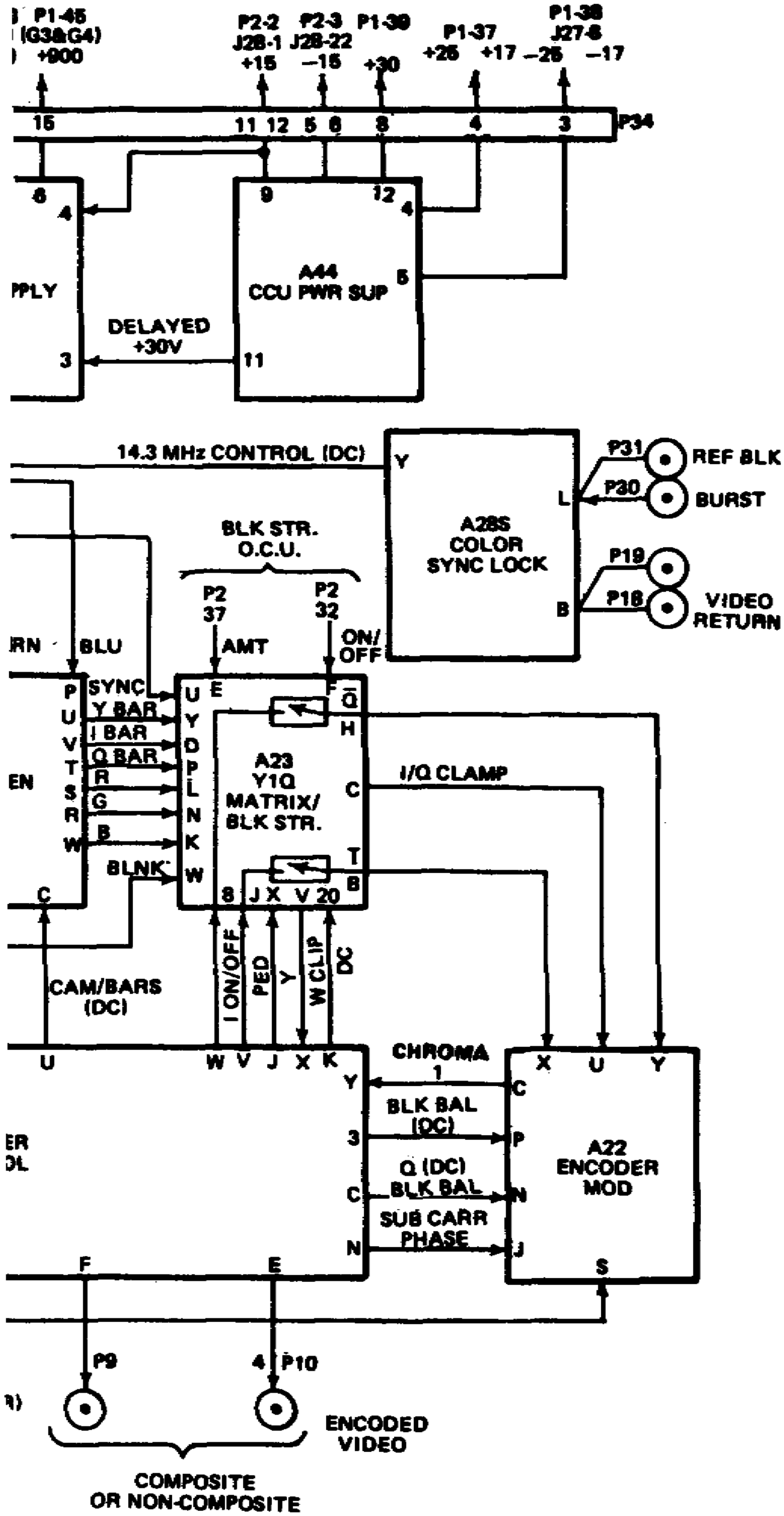


Figure 3-3. Foldout block diagram of camera control unit, Continued

LESSON 4
DEFINE THE PURPOSE AND USE OF A TELEPROMPTER PEDESTAL AND CAMERA HEAD

TASK

Describe the purpose and use of a teleprompter, pedestal and camera head.

CONDITIONS

Given information, illustrations and terms relating to a teleprompter pedestal and camera head.

STANDARDS

Demonstrate competency of the task skills and knowledges by responding to the multiple-choice test covering terms, use and theory of operation of teleprompter, pedestals and camera heads.

REFERENCES

None

Learning Event 1:
DESCRIBE THE PURPOSE AND USE OF A TELEPROMPTER

1. Teleprompters that are used in Army studios fall under two areas: mechanical and an electrical mechanical, which is a video feed. Both types can be attached to the front of your studio cameras. The video prompter uses a video monitor and is a simple camera system.

2. In the mechanical system you must ensure that the gears in the box are well greased. This must be done for two reasons. First, if a gear squeaks too loudly during a production, and can be picked up by a microphone used in the show, it will destroy the show. The second reason is that the noise could affect your video by the vibration, making your video useless to record. There is one other problem that may happen; your electrical ground on the mechanical prompter may short cut your camera, if it is mounted on the front of your studio camera.

3. The video prompter system will give your studio a better mobility. However problems may arise that would be as hard to fix as the studio camera itself, because the video prompter has a power supply, video DA cables, video monitor and camera, plus the mechanical device that rolls your script.

Learning Event 2:
DESCRIBE THE PURPOSE AND USE OF A PEDESTAL

1. Camera mounting equipment: Ease and fluidity of camera movement are essential factors of television and photography. Good and flexible mounting devices for television cameras are extremely important.

2. Three basic units have been developed that enable the cameraman to move the camera freely and smoothly about the studio. These units are the tripod dolly, studio pedestal, and the studio crane. The crane will usually not be seen in military studio operations.

3. The tripod dolly consists of either a wooden or metal tripod fastened to a three-caster dolly base. As a technician, you must ensure that your cable guards and locking devices are in perfect working order.

a. If the cable guards cannot be locked down, this may allow your cameraman to roll the camera over the camera cable, causing damage to the cables.

b. If just one of the three locks does not hold securely to its dolly, the tripod could slip out, causing your camera to fall to the ground. This would probably destroy the camera beyond repair. You must ensure that the leg height locks are in working order, because this could also cause the camera to tilt, and probably fall as well.

4. The studio pedestal gives you two advantages over the tripod dolly. First it is one complete unit making it much more secure because no legs may slip out of the locks. The other advantage is that you now have a means of raising or lowering your camera easily.

5. But as with the tripod dolly, you must ensure that it is in perfect working order. On the studio pedestal you must either check the air pressure or its fluid levels. The cable guards must be checked because the weight of this pedestal could destroy your cables.

6. On the better studio pedestals, the steering gears should be checked on a weekly basis for proper operation.

Learning Event 3:
DESCRIBE THE PURPOSE AND USE OF A CAMERA HEAD

1. Along with your pedestals you have three different types of camera mounting heads: Camera friction head, cradle head, and the camera cam head.

2. The camera friction head counter balances the weight of the camera by a strong spring. This spring can be adjusted to the specific weight of the camera in use. This head was made for the old, lighter monochrome cameras, but can now be used for the new lightweight color cameras.

3. The camera cradle head assures excellent camera balance at all times and thus prevents the camera from over balancing even at the most extreme tilting angle. The cradle head can accommodate any camera without special adjustments. The cradle head is extensively used for the heavier color cameras.

4. The cam head uses two cams, one on each side of the head, to assure balanced, smooth tilting and panning even with the heaviest camera. The cam head is designed for the heavy color camera, but can also be used for the new lighter color camera simply by changing the set of counter balancing cams.

5. All three types of mounting heads have horizontal and vertical locking devices, and drag controls that can be adjusted to the desired drag necessary for smooth, jerk-free camera operation.

6. You should apply a light film of graphite oil on your wheels and cams at least once per month.

LESSON 4

PRACTICE EXERCISE

1. What are the three basic units developed to carry a camera?

    a. Tripod, pedestal, crane.
    b. Dolly, mount, lift.
    c. Truck, flat, dolly.

2. What are the three camera heads called?

    a. Mount, hold, pivot.
    b. Friction, cradle, cam.
    c. Cam, pivot, friction.
    d. Cradle, cam, pivot.

3. Which camera head is best used for the big studio camera?

    a. Cradle.
    b. Friction.
    c. Cam.

4. What are the two types of teleprompters?

    a. Mechanical and manual.
    b. Electrical and photosensitive.
    c. Mechanical and electrical.

ANSWERS TO PRACTICE EXERCISE

1. a
2. b
3. c
4. c

LESSON 5
DEFINE AUDIO MAINTENANCE PROCEDURES FOR MICROPHONES AND CABLES

TASK

Describe the audio maintenance procedures necessary to ensure proper care and handling of audio equipment (microphone and cables).

CONDITIONS

Given information, illustrations, procedures and terms for the proper care and handling of audio equipment (microphones and cables).

STANDARDS

Demonstrate competency of the task skills and knowledges by responding to the multiple-choice test covering terms, use and the proper care and handling of audio equipment (microphones and cables).

REFERENCES

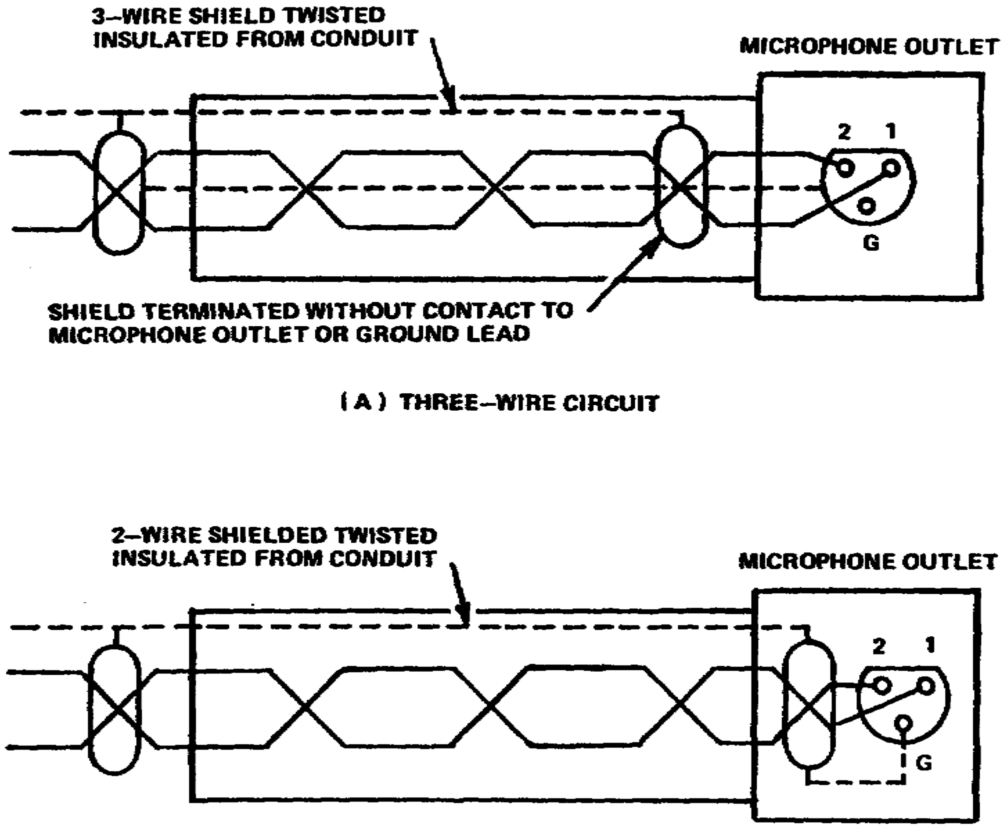
None

Learning Event 1:
DESCRIBE THE PROPER CARE AND HANDLING OF MICROPHONES

1. The microphone is perhaps one of the most delicate pieces of equipment associated with the broadcasting system. And if the proper care is taken, the microphone will last a long time. One major step in prolonging the life of a microphone is always store the microphone in a fairly strong box lined with foam rubber to absorb any shock the box may receive. Also, try to keep some type of felt material wrapped around the microphone. These two precautions will help greatly to keep your microphones working properly.

2. If the response from the microphone is zero when it is connected to an amplifier known to be good, several problem possibilities exist. Either the "hot" lead is open (if the ground side were open, noise would result), a short exists, or the internal element of the microphone is defective. The first place to check for a defect is in the plug. This is the point where the cable leaves the microphone housing.

a. Figure 5-1 shows a typical low-impedance microphone circuit in which a three-conductor cable is used. In this case, an open in either the No. 1 or No. 2 wire will cause weak or distorted sound. A break in the shielding results in a higher noise level (buzz).



(A) THREE-WIRE CIRCUIT

(B) TWO-WIRE CIRCUIT.

Figure 5-1. Wiring of microphone circuits

b. Sometimes the trouble is only intermittent and must be traced by jiggling the cable. Start at the plug and work back a foot or so at a time to the microphone housing. The following is a good general procedure to use in checking for microphone housing and for microphone and cable troubles.

(1) First check the plug and receptacle. All types are encountered in microphone input circuits. Some simple two-conductor microphones use the familiar jack and jack plug.

(2) Some use a metal shell that is insulated from the outer conductor which has a single pin in the center. For the latter type, the receptacle is a matching female plug with a spring-loaded connector that grips the center pin tightly, and has a knurled metal ring connector to hold the outer conductor firmly in place.

(3) The three conductor circuits vary considerably in design. But all are similar as far as inspection is concerned. Some have on the receptacle shell a small lever which must be depressed in order to pull the plug from the receptacle.

(4) Other types have a small knurled knob on the shell of the plug which must be depressed. When connecting the plug to the receptacle ensure that it is properly placed in the receptacle, then when pressure is applied, a pin springs up through a hole in the receptacle and locks the two parts together.

3. Plug connections that are made inside the shell require removal of the shell for inspection. In some cases, the shell and plug are both threaded and may simply be unscrewed. Others are held together by clamps and screws. Some cable conductors are soldered to the pins, others are held by screws on a pin lug.

a. Check the connections to the pins for looseness, corrosion dirt, faulty insulation, broken wires, or bent pins. Check the plug body for damage, and dirt. Check the shell for dents, cracks and dirt.

b. When the assembly is taken apart, clean everything with a cloth and cleaning fluid.

Learning Event 2:
DESCRIBE THE PROPER CARE AND HANDLING OF AUDIO CABLES

1. Checking your audio cable: Check about one foot of the audio cable at a time. Loop and unloop this amount of cable between your hands while slowly twisting it. Listen to the output of your amplifier and continue to handle each small section in this manner for at least fifteen seconds. Broken insulation or wires usually show up in this test.

2. If you find a break, it is better to replace the entire cable than to remove and splice the faulty section of cable. Splicing can be done in emergencies when a new cable cannot be obtained.

3. Some microphones have an OFF/ON switch that allows greater flexibility in their applications. If this switch is a sealed type with inaccessible contacts, it can be checked for proper working order. If it is faulty, simply replace it.

4. If the contacts are accessible, inspect the terminal connections for tightness and cleanliness, and the mounting for firmness. While operating the switch, observe all moving parts for freedom of movement, and look closely at the stationary spring contacts to check their tension.

a. Use pliers to tighten contacts that have loose tension.

b. Sections of a switch that are dusty, or pitted, should be cleaned with a dry cloth. For more serious conditions, moisten a dry cloth with cleaning fluid and rub the affected parts vigorously.

c. When points of contact show signs of excessive wear, replace the entire switch. Coarse cloth dipped in cleaning fluid can be used to clean the contacts. For emergencies you can use a No. 0000 or No. 000 sandpaper to polish and clean the contacts.

d. If dryness and binding are noticed, apply a drop of instrument oil with a toothpick at the point of friction. Do not allow the oil to flow into the electrical contacts.

e. The above are the most common faults found in most audio systems.

Learning Event 3:
DESCRIBE THE PROPER PROCEDURES FOR TROUBLESHOOTING SUSPECTED DEFECTIVE MICROPHONES

1. After cables and plugs have been eliminated as a source of trouble, check the transformer and terminal block connections. Remember that the microphone lines must not be checked with an ohmmeter without first disconnecting the ribbon microphone. The line then may be checked, (unterminated), for high resistance, shorts, or (terminated), for opens or high resistance connections.

2. Hum and noise may occur in any part of the audio circuit; In the microphone circuit this can result from ground loops or imbalance caused by faulty or improper cable connections to the bus or preamplifiers. Electrical machinery may induce hum into the microphone transformer or ribbon microphones. Sometimes this can be minimized by turning, tilting, or relocating the microphone relative to the magnetic field.

3. Microphone phasing: It is well known that correct phasing is important to the operation of any system using more than one microphone simultaneously. This is especially true when two similar microphones are placed in symmetrical relationship to a performer.

4. Polarity of a microphone, or the microphone transducer elements, refers to in-phase or out-of-phase conditions of voltage developed at its terminals with respect to the sound pressures of a sound wave causing voltage. An exact in-phase relationship can be taken to mean that the phase of the voltage is coincident with the phase of the sound-pressure wave causing the voltage. In practical microphones this perfect relationship may not always be obtainable.

5. The in-phase terminal, or a microphone, is that terminal of the connector or conductor that is connected to the in-phase terminal of the transducer. On microphones using a connector per E1A, the in-phase terminal is No. 1, the out-of-phase terminal is No. 2, and the ground terminal is No. 3. On microphones with a cable but no connector, the out-of-phase terminal is black.

6. The polarity of a pressure microphone (or omnidirectional) does not vary with the direction of arrival of a sound wave. The polarity of a gradient microphone is reversed for sound waves toward the rear of the microphone. There may be a substantial phase shift in the microphone at the low and high frequency ends of the spectrum. Therefore, the definition of polarity is generally restricted to the midpoint of the useful transmission band.

7. To check the phasing of two or more microphones, connect one microphone to the associated amplifier input and set the volume control to obtain the desired output. Then talk into the microphone. Now connect the second microphone in parallel with the first, without changing the volume control setting. Hold both microphones close together and speak into them. If the volume decreases from the previous level, reverse the connections of one of the microphone cables at the microphone plug. Similarly check each additional microphone for phasing.

8. In practice, polarity turnover between microphone channels may occur because of the installation of different types of amplifiers. Turnover also may result from the installation of the same type of amplifiers pad combinations when no attention is given to color-coded wiring with identical connections.

LESSON 5

PRACTICE EXERCISE

1. What will an open in either the No. 1 or No. 2 wire cause?

   a. Weak or distorted audio.
   b. Loud hum.
   c. No audio out.

2. What happens to your audio if your shield is broken?

   a. Weak or distorted audio.
   b. Buzz.
   c. No sound.

3. What is the most expedient way to find a break in your audio cable?

   a. Hold small loop and twist.
   b. Look at whole cable.
   c. Clean the cable.

4. What can be used in emergencies to clean the contacts of a switch?

   a. File.
   b. No. 0000 or No. 000 sandpaper.
   c. Drop of oil.

ANSWERS TO PRACTICE EXERCISE

1. a
2. b
3. a
4. b

LESSON 6

DEFINE AND EVALUATE PROPER LIGHTING FOR A TELEVISION STUDIO

TASK

Describe what makes good lighting for a television studio, and evaluate different lighting illuminations and wavelengths.

CONDITIONS

Given information, illustrations and terms relating to studio lighting requirements, lighting illuminations theories, and light wavelengths.

STANDARDS

Demonstrate competency of the task skills and knowledges by responding to the multichoice test covering terms, use, and theory of light for proper television studio lighting.

REFERENCES

None

Learning Event 1:
DESCRIBE PROPER LIGHTING REQUIREMENTS FOR A TELEVISION STUDIO

1. The requirements for good lighting are directly related to the quality of the desired television image. If available light is to be used, the optimum performance settings must be adjusted to the average light conditions.

2. The first consideration of studio lighting is the location of its sources. The common practice is to keep all sources of light off the studio floor and above the cameras, microphones, and sets. An accepted method of supporting lighting fixtures is to suspend pipe battens from the ceiling by chains and hooks, or to use a system of anchored piping to the studio ceiling.

a. A connector strip is mounted on brackets along the length of the batten. The space between the strip and batten is for clamping the lighting fixtures to the batten. The circuit for each outlet is connected through the end of the batten to a terminal box. This is connected to a cable duct or conduit. The circuits are then routed to the lighting switch board. This strip contains a number of cables with outlets spaced along its length for the lights.

b. The connector strips and outlets must be arranged to provide enough electrical power to handle the illumination necessary for good color reproduction. A typical layout provides more than the recommended 80 to 100 watts per square foot of power for color television. But not all of the outlets are operated at their full rated output, and some are not used at all. Also, some outlets should be provided in the overhead fixtures and along the walls to handle special lighting fixtures.

Learning Event 2:
DESCRIBE THE CHARACTERISTICS OF LIGHT SOURCES WHICH MUST BE CONSIDERED WHEN LIGHTING A STUDIO

1. Characteristics: It is known that spectral characteristics of light source should be compatible with those of the camera pickup tube used, and be suited to the production requirements.

a. Figure 6-1 shows the relative characteristics of several light sources.

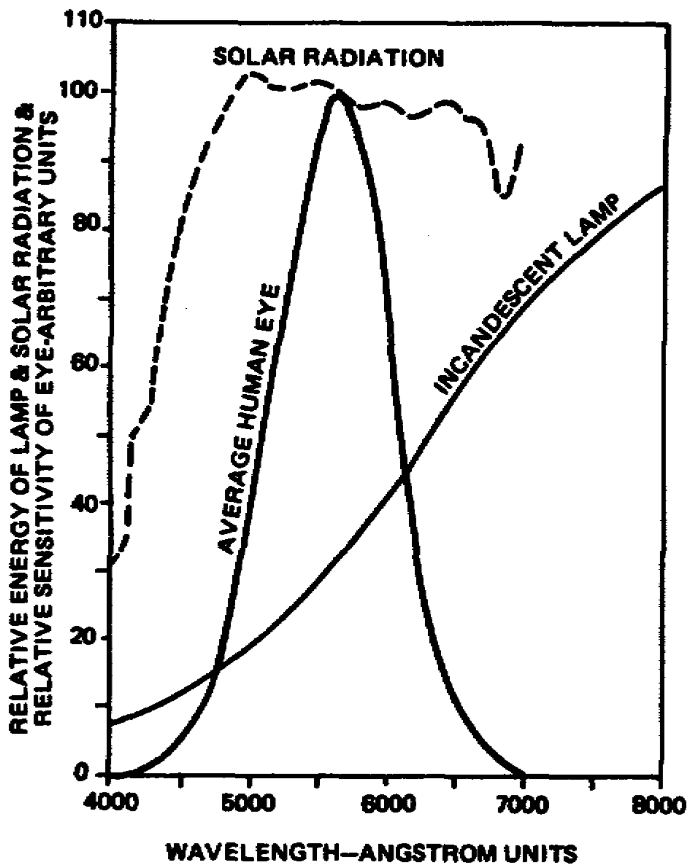


Figure 6-1. Relative light energy

b. The first curve (dashed line) represents the energy from solar radiation. Note that this curve is relatively flat and approaches white light which contains all frequencies.

c. The second curve shows the relative energy from a typical incandescent light source. Most of its energy falls in the red region 6000 to 8000 angstrons. For this reason incandescent lamps appear yellow or slightly red to any light source, determined by the relative sensitivity of the human eye as represented by the third curve in figure 6-1.

2. We know that both the plumbicon and the vidicon camera tubes have response curves closely resembling the sensitivity curve of the eye. Although both tubes perform satisfactorily as pickup tubes, they are sensitive to light levels. The spectrum of light is good for both, however, the plumbicon lighting level for producing good pictures lies between 32 and 64 footcandles with an f:8 lens. The average TV installation should be capable of producing 200 footcandles of illumination on any given scene, to permit flexibility in the control of lighting and lens stops.

3. Again referring to figure 6-1, you can see that where the energy of the incandescent lamp is weakest, the sensitivity of the eye is strongest. Since the sensitivity of the camera tubes and the eye compare favorably, you can assume that the incandescent lamp is a good light source for TV. Fluorescent lighting is weak in the red region and, therefore, skintones appear darker.

4. It is for this reason that fill light or key light of an incandescent source must be used with fluorescent lighting. This knowledge of proper lighting techniques is important to the maintenance man for making proper camera adjustments.

5. Incandescent lamps provide good control of the beam pattern and intensity of the lighting. The lamps are easy to dim and very easy to handle and manipulate. The good color output of incandescent lamps is desirable for both monochrome and color applications.

6. A special type of incandescent lamp developed in recent years is tungsten-halogen, or quartz. You should use this lamp where color cameras are used. Characteristics which make it desirable are:

a. Constant lumen output throughout life.

b. Constant color temperature throughout life.

c. Color temperature output that matches the design center for color cameras, normally 3200 kelvin.

d. Increased life over conventional incandescent lamps for equal lumen output and color temperature.

LESSON 6

PRACTICE EXERCISE

1. What is the first lighting requirement you should check in a television studio?

   a. location of light sources
   b. Wattage available per fixture
   c. Availability of color gels
   d. All of the above

2. What is the recommended wattage per square foot of candle power to attain good color reproduction?

   a. 50 to 75 watts
   b. 80 to 100 watts
   c. 100 to 150 watts
   d. 180 to 200 watts

3 If you must use fluorescent lighting in a studio, what should you use to balance its weak characteristics?

   a. Flood lights (front and back)
   b. Incandescent lights (key or fill)
   c. Scrim lights (front and side)
   d. All of the above

4. What is the color temperature output of a tungsten-halogen lamp?

   a. 1800 kelvin
   b. 2700 kelvin
   c. 3200 kelvin
   d. 4000 kelvin

ANSWERS TO PRACTICE EXERCISE

1. a

2. b

3. b

4. c