

IEC 62232

International Standard



## Validation Report



Simplifying Your EMF Compliance

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## **VALIDATION REPORT FOR SURYAEM ENGINE ALGORITHM AS PER IEC 62232 STANDARD**

SuryaEM Engine is based on Cylindrical Spherical Computation algorithm, which is the most recommended Computation method on basis of Simplicity and Applicability as described in the latest international standard IEC 62232- TC106. SuryaEM Engine also incorporates selection of precomputed Uncertainty based on Confidence Interval of CI 95%, CI 80%, CI 50%, CI 20%, CI 5% .

The SuryaEM Engine can determine public and occupational non-compliance zones (Orthoslice and Exclusion Zone) very accurately and displays them in 2-D over a 3-D model.

The power density of the fields transmitted by omni-directional and sector-coverage base station antennas can be calculated using the cylindrical/spherical algorithms as defined in IEC 62232. The correctness of an implementation of these equations are verified here by comparing it against the results of IEC Benchmark problem presented in IEC 62232 in Annexure H.

### **INPUT PARAMETERS**

The input parameters for the calculation as listed in Annexure H of IEC 62232 are below:

<b>Mutual parameters:</b>	
Output power [W]	80
Array length [m]	2.158
Vertical beam width [degrees]	8
Electrical tilt [degrees]	5
<b>Omni-directional antenna:</b>	
Gain and Directivity [dBi]	11
Maximum side lobe gain [dBi]	-9
<b>Sector-coverage antenna:</b>	
Gain and Directivity [dBi]	17
Maximum side lobe gain [dBi]	-3.6
Horizontal beam width [degrees]	84

### **OBJECTIVE**

The calculations are first performed on a line along the direction of the main vertical beams using the cylindrical equations. The calculations are then performed on a line below the antennas on the x-y plane using the spherical equations.

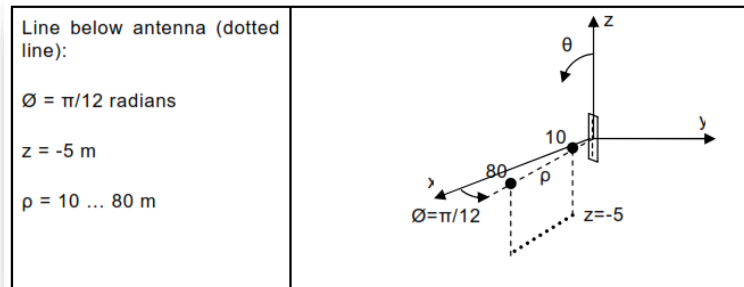
### **SELECTION CRITERIA FOR VALIDATION REPORT**

SuryaEM Engine has to match an implementation of both the cylindrical and spherical equations by checking that the results produced by the IEC 62232 implementation correlates within 1% with the results displayed in the following two sub-clauses.

## VALIDATION OF SPHERICAL EQUATIONS

The power densities has to be calculated along the dotted line described in below figure as per IEC 62232 using each of the four spherical equations.

Requested power density for adjusted and simple spherical equations



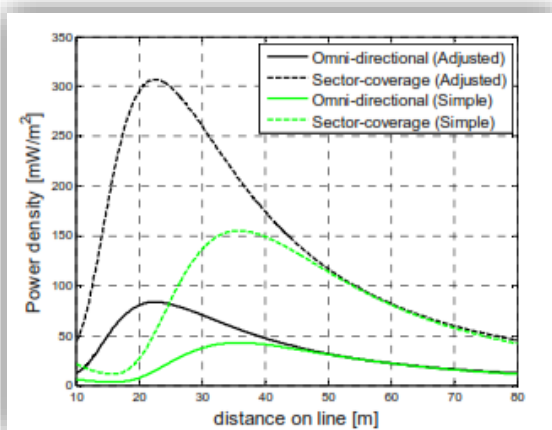
**IEC BENCHMARK** (phi 15° line)

Position x [m]	Adjusted		Simple	
	Omni-directional	Sector-coverage	Omni-directional	Sector-coverage
	Power density [mW/m <sup>2</sup> ]	Power density [mW/m <sup>2</sup> ]	Power density [mW/m <sup>2</sup> ]	Power density [mW/m <sup>2</sup> ]
10	12.2	43.3	6.41	22.2
20	80.3	295	7.37	26.5
30	70.9	260	37.4	136
40	47.6	175	41.1	150
50	32	117	31.4	114
60	22.4	82.2	22.3	81.1
70	16.3	60	15.9	57.8
80	12.4	45.4	11.6	42.1

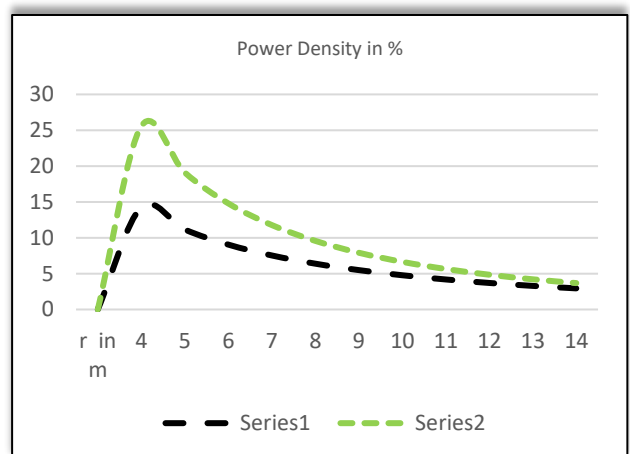
**SURYAEM RESULTS** (phi 15° line)

Sector-Coverage (Power density in %)				Match
Position R (m)	Adjusted	Simple	Validity	IEC Sample Result
5	0.700296	0.555789	0.700296	NA
10	0.433193	0.222316	0.433193	100% Match
15	1.808453	0.115852	1.808453	NA
20	2.945065	0.265295	2.945065	100% Match
25	2.998555	0.843455	2.998555	NA
30	2.604854	1.362655	2.604854	100% Match
35	2.147512	1.550638	2.147512	NA
40	1.747917	1.495086	1.747917	100% Match
45	1.426450	1.331621	1.42645	NA
50	1.174222	1.142681	1.174222	100% Match
55	0.976974	0.965143	0.976974	NA
60	0.821847	0.811422	0.821847	100% Match
65	0.698697	0.683077	0.683077	NA
70	0.599882	0.577577	0.577577	100% Match
75	0.519724	0.491297	0.491297	NA
80	0.454010	0.420693	0.420693	100% Match

**IEC BENCHMARK GRAPH** (phi 15° line)



**SURYAEM RESULTS GRAPH** (phi 15° line)

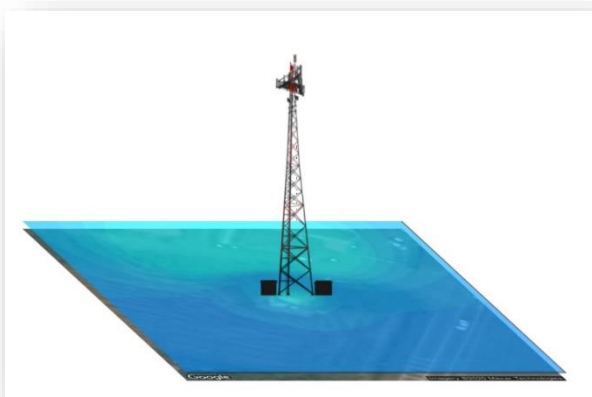


The power density of the fields transmitted by sectoral base station antennas in far field calculated using the spherical equations will lead to pictorial output of Orthoslice by SuryaEM Engine.

### **WHAT IS ORTHOSLICE?**

Colour representation in form of power density values calculated at every point in a plane of interest, expressed as a percentage of ICNIRP general public reference level with logarithmic legend. Results are shown as Orthoslice at 2m above ground level and/or roof top level considering the adult human height as 2m. The standard dimension/area of Orthoslice of 60mX60m is used.

### **SURYAEM ORTHOSLICE RESULTS FOR IEC BENCHMARK ANTENNA**



<b>Struct. ID</b>	Sample_GBT_001
<b>Site Name</b>	Sample Perdana
<b>Lat</b>	2.2403389999999925
<b>Long</b>	102.21431416931152
<b>No. of Antenna</b>	1
<b>Value</b>	<b>3.304%</b>

### **INFERENCE:**

SuryaEM results are matching 100% with Benchmark example by IEC 62232 in dotted line of  $\phi=15^\circ$ .  
SuryaEM Simulation for orthoslice with max value of 3.304% around 22m in line of  $\phi=0^\circ$  which can be conclusively extrapolated to IEC Benchmark results for within 1% discrepancy.

# VALIDATION OF CYLINDRICAL EQUATIONS

The power densities has to be calculated along the dotted line described in Table below using each of the four available cylindrical equations. The results are plotted in Figure A.

Table B — Requested power density for cylindrical equations

Line in main vertical beam (dotted line):  $\varnothing = \pi/12$ radians  $r = 4 \dots 20$ m  $\gamma = 5^\circ$ (electrical tilt)	
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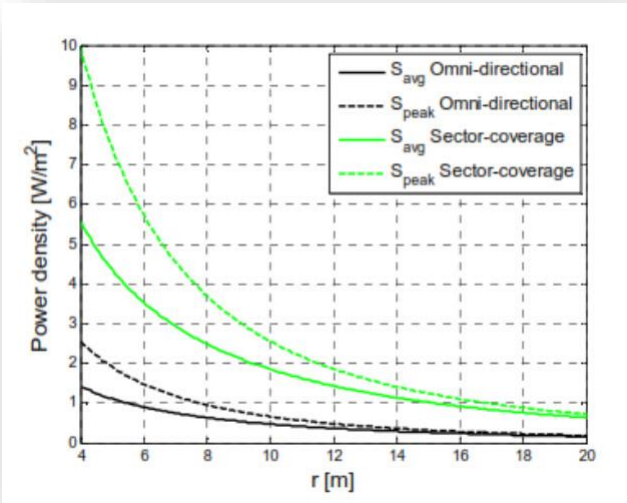
IEC BENCHMARK (phi 15° line)

Position  r [m]	Omni-directional		Sector-Coverage	
	$\bar{S}$	$\hat{S}$	$\bar{S}$	$\hat{S}$
	[W/m²]	[W/m²]	[W/m²]	[W/m²]
4	1.43	2.56	5.58	9.96
6	0.905	1.48	3.54	5.74
8	0.639	0.958	2.49	3.7
10	0.478	0.665	1.86	2.56
12	0.37	0.485	1.43	1.86
15	0.265	0.325	1.02	1.25
20	0.166	0.19	0.639	0.727

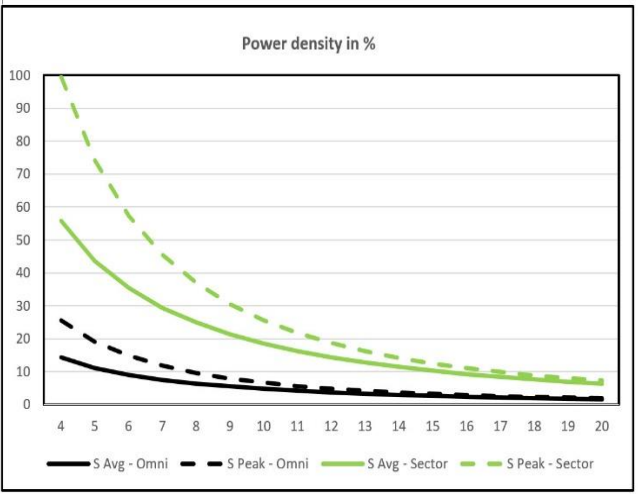
SURYAEM RESULTS (phi 15° line)

Position r gamma	Omni (Cylindrical)		Sector (Cylindrical)		Match IEC Sample Result
	S Avg	S Peak	S Avg	S Peak	
1	59.28937124	117.615768	232.561407	461.1407813	NA
2	29.40394204	56.9929478	115.285195	223.0888643	NA
3	19.3436105	36.2059329	75.7875742	141.3935461	NA
4	14.24823694	25.558793	55.7722161	99.55468801	100% Match
5	11.1473779	19.0946789	43.5864657	74.18541538	NA
6	9.051483234	14.7975785	35.3483865	57.3553441	100% Match
7	7.536416274	11.7776111	29.393815	45.55572568	NA
8	6.389698255	9.5726364	24.888672	36.96152159	100% Match
9	5.492709543	7.91598246	21.3669506	30.51937742	NA
10	4.773669721	6.6424885	18.5463538	25.57753863	100% Match
11	4.186335729	5.64465072	16.2447967	21.71252218	NA
12	3.699394622	4.84986491	14.338836	18.63894202	100% Match
13	3.290774624	4.20765821	12.7413719	16.15885922	NA
14	2.944402786	3.68209989	11.3889314	14.13168255	NA
15	2.648259634	3.24708948	10.2340313	12.45550243	NA
16	2.3931591	2.88333008	9.2403804	11.0551214	100% Match
17	2.171953174	2.57632961	8.37974737	9.874166144	NA
18	1.978995616	2.31505002	7.62984435	8.869767831	NA
19	1.809769543	2.0909758	6.97285507	8.008902027	NA
20	1.660622126	1.89746039	6.39438466	7.265825231	100% Match

IEC BENCHMARK GRAPH (phi 15° line)



SURYAEM RESULTS GRAPH (phi 15° line)



The power density of the fields transmitted by sectoral base station antennas in near field in the bore of sight of antenna calculated using the cylindrical equations will lead to pictorial output of Exclusion Zone by SuryaEM Engine.

### WHAT IS EXCLUSION ZONE?

Area around an antenna or antennas where the RF field values emanating from the antennas exceed the ICNIRP public guidelines (public exclusion zone) or the ICNIRP occupational guidelines (occupational exclusion zone).

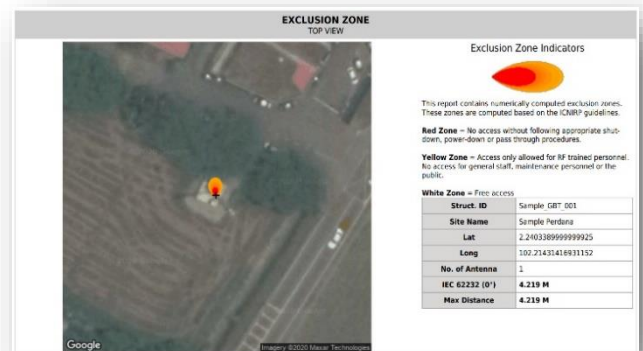
- Red zone indicates Occupational Exclusion Zone no access without following appropriate shut-down, power-down or pass through procedures.
- Yellow zone indicates Public Exclusion Zone with no access to general public. Only allowed for RF trained Occupational personnel.
- White zone is safe and free access to everybody.

### SURYAEM EXCLUSION ZONE RESULTS FOR IEC BENCHMARK ANTENNA

#### IEC BENCHMARK (phi 0°)

Sector Cylindrical (varying Phi)	Exclusion Distance
0	4.270172782
5	4.237933864
15	3.985973699
0	3.774148514

#### SURYAEM RESULTS (phi 0°)



### INFERENCE:

SuryaEM results are matching 100% with Benchmark example by IEC 62232 in dotted line of phi=15. The Exclusion Zone Distance as simulated by SuryaEM is at 4.219m in line of phi= 0 which can be conclusively extrapolated to results for within 1% discrepancy of IEC Benchmark.

SuryaEM Engine computations **EXACTLY** matches both the cylindrical and spherical equations results produced by the IEC 62232 implementation. It correlates within 1% with the results displayed in the following two sub-clauses of IEC 62232 Annexure.

### **SURYAEM ENGINE**



**AGAINST IEC BENCHMARK PROBLEM**

**AS PER IEC 62232 INTERNATIONAL STANDARD**