EG 28-1993

SMPTE ENGINEERING GUIDELINE

Annotated Glossary of Essential Terms for Electronic Production

1 Scope

Program production, as a skill and an applied art, historically began when photographic cinematography followed the Greek theater, and from there, expanded to embrace television and video. Now essential further contributions and modulations are recognized from computer graphics, data processing, graphic arts, telecommunications, psychophysics, etc., and their affiliates. Each of these technologies not only contributes associated hardware and software resources, but — since each has had an independent development — brings unfamiliar terms and uniquely specific definitions to a nominally common vocabulary.

Program production, which is defined in overview in figure 1 and in detail within the text of this glossary, is increasingly reliant upon this full spectrum of resources to be effective and efficient in its subsets of origination, post-production, and distribution.

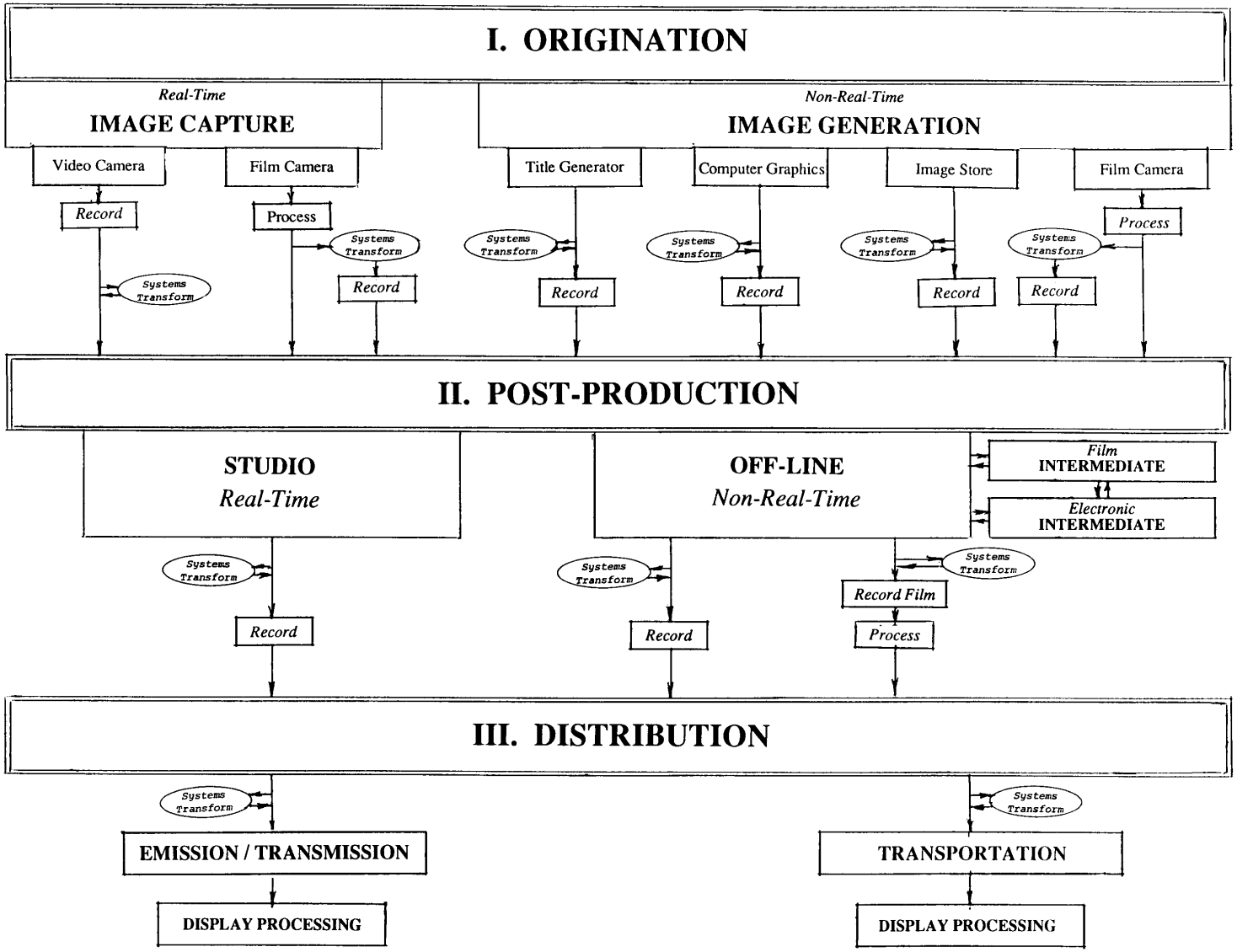
Program origination is provided with a multiplicity of potential sources for capturing, generating, and evaluating images. Post-production offers an increasingly evolving pallet of tools for merging, integrating, and evaluating source material to achieve maximum artistic impact. Distribution channels and facilities are multiplying both in number and in diversity, suggesting that programs' creative formats may need to be transformed eventually into a multiplicity of distribution formats in order to meet definitive needs.

Specific technical glossaries have developed within each technology. In the broadly electronic environment — embracing electronic imaging, computer graphics, data processing, and telecommunications — the primary reference directing unambiguous communication is ANSI/IEEE 100, Dictionary of Electrical and Electronics Terms, with 24,793 entries in the fourth edition. Within the photographic environment there have been several more informal glossaries. ISO 4246, Cinematography — Vocabulary, is taking leadership in coordination with a multilingual vocabulary responding to international concerns for precise communication. Graphic arts is another present focus for integrating technologies. And psychophysics identifying and quantifying the transfer function to human perception is defining the validity of assumptions on what is acceptable and improving methods of evaluation. Each of these technologies meets at the interface with program production as an essential partner.

This glossary beings together many of the terms that are essential in the production process. It draws upon the existing data bases when appropriate, noting the specific definitions and interpretations that apply to program production. Its intent is to include only those terms which impact upon production's basic needs and procedures, and whose clear interpretation in this environment is therefore essential. Nevertheless, it is important to recognize prevalent alternate definitions, perhaps relating to other applications of the participating technologies and thus to caution and to identify that one specific definition which may be most appropriate to program production.

Annotations are an essential component of this glossary since translations often must be accompanied by explanations. It is thus the objective of this limited scope glossary to help clarify and promote both communication and understanding among the formerly distinct technologies involved.

Approved May 1, 1993



NOTE – **Production**, working with images and their associated audio, employs a multidisciplinary blending of technologies and arts. Implementation of concepts first materializes with **origination**. These source materials are then edited and composed into a **program** via **post-production**. Finally, the completed **program** is transformed into the formats required for **distribution**.

Figure 1 – Program production

2 Definitions

adaptation: "Visual process whereby approximate compensation is made for changes in the luminances and colors of stimuli, especially in the case of changes in illuminants" [Hunt].

AES: Audio Engineering Society, New York. Of potential interest in electronic production are the following: SC-2, Subcommittee on Digital Audio; SC-3, Subcommittee on the Preservation and Restoration of Audio Recording; and SC-4. Subcommittee on Acoustics.

alias: An **artifact** in the reproduced image. 1. Most commonly, **artifacts** result from sampling frequencies or bandwidth limits too low for faithful reproduction of image detail, and thereby violating the **Nyquist limit**. Video images are sampled in two or three dimensions and computer graphics are sampled in three. (*Time* = *T* related to field or frame rate; *image height* = *Y* related to scanning lines; and for pixel-type sensors, *image width* = *X*. Upon presentation in the display, the signal is customarily reformatted to appear continuous in *X*.) Sampling theory establishes that the resulting frequency spectrum consists of an infinite number of copies of the baseband signal. These copies overlap if the sampling frequency is less than 2*F*max, where *F*max is the maximum frequency expected to be recoverable from the image without **alias**. The spectrum copies are separated if the sampling frequency is greater than 2*F*max. With overlapped spectra, **aliasing** has been introduced and cannot be removed. Thus the ratio of imaging bandwidth to sampling frequency is a critical design feature. With the desired sequence of separated spectra, **aliasing** can be avoided in the **display** by the choice of a bandpass reconstruction filter that passes only one copy of the spectrum. 2. Appearance of multiple copies of the baseband spectra may also result from FM modulation of an analog video spectrum with its inevitable sidebands and harmonics; if the sidebands of a harmonic overlap the baseband sidebands, visible **aliasing** is observed. A sufficiently low modulation index (the FM equivalent of the ratio of video bandwidth to sampling frequency) becomes critical for these systems. 3. In a composite (complex) spectral channel, any crosstalk of the information cannot be eliminated by filtering, and will produce **aliasing**, for example as **cross-color** and/or **cross-luminance**. 4. Moiré from color subcarrier decoded as **luminance** produces **aliasing**. 5. In a rectilinearly sampled system, lines not parallel to a sampling axis will appear stepped unless antialiasing processing algorithms have been applied. *cf.* **artifact; composite color; cross-color; cross-luminance; Nyquist limit**.

alpha channel: (production) In **electronic production** and **post-production**, there is increasing application of 4:4:4:4 encoding — which provides full-bandwidth R′, G′, and B′ plus the additional **alpha channel** to carry processing information. An adaptation from computer graphics, the **alpha channel** may contain information for **linear key**, for **luminance** and/or **chroma** transparency, for variable **edge enhancement**, and similar image-processing information. The term *alpha* derives from a processing coefficient designed to provide a degree of transparency in the foreground. The parameter *a* carries transparency information, used in the formula that computes the composite (of a foreground image and a background image) = (1-a)(foreground)+(a)(background). *cf.* **chroma key; composite image; linear key; matte channel; post-production**.

aperture, camera: The available maximum dimensions of the optical image on the active surface of the photo-sensor, within which good quality image information is being recorded. The **camera aperture** determines the maximum usable scene information captured and introduced into the system, and available for subsequent processing and display. These dimensions are usually defined by standards. (Note - Not to be confused with lens aperture, which defines the luminous flux transmission of the optical path.) *cf.* **aperture, clean; aperture, display; aperture, production; aperture, safe action; display; post-production.**

aperture, clean: (video) The concept of a clean aperture in a digital system defines an inner picture area (within the **production aperture**) within which the picture information is subjectively uncontaminated by all edge transient distortions (SMPTE 260M). Filtrations for bandwidth limitation, multiple digital blanking, cascaded spatial filtering, etc., introduce tran-

sient disturbances at the picture boundaries, both horizontally and vertically. It is not possible to impose any bounds on the number of cascaded digital processes which might be encountered in the practical **post-production** system. Hence, the **clean aperture** is defined to represent an acceptable (and practical) worst-case level of protection. *cf.* **aperture, camera; aperture, display; aperture, production; aperture, safe action; production, electronic, digital.**

aperture correction: In a scanned image system: 1. "Electrical compensation for the distortion introduced by the [limiting] size of a scanning aperture" [IEEE 100]. 2. **(video)**: The properties of the camera lens, optical beam-splitting installation, and camera tube all contribute to a reduced signal at higher spatial frequencies — generally falling off as an approximate (sin X)/X function. Additionally, it is obvious in a scanning system that the frequency response falls off as the effective wavelength of the detail to be resolved in the image approaches the dimension of the scanning aperture and becomes zero when that effective wavelength equals the dimension of the scanning aperture. **Aperture correction** normally introduced in all video cameras restores the depth of modulation to the waveform at higher frequencies with the objective of flat response to 400 TV lines (in NTSC) for a subjective improvement in image quality. *cf.* **contour enhancement; edge enhancement; image enhancement; resolution, visual; sharpness**.

aperture, display: The available maximum dimensions (mapped back into the camera aperture) for the system's ability to display good quality image information. The information available for **display** is usually cropped from the total captured by the cascade of tolerances that may be incorporated in the system, and also by intentional design features that may be introduced in the **display**. *cf.* **aperture, camera; aperture, production; display; post-production.**

aperture, production: (video) A **production aperture** for a studio digital signal defines an active picture area produced by signal sources such as cameras, telecines, digital video tape recorders, and computer-generated pictures. It is recommended that all of this video information be carefully produced, stored, and properly processed by subsequent digital equipment. In particular, digital blanking in all studio equipment should rigorously conform to this specified **production aperture** [SMPTE 260M]. The width of the analog **active horizontal line** is measured at the 50% points of the analog video signal. However, the analog blanking may differ from equipment to equipment, and the digital blanking may not always coincide with the analog blanking. *cf.* **aperture, camera; aperture, clean; aperture, safe action; lines, active horizontal; lines, active vertical; post-production, electronic**.

aperture, safe action: As defined by a test pattern, a **safe action aperture** indicates the safe action image area within which all significant action must take place, and the safe title image area, within which the most important information must be confined, to ensure visibility of the information on the majority of home television receivers. SMPTE RP 27.3 defines these areas for 35-mm and 16-mm film and for 2x2-inch slides. *cf.* **aperture, camera; aperture, clean; aperture, production.**

artifact: A defect or distortion of the image, introduced along the sequence from **origination** and **image capture** to final **display**. **Artifacts** may arise from the overload of channel capacity by excess signal bandwidth. Artifacts may also result from (1) sampling effects in temporal, spatial, or frequency domains, (2) processing by the **transfer functions**, (3) compromises and inadequacies in the system employed, (4) cascading of minor defects, and (5) basically any other departure of the total system from "complete transparency." *cf.* **alias; image enhancement; judder; mixing, digital; motion artifacts; rounding; transform, systems.**

bandwidth limiting: A reduction in the effective bandwidth of a signal, usually to facilitate recording, transmission, broadcast, display, etc. The reduction is usually accomplished through the action of an algorithm, which may involve simple lowpass filtering, more complex processing such as interleaving or quadrature modulation, or complete **resampling**. The term **bandwidth limiting** is normally applied in analog systems, although it also has a comparable meaning in digital systems. *cf.* **bit-rate reduction; compression, lossless; compression, lossy; data**

compression; data resampling; image compression; IRE units; transfer function.

bit: 1. "A contraction of the term binary digit; a unit of information represented by either a zero or a one" [IEEE 100]. 2. One digit in a binary (base 2) mathematical system. 3. "A unit of information content equal to the information content of a message the a priori probability of which is one-half" [IEEE 100]. *cf.* **byte.**

bit error rate (BER): The average probability of a digital recording system reproducing a bit in error. Note - IEEE 100 defines error rate: "Ratio of the number of characters of a message incorrectly received to the number of characters of the message received." **Bit error rates** typical of current digital tape recording are: digital video tape, about 10-6; digital instrumentation tape, about 10-9; digital computer tape, about 10-12. *cf.* **bit-rate; error concealment; error correction.**

bit-rate: "The speed at which bits are transmitted, usually expressed in bits per second" [IEEE 100]. Video information, in a **digitized image** for example, is transferred, recorded, and reproduced through the **production** process at some rate (bits/s) appropriate to the nature and capabilities of the origination, the channel, and the receptor.

bit-rate, real-time: When the information is obtained from a continuously varying source, and the information is being transmitted continuously without buffering, it is exchanged at the **real-time bit-rate**. Within the **production** sequence, it is actually only the image capture (i.e., camera and its recording system) that is required to be in real-time. The balance of **production**, including **post-production** operations, can be at a fraction of real-time if a more desirable result is achieved. (Subsequent to **production**, the final **display** must of course also be in real-time). *cf.* **bit-rate, recording; display; origination; post-production, off-line; production**.

bit-rate, recording: The **bit-rate** required of a recorder mated to a video camera or functioning in the **origination**, **post-production**, or **distribution** is generally greater than the concurrent **bit-rate, real-time** because of the **error correction** designed into the recording format. This "overhead" may increase the **bit-rate**, sometimes by as much as one-third, and frequently sets a practical limit in systems design. Examples in table 1 are intended only to clarify the definition. They indicate the range of some systems currently considered and a first estimate of their challenges. *cf.* **error concealment; error correction; post-production; origination.**

Table 1 – Probable recording rate, Mbits/s [1), 2)]

Bits per pixel	Maximum levels defined	CCIR Rec 601-2 [3)] 4:2:2	CCIR Rec 601-2 [3)] 4:4:4	CCIR Rec 709 [3)] 4:2:2	CCIR Rec 709 [3)] 4:4:4
8 [3)]	256	227 [4)]	340	1290	1940
10	1024	284	426	1610	2420
12	4096	340	510	1940	2910

[1)] All systems postulated employ field rates of 60 or 59.94 Mbits/s, with component encoding and 2:1 interlace. Progressive scan systems at the same frame rates would have double these **bit-rates**.

[2)] Estimates for gross data recording rates assume the same ratio of overhead to data bits in **component format** recording as that in the D-1 standard.

[3)] CCIR Recommendations 601-2 and 709 document 8-bit and 10-bit sampling, based upon sampling frequencies that are integral multiples of 2.25 MHz (i.e., 13.5 MHz for Rec 601-2).

[4)] The D-1 standard recording format is defined by SMPTE 224M and its related SMPTE Recommended Practices and Engineering Guidelines.

bit-rate reduction: (video) A reduction in the real-time data transmission rate in digital format, usually to facilitate recording, transmission, broadcast, display, etc., or even to comply with fixed limitations. Various algorithms appropriate for **video** signals may be employed from arbitrary resampling to more complex processing with the objective of reducing the transmission of redundant information in the image and possibly eliminating image content that will be inobvious in the final specified **display**. **Bit-rate reduction** is also appropriate and employed in audio records, either associated with video or standing alone. *cf.* **bandwidth limiting; compression, lossless; compression, lossy; data compression; image compression; resampling.**

black, absolute: 1. Optical black is no light. An absolute black can only be produced in a scene via a light-trap, "a black hole." 2. **(video)** A capped lens on the camera is the equivalent of an absolute scene black and should produce **reference black** level video signal from a properly adjusted studio camera. *cf.* **black level; black level, reference; setup.**

black compression: (video) "The reduction in gain applied to a picture signal at those levels corresponding to dark areas in a picture with respect to the gain at that level corresponding to the midrange light value in the picture. Notes – 1. The gain referred to in the definition is for a signal amplitude small in comparison with the total peak-to-peak signal involved. A quantitative evaluation of this effect can be obtained by a measurement of **differential gain**. 2. The overall effect of **black compression** beyond bandwidth limiting is to reduce contrast in the low lights of the picture as seen on a monitor" [IEEE 100]. *cf.* **differential gain; shoulder; toe; transfer function.**

black level: (video) "The level of the picture signal corresponding to the maximum limit of black peaks" [IEEE 100]. *cf.* **black level, reference; blanking level; setup.**

black level, monitor: The **luminance** produced on the monitor display by a signal at **reference black** level. Since the monitor brightness control should be adjusted to align CRT beam cut-off with reference black level signal, this provides zero excitation light from the CRT (only room ambient light reflected from the CRT faceplate). **Monitor black level** is normally set by use of a **PLUGE signal** to adjust CRT beam cutoff subjectively. *cf.* b**lack level, reference; IRE units; monitor, reference; monitor standardization; PLUGE signal; setup.**

black level, reference: The video signal level which is intended to produce **monitor black level** in the reproduced image. In systems with a setup level, i.e., the 7.5 IRE setup in a 525/59.94/2:1/NTSC composite video documented by ANSI/EIA TIA 250-C and SMPTE 170M, **reference black** is at the **setup level**. In systems with no setup level, **reference black** is at **blanking level**. *cf.* **black, absolute; black level; black level, monitor; blanking level; IRE units; PLUGE signal; setup; SMPTE 170M.**

black, projection: The **luminance** level in a projected image that is correlated with **subjective scene black** has two sources: In photographic and other light-modulating systems, 1. there will be **luminance** from whatever transmitted light passes through the maximum modulating density representing scene black, 2. additional **luminance** may be produced by nonimage-forming light (flare, room illumination, stray light, etc.). *cf.* **black, absolute; black, subjective, monitor; black, subjective, scene; luminance range.**

black, subjective, monitor: The **luminance** level which produces the perception of black on the monitor display. This subject has not been explored extensively, but Bartleson and Novick present evidence that it is relative to the highlight or white level, such that the **luminance ratio** to produce **subjective black** on a monitor is higher than that in a televised scene. They propose a **luminance ratio** of 100:1 for subjective white to black on TV monitors in a control room "dimly lighted." This **luminance ratio** specification has been formalized in SMPTE RP 166. *cf.* **black level, monitor; black, subjective, scene; luminance range, monitor; monitor, reference; monitor standardization; SMPTE RP 166.**

black, subjective, scene: That fraction of the highlight **luminance** required in a scene reproduced on a television **display** to convey the perception of black. The **luminance** of **subjective** black on a CRT has been studied by Lowry and Jarvis, who measured **luminances** in the original scenes, and compared the subjective appearance on a CRT display, as evaluated by viewing audiences. They found that the perception of black depends on a great many factors both in the reproduced scene and in the viewing conditions — such as average scene reflection, **luminance** of areas adjacent to the **display**, etc. In most situations, **luminance** levels of 1/40 to 1/60 of the highlight **luminance** produce the perception of black even though the **scene luminance range** may reach 200:1 or more. It follows then that a scene element that is perceived as black may not necessarily be at **reference black level** in a video signal. *cf.* **black level, monitor; black, subjective, monitor; image quality, perceived; luminance range, display CRT.**

blanking level: (video) "That level of a composite picture signal which separates the range containing picture information from the range containing synchronizing information. Note – This term should be used for controls performing this function" [IEEE 100]. *cf.* **black level; black level, reference.**

brightness: "Attribute of a visual sensation according to which an area appears to emit more or less light" [CIE 845-02-28]. The subjective counterpart of objective **luminance**.

byte: "A group of adjacent binary digits operated upon as a unit, capable of holding one character in the local character set, and usually shorter than a computer word (frequently connotes a group of eight bits)" [IEEE 100]. Current usage within the context of electronic production concerns is tending to define a **byte** as eight bits to have a consistent data unit for measuring memory capacities, etc. At the same time, **image files** are being created with samples of 8, 10, or more bits — and image files are being processed in 8-, 16-, and 32-bit channels. *cf.* **bit.**

camera analysis: The measurement and evaluation of the spectral sensitivities of the three color channels of a television camera. The camera **primaries** and **matrixing** are identified and measured. *cf.* **camera analysis, ideal; color-matching functions; colors, primary; matrixing; transfer function, opto-electronic.**

camera analysis, ideal: For optimum **image quality**, both **objective** and **perceived**, the spectral sensitivities of the three color channels of a television camera should be matched to the **primary colors** of the **R,G,B color space**. Note – Some practice still exists matching the color channels of the camera to the **display** phosphors. This reduces the **color gamut** and carries unnecessary noise penalties. The practice is deprecated. *cf.* **camera analysis; colors, primary; display; RGB color space; transfer function, opto-electronic.**

CCIR: Comité Consultatif International des Radiocommunications (International Radio Consultative Committee), Geneva, Switzerland. A permanent organ of the International Telecommunications Union with the duty to study technical and operating questions relating specifically to radio communications and to make recommendations on them. The CCIR does not prepare regulations; it draws up recommendations and reports, produced by experts from both public and private entities, which provide guidance on the best operational methods and techniques. The CCIR is expected to base its recommendations upon ISO and IEC international standards, but when no relevant one exists, the CCIR has been known to initiate standardization. These recommendations and reports provide a basis for international standardization of telecommunications. CCIR decisions are affirmed by international treaties. The U.S. is represented on the CCIR by the State Department, which is assisted by several Technical Advisory Committees composed of selected experts. The CCIR recognizes eight systems for 525/625-line images in current worldwide use [CCIR Report 624-4]. System M has 525/59.94 scanning and **NTSC** color encoding is commonly employed, hence M/NTSC, the dominant format in North America. The other seven systems have 625/50 scanning. All systems employ interlace scanning. **PAL** color encoding is commonly employed in systems B, G, H, and I, but may also be used in systems D, M, and N. **SECAM** color encoding is commonly employed in system D, but may also be used in systems B, G, H, K, K1, and L. The CCIR is currently monitoring the developments in **HDTV**. *cf.* **NTSC; PAL; SECAM; television, HDTV; television, ETV (EDTV).**

CCIR Recommendation 500: "Method for the Subjective Assessment of the Quality of Television Pictures" [CCIR Rec 500-4]. A detailed review of the recommendations for conducting subjective analysis of image quality. The problems of defining **perceived image quality** are reviewed, and the evaluation procedures for **interval scaling**, **ordinal scaling**, and **ratio scaling** are described — along with the applications for which each is best employed. *cf.* **image quality evaluation, interval-scaled; image quality evaluation, ordinal-scaled; image quality evaluation, ratio- scaled; image quality, perceived.**

CCIR Recommendation 601: "Encoding Parameters of Digital Television for Studios" [CCIR Rec 601-2]. "Considering that there are clear advantages for television broadcasters and programme producers in digital studio standards which have the greatest number of significant parameter values common to 525-line and 625-line

systems: ... unanimously recommends that the following be used as a basis for digital coding standards for television studios in countries using the 525-line system as well as those using the 625-line system." Defines specifications and parameters for applications of signals Y, C_R, and C_B in a 4:2:2 system. In an annex provides tentative specifications for applications of Y, C_R, and C_B or of R,G,B in a 4:4:4 system of at least 8 bits per sample. *cf.* **SMPTE 125M**.

CCIR Recommendation 709: "Basic Parameter Values for the HDTV Standard for the Studio and for International Programme Exchange" [CCIR Rec 709]. The recommendation considers "that the HDTV studio standard must be harmonized with those of current and developing television systems and with those of existing motion-picture film." In a review of current systems, a consensus was identified in specifications for opto/electronic conversion, picture characteristics, picture scanning characteristics, and signal format (both analog and digital representations). Work is underway in the editing of national and CCIR related documents to determine whether these consensus values may be affirmed in the next review of the individual documents. The values in Rec 709 are considered interim, and CCIR notes that continuing work is expected to define target parameters for future improved image rendition. *cf.* **CCIR Rep 801; SMPTE 240M; television, broadcast; television, high-definition.**

CCIR Report 801: "The Present State of High-Definition Television" [Report 801-4, 1990]. 1. "At present, the first results on studies related to Study Programme 18U/11 have been collected [CCIR, 1986-90b]. It must be recognized that these studies must be intensified in close cooperation with such organizations as the IEC and ISO to take fully into account the requirements for implementation of HDTV for media other than broadcasting, i.e., cinema, printing, medical applications, scientific work, and video conferencing." 2. "In addition, the transmission of HDTV signals via new digital transmission channels or networks has to be considered and taken into account, for instance, as defined in CCITT Recommendation I.121, Broadband Aspects of ISDN, adopted by the IXth CCITT plenary assembly at the end of 1988. For such new networks, the definition of new services, including those related to HDTV, have to be defined as expressed in a liaison statement (CCIR, 1986-90c) from CCITT Study Group 1 to CCIR Study Group 11." *cf.* **CCIR Rec 709, SMPTE 240M; SMPTE 260M.**

chroma: 1. To avoid the interdisciplinary confusion resulting from the two distinct definitions of **luminance**, it has been proposed that the video documents use **luma** for **luminance (video)** (i.e., the **luminance signal**) and **chroma** for **chrominance (video)** (i.e., the **chrominance signal**). Unfortunately, **chroma** is also a term with multiple distinct definitions. 2. "Chroma: The colorfulness of an area judged in proportion to the brightness of a similarly illuminated area that appears to be white or highly transmitting" [Hunt]. *cf.* **chrominance; chrominance signal; luma; luminance (video); Munsell chroma.**

chroma key: (production) A process for controlling the overlay of one video image over another, the areas of overlay being defined by a specific color or **chrominance** in one of the images. More versatility is available when working in the digital mode than in the analog since the color to define the effective mask can be more precisely specified. Effective use of **chroma key** frequently requires high definition in the color image and, therefore, full bandwidth R′,G′,B′ is preferred. **Linear key** provides an alternate method for control of the overlay. *cf.* **alpha channel; digital image processing; linear key; mixing, digital.**

chrominance: "The colorimetric difference between any color and a reference color of an equal **luminance**, the reference color having a specified **chromaticity**. Notes: (1) In three-dimensional color space, **chrominance** is a vector that lies in a plane of uniform **luminance**. In that plane it may be resolved into components called chrominance components. (2) In color television, the **chromaticity** of the reference color may be that of a specified white" [IEEE 100]. For example, in some systems two chrominance vectors are chosen to be the difference between **reference white** and two **primary colors**; i.e., R–Y and B–Y. *cf.* **chroma; color-difference signal; luminance; R,G,B color space; signal, chrominance.**

CIE: Commission Internationale de l'Eclairage (International Commission on Illumination),

Vienna, Austria. The CIE is concerned with methods of measurement plus recommended practices and standards concerning the properties and applications of light. "(1) The formal decisions or agreements of the CIE on technical matters, prepared by technical committees on which all the national committees having a special interest therein are represented, express as nearly as possible an international consensus of opinion on the subject dealt with. (2) They have the form of recommendations for international use and they are accepted by the national committees in that sense. (3) In order to promote international unification, the IEC expresses the wish that all national committees should adopt the text of the IEC recommendation for their national rules insofar as national conditions will permit" [CIE Publication 17.4].

CIE 1931 Standard Colorimetric System (XYZ): "A system for determining the tristimulus values of any spectral power distribution using the set of reference color stimuli [X],[Y],[Z], and the three CIE color matching functions $x_{(\lambda)}$, $y_{(\lambda)}$, $z_{(\lambda)}$, adopted by the CIE in 1931" [CIE Publication 15.2].

CIELab color space: "Three-dimensional, approximately uniform color space produced by plotting in rectangular coordinates L*,a*,b* quantities defined by the equations:

$$\left.\begin{array}{ll} L^* = 116(Y/Y_n)^{1/3} - 16 & Y/Y_n \\ a^* = 500[(X/X_n)^{1/3} - (Y/Y_n)^{1/3}] & X/X_n \\ b^* = 200[(Y/Y_n)^{1/3} - (Z/Z_n)^{1/3}] & Z/Z_n \end{array}\right\} > 0.008\,856$$

X,Y,Z describe the color stimulus considered, and Xn, Yn, Zn describe a specified white achromatic stimulus [i.e., **white reference**]" [CIE 845-03-56]. "Equal distances in the **color space** represent approximately equal color differences" [Hunt]. *cf.* **color space, reference; image file architecture; video index.**

CIELuv color space: "Three-dimensional, approximately uniform color space produced by plotting in rectangular coordinated L*,u*,v* quantities defined by the equations:

$$\begin{array}{ll} L^* = 116(Y/Y_n)^{1/3} - 16 & Y/Y_n > 0.008\,856 \\ u^* = 13\ L^*\ (u' - u'_n) & \\ b^* = 13\ L^*\ (v' - v'_n) & \end{array}$$

Y,u′,v′ describe the color stimulus considered, and Yn, u′n, v′n describe a specified white achromatic stimulus [**white reference**]" [CIE 845-03-54]. "The coordinates of the associated chromaticity diagram are u′ and v′. L* is the approximate correlation of lightness, u* and v* are used to calculate an approximate correlate of chroma" [Ref. CIE Pub 15.2.]. "Equal distances in the color space represent approximately equal color differences" [Hunt]. *cf.* **color space, reference; image file architecture; video index.**

CMYK color space: "A subtractive color space with cyan, magenta, and yellow as primary color set with an optional addition of black (K). For such a color set subtractive color mixture applies. The CMYK values used represent the amount of colorant placed onto the background medium. They include the effects of dot gain" [CIE; also ISO 8613]. *cf.* **color space, reference; image file architecture; video index.**

code: "A plan for representing each of a finite number of values or symbols as a particular arrangement or sequence of discrete conditions or events. To **encode** (*cf.*) is to express given information by means of a code" [IEEE 100]. "A system of rules defining a one-to-one correspondence between information and its representation by characters, symbols, or signal elements" [CCIR].

color, additive: 1. "Over a wide range of conditions of observation, many colors can be matched completely by additive mixtures in suitable amounts of three fixed primary colors.... The choice of three primary colors, though very wide, is not entirely arbitrary. Any set which is such that none of the primaries can be matched by a mixture of the other two can be used" [Wyszecki and Stiles]. 2. It follows that the **primary color** vectors so defined are linearly independent. Therefore, transformations of a **metameric match** from one **color space** to another can be predicted via a matrix calculation. The limitations of **color gamut** apply to each space. 3. The **additive color** generalization forms the basis of most **image capture**, and of most self-luminous displays (i.e., CRTs, etc.). *cf.* **CIELab color space; CIELuv color space; color space, reference; color, subtractive; display; image capture; metameric match; R,G,B color space; spectrophotometric match.**

color coordinate transformation: "Computation of the **tristimulus values** of colors in terms of

one set of **primaries** from the **tristimulus values** of the same colors in another set of **primaries**. Note: This computation may be performed electrically in a color television system" [IEEE 100]. *cf.* **tristimulus values**.

color correction: "The adjustment of a color reproduction process to improve the perceived-color conformity of the reproduction to the original" [IEEE 100].

color-difference signal: The **chrominance** vectors carrying the color information in a **composite format**. The **color-difference signals** have been defined by the CCIR for existing television systems [Report 624-4] as follows:

NTSC $E'_{I} = -(0.27)(E'_{B} - E'_{Y}) + (0.74)(E'_{R} - E'_{Y})$
$E'_{Q} = +(0.42)(E'_{B} - E'_{Y}) + (0.48)(E'_{R} - E'_{Y})$

PAL $E'_{U} = (0.493)(E'_{B} - E'_{Y})$
$E'_{V} = (0.877)(E'_{R} - E'_{Y})$

SECAM $D'_{R} = -(1.902)(E'_{R} - E'_{Y})$
$D'_{B} = +(1.505)(E'_{B} - E'_{Y})$

The subscripts Y, R, and B refer to luminance and to color-difference points on the chromaticity plane, derived from the relationship of the primary colors red and blue to the luminance. All of the primed values are gamma pre-corrected signals. Conventionally, all color-difference vectors are bandwidth limited. *cf.* **CCIR; chrominance; Y′, C′R, C′B, or Y′, P′R, P′B; R′,G′,B′ color space.**

color gamut: 1. In a system employing three color **primaries** to encode image color, each **primary** can be located on a CIE chromaticity diagram and these points connected as a plane figure. If the apexes are then connected with an appropriate value on the **white point** axis, a solid figure is produced enclosing the **color gamut** for that system. (On the CIE chromaticity diagrams, the points in x,y,z space approximate an inverted tetrahedron. In u,v,w space, they become a somewhat irregular four-cornered solid.) 2. Colors within the **color gamut** solid volume can be reproduced by the system as **metameric matches**. Colors outside the **color gamut** solid volume cannot be matched. Note that the area of the cross-section from the **color gamut** solid is a function of the **luminance**. 3. Although it is advantageous to have the widest possible **color gamut** for the ability to provide **metameric matches** for the largest number of colors, the required transformations from **origination** colorimetry to colorimetry matched to available **display** primaries, for example, may require large matrix coefficients and, therefore, a signal-to-noise penalty. The choice of **color gamut** is a compromise between color rendition and signal-to-noise. *cf.* **color-difference signal; color match, corresponding; color match, metameric; colors, primary; color space, reference; luminance; luminance range; white point.**

colorimetry: 1. "Measurement of colors based on a set of conventions" [CIE 845-05-10]. 2. "The techniques for the measurement of color and for the interpretation of the results of such computations. Note: The measurement of color is made possible by the properties of the eye, and is based upon a set of conventions" [IEEE 100].

color-matching functions: 1. "The tristimulus values of monochromatic stimuli of equal radiant power. Notes: (a) The three values of a set of color-matching functions at a given wavelength are called color-matching coefficients. (b) The color-matching functions may be used to calculate the tristimulus values of a color stimulus from the color stimulus function" [CIE 845-03-23]. 2. The **tristimulus value** per unit wavelength interval and unit spectral radiant flux. 3. "A set of three simultaneous equations used to transform a color specification from one set of matching stimuli to another" [Hunt]. "Note: **Color-matching functions** adopted by the CIE are tabulated as functions of wavelength throughout the spectrum and are given in section 13.5 of ANSI/IES RP16-1986" [IEEE 100].

color match, corresponding: "A corresponding color is defined as the stimulus that, under some different condition of adaptation, evokes the same color appearance as another stimulus when it was seen under the original state of adaptation" [Bartleson and Grum]. **Color match, corresponding** is a subjective judgment. *cf.* **color gamut; color match, metameric; colors, primary; color space, reference; spectrophotometric match; white point.**

color match, metameric: 1. Color images are **metameric matches** when their spectrally different color stimuli have identical **tristimulus values**.

The requirements for such a **metameric match** can be calculated for a specified viewing condition (and for viewing conditions other than those specified, the chromaticity will not be judged to correspond). 2. The corresponding color chosen for the **metameric match** will not provide a **spectrophotometric match**. In practical applications, **spectrophotometric matches** are of only academic interest, and **metameric matches** are sought. 3. **Color match, metameric**, resulting from calculations based upon **colorimetry**, produces a visual match as evaluated by the CIE description of human observers. *cf.* **color gamut; color match, corresponding; colors, primary; color space, reference; spectrophotometric match; white point.**

colors, primary: 1. "The colors of three reference lights by whose additive mixture nearly all other colors may be produced" [Wyszecki et al]. 2. **(video)** The primaries are chosen to be narrow-band areas or monochromatic points directed toward green, red, and blue within the Cartesian coordinates of three-dimensional **color space** — such as the CIE x,y,z color space. These **primary color** points together with the **white point** define the colorimetry of the standardized system. 3. Suitable matrix transformations provide **metameric** conversions — constrained by the practical filters, sensors, phosphors, etc, employed in order to achieve conformance to the defined **primary colors** of the specified system. Similar matrix transformations compensate for the viewing conditions such as a **white point** of the **display** different from the **white point** of the original scene. 4. Choosing and defining **primary colors** requires a balance between a wide **color gamut** reproducing the largest number of observable surface colors and the signal-to-noise penalties of colorimetric transformations requiring larger matrix coefficients as the **color gamut** is extended. 5. There is no technical requirement that **primary colors** should be chosen identical with filter or phosphor dominant wavelengths. The matrix coefficients, however, increase in magnitude as the available **display** primaries occupy a smaller and smaller portion of the **color gamut**. (Thus, spectral color primaries, desirable for improved colorimetry, become impractical for CRT **displays**.) 6. **(video)** Although a number of primary color sets are theoretically interesting, CCIR with international consensus has established that current technology and practice internationally are based (within measurement tolerances) upon the following:

Red	$x = 0.640$	$y = 0.330$
Green	$x = 0.300$	$y = 0.600$
Blue	$x = 0.150$	$y = 0.060$

"Note: These values are related to contemporary CRT technology and may be used for current implementation. Further studies are in progress for improved color rendition. It is recognized that the availability of a wider color gamut is highly desirable in an originating system. Furthermore, it is useful for purposes of picture processing to have available video signals proportional to light levels. In particular, the encoding of linear signals commonly identified as a 'constant luminance' system is believed to be desirable" [CCIR Rec 709]. 7. (video) SMPTE, in appendix A.1 to SMPTE 240M, offers guidance for further studies in improving color rendition by extending the color gamut: "With regard to color gamut, it is felt that the system should embrace a gamut at least as large as that represented by the following primaries:

Red	$x = 0.670$	$y = 0.330$
Green	$x = 0.210$	$y = 0.710$
Blue	$x = 0.150$	$y = 0.060$."

cf. **CIELab color space; CIELuv color space; CMYK color space; color, additive; color space, reference; color, subtractive; metameric match; R,G,B color space; ISO 8613.**

color space, reference: "Geometric representation of colors in space, usually of three dimensions" [CIE 845-03-25]. There are three **reference spaces** recognized by ISO 8613: **CMYK color space**; **CIELuv color space**; and **R,G,B color space**.

color, subtractive: 1. Subtractive colorimetry achieves **metameric matching** by removing portions of the spectrum from white light. The subtractive counterparts to the **additive color primaries** are those which when removed from white leave the red, green, and blue — accordingly cyan, magenta, and yellow. Combinations of these **subtractive colors** in various admixtures provide **metameric matches** to many colors. 2. **Subtractive color** principles are employed in all hard-copy color images and in light-valve systems such as color transparencies, LCD panel displays, motion-picture films, etc..

cf. **CMYK color space; color, additive; color space, reference; display; metameric match**.

common data rate (CDR): In the search for a single worldwide standard for HDTV, one proposal is to establish a **common data rate**, to be independent of line structure, frame rate, and sync/blanking. *cf.* **bit-rate, real-time; bit-rate, recording; common image format.**

common image format (CIF): In the search for a single worldwide standard for HDTV, one proposal is to establish a **common image format** to be independent of data rate, frame rate, and sync/blanking. *cf.* **bit-rate, real-time; bit-rate, recording; common data rate.**

component color: Structure of a video signal wherein the R′, G′, and B′ signals are kept separate from one another or wherein **luminance** and two band-limited **color-difference signals** are kept separate from one another. The separation may be achieved by separate channels, or by time-division multiplexing, or by a combination of both. *cf.* **chrominance; color-difference signal; composite color; luminance; R′,G′,B′ color space; signal, chrominance; signal, luminance.**

composite color: Structure of a video signal wherein the **luminance** and two band-limited **color-difference signals** are simultaneously present in the channel. The format may be achieved by frequency-division multiplexing, quadrature modulation, etc. It is common to strive for integrity by suitable separation of the frequencies, or since scanned video signals are highly periodic, by choosing frequencies such that the **chrominance** information is interleaved within spectral regions of the **luminance** signal wherein a minimum of luminance information resides. *cf.* **chrominance; color-difference signal; component color; luminance; R′,G′,B′ color space; signal, chrominance; signal, luminance; Y′, C'_R, C'_B, or Y′, P'_R, P'_B.**

composite image: An image that contains elements selected from two or more separately originated images. *cf.* **alpha channel; chroma key; image processing, digital; linear key; mixing, digital; post-production.**

compression (amplitude): "1. **(data transmission)** A process in which the effective gain applied to a signal is varied as a function of the signal magnitude, the effective gain being greater for small rather than for large signals" [IEEE 100]. "2. **(video)** The reduction in amplitude gain at one level of a picture signal with respect to the gain at another level of the same signal. Note: The gain referred to in the definition is for a signal amplitude small in comparison with the total peak-to-peak picture signal involved. A quantitative evaluation of this effect can be obtained by a measurement of differential gain" [IEEE 100]. 3. **(production)** A **transfer function** [as in **gamma correction**] or other nonlinear adjustment imposed upon signal amplitude values. *cf.* **black compression; differential gain; image compression; transfer function; white compression.**

compression (bit-rate): 1. **(multimedia)** Increasingly, compression is used in the digital environment to describe (a) initial digital **quantization** employing transforms and algorithms encoding data into a representation that requires fewer bits or lower data rates; or 2. processing of an existing digital bit stream to convey the intended information in fewer bits or lower data rates. **Compression** (bit rate) may be reversible **compression, lossless** or it may be irreversible **compression, lossy**. *cf.* **bit-rate reduction; black compression; compression, lossless; compression, lossy; differential gain; image compression; white compression.**

compression, lossless: 1. **Lossless compression** requires that the reproduced reconstituted bit stream be an exact replica of the original bit stream. The useful algorithms recognize redundancy and inefficiencies in the encoding and are most effective when designed for the statistical properties of the bit stream. 2. **(video) Lossless compression** of image signals requires that the decoded images match the source images exactly. Because of differences in the statistical distributions in the bit streams, different techniques have thus been found effective for **lossless compression** of either arbitrary computer data, pictures, or sound. *cf.* **bit-rate reduction; compression; compression, lossy; compression, quasi-lossless; image compression.**

compression, lossy: 1. **(video and multimedia) Bit-rate reduction** of an image signal by powerful algorithms that compress beyond what is achievable in **lossless compression**, or **quasi-lossless compression**. It accepts loss of information and introduction of **artifacts** which can be ignored as unimportant when viewed in direct comparison with the original. Advantage is taken of the subtended viewing angle for the intended display, the perceptual characteristics of human vision, the statistics of image populations, and the objectives of the **display**. 2. The lost information cannot be regenerated from the compressed bit-stream. *cf.* **bit-rate reduction; compression; compression, lossless; compression, quasi-lossless; image compression**.

compression, quasi-lossless: (video and multimedia) 1. Bit-rate reduction of an image signal, by an algorithm recognizing the high degree of correlation ascertainable in specific images. The reproduced image does not replicate the original when viewed in direct comparison, but the losses are inobvious or unrecognizable under the intended **display** conditions. The algorithm may apply transform coding, predictive techniques, and other modeling of the image signal, plus some form of entropy encoding. 2. While the image appears unaltered to normal human vision, it may show losses and artifacts when analyzed in other systems (i.e., **chroma key**, computerized image analysis, etc.) 3. The lost information cannot be regenerated from the compressed bit-stream. *cf.* **bit-rate reduction; compression; compression, lossless; compression, lossy; image compression.**

contour enhancement: A general term usually intended to include both **aperture correction** and **edge enhancement**. *cf.* **aperture correction; edge enhancement; image enhancement.**

contrast: "1. In the perceptual sense: Assessment of the difference in appearance of two or more parts of a field seen simultaneously or successively (hence brightness contrast, lightness contrast, color contrast, simultaneous contrast, successive contrast, etc.). 2. In the physical sense: quantity intended to correlate with the perceived brightness contrast, usually defined by one of a number of formulae which involve the luminances of the stimuli considered, for example: $\Delta L/L$ near the luminance threshold, or $L1/L2$ for much higher luminances" [CIE 845-02-47]. *cf.* **aperture correction; edge enhancement; sharpness.**

conversion, frame-rate: Standardized image systems now exist in the following frame rates per second: 24, 25, 29.97, 30, and 60. In transcoding from one system to another, **frame-rate conversion** algorithms perform this conversion. The algorithm may be as simple as to drop or add frames or fields, or it may process the information to generate predictive frames employing information from the original sequence. In interlace systems, the algorithm may be applied independently to each field. *cf.* **artifact; line-rate conversion; motion artifacts; Nyquist limit; post-production; resampling; transform, systems.**

conversion, systems: See **resampling; transform, systems**.

cross-color: An **artifact** observed in **composite** systems employing quadrature modulation and frequency interleaving. **Cross-color** results from the multiplicities of line-scan harmonics in the baseband signal, which provide families of frequencies surrounding each of the main harmonic peaks. These families become even more complex if there is movement in the scene **luminance** signals between scans. Since the interstices are, therefore, not completely empty, some of the information on the **luminance signal** is subsequently decoded as color information. A typical visible effect is a moiré pattern. *cf.* **artifact; composite color; cross-luminance.**

cross-luminance: An **artifact** observed in **composite** systems employing quadrature modulation and frequency interleaving. As the analog of **cross-color, cross-luminance** results in some of the information carried by the **chrominance signal** (on color subcarrier) being subsequently interpreted as fine detail luminance information. A typical visible effect is chroma crawl and visible subcarrier. *cf.* **artifact; composite color; cross-color.**

data: "Any representation of a digital or analog quantity to which meaning has been assigned" [IEEE 100]. *cf.* **data compression; resampling.**

data compression: Application of an algorithm to reduce the **bit rate** of a digital signal, or the **bandwidth** of an analog signal while preserving as much as possible of the information — usually with the objective of meeting the constraints in subsequent portions of the system. *cf.* **bandwidth limiting; bit-rate reduction; compression, lossless; image compression.**

definition: "Distinctness or clarity of detail or outline in an [image] reproduction" [IEEE 100]. *cf.* **resolution, image; resolution, visual; sharpness.**

differential gain: 1. "The difference between (a) the ratio of the output of a small high-frequency sinewave signal at two different levels of a low-frequency signal on which it is superimposed, and (b) unity" [IEEE 100]. 2. **(video)** "A curvature in the input-output characteristics of a system handling composite **video** (i.e., **gamma correction** or a nonlinear **transfer function**) permits the **luminance signal** to vary the effective gain of the channel for the **chrominance signals**.... This same **differential gain** change occurring in a feedback amplifier can result in the **chrominance signal** phase [decoded as **hue**] being varied by the **luminance signal**" [Benson]. *cf.* **chrominance; chrominance signal; luminance signal; composite color; hue; transfer function.**

display: (See figure 1.) The visual presentation, a final transduction of the image information into an optical image that is an intended representation of the original scene, for viewing by the targeted audience. The correlated audio information is also transduced. **Display** facilities may include reflective or transmissive screens, self-luminous receivers and monitors, various projection systems, light-valve systems, liquid crystal units, etc. *cf.* **display signal processing; distribution; emission; origination; post-production; transmission; transportation.**

display signal processing: (See figure 1.) 1. An efficient, widely compatible system requires that **distribution** be free of detailed requirements specific to **display**, and that necessary additional **display processing** unique to that **display** class be conducted only at the **display**. 2. The variety of **display** systems, already numerous, continues to increase. Each system or variant has its own set of specifications, performance characteristics, and requirements, including **electro-optic transfer function**, **color gamut**, scanning sequence, etc. 3. **Display signal processing** might include transformation at the **display** to the appropriate **luminance range** and **chrominance**, to **display primaries** and **reference white, matrixing** to achieve **metameric color match, adaptation** to surround, plus conversion to **scanning progressive** or **scanning interlaced**, etc. 4. **Display processing** may not be required for **transmission** if there is unique point-to-point routing clearly identified and appropriate processing has been provided in **distribution**. 5. But it is frequently required for **emission** to a diffuse population of **display** systems. *cf.* **color gamut; color match, corresponding; color match, metameric; display; distribution; emission; luminance range, display; transfer function, electro-optic; transmission.**

distribution: (See figure 1.) 1. The delivery of a completed program to **distribution**-nodes for **emission/transmission** as an electrical waveform, or **transportation** as physical package, to the intended audiences. Preparation for **distribution** is the last step of the **production cycle**. 2. Typical **distribution**-nodes include: release and duplicating laboratories, satellite systems, theatrical exchanges, television networks and groups, cable systems, tape and film libraries, advertising and program agencies, educational systems, government services administration, etc. 3. To prepare an editorially-completed program for **distribution** may involve or may require technical processing of the editorially-completed program, such as: (a) interconversions from electronic to photographic or from photographic to electronic, (b) system conversions to one of the ISO photographic formats, to one of the CCIR electronic formats, to one of the ISO computer formats, or to a special-purpose format. (c) Various simple or complex **bandwidth limiting, data compression** and **data resampling** algorithms may be employed to act upon the information content. (d) Leaving **distribution**, the program may be in the form of an electrical or electromagnetic waveform, or it may be recorded on some media contained, for example, on a reel or in a cassette. (e) The **display** facilities served may include television stations, theaters, cable head-ends, schools, industrial

presentation facilities, conference centers, tape and film sales and rentals, direct consumer, etc. *cf.* **display; emission; image compression; origination; post-production; production; transform, systems; transportation; transmission.**

dynamic range: "**(video)** 1. The difference, in decibels, between the overload level and the minimum acceptable signal level in a system or transducer. 2. The ratio of two instantaneous signal magnitudes, one being the maximum value consistent with specified criteria or performance, the other the maximum value of noise" [IEEE 100]. 3. The concept of **dynamic range** is applicable to many measurements beyond characterization of the video signal, and the ratios may also be expressed as f stops, density differences, illumination or luminance ratios, etc. *cf.* **dynamic range, display; dynamic range, image capture; IRE units.**

dynamic range, display: 1. The range of **luminances** actually achieved in a **display**. The system's overall **transfer function** is the most informative specification of **dynamic range**, inasmuch as nonlinear processing has nearly always been applied to the **luminance** of the reproduced scene. 2. Frequently, however, the **dynamic range, display** is estimated by observing the reproduction of a stepped gray-scale having calibrated intervals. Conventionally, the **dynamic range** is reported to include every step whose transition can be detected — no matter how miniscule. Human vision is less adept at judging **luminance** of extended areas, but particularly sensitive to **luminance** transitions which may even have been exaggerated by **edge enhancement**. "Resolved steps" may be reported, therefore, even when the perceived luminance difference between the areas of adjacent steps is inobvious. 3. **(video)** Visual judgment of **dynamic range** by enumeration of distinguishable gray-scale steps is dependent not only upon the magnitude of image **luminance** differences between adjacent steps, but is also dependent upon the area of each step, the nature of the image surrounding the steps and perhaps the location on the face of the CRT. *cf.* **image compression; luminance range, display; luminance range, recorded; luminance range, scene; luminance, relative, scene; transfer function; transfer function, electro-optic.**

dynamic range, image capture: The range of **luminances** actually captured in the image is defined and limited by the transfer function which is usually nonlinear. Capture and recording systems traditionally limit their linear response to a central portion of their **dynamic range**, and may have extended nonlinear **shoulder** and **toe** regions. For any scene, it is usually possible to place the **luminances** of interest on a preferred portion of the **transfer function**, with excursions into higher and lower limits rolled off or truncated by the respective **shoulder** and **toe** of that curve. *cf.* **luminance range, recorded; luminance, relative, scene; IRE units; shoulder; toe.**

EBU: European Broadcasting Union, Geneva, Switzerland. The EBU Technical Committee publishes EBU technical standards, EBU technical recommendations, EBU technical statements, and EBU technical information, as studied and developed by its working parties and their subgroups. Of particular importance to electronic production are Working Party G, Production-Equipment Technology; Working Party R, Sound and Television Broadcasting; and Working Party V, New Systems and Services.

edge enhancement: 1. Creating hard, crisp, high-contrast edges — beyond the correction of the geometric problem compensated by **aperture correction** — frequently creates the subjective impression of increased image detail. Transversal delay lines and second-derivative types of correction increase the gain at higher frequencies while introducing rather symmetrical "undershoot followed by overshoot" at transitions. 2. In fact — and contrary to many casual observations — image resolution is thereby decreased and fine detail becomes obscured. Creating a balance between the advantages and disadvantages is a subjective evaluation and demands an artistic decision. *cf.* **aperture correction; contour enhancement; image enhancement; resolution, visual; sharpness.**

emission: (See figure 1.) 1. The propagation of a signal via electromagnetic radiation, frequently used as a synonym for **broadcast**. 2. In CCIR usage: "(a) Radio-frequency radiation in the case where the source is a radio transmitter. (b) Radio waves or signals produced by a radio transmitting station. Note 1. The energy from the

local oscillator of a radio receiver, if transferred to external space, is a radiation and not an emission. Note 2. In radiocommunication, the French term emission applies only to intentional radiation" [CCIR]. 3. Emission in electronic production is one mode of distribution for the completed program, as an electromagnetic signal propagated to the point of display. *cf.* **CCIR; display; distribution; transmission; transportation.**

encode: 1. "To express a single character or a message in terms of a code.... To apply the rules of a code" [IEEE 100]. 2. To derive a composite **luminance-chrominance** signal from R,G,B signals. *cf.* **code; video, composite signal.**

error concealment: 1. When the **error correction** program discovers in the reproduced signal, an error too extensive to permit reconstruction, the redundancy in most image information makes it possible for **error concealment** to make the error nearly inobvious. Video images are frequently nearly identical from frame to frame. Adjacent video lines frequently have almost the same detail. It becomes possible, therefore, when a "burst error" involving the modification or loss of many recorded bits occurs, to determine from image segments adjacent in time or in space, a most probable substitution. Such substitutions, when infrequent and supported by the image redundancy, are often accepted by the viewers as "correct." (This is a degree of freedom in image data recording that obviously is not available to scientific and financial data recording.) 2. The additional information needed by the algorithm for decision and substitution is usually provided by a data-storage cache established during reproduction. *cf.* **bit-rate, recording; error correction.**

error correction: Ingenious software programs make it possible to check that the digital stream of image information has not been corrupted by the loss of a few **bits** here and there. Additional information introduced as "overhead" to the image bit stream (thereby increasing the **bit-rate, recording**) is chosen to conform to specific rules of construction. Departures from this construction can be detected readily, so that many potential errors can not only be identified, but corrected so that the information can be restored with high probability. Error correction contributes to the reliability of recording/reproducing and is a normal part of all data recording. *cf.* **bit-rate, recording; error concealment.**

extensibility: "A property of a system, format, or standard that allows changes in performance or format within a common framework, while retaining partial or complete compatibility among systems that belong to the common framework" [FCC ACATS]. *cf.* **JPEG, MPEG.**

field, depth of: 1. The range of distance in subject space within which a lens (or a system) provides an image that reproduces detail with an acceptably small circle of confusion — usually small enough for subjective evaluation as a "point" — defines the **depth of field**. Tables are calculated for lenses as a function of optical aperture and the subject distance at which they are focused. Regrettably, these calculations are strictly geometric (ignoring the possibility of diffraction effects, of all optical aberrations, and of possible differing contributions to focal length from different annuli of the optical system). Thus, the tables are at times overly optimistic. 2. **Depth of field** for a given imaging system decreases with increasing optical aperture of that system, and decreases as the distance to the subject decreases. 3. A "maximum acceptable" diameter for the "circle of confusion" may depend upon the resolution capabilities of the light-sensitive receptor (electronic or photographic) and of the system within which it is functioning. 4. Quantitative measurements for actual imaging systems may be made on an optical bench. Practical determinations are made from subjective examination of the actual images in the system of interest. *cf.* **resolution, image; resolution, visual; resolving power.**

filter, brick wall: A low-pass filter with a steep cut-off (such as 20 dB/octave or greater), such that a negligible amount of higher frequency information passes. The filter typically has uniform group delay.

filter, Gaussian: A low-pass filter providing a gradual attenuation of the higher frequencies. Strictly the attenuation should follow the curve $V = e^{-af^2}$ [IEEE 100]. But the term is also applied to attenuation functions that only qualitatively resemble the precise power function.

filter, optical: In addition to the familiar **optical filters** for modifying spectral energy distribution, and thereby color rendition, **optical filters** are also produced as low-pass filters for spatial detail in an optical image — eliminating high-frequency information that would exceed the **Nyquist limit** of the system and produce excessive **aliasing**. Many of these filters are cut from optically birefringent crystals and function by providing multiple images slightly displaced one from another so that fine detail is blurred (i.e., "low-pass filtered"). *cf.* **Nyquist limit; resolution, image.**

format converter: 1. A device that allows the reformatting of a digital data stream originating from one sampling structure (lines per frame, pixels per line) into a digital data stream of another sampling structure for the purposes of recording or passing the original data stream through distribution devices designed to accommodate the latter structure. Since the data still represents the original sampling structure, this is not the same as **standards conversion**. 2. As an operational convenience with existing recording hardware, one such **format converter** was designed for the Advanced Television Test Center's 1992 comparison of proposed high-definition television systems. It accepts a signal introduced in a proposed format, and converts it for recording on, and subsequent reproduction from, a high-definition television digital recorder designed for the 1125/60/2:1 format. *cf.* **television, high-definition; transform, systems.**

gamma correction: 1. **(video)** Historically, **gamma correction** was a precompensation applied to the video signal at the camera to correct for the nonlinearities of the CRT (i.e., power function of the electron gun) and, as such, it was the inverse of the electron gun function. 2. It is now widely used, however, to describe "the total of all **transfer function** manipulations" (i.e., including the departures from a true power law function), whether inherent or intentionally introduced to act upon the video signal for the purpose of reducing the bandwidth for signal processing, making the image on the final display conform to preconceived artistic objectives, and/or providing noise suppression, or even **bit-rate reduction**. 3. "The insertion of a nonlinear output-input characteristic for the purpose of changing the system transfer characteristic" [IEEE 100]. As this usage has grown, the IEEE definition correlating gamma to an analytical function becomes optimistic. *cf.* **bit-rate reduction; black compression; gamma; knee; monitor electro-optic transfer function; opto-electronic transfer function; shoulder; toe.**

gamma, electronic: 1. "The exponent of that power law that is used to approximate the curve of output magnitude versus input magnitude over the region of interest" [IEEE 100]. 2. **(video)** "The power function of the electro gun in a CRT" [IEEE 100] 3. **(video)** It has become customary in video, as in photography, to extend the meaning and to use **gamma** as a synonym for the complete transfer function — regardless of curve shape. Note – In the electronics system, increasing **gamma** decreases image contrast. 4. **(imaging processing and display)** Nonlinear processing is useful in many television systems as a means of **bandwidth limiting**, and is normally applied at the camera. Given the predominance of CRT displays, the chosen exponent is related to that of the electron gun (typically 2.2 for systems with 525/59.94 scanning, 2.8 for systems with 625/50 scanning, and 2.22 for SMPTE 240M). 5. The **transfer functions** in actual use with current television systems depart from a pure power law function, making expedient changes including the addition of a constant to offset the curve, but they remain loosely called "power law functions." 6. The inverse function is applied at the camera, producing a **gamma corrected** signal throughout most of the electronic environment. *cf.* **black compression; gamma correction; gamma, photographic; transfer function; white compression.**

gamma, photographic: The slope of the **transfer** function: Density (log of reciprocal transmission) vs log exposure. It is thus the power function correlating transmission to exposure. 1. "**Gamma**" in the photographic sense was originally applied specifically to the straight-line portion of the **transfer function**. Only if all of the photographic densities corresponding to light intensities in the scene lie within that straight-line portion of the **transfer function** is **gamma** proportional to **contrast**. 2. It is sometimes loosely used to indicate either an average or a point slope of the **transfer function**. Note – In the photographic system, increasing **gamma** increases image

contrast. *cf.* **black compression; gamma, electronic; transfer function; white compression.**

gray card: A nonselective (color neutral) diffuse reflector intended to be lighted by the normal illumination of the original scene, and having a **reflectance factor** of 18% (compared with a perfect reflector at 100% and prepared magnesium oxide at 98%). The **gray card luminance** is used as a guide in determining scene exposure so that the image is placed upon the most favorable portion of the **transfer function** curve. *cf.* **luminance range, recorded; luminance, relative, scene; reflectance factor; transfer function.**

gray scale: 1. "**(video)** An optical pattern in discrete steps between light and dark. Note: A gray scale with ten steps is usually included in resolution test charts" [IEEE 100]. 2. **(production)** A card bearing a sequence of neutral (spectrally nonselective) chips arranged in **lightness** sequence. The chips are of known reflectivity and usually form either a linear or a logarithmic lightness series. 3. The electrical signal which results from, or would result from, the scanning of such an optical pattern. 4. The reproduction of such an optical pattern in a **display** device. *cf.* **contrast; dynamic range; lightness; luminance; luminance range; luminance signal; luminance, television.**

header/descriptor: See **image file header/descriptor.**

hue: "Attribute of a visual sensation according to which an area appears to be similar to one of the perceived colors, red, yellow, green, and blue, or to a combination of two of them" [CIE 845-02-35].

IEC: International Electrotechnical Commission, Geneva, Switzerland. The IEC and its affiliated International Organization for Standardization (ISO) are the two major global standards-making groups. They are concerned with establishing standards that promote interchange of products, agreement upon methods of evaluation, and resolution of nonfunctional differences among national standards. They are structured as an international federation of the more than 50 national standards organizations. The USA is represented by the American National Standards Institute (ANSI). *cf.* **CCIR; ISO.**

IEEE: Institute of Electrical and Electronics Engineers, New York. The IEEE is an association of 33 technical societies. Those of potential interest in electronic production include the following: BT-02, Broadcast Technology; CAS-04, Circuits and Systems; C-16, Computer; C-19, Communications; CE-08, Consumer Electronics; LEO-36, Lasers and Electro-Optics; and SP-01, Signal Processing.

illuminance: "Quotient of the luminous flux dFv incident on an element of the surface containing the point by the area dA of that element" [CIE 845-01-38]. "The term illuminance also is commonly used in a qualitative or general sense to designate the act of illuminating or the state of being illuminated" [IEEE 100]. Units are lux, footcandle.

image capture: (See figure 1.) The transducing of the information in a real image into the photographic or electronic medium. Normally in motion-reproducing systems, synchronous audio information is simultaneously transduced. *cf.* **display; distribution; image generation; origination; post-production.**

image compression: 1. Application of an appropriate transfer function to the image signal so as to limit **dynamic range**. 2. Application of **bandwidth limiting** or **bit-rate reduction** to an image signal in order to bring it within the limitations of a lower capacity channel. *cf.* **bandwidth limiting; bit-rate reduction; compression, lossless; compression, lossy; compression, quasi-lossless; display; dynamic range; luminance range, scene; luminance range, display; luminance, relative, scene; transfer function.**

image enhancement: (video) "Once the camera response has been made flat to 400 lines (by **aperture correction**), an additional correction is applied to increase the depth of modulation in the range of 250 to 300 lines [in an NTSC system], both vertically and horizontally. This additional correction, known as **image enhancement** ... produces a correction signal with symmetrical overshoots around transitions in the picture. **Image enhancement** must be used very

sparingly, if natural appearance is to be maintained" [Benson]. *cf.* **aperture correction; edge enhancement; resolution, visual; sharpness.**

image file architecture: 1. The Digital Information Exchange Task Force (SMPTE, IEEE, ATSC) on digital image architecture has as its goal the multidisciplinary agreement upon and the definition of fully flexible, interoperable, scalable, and extensible systems. The objective is agreement on the structure of digital image files that will facilitate the exchange of such files across the technology interfaces. 2. The scope includes both the rapid, unambiguous but concise identification of the file and its utilization, as well as the organization of the image data itself. 3. SMPTE Task Force St13.20 has studied several draft proposals, and a final report was published (Report of the Task Force on Digital Image Architecture, Journal of the SMPTE, 101:855-891, Dec. 1992). *cf.* **image file descriptor; image file header; image file header/descriptor; image file motion-picture format; image file video index; post-production, electronic; production, electronic, digital.**

image file descriptor: 1. The **descriptor** is a block of data that enhances the utility of the main data for the user. It may contain, in standardized format, data concerning production, ownership, access, previous processing, etc., relevant to the basic interpretation of the data. 2. SMPTE Working Group P18.41 on Video Index has prepared a draft standard. *cf.* **image file architecture; image file header; image file motion-picture format; image file video index.**

image file header: 1. The **header** is a very compact label, with universally accepted decodable algorithm. 2. Specific objectives are: Identify encoding standard, specify length of the file, indicate whether a readable **descriptor** is included, permit random interception of data stream, and offer optional error protection. *cf.* **image file architecture; image file descriptor; image file header/descriptor; image file motion-picture format; image file video index.**

image file header/descriptor: 1. A standard introductory identification directing access to a **digital image file**. 2. The **header** provides a brief **image file** identification — universally decodable — indicating the format and length of the data block. The (optional) **descriptor** conveys additional information improving the usefulness of the data block to the user, such as cryptographic, priority, or additional error-protection information as well as source, time, authorship, ownership, restrictions on use, processing performed, etc. 3. Emerging **digital image formats** — each optimized for its intended application — demand provisions permitting exchange and multilevel interpretations. The Digital Information Exchange Task Force on Headers/Descriptors (SMPTE, IEEE, ATSC), in a feasibility study (Journal of the SMPTE, 101:411-429, June 1992), defined the objectives and outlined a functional format. It recommended that the SMPTE Standards Comittee arrange for the preparation of enabling standards. 4. The task force noted that the flexible interchange of picture, sound, or related data among diverse systems must recognize and manage conformance to different standards and interpretations as well as differing levels of desired detail. Requirements for a standardized **header/descriptor** include universality, longevity, extensibility, interoperability, cost-performance effectiveness, compactness, rapid capture, and editability. *cf.* **image file architecture; image file descriptor; image file header; image file video index.**

image file motion-picture format: 1. SMPTE Working Group H19.16 on Digital Pictures has proposed SMPTE Standard SMPTE 268M defining the file format for the exchange of digital motion-picture information on a variety of media between computer-based systems. This flexible file format describes pixel-based (raster) images with attributes defined in the binary file **descriptor** — which identifies (a) generic file information, image information, data format, and image orientation information; (b) motion-picture and television industry-specific information; (c) user defined information. The draft assumes nonreal-time application, with formats for real-time to be considered as the developing technology permits. *cf.* **image file architecture; image file descriptor; image file header; image file header/descriptor; image file video index; post-production, electronic; production, electronic, digital.**

image file video index: Proposed **descriptor** developed by SMPTE Working Group P18.41: "This proposed SMPTE recommended practice

is intended to provide a method of coding video index information in which various picture and program related source data can be carried in conjunction with the video signal. There are three classes of **video index** data based on type and use of the data. Class 1 contains information that is required to know how to use the signal. Class 2 contains heritage information for better usage of the signal. Class 3 contains other information not required to know how to use the signal." *cf.* **image file architecture; image file descriptor; image file header; image file header/descriptor; image file video index.**

image generation: (See figure 1.) The creation of an image in the photographic or electronic medium from an image-concept (painted or generated by **computer graphics**, for example). *cf.* **display; distribution; image capture; origination; post-production.**

image processing, digital: 1. Digital images are represented by a stream, currently of 8-bit or 10-bit values, representing the **luminance** and **chrominance** information, or a stream of 8-bit or 10-bit values representing the R′, G′, and B′ information. **Image processing** sometimes involves multiplication of each digital word by (a) its proportional contribution to the processed image, (b) a vector to relocate the pixel, or (c) an algorithm to change overall image size, etc. 2. To control these processes, additional information may be carried in the **alpha channel** synchronized to the image. 3. As an example of the process, if an 8-bit sample is multiplied by an 8-bit factor, the product becomes a 16-bit word. At some point, this may have to be **rounded** or **truncated** back to 8 bits for the next operation. This introduces slight discrepancies in the result which may be visible as jagged edges, color bleeding, etc. If successive truncations are performed during a sequence of **image processing** steps, the **artifacts** frequently become increasingly visible. 4. Good practice calls for maintaining some or all of the "extra bits" throughout as much of the **image processing** as the facilities permit. 5. Experience has shown that digital image processing provides the fewest distracting artifacts when the R′,G′,B′ signals are first converted to the linear R,G,B. 6. For complex image processing, and for critical results, the 8-bit encoding may be replaced by 10 bits (or more if that can be accommodated). *cf.* **alpha channel; artifact; bit-rate reduction; chroma key; chrominance; compression, lossless; compression, lossy; linear key; luminance; mixing, digital; post-production, electronic; production, electronic, digital; R,G,B color space; R′,G′,B′ color space; rounding; SMPTE 125M; SMPTE 244M; truncation.**

image quality evaluation, interval-scaled: For comparisons of **perceived image quality** among significantly different systems — a requirement frequently encountered in **electronic production** — the technique of **interval-scaling** is recommended by most students of psychophysics. **Interval scaling** gives some indication of the magnitude of preference for one system over another. Observers are asked to place a numerical value upon the perceived differences (either in total or with regard to a specified characteristic such as noise, resolution, color rendition, etc.). *cf.* **CCIR Recommendation 500; image quality, perceived; image quality evaluation, ordinal-scaled; image quality evaluation, ratio-scaled.**

image quality evaluation, ordinal-scaled: For comparisons of **perceived image quality** resulting from a controlled variant within a single system — a requirement encountered when fine-tuning a system — the technique of **ordinal scaling** is frequently employed. The **ordinal scale** indicates that one image is preferred over another. Observers are asked to evaluate **perceived image quality** on an established scale, usually of five levels, from excellent to unacceptable. Correlations among isolated tests are sometimes uncertain. *cf.* **CCIR Recommendation 500; image quality, perceived; image quality evaluation, interval-scaled; image quality evaluation, ratio-scaled**.

image quality evaluation, ratio-scaled: When images that differ significantly in creation, display, and content are being compared and **interval scaling** becomes necessary, interpretation of the results becomes more and more complex as the number of observers is increased. **Ratio scaling** provides a means for correlating multiple observations and multiple data sources. Observers are asked to assign a numerical value to **perceived image quality** (either in total or with regard to a specified characteristic such as

noise, resolution, color rendition, etc.). They are also asked to identify numerical values for (1) the best possible image, and (2) the completely unacceptable image. Each is allowed to choose a numerical scale with which the observer feels most comfortable. The relationship between the value for the test image and the two extremes provides a useful ratio. Analyses involving comparisons among observers, comparisons with other systems, correlation of results obtained over periods of time, etc., are made by normalizing each observer's scale (for example, best possible = 100, completely unacceptable = 0). *cf.* **CCIR Recommendation 500; image quality, perceived; image quality evaluation, interval-scaled; image quality evaluation, ordinal-scaled.**

image quality, objective: The evaluation obtained as a result of objective measurement of the quantitative image parameters (including tone scale, contrast, linearity, colorimetry, resolution, flicker, aliasing, motion artifacts, etc.). *cf.* **image quality, perceived.**

image quality, perceived: The evaluation obtained as a result of subjective judgment of a displayed image by a human observer. *cf.* CCIR Recommendation 500; image quality; image quality evaluation, **interval-scaled; image quality evaluation, ordinal-scaled; image quality evaluation, ratio-scaled.**

interoperability: "The capability of providing useful and cost-effective interchange of electronic image, audio, and associated data; among different signal formats, among different transmission media, among different applications, among different industries, among different performance levels" [FCC ACATS]. *cf.* **JPEG, MPEG**.

IRE units: 1. "A linear scale for measuring, in arbitrary IRE units, the relative amplitudes of the various components of a television signal" [Benson]. Reference white is assigned a value of 100, blanking a value of 0. 2. The values for NTSC composite and for SMPTE 240M are shown in table 2. One IRE unit corresponds to 7⅛ mv in CCIR System M/NTSC and to 7.0 mv in all other systems. 3. Measurement procedure developed by the Institute of Radio Engineers, the predecessor to the IEEE. *cf.* **composite signal; luminance signal.**

Table 2 – IRE units for composite color formats

		RF modulation [1]	Video baseband millivolts [2]	
	IRE units	%	M/NTSC	SMPTE 240M
Zero carrier	120	0	—	—
White clip [3]	105–110	6.2–9.4	—	—
Reference white [4]	100	12.5	714 [5]	700
Reference black [6]	7.5	70.3	54	0
Blanking	0	75	0	0
Sync peaks (MAX carrier)	–40	100	– 286 [5]	± 350

[1] From Benson: Television Engineering Handbook.

[2] Video waveform specified in ANSI/EIA/TIA 250-C-1989. It becomes an operational requirement to map the **scene luminance** within the video waveform specifications so that subjectively acceptable image recreation can be obtained on **display**.

[3] Typical (arbitrary) values to limit overload of analog signals, or to define maximum digital equivalent.

[4] Under scene illumination, the light from a nonselective diffuse reflector (white card) whose **reflectance factor** is 90% compared to a "perfect reflector" (prepared magnesium oxide = 98%).

[5] Frequently indicated as +700 and –300, respectively.

[6] Specified for NTSC in ANSI/EIA/TIA 250-C-1989. Many other systems place reference black at blanking level.

IS&T: The Society for Imaging Science and Technology, Springfield, VA.

ISO: International Organization for Standardization. The ISO and its affiliated International Electro-technical Commission (IEC) are the two major global standards-making groups. They are concerned with establishing standards that promote interchange of products, agreement upon methods of evaluation, and resolution of non-functional differences among national standards. They are structured as an international federation of the more than 50 national standards organizations. The U.S. is represented by the American National Standards Institute (ANSI). The ISO and the IEC, through their many focused technical subcommittees, provide the deliberative, judicial, and administrative forums which develop consensus and give substance to the international standards effort and to the finished standards. *cf.* **CCIR; IEC.**

JPEG: Joint Photographic Experts Group. An international standards group functioning under ISO and IEC (both subsidiaries of CCITT), developing an international consensus on an **image compression** algorithm for continuous-tone still color pictures. *cf.* **compression; compression, lossy; image compression; JPEG-1; MPEG.**

JPEG-1: 1. ISO/IEC DIS 10918-1 (2 Jan 1992) begins with a digital image in the format Y', C'_B, C'_R (such as defined in CCIR 601-2) and provides several levels of **compression**. Predictive coding and transforms are employed, with the higher compression ratios selectively recognizing the decrease in human visual acuity with increasing spatial frequencies. It is optimized for about 15:1 compression. 2. As increased data storage and increased processing capabilities are becoming available, there is exploration of adapting JPEG-1 for application to successive frames in real time; i.e., full-motion **JPEG**. *cf.* **compression; compression, lossy; JPEG; JPEG-2; image compression; MPEG.**

JPEG-2: ISO/IEC CD 11172 (6 Dec 1991) describes procedures for compliance testing in applications of JPEG-1. *cf.* **JPEG; JPEG-1.**

judder: A temporal artifact associated with moving images when the image is sampled at one frame rate and converted to a different frame rate for **display**. As a result, motion vectors in the **display** may appear to represent discontinuously varying velocities. The subjective effect of the **artifact** becomes more obvious when the frame-rate conversions are made by simple deletions or repetitions of selected frames (or fields). It may become less obvious when interpolated frames (or fields) are generated by employing predictive algorithms. *cf.* **artifact; conversion, frame rate; motion artifacts.**

Kell effect: 1. Vertical resolution of a scanned image subjectively evaluated is consistently shown to be less than the geometrically-predicted resolution. Observations are usually stated in terms of the ratio of perceived television lines to active lines present in the **display**. 2. From the time that R. Kell published his studies (conducted on a **progressive scanned** image), there have been numerous numerical values and substantiating theories proposed for this effect. The range of results suggests that many details of the experiments influence the result and make defining a single "Kell factor" impossible. Reported experimental results range at least between 0.5 and 0.9. In an otherwise comparable **display**, the "ratio" is lower for **interlaced scanning** than for **progressive scanning**. *cf.* **interlaced scanning; progressive scanning; resolution, visual.**

key channel: See **alpha channel**.

knee: (video) By convention, the circuitry introducing **white compression** into the **opto-electronic transfer function** and thereby modifying the curve for a more gradual approach to **white clip**. *cf.* **shoulder; transfer function; white compression.**

lightness: "The brightness of an area [subjectively] judged relative to the brightness of a similarly illuminated area that appears to be white or highly transmitting" [Hunt].

linear key: A process for the selective overlay of one video image upon another, as through **chroma key**. Control of the ratio of foreground to background determined by the specifications derived from **luminance** information, and provided in the **linear key** data. Ratios to be applied are carried for each picture element in the **alpha**

channel. The process permits realistic rendering of semi-transparent objects. *cf.* **alpha channel; chroma key; image processing, digital; mixing, digital.**

line pair, optical: In optical measurements and specifications, **resolution** is specified in terms of **line-pairs** per unit distance or unit angle — a **line pair** consisting of one "black" plus one "white" line. Thus one **line pair** corresponds to two **television lines**. *cf.* **line, television; resolution, image; resolution, visual.**

line-rate conversion: Standardized video systems currently exist employing the following number of total lines per frame: 525, 625, 1125. Furthermore, each of these operates in a 2:1 interlace mode, with 262.5, 312.5, 562.5 lines per field (with concurrent temporal differences at field rates of 50.00, 59.94, or 60.00 fields per second). Additional systems are being proposed. While simple **transcoding** by deletion or repetition can be applied, it is more commonly done by applying an algorithm to stored information in order to generate predictive line structures in the target system. *cf.* **CCIR; resampling; conversion, frame-rate; transform, systems.**

lines, active horizontal: In the scanning of a video image, the line number associated with the format is the total number of lines assigned to one frame. It is in fact a timing specification defining in conjunction with the field frequency the time interval allocated to each horizontal line (commonly measured in number of samples at the specified sampling rate or in microseconds). Some of these lines and intervals carry image information, some from the total assigned are dedicated to operational and control functions — including returning the scanning beam back to the upper left corner to begin the next field. 1. Those allotted time intervals (lines) actually carrying image information or image-associated information such as captioning, image test signals, etc., are the **active lines**. 2. In further reduction of time allocated to image information, some of each **active line** is dedicated to the horizontal interval to get the scanning beam to return to the left-edge starting point for the next line and to reaffirm color subcarrier, etc. 3. In the U.S. 525/59.94/2:1/NTSC system, about 7.6% of the total field or frame time is assigned to the vertical interval, and about 16% to the horizontal interval. Thus, the 525 **television lines** per frame provide about 480 **active lines**. Correspondingly, each **active line** displays image data about 84% of its time interval. Image information is thus conveyed for only about 76.4% of the total time. 4. In digital encoding, it may be possible to reduce the number of **bits** assigned to the vertical and horizontal intervals and achieve significant **bit-rate reduction**. *cf.* **line, television; picture width; resolution, visual; scanning, interlaced; scanning, progressive.**

lines, active vertical: In a scanning standard, the number of raster lines per frame that are not required to contain blanking. The active vertical lines may include signals containing non-image information. *cf.* **lines, active horizontal; picture height.**

line, television: 1. Television images are scanned in a sequence of horizontal lines, beginning at the upper left corner, and reaching the bottom right corner at the end of the field. Thereupon the scan is returned to the upper left corner to begin the next field. As a consequence of the line structure, all television images are sampled vertically. Within a line, the signal may remain analog or be sampled digitally. 2. A **television line** is also a measure of time, representing the interval allocated to one line. (In the U.S. system 525/59.94/2:1, the line duration is 63.5 µs). 3. **Television lines** also function as a geometric measure, with **resolution** (both vertical and horizontal), for example, specified in terms of "lines per picture height." Since both "black" and "white" lines of a resolution chart are counted, two television lines equal one cycle of the electrical waveform. *cf.* **line, active; line pair, optical; lines, active horizontal; lines, active vertical; resolution, image; resolution, visual.**

luma: 1. To avoid the interdisciplinary confusion resulting from the two distinct definitions of luminance, it has been proposed that the video documents use **luma** for **luminance, television** (i.e., the **luminance signal**), and **chroma** for **chrominance television** (i.e., the **chrominance signal). 2.** Although, unfortunately, **chroma** is also a term with multiple distinct definitions, **luma** does not seem to have been previously defined. *cf.* **chroma; chrominance; luminance, television.**

luminance: Luminance is an objective measure of the visible radiant flux, weighted for color by the CIE Photopic Spectral Luminous Efficiency Function (i.e., as evaluated by the CIE standard photometric observer). From the basic definition, several derivative applications of the term have become common. (See cross-references.) The subjective response to **luminance** is **brightness**. *cf.* **luminance, constant; luminance, physics; luminance, television; luminous flux; signal, luminance.**

luminance, constant: (video) 1. In an image coding system that derives a **luminance** signal and two bandwidth-limited **color-difference** signals, **constant luminance** prevails if all of the **luminance** information is encoded into one signal that is supplemented by but totally independent of two color signals carrying only **chrominance** information, e.g., hue and saturation. 2. **Constant luminance** is only achieved when the **luminance** and **chrominance** vectors are derived from linear signals. The introduction of nonlinear **transform characteristics** (usually for better signal-to-noise and control of **dynamic range** prior to **bandwidth reduction**) before creating the **luminance** and **chrominance** vectors destroys **constant luminance**. Current video systems do not reconstitute the **luminance** and **chrominance** signals in their linear form before further processing and, therefore, depart from **constant luminance**. 3. Note – When R,G,B information is required to be recovered from the set of **luminance** and **color-difference** signals, the values correlated to the original signals are obtained only if the **luminance** and **chrominance** signals have been derived from the linear functions of R,G,B or have been transformed back to linear. 4. **Constant luminance** not only provides a minimum of subjective noise in the **display** (since the **luminance** channel does not respond to **chrominance** noise), but also preserves this noise minimum through **chrominance** transformations. *cf.* **chrominance; color-difference; colors, primary; differential gain; gamma correction; luminance; origination; post-production; signal, chrominance; signal, luminance; transfer function.**

luminance factor β: 1. "(At a surface element of a nonself-radiating medium, in a given direction, under specified conditions of illumination) ratio of the **luminance** of the surface element in the given direction to that of a perfect reflecting or transmitting diffuser identically illuminated" [CIE 845-04-69]. 2. No "perfect reflectors" exist, but properly prepared magnesium oxide has a luminance factor equal to 98% and this is usually employed to define the scale. *cf.* **luminance range, scene; luminance, relative, scene; reflectance factor *R***.

luminance, physics (generic usage): Luminance has technical as well as colloquial definitions: 1. "The generic flux from a light-emitting or light-reflecting surface; the subjective response to **luminance** is **brightness**. 2. The quotient of the **luminous flux** at an element of the surface surrounding the point and propagated in directions defined by an elementary cone containing the given direction, by the product of the solid angle of the cone and the area of the orthogonal projection of the element of the surface on a plane perpendicular to the given direction. The **luminous flux** may be leaving, passing through, and arriving at the surface or both" [IEEE 100] 3. "The **luminance** for each element of a surface within the field of view is defined as the ratio of **luminous flux** per solid angle to the unit projected area of the surface" [Bartleson and Grum]. [*cf.* CIE 845-01-35] 4. Units are candelas per square meter, footlamberts, nits. 5. Note the derivative usages in the cross-references. *cf.* **chrominance; luminance; luminance, constant; luminance, television; signal, luminance.**

luminance range: The range in measured luminance between the lightest and the darkest element of a luminous scene or its **display**.

luminance range, display CRT: 1. The **luminance** range that can be displayed on a CRT is the ratio of maximum to minimum **luminance** on the tube face. The maximum practical output is determined by beam current, phosphor efficiency, shadow-mask distortion, etc. The minimum is the **luminance** of that portion of the tube face being scanned with beam current set to cut-off. The contributions from room illumination, external and internal reflections, etc., must be recognized. 2. SMPTE document S17.280 recommends monitor viewing conditions achieving a luminance range of 100:1. *cf.* **black level, monitor; luminance range, display CRT; luminance range, scene; luminance range,**

recorded; luminance, relative, scene; monitor, reference; transfer function; white peak.

luminance range, display theater: The **luminance range** that can be displayed on a theater projection screen is the ratio of maximum to minimum **luminance** achievable during projection of film. The maximum achievable highlight is determined by light-source output capacity, projection optical efficiency, the transmission of minimum film densities, screen gain, etc. The minimum is the **luminance** contribution from house illumination and other stray light, plus optical flare raising black levels, and the transmission of maximum film densities. Measured values in typical first-run theaters show **luminance ranges** of 500:1 to 300:1 (usually limited by house illumination). *cf.* **black, projection; luminance range, recorded; luminance range, scene; luminance, relative, scene; transfer function.**

luminance range, recorded: The **luminance range, recorded** may be reduced from the **luminance range, scene** intentionally and/or by the limitations of the recording system. Most systems have a maximum effective signal level limiting the high end, and noise limiting the low end. All of the scene that is of interest must be placed within these two limits by the choice of an appropriate **transfer function**. Some analog functions permit gradual transitions to overload and/or noise. Digital functions have inflexible limits imposed by the number of levels permitted by the **bit** assignments. *cf.* **black compression, luminance range, scene; luminance, relative, scene; transfer function; white compression; white peak.**

luminance range, scene: The **luminance range** of original scenes varies from outdoor scenes in sunlight with a range possibly exceeding 10000:1, to indoor scenes with controlled lighting, where the range may be reduced to 10:1 or even less. Adjustment of or accommodation to the **luminance range, scene** is one of the conditions to be evaluated in determining how the scene is to be recorded. It is a test of artistic judgment to place the **relative luminances** for the objects of interest on a suitable portion of the **opto-electronic** or **opto-photographic transfer function** in order to produce the desired subjective quality. *cf.* **luminance range, recorded; luminance, relative, scene; transfer function.**

luminance, relative, scene: A convenient linear scale for measuring in arbitrary units the relative **luminance** amplitudes within the scene, to be recorded in a video or photographic image, as shown in table 3. The **relative luminance scale** is one factor affecting the choice of suitably artistic scene reproduction. It may establish the optimum rendition of **reference white** and optimum employment of the nonlinear **transfer function** in image recording. Note that this **relative luminance scale** (linear in **luminance**) resembles **IRE units** (linear in voltage) in positioning both **black level reference** and **reference white** at 0 and 100, respectively, but that it differs in recognizing the extended **luminance range** of many commonly encountered scenes. *cf.* **luminance range, recorded; luminance range, scene.**

luminance, television: 1. When television was monochrome and sensors were in approximate conformance to CIE Photopic Spectral Luminous Efficiency Function, it became common to think of the video signal as the **luminance** signal. 2. With the introduction of color, a matrix was designed to develop a luminance function by weighting the R,G,B signals in accordance with the CIE Photopic Spectral Luminance Efficiency Function, producing a video signal compatible with monochrome receivers. 3. “A signal that has major control of the image **luminance**. It is a linear combination of **gamma-corrected** primary color signals” [IEEE 100]. 4. The specific ratio of **color primaries** that provides a match to the **white point** in a specified **color space**. 5. The **display** of the **luminance** signal specified in current television standards produces a **metameric match** to illuminant C. 6. The definition of **luminance, television** is identical for **NTSC**, **PAL**, and **SECAM** [CCIR Report 624-4], as follows:

$$E'_Y = (0.299)\, E'_R + (0.587)\, E'_G + (0.014)\, E'_B$$

The weighting function is named luminance signal in all of the television standards. For convenience and bandwidth conservation, however, it is always formed from the **gamma correction** signals (i.e., R′,G′, B′) and not from the initial linear signals, and thus it is not an exact representation of **luminance, physics**. 7. Within the **production** environment, the choice among the definitions is determined from the context. *cf.* **CCIR; chrominance; luminance; luminance, constant; luminance, physics.**

Table 3 – Correlation of relative scene luminance

	Reflectance factor %	Relative scene luminance [1] Scale	Relative camera stops
Typical limit of interest	..	640	+5
	..	320	+4
	..	160	+3
Reference white [2]	90	100	..
	..	80	+2
	..	40	+1
Gray card [3]	18	20	0
	..	10	–1
	..	5	–2
Scene black	0	0	..

[1] IEEE Dictionary of Electrical and Electronics Terms defines luminance factor as the ratio to a perfect reflector rather than as the ratio to **reference white**. In practical **electronic production, relative scene luminance** is a more useful measure.

[2] Under scene illumination, the light from a nonselective diffuse reflector (white card) whose reflectance is 90% compared to a perfect reflector (prepared magnesium oxide = 98%).

[3] Under scene illumination, the light from a nonselective diffuse reflector (gray card) whose reflectance is 18% compared with that of a perfect reflector.

luminous flux: "1. The time rate of flow of light. 2. The time rate of flow of radiant energy evaluated in terms of a standardized visual response. ...Unless otherwise indicated, the **luminous flux** is defined for photopic vision" [IEEE 100]. "The unit of flux is the lumen: the **luminous flux** emitted within unit solid angle (1 steradian) by a point source having an isotropic luminous intensity of 1 candela" [Hunt]. *cf.* **luminance; luminance, physics.**

MAC: Multiplexed analog component. A component system that transmits luminance and two color-difference signals in time-compressed serial analog form. Variants A, B, C, D1, D2, HD, S, etc., have been proposed. MAC encoding is employed in some satellite transmissions and in some television recorders. *cf.* **CCIR; component color.**

masking: 1. **(video)** "A process to alter color rendition in which the appropriate color signals are used to modify each other. Note: The process is usually accomplished by suitable cross coupling between primary color-signal channels" [IEEE 100]. 2. **(photography)** Comparable control of color rendition is accomplished by the simultaneous optimization of image dyes, masking dyes, and spectral sensitivities. 3. **Masking** is one way of partial compensation for photoreceptor color sensitivity, nonoptimum color filters, nonideal **display** phosphors, unwanted dye absorption, etc. *cf.* **color match, corresponding; color match, metameric.**

matrixing: "To perform a color coordinate transformation by computation or by electrical, optical, or other means" [IEEE 100].

matte: An operational image or signal carrying only transparency information and intended to overlay and/or control a conventional image or image signal. *cf.* **alpha channel; chroma key; composite image; linear key; post-production.**

matte channel: See **alpha channel**.

mixing, digital: 1. A step in **post-production** when two or more digital representations are combined to create an edited composite. 2. **(audio)** "In a sound transmission, recording, or reproducing system, combining two or more inputs into a common output, which operates to combine linearly the separate input signals in a desired proportion in an output signal" [IEEE 100]. 3. **(production)** Generally the editing of digital image data, resulting in composites ranging from simple transitions to multilayered collages

combining selected information from many interim images. 4. The combining of digital images is accomplished by suitable arithmetic calculations on the related pairs of digital words. 5. "**(data processing)** A process of intermingling of data traffic flowing between concentration and expansion stages" [IEEE 100]. *cf.* **artifact; chroma key; image processing, digital; linear key; matrixing; rounding.**

monitor, control: A **control monitor** is one employed primarily for decisions on subject matter, composition, and sequences to be selected in real-time. It is frequently one of several monitors mounted together in close proximity as in a studio — for example, to **display** multiple sources that are to be compared, selected, and combined in editing — for immediate, direct routing to **display**. The physical arrangements may make it very difficult to control the surround for each monitor, as specified by SMPTE Working Group on Studio Monitors in Document S17.280 for the **reference monitor**. It is nevertheless essential when sequences on several monitors are being compared and intercut that the monitors match in **luminance** and **colorimetry**. *cf.* **monitor, reference; monitor standardization.**

monitor, reference: A **reference monitor** is one employed for decisions on image quality. Achieving controlled reproducibility for this application is the primary objective of the specifications for **monitor standardization**. SMPTE Working Group on Studio Monitors, S17.28, has recognized the great disparity now existing among studio monitors and control monitors, and has noted the confusing variability among decisions based upon visual judgments of program quality as evaluated on different monitors. They are working to identify and recommend specifications for the variables affecting subjective judgments, coming not only from the monitor capabilities, but also from the adjustment of its controls and the bias introduced by the monitor surround and room illumination. *cf.* **monitor standardization**.

monitor standardization: Although it is customary to make all subjective judgments of image quality from the **reference monitor display**, the infinite possibilities for monitor adjustments have hampered reviewers in exercising effective program control, and have introduced many disparities and great confusion. The SMPTE Working Group on Studio Monitors, S17.28, is completing work on three specifications intended to make the monitor **display** follow a known **transfer function, electro-optic**, and permit a reliable evaluation of the program **image quality**: S17.280, Performance Standard for Monitors; RP 166, Viewing Conditions for Evaluation of Television Pictures; and RP 167, Alignment of Television Monitors. *cf.* **black level, monitor; color match, metameric; color space, reference; luminance range, display CRT; monitor, reference; transfer function; transfer function, electro-optic.**

motion artifacts: In all temporally-sampled systems (i.e., both photographic and electronic), realistic motion reproduction is achieved only with sampling below the **Nyquist limit**. The subjective response to **motion artifacts** is complex, influenced by the various degrees of smoothing and strobing affecting temporal and spatial **resolution —** integration and lag in the sensing, recording, and **display** elements; **sampling** geometry and **scanning** pattern; shutter transmission ratio; perceptual tolerances, etc. (Motion appears "normal" only when significant frame-to-frame displacement occurs at less than half the frame rate; i.e., "significant motion" distributed over at least two frames.) **Motion artifacts** most frequently observed have their origins in the following: (1) image components with velocity functions extending beyond the **Nyquist limit** (such as rotating, spoked wheels), (2) motion samples with such short exposures there is noticeable frame-to-frame separation of sharply defined images (such as synchronized flash illumination), (3) asynchronous sampling of intermittent motion (such as frame-rate conversions). A considerable number of **motion artifacts** appear so frequently as to be accepted by most viewers. *cf.* **artifact; conversion, frame-rate; judder; Nyquist limit; transform, systems.**

MPEG: Moving Pictures Experts Group. An international standards group functioning under the joint direction of ISO and IEC (subordinates of CCITT), developing international standards for the **image compression** of moving pictures and associated audio information. *cf.* **compression; compression, lossy; image compression; JPEG.**

MPEG-1: 1. ISO/IEC CD 11172 (10 Dec 1991) is the first of the standards designed for handling highly compressed moving images in real-time. It accepts periodically chosen frames to be compressed as in JPEG-1, predicts the content of intervening frames, and encodes only the difference between the actual and the prediction. Audio is compressed synchronously. 2. The encoder includes a decoder section in order to generate and verify the predictions. At the **display**, a much simpler decoder becomes possible. 3. MPEG-1 is optimized for a **data rate** of up to 1.5 Mb/s. 4. MPEG expects to develop a series of **compression** codes, optimized for higher **bit rates**. *cf.* **compression; compression, lossy; image compression; JPEG.**

Munsell chroma: 1. **(illuminating engineering)** "The index of perceived (*Y*) and chromaticity coordinates (*x,y*) for CIE Standard Illuminance C and the CIE 1931 Standard Observer" [IEEE 100]. 2. **(television)** "The dimension of the Munsell system of color that corresponds most closely to saturation. Note: Chroma is frequently used, particularly in English works, as the equivalent of saturation" [IEEE 100]. *cf.* **chroma; chrominance; luma; luminance, television; Munsell color system.**

Munsell color system: "A system of surface-color specifications based on perceptually uniform color scales for the three variables. Munsell hue, Munsell value, and Munsell chroma. For an observer of normal color vision, adapted to daylight and viewing the specimen when illuminated by daylight and surrounded with a middle gray to white background, the Munsell hue, value, and chroma of the color correlate well with the hue, lightness, and perceived chroma" [IEEE 100]. *cf.* **chroma; hue; lightness; Munsell chroma.**

NTSC: National Television System Committee. 1. NTSC-I in 1941 established 525/60/2:1 monochrome television in the U.S. 2. NTSC-II in 1953 established 525/59.94/2:1 **composite color** format television in the U.S. with two **color-difference signals** [labeled *I* and *Q*] quadrature-modulated onto a color subcarrier and added to the **luminance signal**. 3. NTSC is often used as the convenient name for North American television. *cf.* **CCIR; chrominance signal; color-difference; colors, primary; composite color; luminance; luminance signal; SMPTE 170M; SMPTE 244M.**

Nyquist limit: 1. When time-varying information is sampled at a rate R, the highest frequency that can be recovered without **alias** is limited to R/2, as was shown by R. Nyquist. Aliasing may be generated by under-sampling temporally in frame rate, or vertically in lines allocated to image height, or horizontally in analog bandwidth or in pixel allocation. 2. Intermodulations prior to band limiting may "preserve" some distracting effects of **aliasing** in the final **display**. 3. **"Nyquist Interval (data transmission):** The maximum separation in time which can be given to regularly spaced instantaneous samples of a wave of bandwidth W for complete determination of the waveform of the signal. Numerically, it is equal to ½ W seconds" [IEEE 100]. 4. Both photographic and electronic imaging usually accept a limited amount of **aliasing** (obvious only on certain image content) in order to achieve the most pleasing image **display**. Some control over the generation and visibility of **aliasing** may be exercised by the program producer through selection of scene details and camera manipulation. 5. Note – Sampling at a rate below the **Nyquist limit** permits mathematical confirmation of the frequencies present (as for example in a Fourier analysis of recorded motion). If the sampling window is very small (as in synchronized flash exposure), however, it may become a subjective judgment whether strobing is perceived in the image for motion approaching the limiting velocity (frequency). *cf.* **alias; artifact; motion artifacts.**

origination: (See figure 1.) The **production** cycle begins with the introduction of images in photographic, electronic imaging, or computational media. **Image capture** in real-time is usually essential for recording live subjects and maintaining the impact of realism. **Image generation**, normally achieved in nonreal-time, provides additional subject matter that can be edited into and combined with recorded live subjects to achieve programs that are more artistic, or more instructional, or both. *cf.* **distribution; post-production.**

PAL: Phase alternate line. A composite color standard similar to NTSC, except that the V-axis subcarrier reference signal inverts in phase at the horizontal line rate (i.e., phase alternation at the line rate of the R–Y component of the chrominance signal). Most applications are in the 625/50/2:1 systems. *cf.* **CCIR; NTSC; SECAM.**

pedestal: Black level expressed as an offset in voltage or **IRE units** relative to **blanking level**. Conventionally about 54 mv (7.5 IRE) in system M as defined by ANSI/EIA/TIA 250-C; conventionally zero in all other systems. *cf.* **black level; blanking level; setup.**

perception, visual: "The interpretation of impressions transmitted from the retina to the brain in terms of information about a physical world displayed before the eye. Note: Visual perception involves any one or more of the following: recognition of the presence of something; identifying it; locating it in space; noting its relation to other things; identifying its movement, color, brightness, or form" [IEEE 100].

picture element: "The smallest area of a television picture capable of being delineated by an electric signal passed through the system or part thereof. Note: It has three important properties, namely P_V, the vertical height of the picture element; Ph, the horizontal length of the picture element; and Pa, the aspect ratio of the picture element. In an analog system $P_V = 1/N$, where N is the number of active scanning lines in the raster, Ph = $t_r A/t_c$, where t_r is the average value of the rise and delay times (10% to 90%) of the most rapid transition that can pass through the system or part thereof, tc is the duration of the part of a scanning line that carries picture information, and A is the aspect ratio of the picture" [IEEE 100]. *cf.* **pixel; resolution, image; resolution, visual.**

picture height: In a scanning standard, the number of raster lines that contain the vertical extent of a white flatfield between the 50% response points, top and bottom. *cf.* **aperture, production; lines, active horizontal; lines, active vertical; picture width.**

picture width: In a scanning standard, that fraction of a total raster line that contains the horizontal extent of a white flatfield between the 50% response points, left and right. *cf.* **aperture, production; lines, active horizontal; lines, active vertical; picture height.**

pixel: 1. Originally an acronym for **picture element.** Now increasingly restricted to defining the digitized sampling of images. 2. A **pixel** is the digital representation of the smallest area of a television picture capable of being delineated by the bit stream; i.e., the digital value or set of values that defines the characteristics of a **picture element**. A **pixel** of a full color image is represented by a minimum of three components, reflecting the trichromatic nature of human vision. A **pixel** of a monochrome image may be represented by a single component. 3. **Pixels** may carry additional information such as transparency, etc. 4. "The total number of **picture elements** in a complete picture is of interest since this number provides a convenient way of comparing systems" [IEEE 100]. *cf.* **picture element; resolution, image; resolution, visual; pixel, square; post-production.**

pixel, square: 1. **Pixels** of equal height and width, having an aspect ratio of 1.0. **Pixels** created by computer graphics normally have an aspect ratio of 1.0. Video originally was unconcerned about the aspect ratio of its **pixels**. Increasing dependence upon **electronic post-production** has emphasized the advantage of **square pixels**. 2. System M/NTSC, by comparison, does not have **square pixels**. With 485 active vertical lines per frame, and 768 samples per active horizontal line (when sampled at four times subcarrier) in a 4:3 aspect ratio, the resulting pixels have an aspect ratio (width:height) of 0.842. 3. During image processing, some transforms that manipulate individual **pixels** as independent **picture elements** — especially those operations involving any image rotation, distortion, or size changes — are performed with simplified programs and less risk of **artifacts** when the **pixels** are square. *cf.* **conversion, systems; image processing, digital; pixel; post-production.**

PLUGE signal: Picture Line-Up Generating Equipment. 1. The **PLUGE** signal was designed for rapid and accurate adjustment of the **black level, reference** and, hence, the **luminance range, display**. It provides adjacent vertical bars, one at **black level, reference** and continuous bars slightly above and slightly below that reference. Following initial development by the BBC, CCIR now recognizes at least eight versions [CCIR Rep 405-5]. 2. SMPTE EG 1-1990, Alignment Color Bar Test Signal for Television Picture Monitors, includes a variant in which the **black level, reference** is flanked by bars at –4 IRE and +4 IRE. When the –4 IRE merges into the **black level, reference** bar, but the +4 IRE

bar is distinguishable, **black level, reference** is correctly set. A white patch is included at **peak white**, to define IRE 100, and the **luminance range, display CRT**. 3. Note: Current work identifying the lack of uniformity over the CRT face of some monitors has emphasized the necessity of locating the **PLUGE signal** appropriately within the frame. *cf.* **black level, reference; IRE units; luminance range, display CRT; monitor, reference; monitor standardization; transfer function; white peak.**

post-production: (See figure 1.) The application of image processing to photographic or electronic recorded image information. Usually in addition to scene selection and simple scene transitions, rather complex processing may be proposed: montage of two or more images; integration of photographic and electronic image information; titling and over-recording; changes of size, contrast, hue, or luminance; introduction of computer-generated components; simulated motion; creation of multilayered composites with control of transparency; etc. Audio information, maintained in synchronism with the images as specified by the script, is processed along with the image information. *cf.* **alpha channel; distribution; image processing, digital; origination; post-production, electronic; production; production, electronic, digital; square pixel.**

post-production, electronic: Performing one or more of the steps in the **post-production** sequence with the image information encoded in the electronic mode. The initial and final records, as well as any of the intermediates, may employ the photographic and electronic modes in any combination or permutation. *cf.* **alpha channel; conversion, systems; distribution; image file architecture; image file header/descriptor; image file motion-picture format; image processing, digital; origination; post-production; production; production, electronic, digital; pixel, square; television, digital, for studios; video index.**

post-production, off-line: (See figure 1.) **(electronic)** Complex **post-production** may require such large image bandwidths, such storage requirements, and such extensive calculations, that it necessitates conduction in nonreal-time, off-line. **(photographic)** Traditionally all photographic **post-production** has been off-line.

post-production, studio: (See figure 1.) When the **studio** and **distribution** standard are identical, and/or program urgency is great, simplified **post-production** is frequently conducted with all program segment decisions made in real-time review. For such applications, the program is usually in **distribution** or **emission/transmission** format. *cf.* **monitor, control; monitor standardization; television, digital, for studios**.

production: (See figure 1.) 1. Creation of recorded image information with associated audio, including necessary editing to achieve the thematic and artistic content desired for **distribution**. **Production** includes the three subdivisions: (a) **origination**; (b) **post-production**, and (c) **distribution**. 2. During **production**, there may be one or more interconversions of the image information between photographic and electronic modes. At the conclusion of the **production** step, the program has its intended final artistic and thematic content. 3. When the major portion of the **production** process has been completed and the program is transferred to **distribution**, it may be required to **transform, systems** to whatever formats best meet the program's **distribution** requirements. *cf.* **display; distribution; origination; post-production; transform, systems.**

production, electronic: Performing one or more of the steps in the production sequence with the image information encoded in the electronic mode. cf. origination; post-production.

production, electronic, digital: The SMPTE Working Group on Digital Pictures (H19.16) with initial focus upon nonreal-time digital representation of images, has been formed to develop standards and recommended practices with emphasis upon the **production** process. The SMPTE Task Force on Digital Image Architecture (St13.20) has been formed to define further requirements for the exchange of digital pictures at various resolutions and across the interfaces with a variety of **video**, computer, and data media. *cf.* **image file architecture; image file header/descriptor; image file motion-picture format; image file video index.**

production system HDTV: 1. **Production system HDTV** is the analog of **studio standard, HDTV**,

and addresses only a small part of what the SMPTE Committee on Hybrid Technology (H19) considers **production**, and in fact only a small part of what they consider **electronic production**. 2. Thus, in the context of SMPTE 240M, Television — Signal Parameters — 1125/60 High-Definition Production System, **production** has a much more restrictive definition than that employed by CCIR, or the SMPTE Committee on Hybrid Technology (H19), or this glossary. To illustrate by example from SMPTE 240M, the scope explains "This standard defines the basic characteristics of the video signals associated with origination equipment operating at the 1125/60 high-definition television production system." It is, therefore, directed to the equipment that first encodes the image information into this electronic format, for example, the studio camera and its associated electronics. *cf.* **display; distribution; emission; image capture; origination; post-production, studio; production; studio standard, HDTV; transportation.**

quantization: "A process in which the continuous range of values of an input signal is divided into nonoverlapping subranges, and to each subrange a discrete value of the output is uniquely assigned. Whenever the signal value falls within a given subrange, the output has the corresponding discrete value" [IEEE 100]. *cf.* **quantization error; sampled data.**

quantization error: "The amount that the digital quantity differs from the analog quantity" [IEEE 100]. *cf.* **artifact; production, electronic, digital; quantization; rounding; sampled data.**

R,G,B, color space: 1. "An [additive] color space with colorimetric coordinates based on red, green, and blue stimuli or primaries. Color values are negative in certain areas outside the gamut defined by the R,G,B, primaries. The R,G,B values used are intensities" [CIE Pub 17.4]. 2. **(video)** The three linear video signals carrying respectively the red, the green, and the blue information. By convention the unprimed symbols signify that there is a linear relationship between the **luminance** in each spectral region and the corresponding video signal. The spectral composition of the **luminance** forming each of these signals is one of the specifications required of the video system. The recently adopted CCIR Rec 709 reflects worldwide agreement on the current definition of **R,G,B primary colors**. CCIR Rec 709 identifies this as an interim agreement to be superseded by preferred **primary colors** encompassing a wider **color gamut** as soon as the technologies and practices permit. *cf.* **CCIR Rec. 709; color gamut; color primaries; R′,G′,B′ color space; SMPTE 240M; transfer function.**

R′,G′,B′ color space: The colorimetric **coordinates** defined by three nonlinear video signals carrying respectively the red, the green, and the blue information. By convention the primed symbols signify that there has been a nonlinear transformation of the video signals vs **luminance, relative, scene,** with its resulting modification of the **opto-electronic transfer function**. *cf.* **CCIR Report 624; color primaries; gamma correction; gamma, electronic; R,G,B color space; SMPTE 240M; transfer function.**

recorder, film: (See figure 1.) Equipment for transducing the **video** waveform into displayed images, and making a record of such images on motion-picture film so that they may be stored and subsequently retrieved as film images.

recorder, video: (See figure 1.) Equipment for making a record of the **video** waveform so that the mapped images may be stored and subsequently retrieved as the video waveform.

reflectance factor *R***:** "(At a surface element, for the part of the reflected radiation contained in a given cone with apex at the surface element, and for incident radiation of given spectral composition, polarization, and geometric distribution.) Ratio of the radiant or luminous flux reflected in the directions delimited by the given cone to that reflected in the same directions by a perfect reflecting diffuser identically irradiated or illuminanted" [CIE 845-04-64]. *cf.* **dynamic range; IRE units; luminance; luminance factor β; luminance range, scene; luminance, relative, scene.**

resampling: Video image information may be presented in a specific system — with, for example, its own frame rate, line count per frame, and line resolution (if the system is analog, resolution = video **bandwidth**; if the system is digital, resolution = **pixels** per line) — and need to be recast into a target system differing in one or more

of the specifications. Or in **post-production**, it may be desirable to change image size, to crop or zoom, or to distort geometrically, etc. The original signal is sampled and the samples processed by a suitable algorithm to generate a new set of samples compatible with the specifications of the target system. *cf.* **conversion, frame-rate; conversion, systems; line-rate conversion; transcoding; transform, systems.**

resolution, image: 1. In a practical sense, **resolution** is usually judged by imaging test targets bearing sets of spaced black-and-white lines in a square-wave pattern, and determining the minimum spacing for which the lines are distinguishable in the resultant image. [Practitioners explain, "If I can agree that lines are distinguishable as lines, and if they correspond in number and arrangement with the target, they are resolved."] 2. With instrumentation readout, **resolution** target charts are less ambiguous and more useful if they bear sets of spaced "black" and "white" lines sinewave modulated in density, rather than square-wave modulated. 3. Whereas square-wave targets introduce a Fourier series of higher frequencies, sinewave targets limit the analysis to a single frequency for each line set. Quantitative measurement of the modulations provides convenient determination of the **transfer function**. 4. **Resolution** as a continuous function of geometric detail is shown in the **transfer function**, identifying depth of modulation vs wavelength. 5. **Resolution** may be azimuth sensitive. 6. **Resolution** is a function of the **contrast** of the target, reaching a maximum at target contrast ratios of about 1000:1, and decreasing as the **contrast** decreases into the range of normal subjects. 7. **(electronics)** Both white and black lines are counted. 8. **Resolution** is usually expressed in terms of a number of lines discriminated on a televised test chart [normalized to picture height]" [IEEE 100]. 9. **(optics and photography)** A pair consisting of one white and one black line is counted as a single cycle. **Resolution** is usually expressed in terms of the maximum cycles/mm or cycles/degree, identifiable and discriminated on an aerial or photographic image. 10. For an image of equal **resolution, image,** the electronics number will be twice the optics and photographic number. ***cf.*** **Kell effect; line, television; line-pair, optical; Nyquist limit; resolving power; resolution, visual; transfer function.**

resolution, visual: 1a. "Qualitatively: Capacity for seeing distinctly fine details that have a very small angular separation. 1b. Quantitatively: Any of a number of measures of spatial discrimination such as the reciprocal of the value of the angular separation in minutes of arc of two neighboring objects (points or lines or other specified stimuli) which the observer can just perceive to be separate" [CIE 845-02-43]. 2. In system design, the reference value for normal human visual limiting resolution is 30 cycles/degree, i.e., 60 TV lines per angular degree subtended at the viewing position. For systems of current interest, the maximum viewing distances for discrete vertical resolution of the number of lines presented are shown in table 4. *cf.* **Kell effect; resolution, image.**

Table 4 – Limiting resolution of vertical detail[1)]

TV lines per frame Total	Active	Subtended vertical angle	Maximum viewing distance[1),2)]
525	485	8.08°	7.1h[3)] = 5.3*w*[4)]
625	575	9.58°	6.0h = 4.5*w*[4)]
1125	1035	17.25°	3.3h = 1.9*W*[5)]

[1)] No adjustment has been applied for possible interlace or **Kell effects**.
[2)] Assumes a shadow mask, if present, is not limiting.
[3)] *h* is vertical height of **display**.
[4)] *w* is horizontal width of **display** for 4:3 aspect ratio.
[5)] *W* is horizontal width of **display** for 16:9 aspect ratio.

resolving power: 1. Classically, two point objects are considered resolved when the centers of their diffraction disks in the image are separated by at least one disk diameter. This leads to a theoretical minimum angular separation for objects at a distance: $a = (1.22)(\lambda)/D$. **Resolving power** of a lens increases with increasing optical aperture. 2. Systems vary enormously in the closeness with which their actual **resolving power** approaches this diffraction-controlled ultimate limit. *cf.* **resolution, image; resolution, visual.**

rounding: Deleting the least significant digits of a quantity and applying some rule of compensation and correction to the part retained. *cf.* **truncation.**

sampled data: "Sampled data is that in which the information content can be, or is, ascertained only at discrete intervals of time. Note: Sampled data can be analog or digital" [IEEE 100]. *cf.* **data; quantization; sampling, orthogonal; sampling, quincunx.**

samples per picture width: 1. In a digital video system, the number of **pixels** corresponding to the reference picture width. 2. Some **pixels** at the borders of the picture region may be corrupted by the picture blanking transitions and by the effects of **post-production** image processing. Currently, SMPTE 260M defines a **clean aperture** within the **production aperture**, confining visible **artifacts** around the image to a thin border. *cf.* a**perture, clean; aperture, production; aperture, safe action; lines, active horizontal; picture height; picture width; pixel.**

sampling, orthogonal: In digital video, the sampling is **orthogonal** if the **luminance** and **color-difference** samples are generated from **pixels** arranged in common, continuous vertical and horizontal lines on a rectilinear grid that remains constant field/frame to field/frame. *cf.* **data; pixel; quantization; sampled data; sampling, quincunx.**

sampling, quincunx: 1. In a digital video system, the sampling is **quincunx** if the luminance and color-difference samples are generated from pixels arranged on one of two congruent rectilinear grids, the one being displaced horizontally from the other by half the horizontal **pixel** spacing. The alternate grid is usually chosen for alternate lines, but may instead be chosen for alternate field/frames. 2. In a digital video system, a sampling structure with an array of samples wherein alternate rows of **pixel** samples are displaced horizontally in the grid by half of the pitch of the **pixel** samples along the remaining rows. 3. Note – Pictorially descriptive name chosen directly from the classical Latin, *quincunx, -uncis, m*: The figure five (as arranged on dice or cards). *cf.* **pixel; quantization; sampled data; sampling, orthogonal.**

scalability: "The degree video and image formats can be combined in systematic proportions for distribution over communications channels for varying capacities" [FCC ACATS]. *cf.* **JPEG, MPEG.**

scanner, motion-picture film: 1. A device for scanning photographic motion-picture images and transcoding them into an electronic signal in one of the standardized or accepted video formats. 2. **Film scanner** is a general term, and may be applied to slow-rate as well as real-time transcoding, and may provide the input to a recorder, a signal processor, a transmission channel, or any other desired peripheral system. *cf.* **post-production; post-production, off-line; recorder, film; telecine; transfer function, opto-electronic.**

scanning, interlaced: 1. "A scanning process in which the distance from center to center of successively scanned lines is two or more times the nominal line width, and in which the adjacent lines belong to different fields" [CCIR and IEEE 100]. 2. For a given number of active vertical lines per frame, and a given frame-rate, **interlaced scanning** provides system-limited **definition** for still images. Moving images, however, provide reduced perceived **spatial definition**. Although the interlaced scanning field-rate at a multiple of the frame-rate could improve temporal resolution, this is seldom perceived. 3. When **scanning interlaced** 2:1 in either **capture** or **display** mode, the lines constituting one frame of the image are scanned and/or presented in two successive fields — one-half the lines in one field and the other half interleaved as the following field. In a system based upon a nominal 60 Hz, for example, the generation and presentation of the two fields in succession requires a total of 1⁄30 sec per frame, with a continual temporal progression from start to finish of the scanning. 4. Note – **Interlaced scanning** may be introduced in the original scanning for **image capture**, or may be developed from **progressive scanning** of the original. *cf.* **bandwidth limiting; definition; Kell effect; post-production, electronic; resolution, visual; scanning, progressive.**

scanning, progressive: 1. "A rectilinear scanning process in which the distance from center to center of successively scanned lines is equal to the nominal line width" [IEEE 100]. 2. A **display** mode for electronic imaging in which all of the scanned lines are presented successively, and

each field has the same number of lines as a frame. Also known as **sequential scanning**. 3. For a given number of **active vertical lines per frame**, and a given frame rate, **progressive scanning** requires the same bandwidth as **interlaced scanning**. When compared at a given field rate, **progesssive scanning** requires twice the bandwidth of 2:1**interlaced scanning**. 4. Note – Most image processing in **electronic post-production** requires that a **progressive scanned** image first be captured or created. 5. The image information may have originated in **progressive scanning**, or it may have been interpolated from an origination in **interlaced scanning**. *cf.* **definition; Kell effect; post-production, electronic; resolution, visual; scanning, interlaced.**

scanning, sequential: *cf.* **scanning**, **progressive.**

SECAM: Sequential Couleur avec Memoire. A composite color standard based upon line-alternate B–Y and R–Y color-difference signals, frequency modulated upon a color subcarrier. All applications are in 625/50/2:1 systems. *cf.* **CCIR; NTSC; PAL.**

setup: 1. "The ratio between **reference black level** and **reference white level**, both measured from **blanking level**. It is usually measured in percent" [IEEE 100]. 2. **Black level reference** expressed as a percentage of the blanking-to-reference-white excursion. Conventionally 7.5% in system M, conforming to ANSI/EIA/TIA 250-C. Conventionally zero in all other systems where **blanking level** and **black level reference** are identical. *cf.* **black level, reference; blanking level; PLUGE signal; SMPTE 170M; white peak; white, reference.**

sharpness: 1. **Sharpness** is the casual, subjective evaluation of detail clarity in an image. 2. It is often assumed that **sharpness** and **resolution** are directly related, in that images possessed of greater **sharpness** are assumed to have greater **resolution**. An increase in subjective **sharpness** is usually reported when objects are more clearly delineated from each other and from background having hard, sharply-defined edges. 3. A major contribution to subjective sharpness is this high contrast at edge transitions, as is emphasized by both **edge enhancement** and **aperture correction**, for example. In many practical systems, increasing the contrast at edge transitions is often accompanied by a reduction in fine detail, and under these conditions **sharpness** and **resolution** may describe opposite characteristics. *cf.* **aperture correction; definition; edge enhancement; resolution, image; resolution, visual; resolving power.**

shoulder: 1. On the characteristic curve for a photographic material (the plot of density vs log exposure) that portion representing nonlinear response at the higher densities. 2. For the electronic relationship of a positive **video** image to the **shoulder** of photographic negatives. *cf.* **knee; white compression, transfer function.** 3. For the electronic relationship of a positive **video** image to the **shoulder** of photographic positives. *cf.* **black compression; transfer function.**

signal, chrominance: 1. "**(video)** The **color-difference** signal(s) and the equation(s) for their derivation. 2. **(color television)** The sidebands of the modulated **chrominance** subcarrier that are added to the **luminance** signal to convey color information" [IEEE 100]. *cf.* **CCIR Rec 601-2; CCIR Rec 709-1; CCIR Rep 624-4; chroma; color-difference signal; signal, luminance; SMPTE 170M; television, broadcast.**

signal, luminance: 1. "**(video)** The signal that describes the distribution of **luminance** levels within the image and the equation for deriving that information from the camera output. 2. **(television, composite color)** "A signal that has major control of the **luminance**. Note: It is a linear combination of **gamma-corrected primary color** signals" [IEEE 100]. *cf.* **CCIR Rec 601-2; CCIR Rec 709-1; CCIR Rep. 624-4; composite color; luma; luminance, television; SMPTE 170M; television, broadcast.**

SMPTE 125M: Bit-Parallel Digital Interface — Component Video Signal 4:2:2. This standard defines an interface for system M (525/60) digital television based on CCIR Rec 601. The standard has application in the television studio over distances up to 300 m (1000 ft). *cf.* **CCIR Rec 601-2; SMPTE 244M.**

SMPTE 170M: Proposed SMPTE Standard for Television — Composite Analog Video Signal, NTSC for Studio Applications. 1. This standard describes the composite color video signal for

studio applications, system M/NTSC, 525 lines, 59.94 fields, 2:1 interlace, with an aspect ratio of 4:3. 2. This standard specifies the interface for analog interconnection and serves as the basis for the digital coding necessary for digital interconnection of system M/NTSC equipment. 3. Note – Parts of the system M/NTSC signal defined in this document differ from the final report of the Second National Television System Committee (NTSC 1953) due to changes in the technology and studio operating practices. *cf.* **NTSC; SMPTE 244M.**

SMPTE 240M: SMPTE Standard for Television — Signal Parameters — 1125/60 High-Definition Production System: "[Scope] This standard defines the basic characteristics of the video signals associated with origination equipment operating in the 1125/60 high-definition television production system. As this standard deals with basic system characteristics, all parameters are untoleranced." *cf.* **CCIR Rec 709-1; SMPTE 260M; television, high-definition (HDTV).**

SMPTE 244M: Proposed SMPTE Standard for Television — System M/NTSC Composite Video Signals — Bit-Parallel Digital Interface. This standard describes a bit-parallel composite video digital interface for systems operating according to the 525-line, 59.94-Hz NTSC standard as described by SMPTE 170M, sampled at four times color subcarrier frequency. Sampling parameters for the digital representation of encoded video signals, the relationship between sampling phase and color subcarrier, and the digital levels of the video signal are defined. *cf.* **NTSC; SMPTE 125M; SMPTE 170M.**

SMPTE 259M: Proposed SMPTE Standard for Television — 10-Bit 4:2:2 Component and 4fsc NTSC Composite Digital Signals — Serial Digital Interface. This standard describes a serial digital interface for system M (525/60) digital television equipment operating with either 4:2:2 component signals or 4fsc NTSC composite digital signals. It also gives specifications to ensure that the signal loss at 70 MHz (4fsc) or 135 MHz (4:2:2) due to coaxial cable characteristics (1/vf) does not exceed approximately 30 dB. *cf.* **NTSC; SMPTE 125M; SMPTE 244M.**

spectral analysis: 1. "Determination of the monochromatic components of the **luminance** considered" [CIE 845-01-08]. 2. Objective detailed specification of a **white reference**, of a **color**, or of the **transmission function**, with respect to wavelength and intensity. 3. Spectrophotometry. *cf.* **colorimetry; color-matching functions; spectrophotometric match.**

spectral sensitivity: (of a **detector**) "Quotient of the detector output $dY(\lambda)$ by the monochromatic detector output $dXc(\lambda) = Xc\lambda(\lambda)d\lambda$ in the wavelength interval $d\lambda$ as a function of the wavelength λ" [CIE 845-05-56].

spectrophotometric match: 1. "Spectrophotometry determines the spectral transmittance and the spectral reflectance of objects ... to compare at each wavelength the radiant flux leaving the object with that incident upon it" [Wyszeki and Stiles]. 2. A **spectrophotometric match** thus occurs only when the two objects being compared are identical in their color structure. Such a match will be maintained regardless of viewing conditions. 3. **Spectrophotometric matches** are seldom encountered and rarely necessary; in practice, the usual objective is to achieve a **metameric match**. **Metameric matches**, however, appear identical only under one set of specified viewing conditions. *cf.* **color match, corresponding; color match, metameric.**

standards conversion: *cf.* **transform, systems.**

studio standard, HDTV: 1. Approaches to the specification of a **studio standard, HDTV** have been in the context of present operations in 525/59.94 and 625/50 — i.e., operations in the studio conform to the specifications for transmission and broadcast. The **studio standard** with its implication of no **systems transform**, therefore, might be described also as one of the **distribution** standards — expected to be one of the inputs to **display**, and to be evaluated by subjective judgment of the display. 2. As employed by **CCIR Rep 801-4** and its annexes, the term **studio standard** loosely embraces everything from **image capture** through **distribution**. To illustrate the interpretation by examples from the document: (a) Sec 1, Introduction: "A single standard could be beneficial to programme producers as well as broadcasting organizations and viewers." (b) Sec 2, Technical Matters: This entire section is concerned with defining the system by reference to the subjective, visual

appraisal of the final **display**. (c) Annex II, entitled "Parameter values for signal generation in HDTV studios and for international exchange of HDTV programmes." (d) Sec 1 (e) explains: "...that the advantages of a single HDTV worldwide standard include lower HDTV equipment costs for broadcasters and viewers, easier exchange of programmes and technical information, and encouragement to the ideal of international solutions to common technical problems." 3. These concepts of a **studio standard** accordingly address only a small part of what the SMPTE Committee on Hybrid Technology considers **production**. *cf.* **common data rate (CDR); common image format (CIF); display; distribution; emission; image capture; origination; post-production; production; production system HDTV; transmission.**

telecine: A device for scanning photographic motion-picture images and transcoding them into video images in one of the standardized video formats. Its most common usage is to prepare video tape transfers from completed film programs. **Film scanner** is a more general term and **telecine** is frequently reserved for a scanner that operates only in real-time. *cf.* **distribution; recorder, film; scanner, motion-picture film; transfer function, opto-electronic.**

television, broadcast: Generally refers to terrestrial radiation of television signals in one or more of the frequency bands defined by CCIR (and in the U.S. reaffirmed by the FCC). The U.S. has 59 television channels, each 6 MHz wide, for video plus correlated audio. *cf.* **CCIR Rep 624-4; distribution; emission; transmission.**

television, digital component: 1. A signal format in which either the **tristimulus value** red (R), green (G), and blue (B) signals representing the picture contents — or a matrixed version consisting of the **luminance** (*Y*) and two color-difference signals (R–Y, *B–Y*) — are individually digitized and combined into a single data stream. SMPTE 125M describes a **digital component television** signal interface for 525-line/59.94 field/sec television systems. 2. Specifications for digital magnetic video tape recording of component digital **video** of 525-line or 625-line structure sampled at 13.5 MHz are grouped into the D-1 VTR standards. For 525-line, sampled at 13.5 MHz, the specifications are SMPTE 224M, 225M, 226M, 227M, RP 155, and EG 10. An index to the specifications for D-1, both 525-line and 625-line versions, is SMPTE EG 22. *cf.* **CCIR Rec 601-2; CCIR Rep 624-4; component color; SMPTE EG 22; television, digital composite; television, digital, for studios.**

television, digital composite: 1. A signal format in which the signal matrix representing the picture contents consisting of the **luminance** (*Y*) and the two **color-difference signals** (*R–Y, B–Y,* or *I,Q*) modulated on a color subcarrier are digitized in the matrixed form as a single data stream. SMPTE 244M describes a **digital composite television** signal interface for 525-line/59.94 field/sec television systems. 2. Specifications for digital magnetic video tape recording of composite digital **video** of 525-line or 625-line structure are grouped into the D-2 VTR standards. For 525-line, sampled at 14.32 MHz, the specifications are SMPTE 245M, 246M, 247M, 248M, EG 20, and RP 155. An index to the specifications for D-2 is SMPTE EG 22. *cf.* **CCIR Rec 624-4; composite color; SMPTE EG 22; television, digital component; television, digital, for studios; video, composite signal.**

television, digital, for studios: An extensible family of compatible digital coding standards for studio use with current television systems is defined by **CCIR Rec 601-2**, equally applicable to **component** encoded 525/60-Hz and 625/50-Hz systems. "The member of the family to be used for the standard digital interface between main digital studio equipment and for international programme exchange (i.e., for the interface with video recording equipment and for the interface with the transmission system) should be that in which the luminance and colour-difference sampling frequencies are related in the ratio 4:2:2." Specifications include: (1) Coded Signals: Luminance (Y) plus two color-difference signals (C_R and C_B); (2) Sampling Frequency: Luminance 13.5 MHz, Color-Difference 6.75 MHz (for each of the two signals); (3) Samples (8-bit) per Digital Active Line: Luminance 720, color-difference 360 (for each of C_R and C_B). Other more detailed specification details are included in **CCIR Rec 601-2**. Compressed and expanded derivatives (4:1:1 and 4:4:4 specifically) are postulated variants with minimum or maximum color information. *cf.* **bit-rate, recording; CCIR**

Rec 601-2; mixing, digital; R,G,B color space; R′,G′,B′ color space; recorder, video; television, digital component.

television, digital, HDTV: An extensible family of compatible digital coding standards for studio use with high-definition television is under study and test by the SMPTE Committee on Television Signal Technology (S17). Digital representation of the 1125/60 system is documented in SMPTE 260M. *cf.* **SMPTE 260M; television, digital, for studios**.

television, enhanced (ETV) (also EDTV): "The term enhanced television designates a number of different improvements applicable to 525/60-Hz and 625/50-Hz television systems." They include all television systems not specified in CCIR Report 624-4, Characteristics of Television Systems, and Report 801-4, The Present State of High-Definition Television, "either with unchanged or new radiation standards" and without specification of aspect ratio [CCIR Report 1077, 1990]. *cf.* **CCIR Rep 1077.**

television, high-definition (HDTV): "A high-definition television system is a system designed to allow viewing at about three times the picture height, such that the system is virtually, or nearly, transparent to the quality of portrayal that would have been perceived in the original scene or performance by a discerning viewer with normal visual acuity. Such factors include improved motion portrayal and improved perception of depth.... A high-definition television system generally implies in comparison with conventional television systems: (1) spatial resolution in the vertical and horizontal directions of about twice that available in CCIR Rec 601-2; (2) any worthwhile improvements in temporal resolution beyond that achievable with CCIR Rec 601-2; (3) improved color rendition; (4) a wider aspect ratio; (5) multichannel high-fidelity sound" [CCIR Report 801-3, 1989]. *cf.* **CCIR Rec 709-1; CCIR Rep 801-4; SMPTE 240M**.

time and control code (SMPTE): SMPTE 12M. A digital code recorded by video and audio magnetic tape recorders, identifying each frame with a unique and complete address. Unassigned bits permit limited **production** identification. The **time and control code** was developed for 525-line/60-field systems. An international version compatible with SMPTE 12M is described in IEC Publication 461. Variants have evolved for 24- and 25-frame systems. *cf.* **IEC Publication 461; ISO/DIS 9642; SMPTE 12M.**

time and control code (cinematography): A digital code format applicable to motion-picture film at 24, 25, or 30 frames/sec. Two types are described: (1) Type C, a continuous code very similar to SMPTE 12M and IEC Publication 461 to be read from continuously moving film, and (2) Type B, a noncontinuous block-type code for intermittently moving film, but still decodable with the same type of electronic equipment used to read Type C. *cf.* **IEC Publication 461; ISO/DIS 9642; SMPTE 12M.**

toe: 1. On the characteristic curve for a photographic material (the plot of density [i.e., log opacity] vs log exposure), that portion representing nonlinear response at the lower densities. 2. For electronic image relationship to photographic negatives. *cf.* **black compression**. 3. For electronic image relationship to photographic positives. *cf.* **knee; white compression**.

transcoding: *cf.* **data resampling; transform, systems.**

transfer function: "A complex function of frequency response [and correlated levels] relating the output to the input of the device as a function of frequency.... A mathematical, graphical, or tabular statement of the influence which a module has on a signal or action compared at input and at output terminals" [IEEE 100].

transfer function, electro-optic: 1. **(display)** The relationship between the video signal supplied to a **display** device and the **luminance** of the resulting image produced by that **display** device. 2. **(recorder, film)** The relationship between the video signal supplied to the recorder and the resultant illuminance exposing the film. *cf.* **CCIR Rep 624-4; display; recorder, film; SMPTE 240M; transfer function, monitor electro-optic.**

transfer function, monitor electro-optic: 1. The relationship between video input to the monitor and the **luminance** of the CRT. 2. Monitors are required to conform to a narrower range of performance specifications than is expected of commercial receivers. 3. Confirming these tighter tolerances requires attention to measurement details since, for example, the **luminance**

may vary if different areas of the tube face are selected. Light output is routinely measured in the center of large, uniform "patches" or windows. 4. Since there is significant "bleeding" of light within a CRT tube face, the **monitor transfer function** also decreases with decreasing size of the windows (it is thus reduced for fine detail) and with increasing video level of the raster surrounding the windows. *cf.* **display; gamma correction; gamma, electronic; monitor standardization.**

transfer function, opto-electronic: The relationship between scene **luminances** and the corresponding video signal. There may be several **opto-electronic transfer functions** for a single system, depending upon where in the progression of possible nonlinear processing, band-limiting, etc., the video signal is being identified. When referred to the camera output before band-limiting and processing, however, it is essentially a linear function. *cf.* **bandwidth limiting; gamma correction; image capture; origination; SMPTE 240M.**

transform, systems: (See figure 1.) **Electronic production** requires that images originating in a multiplicity of systems and formats be made compatible in **post-production** for **image processing**. The necessary **transforms** may include temporal, spatial, resolution, colorimetry, etc. *cf.* **distribution; origination; production.**

transmission: 1. "The electrical transfer of a signal, message, or other form of intelligence from one location to another" [IEEE 100]. 2. The transfer of a video waveform from point to point by conductive cable or fiber. *cf.* **distribution; emission; transportation.**

transportation: (See figure 1.) The delivery in physical form of a program prepared for distribution. The completed program may be in the form of a tape recording, a film print, an optical disc, etc. *cf.* **distribution; emission; transmission.**

tristimulus values: 1. "Amounts of the three reference color stimuli, in a given trichromatic system, required to match the color of the stimulus considered. Note: In the CIE standard colorimetric systems, the tristimulus values are represented by the symbols X, Y, Z and X_n, Y_n, Z_n" [CIE 845-03-22]. 2. "The amounts of the three reference or matching stimuli required to give a match with the light considered in a given trichromatic system" [IEEE 100]. *cf.* **ANSI/IES RP16; color match, metameric; spectrophotometric match.**

truncation: "To terminate a computational process in accordance with some rule" [IEEE 100]. For example, when **digital mixing** or other operations create extra bits per sample (such as 16 bits from multiplication of two 8-bit samples), it is usually necessary at some point to **truncate** (or **round**) the result back to the original bit length, and to apply some rule to the correction of the part retained. Various rules have been introduced for how this may be done with digital **video** images for the least noticeable result. *cf.* **rounding.**

video: 1. "A term pertaining to the bandwidth and spectrum position of the signal resulting from television scanning" [IEEE 100]. 2. The term is commonly used to identify the electronic mapping of scene **luminance** and **color** information, usually within time-variant systems. 3. Correlated audio is included and usually implied.

video, composite signal: "The electric signal that represents complete color picture information and all sync signals. (Includes blanking and the deflection sync signals to which the color sync signal is added in the proper time relationship.)" [IEEE 100]. *cf.* **CCIR Rec 601-2; composite color; SMPTE 170M; television, broadcast.**

video index: A data packet for carrying picture and program related source data in conjunction with the video signal. There are three classes of data to be included: Class 1 contains information that is required to know how to use the signal. Class 2 contains heritage information for better usage of the signal. Class 3 contains other information. The SMPTE Working Group on Video Index (P18.41) is developing the proposed recommended practice. *cf.* **image file architecture; image file header/descriptor; image file video index; post-production, electronic; production, electronic, digital; television, digital, for studios.**

video, peak: *cf.* **white clip; white peak; white, reference.**

video units: *cf.* **IRE units.**

WGHDEP: SMPTE Working Group on High-Definition Electronic Production (N15.04). Now reformed as the SMPTE Committee on Hybrid Technology (H19).

white clip: The maximum video signal excursion in the white direction permitted by the system. *cf.* **IRE units; white, reference.**

white compression: "The reduction in gain applied to a picture signal at those levels corresponding to light areas in the picture, with respect to the gain at the level corresponding to the midrange light value in the picture. Notes: (1) The gain referred to in the definition is for a signal amplitude small in comparison with the total peak-to-peak picture signal involved. A quantitative evaluation of this effect can be obtained by a measurement of **differential gain**. (2) The overall effect of **white compression** beyond **bandwidth limiting** is to reduce contrast in the highlights of the picture as seen on a monitor" [IEEE 100]. *cf.* **knee; shoulder; toe; transfer function.**

white peak: "A peak excursion of the picture signal in the white direction" [IEEE 100]. *cf.* **IRE units; white clip; white, reference.**

white point: That point on the **chromaticity** diagram having the **tristimulus** values of a source appearing white under the viewing conditions; i.e., a spectrally nonselective sample under the illumination of viewing conditions. *cf.* **colors, primary; color match, metameric; color space, reference; tristimulus values.**

white, reference: 1. "The light from a nonselective diffuse reflector (in the original scene) that is lighted by the normal illumination of the scene. That white with which the display device simulates reference white of the original scene" [IEEE 100]. 2. In the **production** context, **reference white** is defined as the **luminance** of a white card having 90% reflectance, and subjected to scene illumination. It is expected that there will be the capability of some discrimination of surface texture or detail within that portion of the **transfer function** incorporating **reference white**. *cf.* **color match, metameric; colors, primary; IRE units; luminance, relative, scene; reflectance factor R; white point.**

Y', C'_R, C'_B: The three nonlinear video signals in which the information has been transformed into a **luminance signal** and two **chrominance signals**, each of which has been subject to nonlinear processing, and the **chrominance signals** at least have also been band-limited. By convention, C'_R and C'_B represent **color-difference signals** in digital format with typical excursion of values from 16 to 240 [CCIR Rec 601-2].

Y', P'_R, P'_B: The three nonlinear video signals in which the information has been transformed into a **luminance signal** and two **chrominance signals,** each of which has been subject to nonlinear processing, and the **chrominance signals** at least have also been band-limited. By convention, P'_R and P'_B represent **color-difference signals** in analog format, with typical excursion between –350 mv and +350 mv [CCIR Rec 601-2].

Annex A (informative)
Bibliography

AES Audio Engineering Society, New York:

– ANSI S4.28-1984 (R1992), Preferred Sampling Frequencies for Professional Digital Audio Applications Employing Pulse Code Modulation

– ANSI S4.40-1992, Digital Audio Engineering — Serial Transmission Format for Two-Channel Linearly Represented Digital Audio Data

Bartleson Bartleson, C.J., Optimum Image Tone Reproduction, Journal of the SMPTE, 84:613-618, Aug. 1975.

– Bartleson, C.J., Annotated Bibliography on Psychophysical Methods, CIE Journal, 4:1-13, 1985.

Bartleson and Grum Bartleson, C.J. and Grum, F., Optical Radiation Measurements: Volume 5, Visual Measurements. Academic Press Inc., 1984.

Benson Benson, K.B., ed: Television Engineering Handbook. New York, 1986: McGraw-Hill.

CCIR Comité Consultatif International des Radiocommunications (International Radio Consultative Committee), International Telecommunications Union, Geneva, Switzerland:

– References and Reports of the CCIR (most recent complete volumes, 1990):

Vol. X-1, Broadcast Service (Sound)
Vol. X/XI-2, Broadcasting-Satellite Service (Sound and Television)
Vol. X-XI-3, Sound and Television Recording
Vol. XI-1, Broadcasting Service (Television)
Vol. XII, Television and Sound Transmission (CMTT)
Vol. XIII, Vocabulary

– Recommendation 500-4 (1990), Method for the Subjective Assessment of the Quality of Television Pictures

– Recommendation 601-2 (1990), Encoding Parameters of Digital Television for Studios

– Recommendation 709-1 (1991), Basic Parameter Values for the HDTV Standard for the Studio and for International Programme Exchange

– Report 294-6 (1986), Standards for the International Exchange of Monochrome and Colour-Television Programmes on Film

– Report 624-4 (1990), Characteristics of Television Systems

– Report 801-4 (1990), The Present State of High-Definition Television

– Report 1077-1 (1990), Enhanced Quality Television Systems

CIE Commission Internationale de l'Eclairage (International Commission on Illumination), Vienna, Austria:

– CIE S001 (1986), Colorimetric Illuminants

– CIE S002 (1986), Colorimetric Observers

– Publication 15.2 (1986), Colorimetry, Second Edition

– Publication 17.4 (1987), International Lighting Vocabulary [Published jointly with IEC, the identical document identified as Publication 50(845)]

EBU European Broadcasting Union, Geneva, Switzerland. The technical center of the EBU publishes technical documents developed by the EBU technical committee in studies of television broadcasting topics of interest to its members.

EIA Electronic Industries Association, Washington, DC:

– ANSI/EIA/TIA 250-C-1989, Electrical Performance Standard for Television Transmission Systems

FCC ACATS Federal Communications Commission Advisory Committee on Advanced Television Service:

– FCC ACATS PS-WP/4, Planning Subcommittee, Working Party 4, Interim Report (31 December 1991)

Hunt Hunt, R.W., Measuring Color. New York, 1989. John Wiley & Sons. An explanation of the CIE system of color measurement, and its recent extensions and improvements. Presented in the context of color perception and practical color measurement.

IEC International Electrotechnical Commission, Geneva, Switzerland:

– IEC Publication 461 (1986), Time and Control Code for Video Tape Recorders

– IEC International Electrotechnical Vocabulary (1987) [Published jointly with CIE, the identical document identified as Publication 17.4-1987]. Definitions Chapter 845:

845-01-08, Spectral Analysis
845-01-35, Luminous Flux
845-01-38, Illuminance
845-02-28, Brightness
845-02-43, Resolution
845-02-47, Contrast
845-03-22, Tristimulus Values
845-03-23, Color Matching Function
845-03-25, Color Space
845-03-54, CIELuv Color Space
845-03-56, CIELab Color Space
845-04-64, Reflectance Factor R
845-04-69, Luminance Factor β
845-05-10, Colorimetry
845-05-56, Spectral Sensitivity

IEEE Institute of Electrical and Electronics Engineers, New York:

– ANSI/IEEE 100-1988, Dictionary of Electrical and Electronics Terms, fourth edition

IES Illuminating Engineering Society of North America, New York:

– ANSI/IES RP16-1986, Nomenclature and Definitions for Illuminating Engineering. Clause 13 includes tables of units, conversions, and luminance efficiency.

– Clause 13.5, Spectral Tristimulus Values for Equal Spectral Power Source

ISO International Organization for Standardization, Geneva, Switzerland:

– ISO 4246:1984, Cinematography — Vocabulary

– ISO/DIS 4246/DAM 1 (1992), Amendment 1 to ISO 4246 introducing audio terms

– ISO DIS/9642, Cinematography — Time and Control Code for 24, 25 and 30 Frames per Second Motion-Picture Systems — Specifications

– ISO 8613:1989, Information Processing — Text and Office Systems — Office Document Architecture (ODA) and Interchange Format:

Part 1, Introduction and General Principles
Part 2, Document Structures
Part 4, Document Profile
Part 5, Office Document Interchange Format (ODIF)
Part 6, Character Content Architectures
Part 7, Raster Graphics Content Architectures
Part 8, Geometric Graphics Content Architecture

JPEG Joint Photographic Experts Group, ISO/IEC JTC1-SC 29/WG 10:

– [JPEG-1] ISO/IEC DIS 10918-1 (1 Jan 92), Digital Compression and Coding of Continuous-Tone Still Images, Part 1, Requirements and Guidelines

– [JPEG-2] ISO/IEC CD 10918-2 (10 Dec 91), Digital Compression and Coding of Continuous-Tone Still Images, Part 2, Compliance Testing

Lowry and Jarvis Lowry, E.M. and Jarvis, J.G., The Luminance of Subjective Black, Journal of the SMPTE, 65:411-414, Aug. 1965.

MPEG Moving Pictures Experts Group, ISO/IEC JTC1-SC 29/WG 11:

– [MPEG-1] ISO/IEC CD 11172 (6 Dec 91), Coding of Moving Pictures and Associated Audio — For Digital Storage Media At Up To About 1.5 Mb/s

Novick Novick, S.B., Tone Reproduction from Colour Telecine Systems, BKSTS Journal, 342-347, Oct. 1969.

SMPTE Society of Motion Picture and Television Engineers, White Plains, NY:

– H19, Committee on Hybrid Technology
– H19.12, Ad Hoc Group on Interface Between HDTV and Film (disbanded)
– H19.16, Working Group on Digital Pictures
– H19.17, Working Group on Production Colorimetry

– P18, Committee on Television Production Technology
– P18.41, Working Group on Video Index

– S17, Committee on Television Signal Technology
– S17.08, Ad Hoc Group on NTSC Documentation (disbanded)
– S17.13, Working Group on Serial HDTV Interfaces
– S17.28, Working Group on Professional/Studio Picture Monitors (disbanded)
– S17.39, Working Group on Advanced Television Production

– St13, Standards Committee
– St13.20, Task Force on Digital Image Architecture

ANSI/SMPTE 12M-1986, Television — Time and Control Code — Video and Audio Tape for 525-Line/60-Field Systems

ANSI/SMPTE 96-1992, Television — 35- and 16-mm Motion-Picture Film and 2x2-in Slides — Scanned Area and Photographic Image Area for 4:3 Aspect Ratio. (Combines the contents and replaces SMPTE 94, PH22.95, and PH22.96.)

ANSI/SMPTE 125M-1992, Television — Component Video Signal 4:2:2 — Bit-Parallel Digital Interface

ANSI/SMPTE 148-1991, Motion-Picture Film — 35- and 16-mm Prints for Television Transmission — Film Image Area for Review Room Viewing

SMPTE 170M, Proposed Standard for Television — Composite Analog Video Signal — NTSC for Studio Applications

SMPTE 224M, Proposed Standard for Television Digital Component Recording — 19-mm Type D-1 — Tape Record

SMPTE 225M, Proposed Standard for Television Digital Component Recording — 19-mm Type D-1 — Magnetic Tape

SMPTE 226M, Proposed Standard for Television Digital Component and Composite Recording — 19-mm Type D-1 and D-2 — Tape Cassettes

SMPTE 227M, Proposed Standard for Television Digital Component Recording — 19-mm Type D-1 — Helical Data and Control Records

SMPTE 240M-1988, Television — Signal Parameters — 1125/60 High-Definition Production System

SMPTE 244M, Proposed Standard for Television — System M/NTSC Composite Video Signals — Bit-Parallel Digital Interface

SMPTE 245M, Proposed Standard for Television Digital Recording — 19-mm Type D-2 Composite Format — Tape Record

SMPTE 246M, Proposed Standard for Television Digital Recording — 19-mm Type D-2 Composite Format — Magnetic Tape

SMPTE 247M, Proposed Standard for Television Digital Recording — 19-mm Type D-2 Composite Format — Helical Data and Control Records

SMPTE 248M, Proposed Standard for Television Digital Recording — 19-mm Type D-2 Composite Format — Cue Record and Time and Control Code Record

SMPTE 260M-1992, Television — Digital Representation and Bit-Parallel Interface — 1125/60 High-Definition Production System

SMPTE 268M, Proposed Standard for File Format for Digital Picture Exchange (DPX)

SMPTE RP 27.3-1989, Specifications for Safe Action and Safe Title Areas Test Pattern for Television Systems

SMPTE RP 115-1983, Dimensions of Photographic Control and Data Record on 35-mm Motion-Picture Release Prints

SMPTE RP 155-1990, Audio Levels and Indicators for Digital Audio Records on Digital Television Tape Recorders

SMPTE RP 166, Proposed Recommended Practice on Critical Viewing Conditions for Evaluation of Color Television Pictures

SMPTE RP 167, Proposed Recommended Practice on Alignment of Professional Television Color Picture Monitors

SMPTE EG 1-1990, Alignment Color Bar Test Signal for Television Picture Monitors

SMPTE EG 10, Proposed Engineering Guideline on Tape Transport Geometry Parameters for 19-mm Type D-1 Television Digital Component Recording

SMPTE EG 20, Proposed Engineering Guideline on Tape Transport Geometry Parameters for 19-mm Type D-2 Composite Format for Television Digital Recording

SMPTE EG 22, Proposed Engineering Guideline on Description and Index of Documents for 19-mm Type D-2 Composite Television Digital Recording

P18.410 Proposed Recommended Practice for Television — Video Index Information Coding

S17.280, Proposed Standard for Television — Professional 525-Line Television/Studio — Type A Color Picture Monitors — Performance

Wyszeki et al Wyszeki, G.; Stiles, W.S.; and Goodman, J.W., Color Science, Concepts and Methods, Quantitative Data and Formulas, 2nd ed. New York, 1982. John Wiley & Sons.

Annex B (informative)
Other potentially useful glossaries

ANSI/IEEE 100-1988, Dictionary of Electrical and Electronics Terms. This dictionary defines over 24,000 technical words from the fields of electrical and electronics engineering, with each definition selected from an official standard of the IEEE. Although useful for the basically electronic operations within the production process, it contains relatively few terms specifically directed toward images. Many of those which are indeed relevant to the production process have been collected herein. A number of the terms and definitions introduced into the electronic production environment by the interfacing technologies have evolved from the familiar IEEE vocabulary.

ANSI/IES RP16-1986, Nomenclature and Definitions for Illuminating Engineering. Clause 13 includes tables of units, conversions, and luminance efficiencies. Clause 13.5, Spectral Tristimulus Values for Equal Spectral Power Source.

CCIR Vocabulary (CMV), Reports of the CCIR, Volume XIII, 1990. International Radio Consultative Committee, International Telecommunications Union, Geneva, Switzerland.

CIE International Lighting Vocabulary, CIE Publication No. 17.4. Commission Electrotechnique Internationale, Vienna, Austria. (Identical with IEC International Lighting Vocabulary.)

IEC International Lighting Vocabulary, IEC Publication 461. International Electrotechnical Commission, Geneva, Switzerland. (Identical with CIE International Lighting Vocabulary.)

ISO Cinematography — Vocabulary, ISO 4246:1984, incorporating Amendment 1 (1992). Cinematographic terms and their definitions which are peculiar to the motion-picture industry. Definitions are provided in the three official languages: English, French, and Russian. Transcriptions have been prepared in German, Italian, and Dutch as annexes to the document.

NAB Engineering Handbook, 6th Edition, 1975, Glossary of Television Terms, pp 672-677. National Association of Broadcasters, Washington, D.C.

M. Schubin, High-Definition Glossary. Editorial supplement to Videography magazine (undated). Sponsored by 1125/60 Group.

SMPTE EG 21, Nomenclature for Television Digital Recording of 19-mm Type D-1 Component and Type D-2 Composite Formats. Prepared for use with the standards evolving from CCIR Recommendation 601, the glossary includes the following: general definitions; track pattern allocations; electrical signal allocation; subsets of binary data; error protection strategy; error protection-data organization; other electrical definitions; mechanical terms; editing definitions. Available from the SMPTE.

ANSI/SMPTE 56-1991, Motion-Picture Film — Nomenclature for Studios and Processing Laboratories. Includes simple television recording terms and correlates them with philosophically-related film terms. Available from ANSI and from SMPTE.

Television Tape Recording Nomenclature, SMPTE Journal, 97:928-936, Nov. 1988. A general reference glossary to terms used in video tape recording, prepared by the SMPTE Committee on Television Recording and Reproduction Technology (V16).

Annex C (informative)
Index

gamma, corrction
gamma, electronic
gamma photographic
gray card
gray scale

header/descriptor
hue

IEC
IEEE
illuminance
image capture
image compression
image enhancement
image file architecture
image file descriptor
image file header
image file header/descriptor
image file motion-picture format
image file video index
image generation
image processing, digital
image quality evaluation, interval-scaled
image quality evaluation, ordinal-scaled
image quality evaluation, ratio-scaled
image quality, objective
image quality, perceived
interoperability
IRE units
IS&T
ISO

JPEG
JPEG-1
JPEG-2
judder

Kell effect
key channel
knee

lightness
linear key
line pair, optical
line-rate conversion
lines, active horizontal
lines, active vertical
line, television
luma
luminance
luminance, constant
luminance factor β
luminance, physics (generic usage)
luminance range
luminance range, display CRT
luminance range, display theater
luminance range, recorded
luminance range, scene
luminance, relative, scene
luminance, television
luminous flux

MAC
masking
matrixing
matte
matte channel
mixing, digital
monitor, control
monitor, reference
monitor standardization
motion artifacts
MPEG
MPEG-1
Munsell chroma
Munsell color system

NTSC
Nyquist limit

origination

PAL
pedestal
perception, visual
picture element
picture height
picture width
pixel
pixel, square
PLUGE signal
post-production
post-production, electronic
post-production, off-line
post-production, studio
production
production, electronic
production, electronic, digital
production system HDTV

quantization
quantization error

R,G,B color space
R′,G′,B′ color space

recorder, film
recorder, video
reflectance factor R
resampling
resolution, image
resolution, visual
resolving power
rounding

sampled data
samples per picture width
sampling, orthogonal
sampling, quincunx
scalabilityscanner, motion-picture film
scanning, interlaced
scanning, progressive
scanning, sequential
SECAM
setup
sharpness
shoulder
signal, chrominance
signal, luminance
SMPTE 125M
SMPTE 170M
SMPTE 240M
SMPTE 244M
SMPTE 259M
spectral analysis
spectral sensitivity
spectrophotometric match
standards conversion
studio standard, HDTV

telecine
television, broadcast
television, digital component
television, digital composite
television, digital, for studios
television, digital, HDTV
television, enhanced (ETV) (also EDTV)
television, high-definition (HDTV)
time and control code (SMPTE)
time and control code (cinematography)
toe
transcoding
transfer function
transfer function, electro-optic
transfer function, monitor electro-optic
transfer function, opto-electronic
transform, systems
transmission
transportation
tristimulus values
truncation

video
video, composite signal
video index
video, peak
video units

WGHDEP
white clip
white compression
white peak
white point
white, reference

Y', C'_R, C'_B
Y', P'_R, P'_B