

Guidelines on Flashing Images and Regular Patterns in Television -- Explanatory Notes from Cambridge Research Systems

Background to ITC Guidance Note for Licensees

The ITC / Ofcom Guidance Note for Licensees on Flashing Images and Regular Patterns in Television ^{1} presents a concise set of guidelines intended to reduce the risk of epileptic seizure for photosensitive viewers and protect them from potentially harmful stimuli.^{4} Previously, human observers monitored for compliance but computer-based verification is now available.

Automatic classification requires greater explanation of acceptable limits and precise definitions of how and when a guideline is violated. This document provides this additional information and is intended to be read in conjunction with the ITC / Ofcom guidelines.

In all cases, the following rules assume standard viewing conditions whereby the television screen subtends a horizontal viewing angle of 10 degrees and gamma = 2.2. As the ITC / Ofcom guidelines are predominately defined with respect to time rather than frame rate, the following rules apply equally to PAL (25 frames per second) or NTSC (30 frames per second) unless separately specified. For ease of cross-reference, the section numbers in the Additional Guidelines section correspond to those in the current ITC / Ofcom Guidance notes ^{1}. For clarity, this document covers luminance and red flashes in detail before introducing the concept of cumulative risk from prolonged exposure. Where it is necessary to make additional definitions, these are shown separately in bold.

Additional Guidelines

Section 3 – A Harmful Flash

- (i) The ITC / Ofcom Guidance Note states that a harmful flash must incorporate two opposing transitions (i.e. an increase in luminance followed by a decrease or vice versa). In addition, these transitions should be visually evident and occur over a small number of frames, as a gradual luminance change over several frames does not necessarily constitute a harmful transition ^{3}.

Definition: a valid transition of 20cd/m² or more must also include a sudden luminance change between successive frames of at least 6cd/m².

For example, a steady ramp of 3cd/m² per frame over 7 frames followed by an opposing step change of 21cd/m² only constitutes a single valid transition and not a full flash. Only these valid transitions can be used to determine whether the guidelines have been violated over any one-second interval.

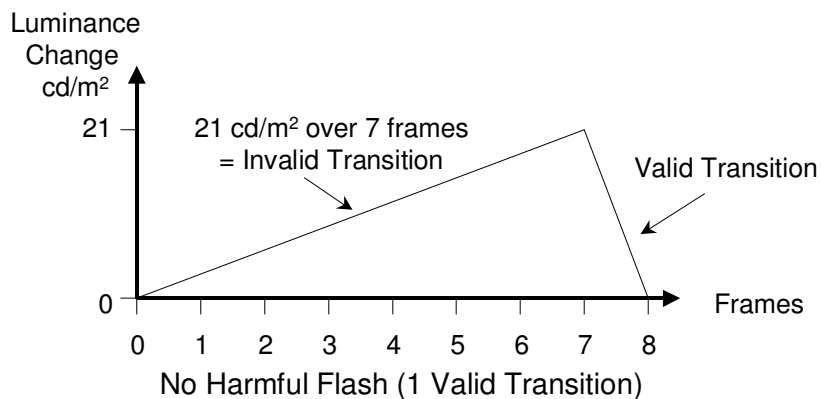
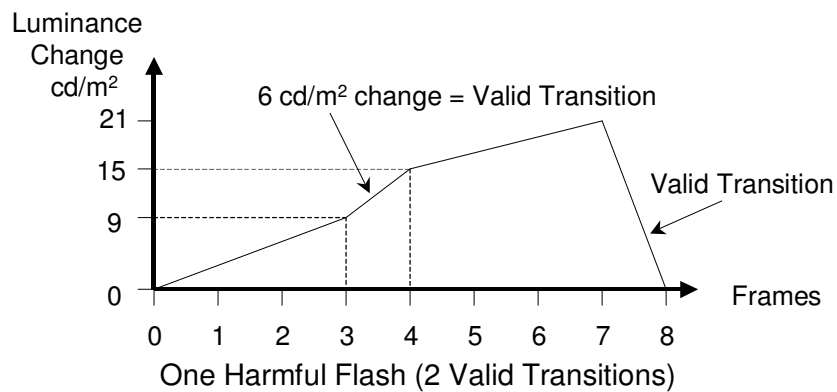
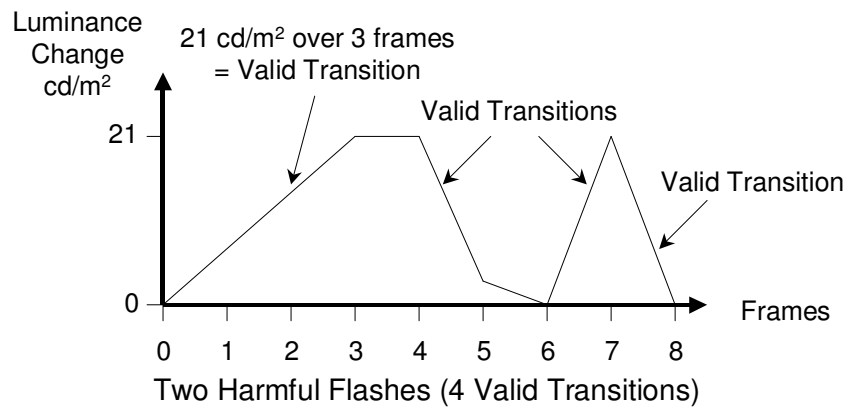


Figure 1: Definition of Harmful Flashes

Section 3 – Transitions to or from a Saturated Red

- (i) The ITC/Ofcom guidelines ^{1} identify transitions to or from a saturated red as potentially harmful. However, saturated red is not explicitly defined and even highly provocative red flash sequences, which are known to have triggered seizures ^{10}, rarely involve a pure red signal.

Definition: Saturated Red requires the red signal component to constitute at least 80% of the gamma corrected total RGB colour signal i.e. $\text{red} / (\text{red} + \text{green} + \text{blue}) \geq 0.8$.

Plotting this definition in a CIE chart shows that red flash analysis is restricted to hues that appear evidently red and exclude those which may be perceived as orange or purple.

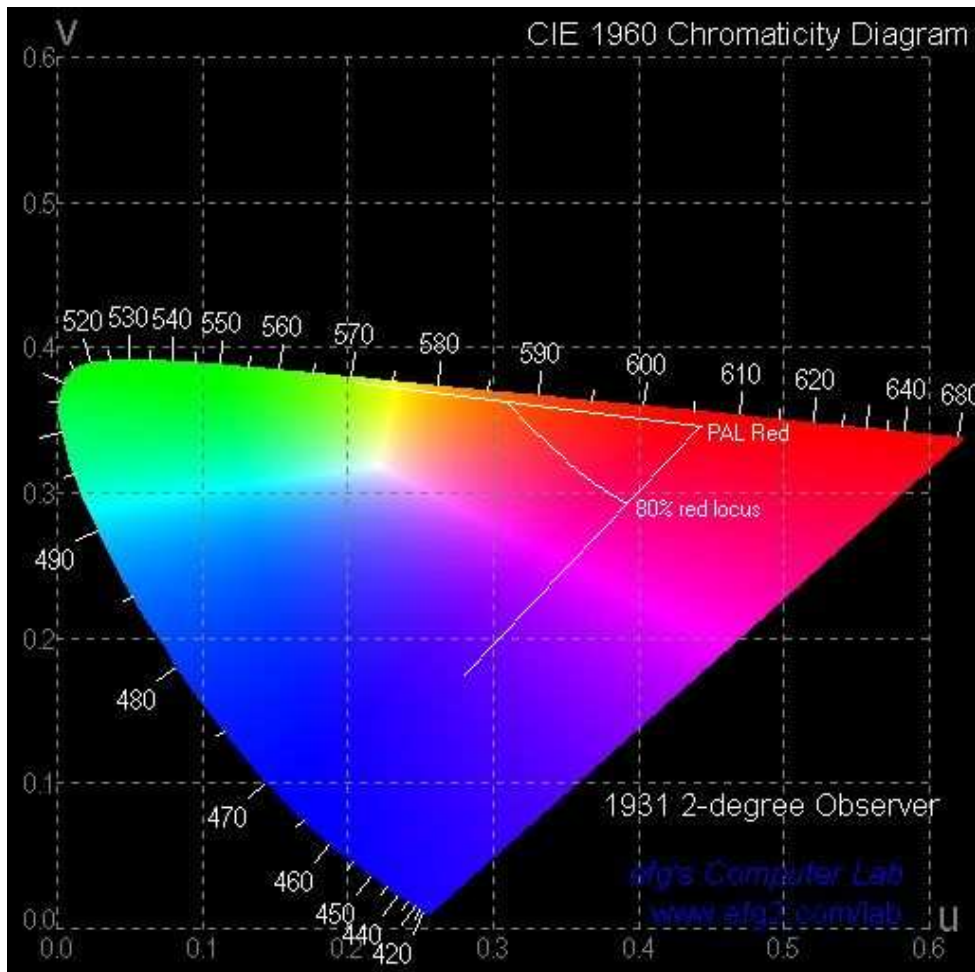


Figure 2: Definition of Saturated Red in CIE Space

- (ii) In addition to defining potentially dangerous hues, red flash analysis also requires a measure of red flash amplitude, or *excess red*, which represents the level of excess stimulation of the retina's red cones relative to the green and blue cones. Following comparative trials between computer and manually generated analysis, a measure of excess red was empirically derived which gives similar assessments over a wide range of red hues and flash intensities.

Definition: excess red is defined on a 0 - 200 range gamma corrected RGB colour signal as: $(\text{red} - \text{green} - \text{blue}) \times 1.6$. Negative values of excess red are set to zero.

Although this conversion does not generate a luminance value, it does allow red flashes to be processed similarly to luminance flash analysis (i.e. where a transition of 20 or more is considered as potentially harmful). Results generate very similar assessments to those independently obtained by Profs G. Harding and C. Binnie on provocative material ⁽¹¹⁾.

Section 3.1.1 - Luminance and Red Flash Rules

- (i) Contiguous Regions. Spatially uncorrelated flashing (e.g. image noise) is not considered provocative ^{2} and therefore does not constitute a flash failure. Potentially harmful active regions need to be both spatially and temporally localised.

Definition: it is necessary for flashing to occur over one or more contiguous region(s) which sum to more than 25% of screen area.

A contiguous region is defined as one or more connected region(s) each covering one degree square of the visible screen area (equivalent to one 75th of the visible screen area on a conventional 4:3 TV screen).

- (ii) Motion Compensation. Luminance changes due to motion are generally exempt, since the viewer compensates by tracking items of interest as they move across the TV screen. However, as motion drift increases, there comes a point at which the viewer will no longer attempt to track items of interest and the stimulus is then perceived as a flash.

Definition: any motion that causes flicker up to 3Hz is acceptable.

Thus, flash analysis only takes place after motion up to this 3Hz limit (i.e. movement up to 1/8 across a TV screen between successive frames) has been compensated. Any motion above this limit is only compensated for up to this limit as illustrated below:

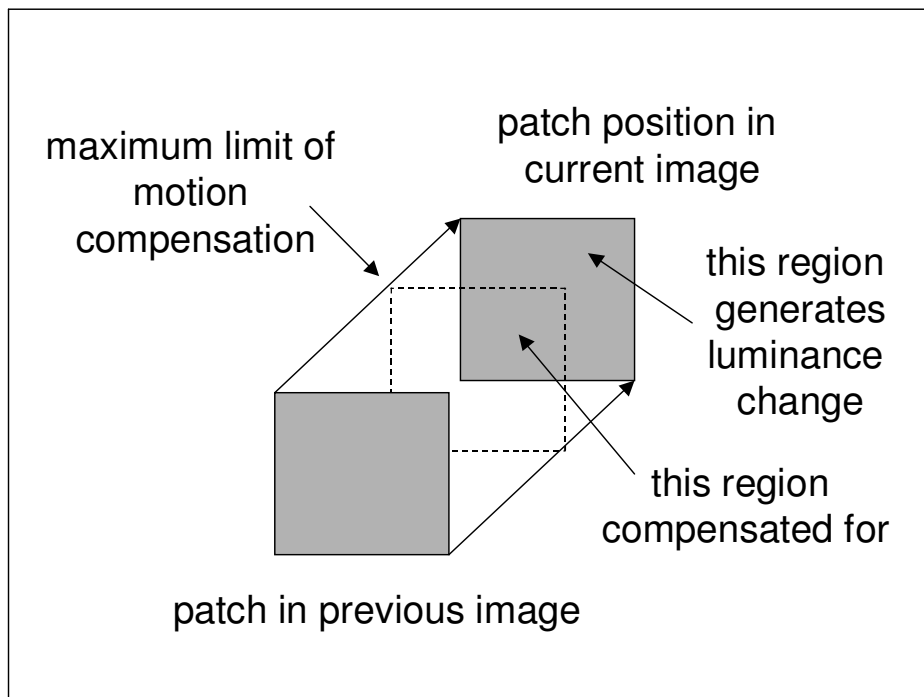


Figure 3: Motion Compensation Prior to Flash Analysis

Section 2 – Cumulative Risk from Successive Sequences of Flashing Images

- (i) ITC/Ofcom ^{1} recognise that flashing which complies with the guidelines but which persists for more than 5 seconds is also potentially harmful. However, it is highly unlikely that any 5-second sequence will only contain images that constitute a risk close to ITC/Ofcom failure.

Definition: a flashing sequence of extended duration is defined as any 5-second sequence of images that contain red or luminance flashing of at least one third of that required for ITC/Ofcom failure in at least 80% of the images.

In PAL format, this equates to 100 provocative (but not failed) images out of the most recent 125 images. In NTSC, this equates to 120 out of the most recent 150 images. The images which constitute a risk are identified as an 'Extended Failure' to assist in excluding such sequences. Images that generate actual flash failures and actual spatial pattern risks or failures are exempt from this running count.

Section 5 – Regular Patterns

- (i) **Definition: a harmful regular pattern is required to contain light and dark stripes that clearly repeat.**

No restriction is placed on the ratio between the widths of the light and dark stripes, nor is any restriction placed on their luminance profile (for example, square wave or sinusoidal etc).

- (ii) Clinical research has shown that spatial frequencies of between 0.5 and 6 cycles per degree are considered to be the most provocative ^{5}.

Definition: a harmful regular pattern requires a fundamental spatial frequency between 0.5 and 6 cycles per degree.

- (iii) Research into pattern-induced seizures demonstrates that a stimulus must be viewed for a number of seconds ^{5, 6, 8} and it is unlikely that a regular pattern could induce a seizure when viewed for only a fraction of a second (although it may of course contribute to a flash-induced seizure).

Definition: any regular pattern that persists for less than 0.5 seconds is an acceptable pattern.

- (iv) Text could be considered as an example of repetitive elements as the letters appear closely packed in distinct rows. However, text is not considered harmful ^{6} despite its frequent use in TV imagery.

Definition: any standard font text is acceptable irrespective of size or line spacing.

- (v) Checkerboard patterns in any orientation are not considered harmful, as they do not contain stripes ^{8}. However, when rotated by 45 degrees, a checkerboard pattern appears as an array of diamond shapes arranged on a square grid.

Definition: repeated elements, which are arranged on a square grid array are acceptable under the current guidelines.

- (vi) Regular patterns which move smoothly across the screen, cause the viewer to track the stimulus and thereby suppress the risk of a pattern-induced seizure ⁽⁹⁾.

Definition: any smoothly flowing pattern is acceptable under the current guidelines.

- (vii) **Definition: patterns that reverse, oscillate or change direction in a way that can be attributed to smooth motion alone will become subject to the above motion exemption clause.**

In all other cases, these patterns will be judged as a flashing stimulus.

References

- (1) *“ITC Guidance Note for Licensees on Flashing Images and Regular Patterns in Television”* (available at: http://www.ofcom.org.uk/codes_guidelines/broadcasting/tv/vrs_code_notes/flsh_imgs/?a=87101)
- (2) Spatially Uncorrelated Flashing, G. F. A. Harding – Verbal Communication (2001)
- (3) Ramp Profile Flashing, G. F. A. Harding – Verbal Communication (2001)
- (4) Harding G. F. A. and Jeavons P. M. *“Photosensitive Epilepsy”* Clinics in Developmental Medicine No 133, (1994), ISBN: 0 898683 02 6.
- (5) A. J. Wilkins, C. D. Binnie and C. E. Darby, *“InterHemispheric Differences in Photosensitive Epilepsy. 1. Pattern Sensitivity Thresholds”* Electroencephalography and Clinical Neurophysiology (1981) Vol 52, pages 461 – 468.
- (6) Text, A. J. Wilkins – Verbal Communication (2002)
- (7) Wilkins A. J. Darby C. E. and Binnie C. D. *“Neurophysical Aspects of Pattern-Sensitive Epilepsy”*, Brain (1979) Vol 102, Pages 1 – 25.
- (8) Binnie, C.D., Findlay, J. and Wilkins, A.J. (1985) *“Mechanisms of Epileptogenesis in Photosensitive Epilepsy implied by the Effects of Moving Patterns”*. Electroencephalography and Clinical Neurophysiology, Vol 61, pages 1-6.
- (9) Wilkins A. J., Binnie C. D., Darby C. E. (1980) *“Visually-Induced Seizures”* Progress in Neurobiology, Vol 15, pages 85-117.
- (10) ‘Pokemon’ (or Pocket Monsters). A children’s’ cartoon transmitted in Japan, December 1997 resulting in 685 hospital admissions.
- (11) Harding G. F. A. and Binnie, C.D., Independent Analysis of the ITC Photosensitive Epilepsy Calibration Test Tape (2002).