Review of Flicker Objectives

Views of CIGRE/CIRED JWG C4.108

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JWG convened in 2007 to address
- Lighting technologies
- Flicker modeling and simulation
- Rapid voltage changes

JWG consists of
- 10 regular members (9 countries)
- 11 corresponding members (9 countries)
- Convener: Mark Halpin (USA)

Major focus is on the correlation of Pst/Plt levels with customer complaints

Observations I

The PCC for large disturbing loads is often located in HV, (emission-) measurements are usually made there.

Significant evidence exists indicating that P_{st} and P_{lt} levels are significantly greater than planning levels in HV and EHV systems

Comparing flicker planning levels given by utility companies world wide, it can be found that there are great differences in HV.

Observations II

Flicker is transferred to the low voltage busses causing disturbing light flicker.

Flicker immunity of equipment connected to LV systems and flicker sensitivity of residential customers are more or less equal in a globalized world.

Task of C4.108

- Gather information on cases of correlation (or lack thereof) between measured flicker levels and customer complaints received. Furthermore, reasonable explanations for lack of correlation should be offered when possible.
- Evaluate the technical issues associated with flicker transfer coefficients between voltage levels with particular emphasis on attenuating effects.
- Evaluate the sensitivities of modern lighting technologies with regard to flicker susceptibility.

Examples of International Flicker Requirements in HV Networks

Country/Standard	Planning Level	Remark
Germany / Grid code (VDEW)	$P_{st} < 0.8$ $P_{lt} < 0.59$	
France	$P_{lt} < 1$ $P_{st} < 1$	
Brazil	$P_{st} < 1.0/TF$ $P_{lt} < 0.8/TF$	Use of transfer factor (TF)
Russia / GOST 13109/97	$P_{st} < 1.3$	
IEC 61000-3-7	$P_{st} < 0.8$ $P_{lt} < 0.6$	

Measured Flicker Values and Complaints I

Country	Voltage level	Measured flicker values	Complaints
Norway	132 kV	P_{st99} 2.0	A lot of complaints
Sweden	400 kV 145 kV	P_{st99} 1.59 P_{st99} 2.84	Some complaints
Slovenia	110 kV	P_{lt95} up to 2.8	1 complaint per 1000 customers per year
Australia	132 kV	P_{st95} 2.78 P_{lt95} 2.14 P_{st99} 3.10	No registered complaints

Measured Flicker Values and Complaints II

Country	Voltage level	Measured flicker values	Complaints
Austria	110 kV	P_{st99} 1.70 P_{st95} 1.42 P_{lt99} 1.63 P_{lt95} 1.33	Some complaints
Survey F-7 *	132 kV 132 kV 132 kV	P_{st99} 1.25 P_{st99} 2.60 P_{st99} 1.62	No complaints Complaints Complaints
F-9-11*	110kV	P_{lt95} 1.32	Complaints
F-17*	130 kV	P_{st95} 1.4 – 2.0	Complaints

* WG C4.07 report. CIGRE Technical Brochure 261, Oct. 2004

Transfer factors

Existing reports recommend a general flicker transfer coefficient of 0.8 from HV/EHV locations to MV.

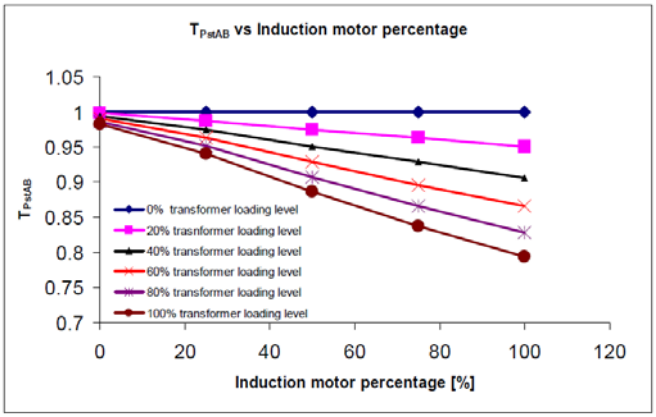
The 20% reduction will be due to the effects of the network and the downstream loads.

If this attenuation is not accurately included in the development of an EMC strategy for flicker, it is indeed likely that resultant planning levels and emission limits will be excessively conservative.

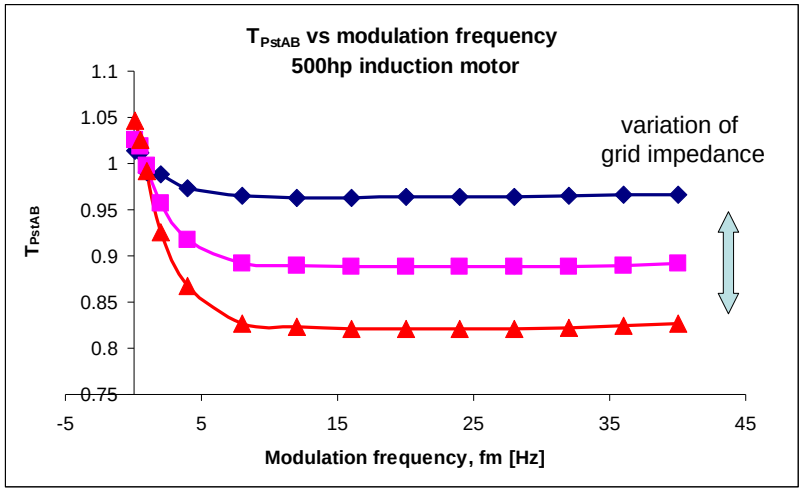
This conservatism could translate into a poor correlation between measured HV/EHV flicker levels and LV user flicker complaints.

Transfer factor simulation I

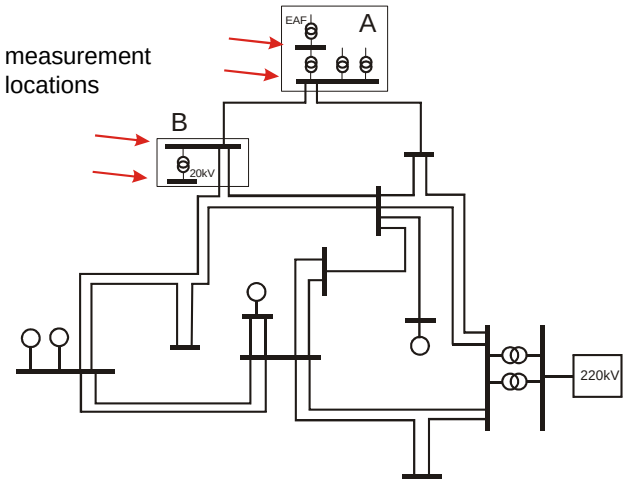
Evaluation of simulation methods to estimate transfer factors (time domain, frequency and hybrid simulation methods)



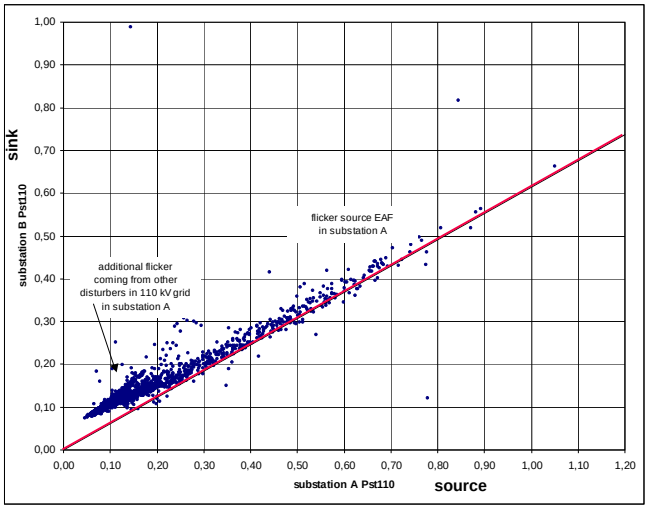
Transfer factor simulation II



Transfer factor measurement

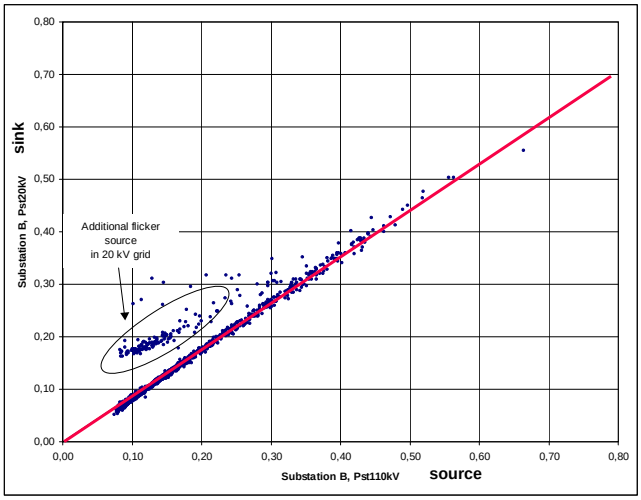


„Horicontal“ flicker transfer



$T_{PST,AB}$=0.61

Flicker transfer downstream



$T_{PST,HV-MV}$=0.87

Lighting technology

- Flicker is the subjective impression of luminance variations as a result of voltage fluctuations.
- Flicker is defined using the characteristics of 60 W incandescent lamp
- Energy saving lamps and fluorescent tubes are widely spread and have completely different sensitivity to voltage fluctuations
- Incandescent lamps will be banned in many regions in near future

Lighting technology

Regulations & Policies Related to Incandescent and Energy-Efficient Lighting:

Argentina:	banning of incandescents 2011
Australia:	banning of incandescents 2010
Canada:	banning of inefficient lighting 2012
European Union:	banning of incandescents 2009-2012
Philippines:	banning of incandescents 2010
United States:	increase efficiency by 30% 2012-2014
Venezuela:	phase-out of incandescents 2005

Tested lamps

- 60 W glass incandescent lamp
- 20 W brilliantline pro tungsten halogen lamp
- 15 W four foot fluorescent lamp set (fluorescent tube with electronic ballast)
- 11 W compact fluorescent tube with electronic ballast, i.e. energy saving lamp
- 9 W compact fluorescent tube (CFL) with magnetic ballast
- 3.4 W LED lamp

Testing tasks

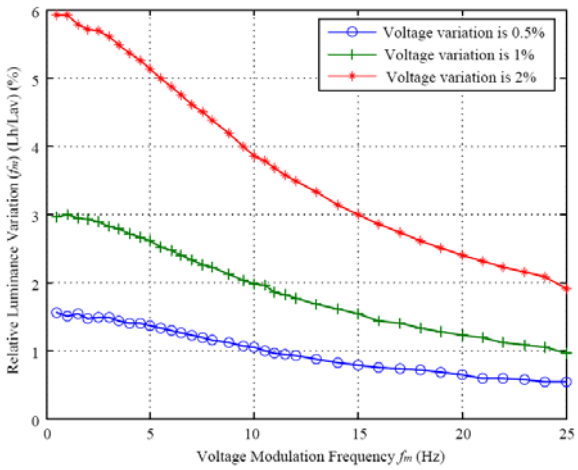
Linearity:

All lamps show a linear correlation between amplitude of voltage variation and amplitude of luminance variation.

Transfer function:

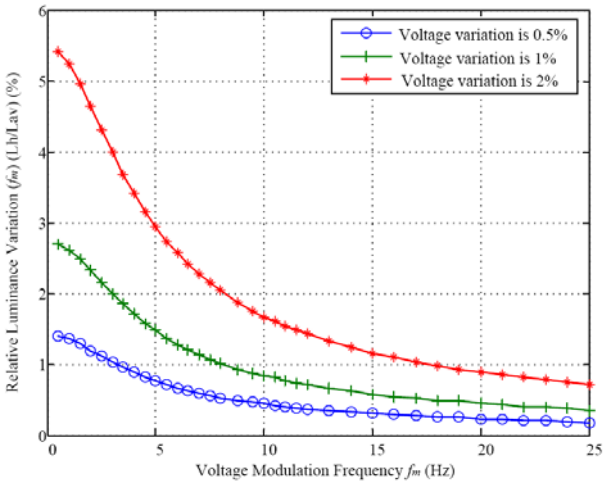
Different lamp technologies show different frequency dependence .

Results I



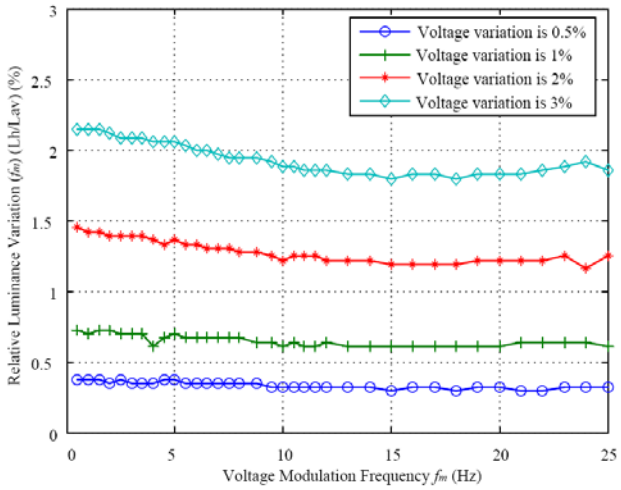
60 W incandescent lamp

Results II



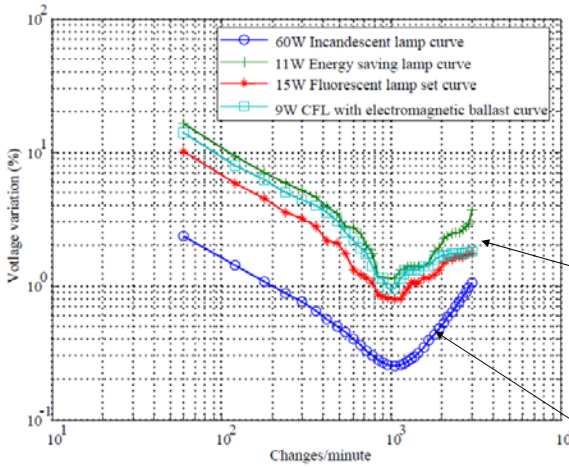
40 W halogen lamp

Results III



15 W fluorescent lamp

Results III



Flicker curves for different types of lamps, sinusoidal voltage fluctuation

same luminance variation as with 60W incand. lamp

standard 60 W incand. lamp

Conclusions

The following hypotheses for the poor correlation between measured flicker levels in HV and complaints are being developed by CIGRE/CIRED JWG C4.108

- Planning levels, and therefore emission limits, are derived using excessive conservatism
- Accurate representation of flicker propagation and attenuation are not presently included
- Modern lighting is significantly less susceptible to voltage fluctuations that 60 W incandescent lamps

Open questions

Considering the banning of incandescent lamps and the spreading of new lighting technology,

- Is there a need for a new flicker meter algorithm taking into account new lighting technology?
- Is there a need to change compatibility levels for flicker in LV?
- What are additional criteria to limit voltage fluctuation besides lamp flicker?
- What about rapid voltage changes, the “missing link” between flicker and dips?