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FM Translator K225CG
Santa Maria, California
RF Exposure Study

Facilities Constructed

K225CG has been constructed on Channel 225D (92.9 MHz) with a maximum lobe effective radiated power of 250 watts. The construction permit bears a condition requiring that RF warning signs be posted at appropriate intervals, and that access be restricted to prevent the exposure of humans to RF emissions in excess of FCC guidelines.

The undersigned has performed calculations based on the methodology described in OET Bulletin No. 65, and concludes that no access restrictions or warning signs are warranted in this particular situation. Consequently, these calculations are submitted to satisfy the requirements of the CP.

RF Exposure Calculations

The power density calculations shown below were made using the techniques outlined in OET Bulletin No. 65. "Ground level" calculations in this report have been made at a reference height of 2 meters above ground to provide a worst-case estimate of exposure for persons standing on the ground in the vicinity of the tower. The equation shown below was used to calculate the ground level power density figures from each antenna.

$$S(\mu W / cm^2) = \frac{33.40981 \times AdjERP(Watts)}{D^2}$$

Where: *AdjERP(Watts)* is the maximum lobe effective radiated power times the element pattern factor times the array pattern factor.

D is the distance in meters from the center of radiation to the calculation point.

Ground level power densities have been calculated for locations extending from the base of the tower to a distance of 1000 meters. Values past this point are increasingly negligible.

The antenna used by K225CG is a single Scala CA2-V dipole-reflector. Use of the ring-stub/dipole element model in FMModel would overstate the ground-level power densities produced by this

antenna by a considerable margin. Included with this Engineering Statement is a complete tabulation of the Scala CA2-V vertical plane radiation pattern as provided by Scala (the antenna manufacturer) along with the calculated ground-level power density from the antenna at 1 meter increments from the antenna. A sample calculation is provided to demonstrate that these calculations were performed correctly using appropriate mathematical principles and the formula from OET Bulletin No. 65. The highest calculated ground level power density from K225CG occurs at a distance of 9 meters from the base of the antenna support structure. At this point the power density is calculated to be $31.9 \mu\text{W}/\text{cm}^2$, which is 16% of $200 \mu\text{W}/\text{cm}^2$ (the FCC standard for uncontrolled environments).

Calculations of the power density produced by K225CG and the other stations at this transmitter site are summarized in the following table:

Call	Avg or Peak ERP Antenna Model	Height AGL	Calculated Max Exposure	Gen Pop FCC Limit	% of Limit
K225CG 225D	0.250 kW V SCA CA2V	9 m	$31.9 \mu\text{W}/\text{cm}^2$	$200 \mu\text{W}/\text{cm}^2$	16.0%
KLMM 231A	0.340 kW H 0.340 kW V ERI LP-4C-HW 4-bay 0.5-wave Type 3	FMMModel Type 3 27 m	$0.9 \mu\text{W}/\text{cm}^2$	$200 \mu\text{W}/\text{cm}^2$	0.5%
KRTO 246A	0.360 kW H 0.360 kW V AC T2M 2-bay 0.6-wave	FMMModel Type 1 13 m	$17.1 \mu\text{W}/\text{cm}^2$	$200 \mu\text{W}/\text{cm}^2$	8.5%
K254CA 254D CP	0.010 kW H 0.010 kW V Bext TFC2K 1-bay	FMMModel Type 2 15 m	$1.1 \mu\text{W}/\text{cm}^2$	$200 \mu\text{W}/\text{cm}^2$	0.6%
K233CQ 275D CP	0.091 kW H 0.091 kW V SCA HDCA5CP	FMMModel Type 1 20 m	$11.3 \mu\text{W}/\text{cm}^2$	$200 \mu\text{W}/\text{cm}^2$	5.7%
KDFS-CD Ch30	14.4 kW H BOG B16UA	0.150 relative field assumed 11 m	$133.6 \mu\text{W}/\text{cm}^2$	$377 \mu\text{W}/\text{cm}^2$	35.4%
Total 66.7% of the General Population MPE					

(For TV translators, LPTV, and Class A TV, the relative field value indicated is the maximum value which occurs at 45 degrees or more below the horizontal, based on the manufacturer's vertical plane pattern. The resulting adjusted ERP value is assumed to be radiated straight down to a point 2 meters above ground level at the base of the tower.)

These calculations show that the maximum calculated power density produced at two meters above ground level by the proposed operation of K225CG and the present operation of the other stations

licensed and authorized at this site (were their maxima to coincide, which they do not) is 66.7% of the FCC standard for uncontrolled environments.

The permittee/licensee in coordination with other users of the site must reduce power or cease operation as necessary to protect persons having access to the site, tower or antenna from radiofrequency exposure in excess of FCC guidelines.

July 15, 2016



Erik C. Swanson, P.E.

Sample Calculation for Single Scala CA2-V antenna

At 9 meters from the base of the antenna support structure, the slant distance to a point 2 meters above ground level is 11.4 meters. This is determined by simple trigonometry, determining the length of the hypotenuse for a right triangle which is 9 meters along the base and 7 meters in height (7 meters being the antenna height above ground, less 2 meters):

$$a^2 + b^2 = c^2$$

$$9^2 + 7^2 = c^2$$

$$c = 11.4 \text{ meters} = \text{hypotenuse}$$

The corresponding depression angle is identical to the angle between the base and hypotenuse, and is determined here as the inverse of the sine of the height over the hypotenuse of the right triangle:

$$\sin(\text{angle}) = \text{opposite} / \text{hypotenuse}$$

$$\sin(\text{angle}) = 7 / 11.4$$

$$\sin(\text{angle}) = 0.6140$$

$$\text{angle} = 37.87 \text{ degrees}$$

From the vertical plane pattern tabulation for the Scala CA2-V antenna, the relative field value at a depression angle of 37 degrees is 0.717, and at a depression angle of 38 degrees is 0.703. Interpolating between these two, we arrive at a relative field value of 0.705 at a depression angle of 37.87 degrees. We use this relative field value to arrive at the adjusted ERP in watts at the depression angle:

$$\text{adjusted ERP} = (\text{watts H} + \text{watts V}) (\text{relative field squared})$$

$$\text{adjusted ERP} = (0 + 250) (0.705^2)$$

$$\text{adjusted ERP} = 124.2 \text{ watts}$$

By plugging this value into the formula from OET Bulletin 65, we arrive at the calculated ground-level power density:

$$S(\mu\text{W} / \text{cm}^2) = \frac{33.40981 \times \text{AdjERP}(\text{Watts})}{D^2}$$

Where: *AdjERP(Watts)* is the maximum lobe effective radiated power times the element pattern factor times the array pattern factor.

D is the distance in meters from the center of radiation to the calculation point.

Thus, for an adjusted ERP of 124.2 watts and a slant distance of 11.4 meters, *S* is calculated to equal 31.9 $\mu\text{W}/\text{cm}^2$.

Vertical Plane Radiation Pattern for Scala CA2-V Antenna
Downloaded from Kathrein Scala Pattern & Download Library

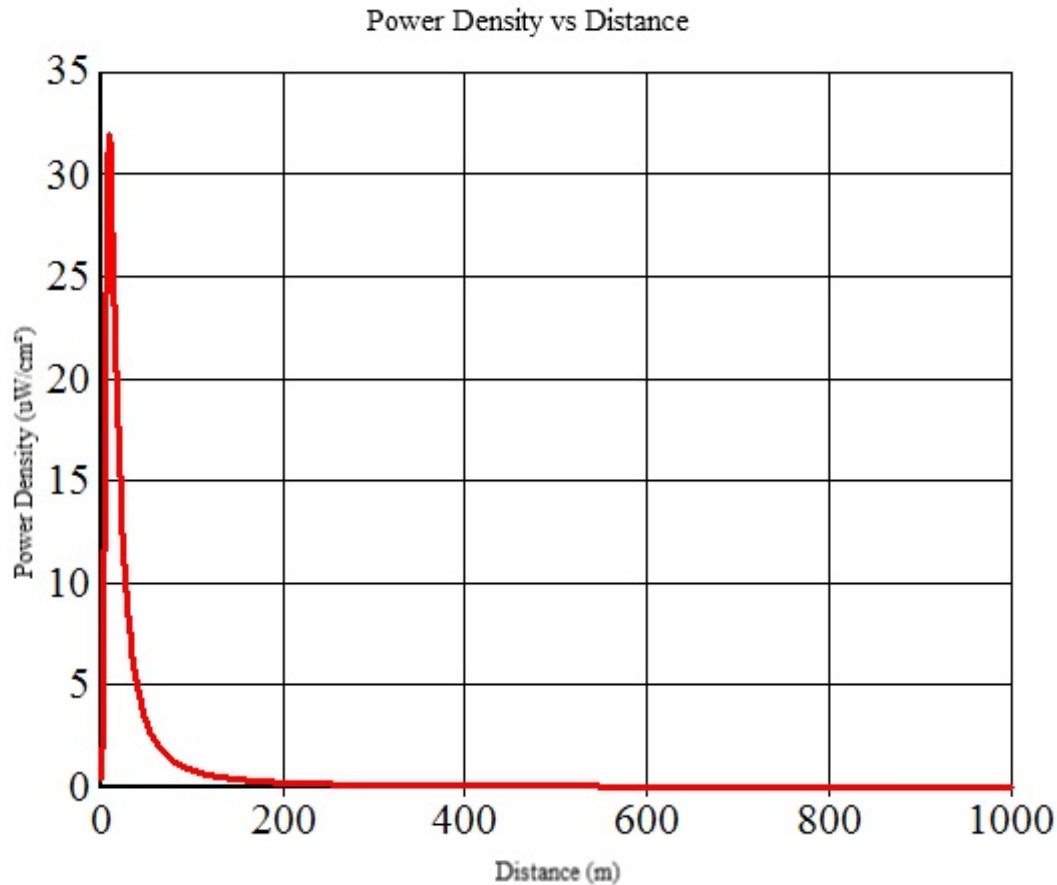
Depression Angle	Relative Field		
0	1.000	46	0.578
1	0.998	47	0.561
2	0.997	48	0.544
3	0.994	49	0.527
4	0.992	50	0.510
5	0.990	51	0.494
6	0.989	52	0.478
7	0.985	53	0.462
8	0.982	54	0.446
9	0.979	55	0.430
10	0.978	56	0.413
11	0.974	57	0.396
12	0.971	58	0.379
13	0.965	59	0.362
14	0.961	60	0.345
15	0.957	61	0.329
16	0.950	62	0.313
17	0.940	63	0.297
18	0.932	64	0.281
19	0.924	65	0.265
20	0.915	66	0.250
21	0.905	67	0.235
22	0.895	68	0.220
23	0.885	69	0.205
24	0.875	70	0.190
25	0.865	71	0.177
26	0.854	72	0.164
27	0.842	73	0.151
28	0.831	74	0.138
29	0.819	75	0.125
30	0.808	76	0.115
31	0.795	77	0.105
32	0.783	78	0.095
33	0.770	79	0.085
34	0.757	80	0.075
35	0.745	81	0.071
36	0.731	82	0.067
37	0.717	83	0.063
38	0.703	84	0.059
39	0.689	85	0.055
40	0.675	86	0.054
41	0.659	87	0.053
42	0.643	88	0.052
43	0.627	89	0.051
44	0.611	90	0.050
45	0.595		

Santa Maria 225D

Ground-Level Power Density Calculations

Using Manufacturer's Vertical Plane Pattern

Antenna CA2V
 ERP 0 Watts H (avg)
 250 Watts V (avg)
 Antenna AGL 9 meters less 2m is 7 meters above the reference plane
 Calculated
 Maximum is 31.92 uW/cm² at 9 meters from the tower



Distance From Tower (meters)	Hypotenuse (meters)	Depression Angle (degrees)	Interp Rel Field	Adjusted ERP (watts)	Power Density uW/cm ²
0	7.00	90.00	0.050	0.6	0.43
1	7.07	81.87	0.068	1.1	0.76
2	7.28	74.05	0.137	4.7	2.97
3	7.62	66.80	0.238	14.2	8.15
4	8.06	60.26	0.341	29.1	14.94
5	8.60	54.46	0.439	48.1	21.72
6	9.22	49.40	0.520	67.7	26.60
7	9.90	45.00	0.595	88.5	30.17
8	10.63	41.19	0.656	107.6	31.82
9	11.40	37.87	0.705	124.2	31.92
10	12.21	34.99	0.745	138.7	31.10
11	13.04	32.47	0.777	151.0	29.67
12	13.89	30.26	0.805	161.9	28.03
13	14.76	28.30	0.827	171.1	26.23

14	15.65	26.57	0.847	179.5	24.48
15	16.55	25.02	0.865	187.0	22.80
16	17.46	23.63	0.879	193.0	21.15
17	18.38	22.38	0.891	198.7	19.64
18	19.31	21.25	0.902	203.6	18.23
19	20.25	20.22	0.913	208.3	16.97
20	21.19	19.29	0.921	212.1	15.79
21	22.14	18.43	0.928	215.5	14.69
22	23.09	17.65	0.935	218.5	13.69
23	24.04	16.93	0.940	221.1	12.78
24	25.00	16.26	0.947	224.2	11.98
25	25.96	15.64	0.952	226.7	11.24
26	26.93	15.07	0.957	228.8	10.54
27	27.89	14.53	0.959	229.8	9.87
28	28.86	14.04	0.960	230.6	9.25
29	29.83	13.57	0.962	231.6	8.69
30	30.81	13.13	0.964	232.5	8.18
31	31.78	12.72	0.966	233.5	7.72
32	32.76	12.34	0.969	234.6	7.30
33	33.73	11.98	0.971	235.5	6.91
34	34.71	11.63	0.972	236.1	6.55
35	35.69	11.31	0.973	236.6	6.20
36	36.67	11.00	0.974	237.1	5.89
37	37.66	10.71	0.975	237.7	5.60
38	38.64	10.44	0.976	238.3	5.33
39	39.62	10.18	0.978	238.9	5.08
40	40.61	9.93	0.978	239.3	4.85
41	41.59	9.69	0.979	239.5	4.62
42	42.58	9.46	0.979	239.6	4.42
43	43.57	9.25	0.979	239.7	4.22
44	44.55	9.04	0.979	239.8	4.04
45	45.54	8.84	0.980	240.0	3.87
46	46.53	8.65	0.980	240.2	3.71
47	47.52	8.47	0.981	240.4	3.56
48	48.51	8.30	0.981	240.6	3.42
49	49.50	8.13	0.981	240.8	3.28
50	50.49	7.97	0.982	241.0	3.16
51	51.48	7.82	0.982	241.3	3.04
52	52.47	7.67	0.983	241.5	2.93
53	53.46	7.52	0.983	241.8	2.83
54	54.45	7.39	0.984	242.0	2.73
55	55.44	7.25	0.984	242.2	2.63
56	56.44	7.13	0.985	242.4	2.54
57	57.43	7.00	0.985	242.6	2.46
58	58.42	6.88	0.986	242.8	2.38
59	59.41	6.77	0.986	243.0	2.30
60	60.41	6.65	0.986	243.2	2.23
61	61.40	6.55	0.987	243.4	2.16
62	62.39	6.44	0.987	243.6	2.09
63	63.39	6.34	0.987	243.7	2.03
64	64.38	6.24	0.988	243.9	1.97
65	65.38	6.15	0.988	244.1	1.91
66	66.37	6.05	0.988	244.2	1.85
67	67.36	5.96	0.989	244.3	1.80
68	68.36	5.88	0.989	244.4	1.75
69	69.35	5.79	0.989	244.4	1.70
70	70.35	5.71	0.989	244.5	1.65
71	71.34	5.63	0.989	244.5	1.60
72	72.34	5.55	0.989	244.6	1.56
73	73.33	5.48	0.989	244.6	1.52

74	74.33	5.40	0.989	244.6	1.48
75	75.33	5.33	0.989	244.7	1.44
76	76.32	5.26	0.989	244.7	1.40
77	77.32	5.19	0.989	244.8	1.37
78	78.31	5.13	0.990	244.8	1.33
79	79.31	5.06	0.990	244.8	1.30
80	80.31	5.00	0.990	244.9	1.27
81	81.30	4.94	0.990	244.9	1.24
82	82.30	4.88	0.990	245.0	1.21
83	83.29	4.82	0.990	245.1	1.18
84	84.29	4.76	0.990	245.1	1.15
85	85.29	4.71	0.990	245.2	1.13
86	86.28	4.65	0.990	245.3	1.10
87	87.28	4.60	0.991	245.3	1.08
88	88.28	4.55	0.991	245.4	1.05
89	89.27	4.50	0.991	245.4	1.03
90	90.27	4.45	0.991	245.5	1.01
91	91.27	4.40	0.991	245.6	0.98
92	92.27	4.35	0.991	245.6	0.96
93	93.26	4.30	0.991	245.7	0.94
94	94.26	4.26	0.991	245.7	0.92
95	95.26	4.21	0.991	245.8	0.90
96	96.25	4.17	0.992	245.8	0.89
97	97.25	4.13	0.992	245.9	0.87
98	98.25	4.09	0.992	245.9	0.85
99	99.25	4.04	0.992	246.0	0.83
100	100.24	4.00	0.992	246.0	0.82