

## Biologic effects Lighting systems

Discharge lamps are worldwide most used lamp types for light sources in working environments. The light flicker from these lamps on 50/60 Hertz operation from the mains is suspected to give rise to undue stress, especially in rooms without natural daylight.

This summary will reflect the investigations and studies from several institutes and universities on improvement of lighting systems with mainly low pressure, fluorescent type of lamps. According professor Rikard Küller (Lund Institute of Technology) the same results will apply for other type of discharge lamps with the same light modulation at 50Hz operation.

The second topic shows the positive effect of improved light levels in working areas.

### 1 Light Modulation.

If we investigate the light output of low and medium pressure discharge lamps we can see following modulation of the light, given in figure 1. Light ripple was measured using a photo sensor BPW21 and a 50Hz Electromagnetic ballast and a Nedap electronic ballast operating 400W HID lamps.

White: EM ballast

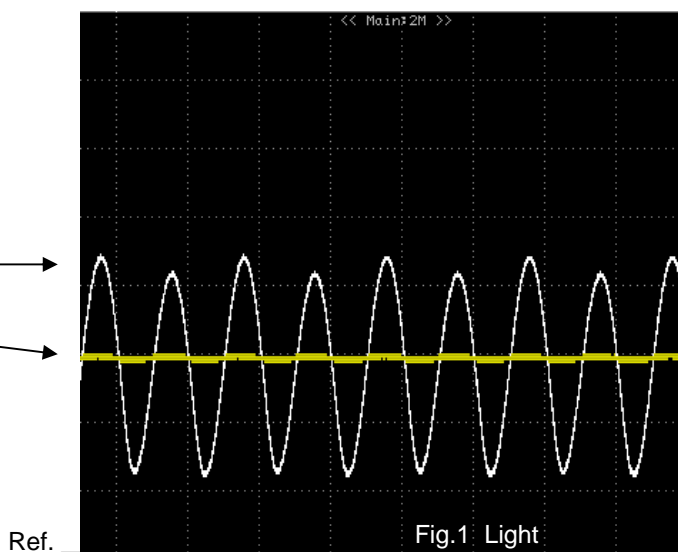
Yellow: Electronic Ballast

Timescale: 10 msec/div

Relative light ripple (pp/av.):

EM ballast = 93%

Electronic = 5.3%



Also a 50Hz ripple can be noticed on the EM ballast (modulation of every second top).

A small number of people experience headaches because of the light ripple caused by the 50/60 Hz power supply of discharge lamps operated on electromagnetic magnetic ballasts. Lamps running on modern, high-frequency electronic ballasts operate above 100kHz and thus do not exhibit this flicker or ripple phenomenon. In a comparison, it has been found that the occurrence of headache is, indeed, significantly lower when electronic ballasts are used [1]. Küller and Laike [2] measured the EEG of persons working in an office environment under respectively magnetic (50 Hz) and high-frequency fluorescent (low pressure) lighting.

At the same time, they also measured the speed and errors made in a proof-reading task. Figure 2 shows that the reciprocal value of the alpha activity of the EEG, and therefore the brain arousal ("stress"), is higher with the 50 Hz operated lighting. The working speed is slightly higher, but the errors are dramatically higher (more than double). The combined effect means that it is wise, from both the well-being and productivity points of view, to use high-frequency operated lighting instead of magnetic 50/60 Hz lighting to limit brain arousal or stress.

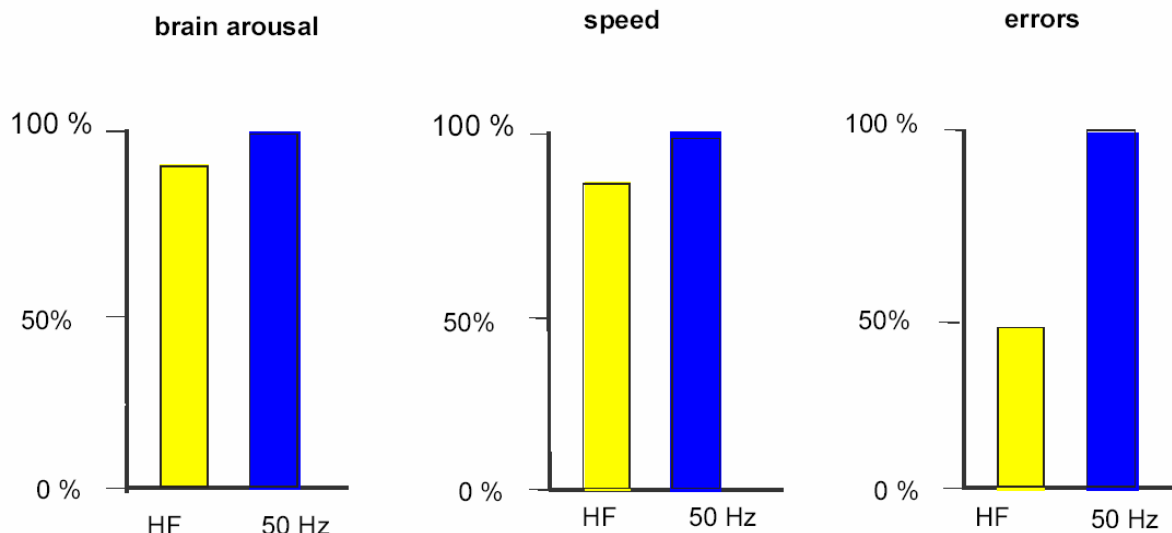


Fig. 2 Brain arousal measured as the reciprocal value of the alpha activity of EEGs in persons in offices under 50 Hz and under high-frequency HF (30 kHz) fluorescent lighting. The working speed and errors of a proof-reading task are also given (graph adapted from: Küller and Laike [2]). Subject group: high flicker sensitivity.

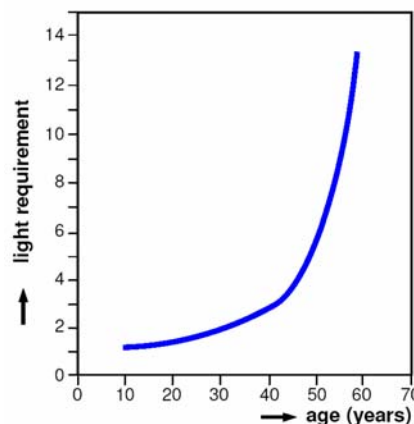
In earlier reports [3] it was mentioned that flicker sensitivity will decrease in older adults, extrapolation of these findings suggest that children may be even more sensitive to flicker, which would in turn imply that the use of conventional electromagnetic ballasts in, for instance school environments, might be inappropriate [2].

## 2 Improved light levels.

As people age, they need more light (fig.3). For the same reading task someone at age of 60 years, will need about 15 times higher light level compared to a 10 years old person.

Also several investigations show advantages of higher performance and lower number of rejects at **higher lighting levels**.

Table 1 summarizes from different publications for different industrial tasks the increase in task performance and the reduction in rejects





Type of work	Lighting level (lx)		Increase in task performance (%)	Reduction in number of rejects (%)
	Before	After		
Camera assembly	370	1000	7	
Leather punching	350	1000	8	
Composing room	100	1000	30	18
Fine assembly work	500	1500	28	
Metal industry	300	2000	16	29
Difficult visual tasks in the metal industry	500	1600-2500	10	20
Miniature assembly	500-1000	4000		90
Weaving mill	250	1000	7	

Table 1

Source: Handbuch für Beleuchtung [4]

In general, also improved lighting levels can reduce the number of accidents at the working place. In figure 3 the number of accidents for different industrial tasks as function of the lighting level is given. In total, 347 accidents were investigated.

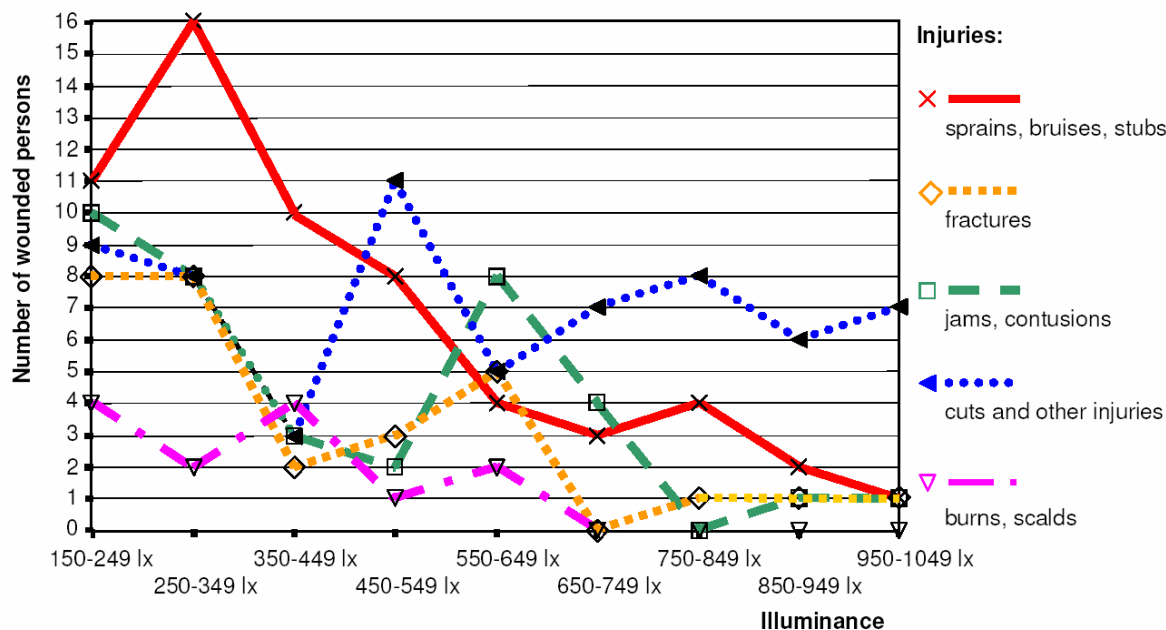


Fig. 3

Source: [5]

With electronic ballasts improved lumen performance with HID lamps can be achieved as electronic ballast generate flicker free light and higher light levels. Therefore electronic ballasts can help to improve the overall performance of the working tasks and reduce the number of failures and accidents.

References:

- General: several publications - Ir.van Bommel/Ir. Van den Beld / Philips
- [1] Wilkens,A/Nimmo-Smith,I/Slater,A/Bedocs,L. - Fluorescent lighting, headaches and eyestrain
- [2] Küller,R/Laike,T. - The impact of flicker from fluorescent lighting on well-being, performance and physiological arousal
- [3] Mayer,M. / Dougherty,R./Hu,L. - A covariance structure analysis of flicker sensitivity
- [4] Lange,H. - Handbuch für Beleuchtung - Auflage 1999
- [5] Völker,S./Rüssenschmidt,H./Gall,D. - Beleuchtung und Unfallgeschehen am Arbeitsplatz