ON THE SUITABILITY OF EMC ANECHOIC CHAMBERS IN THE FREQUENCY RANGE 9KHZ-30MHZ WITH LOOP ANTENNAS

R&S DEMYSTIFYING EMC, SILVERSTONE, UK
FEBRUARY 10, 2020

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INTRODUCTION

- In late 2020 CISPR 16 will publish some key changes:
- Radiated emissions methods and requirements below 30MHz
- This presentation explores :

    1. Standards process & implications for different product groups including the automotive industry.
    2. The implications for existing EMC anechoic chambers.

Automotive

Household

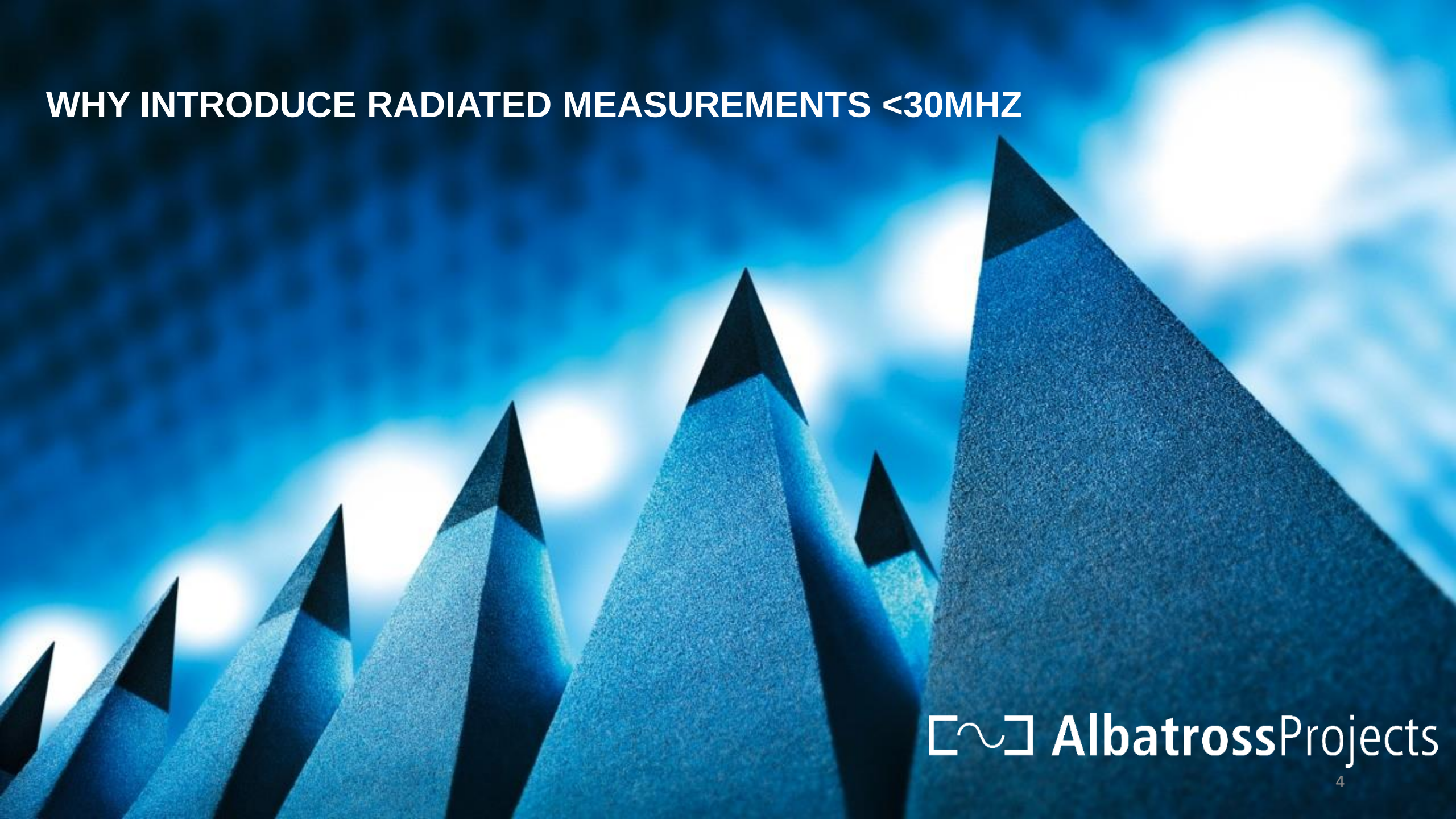
ISM

Multimedia

SUMMARY

- Introduction
- Why RE < 30MHz
- Standardisation
- Chamber Validation Measurements
- Conclusions

WHY INTRODUCE RADIATED MEASUREMENTS <30MHZ



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WHY INTRODUCE RADIATED METHODS < 30MHZ

- **WHY IS THIS SIGNIFICANT?**
- Lot of focus > 1GHz
- Current CISPR standards define radiated measurements – limits, methods and criteria - down to 30MHz only.
- Many other international standards also do the same.
- Almost all EMC Anechoic chambers have been designed to start at 30MHz not lower.
- Can they be used < 30MHz ?

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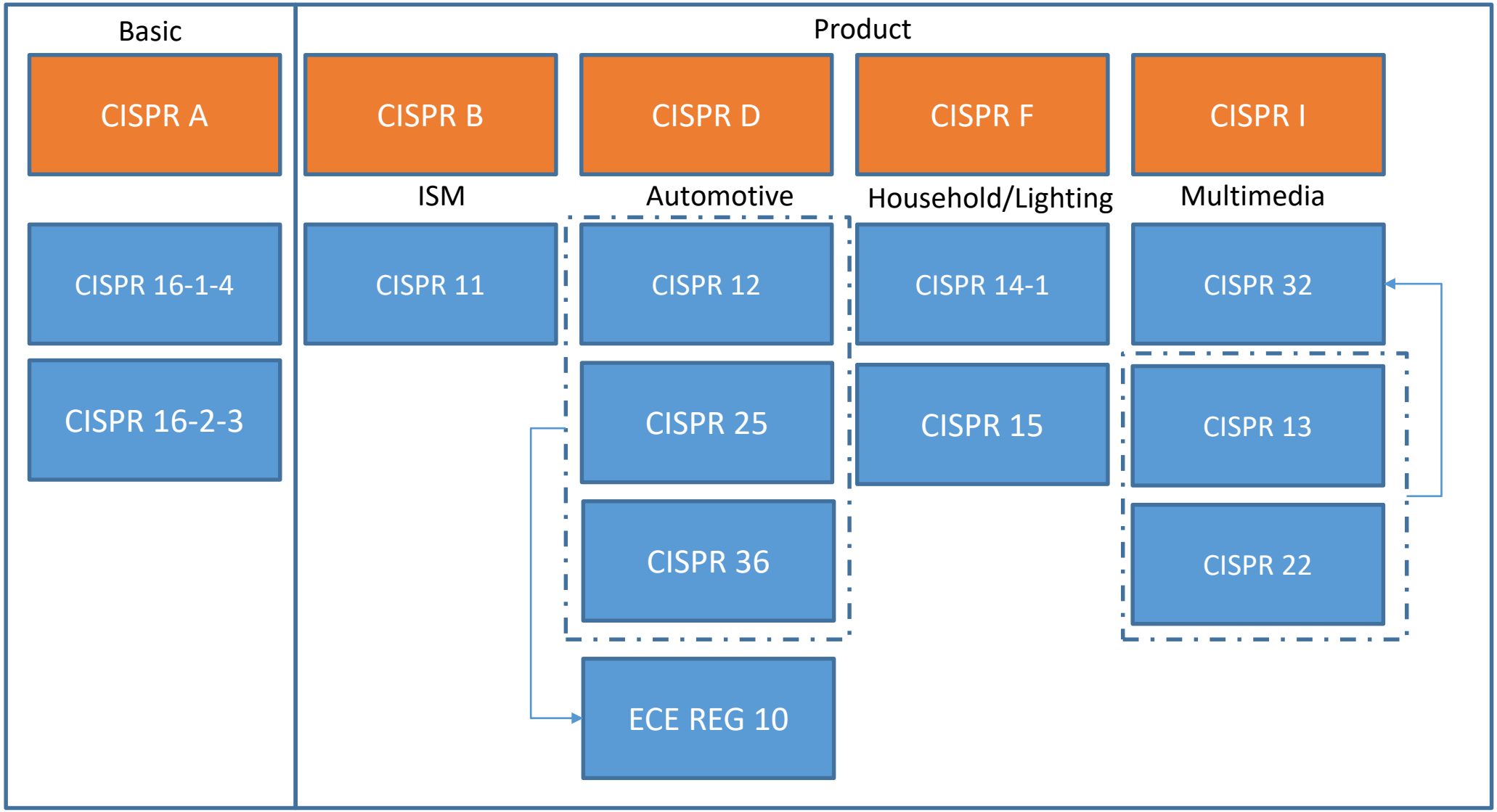
WHY INTRODUCE RADIATED METHODS < 30MHZ



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WHY INTRODUCE RADIATED METHODS < 30MHZ

- **2011 BACKGROUND CISPR B**
  - **CISPR 11 ISM - Industrial Scientific & Medical**
  - Prior to 2011 only CISPR 11 included considerations in the range 150KHz-30MHz for measurement of devices for so called ISM RF applications such as Microwave ovens and other divers heating and medical equipment.
  - Other typical equipment would be induction cooking hobs where limits apply 9KHz-30MHz and it was predicted in 2011 that future induction cooking devices would be covered by CISPR 14-1

WHY INTRODUCE RADIATED METHODS < 30MHZ

- **2011 BACKGROUND CISPR B**
- **CISPR 11 ISM - Industrial Scientific & Medical**
- **INFORMATIVE & UNDER EVALUATION**
- METHOD of measurement concerns the assessment of the RF disturbance generated by the EUT and irradiated through its enclosure port and via its associated cabling.
- MEASURAND: Magnetic field strength component.
- EQUIPMENT electrically screened loop antenna or within the large Van Veen loop antenna. Measurements at installation sites only the usual loop antenna is used.

Van Veen loop antenna.
Courtesy Rohde & Schwarz

WHY INTRODUCE RADIATED METHODS < 30MHZ

- **2011 BACKGROUND CISPR I**
- **CISPR 13 TV & 22 ITE => 32 Multimedia**
- Worldwide, the terrestrial switchover from analog to digital TV was in full swing
- Other devices starting to look at occupying the lower ISM bands at 6.78 and 13.56 MHz.
- **2011 CISPR/I** CISPR/I/359/Q was circulated asking:
- *"Should CISPR I introduce in CISPR 13 the current CISPR 11 Radiated method and limits of induction cooking appliances between 150 kHz and 30 MHz for large plasma TV-sets?"*
- This will be considered as an amendment for CISPR 32

WHY INTRODUCE RADIATED METHODS < 30MHZ

- **2011 BACKGROUND CISPR D**
- **CISPR 12**
- No measurements below 30 MHz.
- Proposal to add requirements relating to charging of EV/PHEVs while connected to the power mains.
- This proposal is in line with changes underway in the ECE Reg 10.

WHY INTRODUCE RADIATED METHODS < 30MHZ

- **2011 BACKGROUND CISPR D**
- **CISPR 25 ED 3 2008**
  - No requirements Presently 4 bands below 30 MHz are identified: 0.15 - 0.3;0.53 - 1.8; 5.9 - 6.2 and 26-28 MHz.
- **=> ED4 2016**
  - ALSE Method 150KHz-1GHz

WHY INTRODUCE RADIATED METHODS < 30MHZ

- **2011 BACKGROUND CISPR H**
- **CISPR 16-4-4 Statistics of complaints and a model for the calculation of limits for the protection of radio services**
- It is not in the present SC-H work program to include radiated emission limits below 30MHz.
- SC-A will define the test methods and the test site characteristics (test instrumentation seems already well defined).

Table A2, Requirements for radiated emissions at frequencies up to 1 GHz for Class A equipment

Table Clause	Frequency Range MHz	Measurement		Class A Limits dB(µV/m)	
		Distance m	Detector Type/ Bandwidth	OATS/SAC (see Table A1)	
A2.1	30 - 230	10	Quasi Peak / 120 kHz	40	
	230 - 1000			47	
A2.2	30 - 230	5		46	
	230 - 1000			53	
A2.3	30 - 230	3		50	
	230 - 1000			57	
NOTE Apply only table clause A2.1 or A2.2 or A2.3 fully across the entire frequency range.					

Table A3, Requirements for radiated emissions for frequencies above 1 GHz for Class A equipment

Table Clause	Frequency Range MHz	Measurement		Class A Limits dB(µV/m)	
		Distance m	Detector Type/ Bandwidth	FSOATS (see Table A1)	
A3.1	1000 - 3000	3	Average / 1 MHz	56	
	3000 - 6000			60	
	1000 - 3000		Peak / 1 MHz	76	
	3000 - 6000			80	
NOTES 1. Apply table clause A3.1 across the frequency range from 1000 MHz to the highest value derived from Table 1. 2. Each enclosure of EUT may be assessed separately when the width of the EUT system is more than 1,5 m.					

Extract CISPR 32 Courtesy IEC

WHY INTRODUCE RADIATED METHODS < 30MHZ

2011 BACKGROUND CISPR A

CISPR 16 measurements of radiated disturbance below 30 MHz,

- The following is **AVAILABLE** :
  - **CISPR 16-1-1** provides a selection of measuring receivers that can be used.
  - **CISPR 16-1-4** provides the loop antenna for general application and a large-loop antenna system for the measurement of radiated magnetic fields of special equipment.
- The following is **NOT AVAILABLE:**
  - **CISPR 16-1-4:** a specification of the test site for radiated disturbance measurements below 30 MHz is needed
  - **CISPR 16-1-4**: a method for test site validation is needed
  - **CISPR 16-1-6**: an antenna calibration method is needed
  - **CISPR 16-2-3**: a method specific for radiated disturbance measurements is needed
  - **CISPR 16-4-2**: a value for U_{cispr} of the combined standard uncertainty for radiated disturbance measurements in the frequency range below 30 MHz; the necessary background information is also needed.

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WHY INTRODUCE RADIATED METHODS < 30MHZ

May 2011 CISPR 1202 Q

- 1a. Do you expect that emissions limits will be required in the foreseeable future for radiated emissions below 30MHz?
- 1b. If so, is this because you are aware if interference cases already existing or is it because of expected increases in interference in the future?
- 2. If work on radiated emissions were to start, assuming that CISPR/A initially works to provide the missing items listed above, should there then be a simultaneous approach across all CISPR product committees to introduce limits for radiated emissions below 30MHz into all CISPR generic and product standards?

September 2011 CISPR/1211A/RQ

Question	Yes	No	Abstain
1a	AT,AU,BG, CA,CN, CZ,DK, FR, IT, MX, NL, NO, PT, RU, TH, ZA 16/23= 70%	BE, GB, JP, NZ	US, DE, ES
2	AT,BG,CN, CZ, FR, MX, PT, RU, TH, ZA 10/23= 43%	AU, BE,CA, DK, GB, IT, JP, NL, NO, NZ	US, DE, ES

This shows :

1a **Support for the introduction of radiated emissions limits below 30MHz,**

2. **A coordinated introduction across all product standards is not supported.**

1b

Country	Comment on 1b
AT	1b: There are interference cases existing (e.g. control systems, meters, …). There are also problems with combinations of products, which are individually compliant with the relevant standards. We expect the increasing of interference in the future. (See also Greek proposal TC210/GR0001/DC)
AU	Cases of plasma TV interference to MF broadcast radio and amateur radio have been reported.
BE	The Belgian NC has not reported such interference cases during previous enquiries; such interferences are possible, but only for products combining multiple worst cases (large size, wide openings, low working frequency)
CA	Expected Increases
CN	Yes, because we are aware that the near-field emission from large equipment below 30MHz can't be measured completely via conducted emission measurement.
DE	Yes, we met interference in industrial installations in the past, which caused problems in other control devices.
F	Increase of interference could happen in the long term due to new applications
GR	We have been repeatedly getting complaints from radio amateurs concerning th disturbance of the radio amateur service by other apparatus or fixed installations in frequencies lower than 30 MHz. In particular, we have studied the problem of interference from electrically-driven vehicles below 30 MHz and we have sent a proposal to CENELEC TC210 to develop new standards for the protection of radio services in that frequency band.
GB	Answered 1a - NO
IT	Some cases may exist now, but certainly more cases are expected in the future.
JP	In Japan, we have few problems as shown in the CISPR/I/344/INF which is the report on CISPR/I/328 /DC. Furthermore, those problems have been already resolved by manufacturers.

1b

Country	Comment on 1b
MX	Because of expected increases in interference.
NL	Because we are aware of already existing interference cases (Plasma TVs and elevators)
NO	There are some interference cases
PL	Expected increases in the future
PT	Interference cases are being reported; therefore this issue requires a future proof and stable regulation.
RU	We consider that radiated interference in principle should also be controlled in the frequency band from 9kHz to 30 MHz. It is necessary to provide a possibility of forecasting the electromagnetic environment due to man-made radio interference within 9kHz and 30 MHz.
TH	Yes to both questions
USA	The US National Committee at this time does not have any comments on the three questions raised in CISPR/1202/Q. However the USNC is interested in the subject and would consider participation in the work if it goes forward
ZA	Yes, it is because I am aware of interferences cases that already exist. A good example is the PLT (where CISPR is still battling to get a consensus amongst National Committees to agree on the limits for this technology).

STANDARDISATION

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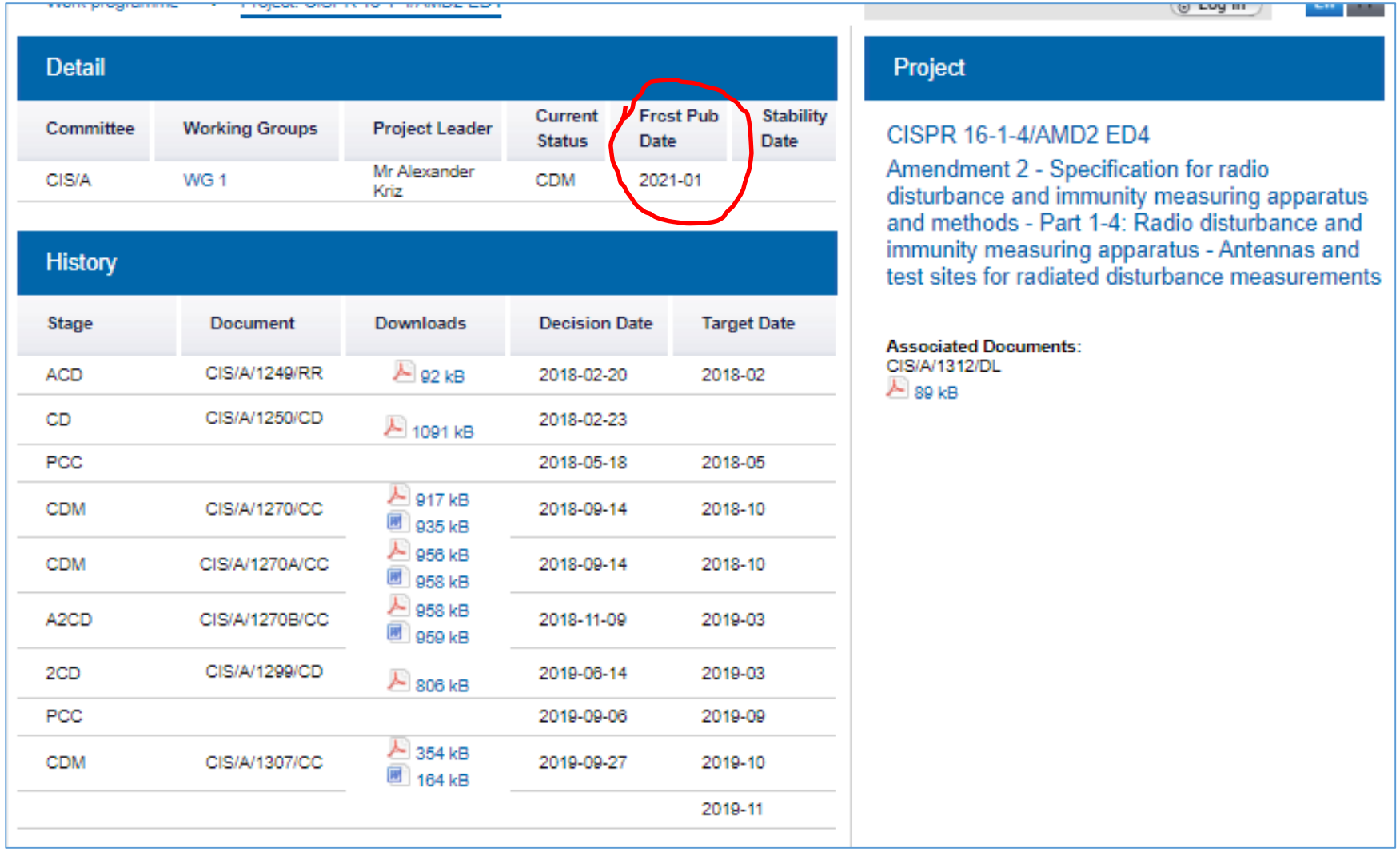
CISPR 16

- CISPR 16-1-4 CIS/A/1299/CD
  - Introduces material to validate a test site in the frequency range from 9 kHz to 30 MHz.
  - Validation in that range uses a pair of loop antennas in combination with the NSIL and RSM methods.

- CISPR 16-2-3 CIS/A/1289/CD
  - Introduces the radiated disturbance measurement procedure

- Both projects are being closely coordinated regarding e.g. test set-up and test distance.

CISPR 16-1-4/AMD2 ED4



Detail

Committee	Working Groups	Project Leader	Current Status	Frcst Pub Date	Stability Date
CIS/A	WG 1	Mr Alexander Kriz	CDM	2021-01	

History

Stage	Document	Downloads	Decision Date	Target Date
ACD	CIS/A/1249/RR	92 kB	2018-02-20	2018-02
CD	CIS/A/1250/CD	1091 kB	2018-02-23	
PCC			2018-05-18	2018-05
CDM	CIS/A/1270/CC	917 kB 935 kB	2018-09-14	2018-10
CDM	CIS/A/1270A/CC	956 kB 958 kB	2018-09-14	2018-10
A2CD	CIS/A/1270B/CC	958 kB 959 kB	2018-11-09	2019-03
2CD	CIS/A/1299/CD	806 kB	2019-06-14	2019-03
PCC			2019-09-06	2019-09
CDM	CIS/A/1307/CC	354 kB 164 kB	2019-09-27	2019-10
				2019-11

Project

CISPR 16-1-4/AMD2 ED4

Amendment 2 - Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-4: Radio disturbance and immunity measuring apparatus - Antennas and test sites for radiated disturbance measurements

Associated Documents:
CIS/A/1312/DL
89 kB

Courtesy IEC

CISPR 16-1-4/AMD2 ED4 CIS/A/1299/CD

- **Annee J : Informative**
- **Recommendations for the design of test sites 9 kHz to 30 MHz**

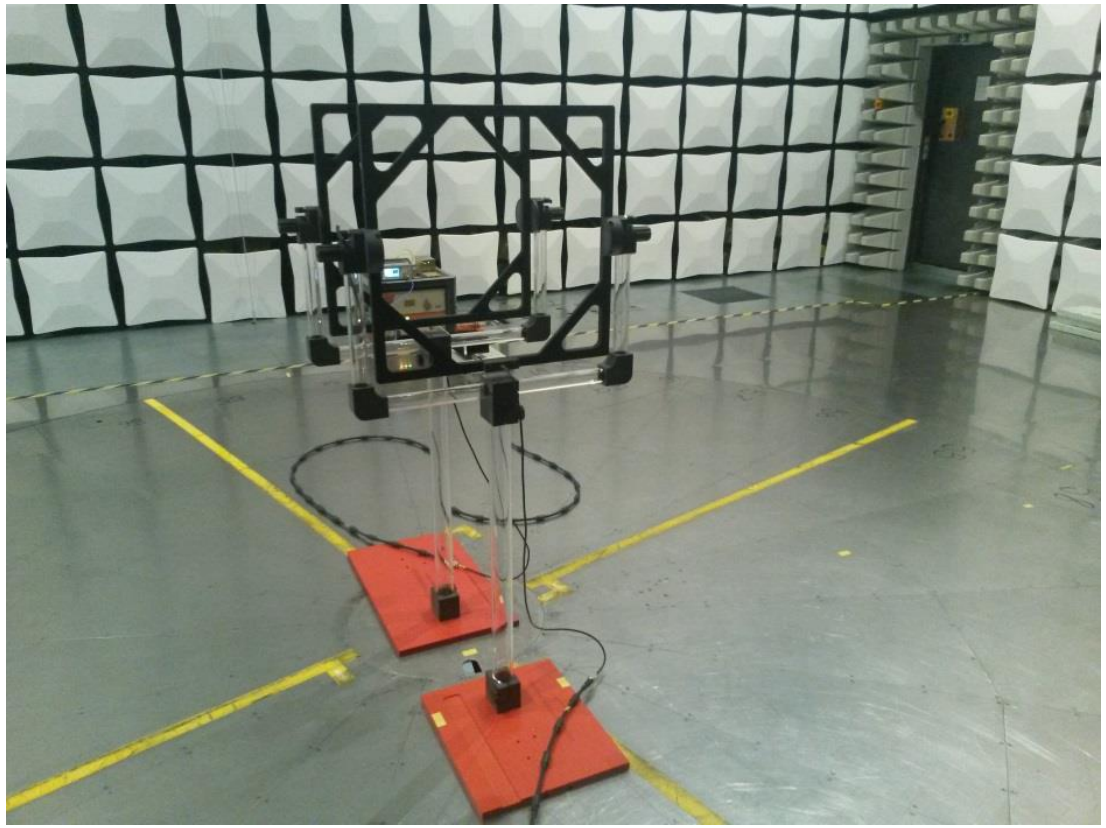
Table J.1 – Skin depth for some practical materials at 9 kHz

Material	**Conductivity** S/m	**Relative Permeability**	**Skin depth** mm	**Minimum ground plane thickness** mm
Copper	5,9E+7	1	0,7	0,7
Stainless steel	1,4E+6	1	4,5	4,5
Zinc coated steel	1,25E+5	240	1,0	1,0
Aluminum	3,7E+7	1	0,9	0,9

Courtesy IEC 2019

CISPR 16-1-4/AMD2 ED4 CIS/A/1299/CD

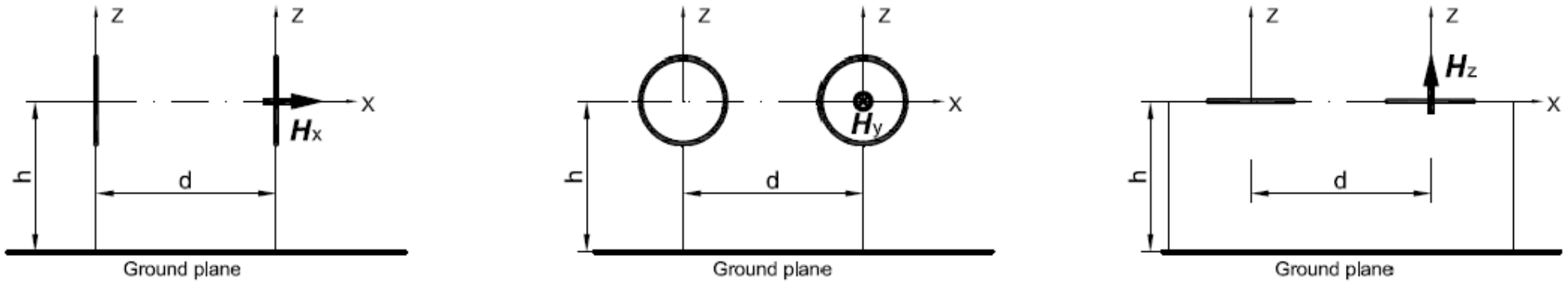
- Why Magnetic Loop Antennas ?
- CISPR Requested magnetic measurements only
- Calibrated loop antennas generally provide more accurate and repeatable field strength measurement results below 30 MHz
- NOTE : It is not acceptable to use an active or passive monopole (rod) antenna when performing measurements to demonstrate compliance with the FCC radiated emission limits below 30 MHz.



60 cm Loop antennas

CISPR 16-1-4/AMD2 ED4 CIS/A/1299/CD

5 Test sites for measurement of radio disturbance field strength for the frequency range of 9 kHz to 30 MHz



(a) Hx Coaxial (b) Hy Coplanar (V-pol.) (c) Hz Coplanar (H-pol.)

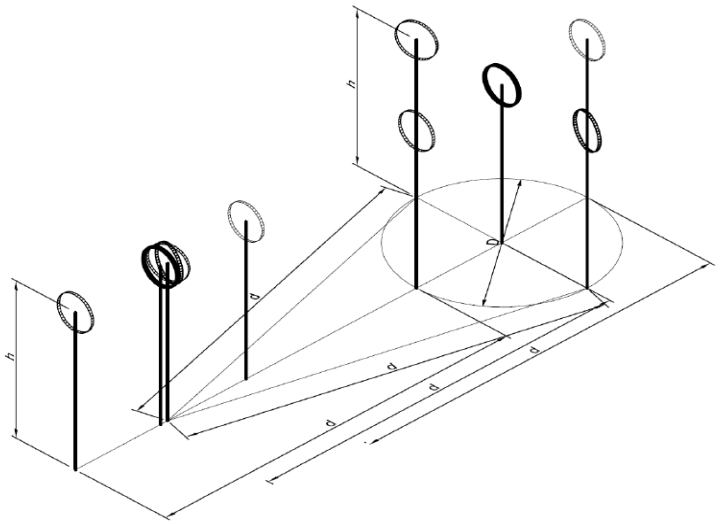
Figure 35 – General arrangement of the three measurement orientations H_X, H_Y and H_Z, where d is the measurement distance and h is the height of the reference point

Courtesy IEC 2019

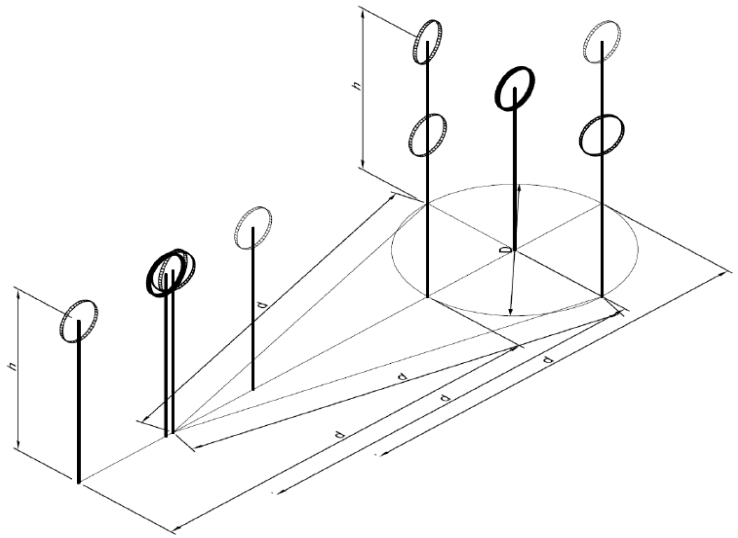
CISPR 16-1-4/AMD2 ED4 CIS/A/1299/CD

5 Test sites for measurement of radio disturbance field strength for the frequency range of 9 kHz to 30 MHz

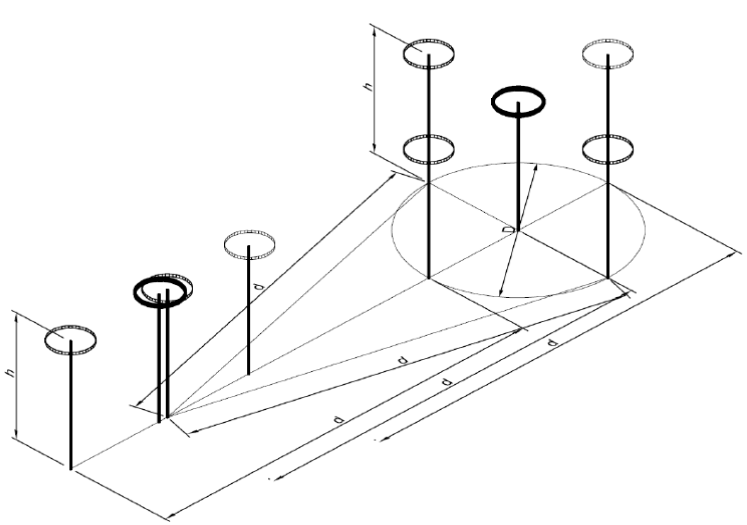
5.5 Validation procedure of test site



a) H_x validation measurement with loop antennas



b) H_y validation measurement with loop antennas



c) H_z validation measurement with loop antennas

Courtesy IEC 2019

CISPR 16-1-4/AMD2 ED4 CIS/A/1299/CD

The Normalised Site Attenuation (NSA) as well as the Reference Site Method (RSM) will be used.

The site insertion loss (attenuation) deviation is calculated by the Equation below :

$$\Delta A_S = V_{DIRECT} - V_{SITE} - F_{a,TX} - F_{a,RX} - A_N$$

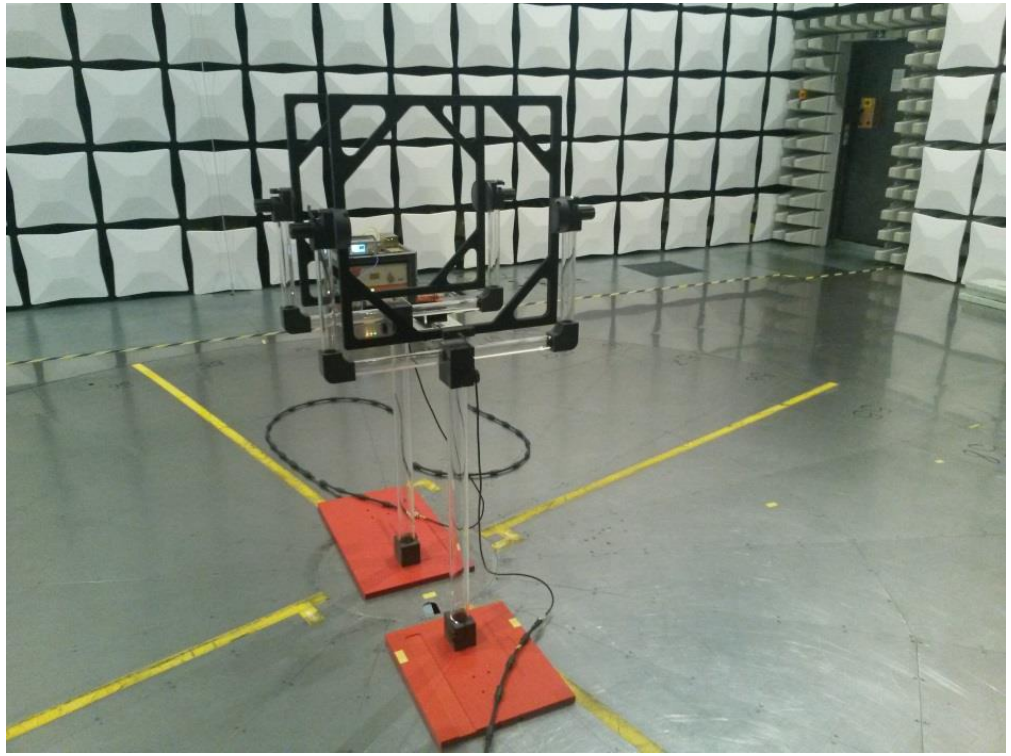
where

V_{DIRECT}	is the level recorded by the receiver when transmit and receive cable are connected by a barrel connector, in dBm or dB(μV);
V_{SITE}	is the level recorded by the receiver when transmit and receive cable are connected to the antennas, in dBm or dB(μV);
$F_{a,TX}$	is magnetic field antenna factor of the transmit antenna, in dB(S/m);
$F_{a,RX}$	is magnetic field antenna factor of the receive antenna, in dB(S/m);
A_N	is the theoretical normalized site attenuation, in dB(m^2/S^2), Calculated by NEC
ΔA_S	is the site insertion loss deviation, in dB.

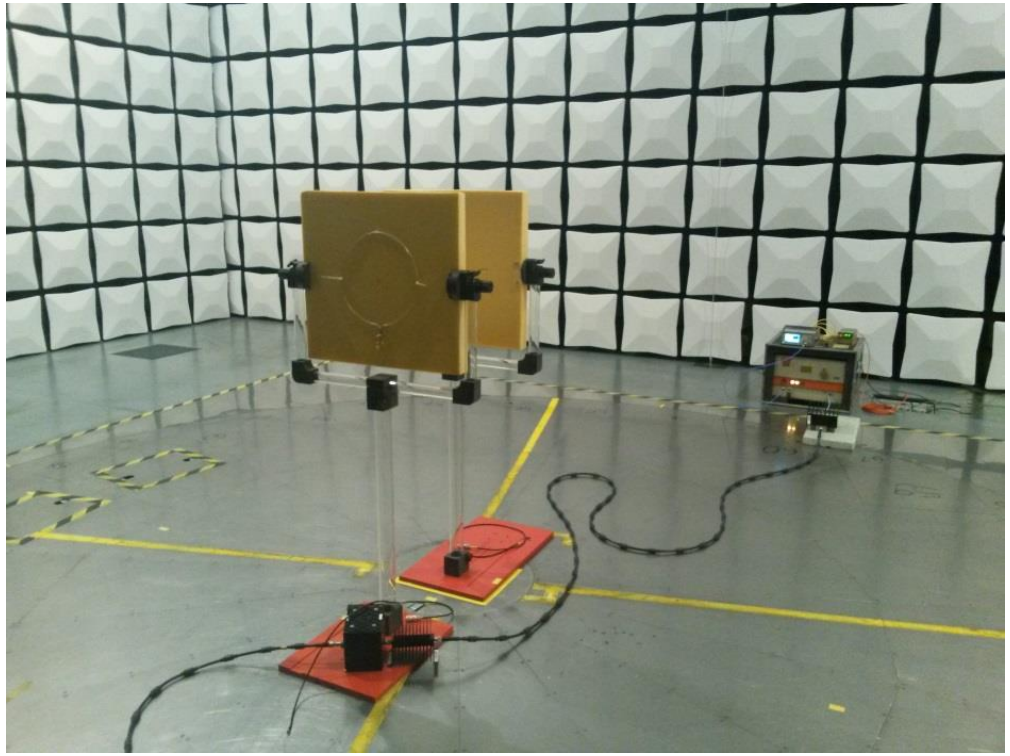
Courtesy IEC 2019

CISPR 16-1-4/AMD2 ED4 CIS/A/1299/CD

For simplicity $F_{a,TX}$ and $F_{a,RX}$ can be measured using a method called the calibration of the sum of antenna factors in the frequency range of 9 kHz to 30 MHz



60 cm Loop antennas



30 cm Loop antennas

CISPR 16-1-4/AMD2 ED4 CIS/A/1299/CD

5.5.4 Acceptance criterion

The site insertion loss deviation ΔA_S, calculated in accordance with 5.5.2 or 5.5.3 depending on which site validation method was used, shall comply with the applicable criterion specified in Table 10 at all frequencies, for all three antenna orientations, and at all five test positions.

Table 10 – Acceptance criterion

Test distance m	Maximum deviation dB
3	±4 dB
5	±4 dB
10	±4 dB [a]

[a] Measurements of 10 m SACs show that it might not be possible to fulfill the criterion of ±4 dB over the complete frequency range. Therefore use of such a SAC is accepted, even if it is not compliant with the ±4 dB criterion. In this case the increased uncertainty shall be taken into account for compliance with the applicable limit. For each frequency the maximum of $|\Delta A_s|$ of all points, where the criterion is exceeded, shall be taken as δA_N to calculate U_{lab}. U_{lab} is calculated separately for each orientation. See CISPR 16-4-2 and Annex L for further information.

Courtesy IEC 2019

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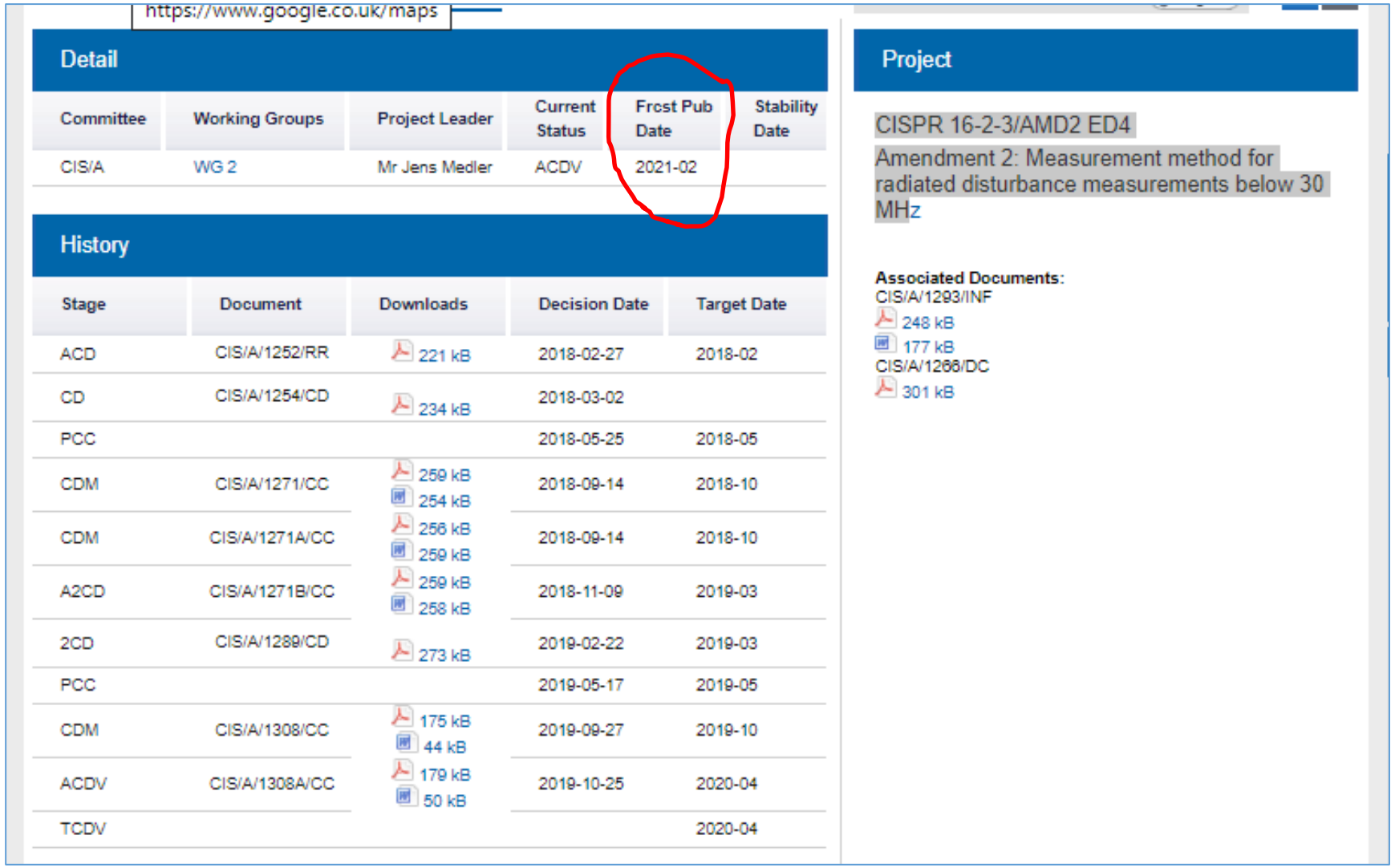
CIS/A/1315/Q 2019-12-20 DEADLINE FEB 7

- **STATEMENT**
  - **IN A 10 M CHAMBER, WHICH IS NOT EQUIPPED WITH FERRITE TILES, IT IS NOT POSSIBLE TO SATISFY THE SITE VALIDATION CRITERION IN 3 M DISTANCE.**
  - The authors conclude that a change of the current site validation criterion, as shown in Table 10 of CIS/A/1299/CD, is justified due to a large economic impact.
  - Since the modification of Table 10 is a major technical change, the opinion of the National Committees is requested.
  - The results of this questionnaire will be used for the upcoming CDV.

- **QUESTION:**
  - **Do you support to update the site validation criterion, as described in the amended Table 10, given in Annex 1 to this questionnaire?**

Courtesy IEC 2019

CISPR 16-2-3/AMD2 ED4



https://www.google.co.uk/maps

Detail

Committee	Working Groups	Project Leader	Current Status	Frcst Pub Date	Stability Date
CIS/A	WG 2	Mr Jens Medler	ACDV	2021-02	

History

Stage	Document	Downloads	Decision Date	Target Date
ACD	CIS/A/1252/RR	221 kB	2018-02-27	2018-02
CD	CIS/A/1254/CD	234 kB	2018-03-02	
PCC			2018-05-25	2018-05
CDM	CIS/A/1271/CC	259 kB 254 kB	2018-09-14	2018-10
CDM	CIS/A/1271A/CC	256 kB 259 kB	2018-09-14	2018-10
A2CD	CIS/A/1271B/CC	259 kB 258 kB	2018-11-09	2019-03
2CD	CIS/A/1289/CD	273 kB	2019-02-22	2019-03
PCC			2019-05-17	2019-05
CDM	CIS/A/1308/CC	175 kB 44 kB	2019-09-27	2019-10
ACDV	CIS/A/1308A/CC	179 kB 50 kB	2019-10-25	2020-04
TCDV				2020-04

Project

CISPR 16-2-3/AMD2 ED4

Amendment 2: Measurement method for radiated disturbance measurements below 30 MHz

Associated Documents:

CIS/A/1293/INF

248 kB

177 kB

CIS/A/1266/DC

301 kB

CISPR 16-2-3/AMD2 ED4- CISPR A 1289 CD

Proposed revision of CISPR 16-2-3
on the measurement method for radiated disturbance measurements below 30 MHz.

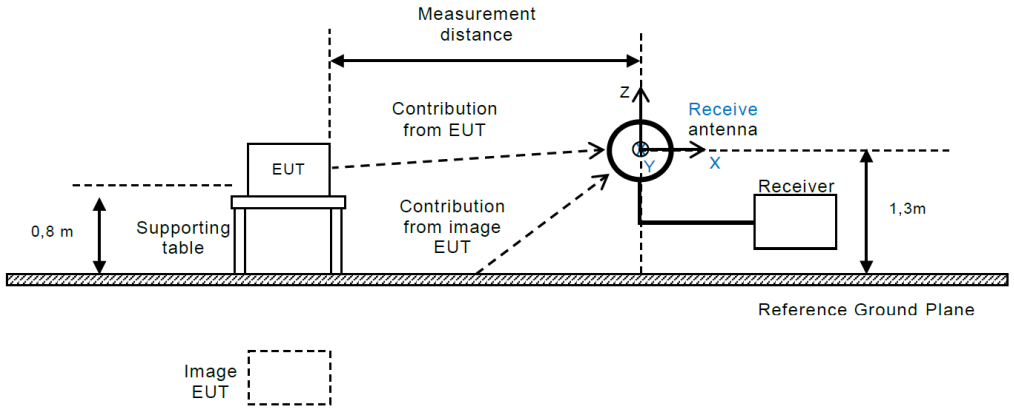


Figure 23 – Concept of magnetic field strength measurements made on an OATS or in a SAC for table-top EUT

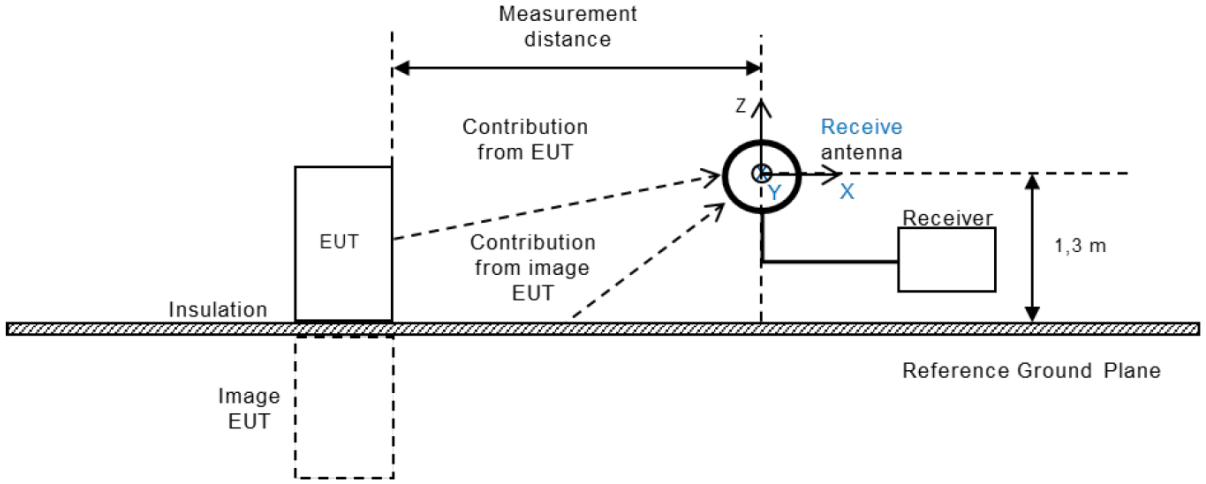
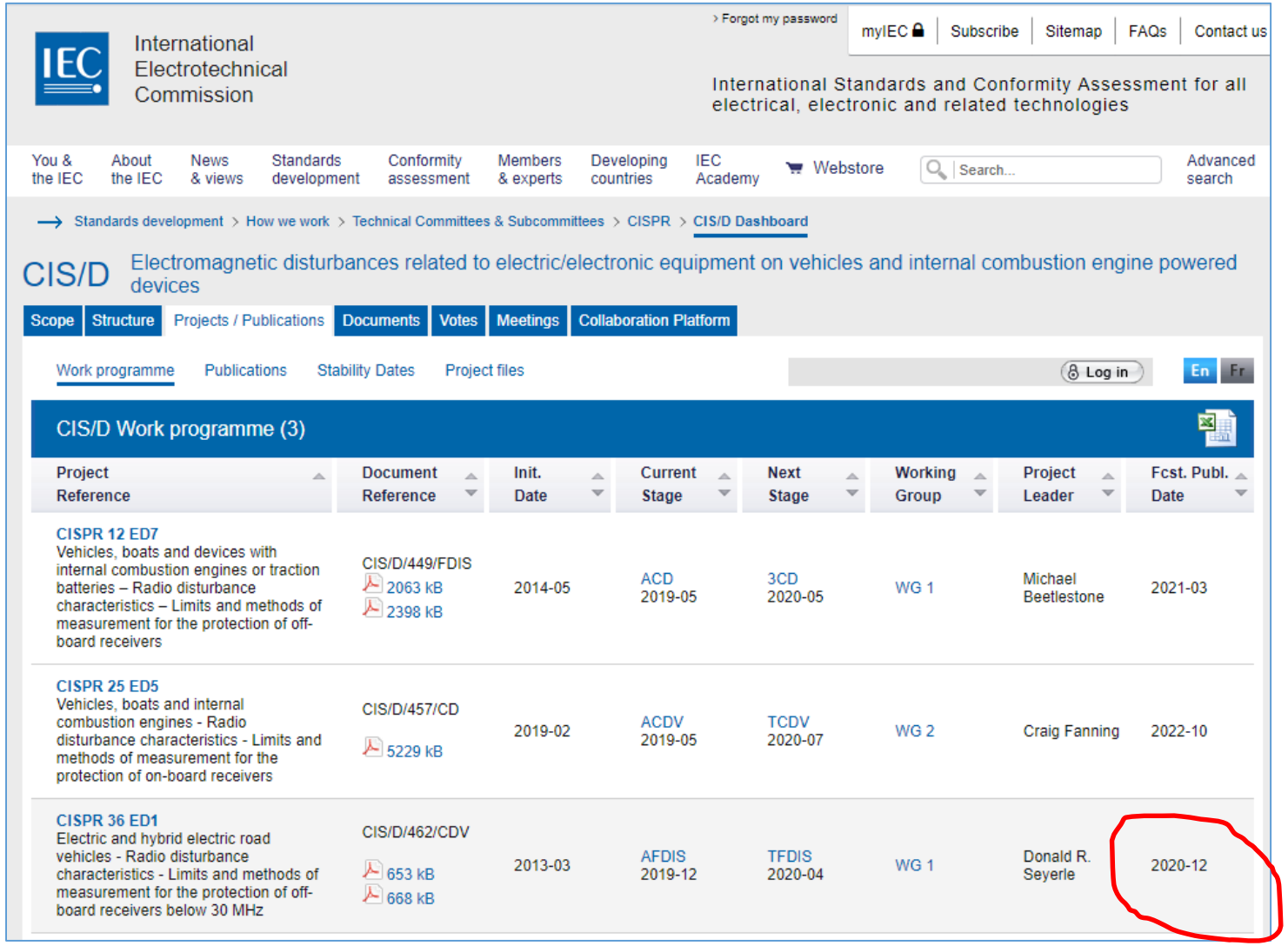


Figure 24 – Concept of magnetic field strength measurements made on an OATS or in a SAC for floor-standing EUT

Courtesy IEC 2019

CISPR D



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CIS/D Electromagnetic disturbances related to electric/electronic equipment on vehicles and internal combustion engine powered devices

Scope | Structure | Projects / Publications | Documents | Votes | Meetings | Collaboration Platform

Work programme | Publications | Stability Dates | Project files | Log in | En | Fr

CIS/D Work programme (3)

Project Reference	Document Reference	Init. Date	Current Stage	Next Stage	Working Group	Project Leader	Fcst. Publ. Date
CISPR 12 ED7 Vehicles, boats and devices with internal combustion engines or traction batteries – Radio disturbance characteristics – Limits and methods of measurement for the protection of off-board receivers	CIS/D/449/FDIS 2063 kB 2398 kB	2014-05	ACD 2019-05	3CD 2020-05	WG 1	Michael Beetlestone	2021-03
CISPR 25 ED5 Vehicles, boats and internal combustion engines - Radio disturbance characteristics - Limits and methods of measurement for the protection of on-board receivers	CIS/D/457/CD 5229 kB	2019-02	ACDV 2019-05	TCDV 2020-07	WG 2	Craig Fanning	2022-10
CISPR 36 ED1 Electric and hybrid electric road vehicles - Radio disturbance characteristics - Limits and methods of measurement for the protection of off-board receivers below 30 MHz	CIS/D/462/CDV 653 kB 668 kB	2013-03	AFDIS 2019-12	TFDIS 2020-04	WG 1	Donald R. Seyerle	2020-12

Courtesy IEC

CISPR 36 Ed 1.0

Automotive equipment, Radiated Emission < 30 MHz for EV and HEV

5.1.2 Magnetic field antenna

For measuring the magnetic field, an electrically-screened loop antenna shall be used

(see CISPR 16-1-4:2019 clause 4.4.2).

Annex C
(informative)

Items under consideration

C.1 General

Annex C contains future work items that are under consideration for the next edition or an amendment to this document.

C.2 Plug-in charging mode and WPT charging mode

There is parallel work in other CISPR or IEC committees (e.g. CISPR/B on WPT, IEC 61980, IEC 61851-21-x). Therefore, CISPR 36 does not consider the charging mode for the moment. The decision to include the charging mode into CISPR 36 will depend on the output of these other committees.

C.3 Correlation between OTS, OATS and ALSE measurements

The work on this topic has been started in the CISPR/D Task Force "Chamber Validation Methods".

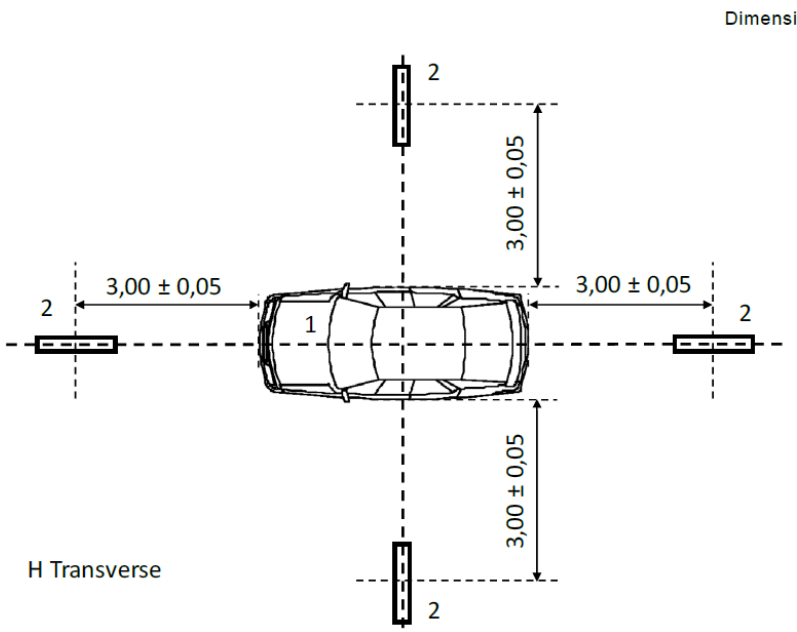
C.4 Measurement distance of 10 m

CISPR 16-2-3 defines measurement distances of 3 m, 5 m and 10 m. Based on the experience collected with CISPR 16-2-3, CISPR/D may consider to also add 10 m measurement distance in CISPR 36.

Courtesy IEC 2019

CISPR 36 Ed 1.0

Automotive equipment, Radiated Emission < 30 MHz for EV and HEV

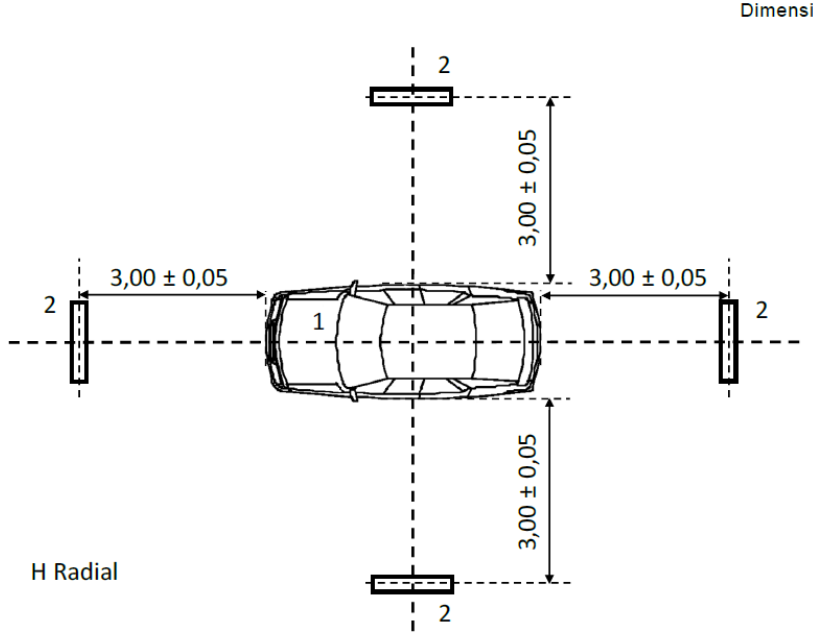


Key

1 vehicle under test

2 antenna (four positions)

Figure 3 – Magnetic field measurement – transverse loop orientation



Key

1 vehicle under test

2 antenna (four positions)

Figure 4 – Magnetic field measurement – radial loop orientation

Courtesy IEC 2019

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CISPR B

Industrial, scientific and medical equipment (ISM)

- **CISPR 11/AMD3/FRAG1 ED6**:
- Radio-frequency disturbance characteristics
- Limits and methods of measurement
- Requirements for air-gap wireless power transfer (WPT)

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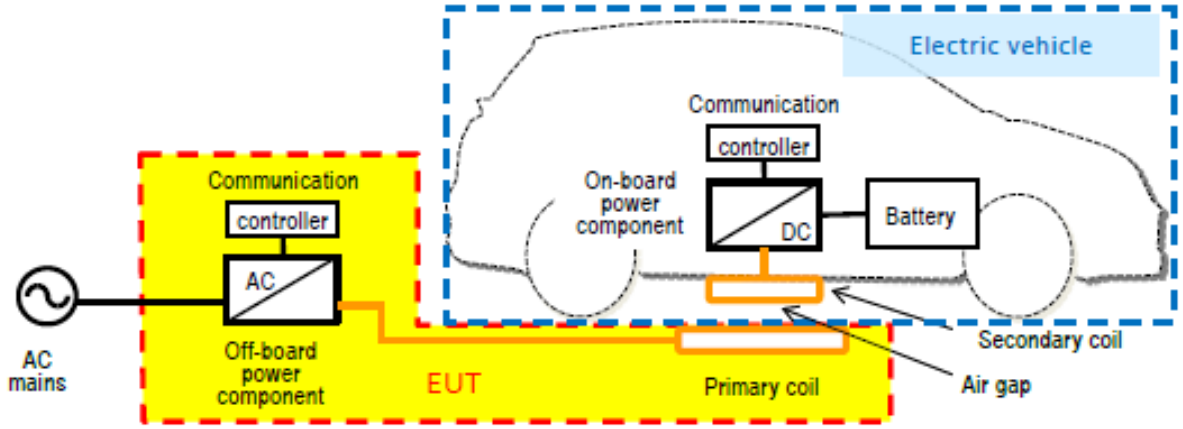
CISPR B

Industrial, scientific and medical equipment (ISM)

Table ≇DA – Electromagnetic radiation disturbance limits for class A WPT equipment for EV measured on a test site

Frequency range [MHz]	Limits for a measuring distance *D* in m		
	D = 30 m	*D* = 10 m	*D* = 3 m
	Magnetic Field Quasi-Peak [dB(µA/m)]	Magnetic Field Quasi-Peak [dB(µA/m)]	Magnetic Field Quasi-Peak [dB(µA/m)]
0,15 – 2,0	-7 decreasing linearly with logarithm of frequency to -24,6	24,5 decreasing linearly with logarithm of frequency to 6,9	49 decreasing linearly with logarithm of frequency to 13
2,0 – 4	-24,6 increasing linearly with logarithm of frequency to -17,3	6,9 decreasing linearly with logarithm of frequency to 2,2	
4 – 11	-17,3 increasing linearly with logarithm of frequency to -6,7	2,2 increasing linearly with logarithm of frequency to 9,8	
11 – 16	-6,7 increasing linearly with logarithm of frequency to -2,7	9,8 increasing linearly with logarithm of frequency to 7,3	
16 – 30	-2,7 decreasing linearly with logarithm of frequency to -7	7,3 decreasing linearly with logarithm of frequency to 3	

On a test site, class A equipment can be measured at a nominal distance of 3 m, 10 m or 30 m. A measuring distance less than 10 m is allowed only for equipment which complies with the definition given in 3.17.
At the transition frequency, the more stringent limit shall apply.



Courtesy IEC

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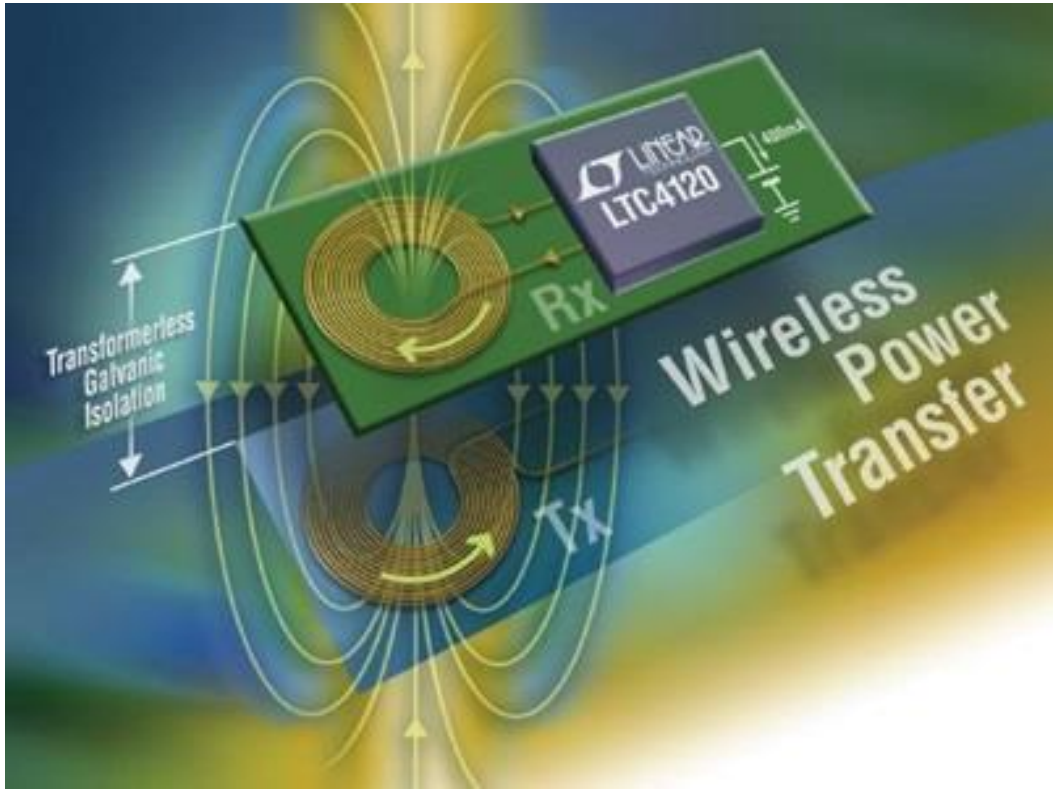
Wireless Power Transfer (WPT)

- Process where electrical energy is transmitted from a power source to an electrical load across an air gap using induction coils.
- These coils produce an electromagnetic field which sends energy from a charging base station (transmitter) to a coil on a portable device (receiver) with complete galvanic isolation.
- The receiver coil takes power from the electromagnetic field and converts it into electrical power.



Courtesy Analog Devices

Wireless Power Transfer (WPT)

Technology	Frequency	Current and/or possible future applications
Inductive coupling	Hz – MHz	Electric tooth brush and razor battery charging, induction stovetops and industrial heaters.
Resonant inductive coupling	kHz – GHz	Charging portable devices, biomedical implants, electric vehicles, powering buses, trains, MAGLEV, RFID, Smartcards.
Capacitive coupling	kHz – MHz	Charging portable devices, power routing in large-scale integrated circuits, Smartcards, biomedical implants
Magnetodynamic coupling	Hz	Charging electric vehicles biomedical implants.[

CISPR F

Interference relating to household appliances tools, lighting equipment and similar apparatus

- **CISPR 14-1 Ed 6.0**
  - **Electromagnetic compatibility - Requirements for household appliances, electric tools and similar apparatus - Part 1: Emission**
  - Alignment of < 30MHz Limits and upcoming changes on the < 30MHz test methods and equipment (LLAS and 60cm loop antenna)
  - **Maintenance 2021**

- **CISPR 15 Ed 9.0**
  - **Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment**
  - Alignment of < 30MHz Limits and upcoming changes on the < 30MHz test methods and equipment (LLAS and 60cm loop antenna)
  - **Maintenance 2021 -2022**

CISPR I

Electromagnetic compatibility of information technology equipment, multimedia equipment and receivers

- **CISPR 32 Ed 2**
- Electromagnetic compatibility of multimedia equipment - Emission requirements
- **Wireless Power Transfer** Inclusion of methods and limits (This was an item under 525/RR resulting in CISPR/I/567/CD but was not considered mature enough to proceed further at the time)
- **Smart Grid** Limits for emissions below 150KHz under consideration
- 2021 Maintenance

FCC

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- **RADIATED EMISSION TEST SITES FOR MEASUREMENTS FROM 9 kHz TO 30 MHz**
- The test site requirements of Section 15.31(d) apply for part 15 device radiated emission measurements at frequencies below 30 MHz.
- Site validation requirements for radiated emission measurements below 30 MHz have not been established.
  - NOTE: At the time of publication of this document, site criteria and validation methods are under development in ASC C63® SC-4, and in IEC SC CISPR/A (Proposed draft amendment to CISPR 16-1-4 for test site validation from 9 kHz to 30 MHz).
  - When that work product is sufficiently mature, it will be reviewed to determine its acceptability then updates to this or other KDB publications may be proposed accordingly
- However, ANSI C63 standards provide general criteria for test sites used to make measurements in the 9 kHz to 30 MHz frequency range.
  - 5.3 of ANSI C63.4-2014,
  - 5.2 of ANSI C63.10-2013
  - 4.6.3.1 of ANSI C63.26-2015

Courtesy FCC

Chamber Validation Measurements

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MEASUREMENT SET UP

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- Care to avoid ground loops
- Cable resonances are critical,
- Multiple solutions available
- Dynamic range is a problem
- The solution is, to place the generator and amplifier are placed inside the SAC and control them via fibre optics;

Test set up transmitting side FO control module, generator amplifier, attenuator

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CISPR 16-1-4/AMD2 ED4 CIS/A/1299/CD

Reminder: table 10

5.5.4 Acceptance criterion

The site insertion loss deviation ΔA_S, calculated in accordance with 5.5.2 or 5.5.3 depending on which site validation method was used, shall comply with the applicable criterion specified in Table 10 at all frequencies, for all three antenna orientations, and at all five test positions.

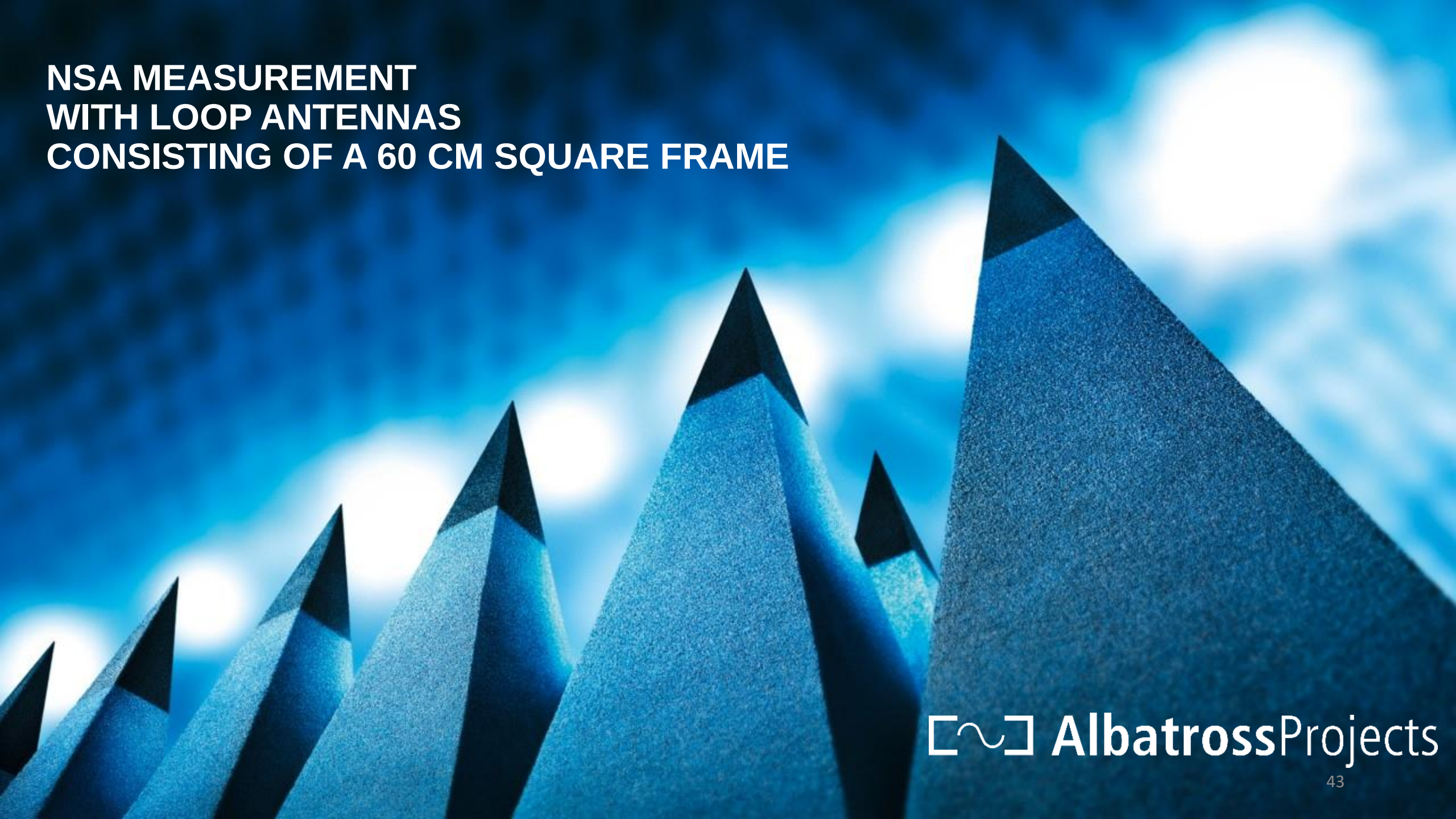
Table 10 – Acceptance criterion

Test distance m	Maximum deviation dB
3	±4 dB
5	±4 dB
10	±4 dB [a]

[a] Measurements of 10 m SACs show that it might not be possible to fulfill the criterion of ±4 dB over the complete frequency range. Therefore use of such a SAC is accepted, even if it is not compliant with the ±4 dB criterion. In this case the increased uncertainty shall be taken into account for compliance with the applicable limit. For each frequency the maximum of $|\Delta A_s|$ of all points, where the criterion is exceeded, shall be taken as δA_N to calculate U_{lab}. U_{lab} is calculated separately for each orientation. See CISPR 16-4-2 and Annex L for further information.

Courtesy IEC 2019

NSA MEASUREMENT WITH LOOP ANTENNAS CONSISTING OF A 60 CM SQUARE FRAME



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60CM LOOP ANTENNAS

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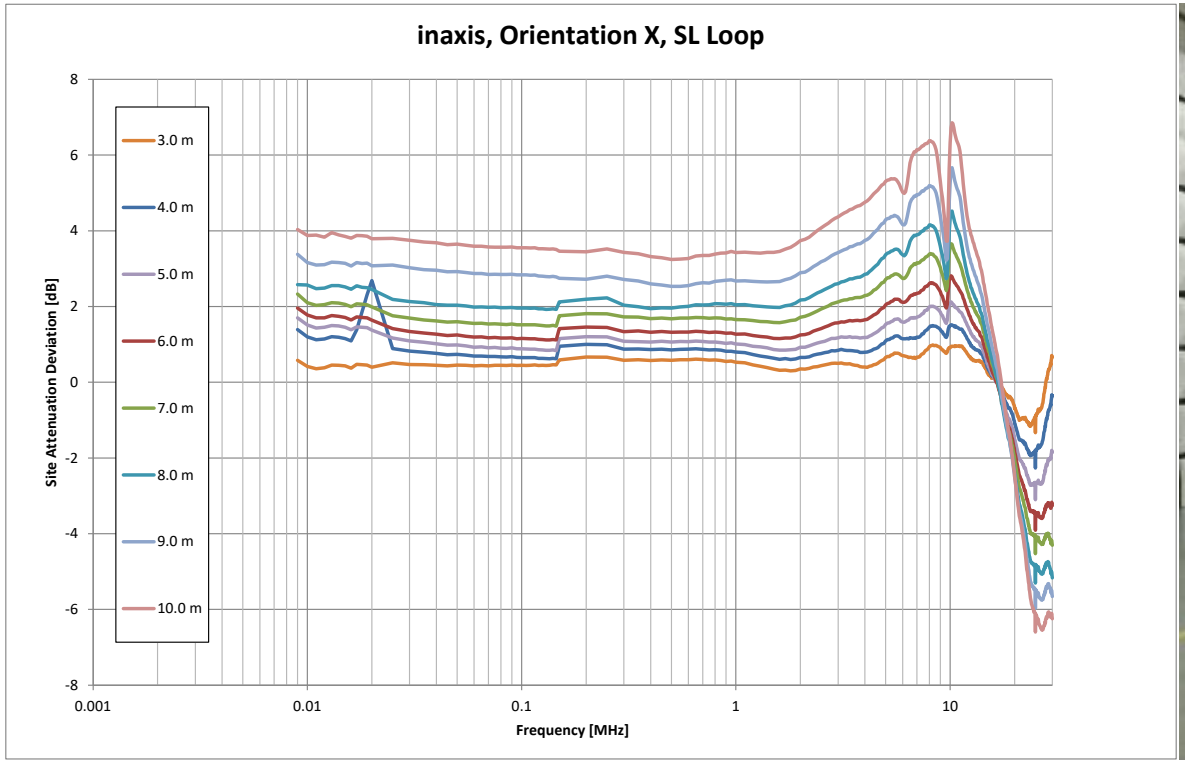
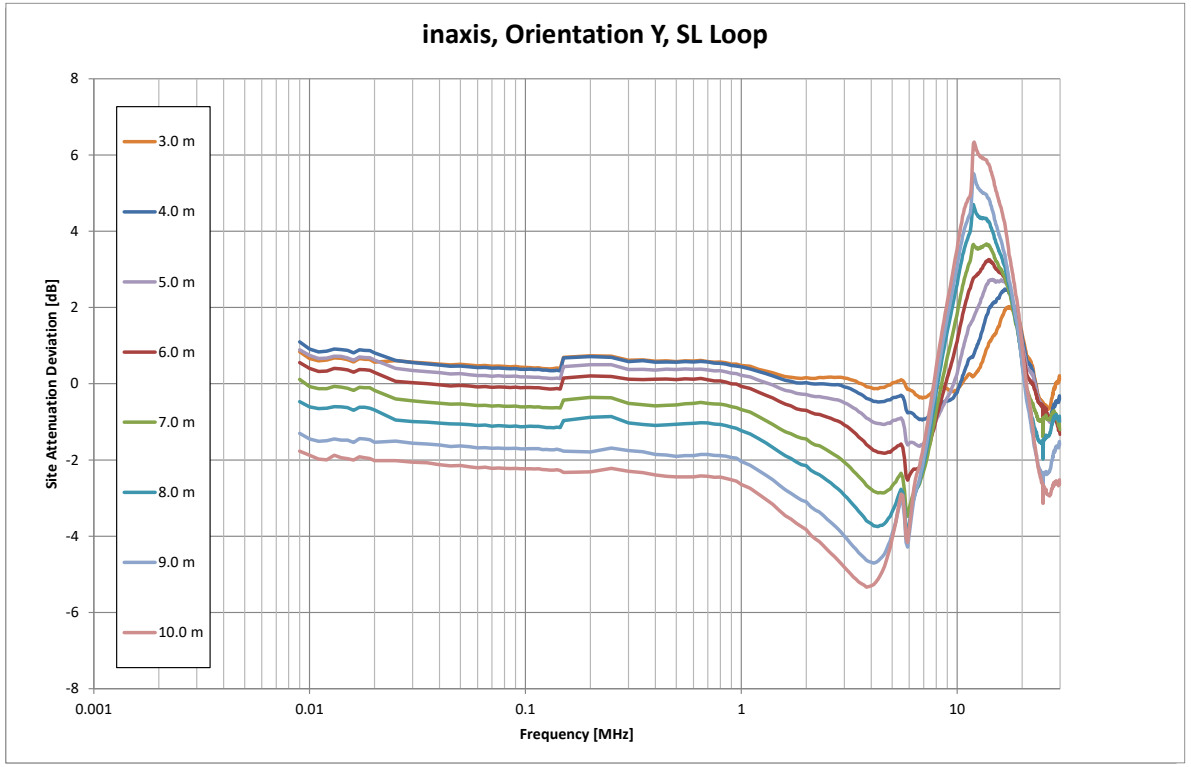
(in length axis) H_x



60CM LOOP ANTENNAS

AlbatrossProjects

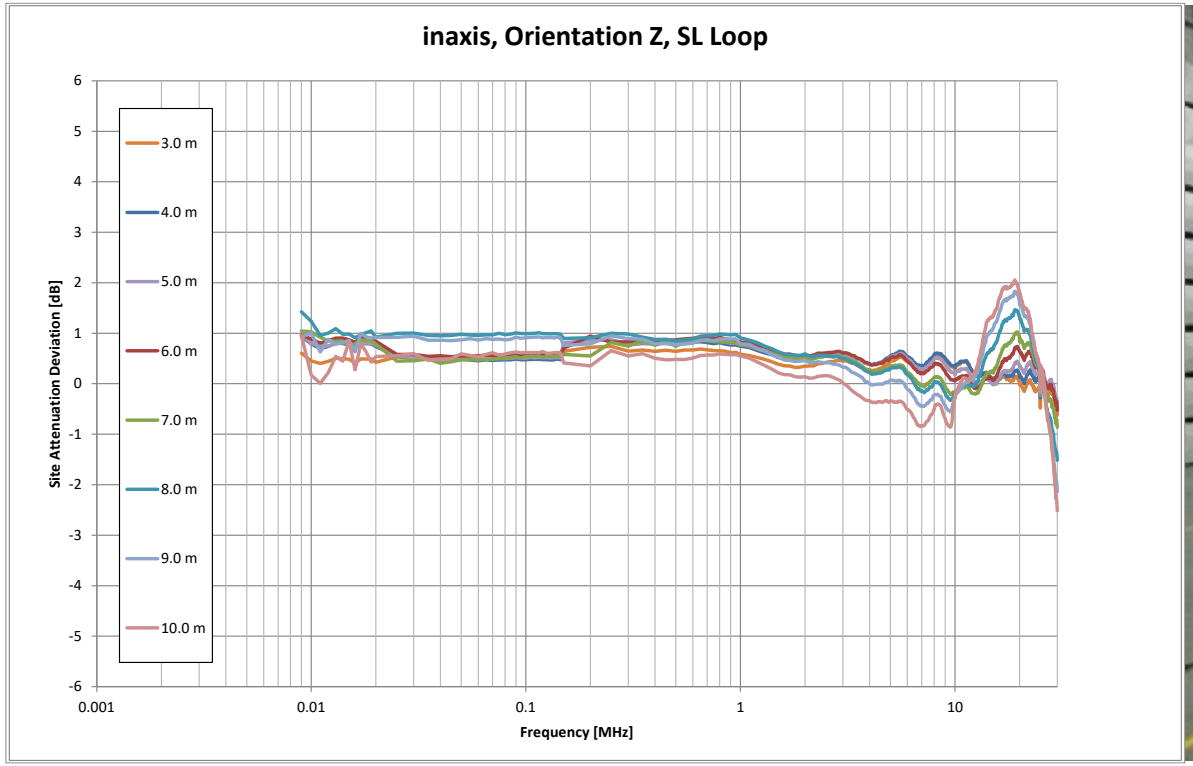
(in length axis) H_y



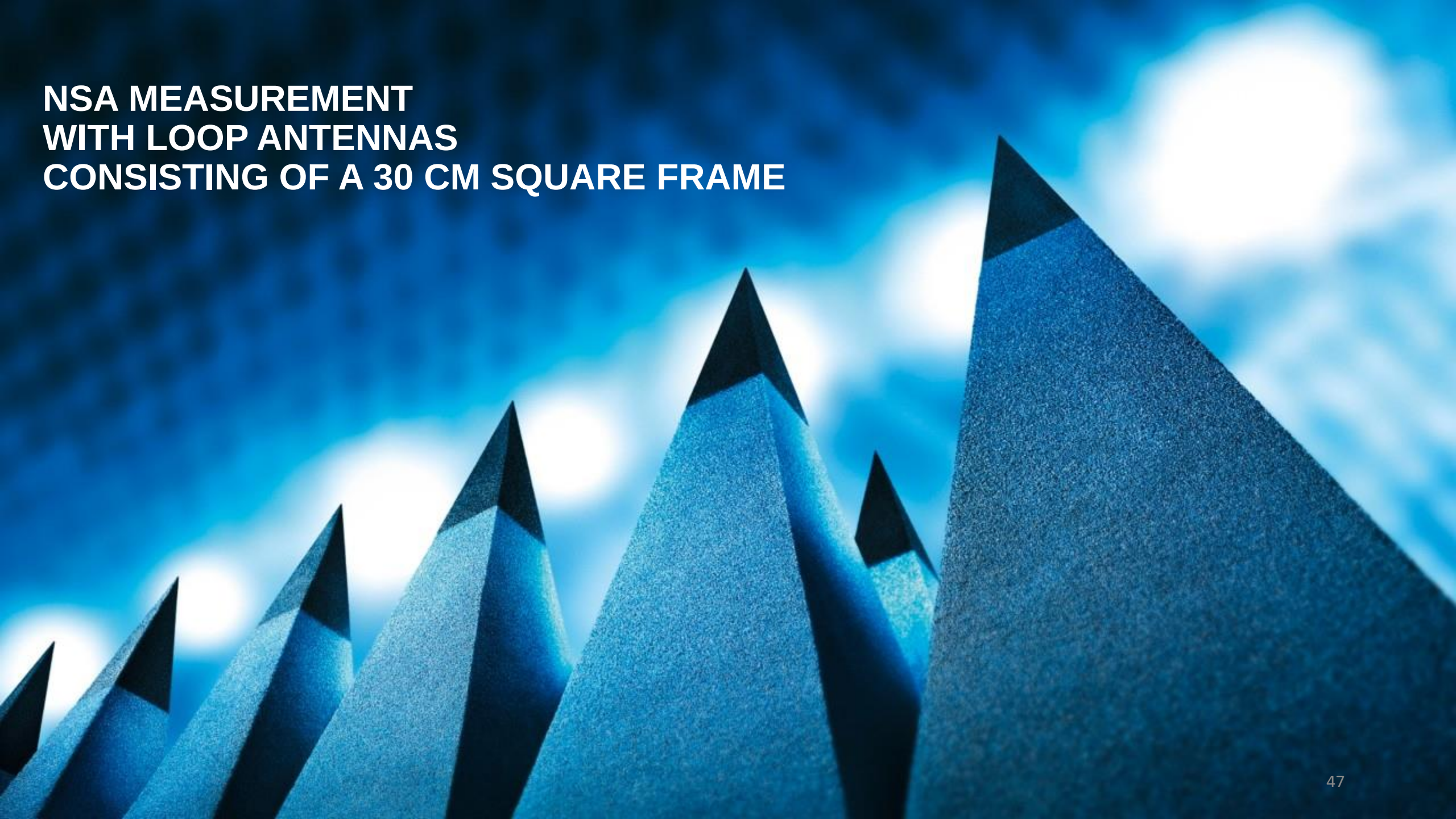
60CM LOOP ANTENNAS

AlbatrossProjects

(in length axis) H_z



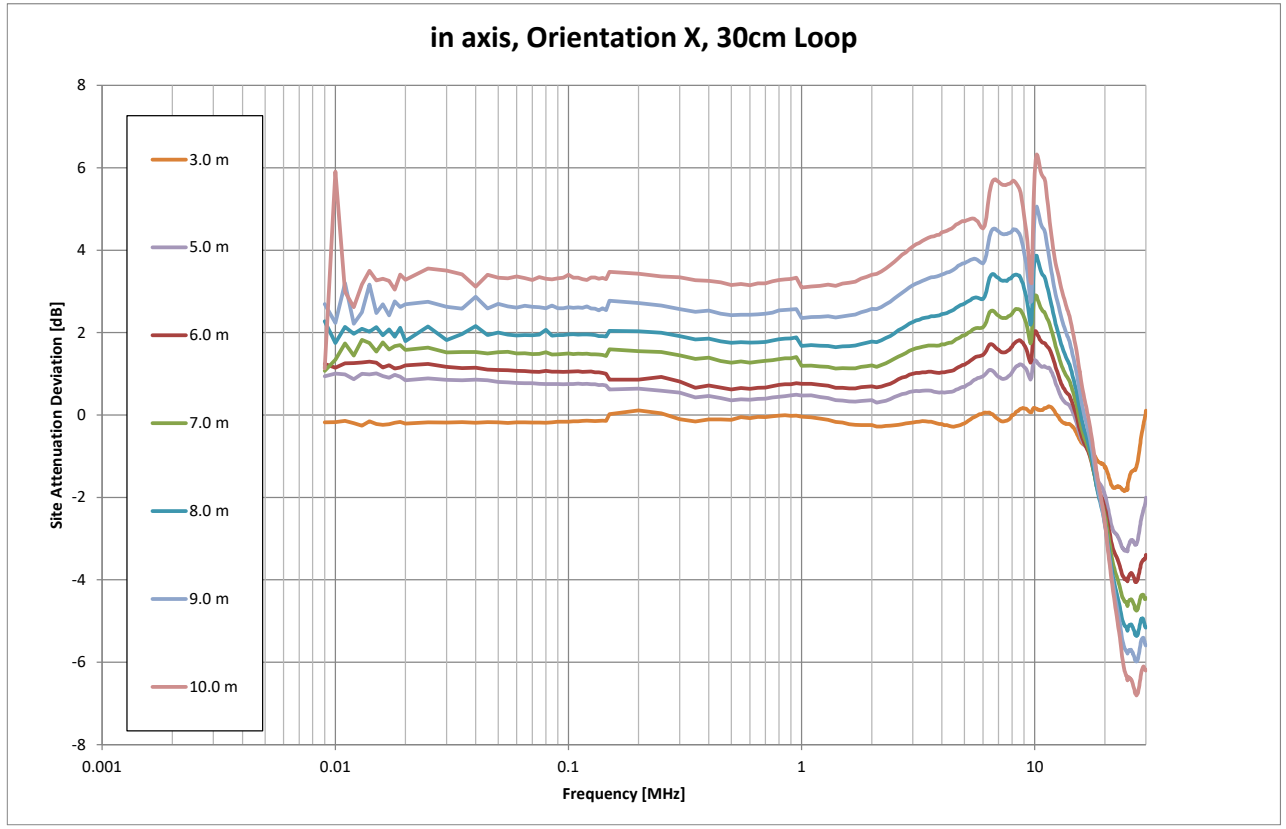
NSA MEASUREMENT WITH LOOP ANTENNAS CONSISTING OF A 30 CM SQUARE FRAME



30CM LOOP ANTENNAS

AlbatrossProjects

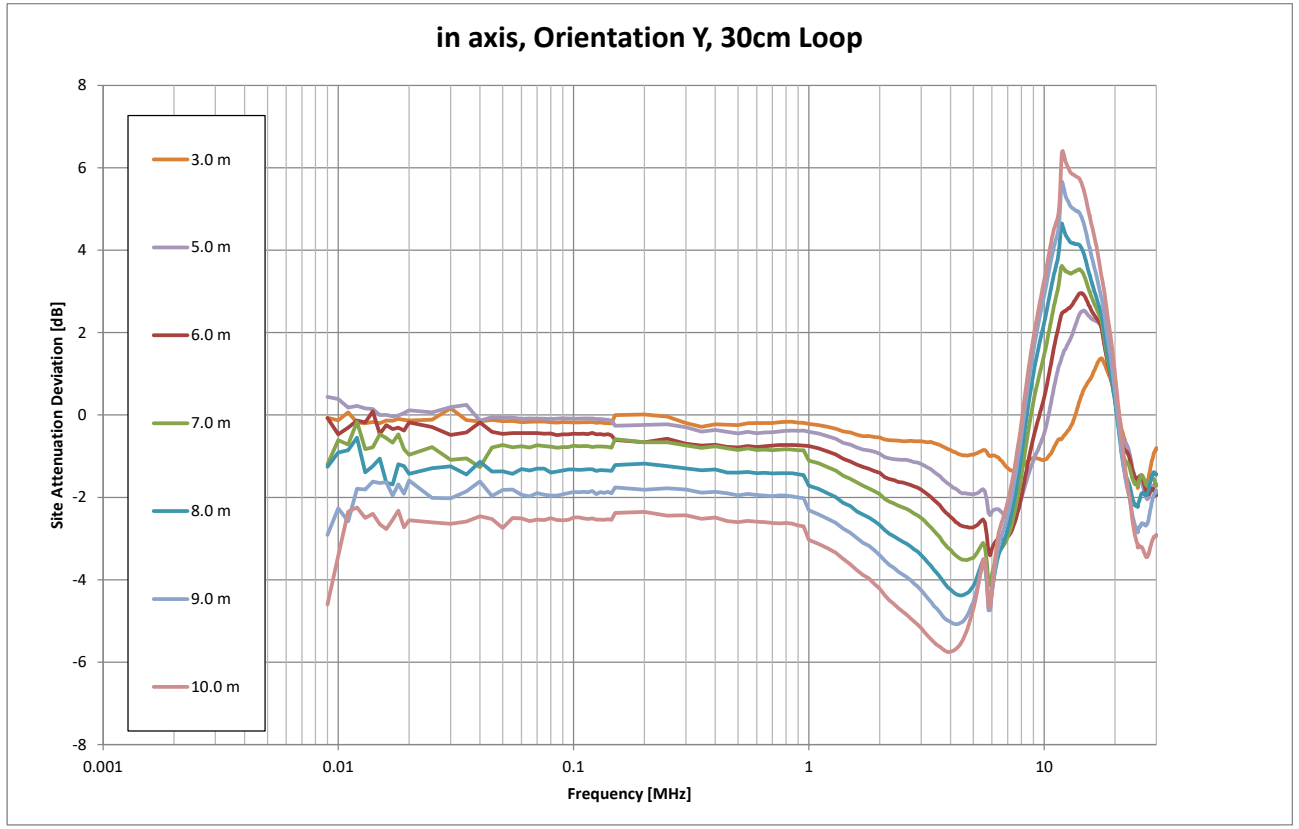
(in length axis) H_x

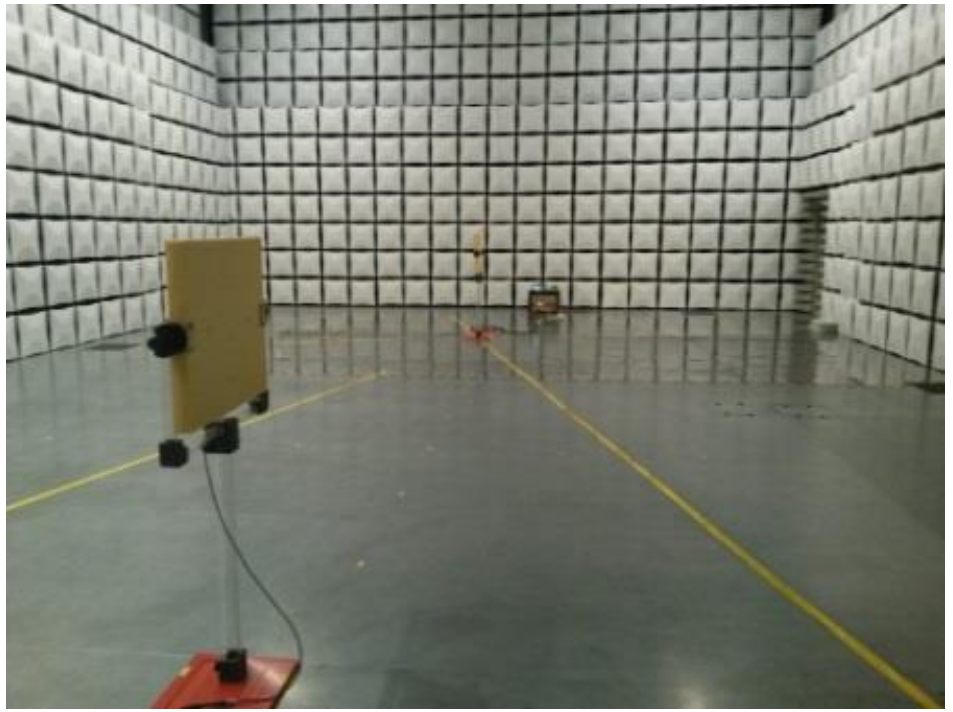


30CM LOOP ANTENNAS

AlbatrossProjects

(in length axis) H_Y

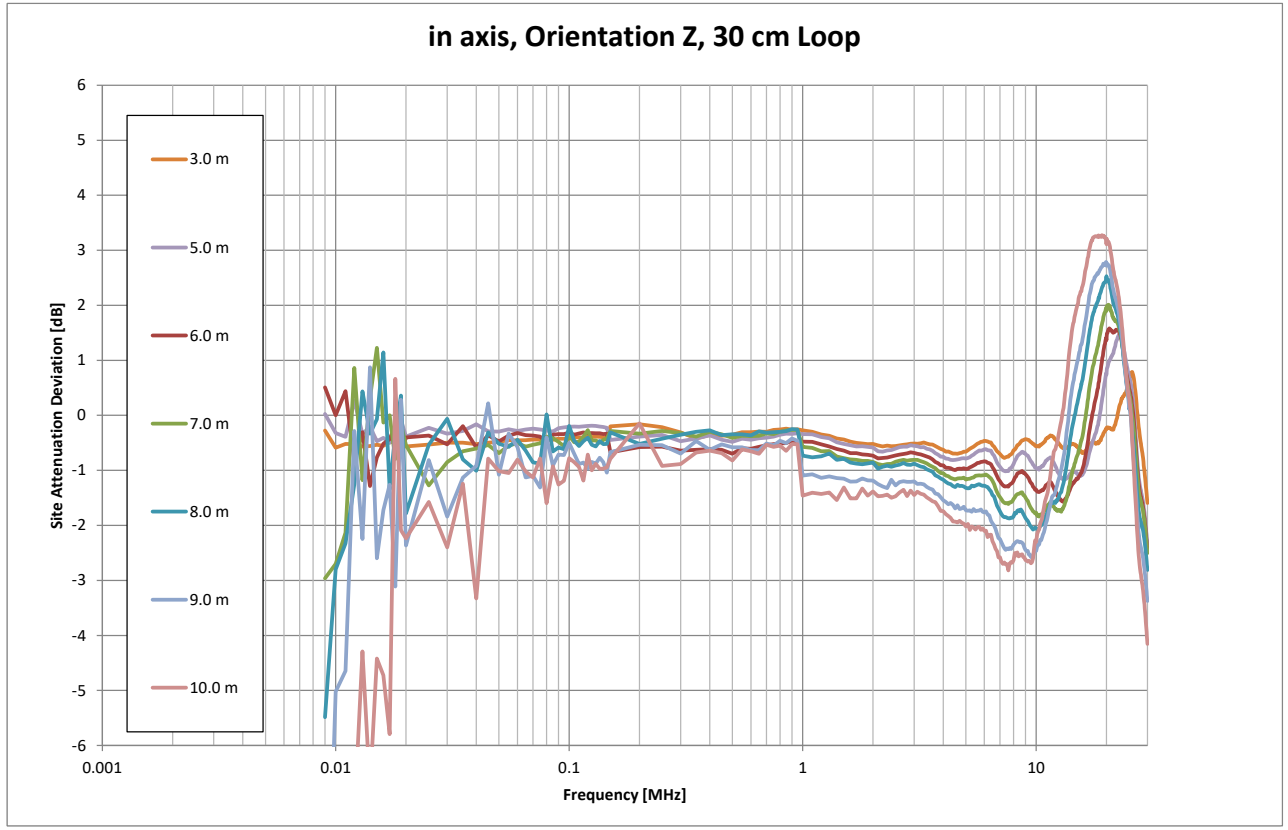




30CM LOOP ANTENNAS

AlbatrossProjects

(in length axis) H_z



NSA MEASUREMENT
3M VOLUME IN 5M DISTANCE

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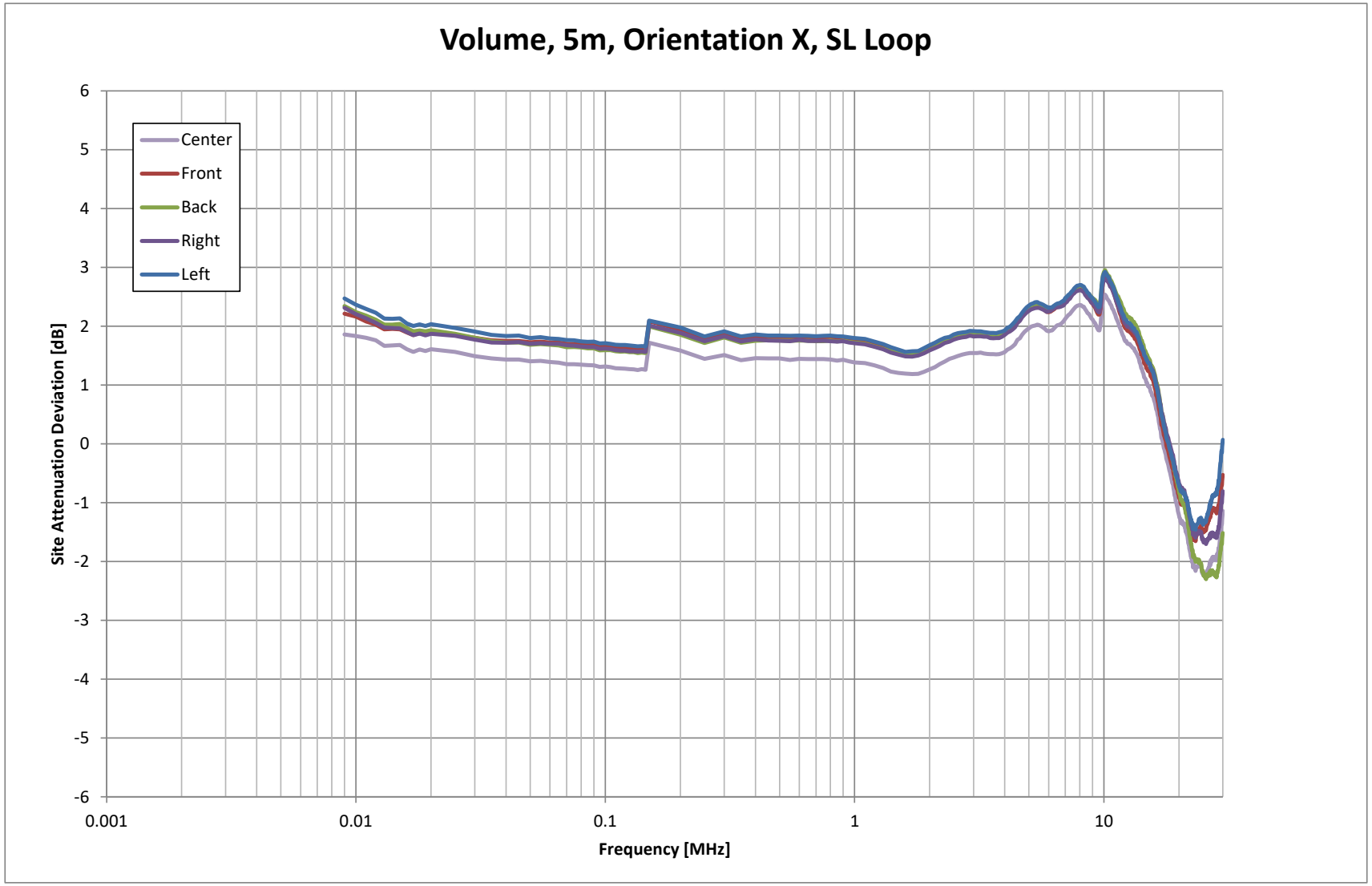
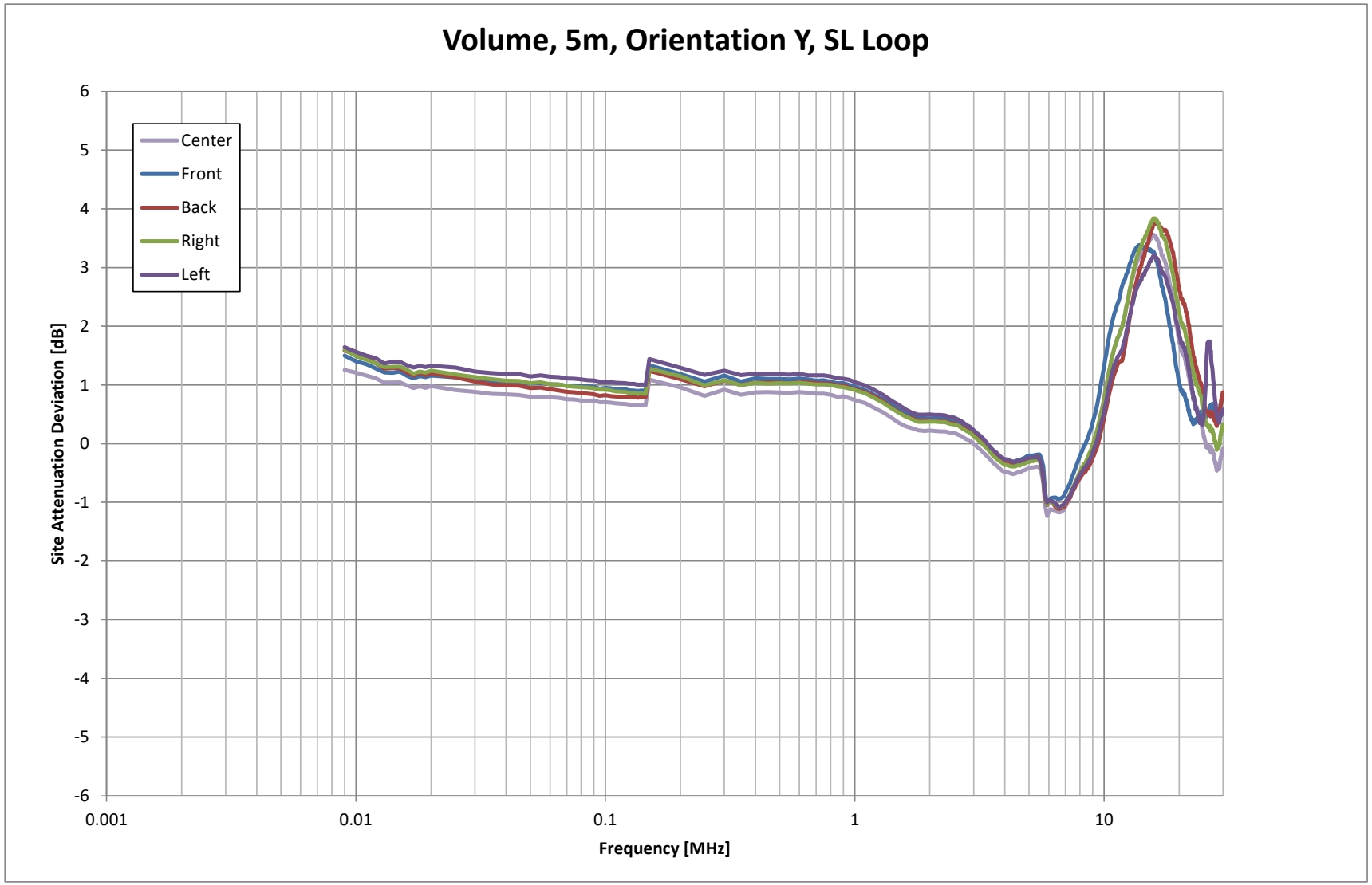
NSA 5M / QZ 3M

AlbatrossProjects



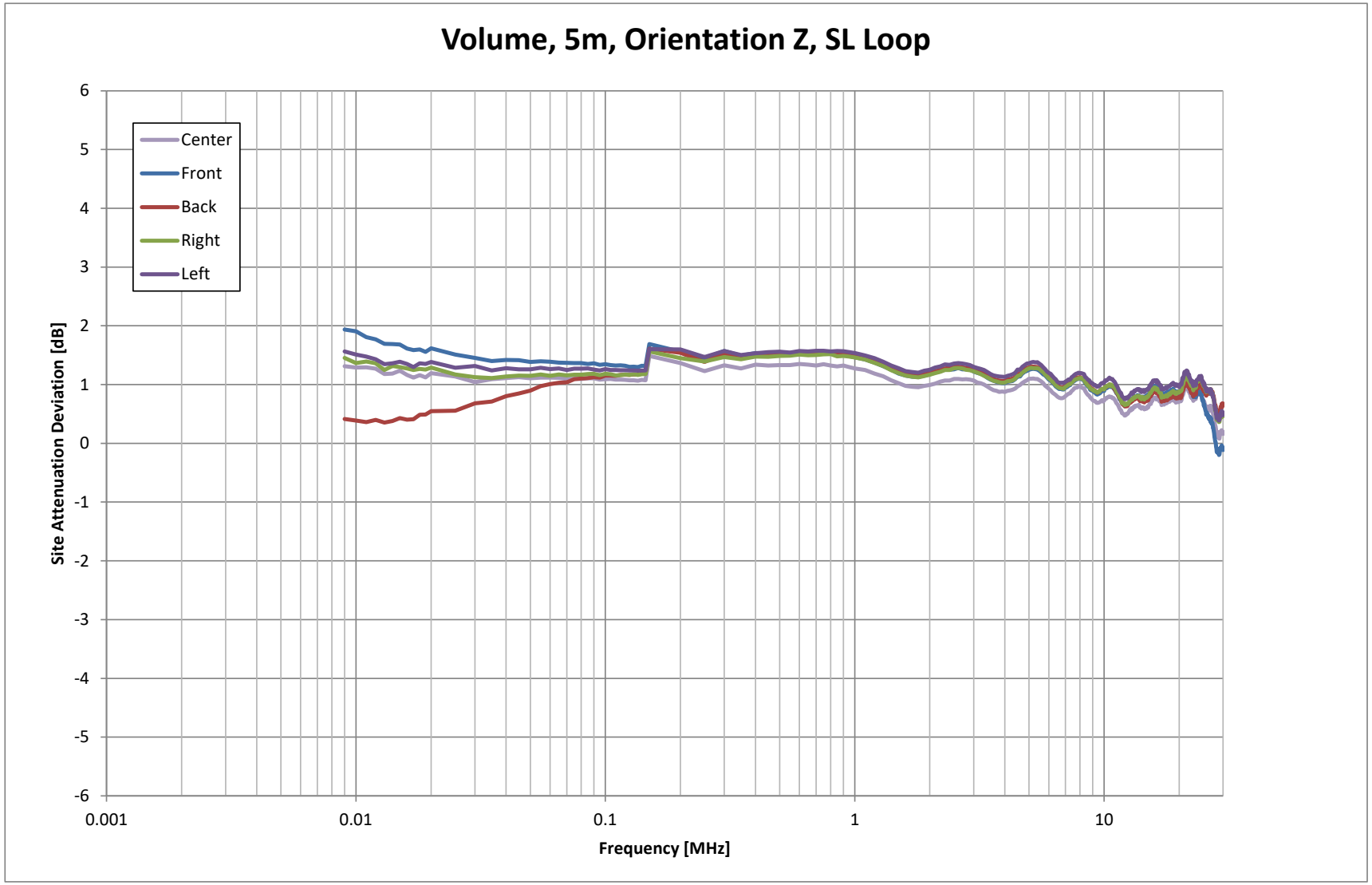
NSA 5M / QZ 3M

AlbatrossProjects

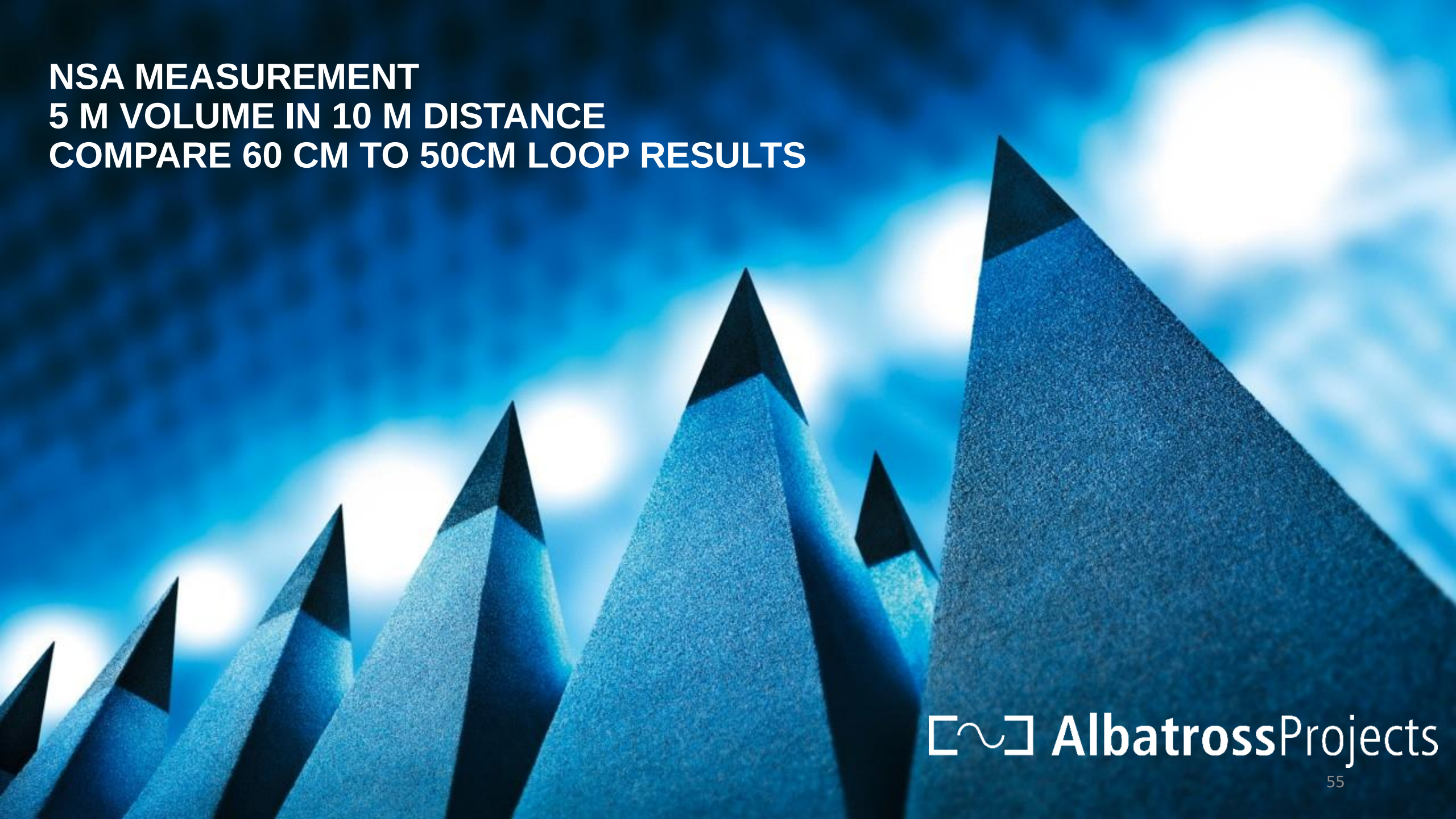


NSA 5M / QZ 3M

AlbatrossProjects



NSA MEASUREMENT
5 M VOLUME IN 10 M DISTANCE
COMPARE 60 CM TO 50CM LOOP RESULTS



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NSA 10M / QZ 5M

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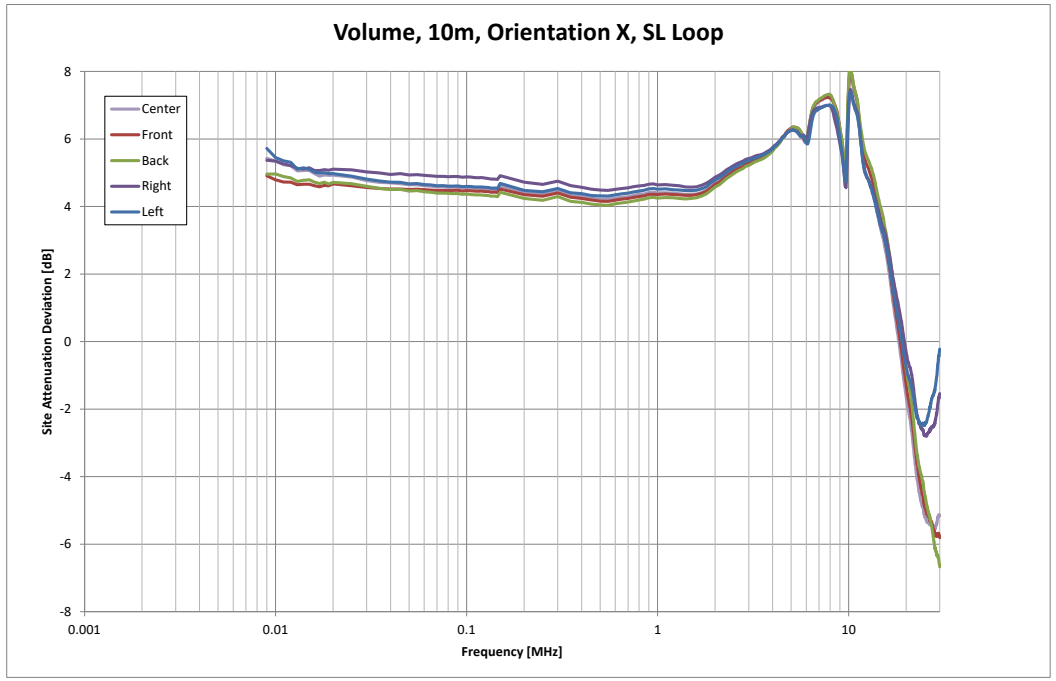
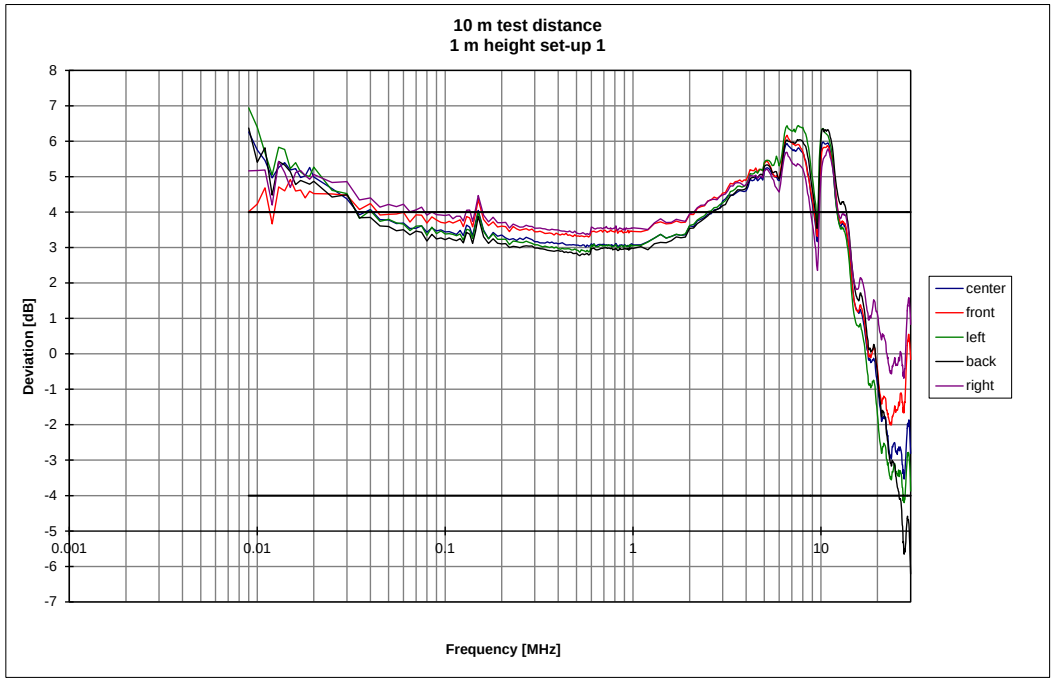
NSA measurement Comparison
of a 5 m volume in 10 m distance same test site, same axis 50 & 60 cm loops

60 cm (measurement 2016)



50 cm (Measurement RRT 2012, reference OATS)



NSA 10M / QZ 5M

AlbatrossProjects

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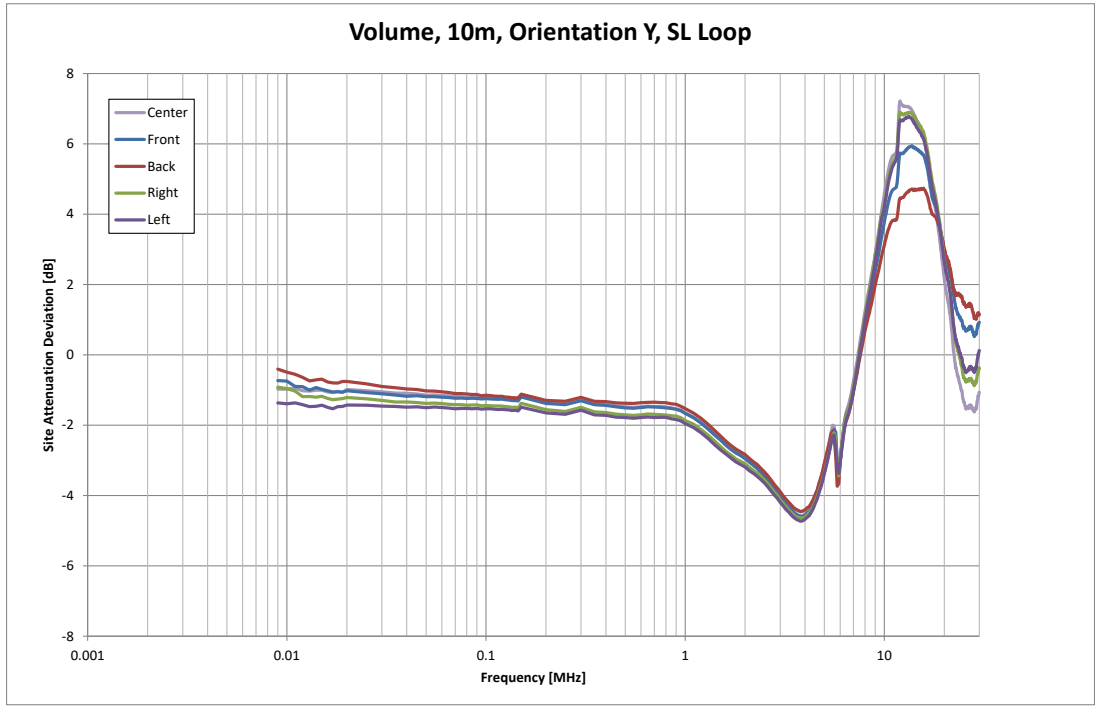
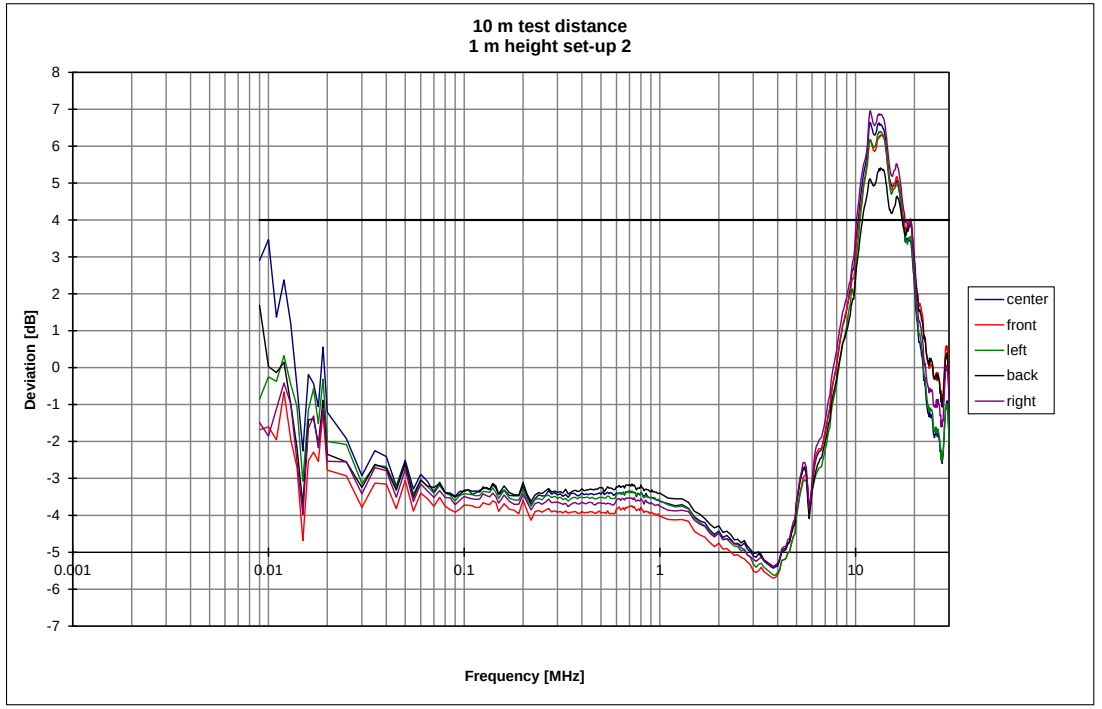


50 cm (Measurement RRT 2012, reference OATS)



NSA 10M / QZ 5M

AlbatrossProjects

NSA measurement Comparison
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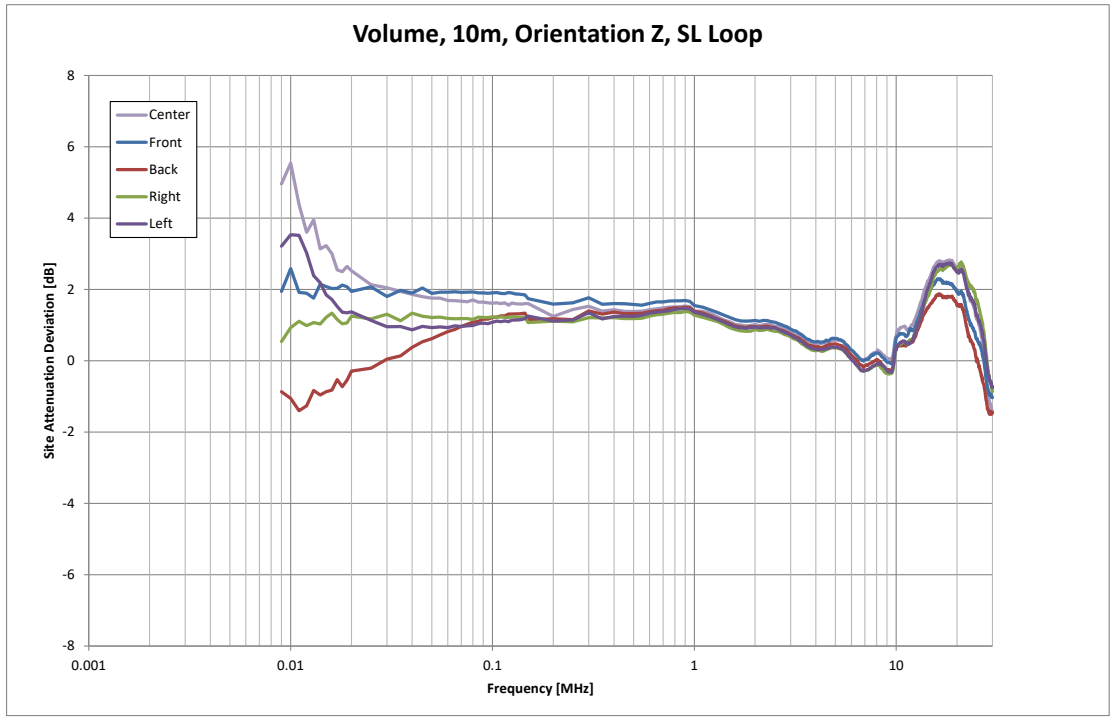
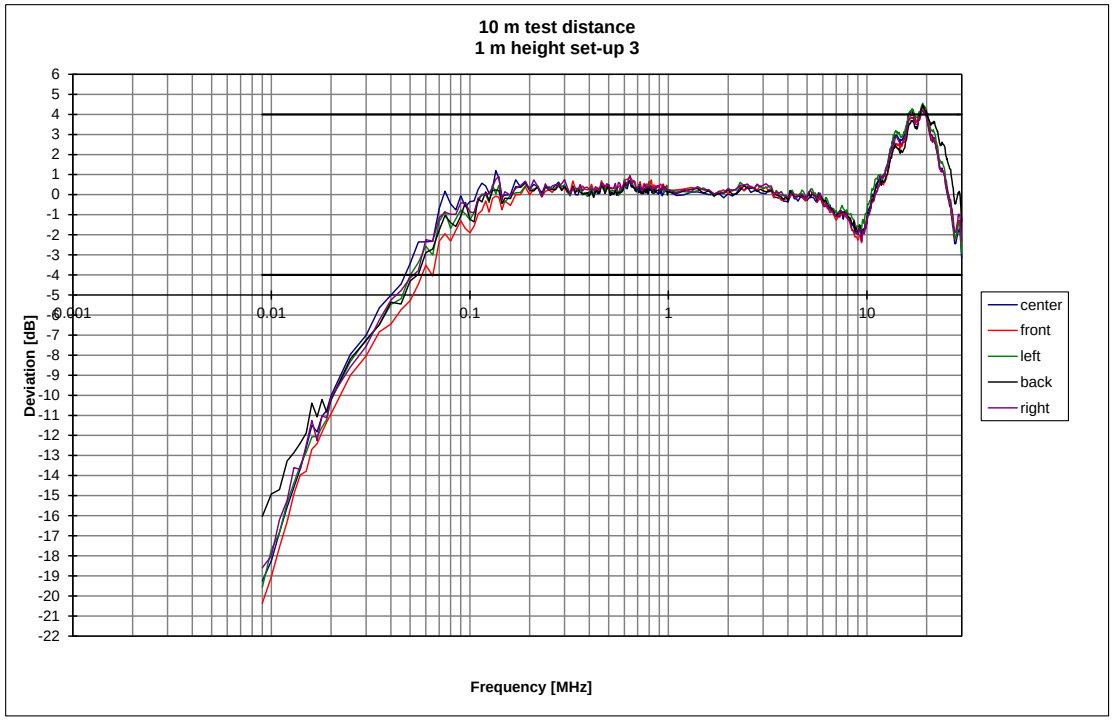


50 cm (Measurement RRT 2012, reference OATS)



CONCLUSIONS

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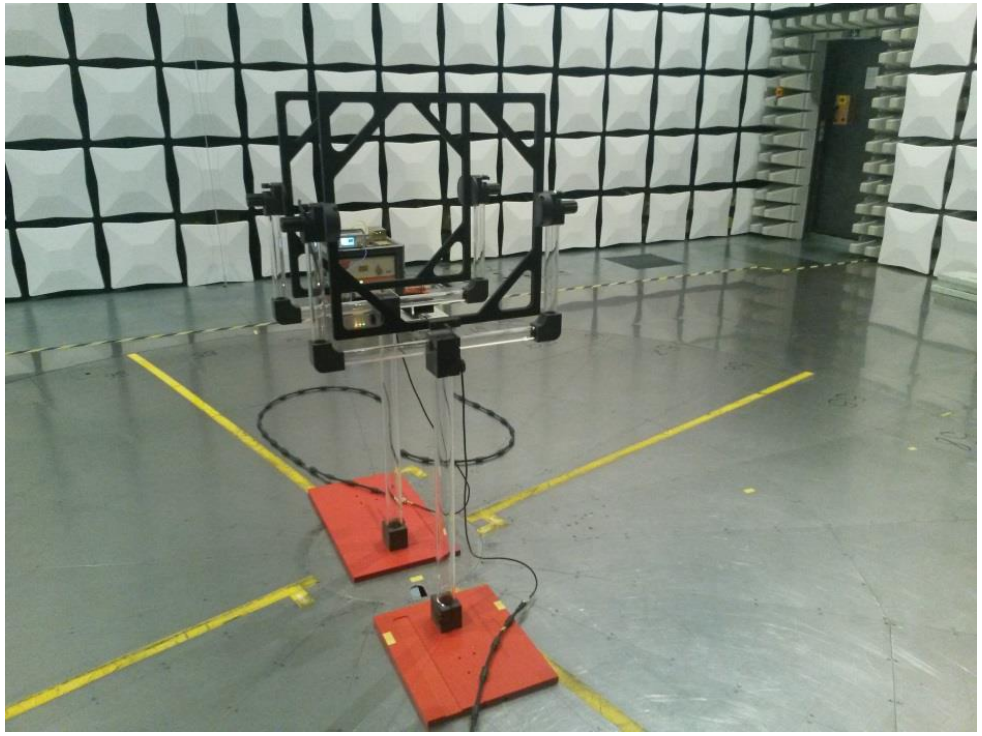
CONCLUSIONS #1 MEASUREMENTS

- **CISPR 16-1-4 Chamber Validation NSA**
  - 60 cm loops preferred antenna choice.
  - NSA ± 4 dB relaxed at 10m.
  - Non-Ferrite lined EMC Anechoic Chambers will not meet NSA ± 4 dB criteria at any distance.
  - Relaxing NSA ± 4 dB criteria for the 3 and 5m distance is being discussed.

- **CISPR 16-2-3 Disturbance Measurements**
  - Experience with product measurements is less well developed currently = > CISPR B work .



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CONCLUSIONS #2 STANDARDS

- **Technology changes** created concerns about protecting the radio spectrum below 30MHz 10 years ago.
- **New methods and criteria will be published end of 2020 early 2021 in CISPR 16**
- **CISPR Product standards will follow**
- **International standards** will also follow

Automotive

Household

ISM

Multimedia

ON THE SUITABILITY OF EMC ANECHOIC CHAMBERS IN THE FREQUENCY RANGE 9KHZ-30MHZ WITH LOOP ANTENNAS

R&S DEMYSTIFYING EMC, SILVERSTONE, UK
FEBRUARY 10, 2020

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Albatross Projects GmbH
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