On the suitability of EMC anechoic chambers in the frequency range 9KHz-30MHz with loop antennas

Martin Wiles BSc, MSc, MBA

Albatross Projects GmbH,
Daimlerstrasse 17,
89564 Nattheim, Germany.
M.Wiles@albatross-projects.com

F-W. Trautnitz

Albatross Projects GmbH,
Daimlerstrasse 17,
89564 Nattheim, Germany.
F-W.Trautnitz@albatross-projects.com

Dr. Alexander Kriz

Seibersdorf Laboratories,
Seibersdorf, Austria.
alexander.kriz@seibersdorf-laboratories.at

***Abstract*— In CISPR 16-1-4 [1], an extension of the chapter on the suitability of EMC test sites in the frequency range from 9 kHz to 30 MHz is in preparation. The work on the verification method has progressed so far that a first CD (Committee Draft) [2] was published early 2018. An international standard is currently forecast for publication in late 2019.**

Keywords—NSA below 30MHz; Magnetic Loop; Coupling Effects, Ground Plane.

I. INTRODUCTION

As part of the work of the German VDE Standard Working Group and the CISPR Ad Hoc Group 1 an extensive measurement campaign has been carried out. Interlaboratory comparisons in 2012 and the work on the suitability of EMC test sites below 30 MHz [3] as well as further studies on coupling effects in the test setup were undertaken [4].

Furthermore, the Normalized Site Attenuation (NSA) was analyzed at various measurement distances in the range of 3 m to 10 m, in increments of 1 m, with loop antennas, see fig.1, (diameter: 60 cm and 30 cm) and finally related to the measured values from the interlaboratory comparisons from 2012 determined with 50 cm loop antennas, and recorded at the same test site at a distance of 10 m.

It will be shown that the required measuring accuracy for the chamber validation is guaranteed using most of the available chamber technology. The investigations regarding the measuring distance have shown that compliance with the acceptance criterion is no longer guaranteed from a measuring distance of approximately 7 m. This will be taken into consideration in the measurement uncertainty text of the draft standard.

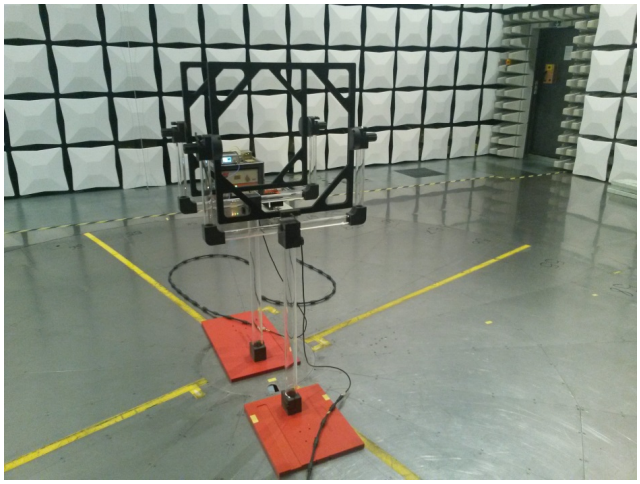

Fig 1. 60cm magnetic loops

II. METROLOGICAL INVESTIGATIONS AND MEASUREMENT OF THE NSA FROM 9 KHZ TO 30 MHZ

At the beginning of the NSA measurements from 9 kHz to 30 MHz, a more extensive investigation of the measurement setup was made. As was already evident from the previous measurements in the context of the interlaboratory comparisons, coupling effects between the measuring antennas or couplings via the cable shielding, depending on the contacting of the shielding of transmitting and receiving cables on the shielding, as well as the ground connection of the measuring devices can lead to larger deviations of the measured NSA values. These influencing factors were analyzed by different measuring configurations, ground connections up to the complete electrical isolation of the transmitting and receiving measurement systems. More

information about the influence of ground loops can be found in [5].

The antennas used were laboratory samples from Seibersdorf Labor GmbH with a frame diameter of 60 cm and 30 cm. The measurements were carried out according to the proposal in [2]. This proposal proposes a fixed antenna height volume method. The NSA is measured in three orientations Hx, Hy, and Hz as shown in perspectives configurations in fig. 2(a), (b), (c).

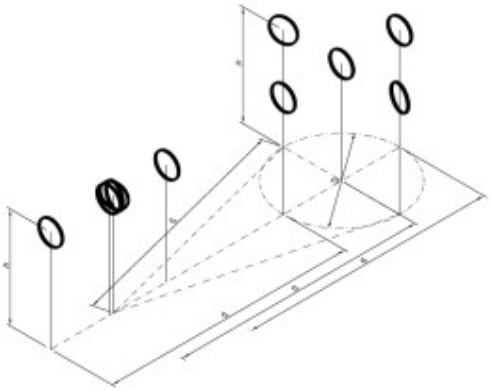

Fig. 2a: Orientations Hx

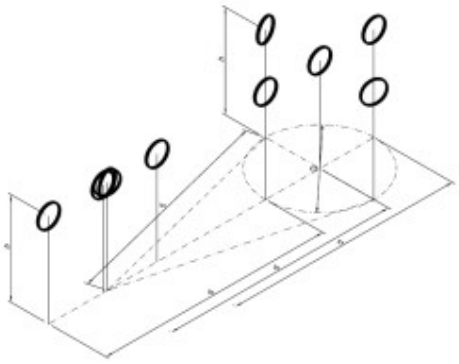

Fig. 2b: Orientations Hy

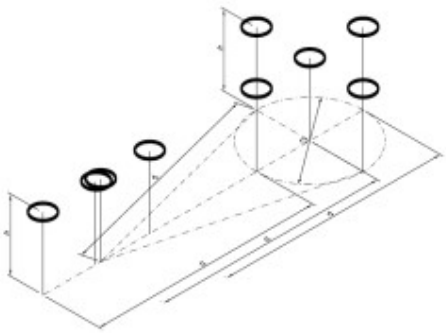

Fig. 2c: Orientations Hz

1) Influence of the ground plane:

The metal conductive floor surface or ground plane (GP) of the test site in question was assembled with a 2 mm thick galvanized sheet steel and with a cover plate on the turntable made of 6 mm chrome steel. Both versions were verified to see if they influenced the NSA. For this purpose, the results of the NSA were compared at four positions in the test site over different configurations of the conductive floor space, as shown in fig.3. The influence of the different metallic floor surfaces on the NSA in the orientations Hx, Hy, and Hz is in the range of up to 0.5dB.

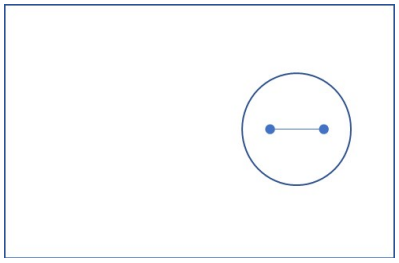

Fig. 3a Position 1
Both antennas on the turntable in the middle

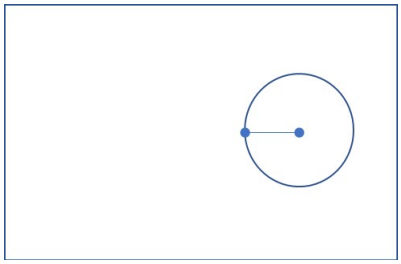

Fig 3b Position 2
One antenna in the center of the turntable, the second at the edge

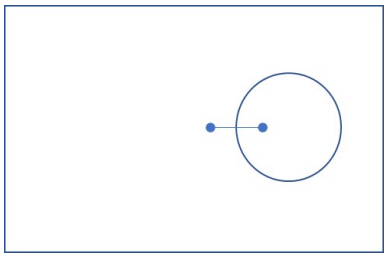

Fig. 3c position 3
One antenna on the turntable, the second on the GP

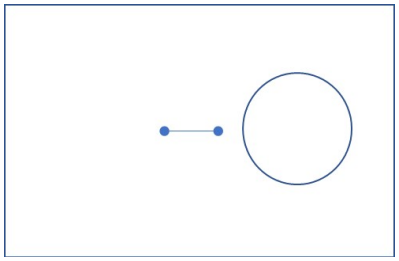

Fig. 3d position 4
Both antennas on the GP, two meters from the turntable

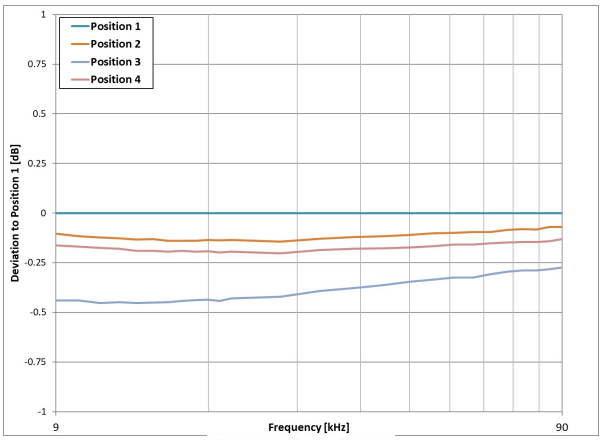

Fig. 4a: Orientation Hx

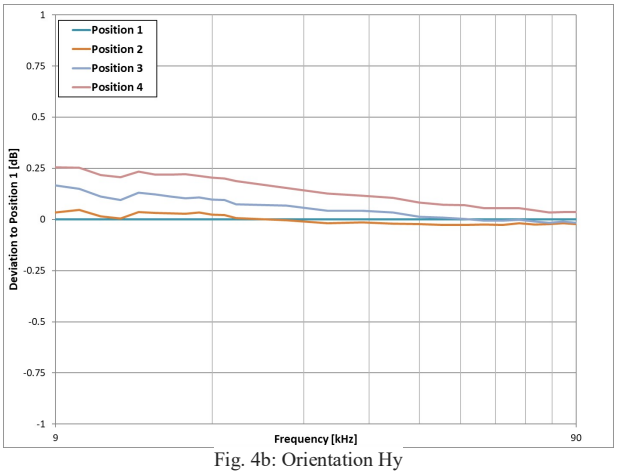

Fig. 4b: Orientation Hy

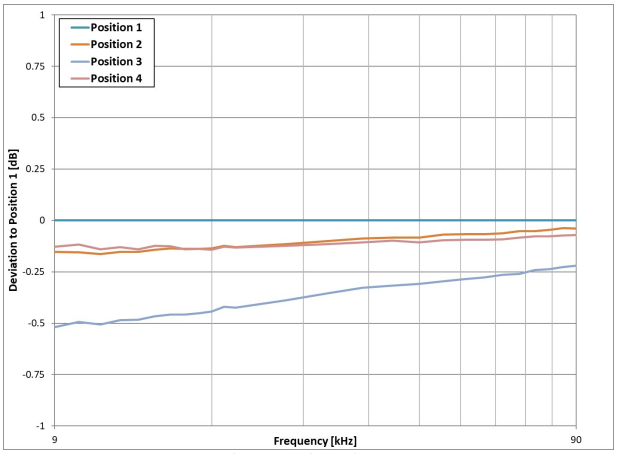

Fig. 4c: Orientation Hz

Figures 4a - 4c show the deviations of the different measurements, in the orientations Hx, Hy, and Hz, in the frequency range 9 kHz - 90 kHz normalized to the typical measurement configuration for test piece measurements according to position 3.

2) Measurement of the lateral volume points

The measurement of the NSA in the lateral volume point, as shown in fig.5, is currently regulated differently in the ANSI C63.4 [6] and CISPR 16-1-4 [1] standards in the frequency range 30 MHz - 1 GHz. It was examined whether the engagement of the reference point of the transmitting antenna in the lateral positions of the volume (reference point on the perimeter of the volume to outer antenna element flush with the perimeter of the volume) provides a measurable influence on the measurement result.

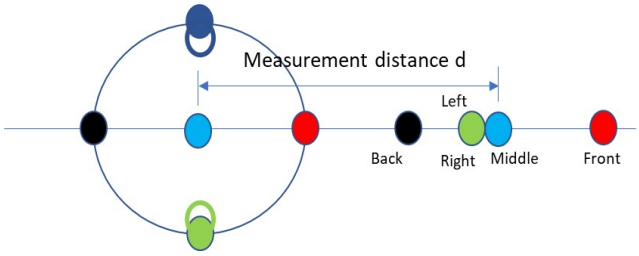

Fig. 5: Measurement positions Hx in volume: reference point on the circumference of the volume or outer antenna element flush with the circumferential line of the volume.

As can be seen from the results, in fig. 6 the difference between center axis and off-center axis antennas is less than 0.2dB.

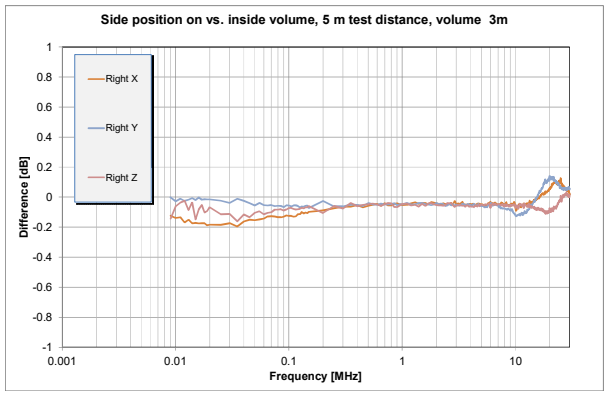

Fig. 6: Difference between the center axis and off-center axis NSA for all 3 orientations at a measurement distance of 5 m, volume size 3 m

3) Measurement of NSA at measurement distances of 3 m to 10 m with 60 cm and 30 cm loop antennas in the orientations Hx, Hy, and Hz

Measurements of the NSA in the longitudinal axis of the absorber hall at the measuring distances of 3 m to 10 m were performed in increments of 1 m in the orientations Hx, Hy, and Hz. Figures 7 to 12 show the measurement results in the orientations Hx, Hy, Hz measured with 60 cm loop antennas.

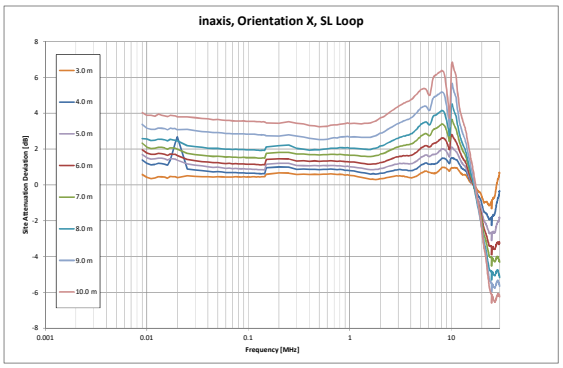

Fig. 7: NSA measurement (Hx), 3 to 10m test distance, 60cm loop.

Fig. 8: Measurement setup

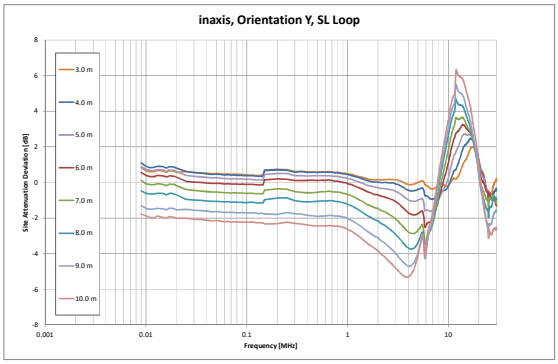

Fig. 9: NSA measurement (Hy), 3 to 10m test distance, 60cm loop.

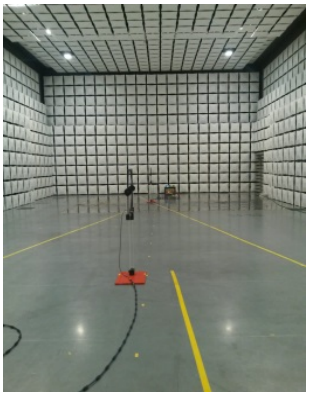

Fig 10: Measurement setup

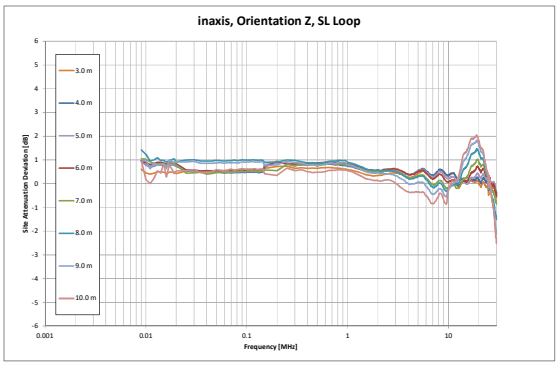

Fig 11: NSA measurement (Hz), 3 to 10m test distance, 60cm loop.

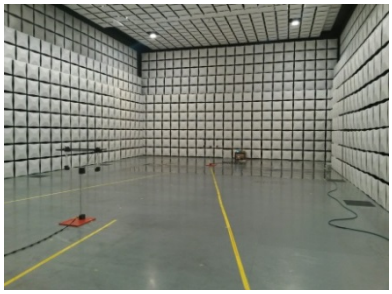

Fig. 12: Measurement setup

Figures 13 to 18 show the comparable measurements in the orientations Hx, Hy, Hz measured with 30 cm loop antennas.

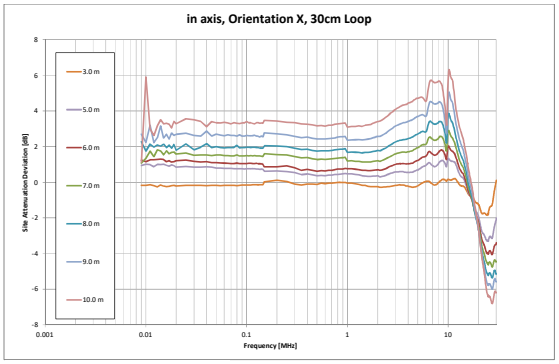

Fig. 13: NSA measurement (Hx), 3 to 10m test distance, 30cm loop.

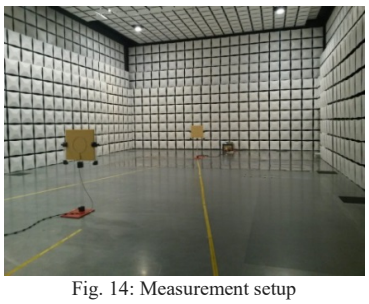

Fig. 14: Measurement setup

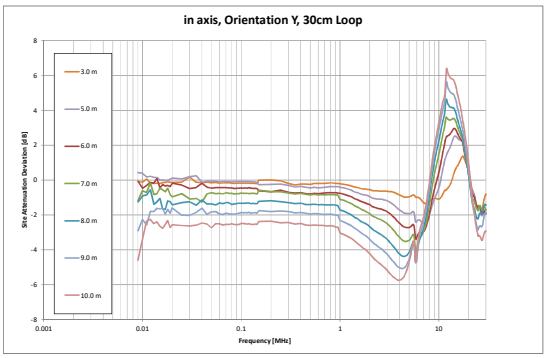

Fig.15: NSA measurement (Hy), 3- 10m (excl.4m) test distance, 30cm loop.

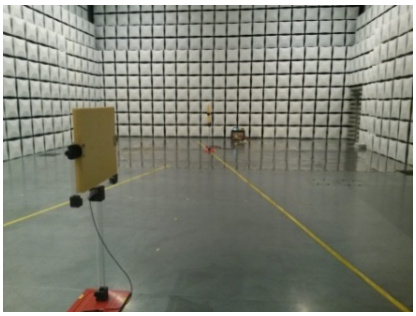
Fig.16: Measurement setup

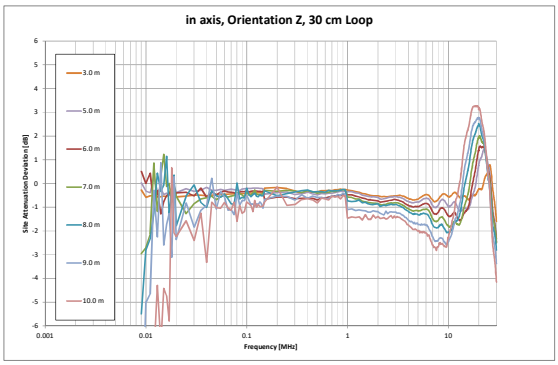

Fig. 17: NSA measurement (Hz), 3- 10m (excl.4m) test distance, 30cm loop.

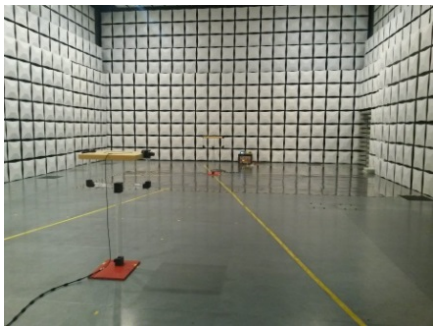
Fig. 18: Measurement setup

Below 100 kHz, larger deviations in measurements with loop antennas with a diameter of 30 cm can be seen in the measurement results, due to the limited measurement dynamics and the associated influence of noise. Comparing the measurements with 60 cm and 30 cm loop antennas, it can be seen that in Hx and Hy orientation the results show deviations of approximately 1.0dB with a small measuring distance, with increasing measuring distance the influence is reduced to values up to approximately 0.5dB. This is in contrast to the Hz orientation, in which the deviation is continuously around 1dB.

III. CONCLUSION

The measuring method proposed in [2] was carried out at a test site at various measuring distances and the results of the measurements have been discussed. It has been shown that the required measuring accuracy for the suitability test of the measuring site can be guaranteed with the available measuring technology. The investigations regarding the measuring distance have shown that compliance with the acceptance criterion is no longer guaranteed from a measuring distance of approx. 7 m. This should be considered in the draft standard in the consideration of the measurement uncertainty according to the additional deviation.

As shown in the interlaboratory comparisons [3], the acceptance criterion on an open area test site can also be met in a distance of 10 m.

ACKNOWLEDGMENT

Dipl.-Ing. (Univ.) Jochen, Riedelsheimer, Albatross Projects GmbH and Dipl.-Ing. Ronald, Svadlenka, SLG Prüf- und Zertifizierungs GmbH.

REFERENCES

[1] CISPR 16-1-4 :2010+AMD1:2012+AMD2:2017: Radio disturbance and immunity measuring apparatus - Antennas and test sites for radiated disturbance measurements. 2017.

[2] CISPR A 1250 CD. CISPR 16-1-4 am1 f2 Ed. 4.0: “site validation below 30 MHz”. February 2018.

[3] Trautnitz, F.-W., Riedelsheimer, J.: Erstellung eines Validierungsverfahrens für EMV Messplätze im Frequenzbereich von 9 kHz – 30 MHz mit Magnetfeldantennen, EMV Düsseldorf 2014.

[4] Trautnitz, F.-W., Riedelsheimer, J.: Validierung von Störfeldstärke – Messplätzen im Frequenzbereich von 9 kHz – 30 MHz mit Rahmenantennen, EMV Düsseldorf 2016.

[5] Kriz.A. “Ground Loops during Site validation of anechoic rooms”, IEEE EMC & SI Long Beach, 2018.

[6] ANSI C63.4-2014 American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz. 2014.