Disturbance Emission Level Assessment Techniques
(CIGRE-CIRED Joint Working Group C4.109)

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The context

- IEC Technical Reports 61000-3-6 (harmonics), 61000-3-7 (flicker and voltage fluctuations) and 61000-3-13 (unbalance)

Task of the JWG C4.109:

- State-of-the-art review of existing disturbance emission level assessment methods
- Practical guidelines for undertaking emission level assessment
The concept of individual harmonic emission

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Individual harmonic current emission level

\[ \bar{I}_h = \bar{I}_{hc} \frac{Z_{hc}}{Z_h + Z_{hc}} - \frac{\bar{E}_{h0}}{Z_h + Z_{hc}} \]

Component from consumer

Component from grid

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Individual harmonic voltage emission level

\[ E_{h0} \quad \rightarrow \quad U_h \quad \rightarrow \quad I_{hc} \quad \rightarrow \quad U_h \quad \rightarrow \quad E_{h0} \]

Voltage emission level
Statistical approach
Harmonic voltage vs. harmonic current plot

$|\bar{U}_h|$ $|\bar{I}_h|$ $Slope$ $|Z_{hc}|$ $Slope$ $|Z_h|$
Harmonic voltage vs. harmonic current plot

Example of non dominant disturber

\[ V_{he} = Z_h I_{he} \]

\[ I_{he} = 95^{th} \text{ percentile over one week} \]
Harmonic voltage vs. harmonic current plot

Example of dominant disturber

\[ V_{he} = Z_h I_{he} \]

\[ I_{he} = 95^{th} \text{ percentile over one week} \]
Harmonic voltage vs. harmonic current plot

Example of the effect of filters

\[ V_{he} = Z_h I_{he} \]

\[ I_{he} = 95^{th} \text{ percentile over one week} \]
Individual flicker emission level assessment: typical configuration

\[ u_A(t) \]
\[ u_B(t) \]
\[ u_N(t) \]
\[ i_{TOT}(t) \]
\[ i_{LOAD}(t) \]

Other installations

Installation under consideration

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Direct on-line measurement: *Difference method*

Simultaneous voltage measurement at both sides of the known impedance $Z_2$ between points A and B are used in order to compute the flicker linked to the voltage difference

$$\Delta u_{AB}(t) = u_A(t) - u_B(t)$$

$$= R_2 \cdot i_{LOAD}(t) + L_2 \cdot \frac{di_{LOAD}(t)}{dt}$$
Direct on-line measurement: 
**Load current method**

- Simultaneous (waveform) measurement of
  - The *voltage* $u_B(t)$ *at the PCC* (point B)
  - The *load current* $i_{LOAD}(t)$

- Computation of the voltage fluctuations caused by $i_{LOAD}$ at the PCC, by *injecting the measured current waveform* $i_{LOAD}(t)$ *into a grid model (“fictitious grid”)
Direct on-line measurement: 
**Load current method**

**Real situation**
(all disturbing loads are present)

**Simulated situation**
(the considered disturbing load is the only one present)
What’s next?

- Other approaches / methods investigated
  - **Harmonics:** Harmonic Vector Method
  - **Flicker:** emission assessment based on r.m.s. half-cycle values measurement (P, Q, U) combined with the use of a simulation software

- Unbalance emission: still under study

- Final report should be ready by end 2009