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TECHNICAL REPORT

Noise measurement method on power capacitors

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IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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NOISE MEASUREMENT METHOD ON POWER CAPACITORS

FOREWORD

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IEC 63396 has been prepared by technical committee 33: Power capacitors and their applications. It is a Technical Report.

The text of this Technical Report is based on the following documents:

Draft	Report on voting
33/658/DTR	33/663/RVDTR

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Technical Report is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

Power capacitors are important equipment for HVDC project, but at the same time they are also the main noise source. However, there is no IEC document which is specific to the noise measurement on power capacitors until now.

In recent years, Chinese authoritative testing organizations have conducted a large number of experiments in this area. Now, many laboratories in China are able to simulate the actual operating conditions of power capacitors in HVDC converter stations for noise testing.

This new technical report is aimed to document a feasible method to measure power capacitor's noise in AC and DC systems, in particular in HVDC converter stations, based on the experience developed in China. Furthermore, the testing laboratories could also check and validate periodically the common technical parameters of the noise measurement on power capacitors in an uniform way by this method, in order to promote the practical application of the measurement method and possibly to improve it (in view of a possible future conversion of the technical report to a technical specification).

This document is intended to fill the gap in this technical field, and to promote the construction of environmentally friendly AC and DC substations.

NOISE MEASUREMENT METHOD ON POWER CAPACITORS

1 Scope

The object of this Technical Report is to document a method for the sound pressure level measurement on power capacitor units, by which the sound power level of power capacitor units is determined.

This method is applicable to shunt capacitor units and AC filter capacitor units for AC power systems with a nominal voltage of 1 kV and above and a frequency of 50 Hz or 60 Hz.

This method also applies to the DC filter capacitor units.

Other measurements on power capacitor units can be implemented with reference to this method.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61260-1:2014, *Electroacoustics – Octave-band and fractional-octave-band filters – Part 1: Specifications*

IEC 61672-1:2013, *Electroacoustics – Sound level meters – Part 1: Specifications*

ISO 3744:2010, *Acoustics – Determination of sound power levels and sound energy levels of noise sources using sound pressure – Engineering methods for an essentially free field over a reflecting plane*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
noise
unwanted sound

[SOURCE: IEC TS 61973:2012, 3.1.13]

3.2
sound pressure
p
fluctuating pressure superimposed on the static pressure

Note 1 to entry: Sound pressure is expressed in pascals (Pa).

Note 2 to entry: Sound pressure is usually expressed through the use of a decibel scale, as sound pressure level.

[SOURCE: IEC TS 61973:2012, 3.1.3]

3.3
sound pressure level
L_p
logarithm of the ratio of the RMS value of a given sound pressure to the reference sound pressure

$$L_p = 10 \log \frac{p^2}{p_0^2} = 20 \log \frac{p}{p_0} , \qquad (1)$$

where:

p is the measured RMS sound pressure, in pascals;

p_0 is the reference RMS pressure of 2×10^{-5} Pa, which corresponds to the 0 dB as threshold of audibility.

Note 1 to entry: log(x) means the logarithm with base 10 of x; this convention is used throughout this document.

Note 2 to entry: The sound pressure level (L_p) is expressed in decibels (dB).

Note 3 to entry: Sound pressure level is measured with sound level meters, which normally incorporate a frequency-weighting filter. For further details see 3.2.3 of IEC TS 61973:2012.

Note 4 to entry: Since the sound level distribution measured around sound emitting objects is usually non-uniform it is normally necessary to assess sound levels on spatial average figures gained from several measuring positions rather than on one single discrete position.

[SOURCE: IEC TS 61973:2012, 3.1.4]

3.4
sound power
P
through a surface, product of the sound pressure, p, and the component of the particle velocity, u_n, at a point on the surface in the direction normal to the surface, integrated over that surface

Note 1 to entry: Sound power is expressed in watts.

Note 2 to entry: The quantity relates to the rate per time at which airborne sound energy is radiated by a source.

[SOURCE: ISO 3744:2010, 3.20]

3.5
sound power level
L_w
ten times the logarithm to the base 10 of the ratio of the sound power of a source, P, to a reference value, P_0, expressed in decibels (dB)

$$L_W = 10 \log \frac{P}{P_0} \qquad (2)$$

where the reference value, P_0, is 1 pW

Note 1 to entry: If a specific weighting as specified in IEC 61672-1 and/or specific frequency bands are applied, this is indicated by appropriate subscripts; e.g. $L_{W(A)}$ denotes the A-weighted sound power level.

[SOURCE: ISO 3744:2010, 3.21]

3.6
reference box
hypothetical right parallelepiped terminating on the reflecting plane(s) on which the noise source under test is located, that just encloses the source including all the significant sound radiating components and any test table on which the source is mounted

Note 1 to entry: The test table as small as possible be used.

Note 2 to entry: Reference radiating plane of capacitor unit is the cuboid surface consisting of the six sides of the capacitor unit enclosure only and excluding the wiring terminals.

[SOURCE: ISO 3744:2010, 3.10]

3.7
measurement surface
S
hypothetical surface of an area, S, on which the microphone positions are located at which the sound pressure levels are measured, enveloping the noise source under test and terminating on the reflecting plane(s) on which the source is located

[SOURCE: ISO 3744:2010, 3.14]

3.8
background noise
noise from all sources other than the noise source under test

Note 1 to entry: Background noise includes contributions from airborne sound, noise from structure-borne vibration, and electrical noise in the instrumentation.

Note 2 to entry: The background noise considers noise from the associated power equipment which operates and stops simultaneously with the capacitor unit.

[SOURCE: ISO 3744:2010, 3.15]

3.9
synthesis of sound pressure level
superposition of sound pressure levels generated by two or more sound sources at a certain point in the sound field

3.10
directivity index
D^*_{Ii}
measure of the extent to which a noise source under test radiates sound in the direction of the i_{th} microphone position on a measurement surface, relative to the mean sound radiation over the measurement surface

$$D^*_{Ii} = L_{pi(ST)} - (\overline{L'_{p(ST)}} - K_1) \tag{3}$$

where

$L_{pi(ST)}$ is the background noise-corrected time-averaged (or single event time-integrated) sound pressure level for the i_{th} microphone position on the measurement surface, with the noise source under test (ST) in operation, in decibels;