Epilepsy and Public Displays of Strobes in Quantity

Notice: Birket Engineering is not qualified to offer definitive advice or information on the subject of photosensitive epileptic seizures, or to evaluate certain lighting effects with regard to this concern. Even those knowledgeable regarding photosensitive epileptic seizures admit that the mechanism by which rhythmic light stimulation can cause a seizure is not well understood.

In the implementation of strobes, each public venue is unique as is each designer's creative intent. Lighting designers must evaluate their requirements in light of the available information on epilepsy to ensure that the combination of factors at their venue does not pose a risk to the public. The information presented here offers a starting point for this discovery effort.

Designers implementing strobes in public settings must be aware of concerns regarding photosensitive epileptic seizures which may be triggered by certain strobe sequences. While it is quite unlikely that a lighting designer using Birket's *DMX Multi-Strobe Brik* would create an effect that could induce a photosensitive epileptic seizure, it is strongly advised that designers become familiar with the lighting effects which are capable of causing seizures so as to most effectively avoid them. This paper is intended as a guide toward the needed familiarity.

Key Points

- About one in 4000 individuals has photosensitive epilepsy. Repetitive flashing lights may induce seizures in these individuals. The flash frequency of concern is from 5 Hz to 70 Hz, with most individuals only susceptible in the range of 15 Hz to 20 Hz.
- A flashing strobe (or a close combination of multiple strobes sequenced together) must not be programmed to flash in the 5 Hz to 70 Hz frequency range.
- Slower flash rates, and randomly flashing lights are not known to be a cause of photosensitive epilepsy.
- Point sources of light are much *less* likely to induce seizures than a diffuse source of light which covers a large part of a person's field of vision.
- To induce a seizure the light must be present in the center of the field of vision as opposed to the periphery.
- Reducing brightness or increasing distance between a photosensitive viewer and the light source is effective for preventing photosensitive epileptic seizures.
- Lights flashing in the distance, even in the frequency range of concern, are not known to cause seizures when in the presence of other lights of a more natural or chaotic nature.
- The probability of inducing a seizure is greatly increased (by up to a factor of ten) if the light source is arranged in a regular pattern, such as a raster scan image. (This would be far more difficult to accomplish with the *DMX Multi-Strobe Brik* than with say, a television image.) Stated another way, avoid adding spatial contrast (pattern) to temporal contrast (flickering).

Each of these points is derived from reading Graham Harding's "Photosensitivity: a vestigial echo? The first Grey Walter lecture." in the International Journal of Psychophysiology, 1994, volume 16, pages 273-279.

Introduction

Individual strobes, or small groups of strobes have been used in entertainment venues for years. Photosensitive epilepsy has been known and studied for many years. Consequently, a considerable body of knowledge exists relative to strobes and photosensitive epilepsy. Standards exist regarding the use of strobes in signaling applications such as for fire alarms. For example, the NFPA and ADA codes seek to insure that fire alarm strobes do not blink faster than twice per

second so that a person between two adjacent strobes which happen to be synchronized and alternating will not experience a combined blink rate faster than four flashes per second (4 Hz).

A product such as Birket's *DMX Multi-Strobe Brik* facilitates the creation of strobe light sequences using dozens or even hundreds or more of separate strobe fixtures for creative purposes in public settings. Examples are twinkle-effects on a building, trees, or across large areas of a theme park; chase light sequences on billboards, and special lighting effects within confined environments such as theaters and attractions. While the Birket *DMX Multi-Strobe Brik* does not permit programming a single strobe to flash faster than once per second, the time between successive strobe firings may be as fast as DMX channels update - about 30 Hz. Thus, for example, thirty strobes in one location could be made to create a continuous flicker as fast as 30 Hz. With effort, the *DMX Multi-Strobe Brik* could be made to operate in a way which, at close range, could induce a photosensitive epileptic to have a seizure.

Research and experience is quite limited with the strobe effects which may be generated with a controller such as Birket's *DMX Multi-Strobe Brik* i.e. numerous small strobes distributed over a field of view. There are no industry consensus standards from which to draw specific guidance regarding the responsible creative implementation of large quantities of strobes. Neither is there any evidence that these strobe effects have ever caused a single epileptic seizure. Still, it would seem that there is a risk, so each designer must consider what is known about photosensitive epilepsy when creating strobe lighting effects.

It should be noted that it is not the "strobe" that is the problem. Any light flashing at the noted frequencies may be a problem. In fact, flashing television images are the best known source of concern.

Much more may be learned by reading the journal papers listed at the end of this paper. If only one such reference to be read, we suggest the paper in the International Journal of Psychophysiology by Graham Harding titled "Photosensitivity: a vestigial echo? The first Grey Walter lecture."

What is Epilepsy?

> Epilepsy is a neurological disorder characterized by recurrent episodes (ranging from several times a day to once in several years) of convulsive seizures, impaired consciousness, abnormal behavior, and other disturbances produced by uncontrolled electrical discharges from nerve cells in the brain. Trauma to the head, brain tumor, chemical imbalances, and other factors may be associated with epilepsy, but in most cases the cause is unknown.[i]

About 4.7 people in 1000 will have two or more seizures in their lifetime.[ii] Seizures are considered to be either "grand mal" or "petit mal", meaning very bad, or a little bad. During a grand mal seizure, a person will begin by stiffening up, and perhaps "yelp" as the lungs are squeezed by the stiffening chest muscles. The person loses consciousness, and then starts to shake all over for about one to three minutes. The person "comes to" being confused and often combative, regaining normal awareness within an hour. Two or more grand mal seizures without regaining normal awareness is a serious medical emergency requiring immediate hospitalization. With a petit mal seizure a person just seems to "fade out". If speaking, they may start dropping words, then stop speaking completely. There may be eye blinking, lip smacking, chewing movements, or head turning. This may last up to three minutes followed by mild confusion and a return to normal within minutes. In either case, the person is not aware of what happened during the seizure.[iii] Single seizures that impair consciousness are almost never fatal, although fatalities from epilepsy are possible.[iv]

Many things can trigger seizures, the most common being lack of sleep, lack of food, alcohol or other drugs, and failure to take anti-seizure medication. In fact, anything can trigger seizures

including certain smells, memories, a sunrise, or a particular voice. When a specific event triggers a seizure, this is called "reflex epilepsy". One type of reflex epilepsy is photosensitive epilepsy in which certain light events trigger a seizure.

What is known about photosensitive seizures?

Photosensitive seizures are those triggered by either flashing or flickering lights, or rapidly changing geometric shapes or patterns. Many people with epilepsy are unaware that they are sensitive to certain kinds of lights or flickering patterns until they have a seizure.

Less than 5% of those who suffer from epilepsy are photosensitive. This means that approximately one in 4,000 individuals suffer from this - less than 100,000 in the U.S. population. The characteristics of each individual's susceptibility are unique. A certain photosensitive individual may not be susceptible to a given light display at all. Still it is clear that every public display of lights can expect to regularly entertain photosensitive epileptics - thus a high degree of diligence is due the effort to eliminate displays which may trigger seizures.

Seizures in photosensitive individuals may be triggered by events such as:

- flickering or rolling television images
- certain video games
- computer monitors
- alternating patterns of different colors

It is well documented that the range of 15 to 20 Hz is of greatest concern, however some individuals are susceptible to flashing lights as slow as 5 Hz and some as high as 84 Hz.

What can be done to reduce or eliminate the concern?

Do not program strobes to flash at continuous rates between 5 and 70 Hertz, particularly when the strobe light is in close proximity to observers. Increasing distance between the viewer and the strobe light and decreasing light intensity are both effective for eliminating the risk of photosensitive epileptic seizures. Less clear is "how far" and "how bright is too bright". Little research has been done to determine the extent to which reducing brightness or increasing distance eliminate the possibility of inducing seizures. However, there is clear evidence that both of these are valid techniques for preventing photosensitive epileptic seizures. Indications are that the flashing light must be present in a substantial part of a susceptible individual's field of vision to induce a seizure. *To learn about distance and brightness relative to photosensitive epilepsy, read the documents suggested at the end of this paper.* You will find that the existing research approaches the issue from the opposite perspective - that of insuring adequate intensity to detect an impending seizure in a clinical setting.

Relevant experiences

- Informal inquiries of major theme park operators with extensive experience using strobes has not indicated any incidences of seizures resulting from strobes in public settings.
- Large commercially available and widely used strobes exist for theatrical and night-club applications. Some are easily programmed to operate up to 15 Hz (and reportedly faster). While at a recent entertainment trade show I asked to see one such strobe operate. The vice-president of the strobe manufacture directed the strobe at my face at a range of about two feet and turned it to maximum intensity at 15 Hz. Surprised, I asked if this wasn't capable of causing a seizure in a small segment of the population. He replied that the concern is only for rates above 15 Hz. He went on to explain that his competitor's strobes operate up to 30 Hz but to address this concern his only operate up to 15 Hz. Based upon what I've read, he is wrong! A meaningful percentage of the public would react

negatively to the intense close-range 15 Hz demonstration he gave me. I include this story only as an indication that the concern must not be large or this man and his company, who have both been in the strobe business for over a decade, would know and would have reacted to the negative consequences upon their business.

Standards addressing photosensitive epilepsy

Historically, strobes have been implemented in smaller quantities than is possible with the Birket *DMX Multi-Strobe Brik*. Only two standards address strobes as related to epilepsy. The Americans With Disabilities Act Accessibility Guidelines (ADAAG) and NFPA 72[v] address the concern for photosensitive epilepsy with respect to the use of strobes for signaling purposes such as fire alarms. A recent revision to NFPA 72 lowered the requirement from "below 3 Hz" to "below 2 Hz" due to a concern for adjacent strobes synchronizing to create an apparent flash rate double that of one strobe. Their goal was to insure that a composite rate does not reach 5 Hz.

Suggested Reading

Binnie, C. D., Darby, C. E., De Korte, R. A., Veldhuizen, R., & Wilkins, A.J. (1980). EEG Sensitivity to Television: Effects of Ambient Lighting. Electroencephalography and Clinical Neurophysiology, 50, 329-331.

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Harding, G. (1994). Photosensitivity: a vestigial echo? The first Grey Walter Lecture. International Journal of Psychophysiology, 16, 273-279.

Leijten, F. S., Dekker, E., Spekreijse, H., Kasteleijn-Nolst Trenite, D. G., & Van Emde Boas, W. (1998). Light Diffusion in Photosensitive Epilepsy. Electroencephalography and Clinical Neurophysiology, 106, 387-391.

Plaster, G. A., Lodge, K. J., & Mulvaney, D. E. (1979). Effect of Distance of Photostimulation on a Photosensitive Epileptic Subject, Psychological Reports, 45, 271-274.

Takahashi, T. (1989). Techniques of Intermittent Photic Stimulation and Paroxysmal Responses. American Journal of EEG Technology, 29, 205-218.

Wilkins, A. J., Darby, C. E., Binnie, C. D., Steransson, S. B., Jeavons, P. M., & Harding, G. F. A. (1979). Television Epilepsy - The Roll of Pattern. Electroencephalography and Clinical Neurophysiology, 47, 163-171.

[i] Rothenberg, M. A., & Chapman, C.F. (1989). Dictionary of Medical Terms for the Non-medical Person, 2nd Ed. New York: Barrons.

[ii] Centers for Disease Control (1994). Current Trends Prevalence of Self-Reported Epilepsy - United States, 1986-1990, CDC MMWR Weekly

[iii] Shinder, T. W. (1998). Flashing Light Hazard: Strobe-Induced Seizures, 1998

[iv] Epilepsy Association, http://www.epilepsy.com, September 24, 2002

[v] National Fire Protection Association, NPPA 72 - National Fire Alarm Code. Boston: NFPA, 1999.